ملازمنا

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ملزمة

Physics

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الفيزياء

الرابع متميزين

باللغتين
العربية والانكليزية
ثنائي اللغة

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CHAPTER 1 الفصل الاول

BASIC PARAMETERS
IN
PHYSICS

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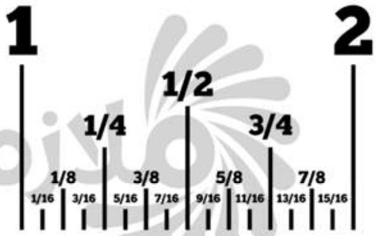
CHAPTER 1

BASIC PARAMETERS IN PHYSICS

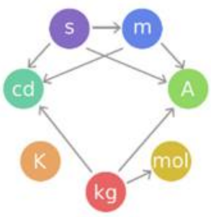


Measurement القياس

Measurement is a way to describe the word with number.

Measurement is the assignment of a number to a characteristic of an object or event, which can be compared with other objects or events

The SI Systems of Units النظام الدولي للوحدات



The group of internationally accepted standard units is called the metric system or 'the international system'. abbreviated as SI from *'Le Système* International' d 'Unites' in French. in this system. each measurement is a comparison with the fundamental SI unit of the related quantity. By expressing the length of an object to be. say, 7.5 metres you are uctuully making a comparison. Everybody acknowledges the length ofthe room to be 7.5 times as long as the fundamenttal unit of length, defined as 1.0 metre.

تسمى مجموعة الوحدات القياسية المقبولة دوليًا النظام المتري أو "النظام الدولي". يختصر SI من *Le Système* International' d 'Unites' باللغة الفرنسية. في هذا النظام. كل قياس هو مقارنة مع وحدة SI الأساسية للكمية ذات الصلة. من خلال التعبير عن طول كائن ليكون. أقول ، 7.5 متر كنت تجري مقارنة بدقة. يقر الجميع بأن طول الغرفة يبلغ 7.5 أضعاف طول الوحدة الأساسية ، والمعروفة بأسم 1.0 متر.

Quantity	*Name*	*Symbol*
Length	Meter	M
Mass	Kilogram	Kg
Time	Second	S
amount of substance	Mole	Mol
temperature	Kelvin	K
electric current	Ampere	A
luminous intensity	Candela	Cd

Prefixes البادئات

Standard prefixes are used for very large or very small quantities. The mort common ones are shown in table below: For example, the frequency of an FM radio band, 102.8×10^6 Hertz, is abbreviated as 102.8 MHz (mega-hertz). A honey bee flaps its wings once every 0.004 s or $4x10^{-3}$ s. which can be abbreviated as 4 ms (milliseconds.)

تستخدم البادئات القياسية لكميات كبيرة جداً أو صغيرة جداً. تظهر الأشكال الشائعة الشائعة في الجدول أدناه: على سبيل المثال ، يتم اختصار تردد نطاق راديو FM، 102.8 x 10^6 Hertz ، على ان 102.8 MHz (mega-hertz) . نحلة العسل ترفرف بجناحيها مرة واحدة كل 0.004 ثانية أو 4s $x10^{-3}$. والتي يمكن اختصارها إلى 4 مللي ثانية (مللي ثانية).

Standard prefixes for the SI units of measure

Multiples	**Prefix name**		deca	hecto	kilo	mega	giga	tera	peta	exa	zetta	yotta
	Prefix symbol		da	h	K	M	G	T	P	E	Z	Y
	Factor	10^0	10^1	10^2	10^3	10^6	10^9	10^{12}	10^{15}	10^{18}	10^{21}	10^{24}
Fractions	**Prefix name**		deci	centi	milli	micro	nano	pico	femto	atto	zepto	yocto
	Prefix symbol		d	C	M	μ	n	p	f	a	z	Y
	Factor	10^0	10^{-1}	10^{-2}	10^{-3}	10^{-6}	10^{-9}	10^{-12}	10^{-15}	10^{-18}	10^{-21}	10^{-24}

Radian: it's a central angle opposite to the arc, its length equals to radius of the circle.

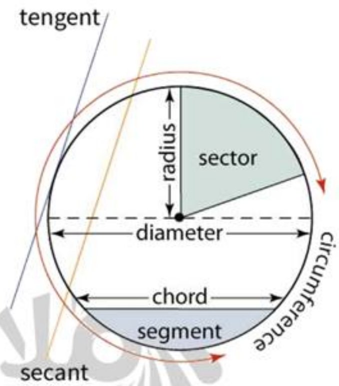
الزاوية النصف قطرية: هي الزاوية المركزية المقابلة لقوس طوله يساوي نصف قطر الدائرة.

Circumference of a circle opposite to the radian (2π rad) **محيط الدائرة يقابل زاوية نصف قطرية**

$$2\pi\, rad = \frac{2\pi\, r}{r} \qquad 1\, rad = \frac{360^\circ}{2\pi} = 57.3^\circ$$

Solid angle: it is a central solid angle that opposite a part of a spherical surface with an area equal to squrare radius of that ball, it is measured in units (**Sr**).

الزاوية المجسمة : هي الزاوية المركزية المجسمة التي تقابل جزء من سطح كروي مساحته بقدر مربع نصف قطر تلك الكرة وتقدر بوحدة Sr



$$\frac{4\pi\, r^2}{r^2} = 4\pi\ Sr$$

errors in measurementsأخطاء في القياسات

Experimental work is never free of error. Experimental errors that are inv- loved in each measuring process would make experimental measurements in acu- rate, nonprecise, or both. Although it is impossible to avoid experimental errors completely, yet it is very important to try to minimize them in order to obtain the best results. Experimental measurement errors are two types: human error and instrumental error.

العمل التجريبي لا يخلو من الأخطاء. من شأن الأخطاء التجريبية التي يتم حبها في كل عملية قياس إجراء قياسات تجريبية في الدقة أو عدم الدقة أو كليهما. على الرغم من أنه من المستحيل تجنب الأخطاء التجريبية تمامًا ، إلا أنه من المهم جدًا محاولة تقليلها إلى الحد الأدنى للحصول على أفضل النتائج. أخطاء القياس التجريبية نوعان: خطأ بشري وخطأ الاداة.

Personal (Human) errorخطأ بشري

Human error can occur, for example, ifa mistake is made in reading an instrumemt or recording the results. One way to avoid human error is to take repeated measurements to be certain they are consistent, and to put strict rules for measuring techniques.

يمكن أن يحدث خطأ بشري، على سبيل المثال، إذا حدث خطأ في قراءة أداة أو تسجيل النتائج. تتمثل إحدى طرق تجنب الخطأ البشري في أخذ قياسات متكررة للتأكد من أنها متسقة، ووضع قواعد صارمة لتقنيات القياس.

Instrumental error خطأ في جهاز القياس

If the balance or the meter stick arc not correct, thcy lcad to an error in measurements. so, measuring instruments must be chosen very carefully, and must be in good condition.

إذا كان التوازن أو عصا قوس العداد غير صحيح، فقم بإدخال خطأ في القياسات. لذلك، يجب اختيار أدوات القياس بعناية فائقة، ويجب أن تكون في حالة جيدة.

Graphالرسم البياني

Graphs considered one of the favorite ways to get the arithmetic mean for a number to readings. To illustrate the relation between two experimentally variables prefer plot graphic chart. And graph can be used in many cases to conclude the mathematical relation connect these two variables, in addition to determining the constants values from the graph.

تعد الرسوم البيانية من الطرائق المفضلة للحصول على المتوسط الحسابي لعدد من القراءات بصورة جيدة. ولتوضيح العلاقة بيم متغيرين تجريباً يفضل رسم تخطيط بياني، ويمكن استعمال الرسم البياني في كثير من الحالات لأستنباط علاقة رياضية تربط هذين المتغرين، اضافة الى تحديد قيم الثوابت من الرسم البياني.

To Plot a Graph requires the following:

1. Determining the origin point in a proper location on the graph paper (0,0).

2. Drawing the two perpendicular axes from the origin point so the horizontal axis represents the (x-axis) and the vertical axis represent the (y-axis).

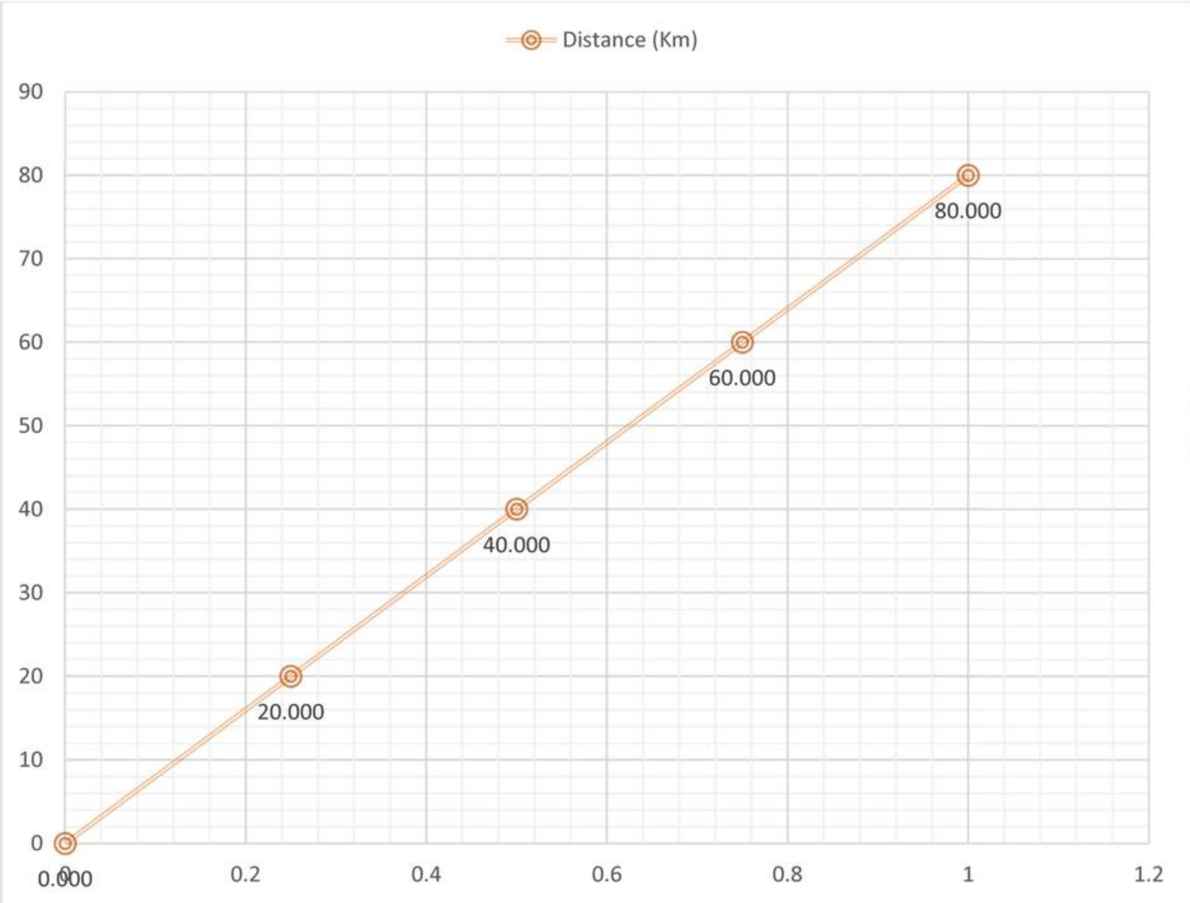
3. Selecting proper scale drawing for each axis alone or for two of them together according to readings that have been collected for purpose benfit from graph paper that you have.

4. its berter to use even number for the scales drawing.

يتطلب رسم الرسم البياني ما يلي:

1. تحديد نقطة الأصل في مكان مناسب على ورقة الرسم البياني (0،0).
2. ارسم محورين عموديين من نقطة الأصل بحيث يمثل المحور الأفقي (المحور س) ويمثل المحور العمودي (المحور ص).
3. اختيار رسم المقياس المناسب لكل محور بمفرده أو لاثنين منهم معًا وفقًا للقراءات التي تم جمعها للغرض المستفيد من ورقة الرسم البياني التي لديك.
4. من الأفضل استخدام رقم زوجي للرسم المقاييس.

Distance (Km)	Time (s)
20	0.25
40	0.5
60	0.75
80	1



$$m = \frac{\Delta y}{\Delta x}$$

$$v = \frac{d_2 - d_1}{t_2 - t_1} = m$$

$$v = \frac{100 - 20}{1.25 - 0.25} = \frac{80}{1} = 80km/h$$

Direct proportion and Inverse proportion for physical quantities

Direct proportion:

$$\frac{a_1}{b_1} = \frac{a_2}{b_2} = \frac{a_3}{b_3} \ldots\ldots\ldots\ldots\ldots. = \frac{a}{b} = constant$$

Example 1

A train moves with a constant speed (v), and the distance (d) that the train travels is direct proportion with the time (t) the train takes to travel that distance, then if the traveled distance in two hour is (160Km) what is the time needed for the train to travel a (400km) distance.

constant speed (v) =k

$$d \propto t \quad d_1 = kt_1$$
$$160km = k \times 2h$$
$$k = \frac{160km}{2h} = \frac{80km}{h}$$
$$d \propto t \quad d_2 = kt_2$$
$$400km = 80 \times t_2$$
$$t_2 = \frac{400km}{80} = 5h$$

Or anther way to solve

$$\frac{d_1}{t_1} = \frac{d_2}{t_2}$$
$$\frac{160km}{2h} = \frac{400km}{t_2}$$
$$t_2 = \frac{2h \times 400km}{160km}$$
$$t_2 = 5h$$

EXAMPLE 2

The volume (V) of a standing cylinder change with respect to the square of its base radius (r^2) while the height (h) is constant, and its volume changes with respect to the Hight while the radius is constant. If the base radius was (14cm) and the height was (10cm) the cylinder volume become (6160cm^3). Find the cylinders hight when the cylinder volume is (3080cm^3) and base radius is (7cm).

$V \propto r^2$ with constant (h)
$V \propto h$ with constant (r)

$$V \propto r^2 h \Leftrightarrow V = K r^2 h$$

$$V_1 = K r_1^2 h_1$$

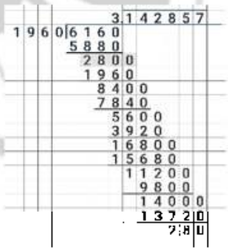
$$6160cm^3 = K \times 14cm \times 14cm \times 10cm$$

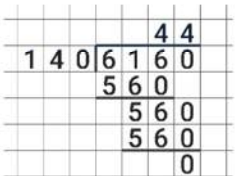
$$\boldsymbol{K} = \frac{6160}{14 \times 14 \times 10} = \frac{44}{14} = \frac{22}{7} = \qquad \frac{6160}{1960} = 3.14 = \pi$$

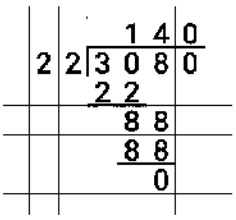
$$V_2 = K r_2^2 h_2$$

$$3080cm^3 = \frac{22}{7} \times (7cm^2)^2 \times h_2$$

$$\boldsymbol{h} = \frac{3080 \times 7}{22 \times 7 \times 7} = \frac{140}{7} = 20cm$$







Inverse proportion

$$a \propto \frac{1}{b} \Leftrightarrow a = k\,\frac{1}{b}$$

Example 3

Found practically the volume(V) of a certain mass of gas is directly propotional with the absolute temperature (T) when the pressure (P) is constant and this is **charle's law**.

$$V \propto T$$

And the volume(V) of a certain mass of gass is inversely proportional with the applied pressuere (P) on it while the temperature (T) is kept constant and this is **Boyl's Law**.

$$V \propto \frac{1}{P}$$

$$V \propto \frac{T}{P} \Leftrightarrow V = K\,\frac{T}{P}$$

$$PV = KT \Leftrightarrow PV = nRT$$

$$R = 8.314\, J.mol^{-1}.K^{-1}$$

$$R = 8.314\,\frac{J}{mol.K}$$

QUESTIONS of CHAPTER 1

Q1. Choose the correct answer for the followings:

1. Radian is the centered angle that faces an arc with length of:

a. Circle radius b. Circle diameter c. Half circumference d. Circumference

2. Circumference faces:

a. π from the radius angle b. 2π from the radius angle c. 3π from the radius angle d. One radius angle

3. Surface area of sphere faces:

a. π Sr b. 2π Sr c. 3π Sr d. 4π Sr

4. One of the following physical quantities is measured by ampere

a. Electrical voltage difference e. Electrical current b. Resistance d. Electrical power

5. Square millimeter equals to:

a. 10^{-2} m^2 b. 10^{-6} m^2 c. 10^{-4} m^2 d. 10^{-3} m^2

6. If x is directly propositional with(y) and (x=8) when (y= 15). then what is (x) equals when (y=10)

a. 7/3 b.2 c. 16/3 d. 3

$$x_1 = ky_1$$

$$x_2 = ky_2$$

$$\frac{x_1}{y_1} = \frac{x_2}{y_2}$$

$$\frac{8}{15} = \frac{x_2}{10}$$

$$x_2 = \frac{8 \times 10}{15} = \frac{16}{3}$$

7. If (x) inversely propositional with (y) and (x=7) when (y=3). then what (x) equals when (y=7/3).

a. 7 b. 9 c. 10/3 d. 6

$$x_1y_1 = x_2y_2$$
$$7 \times 3 = x_2 \times 7/3$$
$$x_2 = \frac{7 \times 3 \times 3}{7} = 9$$

8. The radius angle that equals to (1) rad faces an angle that equals to:

a. 57.3° b. 360°/π c.90°/π d.1°

9. The value of number (5) that is rained to the power of zero (5^0) equals to 2

a. 5 b. Zero c.1 d. Infinity

10. If the mathematical relation that connects the variables (x,y) la (y=2x + 5) then (y) changes

a. Linearly directly with x and passes through the origin point.

b. inversely with (x).

c. Linearly directly with x and doesn't pass through the origin point

d. Not linearly with (x).

11. If the mathematical relation that connects the variables (x,y) is (y = mx) then (y) Changes:

a. Linearly directly with x and doesn't pass through the origin point.

b. Inversely with (x).

c. Not linearly with (x).

d. Linearly directly with (x) and passes through the origin point.

CHAPTER 2 الفصل الثاني

MECHANICAL PROPERTIES OF MATERIALS

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CHAPTER 2 MECHANICAL PROPERTIES OF MATERIALS

Mechanical properties of materials depend on external force acts on them.

الخواص الميكانيكية للمادة تعتمد على القوة الخارجية المؤثرة عليها.

external force is applied on	Volume	Shapes
Solid (they are deformed)	Constant	Change
Liquid	Constant	Change
Gas	Change	Change

The deformed change depends on many effects in soild state. Some of them are listed below:

1. magnitude of force acts on the object. **مقدار القوة الخارجية المؤثرة على الجسم**

2. Dimensions (size (of the object. **ابعاد الجسم**

3. type of the material. **نوع مادة**

Studying about Mechanical properties of materials are important for improvements in technology. Therefore; invention of these materials:

دراسة الخصائص الميكانيكية للمواد مهمة للتحسينات في التكنولوجيا. وبالتالي؛ اخترعت هذه المواد:

1- Industrial applications, Artificial fibers used in industry; They are used in manufacturing of compressed gas cylinder, tires, bodies of transport vehicles and wings and sports tools.
التطبيقات الصناعية : الألياف الاصطناعية المستخدمة في الصناعة ؛ يتم استخدامها في تصنيع أسطوانات الغاز المضغوط والإطارات وأجسام مركبات النقل والأجنحة والأدوات الرياضية.

2- Space applications, Artificial fibers used in space systems: They are used in manufacturing missiles, shuttles and fuel tanks.

الألياف الاصطناعية المستخدمة في النظم الفضائية: تُستخدم في تصنيع الصواريخ والمكوك وخزانات الوقود.

Elasticity and Hook's Law قانون المرونة و هوك

Activity: Elasticity Concept

Tools: A spring, 0.1N loads, iron hanger, ruler, paper

Steps:

Set up experiment as shown in figure.

· Hang the spring perpendicularly. Then place the paper behind of the spring and sign position of free end of the spring on the paper.

· Attach a load (0.1N) to the spring. Then sign the position again.

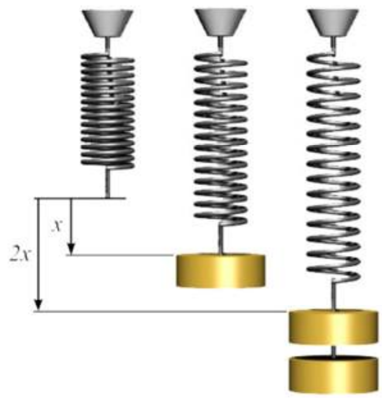
· Then attach one load more. The weight of the load is 0.2N that means extension will be twice of the initial one.

· Repeat the process for the other loads.

Write each data on the table.

· Draw extension-weight table on the plotting table. The weight of the spring is neglected.

Result: Extension is directly proportional to change in weight.



النشاط: مرونة

الأدوات: نابض حلزوني، أثقال N0.1، مسطرة، ورق

خطوات

قم بإعداد التجربة كما هو موضح بالشكل.

• نعلق النابض الحلزوني بشكل عمودي. ثم ضع الورقة خلف النابض الحلزوني وقم بوضع علامة نهاية النهاية الحرة للنابض على الورقة.

• قم بتعليق الثقل (N0.1) إلى النابض الحلزوني. ثم سجل على القراءة مرة أخرى.

• ثم نعلق الثقل واحدة اخر. وزن الثقل يصبح N0.2 وهذا يعني أن الاستطالة ستكون ضعف الوزن الأول.

• كرر العملية للاثقال الأخرى.

اكتب كل البيانات على الجدول.

• ارسم جدول وزن الاستطالة على طاولة التخطيط. اهمل وزن النابض الحلزوني.

النتيجة: الاستطالة تتناسب طرديًا مع تغير الوزن.

F (N)	ΔL (cm)
0	0
0.1	0.3
0.3	0.6
0.3	0.9
0.4	1.2

Therefore;حيث ان

Elastic Force = spring constant x change in length of the spring

$$\Delta F = K \, \Delta L$$

F: Elastic Forceقوة الشد

ΔL: change in length of the spring (مقدار الاستطالة) التغيير في طول النابض الحلزوني

k: spring constant which depends on the size, geometry and type of the material.

ثابت النابض يعتمد على ابعاده، هندستها ونوع المادة المصنوع منه.

قوة الشد = ثابت النابض × الاستطالة

ELASTICITY: is the resistance against the force which works to change the shape, volume and size of the object.

Therefore; when the force is removed, object returns to its original shape, volume and size.

المرونة: هي الاعاقة التي يبديها الجسم للقوة المغيرة لشكله او حجمه او طوله مع رجوعه الى وضعه السابق بعد زوال ذلك المؤثر.

المرونة: هي المقاومة ضد القوة التي تعمل على تغيير شكل وحجم وابعاد الجسم. وبالتالي؛ عند زوال القوة، يعود الجسم إلى شكله الأصلي وحجمه وابعاده.

Properties of Elastic Objects; يتصف الجسم المرن بما يأتي

- when the applied force is removed, the object returns to its original shape, volume and size.يعود الى شكله او حجمه او طوله السابق بعد زوال تأثير القوة عنه
- deformation of material is directly proportional to force on it in the elastic limit.

يتناسب التشوه الحاصل فيه تناسباً خطياً مع القوة المسببة له ضمن حدود المرونة.

ELASTIC LIMIT: حد المرونة

The greatest stress that can be applied to a material without causing **permanent deformation**. The stress point at which a material, if subjected to higher stress, will no longer return to its original shape.

حد المرونة: هو الحد الذي إذا اجتازته القوة المؤثرة لايعود الجسم الى ما كان عليه بعد زوال تلك القوة، وإذا اجتازته يحدث فيه تشوه دائمي

أعظم الإجهاد الذي يمكن تطبيقه على المواد دون التسبب في تشوه دائم. لن تتوقف نقطة الإجهاد التي تتعرض عندها المادة، إذا تعرضت الى اجهاد أعلى لايعود الجسم إلى شكله الأصلي.

If the deformation is too great, beyond the elastic limit for the substance, deformation is permanent.

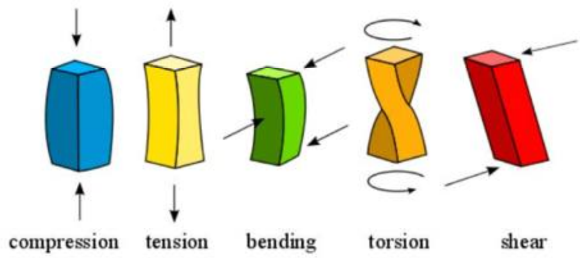
إذا كان التشوه كبيراً جداً، وبعيداً عن الحد المرونة للمادة، يكون التشوه دائمًا

STRESS AND STRAIN

Stress: is the force on unit area of an object.

An object under stress means that shape of an object or its volume or both of the quantities are changed by force.

Unit of stress is N/m^2.



الإجهاد: هي القوة العمودية المسلطة على وحدة المساحة.

الاجهاد المؤثر على جسم يحدث فيه تشوه (تغيراً في الشكل او الحجم او كليهما)

وحدة الاجهاد N/m^2

1- Longitudinal Stress: Vertical stress causes deformation in length of the object.
الاجهاد الطولي: هو الاجهاد الذي يسبب تشوهاً في طول الجسم.

There are two types of vertical stress. **ويكون الاجهاد الطولي على نوعين**

a- Tensile Stress: If an applied force is perpendicular to cross sectional area of an object, the stress is called tensile stress. An object elongates under tension.
اجهاد الشد: اذا اثرنا بقوة عمودية في سطحين متقابلين يؤدي بالنتيجة الى زيادة في الطول (استطالة).

b- Compressive Stress: Stress on materials that leads to a smaller volume. Therefore, length of the object decreases.

Compressive stress can be calculated by

$$compressive\ strees = \frac{vertical\ component\ of\ force}{cross\ sectional\ area}$$

2- Shear Stress: When a book is pushed on rough surface, the book is deformed because friction.

اجهاد القص : اذا وضعت كتاباً على سطح منضدة خشنة ودفعته بقوة مماسية لسطحه نلاحظ حدوث تشوه بسبب الاحتكاك.

Shear Stress = Component of the force / cross sectional area

STRAIN المطاوعة

It is the elongation of an object per unit length.

المطاوعة : انها الاستطالة المادة لوحدة الطول.

Strain depends on stress of the object: المطاوعة تتوقف على نوع الاجهاد الذي يتعرض له

1- Longitudinal Strain: When an object elongates or shrinks its shape changes but volume remains constant. The initial length (L_o) changes with ΔL.

المطاوعة الطولية : عند استطالة الجسم او انضغاطه يتغير شكله من غير تغير في حجمه. اذ يتغير الطول الاصلي L_o بمقدار ΔL

$$strain = \frac{change\ in\ length}{initial\ length} = \frac{\Delta L}{L_\circ}$$

$$\text{المطاوعة الطولية النسبية} = \frac{\Delta L}{L_o} = \frac{\text{التغير في الطول}}{\text{الطول الاصلي}}$$

2- Shear Strain: A condition in or deformation of an elastic body caused by forces that tend to produce an opposite but parallel sliding motion of the body's planes. Therefore; the body is deformed but volume remains constant. Shear strain is measured by angle between the sheared line and its original orientation.

مطاوعة القص : حالة في أو تشوه لجسم مرن ناتج عن قوى تميل إلى إنتاج حركة انزلاقية متوازية ولكن موازية مستوى الجسم. وبالتالي؛ تشوه الجسم لكن الحجم يبقى ثابت. يتم قياس إجهاد القص بالزاوية بين خط القص واتجاهه الأصلي.

3- volume Strain: When an object is completely exposed to pressure, the strain is called volume strain. The shape of the object does not change but its volume decreases.

$$volume\ strain = \frac{change\ in\ volume}{initial\ \ volume} = \frac{\Delta v}{V_\circ}$$

$$\text{المطاوعة الحجمية النسبية} = \frac{\Delta V}{V_o} = \frac{\text{التغير في الحجم}}{\text{الحجم الاصلي}}$$

مطاوعة الحجمية: عندما يتعرض الجسم بالكامل للضغط ، تسمى المطاوعة بالمطاوعة الحجمية. لا يتغير شكل الجسم ولكن حجمه يتناقص.

YOUNG MODULUS معامل يونك

It is the ratio of stress to the resulting strain.

It defines the relationship between stress (force per unit area) and strain (proportional deformation) in a material in the linear elasticity regime of a uniaxial deformation

هي النسبة بين الاجهاد والمطاوعة النسبية.

$$\text{Young Modulus} = \frac{stress}{strain}$$

$$Y = \frac{F/A}{\Delta L/L_\circ}$$

$$Y = \frac{F.L_\circ}{A.\Delta L}$$

$$\text{معامل يونك} = \frac{F/A}{\Delta L/L_o} = \frac{\text{الاجهاد}}{\text{المطاوعة النسبية}}$$

Y: Young modulus معامل يونك The unit of young modulus is N/m^2

F: Vertical component of force القوة المسلطة عمودياً

A: Cross sectional area مساحة المقطع العرض

ΔL: change in length (الزيادة الحاصلة في الطول (الاستطالة

L_o: Initial length الطول الاصلي

Example

A steel rope which length is 4m and cross-sectional area $0.05cm^2$ is pulled by 500N force. Calculate magnitude of elongation if young modulus of steel is $200x10^9$ N/m^2.

$$Y = \frac{F.L_\circ}{A.\Delta L}$$

$$\Delta L = \frac{F.L_\circ}{Y.A} = \frac{500 \times 4}{200 \times 10^9 \times 0.05 \times 10^{-4}} = 2 \times 10^{-9+2+4} = 2 \times 10^{-3}m = 2mm$$

Exercise (Question):

A group of students does some experiments to find type of a material and the data in the table are calculated. If the wire has 2m length and $1.25x10^{-6}$ m^2 :

a- draw graph of force and elongation of the wire.
b- and young modulus due to slope of the graph.

- Given:
  - Length of the wire L=2 m
  - Cross-sectional area $A=1.25\times10^{-6}$ m^2
  - A table of Force (F) and Elongation (ΔL) (you mentioned it's calculated but not provided — we need that to proceed).

✅ Step a: Draw the Graph

1. Plot a graph with:
   - X-axis: Elongation ΔL in meters (or mm)
   - Y-axis: Force F in newtons (N)
2. The graph should be a straight line if the material obeys Hooke's Law (in the elastic region).
3. Slope of the graph $=F/\Delta L$

You can use Excel, Google Sheets, or a graphing tool. If you provide the data table, I can draw the graph for you directly.

✅ Step 6: Find Young's Modulus (Y)

The Young's modulus formula is:

$$\text{oung Modulus} = \frac{stress}{strain}$$

$$Y = \frac{F/A}{\Delta L/L_\circ}$$

$$Y = \frac{F.L_\circ}{A.\Delta L}$$

$$\text{معامل يونك} = \frac{F/A}{\Delta L/L_o} = \frac{\text{الاجهاد}}{\text{المطاوعة النسبية}}$$

But if you're using the slope of the graph, then:

$$Y = L/A \times slope\ of\ the\ graph$$

Where:

- slope=F/ΔL
- L=2 m
- A=1.25×10^{-6} m^2

So just multiply the slope by L/A

Example:

Let's say from the graph, the slope is 100 N/m

Then:

$$Y = \frac{L}{A} \times\ slope\ of\ the\ graph = \frac{2}{125 \times 10^{-6}} \times 100 = 1.6 \times 10^8 Pa$$

MECHANICAL PROPERTIES OF RIGID BODIES

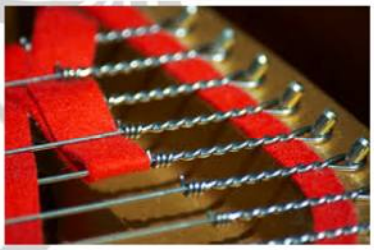
الخصائص الميكانيكية للمواد الصلبة

Mechanical properties of rigid bodies must be considered to manufacture construction materials and household applications.

الخصائص الميكانيكية للمواد الصلبة ينبغي ان تؤخذ بنظر الاعتبار عند اختبار المواد الصلبة لتصنيع مواد البناء والادوات المنزلية

1- **Ductility**: Ability of a material to deform material by elongation, bending, shrink, drawing or hammering. i.e. copper.

اللیونة: القدرة على تشويه المواد عن طريق الاستطالة، الانحناء (التقوس)(اللي)، التقلص (انكماش)، السحب أو الطرق أي النحاس.



2- **Brittleness**: The property of materials that do not deform under strain, but tend to break suddenly.

الهشاشة: خاصية المواد التي لا تشوه تحت الاجهاد، ولكنها تميل إلى الانهيار فجأة.

Brittle materials are defined as; materials such as glass, pig iron and concrete which break by exceeding over the elastic limit.

يتم تعريف المواد هشة كما؛ مواد مثل الزجاج والحديد الخام (حديد الصب أو حديد الزّهر أو تماسيح الحديد أو حديد خام أو حديد غفل) (يحتوي نسب عالية جداً من الكربون، تصل عادةً إلى 3.5–4.5 ٪ من وزن السبيكة، مما يجعله هشا جداً ولا يمكن استخدامه مباشرةً إلا في بعض الحالات الخاصة.) **والكونكريت التي تكسر من خلال تجاوز الحد المرونة.**

3- **Rigidity (Stiffness)** : Ability of materials which conserve their shape and volume when force is applied on them. Rigid bodies have great Young modulus. i.e. Young modulus of steel is $2x10^{11}$ N/m^2.

الصلابة (القساوة): قدرة المواد التي تحافظ على شكلها وحجمها عند استخدام القوة عليها. الاجسام الصلبة (جاسىء) لديها معامل يونك كبير. بمعنى أن معامل الحديد الفولاذ يساوي $2x10^{11}$ N/m^2.

4- **Toughness**: It is defined as the resistance to fracture of a material when stressed. Toughness can be calculated by;

Toughness = Force/ Cross sectional area

The unit of toughness is N/m^2.

المتانة: يتم تعريفها على أنها مقاومة لكسر المادة عند الاجهاد (خاصية المادة لمقاومة القوة القاطعة لها). يمكن حساب الصلابة بواسطة:

المتانة = القوة / منطقة المقطع العرضي

وحدة المتانة هي N/m^2.

5- **Hardness:** Resistance of a material to deformation, indentation, or penetration by means such as abrasion, drilling, impact, scratching, and/or wear.

الصلادة: مقاومة مادة للتشوه، الخدش أو الاختراق بوسائل مثل التآكل أو الحفر أو التأثير أو الخدش و / أو التآكل.

Hardness of some material are listed (ascending order) in the table.

1. Talc التلك	6. Feldspar الفلسبار(سلكات الالمينوم)
2. Gypsum (Plaster) الجص	7. Quartz الكوارتز
3. Calcite الكالسيت $CaCO_3$	8. Topaz التوباز
4. Fluoride فلورايت	9. Ruby الياقوت
5. Apatite الابتايت	10. Diamond الماس

6- **Failure:** A bility to lose resistance under stress.

الفشل: القدرة على فقدان قوة تحملها تحت الاجهاد.

Think! Compare mechanical properties of caoutchouc (rubber **Ductility**) and diamond **Hardness**.

Elastic and Plastic Deformation التشوه المرن والتشوه البلاستيكي

a. Elastic Deformation

The temporary increase in length or shape (Hooke's Law is applied). When the force on the object is removed, it returns to its initial length and shape.

تشوه مرن

الزيادة المؤقتة في الطول أو الشكل (يتم تطبيق قانون هوك). عندما تتم إزالة القوة على الجسم ، فإنها تعود إلى طولها وشكلها الاصلي.(ضمن حدود المرونة)

b. Plastic Deformation

The permanent increase in length or shape (Hooke's Law is not applied). When the force on the object is removed, it cannot return to its initial length and shape.

تشوه البلاستيك (اللدن)

الزيادة الدائمة في الطول أو الشكل (لا يتم تطبيق قانون هوك). عند إزالة القوة الموجودة على الجسم ، لا يمكن العودة إلى طوله وشكله الأولي.(خارج حدود المرونة)

DO YOU KNOW هـل تعلم !

1- Split (breaking) starts form the cracked parts of the body. Because crystal structure of those parts is deformed.

بداية القطع (الكسر) يظهر في سطح المادة في المناطق ذات المتانة القليلة والتي تظهر فيها التشققات كونها تمتلك عجز في تركيبها البلوري

2- Resistance of brittle substances increases with increasing pressure. For example; 10 km below the earth's crust, the rocks are less brittle and elastic deformation is more.

مقاومة المادة الهشة تزداد بالضغط فمثلا عند عمق Km10 في القشرة الارضية تصبح الصخور اقل احتمالاً للتكسر واكثر احتمالية لتشوه المط

3- In order to prevent breaking of glass, polyvinyl butyral is placed between two glass plates

لتجنب كسر الزجاج (او امتصاص نمو الكسر) تؤخذ صفيحتان من الزجاج مفصولتان بطبقة من مادة بولي فنايل بيوترال والتي تعمل كماصة لنمو الكسر

QUESTIONS of CHAPTER 2

Q.1. Choose the correct answer.

1- When the stretched spring is released, it returns to its original shape. Which one of the following properties explains that;

a- brittleness b- softness c- hardness d- elasticity

2- the steel elasticity of is greater than caoutchouc (rubber), because

a- Steel needs more tensile and compressive force b- caoutchouc (rubber) needs more tensile and compressive force c- Young modulus of steel is greater d- Young modulus of steel is smaller

3- Hooke's Law is applied in

a- hardness b- deformation c- elasticity d- shear strain

4- the material that's length can't increased unless by high stress and in their elasticity, limit is called;

a- brittleness b-have high elasticity c- inelastic d- can be hammered

5- When the force is applied, the longitudinal stress is defined as;

a- change in length b- perpendicular force on cross sectional area c- young modulus d- elastic limit

6- Shear stress affects; a- length b- width c- volume d- shape

7- What does the strain which affects load attached wire depend on;
What doesn't the stress which affects load attached wire depend on;

a-length of the wire b- diameter of the wire c- mass of the load d- gravitational acceleration

8- Consider two identical wires (x and y). The length of wire x is half of the length of wire y and the diameter of wire x is twice of the diameter of wire y. If magnitude of elongations of wires are same, force applied on wire x is;

a- half of the force on wire y b- twice of the force on wire y c- 4 times greater than force on wire y d- 8 times greater than force on wire y

$L_x = \frac{1}{2} L_y$, $R_x = 2R_y$, $\Delta L_x = \Delta L_y$, identical wires (x and y) $Y_x = Y_y$

$$Y_x = Y_y$$

$$\frac{F_x \times L_x}{A_x \times \Delta L_x} = \frac{F_y \times L_y}{A_y \times \Delta L_y}$$

$$\frac{F_x \times 1/2L_y}{(2 \times r_y)^2 \times \pi \times \Delta L_x} = \frac{F_y \times L_y}{(r_y)^2 \times \pi \times \Delta L_y}$$

$$\frac{F_x \times 1/2}{(2)^2} = \frac{F_y}{1}$$

$$\frac{F_x}{8} = F_y$$

$$F_x = 8F_y$$

9- Increasing in length or shape of the object over elastic limit is: -

a- called temporary deformation b- called permanent deformation c- directly proportional to force d- inversely proportional to force

10- When two forces pull that are equal in magnitudeand opposite direction and parallel to each other are applied on object. The stress is called;

a-tensile stress b- compressive stress c- vertical d- shear

Q.2. In order to cut a wire, required force is F. Calculate the force applied on; (Note: all wires are identical)

a- two identical successive wires tied together. 2F
b- a wire which diameter is twice of the wire used in question. 4F
c- a wire which length is twice of the wire used in question. F

Q.3. What are the factors that determine the amount and type of deformation that occurs in solid material?

Q.4. What is meant by the elasticity constant of the spring? What is the unit which we use to mm it? and on what does its magnitude depends on?

Q.5. Define type of strain for following choices;

a- ratio of change in length to length
b- ratio of change in volume to volume
c- magnitude of an angle between the sheared line and its original orientation.

PROBLEMS of CHAPTER 2

Q.1: A tensile stress effect of (20×10^6 N/m²) on a metal wire having cross sectional area of (1.5mm²) What is the force acting on it?

$$A\ tensile\ strees = \frac{vertical\ component\ of\ force}{cross\ sectional\ area}$$

$$1mm^2 = 10^{-6}m$$

$$10^{6-6} = 10^0 = 1$$

$$20\ x\ 10^6 = \frac{F}{1.5\ \times 10^{-6}}$$

$$F = 20 \times 1.5\ \times 10^{6-6} = 30N$$

Q.2: What is the amount of length that occurs an (2m) long steel wire with diameter of(1mm) if mass of (8 kg) is attached to its end($g=10m/s^2$)? Steel= $200 \times 10^9 N/m^2 = 2 \times 10^{11} N/m^2$

$$diameter = 1mm$$

$$cross\ sectional\ radius = \frac{1}{2}mm$$

$$A = \pi r^2$$

$$1mm = 10^{-3}m$$

$$W = mg$$

$$W = 8\ kg\ \times 10m/s^2$$

$$W = 80\ kg.\frac{m}{s^2}$$

$$F = 80\ N$$

$$Y = \frac{F.L_\circ}{A.\Delta L}$$

$$2 \times 10^{11} = \frac{80\ \times 2}{\pi r^2 . \Delta L}$$

$$2 \times 10^{11} = \frac{80\ \times 2}{\frac{22}{7}(\frac{1}{2} \times 10^{-3})^2 . \Delta L}$$

$$\Delta L = \frac{80\ \times 2}{\frac{22}{7} \times \frac{1}{4} \times 10^{-6}\ \times\ 2 \times 10^{11}}$$

$$\Delta L = \frac{80\ \times 4 \times 7}{22 \times 10^5} = \frac{80 \times 2 \times 7 \times 10^{-5}}{11} = \frac{1120 \times 10^{-5}}{11}$$

```
0.01120 ÷ 11 = 112 ÷ 1100
                 0.001018
110000 | 112.000
         110000
           200000
           110000
```

Q.3: A wire with cross sectional radius of (0.5mm) and length of (120cm) hanging vortically. What is the perpendicular forces that needs to he applied to its end so that in length become (121.2 cm) (young module of the material is (1.4×10^{10} N/m²).

$$L_\circ = 120cm = 120 \times 10^{-2}m, \qquad L = 121.2cm = 121.2 \times 10^{-2}m$$

$$\Delta L = L - L_\circ = 121.2 \times 10^{-2}m - 120 \times 10^{-2}m = 1.2 \times 10^{-2}m$$

$$F = \frac{Y.\ \pi r^2 . \Delta L}{L_\circ}$$

$$F = \frac{1.4\ \times 10^{10} \times 3.14\ \times (0.5 \times 10^{-3})^2 .1.2 \times 10^{-2}}{120 \times 10^{-2}}$$

$$F =\ 3.14 \times 0.25 \times 10^{10-6-2}$$

$$F = \frac{Y.\ \pi r^2 . \Delta L}{L_\circ}$$

$$F = \frac{1.4 \times 10^{10} \times \frac{22}{7} \times (0.5 \times 10^{-3})^2 .1.2 \times 10^{-2}}{120 \times 10^{-2}}$$

$$F = 0.2 \times 22 \times 0.25 \times 10^{10-6-1}\ 1.1 \times 10^3 = 110N$$

$F = 1.4 \times 3.14 \times 0.25 \times 10^2 = 109.9N$

Q.4: Two identical wires the length of one of them is (125 cm) and the other B (375 cm) if the first wire was cut by a force of (489N). What is the force required to cut the second wire?

$F_1=F_2=489N$ because both of wire has same the cross-sectional radius

Q.5: A rod with length of (0.4m) was pressed an its length shortened by (0.05m) what is its relativity strain?

$$strain = \frac{change\ in\ length}{initial\ length} = \frac{\Delta L}{L_\circ} = \frac{0.05}{0.4} = \frac{5}{40} = 0.125$$

Q.6: A bronze wire with length of (2.5m) and a cross sectional area of (1×10^{-3} cm^2) pulled and elongated (1 mm) by attaching an object of (0.4 kg). calculate young modulus for the metal. Consider the gravitational acceleration is (10N/kg).

$$Y = \frac{F.L_\circ}{A.\Delta L} = \frac{4 \times 2.5}{10^{-7} \times 10^{-3}} = 10^{1+7+3} = 10^{11}N/m^2$$

CHAPTER 3 الفصل الثالث

STATIC FLUIDS

07740133377 07718597632

وليد خالد الفتلاوي

CHAPTER 3 STATIC FLUIDS

Fluid is the material that have weak cohesive force and can't keep a certain shape for the material thus the particles move and take the shape of the container that its placed in and this definition fits liquids and gases and its easy in response to the external forces that tries to change its shape.

المائع انه المادة التي فيها قوى التماسك ضعيفة وغير قادرة على حفظ شكل معين للمادة لذا تتحرك الجزيئات وتاخذ المادة شكل الوعاء الذي توضع فيه.

Pressure is the (perpendicular) force per unit area.

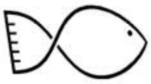
SI unit for pressure is Pascal (Pa). 1 Pascal is the pressure applied by 1 Newton force over pushing against 1 m^2 area.

Fluid Pressure

Liquid pressure:

A liquid has a weight, it too exerts a downward pressure but it also exerts pressure in every direction.

Liquid pressure increases as we go down from the surface to the bottom of the liquid.

 Fish and  divers at the bottom of the sea feel greater pressure, which is due to the weight of water above them. The water presses in all directions on the bodies. Therefore, divers wear very special suits to protect themselves from the effects of pressure.

liquid pressure properties:

1- A liquid exerts pressure in all directions.
2- The pressure of a liquid is directly proportional to the depth of the liquid.
3- The liquid pressure depends on the density of the liquid.

ضغط السائل:

فالسائل له وزن، كما أنه يسلط ضغطًا للاسفل، ولكنه أيضًا يسلط ضغطًا في كل الاتجاهات.

يزداد ضغط السائل كلما هبطنا من السطح إلى قاع السائل.

Do you Know?

Mercury is the metal that found in liquid state under the room temperatrue and considered as fluid.

الزئبق هو الفلز الذي يوجد في الحالة السائلة ضمن درجة الحرارة الغرفة ويعد مائعا

الأسماك والغواصين في قاع البحر يشعرون بمزيد من الضغط، بسبب وزن الماء فوقهم. تسلط المياه ضغطاً في جميع الاتجاهات على الأجسام. لذلك، يرتدي الغواصون بذلات خاصة لحماية أنفسهم من آثار الضغط.

خصائص ضغط السائل:

1- » سائل يسلط ضغط في كل الاتجاهات.

2- »إن ضغط السائل يتناسب طرديا مع عمق السائل.

3- »يعتمد ضغط السائل على كثافة السائل.

Pascal's principle Liquids (in equilibrium) transmit pressure equally in all directions.

that's the Weight of the column of liquid represents the perpendicular force that acts on the area.

$$P_{liquid} = \frac{F}{A} = \frac{weight\ of\ liquid}{A} = \frac{mg}{A} = \frac{\rho g V}{A} = \frac{\rho g A h}{A}$$

$$P_h = \rho g h$$

Liquid Pressure = liquid density x gravity x depth

$$m = \rho \times v$$
$$v = A \times h$$
$$m = \rho \times A \times h$$
$$Weight = m \times g = \rho \times A \times h \times g$$
$$P = \frac{F}{A} = \frac{\rho \times A \times h \times g}{A}$$
$$P = \rho \times h \times g$$

$$P_h = \frac{Kg}{m^3} \times \frac{N}{Kg} \times m = \frac{N}{m^2}$$

liquid have two properties these are inability to be compressed and sliding of its molecules on each other easily that let it apply force on the walls of the container that it's in and also a force upward.

That's the pressure of the liquid doesn't only affects downward but it affects in all directions

السائل له صفتان، وهما عدم القدرة على ضغطه (الانكباس) وانزلاق جزيئاته على بعضها البعض بسهولة مما يسمح لها بتطبيق القوة على جدران الحاوية التي تحتويه وأيضاً قوة دافعة نحو الاعلى. إن ضغط السائل لا يؤثر فقط على نحو الاسفل ولكنه يؤثر في جميع الاتجاهات.

EXAMPLE

Calculate the pressure in N/m^2 unit generated on a diver in a depth of (20m) below the water surface noting water density is (1000Kg/m^2).

احسب الضغط المتولد من قبل الماء على غواص على عمق 20m تحت سطح الماء علماً ان كثافة الماء 1000Kg/m^2

$$P_h = \rho g h$$

$$P_h = 1000 \frac{\text{Kg}}{m^2} \times 9.8 \frac{m}{s^2} \times 20\, m$$

$$P_h = 196000 \frac{N}{m^2}$$

Atmospheric pressure

- **الضغط الجوي** Atmospheric Pressure – Simplified Academic Points

1. **الضغط الجوي هو الضغط الذي يمارسه الغلاف الجوي على سطح الأرض.**
   Atmospheric pressure is the pressure exerted by the atmosphere on the Earth's surface.
2. **نحن نعيش تحت بحر من الهواء يضغط بكل وزنه على كل شيء في الهواء الطلق.**
   We live under a sea of air that pushes with all its weight on everything in open air.
3. **الضغط الجوي ناتج عن وزن عمود الهواء المؤثر عموديًا على وحدة المساحة.**
   Atmospheric pressure results from the weight of the air column applied perpendicularly on a unit area.
4. **يُقاس الضغط الجوي باستخدام جهاز يُسمى الباروميتر**
   Atmospheric pressure is measured using a device called a barometer.
5. **الباروميتر هو أنبوب زجاجي طوله متر، مفتوح من طرف، ومملوء بالزئبق.**
   The barometer is a one-meter-long glass tube, open at one end, and filled with mercury.
6. **يوضع طرف الأنبوب المفتوح في وعاء يحتوي على زئبق، مما يؤدي إلى ثبات الزئبق في الأنبوب عند ارتفاع معين.**
   The open end of the tube is placed in a mercury container, causing the mercury in the tube to stabilize at a certain height.

7. يترك هذا التوازن فراغًا في أعلى الأنبوب يسمى الفراغ التورشيلي.
This balance creates a vacuum at the top of the tube, called the Torricellian vacuum.

8. توصل توريشيللي إلى أن الضغط الجوي يعادل ضغط عمود الزئبق عند نفس المستوى الأفقي.
Torricelli concluded that atmospheric pressure equals the pressure of the mercury column at the same horizontal level.

9. عند مستوى سطح البحر ودرجة حرارة صفر مئوية، يبلغ ارتفاع عمود الزئبق 76 سم.
At sea level and 0°C, the height of the mercury column is 76 cm.

10. يتغير طول العمود الزئبقي حسب الارتفاع؛ فكلما زاد الارتفاع عن سطح البحر قل الضغط الجوي.
The height of the mercury column changes with altitude; atmospheric pressure decreases with increased elevation above sea level.

Example

What is the length of the water column that is needed to equalize the atmospheric pressure where the mercury column equals to (76cm) noting that the water density is (1000kg/m^3) and the mercury density is (13600kg/m^3).

ما هو طول عمود الماء المطلوب اللازم لمعادلة في الضغط الجوي حيث يساوي عمود الزئبق (cm76) مع ملاحظة أن كثافة الماء (kg/m^{3}1000) وكثافة الزئبق (kg/m^{3}13600).

$$P_w = P_m$$

$$\rho_w g h_w = \rho_m g h_m$$

$$1000\frac{\text{kg}}{\text{m3}} \times 9.8\frac{m}{s^2} \times h_w = 13600\frac{\text{kg}}{\text{m3}} \times 9.8\frac{m}{s^2} \times 0.76m$$

$$h_w = \frac{136 \times 0.76}{10} = 10.33m$$

×	1 3 6
	0.0 7 6
	8 1 6
+	9 5 2
	1 0.3 3 6

PASCAl S PRINCIPLE

principle in fluid mechanics given by Blaise Pascal that states

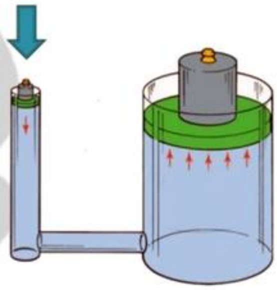
that a pressure change at any point in a confined incompressible fluid is transmitted throughout the fluid such that the same change occurs everywhere.

الضغط الاضافي المسلط على أي جزء من مائع يتوزع انياً الى جميع اجزاء ذلك السائل وبدون نقصان.

$$P_1 = P_2$$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

Example



Calculate the force required to lift a car with (3000kg) mass using the hydraulic lift that is used in car washing garages knowing that the sectional area of the small cylinder is ($15cm^2$) and the sectional area of the big cylinder is ($2000cm^2$)? Consider g = 10 m/s^2.

احسب القوة اللازمة لرفع سيارة بكتلة (kg3000) باستخدام المصعد الهيدروليكي المستخدم في مرائب غسيل السيارات مع العلم أن المساحة المقطعية للاسطوانة الصغيرة هي ($cm^2$15) والمساحة المقطعية للاسطوانة الكبيرة هي ($cm^2$2000)؟ يتعبر g = 10 m/s^2

$$F_2 = mg = 3000 \times 10 = 30000N$$

$$P_{\text{small cylinder}} = P_{car\text{ big cylinder}}$$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$\frac{F_1}{15} = \frac{30000}{2000}$$

$$F_1 = \frac{30000 \times 15}{2000} = 15 \times 15 = 225N$$

oil is used in hammers and hydraulic lifts since it has very low compressibility.

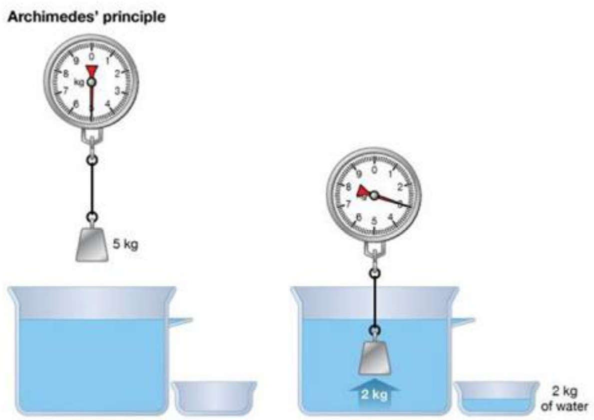
ARCHIMEDES PRINCIPLE

if an object is partially or totally immersed in a fluid it loses from weight equal to weight of the displaced fluid.

إذا غُمر جسم ما جزئياً أو كلياً في مائع، فإنه يفقد من وزنه بقدرمساوٍ لوزن السائل المزاح.

Examining the figure above, we see that the lifting force of the water on the object equals the weight of overflowing water. Since the volume of overflowing liquid equals volume of object under the liquid surface (called the "immersed volume"), we can write the formula for the magnitude of the force trying to lift the object up (called the "buoyant force")

من الصيغة اعلاه، نرى أن قوة دفع الماء على الجسم تساوي وزن الماء المزاح. نظرًا لأن حجم السائل المزاح يساوي حجم الجسم الموجود أسفل السطح السائل (يُسمى "الحجم المغمور")، يمكننا كتابة الصيغة لحجم القوة التي تحاول رفع الجسم للاعلى (تسمى "القوة الطافية")



$F_B = Weight\ of\ displaced\ liquid$(Buoyant force)

F_b =وزن الماء المزاح (قوة الطفو)(قوة الدافعة نحو الاعلى)

Buoyant force = volume of immersed object x weight density of the liquid

$$F_B = m_{disp\ liq} \times g = \rho_{liq} \times V_{disp\ liq} \times g$$

$$F_{bouyant} = \rho_{liq} \times V_{disp\ liq} \times g$$

So, we can say that any object when immersed in a fluid effect on it by two forces and they are:

1. Weight (mg) that is perpendicular in downward direction

2. Buoyant force F_B (displaced fluid weight) that is perpendicular in upward direction.

لذلك، يمكننا أن نقول إن أي جسم عندما يغطس (يغمر) في المائع يؤثر عليه من قبل قوتين وهما:

1– الوزن (mg) الذي هو يتجه عمودياً نحو الاسفل.

3- قوة الطفو F_B (وزن السائل المزاح) والذي يكون يتجه عمودياً نحو الاعلى.

Sinking: Weight is greater than the up thrust.

The density of the object is greater than the density of the liquid, the **object sinks** to the bottom.

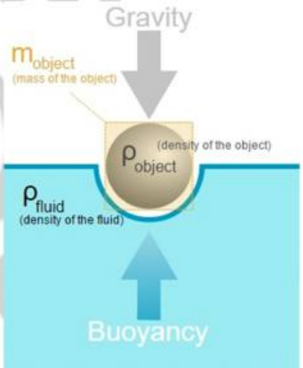
كثافة الجسم أكبر من كثافة السائل، حيث يغرق الجسم في الأسفل.

$$F_B < mg$$

weight < up thrust Weight

density object = the density of the liquid is hanged inside the liquid and in an equilibrium state.

الكثافة الجسم = الكثافة السائل الجسم معلق داخل السائل وفي حالة توازن.



$$F_B = mg$$

weight = up thrust Weight

Floating: Up thrust balances weight

The density of the object is less than the density of the liquid the object **Floating**.

كثافة الجسم أقل من كثافة السائل يطفو فوق سطح الماء.

$$F_B > mg$$

weight > up thrust Weight

In case of floating the weight of water displaced is equal to the weight of the object.

Floating is a special case; The up thrust of the liquid is equal to the weight of the object. Ships, boats and all things moving on water experience up thrust equal to their weights. And also, they displace water equal to their weights.

في حالة الطفو وزن المياه المزاحة يساوي وزن الجسم.

الطفو هو حالة خاصة. القوة الدافعة نحو الأعلى للسائل تساوي وزن الجسم. فالسفن والقوارب وكل الأشياء التي تتحرك على الماء تواجه قوة دفع تساوي أوزانها. وأيضا ، يحل محل الماء المزاح يساوي أوزانهم.

a. for fully immersed objects.

Buoyant force for liquid = weight of displaced liquid

قوة الطفو للسائل = وزن السائل المزاح

Weight object in air – Weight object in liquid = weight of displaced liquid

وزن الجسم في الهواء – وزن الجسم في السائل = وزن السائل المزاح

Weight object in air –Weight object in liquid = volume of displaced liquid x weight density of liquid

وزن الجسم في الهواء – وزن الجسم في السائل = حجم السائل المزاح × كثافة السائل

$$\text{weight of displaced liquid} = W_{Air} - W_{Water}$$

$$W_{Air} - W_{Water} = \rho V g$$

b. for partially immersed objects (Boating objects)

The weight of floating object in the liquid = zero

the weight of floating object in the air — zero = weight of the displaced liquid

Weight of the Boating object (W body) = the volume of immersed part (V) x weight density of the liquid(ρ_w)

$$W_{body} = \rho_m V g$$

weight density of the liquid(ρ_w) = mass density of the liquid (ρ_m) x g

EXAMPLE

An object weights (5N) in air and weights (4.55N) when fully immersed in water, find the object's volume?

water density as: (1000 kg/m^2) and that gravity equals to (g =10 N/kg).

$W_{Air} - W_{Water} = \rho V g$

$5.00 - 4.55 = 1000 \times V \times 10$

$0.45 = 10000 \times V$

$V = 0.45 \times 10^{-4} m^3$

Example

A wooden cube have aside length of (10 cm) and weight density of (7840N/m^3) floats on water, what is the length of the immersed part in water?

يبلغ طول المكعب الخشبي (10 cm) وكثافة الوزن (7840N/m^3) جانباً على الماء، ما هو طول الجزء المغمور في الماء؟

Weight object in air = weight of displaced liquid

$$W_{body} = \rho_m V g$$

$$(\rho_w V)_{body} = (\rho_m V)_{water} g$$

$$7840 \frac{\text{N}}{\text{m3}} \times (0.1)^3 = 1000 \times V \times 9.8$$

$$V = \frac{7840 \ \times 0.001}{9800} = 0.0008\, m^3$$

$$V = A \times h \qquad h = \frac{V}{A} = \frac{0.0008}{0.01} = 0.08m$$

Surface Tension الشد السطحي




- التوتر السطحي Surface Tension – Simplified Academic Points

1. الجزيئات داخل السائل تتأثر بقوى تجاذب متساوية من جميع الاتجاهات.
   Molecules inside a liquid are affected by equal attractive forces from all directions.
2. أما الجزيئات على سطح السائل، فتتعرض لقوة محصلة تسحبها إلى الداخل.
   Molecules on the surface of the liquid experience a net force pulling them inward (into the fluid).
3. نتيجة لذلك، يتصرف سطح السائل كغشاء مرن رقيق مشدود باستمرار.
   As a result, the liquid surface behaves like a thin flexible membrane in continuous tension.
4. هذا التوتر يقلل من مساحة سطح السائل إلى أقل قدر ممكن.
   This surface tension minimizes the surface area of the liquid as much as possible.
5. التوتر السطحي يسبب بعض الظواهر الفيزيائية المعروفة.
   Surface tension causes some well-known physical phenomena.

6. أمثلة على ذلك: طفو الإبرة على سطح الماء.
Examples include: the floating of a needle on the water surface.

7. وأيضًا سير الحشرات على سطح السائل دون أن تغوص.
Also, the movement of insects on the liquid surface without sinking.

8. وكذلك الشكل الكروي الذي تتخذه قطرات الماء.
And the spherical shape that water droplets form.

Capillary Property الخاصية الشعرية

1. من الظواهر المرتبطة بالتوتر السطحي: ارتفاع أو انخفاض السوائل في الأنابيب الزجاجية الضيقة.
One of the phenomena related to surface tension is the rising or falling of liquids in narrow glass tubes.

2. تُعرف هذه الظاهرة باسم "خاصية الشعيرات" (Capillary Property).
This phenomenon is called the capillary property.

3. عند غمر أنبوب شعري مفتوح الطرفين عموديًا في الماء، يرتفع الماء داخل الأنبوب فوق مستواه الخارجي.
When a two-ends-opened capillary tube is vertically immersed in water, the water rises inside the tube above the outside level.

4. أما في حالة الزئبق، فإن مستواه داخل الأنبوب ينخفض عن مستواه خارجه.
But in the case of mercury, its level inside the tube drops below the outside level.

5. يرجع ارتفاع الماء إلى تفوق قوى التلاصق بين الماء والزجاج على قوى التماسك بين جزيئات الماء.
The rise of water is due to the dominance of adhesive forces between water and glass over the cohesive forces among water molecules.

6. بينما في الزئبق، تكون قوى التماسك بين جزيئاته أكبر من قوى التلاصق مع الزجاج.
In mercury, the cohesive forces between its particles are greater than the adhesive forces with the glass.

تذكر REMEMBER

*The cohesive force is the attraction force between the particles of the material itself meaning particles from same type (mercury).

* The adhesive forces is the attraction force between different particles, and its amount varies depending on the materials such as water adhesion to the glass.

* القوة التماسك هي قوة التجاذب بين الجزيئات المادة نفسها وتعني الجزيئات من نفس النوع (الزئبق).

* القوى التلاصق هي قوة الجذب بين الجسيمات المختلفة، وكمية تختلف تبعا للمواد مثل التصاق المياه بالزجاج.

The capillary property has very big importance:

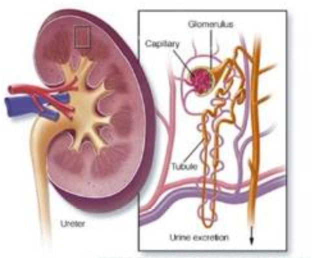
1. Rising of the underground water inside the soil pores and it prove is the appearance of the salt on the soil surface.

2. Rising of the water through the plant roots and stems.

3. Filtration of the blood in the human's kidney.

4. The rising of the petrol used in the petrol heater's filament.

الخاصية الشعرية لها أهمية كبيرة جدا:



1. ارتفاع المياه الجوفية داخل مسام التربة وإثبات ذلك هو ظهور الملح على سطح التربة.

2. ارتفاع الماء من خلال جذور النبات والسيقان.

3. ترشيح الدم في الكلى البشرية.

4. ارتفاع البنزين المستخدم في خيوط سخان البنزين.

Mechanical Properties for Dynamic Fluids الخصائص الميكانيكية للمادة

Properties of ideal fluid

Incompressible means can't be presses so its density remains constant during flowing	regular flowing: means that the speed of the fluid How in a certain point remain constant in amount and direction with time	not viscos: viscosity is considered a measure to the internal friction in the fluid at flowing therefore we assume viscosity of the fluid is zero	not spiral or rotational: its flowing is not Turbulent, means flowing lines don't overlap so no spirals form in it

خصائص المائع المثالي

(غير قابل للانكباس)أي لايمكنه الانضغاط لذلك تظل كثافتها ثابتة أثناء التدفق

التدفق المنتظم: يعني أن سرعة المائع كيف في نقطة معينة تبقى ثابتة من حيث الكمية والاتجاه مع مرور الوقت

عديم الزوجة: تعتبر اللزوجة مقياسًا للاحتكاك الداخلي في السائل عند التدفق وبالتالي نفترض أن لزوجة المائع هي صفر

ليس دوامي أو دوّاراً : فالتدفق ليس مضطربًا ، مما يعني أن خطوط التدفق لا تتداخل حتى لا تتشكل دوامات فيه

Continuity Equation in Fluids معادلة الاستمرارية في السوائل

The average flow of the fluid amount in any section inside the pipe stays constant

يبقى معدل تدفق كمية السائل في أي مقطع داخل الأنبوب ثابتاً

$$A_1V_1 = A_2V_2$$

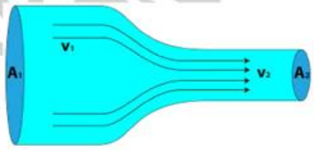
Small section area A_1 x flowing speed V_1 = big section area A_2 x flowing speed V_2

Example

The water flows in a horizontal pipe with two sections the diameter of the big section is (2.5cm) with a speed of (2m/s) to its small section that's radius is (1.5cm), what is the water flowing speed in the narrow pipe?

مثال

يتدفق الماء في أنبوب أفقي مع قسمين يبلغ قطر القسم الكبير (cm2.5) بسرعة (m/s2) إلى قسمه الصغير الذي يبلغ نصف قطره (cm1.5) ، ما هي سرعة تدفق المياه في أنبوب ضيق؟



$$A_1V_1 = A_2V_2$$

$$\pi r^2 V_1 = \pi r^2 V_2$$

$$r^2 V_1 = r^2 V_2$$

$$V_2 = \frac{r^2 V_2}{r^2} = \frac{(2.5)^2(2)}{(1.5)^2} = \frac{1250}{2.25} = 555\frac{cm}{s} = 5.55\ m/s$$

Bernoulli's Equation معادلة برنولي

The sum of all pressures and kinetic energy per unit volume and the potential energy per unit volume equal to a constant amount in all the points along the path of the ideal fluid.

مجموع الضغط المسلط والطاقة الحركية لوحدة الحجوم والطاقة الكامنة الوضعية لوحدة الحجوم تساوي مقداراً ثابتاً في النقاط جميعها على طول مجرى المائع المثالي.

$$P_1 + \frac{1}{2}\rho v^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v^2 + \rho g h_2$$

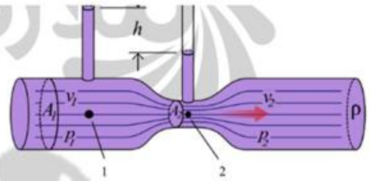
noting that p is the fluid density and its constant since the fluid is incompressible.

Application of equation and Bernoulli's Principle

a) Venturi scale $P_1 - P_2 = \rho gh$

Example The figure shows the venturi scale, if the height difference between the two pipes of the manometer is (0.075m) calculate the pressure difference between the two-venturi scale's section noting that the (ρ) of mercury is (13600kg/m²).

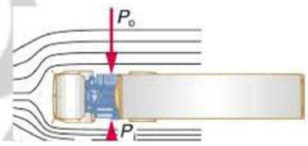
$$P_1 - P_2 = \rho gh$$
$$P_1 - P_2 = 13600 \times 9.8 \times 0.075$$
$$= 9.997 \times 10^3 N/m^2$$

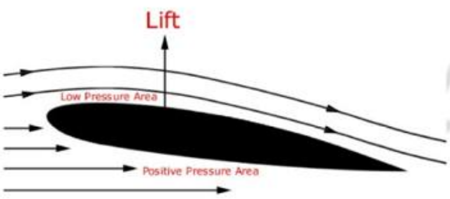


b) Atomizer

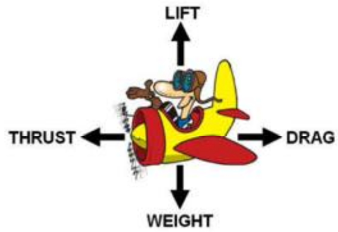
c) Airplane lift force

Lifting force is the pressure on the lower surface is greater than the pressure on the upper surface which leads to generating pressure difference between the two surfaces of the airplane's wing and creating a force in the vertical direction, which helps to lift the airplane





قوة الرفع هي أن الضغط على السطح السفلي أكبر من الضغط على السطح العلوي مما يؤدي إلى توليد فرق الضغط بين سطحي جناح الطائرة وخلق قوة في الاتجاه العمودي، مما يساعد على رفع الطائرة



Viscosity اللزوجة

Viscosity is the friction force between the layers of the fluid itself and between the layers of the fluid and the walls of the tube contains them

and it was found experimentally that fluid viscosity depends on

1. Fluid type
2. Its temperature

اللزوجة هي قوة الاحتكاك بين طبقات المائع نفسه وبين طبقات السائل وجدران الأنبوب الذي يحتوي عليها.

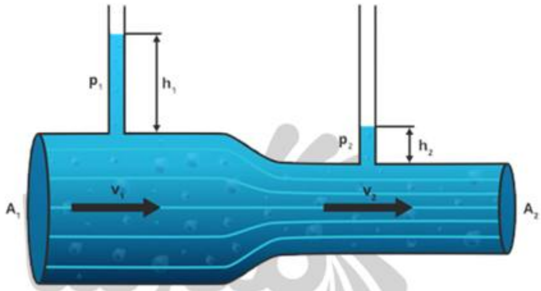
وقد وجد تجريبيا أن لزوجة السوائل تعتمد على

1- نوع المائع

2-درجة حرارته

QUESTIONS of CHAPTER 3

Q1. Choose the true answer for the following:



1. The following figure shows a fluid of neglected viscosity that flows regularly in tube with changing cross section area, then:

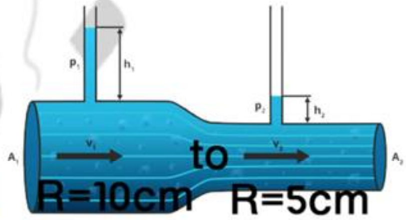
a- The liquid pressure in section (A_1) less than me liquid pressure in section (A_2).

b. The height of the liquid in tube y equals to the height of the liquid in tube (X)

c. The flowing average of the liquid in section (A_1) is greater than its flowing average in section (A_2).

d. The height of the liquid in tube (X) is greater than the height of the liquid in tube (Y).

2. A horizontal tube where a liquid flow, its diameter decreased from (10 to 5cm), then which one of the followings is true:



   a. Fluid's speed and pressure increases.
   b. Fluid's speed and pressure decreases.
   c. Fluid's speed increases and its pressure decreases.
   d. Fluid's speed decreases and its pressure increases.
3. The pressure applied to an enclosed fluid moves in all direction and without decreases according to:
   a. Archimedes principle b. Pascal principle
   c. Bernoulli effects d. Continuity flowing equation
4. The weight loss of the object immersed in a liquid depends on:
   a. Mass of the object b. Weight of the object c. Shape of the object
   d- volume of the object
5. Bernoulli principle is bases on:
   a. Energy conservation law b. Archimedes principle c. Pascal principle d. Capillary tubes
6. Gases and liquids are called fluid since the have flowing property because of;
   a. The high internal friction between its particles b. Big distance between particles
   c. Big particles force d. The low internal friction between its particles
7. Fluids have force that lifted the immersed objects in it which called:
   a. Buoyant force b. Gravitational force c. Frictional force d. Compressing force
8. one of the following applications doesn't depend on Bernoulli's effect: a. sailing boat b. Airplane c. hydraulic press d. Atomizer.

9. a swimming pool of (100m) length and (20m) width and the water height in it is (5m), then the pressure on the pool base is: a.$98\times10^2 N/m2$ b. $95\times10^6 N/m^2$ c. 49×10^6 N/m^2 d. 49×10^3 N/m^2

$$P = \rho g h = 1000 \times 9.8 \times 5 = 49 \times 10^3 N/m^3$$

10. When the liquid flows from a side tap into a closed container like in the given, we note that the liquid rises in all the different containers by the same amount, this can he explained by:
a. Archimedes' Principle b. Pascal's principle c. Atmospheric pressure d. Liquid pressure

11. From the given shape which of the following relation is true:
a. $h_1 = h_3$
b. $h_1 < h_3$
c. $h_1 > h_3$
d. $h_2 > h_1$

12. If an object of weight mg is immersed inside a liquid and still hanged in an equilibrium state then the buoyant force (F_B) is:
a. $F_B > mg$ b. $F_B = mg$ c. $F_B < mg$ d. $F_B = 2\ mg$ (the density of object = the density of a liquid)

13. to describe the regular flowing of a fluid at any time, we need to know:
a. Its density, weight and pressure b. Only its density and flowing speed
c. its density, volume and pressure d. Its pressure, density and flowing speed

14. If an object is immersed in a liquid and this object's density is greater than the liquids density, then the object:
a. Floats on the liquid's surface
b. Fully immersed in the liquid
c. Still hanged the liquid and, in an equilibrium, state
d. Still partially immersed in the liquid.

Q2. Give reason for the following

1- A razor can be placed on a steady water surface without immersed.
Because of the surface tension generated in the surface of the water as it is in the form of a thin and flexible membrane and in a state of constant tension.

بسبب الشد السطحي المتولد في سطح الماء إذ يكون بشكل غشاء رقيق ومرن وفي حالة توتر دائم. يمنع سقوط شفرة الحلاقة في الماء فهو يولد قوة للاعلى تعادل وزنها.

2- swimming skin sticks to the swimmer body when he comes us of the water but doesn't stick when he is inside the water.
If it is immersed, there is the adhesive forces between the water and the swimsuit. There is also the adhesive forces between the swimmer's body and the swimsuit.These forces are

equal. If he comes out of the water, only the adhesive forces between the swimmer's body and the swimsuit will keep the swimsuit sticking out of the water.

اذا كان مغموراً فان هناك قوة تلاصق بين الماء وقميص السباحة وكذلك هناك قوة تلاصق بين جسم السابح وقميص السباحة هاتان القوتان متساويتان، اما اذا خرج من الماء فستبقى فقط قوة التلاصق بين جسم السابح وقميص السباحة التي تجعل قميص السباحة يلتصق عند خروجه من الماء.

3- when pressing the internal surface of a tent with a finger while it's raining water flows from that point.

Because the pressure on the inner surface of the tent reduces the surface tension of the water and its fading at that point, the water runs out of that point.

لان عملية الضغط على السطح الداخلي للخيمة يعمل على نقصان الشد السطحي للماء وتلاشيه في تلك النقطة فينفذ الماء من ذلك الموقع.

4- a wet towel absorbs water from the skin faster than dry towel?
Because the wet towel increases the forces of adhesion to water and according to the capillary property absorb water.

لان المنشفة المبللة تزداد فيها قوى التلاصق للماء وحسب الخاصية الشعرية فتمتص الماء.

5- The concavity of the liquid surfaces that touches the walls of the capillary tubes?
Because the strength of the liquid the adhesive forces to the walls of the pipe is greater than the strength of the cohesive forces of its molecules.

لان قوة تلاصق السائل لجدران الانبوب أكبر من قوة تماسك جزيئاته.

6- The flying of buildings roofs that made up of aluminum sheets during hurricane?
The roofs of buildings are flying due to different wind (pressure and speed) and low pressure at the bottom of the roofs.

تطاير السقوف بسبب اختلاف الضغط للريح وضغط وواطئ وفي أسفل السقوف

7- The barefooted swimmer feels pain in the rough beach and his pain decreases as he goes deeper in the water?
The lifting force of the water "buoyant force", which raises the body upward, increases as it permeates into the water, which reduces its weight in the water.

لنشوء قوة دفع الماء الصعودية التي ترفع الجسم نحو الاعلى، فتزداد كلما تغلغل في الماء والتي تقلل من وزنه في الماء فيكون ضغطه على السطح الخشن قليل.

PROBLEMS of CHAPTER 3

Q1. A rectangular fish growing pool of (20m) length, (12m) width and the water height in it is (5m) calculate: a. Pressure on the pools base? b. The force acting on the base?

$$P = \rho g h = 1000 \times 9.8 \times 5 = 49000 N/m^2$$

$$A = L \times w = 20m \times 12m = 240m^2$$

$$P = \frac{F}{A}$$

$$F = P \times A = 49000 \times 240 = 1176 \times 10^4 N$$

Q2. If the mercury barometer reading is (75cm), then what is the amount of the atomospheric pressure in Pascal?

$$P = \rho g h = 13600 \times 9.8 \times 0.75 = 99960\ Pa$$

Q3. In a hydraulic press has big press area is (50) times as much the small one, if the force applied on the big press is (6000N), the calculate the force applied onn the small press?

$$\frac{A_2}{A_1} = 50$$

$$F_2 = F_1 \frac{A_2}{A_1}$$

$$6000 = F_1 50$$

$$F_1 = \frac{6000}{50} = 120N$$

Q4. A person is about to float while totally immersed in water if the body weight is (600N), calculate its volume? Considering the gravity is ($10m/s^2$)?

$$W_{body} = F_B$$

$$W_{body} = \rho \times g \times V$$

$$600 = 1000 \times 10 \times V$$

$$V = \frac{600}{10000} = 0.06m^3$$

Q5. The weight of a solid object in air is (20N) and in water is (15N) calculate the objects volume?

$$F_B = W_{in\ air} - W_{in\ water}$$

$$W_{in\ air} - W_{in\ water} = \rho \times g \times V$$

$$20 - 15 = 1000 \times 10 \times V$$

$$V = \frac{5}{10000} = 5 \times 10^{-4} m^3$$

Q6. The water flows through the big section of a tube with a speed of (1.2m/s) and when reaches the small section its speed becomes (6m/s). calculate the ratio between the two-section diameter?

$$A_1 V_1 = A_2 V_2$$

$$\pi r_1^2 V_1 = \pi r_2^2 V_2$$

$$r_1^2 V_1 = r_2^2 V_2$$

$$r_1^2 \times 1.2 = r_2^2 \times 6$$

$$\frac{r_1^2}{r_2^2} = \frac{6}{1.2} = \frac{60}{12}$$

$$\frac{r_1}{r_2} = \sqrt{5} \Rightarrow \frac{2r_1}{2r_2} = \frac{R_1}{R_2} = \sqrt{5}$$

CHAPTER 4 الفصل الرابع

THERMAL PROPERTIES OF MATERIAL

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وليد خالد الفتلاوي

CHAPTER 4

THERMAL PROPERTIES OF MATERIAL

the internal energy (U):the sum of the kinetic and the potential energy of the particle.

الطاقة الداخلية (U): مجموع الطاقة الحركية والطاقة الكامنة للجسم.

Remember

Specific heat depends only on the type of material and the heat capacity changes with object mass and the specific heat for its material.

تعتمد الحرارة النوعية على نوع المادة فقط وتختلف السعة الحرارية باختلاف كتلة الجسم والحرارة النوعية لمادته

Do you Know?

That heat quantity is measured by calorie unit and one calorie equals to (4.2 J) 1 cal=4.2 J

Heat an object depends on: كمية الحرارة اللازمة لتسخين جسم تعتمد على

1. mass of the object 2. The change in its temperature 3. The type of the material it made of

1- كتلة الجسم 2- التغير في درجة حرارته 3- نوع المادة المصنوع منها.

Heat quantity = mass of the object x Specific heat of the material x Change in temperature

كمية الحرارة = كتلة الجسم x الحرارة النوعية للمادة x التغير في درجات الحرارة

$$Q = mC_p\Delta t = mC_p(T_2 - T_1)$$

(C_p) **The specific heat of the material** measured under a constant pressure (P): the quantity of heat required to raise the temperature of (1 kg) from material one degree Celsius and its unit is (Joule/kg.°C)

(C_p) **الحرارة النوعية للمادة** مقاسة عند ضغط ثابت (P) **انها كمية الحرارة اللزمة لرفع درجة حرارة كتلة كيلو غرام واحد من المادة درجة سليزية واحدة وتقاس بوحدات (Joule/kg.°C)**

Its important to mention that the sign of (Δt) and (Q) is **positive** when the material gains heat energy from the surrounding so its temperature increases, and the sign is **negative** when the material losses heat energy to the surrounding so its temperature decreases.

ومن الجدير بالذكر ان اشارة (Δt) and (Q) موجبة عندما تكتسب المادة طاقة حرارية من المحيط فترتفع درجة حرارتها وتكون سالبة عندما تفقد المادة طاقة حرارية الى المحيط فتنخفض درجة حرارتها.

Heat Capacity السعة الحرارية

(C) **Heat Capacity**: The amount of heat required to raise the temperature of the whole mass from material one degree Celsius and its unit is (Joule/°C).

كمية الحرارة اللازمة لرفع درجة حرارة الجسم بكامله درجة سليزية واحدة بالسعة الحرارية للجسم.

(the Heat capacity of that object), and it can be calculated by the following relation:

Heat Quantity = Mass of the Object x Specific Heat x Change in Temperature

Heat Quantity = Heat Capacity x Change in Temperature

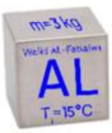
Heat Capacity = Mass of the Object x Specific Heat

$$C = mC_p$$

$$Q = C\Delta t = C(T_2 - T_1)$$

Where (C) is the heat capacity for the material, and heat capacity for a certain mass of the mate

EXAMPLE 1



What is the amount of heat energy required to raise the temperature of (3 kg) aluminum from (15°C) to (25°C) noting that the specific heat of aluminum is (900 J/kg.°C).

ما مقدار الطاقة الحرارية اللازمة لرفع درجة حرارة 3 kg من الالمنيوم من 15°C الى 25°C علماً بأن الحرارة النوعية للالمنيوم 900 J/kg.°C

$$Q = mC_p\Delta t = mC_p(T_2 - T_1)$$

$$Q = 3\,kg \times 900\ \frac{\text{J}}{\text{kg.}\,°\text{C}}(25 - 15)°\text{C} = 2700 \times 10 = 27000J = 27kJ$$

The specific heat for water is greater than all other material used in our daily life. And this can help us to explain many natural phenomena. And its also useful in many daily applications as:

الحرارة النوعية للماء أكبر منها لجميع المواد المستعملة في حياتنا اليومية. يساعدنا هذا في تفسير الكثير من الظواهر الطبيعية، وكما يفيد في العديد من التطبيقات الحياتية منها:

1. Its Effect to the weather (land and sea breeze). **تأثير على المناخ (نسيم البر والبحر)**

2. Its use in car engine cooling.**استعماله في عملية تبريد محرك السيارة**

4. Cooling of the machines in the factories using water. **تبريد الالات في المصانع باستعمال الماء**

EXAMPLE 2

What is the heat capacity for a piece of iron of (4 kg) mass and its specific heat is (448 J/kg.°C)?

ما السعة الحرارية لقطعة من الحديد كتلتها 4 kg وحرارتها النوعية 448 J/kg.°C ؟

$$C = mC_p = 4\,kg \times 448 \frac{\text{J}}{\text{kg.}\,°\text{C}} = 1792\ \frac{\text{J}}{°\text{C}}$$

Question

If you have three different metal pieces and where given the same heat quantity so their temperature increased as shown in the following figure then which one of them have the greater heat capacity, explain your answer?

إذا كان لديك ثلاث قطع معدنية مختلفة وزودت بكمية الحرارة نفسها فارتفعت درجة حرارتها كما مبين في الشكل التالي فاي القطع لها سعة حرارية أكبر؟ فسر اجابتك؟

$\Delta T = 5°\text{C}$ | $\Delta T = 9°\text{C}$ | $\Delta T = 3°\text{C}$

$$C \propto \frac{1}{\Delta t}$$

$$C = \frac{Q}{\Delta t}$$

$$Q = C\Delta t$$

$$Q_1 = Q_2 = Q_3\ it's\ same\ (constant)$$

$$C_1\Delta t_1 = C_2\Delta t_2 = C_3\Delta t_3$$

$$C_1 5°\text{C} = C_2 9°\text{C} = C_3 3°\text{C}$$

$$C_3 = \frac{Q}{3°\text{C}} > C_1 = \frac{Q}{5°\text{C}} > C_2 = \frac{Q}{9°\text{C}}$$

Thermal Equilibrium الاتزان الحراري

1. الحرارة هي شكل من أشكال الطاقة، والطاقة لا تُفنى ولا تُستحدث.
   Heat is a form of energy, and energy cannot be created or destroyed.
2. بالتالي، لا تُفنى الحرارة ولا تُستحدث، بل تنتقل من جسم إلى آخر.
   Therefore, heat cannot be created or destroyed, only transferred from one object to another.
3. إذا كان جسمان معزولان حراريًا عن الوسط المحيط، فإنهما لا يتبادلان حرارة مع البيئة الخارجية.
   If two objects are thermally isolated from the surrounding medium, they exchange no heat with the external environment.
4. عندئذ، نقول إن الجسمين في حالة اتزان حراري عندما تتساوى درجات حرارتهما.
   We then say the two objects are in thermal equilibrium when their temperatures become equal.
5. عند خلط سائلين بدرجتي حرارة مختلفتين، تنتقل الحرارة من السائل الساخن إلى البارد.
   When mixing two liquids at different temperatures, heat flows from the hotter liquid to the cooler one.
6. يستمر تدفق الحرارة حتى تصل درجة حرارة السائلين إلى نفس القيمة النهائية.
   The heat flow continues until both liquids reach the same final temperature.
7. عند وصولهما لدرجة الحرارة الموحدة، يتوقف تدفق الحرارة.
   Once they reach the uniform temperature, heat flow stops.

The principle of conservation of heat energy the heat lost by the hot object is equal to the heat gained by the cold object.

مبدأ الحفاظ على الطاقة الحرارية الحرارة المفقودة من الجسم الساخن يساوي الحرارة المكتسبة من الجسم البارد.

Heat lost by hot object = **Heat gained** by cold object

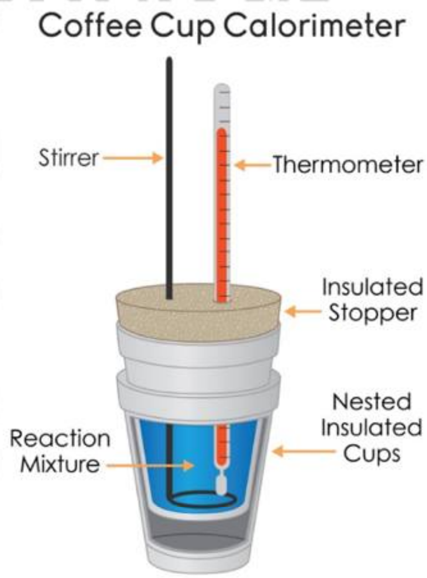
$$Q_{lost} = Q_{gained}$$

DO YOU KNOW هل تعلم!

eat energy is measured by joule unit that's if a matchstick burns it will produce about (2000 J)

تقاس الطاقة الحرارية بوحدات الجول , فلو احترق عود ثقاب لأنتج قرابة J2000

the calorimetry It to measuring the specific heat for a certain object



- المسعر الحراري Calorimeter

1. **المسعر الحراري جهاز لقياس الحرارة النوعية لمادة معينة.**
   A calorimeter is a device for measuring the specific heat of a substance.
2. **يتكون من وعاء داخلي رقيق من معدن موصل جيد مثل النحاس.**
   It consists of a thin inner container made of a good heat-conducting metal, such as copper.
3. **يحاط الوعاء الداخلي بوعاء خارجي من نفس المعدن.**
   The inner container is surrounded by an outer container of the same metal.
4. **تفصل بين الوعائين مادة عازلة للحرارة (مثل نشارة الخشب أو اللباد).**
   The two containers are separated by a thermal insulating material (e.g., sawdust or felt).
5. **التصميم اللاصق يضمن عزلاً حرارياً بين محتويات المسعر والوسط المحيط.**
   This design ensures thermal isolation between the calorimeter's contents and the surrounding environment.
6. **للجهاز غطاء يحوي فتحتين: الأولى لإدخال المحرار (الترمومتر)، والثانية لإدخال المحرك (لخلط المحتويات).**
   The calorimeter has a lid with two apertures: one for a thermometer and one for a stirrer to mix the contents.
7. **يُملأ الوعاء الداخلي بماء سبقِ معايرِته لبدء التجرِبة واحتساب كمية الحرارة الممتصة أو المنطلقة.**

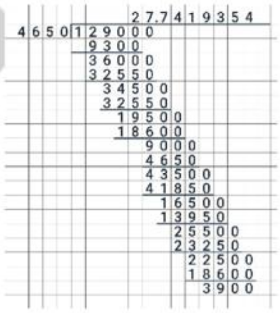
The inner container is filled with a known mass of water to begin the experiment and calculate the absorbed or released heat.

Example 3

An aluminum cube of (0.5 kg) at (100°C) was placed in a container filled with (1 kg) of water at (20 °C), (suppose that there is no lose for the heat energy to the surrounding), calculate the final temperature for the (aluminum and water) when thermal equilibrium is reached (means the temperature of the aluminum and water equalize). (Noting that the specific heat for water is (4200 J/kg.°C) and specific heat of aluminum is (900 J/kg.°C)

مكعب من الالمينوم كتلته 0.5 kg عند درجة حرارة 100°C وضع داخل وعاء يحتوي على من الماء 1 kg عند درجة حرارة 20 °C (افترض عدم حصول ضياع للطاقة الحرارية الى المحيط) , احسب درجة الحرارة النهائية (الالمنيوم والماء) عند حصول التوازن الحراري (أي تتساوى درجة حرارة الالمنيوم والماء).

علماً بان الحرارة النوعية للماء 4200 J/kg.°C والحرارة النوعية للالمنيوم 900 J/kg.°C



$$Q_{lost\ by\ \text{aluminum}} = Q_{gained\ by\ \text{water}}$$

$$mC_p(T_f - T_i) = mC_p(T_2 - T_1)$$

$$0.5 \times 900(T_f - 100) = 1 \times 4200(20 - T_f)$$

$$450(T_f - 100) = 4200(20 - T_f)$$

$$450\ T_f - 45000 = 84000 - 4200\ T_f$$

$$450\ T_f + 4200\ T_f = 84000 + 45000$$

$$4650\ T_f = 129000$$

$$T_f = \frac{129000}{4650} = 27.7\text{°C}$$

Example 2

Calculate the heat capacity for a copper calorimeter contains (100 g) of water at a temperature (10°C) add mother amount of water its mass of (100 g) at a temperature (80°C) and the mixtures final temperature became (38°C)?

احسب السعة الحرارية لمسعر من النحاس فيه ماء كتلته 100 g بدرجة حرارة 10°C أضيف إليه كمية ماء اخرى كتلتها 100 g بدرجة حرارة 80°C فأصبحت درجة حرارة الخليط النهائية 38°C

$$Q_{(hot\ water\ )lost} = (Q_{Cppper} + Q_{cold\ water})_{gained}$$

$$mC_p(T_f - T_i) = C(T_f - T_i) + mC_p(T_f - T_i)$$

$$(0.1)(4200)(38 - 80) = C(38 - 10) + (0.1)(4200)(38 - 10)$$

$$(420)(-42) = C(28) + (420)(28)$$

$$17640 = C(28) + 11760$$

$$C(28) = 17640 - 11760$$

$$C(28) = \frac{5880}{28} = 210\ J/°C$$

Heat Effect on Materials تأثير الحرارة على المواد

Materials expand by heat:تمدد المواد بالحرارة

When the temperature of the solid, liquid or gas material is increasing the average kinetic energy of the particles increases so the gaps between them increase then it gets in expansion but this expansion is different depending on the state of the material, so gases expansion is more than liquids and liquids expansion is more than solids if the gained heat was equal for the three states.

عند رفع درجة حرارة المادة الصلبة او السائلة او الغازية يزداد معدل الطاقة الحركية للجزيئات فيزداد التباعد فيما بينهما فيحصل التمدد ولكن هذا التمدد يختلف باختلاف حالة المادة فتمدد الغازات يكون أكبر مما هو عليه في السوائل وتمدد السوائل أكبر مما هو عليه في الصلب اذا كانت الحرارة المكتسبة متساوية للحالات الثلاثة للمادة.

a. Expansion of solidsتمدد المواد الصلبة

Expansion means increase in the dimensions of the material, thus there is:

* Longitudinal expansion means increase in the length of the stem (expansion in one dimension).

* Surface expansion means increase in the surface area (expansion in two-dimensions).

* Volumetric expansion means expansion in objects volume (expansion in three-dimensions).

التمدد يعني زيادة في ابعاد المادة وعليه فهناك:

- **تمدد طولي أي زيادة في طول الساق (التمدد في بعد واحد**
- **تمدد سطحي أي زيادة في مساحة السطح (التمدد في بعدين**
- **تمدد حجمي أي زيادة في حجم الجسم (تمدد في ثلاثة ابعاد**

Longitudinal expansion: التمدد الطولي

Length change = Longitudinal expansion factor x Original length x Amount of temperature change

Where ΔL= new length – original length

α = longitudinal expansion factor **معامل التمدد الطولي**

$$\alpha = \frac{\Delta L}{L\ \Delta T}$$

The longitudinal expansion factor (α) (alpha) can be defined as: The amount of increase in the unit lengths of the material when heated one degree Celsius is measured by ($1/^0C$) unit and it differs according to the material.

التمدد الطولي α : مقدار الزيادة الحاصلة في وحدة الاطوال من المادة عند تسخينها درجة سليزية واحدة ويقاس بوحدة $1/C^0$ وهو يختلف باختلاف المواد.

Surficial expansion: التمدد السطحي

Change in area = surficial expansion factor X original Area X Amount of temperature change

$$\gamma = \frac{\Delta A}{A\ \Delta T}$$

The surficial expansion factor (γ) (Gamma) (γάμμα) can be defined as: The amount of increase in the area unit from object when temperature rises one degree Celsius and is measured by ($1/°C$) unit.

معامل التمدد السطحي γ: مقدار الزيادة الحاصلة في وحدة المساحة من الجسم عندما ترتفع درجة الحرارة درجة سليزية واحدة. وتقاس لوحدة $1/C°$

Surface expansion factor = twice the longitudinal expansion factor

$$\gamma=2\alpha$$

Volumetric expansions: التمدد الحجمي

Cahnge in Volume = Volumetric Expansion Factor x Original Volume x Amount of temperature change

$$\beta = \frac{\Delta V}{V\ \Delta T}$$

The volumetric expansion factor β beta (βήτα) can be defined as : is amount of increase in the volume unit of the material when temperature one degree Celsius and measured by (1/°C) unit.

التمدد الحجمي β: هي مقدار الزيادة الحاصلة في وحدة الحجم من المادة عند ارتفاع درجة حرارتها درجة سيليزية واحدة وتقاس لوحدة C°/1

Volumctric Expansion Factor (β) = three times the Longitudinal Expansion Factor (α)

$$\beta = 3\alpha$$

Applications on solid material expansion by heat:

The phenomenon of the expansion materials as the temperature increase and the contraction of them as the temperature decreases had been used in many practical applications like the automatic thermostat in electrical devices like fridge, freezer, flat irons and fire alarm device, where a bimetallic strip band is used to control the opening and the closing of the electric circuit.

لقد تمت الاستفادة من ظاهرة تمدد المواد بارتفاع درجةالحرارة وتقلصها بانخفاض درجة الحرارة في الكثير من التطبيقات العملية ومنها الضابط الاوتوماتيكي الحراري في الاجهزة الكهربائية مثل الثلاجة والمكواة والمجمدة وجهاز انذار الحريق، اذ يستعمل شريط ثنائي المعدن للسيطرة على فتح وغلق الدائرة الكهربائية.

The metal of high expansion factor bends around the metal of lower expansion factor when temperature increases leads to open the electric circuit and when the temperature decreases it retums straight to close the circuit and open it again.

فالمعدن ذو معامل التمدد الاكبر ينحني حول المعدن ذو معامل التمدد الاقل عند ارتفاع درجة الحرارة مسبباً فتح الدائرة الكهربائية للجهاز وعندما تنخفض درجة حرارته يرجع بصورة مستقيمة غلق الدائرة وتشغيلها مرة ثانية.

Some of the important application for the difference solid material expansion phenomenon.

- The usage of two different materials have equal thermal expansion factor and taking the advantage of this in the electric lamp industry. The lamp's glass has equal thermal expansion factor to the wire used so when the wire that holds the lamp filament and that's another end is immersed in the lamp's glass expands the glass also expands by the same amount in order to prevent the lamp's base from breaking.

الاستفادة من مادتين مختلفتين لهما معامل تمدد حراري متساوي اذ يستثمر ذلك في صناعة المصابيح الكهربائية، اذ يمتلك زجاج المصباح معامل تمدد حراري مساوٍ لمعامل التمدد الحراري للسلك المستعمل فان السلك الحامل لخويط المصباح والمغمور طرفه الأخر في زجاج المصباح عند تمدده يتمدد الزجاج بالمقدار نفسه لمنعها من كسر قاعدة المصابيح الزجاجية

- Also, materials thermal expansion was taken into account in the construction design to avoid the dangers, and that's by putting proper spaces or separators in bridges and leaving spaces between railway bars.

كما روعي في تصميم الانشاءات تمدد المواد بالحرارة تجنبا للمخاطر وذلك عن طريق وضع فراغات او فواصل مناسبة في الجسور وترك مسافات بين خطوط سكك الحديد

b. Thermal expansion of liquids تمدد السوائل

The solid material expands by increasing temperature, liquids also expands by it and to know about the liquid expansion we perform the following activity:

Activity Extent the fluids by heat

Tools: glass beaker, big container, two-end opened narrow glass tube, a rubber cub that's the tube passes through, colored water, thermal source

Steps:

1. we fill three quarters of the container with water and then heat it by the thermal source.

2. we fill the beaker with the colored water and close it by cub and make a sign at the water surface in the tube.

3. Put the beaker in the container and observe what happen to the water height in the tube. When heating starts the level of the water drops a little in the tube because the class expands at first and increases in the volume, so the water level drops to replace, the vacuum resulting from the increase in the volume of the beaker. When the heat reaches the water through the beaker's glass it expands and raises in the tube due to its volume increase but the volumetric expansion of liquids is greater than the volumetric expansion of solid materials under the same temperature change, as a result of the containers expansion that contain the i liquid then the expansion that we see and measure is less than the real expansion and its called apparent expansion.

And so, we can define:

Apparent Volumetric expansion factor (β_v) for the liquid in a container: is the ratio of the apparent volume increase for each Celsius degree.

Real Volumetric expansion factor (β_r) for the liquid in a container: is the ration of the real volume increase for each Celsius degree (β_v).

معامل التمدد الحجمي الظاهري β_v للسائل الذي في وعاء: هو نسبة الزيادة الظاهرية في الحجم لكل درجة سليزية واحدة.

معامل التمدد الحجمي الحقيقي β_r للسائل الذي في وعاء: هو نسبة الزيادة الحقيقية في الحجم لكل درجة سليزية واحدة.

Its important to know the following:

Real expansion factor for the liquid (β_r)> apparent expansion factor (β_v).

And also:

Real expansion factor for the liquid (β_r)=apparent expansion factor(β_v)+Volumetric expansion

معامل التمدد الحقيقي للسائل β_r = معامل التمدد الظاهري β_v + معامل التمدد الحجمي للأناء

$$\beta_r = \beta_v + 3\alpha$$

That the Pyrex glass with stand fast changes in temperature without breaking and that's because its longitudinal expansion factor is smaller compared to normal glass.

فكر THINK!

When placing a mercurial thermometer in a hot liquid then it drops a little at first then rises, explain that?

عند وضع محرار زئبقي في سائل ساخن فانه ينخفض قليلا في البداية ثم يرتفع فسر ذلك؟

1. زيادة الضغط الهيدروستاتيكي على المستودع عند الغمر يجعل عمود الزئبق ينضغط قليلاً وينخفض في الأول.
   The hydrostatic pressure on the bulb increases when it's immersed, slightly compressing the mercury reservoir and forcing the column downward at first.
2. المساحة التعرضات الحرارية المختلفة: الزئبق في العمود لا يسخن فورًا بقدر ما يسخن المصباح، فيحدث انكماش طفيف أولي.
   Thermal lag between bulb and stem: the mercury in the stem doesn't heat as quickly as the reservoir, causing an initial slight contraction.
3. مع انتقال الحرارة تدريجيًا إلى الزئبق في المصباح، يبدأ الزئبق في التمدد الحراري.
   As heat gradually conducts into the mercury reservoir, the mercury begins to thermally expand.
4. التمدد الحراري يتغلب على الضغط الهيدروستاتيكي، فيرتفع عمود الزئبق إلى قراءة درجة الحرارة الحقيقية.
   Thermal expansion overcomes the hydrostatic compression, causing the mercury column to rise to the true temperature reading.

Example

The gasoline tank of the car of (60) litter volume was fully tilled with gasoline when the temperature was (25°C), then the car was left under the sun light many hours till the tank temperature became (45°C), calculate the volume of the gasoline that's expected to spill from the tank (neglect the gasoline tank expansion)?

مُليءَ خزان بنزين السيارة حجمه 60L بالبنزين تماما حينما كانت درجة الحرارة (25°C) ثم تركت السيارة تحت اشعة الشمس ساعات عدة الى ان اصبحت درجة حرارة الخزان (45°C) احسب حجم البنزين المتوقع ان ينسكب من الخزان (أهمل تمدد الخزان)؟

$\beta = 9.6\times10^{-4}\ 1/°C$

$\Delta T = T_f - T_i$

$\Delta T = 45 - 25 = 20\ °C$

$\Delta V = V\beta\Delta T$

$\Delta V = 60 \times 9.6 \times 10^{-4} \times 20 = 1.152$ Litter

C. Gases expansion تمدد الغاز

The gases expansion is greater than the liquids expansion and greater the solid materials due to less molecular force between their molecules. and gases are characterized by having equal volumetric expansion factor at constant pressure, and it has been proven that the expansion of the container that contain the gas is very small compared to the expansion of the gas itself so containers expansion can be neglected thus the apparent expansion of gases is considered as real expansion.

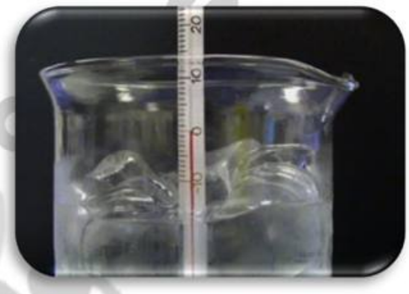
تمدد الغازات أكثر من تمدد السوائل وأكثر من المواد الصلبة بسبب قلة القوى الجزيئية بين جزيئاتها. وتمتاز الغازات بتساوي معامل التمدد الحجمي لجميعها عند ثبوت الضغط وقد ثبت ان تمدد الاناء الحاوي على الغاز بتاثير الحرارة يكون صغيراً جداً قياسا لتمدد الغاز نفسه عندها يمكن اهمال تمدد الاناء وبهذا يعد التمدد الظاهري للغازات تمدداً حقيقياً.

كمية الحرارة اللازمة لأنصهار المادة = الكتلة × الحرارة الكامنة للانصهار

State Change of Matter تغير حالة المادة

Latent heat of fusion الحرارة الكامنة للانصهار

Each pure material has its own melting point. The different kinds of materials require different quantity from heat to melt equal masses. (for example, melting point for ice is 0°C)



ان لكل مادة نقية درجة انصهار خاصة بها، وان الانواع المختلفة من المواد تحتاج الى كميات مختلفة من الحرارة لانصهار الكتل المتساوية منها. على سبيل المثال نقطة انصهار الثلج 0°C

Latent heat of fusion: is the quantity of heat required to convert a masses unit from solid to liquid at the same temperature and under constant pressure. (measured by (J/kg) units).

الحرارة الكامنة للانصهار: كمية الحرارة اللازمة لتحويل وحدة الكتل من حالة الصلابة الى حالة السيولة وبدرجة الحرارة نفسها وتقاس بوحدات J / kg

Quantity of heat required to melt the material = mass x latent heat of fusion

كمية الحرارة اللازمة لأنصهار المادة = الكتلة × الحرارة الكامنة للانصهار

$$Q = mL_f$$

Example 1

Calculate the quantity of heat required to convert an ice piece of (25g) at (0°C) to water under the same temperature. the latent heat of fusion for ice at (0 °C) is (335 kJ/kg)

احسب كمية الحرارة اللازمة لتحويل قطعة من الجليد كتلتها (g25) بدرجة حرارة (C°0) الى ماء عند درجة الحرارة نفسها.

$$Q = mL_f = 0.025 \times 335 = 8.375KJ$$

تذكر REMEMBER

That β for any gas equals to 1/273 (1/°C) under constant pressure.

ان β لأي غاز يساوي 1/273 (1/°C)

Example 2

Calculate the quantity of heat required to convert (2 kg) of ice at (–15°C) to water at (25°C) noting that specific heat of water is (4 200 J/kg.°C) and the latent heat of fusion for ice at (0°C) is (335 kJ/kg) and specific heat of ice is (2 093 J/kg.°C).

احسب كمية الحرارة اللازمة لتحويل (2 kg) من الجليد بدرجة (–15°C) الى (25°C) ماء بدرجة حرارة علما ان الحرارة النوعية للماء (4 200 J/kg.°C) والحرارة الكامنة لانصهار الجليد عند $0°C$ هي (335 kJ/kg) والحرارة النوعية للجليد تساوي (2 093 J/kg.°C)

$$Q_1 = mC_p\Delta T = 2 \times 2\,093 \times (0 - (-15)) = 62\,790J = 62.79KJ$$

$$Q_2 = mL_f = 2 \times 335 = 670KJ$$

$$Q_3 = mC_p\Delta T = 2 \times 4\,200 \times (25 - 0) = 210\,000J = 210KJ$$

$$Q_{total} = Q_1 + Q_2 + Q_3 = 62.79KJ + 670KJ + 210KJ = 942.79KJ$$

Latent heat of vaporization is the heat quantity required to convent a masses unit of the material from liquid to gas state at the boiling point.

الحرارة الكامنة للتبخر: وتسمى كمية الحرارة اللازمة لتحويل وحدة الكتل من المادة من حالة السيولة الى الحالة الغازية عند درجة الغليان.

The temperature which matter start converting from liquid state to gas state is known by **boiling temperature**

درجة الحرارة التي تبدأ عندها المادة بالتحول من الحالة السائلة الى الحالة الغازية **بدرجة حرارة الغليان**

which is a physical property of matter, where each pure matter has specific boiling temperature at a specific atmospheric pressure.

وهي من الخواص الفيزيائية المميزة للمادة، حيث ان لكل مادة نقية درجة حرارة غليان خاصة بها عند ضغط جوي معين.

Heat quantity required to convert an amount of liquid to vapor under the same temperature = mass X latent heat of vaporization

$$Q = mL_v$$

Example

Calculate the quantity of heat required to convert (3kg) of water at (20°C) to vapor at (110°C) noting that the specific heat of water is (4200 J/kg) and the latent heat of vaporization of water is (2260 kJ/kg) and the specific heat of water vapor is (2010 J/kg°C) ?

احسب كمية الحرارة اللازمة لتحويل(kg3) من الماء درجة حرارته(C°20) الى بخار درجةحرارته (C°110) علماً ان الحرارة النوعية للماء تساوي (J/kg 4200) والحرارة الكامنة لتبخر الماء (2260 kJ/kg)والحرارة النوعية لبخار الماء (2010 J/kg°C)

$$Q_{total} = Q_1 + Q_2 + Q_3$$

$$Q_{total} = mC_p\Delta T + mL_v + mC_p\Delta T$$

$$Q_{total} = m(C_p\Delta T + L_v + C_p\Delta T)$$

$$Q_{total} = 3(4.200(100-20) + 2260 + 2.010(110-100))$$

$$Q_{total} = 3(4.200 \times 80 + 2260 + 2.010 \times 10)$$

$$Q_{total} = 3(336 \ + 2260 + 20.1)$$

$$Q_{total} = 3(2616.1) = 7848.3\ kJ = 7848300\ J$$8h

Methods of HEAT TRANSFER طرق انتقال الحرارة

There are three ways for heat to travel: هنالك ثلاث طرق لانتقال الحرارة

(1) conduction (2) convection (3) radiation

(1)التوصيل (2) الحمل (3) الاشعاع

thermal conduction

Heat transfers in solid material by conduction method, and the time average of the transferred thermal energy differs from one material to another depending on the internal structure of the material and metals are considered good thermal conduction materials and that is because of their free electrons and close atoms while heat transfers very weekly in poor thermal conduction materials like wood, rubber, plastic and others.

الحرارة تنتقل في المواد الصلبة بطريقة التوصيل ويتفاوت المعدل الزمني للطاقة الحرارية المنقولة من مادة الى اخرى حسب التركيب الداخلي للمادة وتعد الفلزات مواد جيدة التوصيل الحراري ويعود ذلك الى احتوائها على الالكترونات الحرة وتقارب ذراتها بينما تنتقل الحرارة على نحو ضعيف في المواد رديئة التوصيل مثل الخشب والمطاط

The heat energy amount that is transferred through an object by conduction method depends on a property on a **Thermal conductivity of matter**.

ان مقدار الطاقة الحرارية المنتقلة خلال جسم ما بطريقة التوصيل يعتمد على خاصية تدعى التوصيلية الحرارية للمادة

Thermal gradient: is the amount of change in conductor's temperature at each meter of its length when the heat transfer perpendicular on its cross-sectional area.

الانحدار الحراري: هو مقدار التغير في درجة حرارة الموصل في كل متر من طوله حينما تنتقل الحرارة عموديا على مساحة مقطعه العرضي.

$$Thermal\ gradient = \frac{\Delta T}{L}$$

And from this we find that as long as the thermal gradient increases the amount of thermal energy flow increases, and the time average for the transfer of thermal energy can be expressed by the following relation.

the time average for the transfer of thermal energy = thermal conduction coefficient x cross sectional area x thermal gradient

المعدل الزمني لانتقال الطاقة الحرارية = معامل التوصيل الحراري ×مساحة المقطع العرضي ×الانحدار الحراري

$$H = KA\frac{\Delta T}{L}$$

Where:

H: represents the time average for the transfer of thermal energy by conduction method and measured by Watt

يمثل المعدل الزمني لانتقال الطاقة الحرارية بطريقة التوصيل وتقاس بوحدات Watt

A: cross section area measured by (m^2).

ΔT : temperature differences measured by (°C).

L: length of the rod (or its thickness) measured by (m).

k: thermal conduction coeflicient measured by (watt/m.°C).

معامل التوصيل الحراري ويقاس بوحدات (watt/m.°C)

Question

Why does firefighters use helmet made of yellow copper (Brass is an alloy of copper and zinc) rather than helmet made of red copper?

لماذا يستعمل رجال اطفاء الحرائق خوذة على الرأس مصنوعة من النحاس الاصفر بدلا من خوذة مصنوعة من النحاس الأحمر

because the conductivity coefficient yellow copper less than red copper

وذلك بسبب ان معامل التوصيل الحراري للنحاس الأصفر أقل من النحاس الأحمر

تذكر REMEMBER

Engineers took the expression of thermal resistance for an insulating layer and it's calculated according to the following equation

$$Thermal\ resistance = \frac{Layer\ thickness}{Thermal\ conduction\ Coefficient\ of\ the\ layer}$$

EXAMPLE 1

An iron rod of (50cm) length and sectional area of ($1cm^2$), its one side was placed on flame at (200°C) and the other end was placed in crushed ice at (0°C), if the rod was covered by insulating material and if the thermal conduction coefficient of iron is (79Watt/m.°C) then calculate:

1. Thermal gradient
2. The time average for the transfer of thermal energy.

ساق من الحديد طوله (50cm) ومساحة مقطعه ($1cm^2$)وضع احد طرفيه على لهب درجة حرارته (200°C) ووضع طرفه الاخر في جليد مجروش (0°C), اذا كان الساق مغلفا بمادة عازلة علما ان معامل التوصيل الحراري للحديد يساوي (79Watt/m.°C) احسب:

1-الانحدار الحراري

2-المعدل الزمني لانسياب الطاقة الحرارية

$$Thermal\ gradient = \frac{\Delta T}{L} = \frac{200-0}{50\times10^{-2}} = 400\ ℃$$

$$H = KA\frac{\Delta T}{L} = 79\times10^{-4}\times400 = 3.16\ watt$$

EXAMPLE 2

Room window with one-layer, if the length of the window (2.2m), width (1.2m) and thickness 5mm, assuming the temperature of the window surface inside the room (22 °C) and the temperature outside it (3°C), calculate the time average to transfer thermal energy from room, note the thermal conduction coefficient of glass (0.8w/m.°C)?

غرفة لها نافذة زجاجية ذات طبقة واحدة فاذا كان طول النافذة (m2.2) وعرضها (m1.2) وسمكها 5mm وعلى افتراض ان درجة حرارة سطح النافذة الزجاجية داخل

الغرفة (22 °C) ودرجة حرارتهامن الخارج (3° C)احسب المعدل الزمني لأنتقال الطاقة الحرارية من الغرفة علما ان معامل التوصيل الحراري للزجاج (0.8 w/m.°C)؟

$$H = KA\frac{\Delta T}{L} = 0.8 \times (2.2 \times 1.2) \times \frac{22-3}{5\times10^{-3}} = \frac{2112\times19}{5} = 8{,}025.6\, watt$$

1. Using metals to make Kitchen-ware.
2. Using insulating material for handles in Kitchen-ware.
3. Thermal insulation in house constructions using insulating materials like air, glass and polystyrene.

One of the other applications on thermal insulation is the thermos can which is made of an interior layer of plastic and an exterior layer of polystyrene, and according to this system the temperature of the liquid in it is kept by reducing thermal leakage to the outside.

ومن التطبيقات على التوصيل الحراري:
استعمال المعادن لصناعة اواني الطبخ.
استعمال مواد عازلة للمقابض في اواني الطبخ.
العزل الحراري عند بناء البيوت باستعمال مواد عازلة مثل الهواء والزجاج والبوليسترين.

ومن التطبيقات العملية الاخرى على العزل الحراري هي قنينة الترموساذ تتكون من طبقة داخلية من البلاستك وخارجية من البوليسترين، ووفق هذا النظام يتم الحفاظ على درجة حرارة السائل الموضوع فيهمن خلال تقليل تسرب الحرارة الى الخارج.

Transfer of heat by convection الحمل الحراري

We find in thermal convection method that the material's particles themselves move and transfer from one place to another, and thermal convection occurs only in fluid and doesn't occur in solids, And convectional streams also occur in liquids, the water that is near the heat source warms up more than the water in the other places thus it expands and its density decreases compared to the density of the surrounding water as a result it raises carrying thermal energy with it by method called thermal convection and another water with less temperature comes to its place, heat is transferred in gases by the same way.

نجد في طريقة الحمل الحراري ان جزيئات المادة نفسها تتحرك وتنتقل من مكان الى اخر والحمل الحراري يحصل فقط في الموائع ولايحصل في المواد وتحصل تيارات الحمل كذلك في السوائل فعند وضع ابريق معدني فيه ماء فوق مصدر حراري الصلبة الماء الذي في المناطق القريبة من المصدر الحراري يسخن اكثر من الماء الذي في المناطق الاخرى فيتمدد وتقل كثافته عن كثافة الماء المحيط به فيرتفع حاملا معه الطاقة الحرارية بطريقة تسمى الحمل الحراري ويحل محله ماء درجة حرارته اقل وتنتقل الحرارة في الغازات بالطريقة نفسها

Types of converction

1. Free convection

In this type the convectional current generate by effect of gravity, cold air have greater density so it comes down because the upthrust force is less than its weight, while hot air's density is less so it goes up carrying the thermal energy with it because the upthrust force is greater than its weight in this case.

الحمل الحراري الطبيعي الحر

تتولد تيارات الحمل الحرارية في هذا النوع بتاثير الجاذبية الأرضية فالهواء البارد يكون اكبركثافة فيهبط الى الاسفل لان القوة الصعودية تكون اقل من وزنه بينما كثافة الهواء الساخن تكون قليلة فيرتفع الى الاعلى حاملا معه الطاقة الحرارية لان القوة الصعودية تكون في هذه الحالة أكبر من وزنه

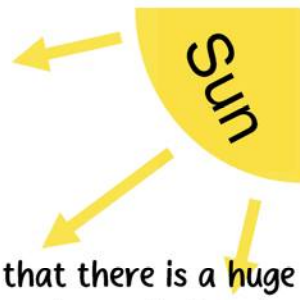
2. Forced convection

In this type the fluid is motivated to circulate by installing a pump or a fan in the fluid's way that creates a pressure difference which forces the particles to move, hence in some central heating processes the hot air is pushed into the halls using fan or the hot water is pumped into radiators that's placed on the ground.

الحمل الحراري الاضطراري (القسري)

في هذا النوع يحرض المائع على الدوران من خلال تركيب مضخه او مروحه في مجرى المائع ينشا عنها فرق في الضغط يجبرالجزيئات على الحركة ففي بعض عمليات التدفئة المركزية اما يدفع الهواء الساخن في القاعات بوساطة مروحة او يضخ الماء الساخن الى مشعات حرارية توضع على الأرض

Heat transfer by radiation



The sun's heat transfers and reaches to the earth and warms it and know that there is a huge gap between the sun and the earth that doesn't allow heat to be transferred we whether by conduction or by convection method since there is no material medium that transfers the heat, the method that heat is transferred from the sun is called radiation. Heat is transferred by radiation in form of **electromagnetic waves** in the speed of light and its wavelengths differ depend on the radiating object's temperature, and it ranges between violet rays and infrared rays And all the objects radiate energy in the form of electromagnetic waves even the ice cube and our bodies And the amount of radiation energy emitted from the objects depends on:

أن حرارة الشمس تنتقل وتصل الى الارض وتسخنها ونحن نعلم انه يوجد فراغ هائل بين الشمس والارض لايسمح بنقل الحرارة بطريقتي التوصيل والحمل لعدم وجود وسط مادي ناقل للحرارة ان الطريقة التي تنتقل الحرارة بها من الشمس تسمى طريقة الاشعاع. تنتقل الحرارة بالإشعاع بشكل **موجات كهرومغناطيسية** بسرعة الضوء نفسها وتختلف اطوالها الموجية حسب درجة حرارة الجسم المشع فهي تتراوح بين الاشعة البنفسجية والاشعة تحت الحمراء. والأجسام جميعها تشع طاقة بشكل موجات كهرومغناطيسية حتى المكعب الثلجي واجسامنا. وان مقدار الطاقة الاشعاعية المنبعثة من الاجسام يعتمد على:

1. The nature of the surface that emits radiation energy that's as long as the surface's area increases the amount of emitted energy increases. also, its color, since black surface radiates energy with an average that is very greater than the average emitted by a fair colored object.

1. طبيعة السطح الباعث للطاقة المشعة مثل مساحة سطحه فكلما زادت مساحة السطح ازدادمقدار الطاقة المنبعثة، وكذلك لونه فالسطح الاسود يشع طاقة بمعدل يفوق كثيرا معدل اشعاع السطح ذي اللون الفاتح.

2. Temperature: the objects radiates energy in the form of electromagnetic waves that can be seen if the temperature of the objects was high while the radiations are invisible when the object's temperature is low.

2. درجة الحرارة: حيث ان الاجسام تشع طاقة على شكل موجات كهرومغناطيسية يمكن رؤيتها اذاكانت درجة حرارة الاجسام مرتفعة بينما تكون الاشعاعات غير مرئية إذا كانت درجة حرارة الاجسام منخفضة.

that material those are good heat radiation are also good heat absorbers and the amount of absorbed heat energy differs by the following changes:

ان المواد جيدة الاشعاع الحراري تكون جيدة الامتصاص الحراري وان مقدار الطاقة الحرارية الممتصة تختلف باختلاف مايلي

1. Type of the material نوع المادة
2. Color of the materialلون المادة
3. How smooth it is. مدى صقلها

Where smooth and fair colored objects absorb radiation energy less than rough and dark colored objects do

حيث ان الاجسام الفاتحة والمصقولة تمتص طاقة اشعاعية اقل من الاجسام الخشنة والقاتمة

Application on heat transfer by convection and radiation methods:

تطبيقات على انتقال الحرارة بطريقتي الحمل والاشعاع

1. Plastic (glass) houses → radiation.
2. Solar heater → radiation.

3. Central heating → convection + radiation
4- Night photographing by infrared rays → radiation.

1. البيوت البلاستيكية ← اشعاع
2. السخان الشمسي ← اشعاع
3. التدفئة المركزية ← حمل + اشعاع
4. التصوير الليلي بالاشعة تحت الحمراء ← اشعاع

Thermal Pollution التلوث الحراري

Human our century is making many activities that result together in the temperature increase or the land and atmosphere and water which leads to a dysfunction in the environmental structure and this phenomenon is named thermal pollution.

يقوم الإنسان في عصرنا الحالي بنشاطات عدة تعمل بعضها على رفع درجة حرارة البر والجو والماء مما يؤدي الى خلل في التركيبة البيئية وتسمى هذه الظاهرة بالتلوث البيئي الحراري

Thermal pollution sources:مصادر التلوث الحراري

Thermal pollution is considered an industrial problem in spite of the civil waste also cause a limited change in the temperature of receiving water for this waste, the most important thermal Pollution sources are:

يعد التلوث الحراري معضلة صناعية على الرغم من ان الفضلات المدنية تسبب هي الاخرى تغيرا محدودا في درجات حرارة المياه المستقبلة لهذه الفضلات واهم مصادر التلوث الحراري هي:

1. Electrical energy generating Sources. مصادر توليد الطاقة الكهربائية
2. Petroleum industry and refineries الصناعات النفطية والمصافي

QUESTIONS of CHAPTER 4

Q1. Choose correct answer for the following questions:

1. When water converse from one state to another then its temperature:
a. Increases by one Celsius degree.
b. Always changes.
c. Decreases by one Celsius degree then stay constant until all the water amount i
d. Stay constant until all the water amount is converted.

2. When the first object of (T_1) temperature contacts with the second object of (T_2) temperatrue both are thermally insulated from the surrounding medium, so if ($T_1 > T_2$) then the heat energy transfer between them continues until:
a. The second object's temperature become less than the first object.
b. The first object's temperature become less than the second object.

c. Both of them reaches the same temperature (T) where ($T_2<T_f<T_1$).
d. The temperature of the first object become zero.

3. If The time average of the transfer of thermal energy from the window's glass to the room was (H), then if the **area** and the **thickness** of the glass were **decreased** to **half** then the time average of the transfer of thermal energy becomes:
a. 4H b. 2H c. H d. H/2

$$H = \frac{k\,1/2\,A\Delta T}{1/2\,L}$$

4. Heat Transfer in gases occurs by:
a. Radiation only.
b. Convection only.
c. Radiation and convection only.
d. Radiation, conduction and convection.

5. When Vapor condenses and becomes liquid:
a. Its temperature increases.
b. Its temperature decreases.
c. Absorbs heat.
d. Emits heat.

6. Heat transfer is space is done by:
a. Radiation only.
b. Convection only.
c. Radiation and convection only.
d. Radiation, conduction and convection.

7. When **the mass (m) and the temperature (ΔT) is constant** then the heat quantity of the object depends on:
a. Volume of the object.
b. Shape of the object.
c. Type of the material of the object.
d. All of the above.

$$Q = mC_p\Delta T$$
$$Q \propto C_p$$

8. when matter converse from liquid state to gaseous state at the boiling point then it should be supplied by a heat quantity equals to:
a. Multiplication result of the mass x latent heat of vaporization x temperature.
b. Multiplication result of the mass x temperature difference.
c. Quantity of latent heat of vaporization.
d. Multiplication result of the mass x latent heat of vaporization.

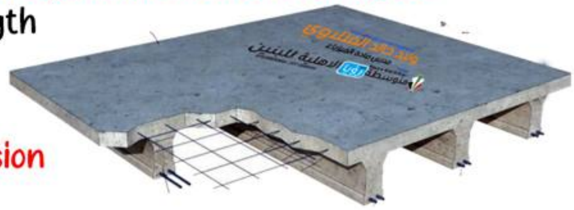
$$Q = mL_v$$

Q2 Answer the following questions:

1. Three rods of copper, steel and aluminum have equal length at (0°C) which one of them will be longer at (250°C).

Aluminum will be the longest because the longitudinal expansion coefficient largest.

2. Steel rods are added to reinforced cement to strength it, why the steel is considered suitable to strength then the cement?
   That because to equal the longitudinal expansion coefficient for both cement and steel is 2×10^{-6} 1/°C



3. Why its advised not to open the radiators cover until the engine cools down, explain that?
   Because the cooling system in car engines is closed, it acquires extra heat from the engine body and when the cap is opened directly, the excess water temperature burns the hand.
4. The pipes in the solar heater are painted with black paint, why?
   Because the solar radiation energy **absorbed** by the black coated tubes increases
5. The water in the aluminum cup freezes before the water in the glass cup when placed in the fridge?
   Because the specific heat of aluminum is **greater** than the specific heat of glass.
6. When you touch two pieces one is iron and the other is wood at (0°C) you feel like the iron is colder. Why?
   Because iron is a better conduction of heat than wood, iron gain hand temperature, and you feel its cold
7. Hot water is poured out on the glass containers cover that contain specific food in order to open it easily?
   Because the coefficient of thermal expansion of the cover is greater than that of glass, when pouring hot water, the cover expands more than the expansion of the glass.

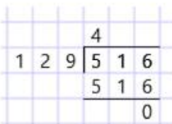
PROBLEMS of CHAPTER 4

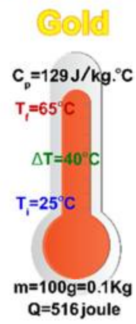
1. A piece of gold of 100g mass and at (25°C) and its specific heat is (129 J/kg.°C) calculate:
a. Thermal capacity of the piece
b. Temperature of the gold piece if it is supplied by heat quantity of 516 joule

Ans: a. c =12.9 Joule/°C, b. T_f = 65°C

$$C = mC_p = 0.1\times129 = 12.9\ J/°C$$

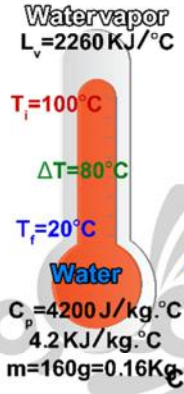
$$Q = mC_p\Delta T$$
$$\Delta T = \frac{Q}{mC_p} = \frac{516}{0.1\times129} = 40°C$$
$$\Delta T = T_f - T_i$$
$$T_f = \Delta T + T_i = 40 + 25 = 65°C$$





2. What is the quantity of heat that a (160g) mass of water vapor lost at (100°C) when the water became (20°C)?

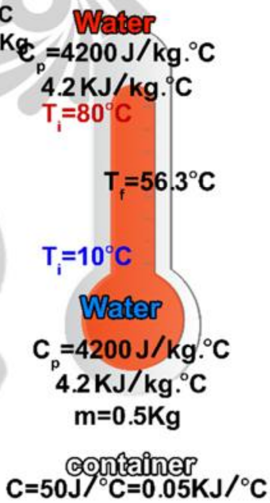
Ans: Q_{Total} = – 415360 Joule



$$Q_1 = mL_v = 0.16 \times 2260 = -361.6\ KJ$$
$$Q_2 = mC_p\Delta T = 0.16 \times 4.2 \times -80 = -53.76\ KJ$$
$$Q_{total} = Q_1 + Q_2 = 361.6 + 53.76 = 415.36\ kJ$$

3. A container of (50 J/°C) thermal capacity contains (0.5kg) of water at (10°C), an amount of (1 kg) hot water at (80°C) was added to the water in the container, what is the final temperature of the mixture?

Ans: T_f = 56.3°C 5

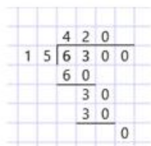


$$Q_{1container} = C\Delta T = 0.05 \times (T_f - 10) = 0.05\,T_f - 0.5$$
$$Q_{2cold\ water} = mC_p\Delta T = 0.5 \times 4.2 \times (T_f - 10) = 2.1\,T_f - 21$$
$$Q_{3hot\ water} = mC_p\Delta T = 1 \times 4.2 \times (80 - T_f) = 336 - 4.2\,T_f$$
$$Q_{3hot\ water} = Q_{1container} + Q_{3cold\ water}$$
$$336 - 4.2\,T_f = 0.05\,T_f - 0.5 + 2.1\,T_f - 21$$
$$-0.05\,T_f - 2.1\,T_f - 4.2\,T_f = -0.5 - 21 - 336$$
$$6.35\,T_f = 357.5$$
$$T_f = 56.299\text{°C}$$

4. A wall of bricks with ($10m^2$) area and (15cm) thick, calculate the time average for transfer thermal energy if it's two sides temperature are (T_1: 20°C), (T_2: 10°C), noting that thermal conduction coefficient of bricks is (0.63 watt/m.°C)

Ans: H=420 Watt

$$H = KA\frac{\Delta T}{L}$$
$$H = \frac{0.63 \times 10 \times 10}{0.15} = 420\ watt$$



5. When heating three quantity of water of masses (m_1= 0.5kg), (m_2= 0.1kg), (m_3=1kg) by same heaters for three minute which one of the masses temperatures raise more, and why?

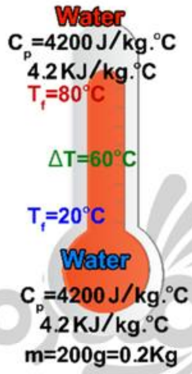
The smaller the mass that heats more, the less water 0.1kg is the one that heats more and has a higher temperature because by give the amount of heat is constant, the lower the mass, the higher the temperature.

$$Q = mC_p\Delta T$$

6. (0.5 kg) of water and the same amount of oil were heated for the same time, which on of the objects gets warm faster? And why?

$$C_{p\ oil} = 1.89\ KJ/Kg.\text{°C},\ C_{p\ water} = 4.2\ KJ/Kg.\text{°C}$$

$Q_{gain\ oil} = Q_{gian\ water}$
$mC_{p\ oil}\Delta T_{oil} = mC_{pwater}\Delta T_{water}$
$0.5 \times 1.89 \times \Delta T_{oil} = 0.5 \times 4.2 \times \Delta T_{water}$
$1.89 \times \Delta T_{oil} = 4.2 \times \Delta T_{water}$
$\Delta T_{oil} = \frac{4.2 \times \Delta T_{water}}{1.89}$
$\Delta T_{water} = \frac{1.89 \times \Delta T_{oil}}{4.2}$



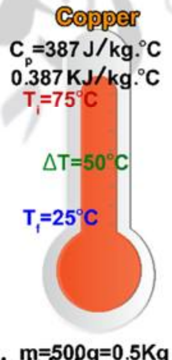
$\because 1.89 < 4.2$
$\therefore \Delta T_{oil} > \Delta T_{water}$
The oil warm faster than water

7. What is the quantity of heat that a (200g) of water gains when temperature increase from (20°C to 80°C)?

Ans : Q = 50400 Joule

$Q = mC_p\Delta T = 0.2 \times 4.2 \times 60 = 50.4KJ$

8. What is the quantity of heat that a (500g) of copper loses when its temperature decreases from (75°C to 25°C)?



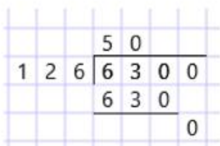
Ans : Q = -9675 Joule

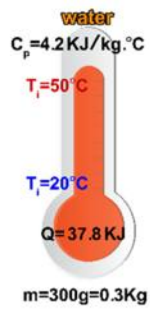
$Q = mC_p\Delta T = 0.5 \times 0.387 \times -50 = -9.675KJ$

9. What is the final temperature for a (300g) of water with initial temperature of (20°C) when gains (37800 Joule) of heat quantity?

Ans: T = 50°C

$Q = mC_p(T_f - T_i)$
$\Delta T = \frac{Q}{mC_p} = \frac{37.8}{0.3 \times 4.2} = 30°C$
$T_f = \Delta T + T_i = 30 + 20 = 50°C$



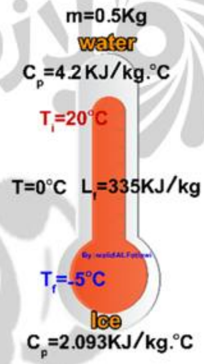


$T_f = \frac{mC_pT_i + Q}{mC_p} = \frac{0.3 \times 4.2 \times 20 + 37.8}{0.3 \times 4.2} = \frac{25.2 + 37.8}{1.26} = \frac{63}{1.26} = 50°C$

10. A (0.5kg) of water at (20°C) was placed in the ice cubes tray and then entered to the upper freezing part of the fridge, what is the amount of energy that need to be removed from the water to convert it into ice cubes at (-5°C)?

Ans: Q= -214732,5 Joule

$$Q_{1\,water} = mC_p\Delta T = 0.5 \times 4.2 \times (0-20) = -42\ KJ$$
$$Q_{2\,water\ to\ ice} = mL_f = 0.5 \times 335 = -167.5\ KJ$$
$$Q_{3\,ice} = mC_p\Delta T = 0.5 \times 2.093 \times (-5-0) = -5.2325\ KJ$$
$$Q_{total} = Q_{1water} + Q_{2water\ to\ ice} + Q_{3ice}$$
$$Q_{total} = -42 + (-167.5) + (-5.2325) = 214.7325\ Kj$$



CHAPTER 5 الفصل الخامس

THE LIGHT

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وليد خالد الفتلاوي

CHAPTER 5 THE LIGHT

LIGHT NATURE AND ITS PROPAGATION

Light is a kind of energy; it is essential in order to see things.

The light that falls on objects and being reflected from them and that reaches to the eye allows us to see them.

In the dark we cannot see

LUMINOUS OBJECTS are an object the objects that emit light.

Self-luminous natural sources: Sun, stars, glow-worms etc.

Artificial light sources: Lamps, candles, and torches are.

ILLUMINATED OBJECTS such as the  moon and mirrors are not light sources, because they just reflect the light falling upon them

Does light pass through all matter? Light cannot pass through all materials.

But the light does not limit to this. For example, the bodies that sun light falls on them are heated.

This means the light has energy that transfers it from the sun to the earth through the free space, and its known that energy transfers either by waves or particles, and according to this the nature of light was explained by two theories:

they are **THE PARTICULATE THEORY** and **THE WAVE THEORY**.

THE PARTICULATE THEORY, the light is a flux of very small particles called by **Newton** (corpuscles) diffused in a medium and he explained using it the phenomena of reflection, refraction and the spread of light in straight lines in the homogeneous medium (but his explanation of the phenomenon of refraction was wrong).

النظرية الدقائقية فأن الضوء عبارة عن سيل من الجسيمات الصغيرة جداً التي دعاها نيوتن بالدقائق (corpuscles) المنتشرة في وسط ما. وقد فسّر بموجبها ظواهر الانعكاس والانكسار وانتشار الضوء بخطوط مستقيمة في الوسط المتجانس (الا ان تفسيره لظاهرة الانكسار كان خاطئاً).

THE WAVE THEORY for the scientist **Huygens** and he explained using it the Phenomena of reflection, refraction, interference and diffraction in light.

Although that neither of these two theories alone could not explain all optical phenomena fully explained.

النظرية الموجية للضوء للعالم هايجنز التي فسّر بموجبها ظواهر الانعكاس والانكسار والتداخل والحيود في الضوء.

على الرغم من ان اي من هاتين النظريتين وبصورة منفردة لم تستطيع تفسير جميع الظواهر البصرية تفسيراً كاملاً

THE ELECTROMAGNETIC THEORY, for **Clark Maxwell** (at the end of the 19th century) it showed that each light ray is an electromagnetic wave.

النظرية الكهرومغناطيسية للعالم كلارك ماكسويل (نهاية القرن التاسع عشر) تبين ان كل شعاع ضوئي هو عبارة عن موجات كهرومغناطيسية

And by that he reinforces the role of the wave theory again.

وبذلك عزز دور النظرية الموجية من جديد

we find that the frequency of the electromagnetic spectrum includes frequencies of visible light waves whose wavelengths range from approximately (400nm) and it is the violet color to approximately (700nm) and it is the red color.

In 1905, Albert Einstein explained the emission of electrons from metallic surfaces exposed to light (photoelectric effect) using the particle nature of light. According to Einstein the interaction ofa photon and an electron in the photoelectric effect was similar to the collision of two particles.

the particulate theory	the wave theory	the electromagnetic theory
the light is a flux of very small particles called by Newton (corpuscles) diffused in a medium	For the scientist Huygens	for Clark Maxwell it showed that each light ray is an electromagnetic wave And by that he reinforces the role of the wave theory again
the phenomena of reflection, refraction and the spread of light in straight lines in the homogeneous medium (but his explanation of the phenomenon of refraction was wrong).	explained using it the Phenomena of reflection, refraction, interference and diffraction in light.	

نجد ان ترددات الطيف الكهرومغناطيسي يتضمن ترددات موجات الضوء المرئي التي اطوالها الموجية تمتدnm400 من تقريباً وهو اللون البنفسجي الىnm700 تقريباً وهو اللون الأحمر

$$C = \lambda f$$

DO YOU KNOW هل تعلم

That light year is the distance that the light travels it in the vacuum at speed of (3×10^8) m/s in (365) days Which is estimated about (10^{13} km)

$$speed\ of\ light\ in\ vacuum = (wavelength)(speed\ of\ light\ in\ vacuum)$$

c: speed of light in vacuum (3×10^8) m/s.
λ: wavelength (m)
f: frequency (Hz)

And it is worth mentioning that there are other phenomena that the electromagnetic theory has failed to explain such as the phenomenon of blackbody radiation and photoelectric phenomenon, which was later explained by the scientist **Max Planck** (assuming that the light does not radiate from the source in the form of waves but in the form of specific packages of energy those are indivisible called (Photons), and light quantum energy (photon) is directly proportional to the frequency of its radiation.

ومن الجدير بالذكر ان هناك ظواهر اخرى اخفقت النظرية الكهرومغناطيسية في تفسيرها مثل ظاهرة اشعاع الجسم الاسود والظاهرة الكهروضوئية، والتي فسرت لاحقاً من قبل العالم ماكس بلانك (اذ افترض ان الضوء لا يشع من مصدره على هيئة موجات بل على هيئة رزم محددة من الطاقة غير قابلة للتجزئة تدعى كمّات (فوتونات)، وان طاقة الكم الضوئي (الفوتون) تتناسب طردياً مع تردد اشعاعه.

$$E = h.f$$

$$Photon\ energy = Planck\ constant\ .frequncy\ of\ radiation$$

E : energy of the photon (Joule)
f : frequency (Hz)
h: Planck's constant equals (6.63×10^{-34} J.S)

EXAMPLE 1

Calculate the frequency of the violet light that have wavelength of (400nm), noting that the speed of light in the vacuum is ($c = 3 \times 10^8$ m/s)?

إحسب تردد الضوء البنفسجي الذي طوله الموجي 400nm علماً أن سرعة الضوء في الفراغ تساوي ($c = 3 \times 10^8$ m/s)؟

$$f = \frac{c}{\lambda} = \frac{3\times10^8}{400\times10^{-9}} = 0.75\times10^{15} Hz$$

Example 2

What is the energy of the green light radiation photon whose wavelength is (555nm)?

ما طاقة فوتون الاشعاع للضوء الاخضر الذي طوله الموجي 555nm؟

$$E = \frac{h.c}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{555 \times 10^{-9}} = 3.58 \times 10^{-19} joule$$

POINT LIGHT SOURCE

The light waves are transmitted in the homogeneous medium in straight lines and in the direction of light propagation.

ان موجات الضوء تنتقل في الوسط المتجانس في خطوط مستقيمة وباتجاه انتشار الاشعة الضوئية

If these waves encounter a barrier with a circular opening of diameter (d) that is much larger than the wavelength of light **($d>>\lambda$)**, the wave passes through this opening and continues to move in a **straight line**

فاذا صادفت هذه الموجات حاجزاً فيه فتحة دائرية قطرها (d) أكبر كثيراً من طول موجة الضوئية ($d>>\lambda$) فانالموجة تجتاز هذه الفتحة مستمرة على الحركة بخط مستقيم

But If the diameter of the barrier's opening is approximately as much as the wavelength of this light **($\lambda= d$)** then it will be **diffused** from the opening in **all directions**.

اما إذا كان قطر فتحة الحاجز بقدر طول الموجة تقريباً لهذا الضوء ($\lambda= d$) عندها ستنفذ منتشرة من الفتحة في جميع الاتجاهات

But If the diameter of the barrier's opening is much smaller than the wavelength of the light **($d<<\lambda$)** then this opening is considered as **a point source of light**

اما إذا كان قطر فتحة الحاجز أصغر بكثير من الطول الموجي للضوء ($d<<\lambda$) عندئذ تعد هذه الفتحة مصدراً نقطياً للضو

HUYGENS PRINCIPLE

Huygen's principle states that (Each point of the wave front points is considered a point source to generate secondary spherical waves called wavelets)

إن مبدأ هايجنز هذا ينص «كل نقطة من نقاط جبهة الموجة المفترضة تعد مصدراً نقطياً لتوليد موجات ثانوية كروية تسمى المويجا

Which spread away from the source through the medium at a certain wave's velocity in that medium. After some time, the new position of the wave front is the tangential surface of the wavelets.

والتي تنتشر بعيداً عن المصدر خلال الوسط بسرعة معينة للموجات في ذلك الوسط، وبعد انقضاء بعض الوقت يكون الموضع الجديد لجبهة الموجة هو السطح المماس للمويجات.

According to Huygen's virtual principle any point on the wave front is considered as a point source.

على وفق مبدأ هايجنز الافتراضي كل نقطة على جبهة الموجة تعد مصدراً نقطياً

LUMINOUS INTENSITY (I): is known as the amount of light energy (visible) emitted from a light source per unit time.

I = illumination intensity of the point source measured by Candela (cd)

كمية الطاقة الضوئية المرئية المنبعثة من مصدر ضوئي خلال وحدة الزمن

I= تمثل قوة اضاءة المصدر النقطي مقدرة بالشمعة القياسية cd

LUMINOUS FLUX (ϕ): The part of the radiation flux that generates a light sensation in the eye so it is a measure to luminous intensity of the source.

is measured by lumen (Lm) which is known by incident flux on a ($1m^2$) unit area of a spherical surface that's radius is one meter and a point light source of one Candela (cd) is placed in its center

السيل الضوئي (ϕ): ذلك الجزئ من سيل الاشعاع الذي يولد احساساً ضوئياً في العين فهو مقياس لقوة إضاءة المصدر.

ويقاس السيل الضوئي Φ بوحدة اللومن Lm والذي يعرف بالسيل الساقط على وحدة المساحة من سطح كروي نصف قطره متر واحد ويقع في مركزه مصدر ضوئي نقطي قوة اضاءته شمعة قياسية واحدة

$$\phi = 4\pi I$$

ILLUMINANCE (E): is the total luminous flux incident on a surface, per unit area.

illuminance and measured by lumen/m^2 and it's called: (Lux).

شدة الاستضاءة E : هي كمية السيل الضوئي الساقط على وحدة المساحة للسطح المضاء.

شدة الاستضاءة وتقاس بوحدة Lumen/m^2 وتسمى اللوكس Lux

$$E = \frac{\phi}{A}$$

Illuminance (E) is measured tools by the photometer device and the Luxmeter

تقاس شدة الاستضاءة E بوساطة جهاز الفوتوميتر واللوكسميتر

There are two ways to increase the illuminance on a surface using a point source of Luminous intensity is known and they are:

1. Increase the incident luminous flux (ϕ) on the lighted surface.
2. Decrease the distance between the point light source and the lighted surface.

هناك طريقتان لزيادة شدة الاستضاءة على سطح ما باستعمال مصدر نقطي قوة اضاءته معلومة وهما:

(1) زيادة السيل الضوئي Φ الساقط على السطح المضاء.

(2)نقصان المسافة بين المصدر الضوئي النقطي والسطح المضاء.

$$E = \frac{\phi}{4\pi r^2} = \frac{4\pi I}{4\pi r^2} = \frac{I}{r^2}$$

Example 3

A white screen is placed at a perpendicular level to the direction of the incidence of a ray of light from a point source having a luminous intensity of (5cd), calculate the amount illuminance on the screen if it is (5m) away from the source.

وضعت شاشة بيضاء بمستوي عمودياً على اتجاه سقوط اشعة ضوئية من مصدر نقطي قوة اضاءته (5cd) احسب مقدار شدة الاستضاءة على الشاشة إذا كان بعدها عن المصدر (5m).

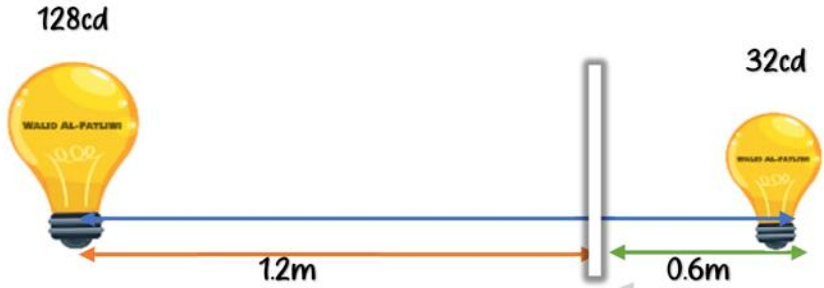
$$E = \frac{I}{r^2} = \frac{5\ cd}{(5)^2 m} = \frac{1}{5} = 0.2\frac{Lm}{m^2}\ (Lux)$$

Example 4

A lamp having a luminous intensity of (32cd), and its distance of (0.6m) from a screen and there is another lamp on the other side of the screen its distance of (1.2m) from it then if the illuminance was equal on both side of the screen, what is the luminous intensity of the second lamb?

مصباح قوة اضاءته(32cd) يبعد (0.6m)عن شاشة وهناك مصباح آخر من الجهة الثانية من الشاشة يبعد عنها(1.2m) فإذا تساوت شدة الاستضاءة على وجهي الشاشة، مامقدار قوة اضاءة المصباح الثاني؟

$$E_1 = E_2$$
$$\frac{I_1}{r^2{}_1} = \frac{I_2}{r^2{}_2}$$
$$\frac{32}{(0.6)^2} = \frac{I_2}{(1.2)^2}$$
$$I_2 = \frac{32 \times 1.2 \times 1.2}{0.6 \times 0.6} = 32 \times 4 = 128cd$$



QUESTIONS of CHAPTER 5

Q.1: Choose the correct answer for the following questions.

1. Light produces a point source spread in the vacuum in:

a. One direction b. Two direction

c. All directions d. All of the above

2. The amount that doesn't change when a beam of light is transferred in an oblique way from one medium to another is:

a. Its direction b. Its speed

c. Its wavelength d. Its frequency

3. To double the illuminance directly on a horizontal table surface where the lighted lamb is placed exactly above it on 1m height from its center, by making the lamb at Height

a.0.75m b. 0.707m

c. 0.5m d. 0.25m

$I_1 = I_2$

$\frac{E_1}{E_2} = \frac{r^2{}_2}{r^2{}_1}$

$\frac{E_1}{2E_1} = \frac{r^2{}_2}{(1)^2}$

$r^2{}_2 = \frac{1}{2}$

$r_2 = \sqrt{1/2} = 0.707m$

4. The luminous intensity is measured by:

a. Candle b. lux

c. Watt d. Lumen

5. Illuminance is measured by:

a. Joule b. Lumen

c. Lux d. Watt

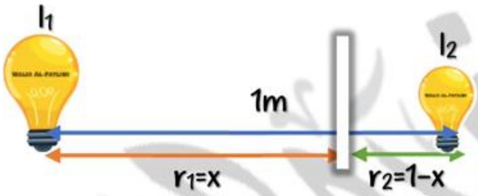
6. As long as the distance of the surface that's lighted by a point source increases the illuminance on the surface:
a. Decreases b. Increases
c. Not effected d. All of the above

7. A point light source is placed in the center of a spherical surface, if the radius of curvature for this plane increased then the incident luminous flux from the source:
a. Decreases b. Increases
c. Doesn't change d. All of the abov

Problems

Q1. Two lamps the luminous intensity of the first one is nine times that of the second one and the distance between them is (1m), where a photometer should be placed between the two sources to become the illuminance to be equal on both sides of the photometer?

Answer: X = 0.75m

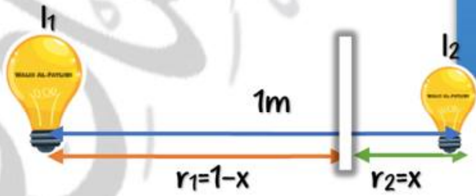


$$E_1 = E_2$$
$$\frac{I_1}{r^2{}_1} = \frac{I_2}{r^2{}_2}$$
$$\frac{9\,I_2}{(x)^2} = \frac{I_2}{(1-x)^2}$$
$$\frac{3}{x} = \frac{1}{1-x}$$
$$x = 3 - 3x$$
$$4x = 3$$
$$r_1 = x = \frac{3}{4} = 0.75m$$

$I_1 = 9\ I_2$

Other slo.

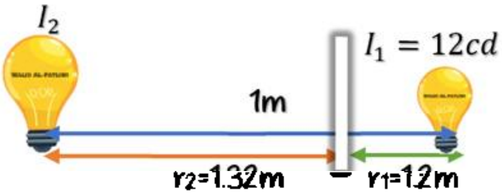
$$E_1 = E_2$$
$$\frac{I_1}{r^2{}_1} = \frac{I_2}{r^2{}_2}$$
$$\frac{9\,I_2}{(1-x)^2} = \frac{I_2}{(x)^2}$$
$$\frac{3}{1-x} = \frac{1}{x}$$
$$1 - x = 3x$$
$$4x = 1$$
$$r_2 = x = \frac{1}{4} = 0.25m$$
$$r_1 = 1 - x = 1 - 0.25 = 0.75m$$



Q2. A lamp with luminous intensity of (12cd) was placed (1.2m) distance from a photometer and on the other side of it another lamp was placed at (1.32m) distance, the illuminance was equal on both sides of the photometer, calculate the luminous intensity of the second lamp.

Answer: I_2 = 14.52 cd

$$E_1 = E_2$$
$$\frac{I_1}{r^2{}_1} = \frac{I_2}{r^2{}_2}$$
$$\frac{12}{(1.2)^2} = \frac{I_2}{(1.32)^2}$$



$$I_2 = \frac{12 \times 1.32 \times 1.32}{1.2 \times 1.2} = 12 \times 1.1 \times 1.1 = 12 \times 1.21 = 14.52cd$$

Q3. A lighted lamp in a perpendicular incidence on a book's page creating a luminous flux of (100πLm) how far the book from the lamp? if its illuminance was (4Lux).

Answer: r = 2.5m

$$E = \frac{\phi}{4\pi r^2} \rightsquigarrow r^2 = \frac{\phi}{4\pi E} = \frac{100\pi}{4\pi 4} = \frac{100}{16} \rightsquigarrow r = \frac{10}{4} = 2.5m$$

Q4. In a moonlighted night where the moon was full in it, the illuminance was (0.6 Lux) find the luminous intensity of the moon in that night, noting that the distance between the moon and the earth is (3.84×10^8m).

Answer: $I = 8.84 \times 10^{16}$ cd

$$E = \frac{I}{r^2} \rightsquigarrow I = Er^2 = 0.6 \times (3.84 \times 10^8)^2 = 8.84736 \times 10^{16} cd$$

Q5. A light photon having a radiation wavelength of (600nm), what is the amount of energy noting that Planck's constant is ($h=6.63 \times 10^{-34}$ J.s)?

Answer: $E= 3.315 \times 10^{-19}$ J

$$E = \frac{h.c}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{600 \times 10^{-9}} = 3.315 \times 10^{-19} joule$$

CHAPTER 6 الفصل السادس

REFLECTION AND REFRACTION OF LIGHT

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وليد خالد الفتلاوي

CHAPTER 6

REFLECTION AND REFRACTION OF LIGHT

REFLECTION OF LIGHT is the phenomenon of the rebound of the incident light on a surface that separates between two medium to the medium that came from it.

is when light bounces off an object, same medium.

انعكاس الضوء بانه ظاهرة ارتداد الضوء الساقط على سطح فاصل بين وسطين الى الوسط الذي قدم منه

REFRACTION OF LIGHT is a change of the direction of the light ray when moving between two transparent medium different in optical density if it fall in an oblique way on the separating surface between two medium.

انكسار الضوء هو تغير في اتجاه الشعاع الضوئي عند انتقاله بين وسطين شفافين مختلفين في الكثافة الضوئية إذا سقط بصورة مائلة على السطح الفاصل بين الوسطين.

is as the bending of light, when light passes from one medium into another, it changes direction.

OPTICAL DENSITY is a property of the transparent medium that the speed of the light passing through the medium depends on.

الكثافة الضوئية هي صفة للوسط الشفاف تعتمد عليها سرعة الضوء المار فيه.

THE NORMAL The line perpendicular to the point where the light strikes the boundary, it is represented by N. The angle between N' and the mirror is 90

THE ANGLE OF INCIDENCE θ_1 The angle between 'N' and the incident light.

زاوية السقوط وهي الزاوية المحصورة بين الشعاع الساقط والعمود المقام

THE ANGLE OF REFLECTION θ'_1 The angle between 'N' and the reflected light.

وهي الزاوية المحصورة بين الشعاع المنعكس والعمود المقام

LAWS OF REFECTION

There are two rules for reflection of light: θ'_1

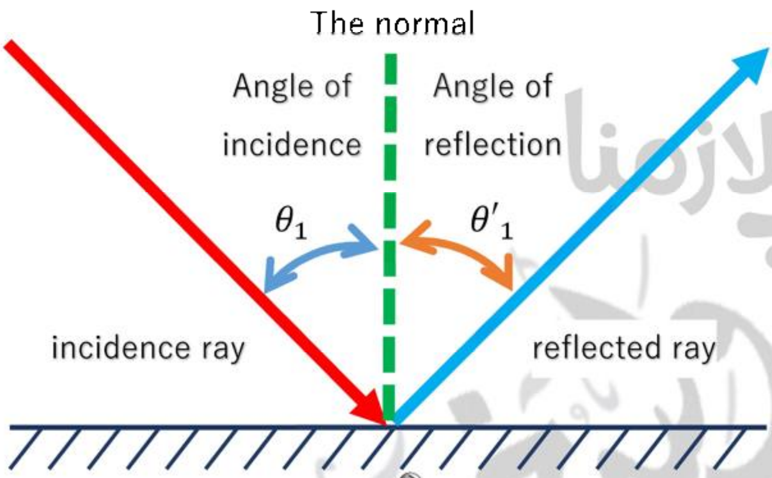
a. The angle of incidence is equal to the angle of reflection.

زاوية السقوط تساوي زاوية الانعكاس

$$\theta_i = \theta_r$$

b. The incident ray, the reflected ray and the normal are all in the same plane.

الشعاع الساقط والشعاع المنعكس والعمود المقام من نقطة السقوط تقع جميعها في مستو واحد



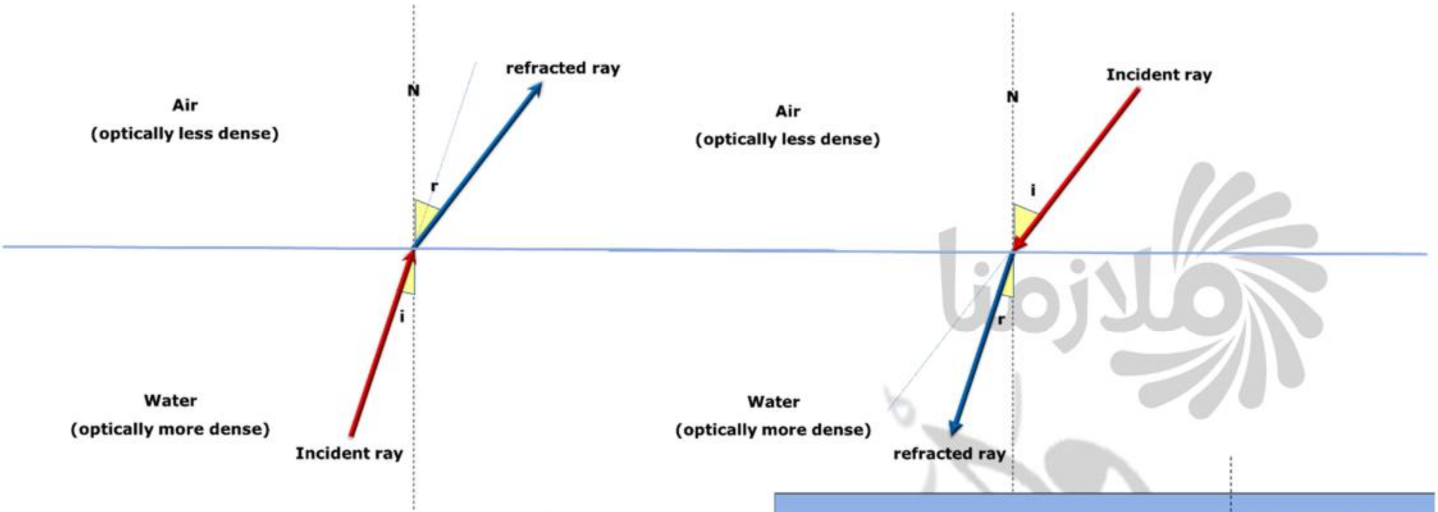
REFRACTION OF LIGHT AND THE LAWS OF REFRACTION

When a light ray that have fallen obliquely from a transparent medium that is less optical density such as air to another medium of higher optical density such as glass, so is transmits into the other medium and refract getting close to the normal of the surface that separate between two mediums

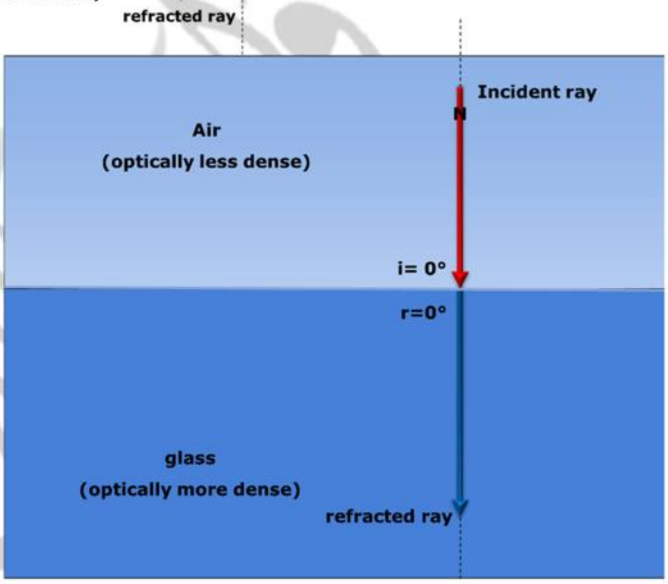
عندما ينتقل شعاع ضوئي ساقط بصورة مائلة من وسط شفاف اقل كثافة ضوئية كالهواء الى وسط شفاف آخر أكبر كثافة ضوئية كالزجاج، فانه ينفذ الى الوسط الآخر وينكسر مقتربا من العمود المقام على السطح الفاصل بين الوسطين

And when a light ray that have fallen obliquely from a transparent medium that have high optical density to another medium of lower optical density, so is transmits into the other transparent medium and refract getting away from the normal

وعندما ينتقل شعاع ضوئي ساقط بصورة مائلة من وسط شفاف أكبر كثافة ضوئية الى وسط شفاف آخر أقل كثافة ضوئية، فانه ينفذ الى الوسط الآخر وينكسر مبتعداً عن



العمود المقام على السطح الفاصل بين الوسطين



Direct light ray to be perpendicular to the separating surface between two transparent medium, will notice that the light is transmitted perpendicular on the separating surface between the two mediums without bending or (refracted), means the light ray is not refracted.

نسقط الشعاع الضوئي بحيث يكون عمودياً على السطح الفاصل بين الوسطين نلاحظ بان الضوء ينفذ على استقامته وبصورة عمودية على السطح الفاصل بين الوسطين من غير ان ينحرف (او ينكسر). اي ان الشعاع الضوئي لا ينكسر

THE LAWS OF REFRACTION

1. The incident ray, refracted ray, and the normal or (normal line) drawn from the incidence point on the separating surface are all lie in one plane perpendicular on the surface separating between two transparent medium.

الشعاع الساقط والشعاع المنكسر والعمود المقام من نقطة السقوط على السطح الفاصل تقع جميعها في مستوٍ واحدعمودي على السطح الفاصل بين وسطين شفافين

2. The ratio of the sine of the incidence angle to the sine of the reflected angle is equal to constant value.

النسبة بين جيب زاوية السقوط وجيب زاوية الانكسار يساوي مقداراً ثابتاً

INDEX OF REFRACTION from the first transparent medium to the second transparent medium or the relative index of refraction between two transparent mediums

معامل الانكسار من الوسط الشفاف الاول الى الوسط الشفاف الثاني او معامل الانكسار النسبي بين الوسطين الشفافين

$$_1n_2 = \frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$$

$$n = \frac{c}{v}$$

$$Absolute\ index\ of\ refraction\ of\ the\ medium\ (or\ the\ transparent) = \frac{Light\ speed\ in\ vacuum}{Light\ speed\ in\ the\ transparent\ medium}$$

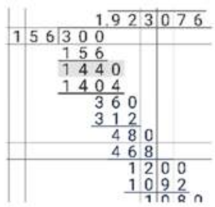
$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \qquad Snell's\ law$$

Example 1

It was found that the light speed in a transparent medium equal to (1.56×10^8 m/s), find the absolute index of refraction of this medium, if you know that the light speed in the vacuum is equal to (3×10^8m/s)?

وجد ان سرعة الضوء في وسط شفافت تساوي ((1.56 ×10⁸ m/s)، جد معامل الانكسار المطلق لهذا الوسط إذا علمت ان سرعة الضوء في الفراغ تساوي (3×10⁸m/s)؟

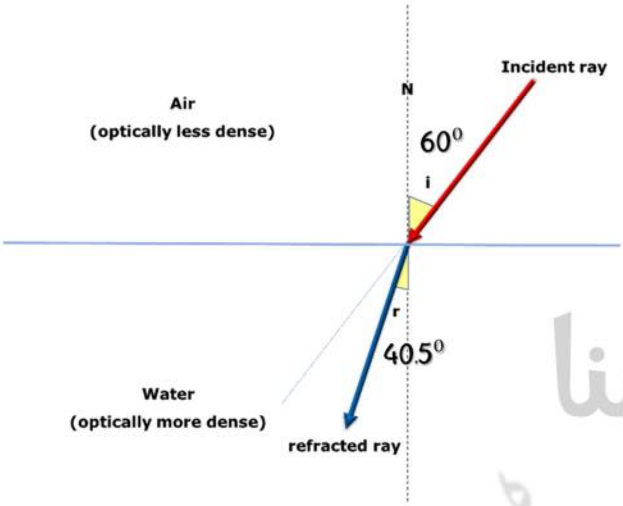
$$n = \frac{c}{v} = \frac{3\times10^8}{1.56\times10^8} = 1.92$$



Example 2

A light ray fell from air on the water surface in an incidence angle of (60°) and its refraction angle in water was (40.5°), find the absolute index of refraction of water? (Noting that sin 40.5°= 0.649, sin 60° = 0.866).

شعاع ضوئي من الهواء على سطح الماء بزاوية سقوط قياسها (60°) وكانت زاوية انكساره في الماء تساوي(40.5°). جد معامل الانكسار المطلق للماء ؟ مع العلم بان
(Noting that sin 40.5°= 0.649, sin 60° = 0.866).

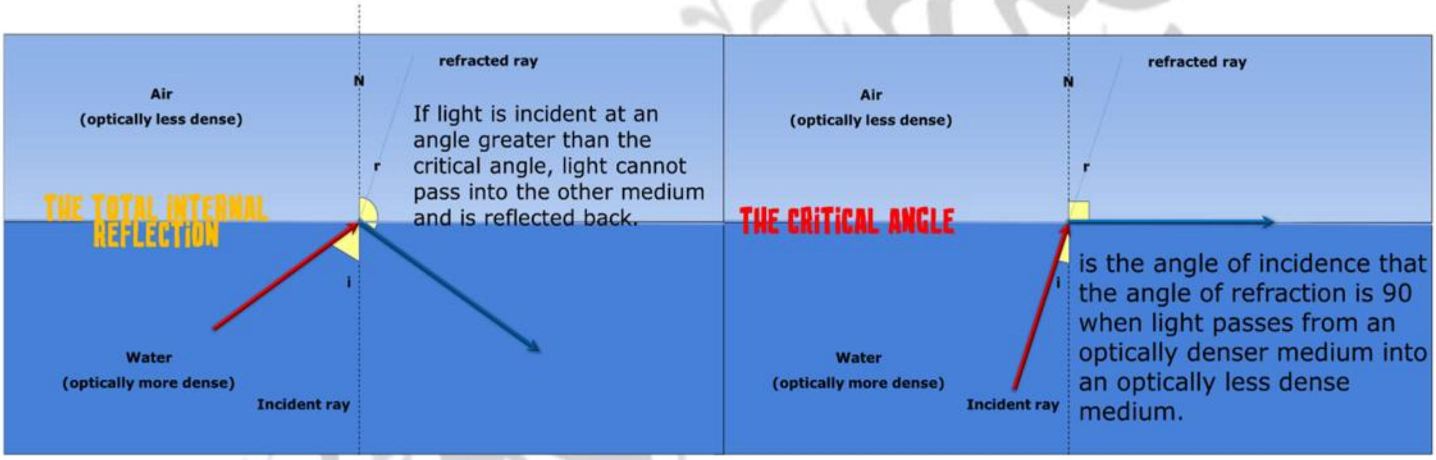


$n_1 \sin\theta_1 =$

$n_2 \sin\theta_2$ *Snell's law*

$1 \times \sin 60° = n_2 \times \sin 40.5°$

$$n_2 = \frac{\sin 60°}{\sin 40.5°} = \frac{0.866}{0.649} = 1.33$$

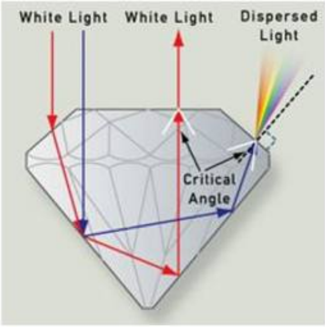


CRITICAL ANGLE: the angle of incidence at which the refracted light makes an angle of (90°) with the normal.

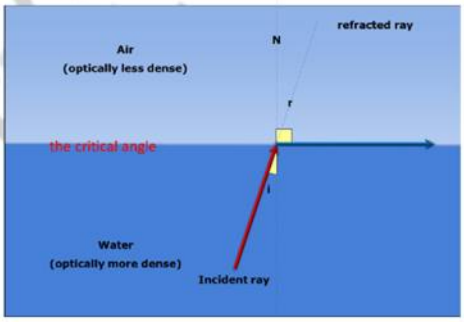
الزاوية الحرجة هي زاوية السقوط في الوسط الاكثف ضوئياً والتي زاوية انكسارها قائمة ° 90 في الوسط الاخر الاقل منه كثافة ضوئية

It is worth mentioning that diamonds owes much of its beauty to the total internal reflection phenomenon, where the brilliance and shininess of the diamond is due to its critical angle (about 24.4°) that is considered one of the smallest critical angles relatively so its absolute index of refraction (about. 2.42) is relatively the greatest absolute index of refraction, the light falling on the diamond passes into it will suffer many internal reflections to comes out to the observer eyes giving the diamond that brilliance

ومن الجدير بالذكر ان الماس يدين بقدر كبير من جماله لظاهرة الانعكاس الكلي الداخلي، حيث يعزى تألق الماس وبريقه الى ان زاويته الحرجة حوالي° 24.4 تعد من أصغر الزوايا الحرجة نسبيا لذا فان معامل انكساره المطلق حوالي2.42 يعد نسبياً من أكبر معاملات الانكسار المطلقة، فالضوء الساقط على الماس والنافذ الى داخله سيعاني عدة انعكاسات كلية ليخرج بعدها الى عين الناظر مكسباً الماس ذلك البريق المتألق



EXAMPLE 3



If you knew that the critical angle of a light transmitted from a transparent medium to air is (41.1°), then what is absolute index of refraction to this material? Noting that (sin 41.1° = 0.657).

إذا علمت ان الزاوية الحرجة° 41.1 للضوء المنتقل من مادة شفافة الى الهواء، فما هو معامل الانكسار المطلق لهذه المادة؟ مع العلم بان (sin 41.1° = 0.657)

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \qquad Snell's\ law$$

$$n_1 \sin 41.1° = 1 \times \sin 90°$$

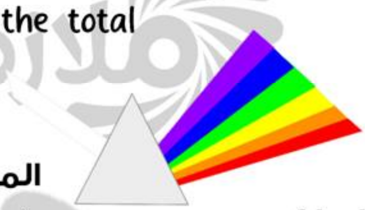
$$n_1 = \frac{1}{0.657} = 1.52$$

There are other natural phenomena that can be explained by the phenomenon of total internal reflection we mention an example them, **mirage** phenomenon which you have known previously, also there are many applications in optical devices for the phenomenon of total internal reflection, mention one of them **the reflecting prism**. Which is a glass prism of angles (45°– 90°– 45°) and its used to change the path of light beam by (90° or 180°).

هناك ظواهر طبيعية اخرى يمكن تفسيرها حسب ظاهرة الانعكاس الكلي الداخلي نذكر منها على سبيل المثال ظاهرة **السراب** والتي تعرفت عليها سابقاً، كما توجد تطبيقات كثيرة في الاجهزة البصرية لظاهرة الانعكاس الكلي الداخلي نذكر منها **الموشور العاكس**، وهو موشور زجاجي قائم ذو زوايا (45 – 90 – 45)، ومن استعمالاته هي في تغيير مسار الاشعة الضوئية بزاوية(90° (او زاوية)° 180)

the binoculars of two prismالناظور ذي الموشورين, the periscope البيرويسكوب

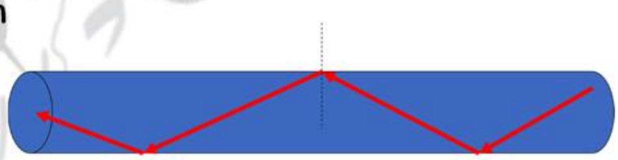
Also preferred use the reflecting prism in optical devices rather than using the plane mirror because its more reflector for light that's because light in the prism reflects a total internal reflection by an approximate percentage to (100%), but in mirror absorption accurs of the light incident on it by certain percentage make their reflection less than reflecting prism (ideal mirror usually reflects about 90%) thus the image looks sharp and clear detailed and brighter when using the reflecting prism. And another important application of the total internal reflection phenomenon is the (fiber optics)



كما يفضل استعمال الموشور العاكس في الأجهزة البصرية على المرآة المستوية، لأنه أكثر عكساً للضوء وذلك لان الضوء في الموشور العاكس ينعكس انعكاساً كلياً داخلياً بنسبة مقاربة جداً الى (100 %)، ولكن في المرآة يحدث امتصاص للضوء الساقط عليها بنسبة معينة تجعل انعكاسها أقل من الموشور العاكس، (المرآة النموذجية عادة تعكس نسبة حوالي 90 %)، ولذلك فان الصورة تبدو حادة المعالم وواضحة التفاصيل واكثرسطوعاً في حالة استعمال الموشور العاكس. ومن التطبيقات المهمة الاخرى لظاهرة الانعكاس الكلي الداخلي هي الالياف البصرية (أو الالياف الضوئية)

OPTICAL FIBERS are fine glass or plastic fibers used to transfer light from one place to another according to the phenomenon of total internal reflection

الالياف البصرية هي الياف زجاجية او بلاستيكية دقيقة تستعمل لنقل الضوء من مكان الى آخر حسب ظاهرة الانعكاس الكلي الداخلي



QUESTIONS of CHAPTER 6

Q1. Choose the correct answer for the following questions.

1. Which of the following statements expresses one of the reflection laws:

a. An incidence angle equals to twice the reflection angle.

b. An incidence angle equals to half the reflection angle.

c. An incidence angle equals to the reflection angle.

d. An incidence angle equals to the square root of the reflection angle.

2. The speed of light in glass is:

a. Less then the speed of light in vacuum b. Greater than the speed of light in vacuum

c. Equals to the speed of light in vacuum d. All of the above

3. The ratio between the sine of the incidence angle of the incident ray in the first transparent medium and the sine of the refraction angle in the second transparent medium is a constant ratio for these two mediums and it called:

a. Energy of the light ray.

b. Momentum of light ray.

c. Relative refraction coefficient between the two transparent mediums.

d. Frequency of the light ray.

4. The unit of the absolute index of refraction for a transparent medium is:

a. m b. 1/m c.m^2 d. has no units

Q2. Answer the following equation:

1. What's the reason for brilliance of diamonds?

It is worth mentioning that diamonds owes much of its beauty to the total internal reflection phenomenon, where the brilliance and shininess of the diamond is due to its critical angle (about 24.4°) that is considered one of the smallest critical angles relatively so its absolute index of refraction (about. 2.42) is relatively the greatest absolute index of refraction, the light falling on the diamond passes into it will suffer many internal reflections to comes out to the observer eyes giving the diamond that brilliance

2.Which one is more efficient in light reflection, reflecting prism or plane mirror? and why?

The reflecting prism in optical devices more efficient than using the plane mirror **because** its more reflector for light that's because light in the prism reflects a total internal reflection by an approximate percentage to (100%), but in mirror absorption accurs of the light incident on it by certain percentage make their reflection less than reflecting prism (ideal mirror usually reflects about 90%) thus the image looks sharp and clear detailed and brighter when using the reflecting prism.

3. What are two laws of refraction? And what are two laws of reflection?

The laws of refraction

a. The angle of incidence is equal to the angle of reflection.

b. The incident ray, the reflected ray and the normal are all in the same plane.

The laws of reflection

a. The incident ray, refracted ray, and the normal or (normal line) drawn from the incidence point on the separating surface are all lie in one plane perpendicular on the surface separating between two transparent medium.

b. The ratio of the sine of the incidence angle to the sine of the reflected angle is equal to constant value.

4. State the mathematical equation for Snell's law explaining the physical meaning for each symbol?

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \qquad Snell's\ law$$

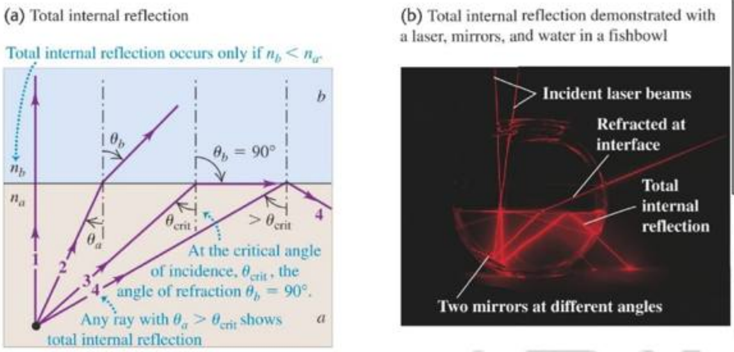
5.what do you mean by critical angle? And what is the relation to absolute index of refraction for a transparent medium?

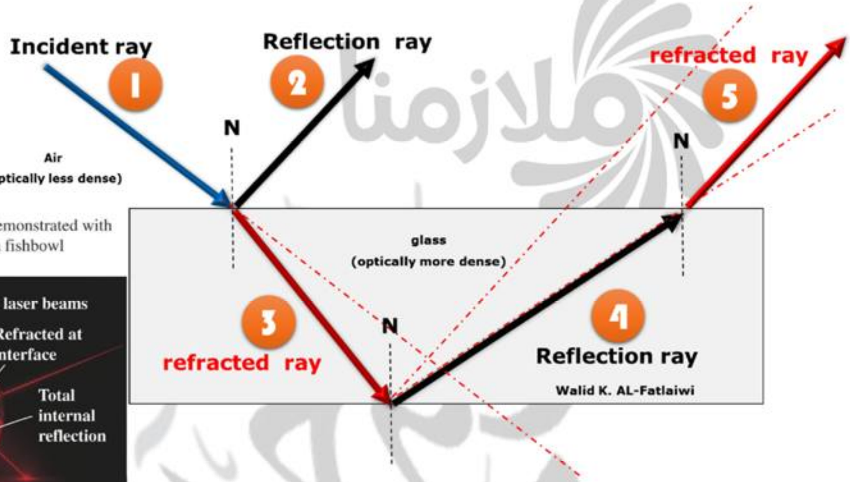
The critical angle is the angle of incidence that the angle of refraction is 90 when light passes from an optically denser medium into an optically less dense medium.

6.what is meant by saying that (the absolute index of refraction of water is 1.33)?

INDEX OF REFRACTION the relative index of refraction between two transparent mediums is 1.33

7. When the ray (1) is the incident ray in the figure, then what are the reflected rays and refracted rays from the other four red rays?





PROBLEMS of CHAPTER 6

1. If you knew that the absolute index of refraction of diamond is (2.42) and light speed in the vacuum is (3×10^8 m/s) find the light speed in the diamond?

Answer: $v = 1.24\times10^8$ m/s

$$n = \frac{c}{v}$$

$$v = \frac{c}{n} = \frac{3\times10^8}{2.42} = 1.24\times10^8 m/s$$

2. If you knew that the light speed in a transparent material is (c/1.52) where (c) is the light speed in vacuum, then what is the absolute index of refraction?

Answer: n = 1.52

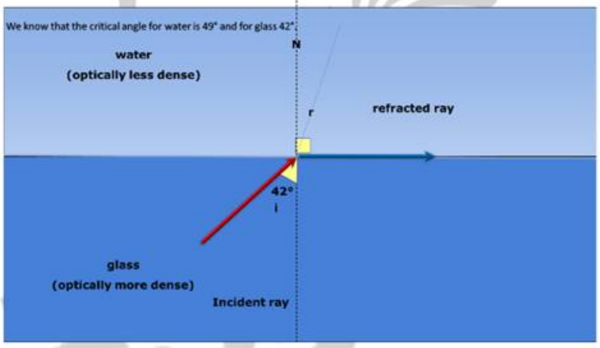
$$n = \frac{c}{v} = \frac{c}{\frac{c}{1.52}} = 1.52$$

3. If the absolute index of refraction of water is (4/3) and the absolute index of refraction for a certain type of glass is (3/2), find the value if the critical angle between these two mediums.

Noting that (sin 62.75° = 0.889)

Answer: θ_c = (62.75°)

$$n_1 \sin\theta_c = n_2 \sin\theta_2$$
$$\frac{3}{2}\sin\theta_c = \frac{4}{3}\sin 90^\circ$$
$$\sin\theta_c = \frac{2\times 4}{3\times 3} = \frac{8}{9} = 0.889$$
$$\theta_c = 62.75^\circ$$



4. A light fall from air on water surface at an incidence angle of (30°), apart of it was reflected and another part was refracted, so if you knew that the absolute index of refraction for water is (4/3) find:

a. Reflection angle

b. Refraction angle

(Noting that sin 30° = 0.5, sin 22.02° = 0.375)

Answer: a. θ_{i1}=30° b. θ_{i2} =22.02°

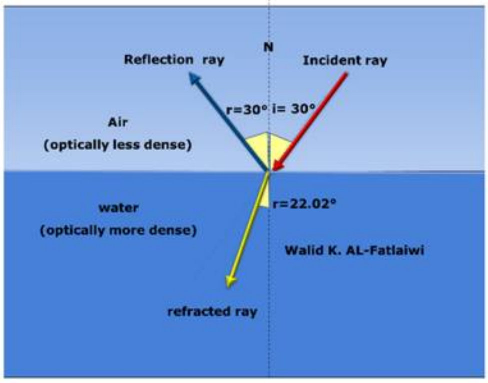
a. $\theta_i = \theta_r$

$30^\circ = 30^\circ$

b. $n_1 \sin\theta_c = n_2 \sin\theta_2$

$1 \times \sin 30^\circ = 4/3 \sin\theta_2$

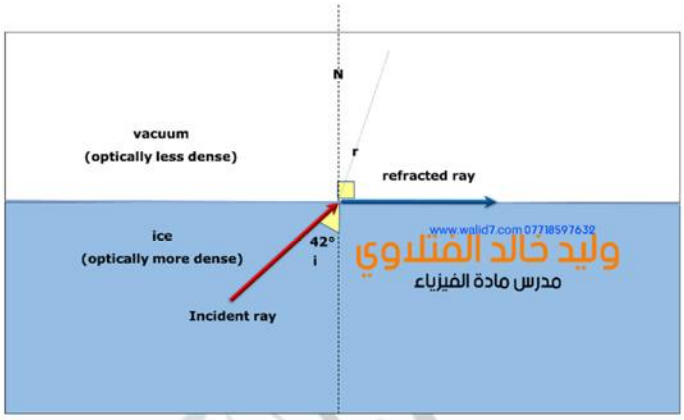
$\sin\theta_2 = \dfrac{3\times 0.5}{4} = 0.375 \rightsquigarrow \theta_2 = 22.02^\circ$



5. If the speed of light in ice was (c/1.31) where c is the speed of light in vacuum, find the critical angle for light transferred from ice to air.
(Noting that sin 49.73° = 0.763)

Answer: θc = 49.73°

$$n = \frac{c}{v} = \frac{c}{\frac{c}{1.31}} = 1.31$$
$$n_1 \sin\theta_c = n_2 \sin\theta_2$$
$$1.31 \times \sin\theta_c = 1 \times \sin 90°$$
$$\sin\theta_c = \frac{1}{1.31} = 0.763$$
$$\theta_c = 49.73°$$



6. Light falls from air on a transparent medium of (1.5) absolute index of refraction and at an angle of (30°), find:
a. Refraction angle
b. Wavelength of the light ray in the transparent medium if its wave length in the air was (600nm)
(Noting that sin 30° = 0.5, sin 19.45° = 0.333)

Answer: a. : θ_{i1} =19.45° b. : λ_2 = 400 nm

$$n_1 \sin\theta_c = n_2 \sin\theta_2$$
$$1 \times \sin 30° = 1.5 \times \sin\theta_2$$
$$\sin\theta_2 = \frac{0.5}{1.5} = \frac{1}{3} = 0.333$$
$$\theta_2 = 19.45°$$
$$\frac{n_2}{n_1} = \frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$$
$$\frac{\lambda_1}{\lambda_2} = \frac{n_2}{n_1}$$
$$\frac{600}{\lambda_2} = \frac{1.5}{1}$$
$$\lambda_2 = \frac{600}{1.5} = \frac{2000}{5} = 400\ nm$$

CHAPTER 7 الفصل السابع

MIRRORS

07740133377 07718597632
وليد خالد الفتلاوي

CHAPTER 7 MIRRORS

PLANE MIRRORI: is the plane mirror is a flat smooth surface, the light is reflected from it a regular reflection.

المرآة المستوية هي سطح مستو صقيل ينعكس عنه الضوء انعكاسا منتظم.

A virtual image: is an image formed when the outgoing rays from a point on an object.

Actually, the candle(object) is not there, it is just an image. Virtual images cannot be formed on a screen.

An object placed in front of a plane mirror has the following properties:

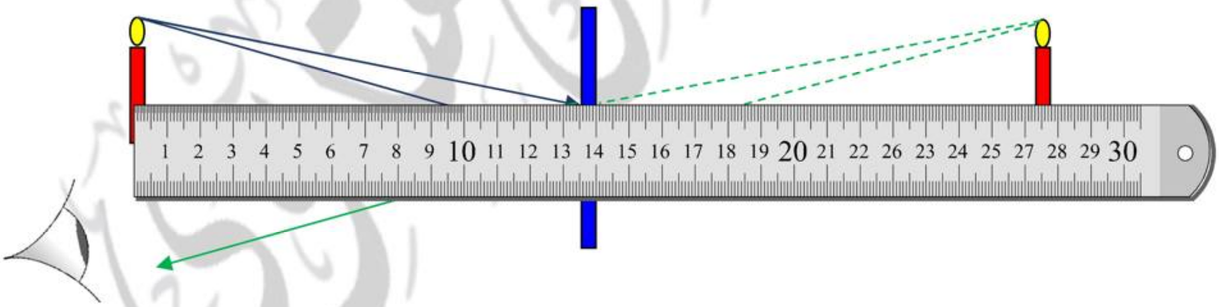
1. The image is the same size as the object ($h_{object} = h_{image}$)

2. The distance between the image and the mirror is equal to the distance between the object and the mirror ($x_{object} = x_{image}$)

3. The image is virtual.

4. The image is behind the mirror

5. The image is laterally inverted, that is, the left side of the object is at the right side of the image.



Why is the word " AMBULANCE " written as on vehicles?

Ambulances carry ill or wounded people to hospitals, so they must travel at high speeds. If an ambulance is at the back of a car in the traffic, the driver of the car can read the reversed writing correctly from the driving mirror as and give way to it.

كلمة إسعاف التي تكتب على مقدمة سيارات الإسعاف تكتب معكوسة بشكل (إسعاف)ليراها سائق السيارة التي أمامها في مرآة سيارته معتدلة ويفسح له الطريق

MULTIPLICITY OF IMAGE IN ANGLED MIRRORS

The number of images formed by the lighted candle changes by changing the angle between the two mirrors according to the following equation

ان عدد الصور المتكونة للشمعة المتقدة يتغير بتغيير قياس الزاوية بين المراتين حسب المعادلة الاتية

$$Number\ of\ formed\ images = \frac{360°}{Angle\ between\ the\ two\ mirrors} - 1$$

$$n = \frac{360°}{\theta} - 1$$

Example 1

An object was places between two plane mirrors the angle between them is (24°). What is the number of formed images for the object?

وضع جسم بين مرآتين مستويتين الزاوية بينهما (° 24). كم يكون عدد الصور المتكونة للجسم؟

$$n = \frac{360°}{\theta} - 1 = \frac{360°}{24°} - 1 = 15 - 1 = 14 \text{ number of images}$$

SPHERICAL MIRRORS المرايا الكروية

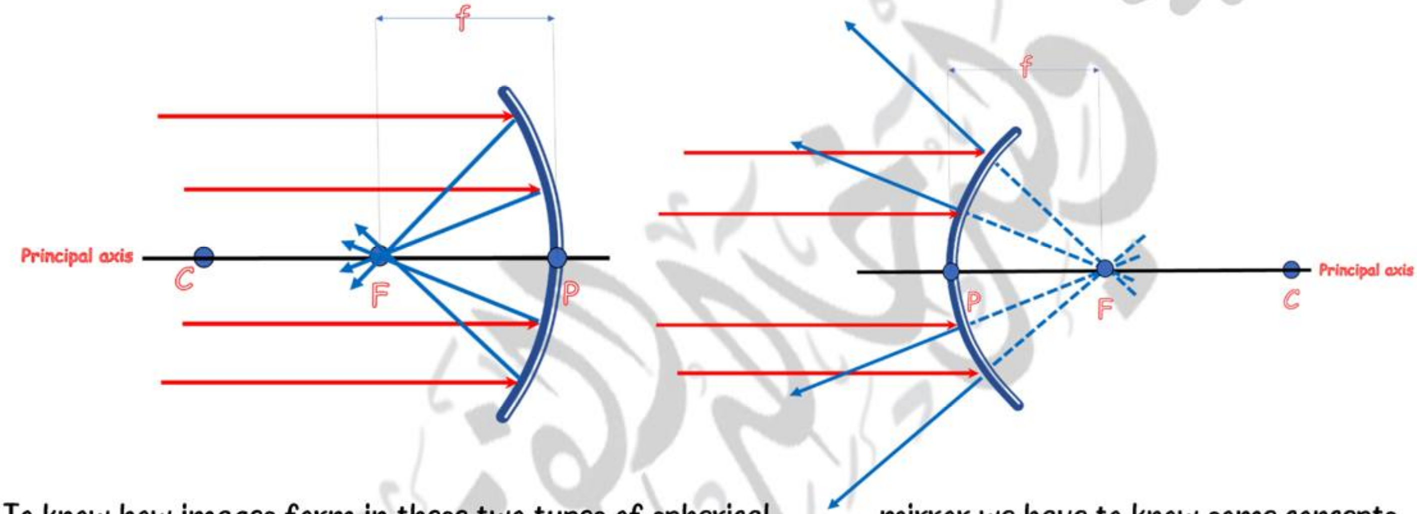
Spherical mirrors: is a mirror which has the shape of piece cut of a spherical surface in another meaning reflecting surface is part of a sphere.

المرايا الكروية وهي المرايا التي يكون فيها السطح العاكس جزءاً من سطح كرة مجوفة.

There are two types of spherical mirrors, **CONCAVE MIRROR** and **CONVEX MIRROR**.

Spherical mirror with **INNER FACE** as the reflecting surface is known as **concave** mirror. Spherical mirror with **OUTER FACE** as the reflecting surface is known as **convex** mirror.

هنالك نوعان من المرايا الكروية مرآة مقعرة ومرآة محدبة
فاذا كان السطح العاكس هو السطح الداخلي سميت مرآة مقعرة وإذا كان السطح العاكس هو السطح الخارجي سميت مرآة محدبة



To know how images form in these two types of spherical mirror we have to know some concepts related to them

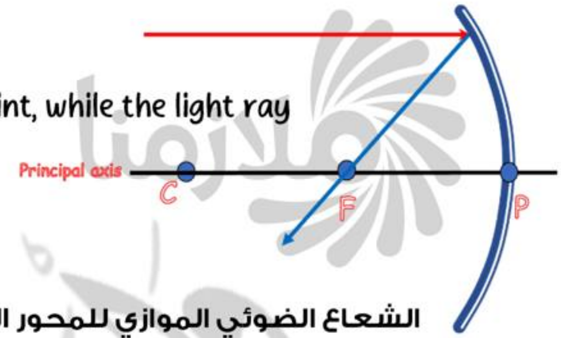
وللتعرف على كيفية تكون الصور في هذين النوعين من المرايا الكروية يجب أن نتعرف إلى المفاهيم التالية المتعلقة

1. Center of curvature (c): is a center of sphere which the mirror was cut from it.
2. Pole of the mirror (v): is a point that in surface center of spherical mirror.
3. Principal axis of the mirror: is the line passing through the center of curvature of the mirror and its pole.
4. Radius of curvature of the mirror (R): the radius of the sphere that's the mirror's surface was cut from it.
5. Focus point (F): the point that is on the principal axis of the mirror and that is resulted from the intersection of the reflected rays on the mirror's surface (or their extensions) and incident in a parallel way to the principal axis.
6. Focal length (f): is the distance between the mirror's pole and its focal point, and the focal length for mirror curvature equals to ($f = \frac{1}{2} R$).

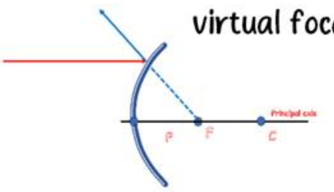
1. مركز تكور المرآة(c)هو مركز الكرة الذي اقتطع منها سطح المرآة
2. قطب المرآة: (v) هو النقطة التي تتوسط سطح المرآة الكروية
3. المحور الاساس للمرآة: هو الخط الواصل بين مركز تكور المرآة وقطبها
4. نصف قطر تكور المرآة : (R) وهو نصف قطر الكرة التي اقتطع منه سطح المرآة

5. بؤرة المراة: (F) هي نقطة واقعة على المحور الاساس للمرآة والناتجة عن التقاء الاشعة المنعكسة عن سطح المراة (او امتداداتها)والساقطة اصلاً بصورة موازية للمحور الاساس

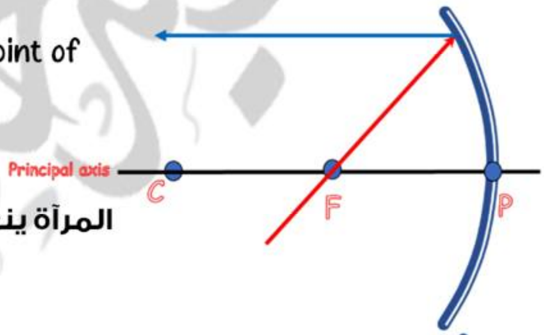
6. البعد البؤري :(f) هو البعد بين قطب المرآة وبؤرتها، والبعد البؤري لتكور المرآة يساوي(f= ½ R)



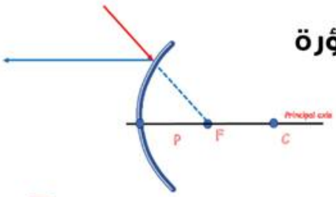
1. The light ray that is **PARALLEL** to the principal axis of the **CONCAVE** mirror reflects passing through its real focal point, while the light ray that is **PARALLEL** to the principal axis of the **CONVEX** mirror reflects where its extensions passing through its virtual focal point.



الشعاع الضوئي الموازي للمحور الأساسي للمرآة المقعرة ينعكس مارا ببؤرتها الحقيقية إما الشعاع الموازي إما الشعاع الموازي للمحور الأساسي للمرآة المحدبة فينعكس بحيث امتداده يمر ببؤرتها التقديرية

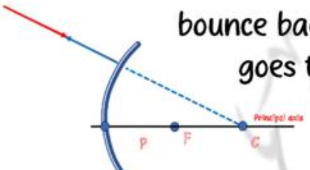


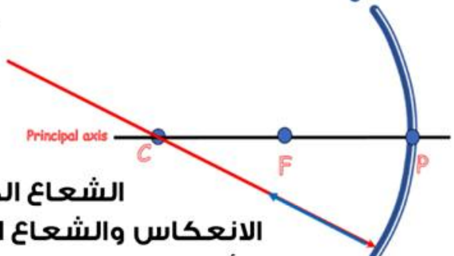
2. The light ray (or it's extensions) that passes throu gh focal point of the mirror reflects in a parallel way to its principal axis.



الشعاع الضوئي (او امتداده) المار في بؤرة المرآة ينعكس موازيا لمحورها الاساسي

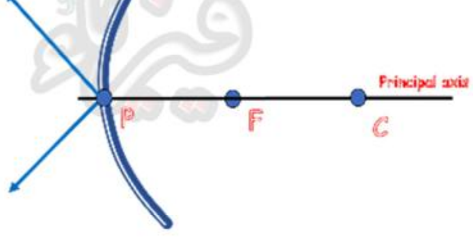
3. The ray that passes through the center of curvature concave mirror bounce back to itself after reflection, and the ray that goes toward the center of curvature of convex mirror also reflected back to itself.

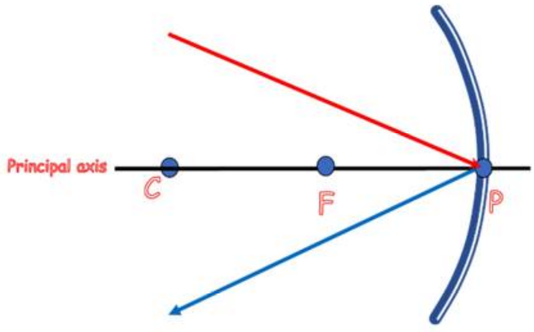




الشعاع المار بمركز تكور المرآة المقعرة يرتد على نفسه بعد الانعكاس والشعاع الذي يتجه نحو مركز تكور المرآة المحدبة ينعكس على نفسه أيضا

4 the angle of incidence of the light striking the pole is **equal** to the angle of reflection.



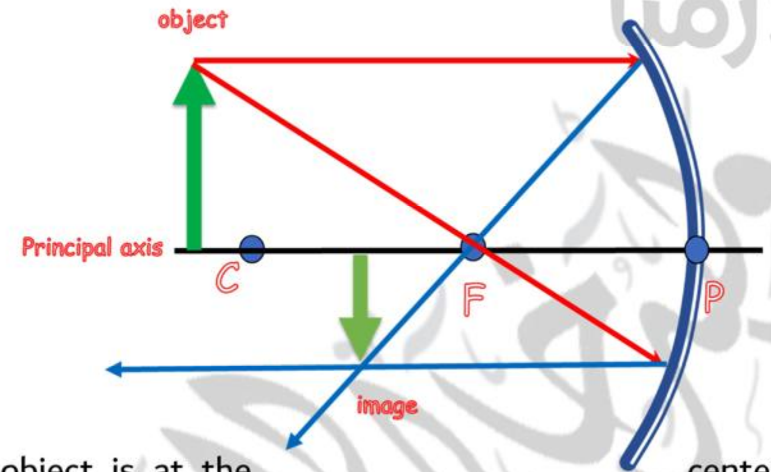


CHARACTERISTICS OF IMAGE FORMED IN CONCAVE MIRROR

IMAGE FORMATION BY A CONCAVE MIRROR

Case 1 : if the object is beyond the center, the image is If the object is located at a distance from the mirror is greater than twice of its focal length (2f)

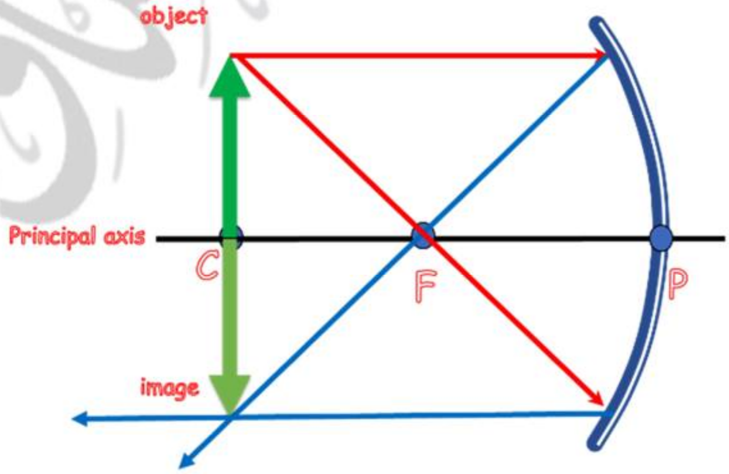
a. Between the center and the focus.
b. Smaller than the object (diminished).
c. Real
d. Inverted



Case 2 : if the object is at the center, the image is ;

If the object is located in the curvature center (means at a distance twice of focal length)

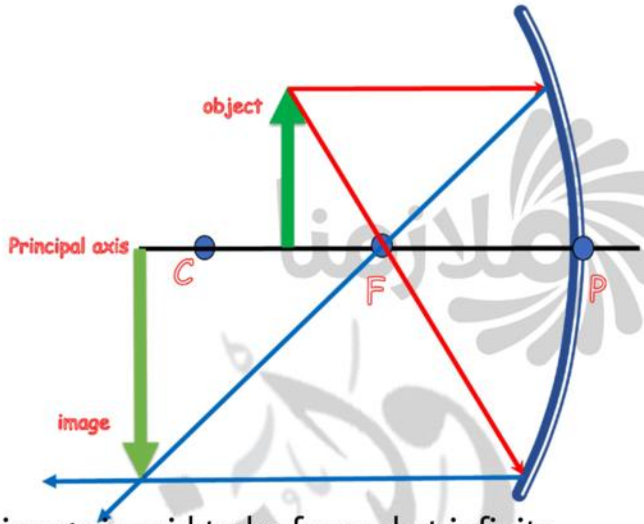
a. at the center.
b. The same size as the object (diminished).
c. Real
d. Inverted



Case 3 : if the object between the focus and center of the mirror, the image is ;

If the object is located between the focus and the center of curvature

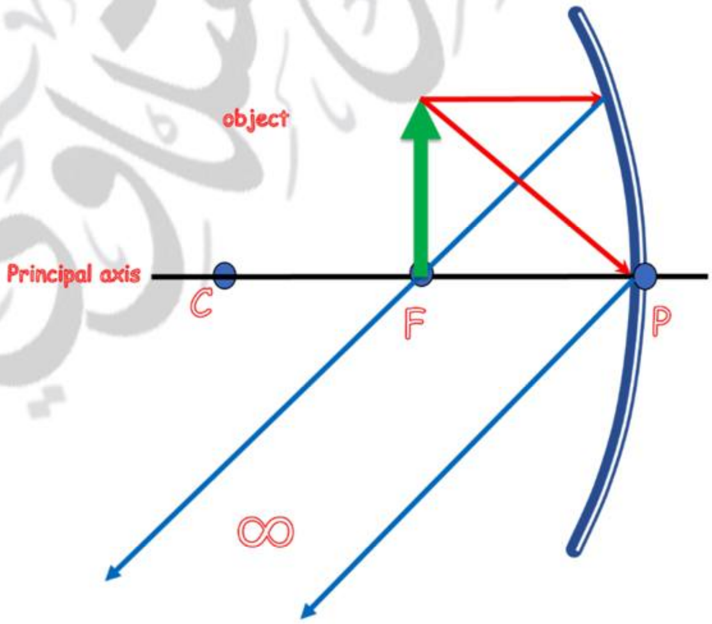
a. Beyond the center.
b. larger than the object (magnified).
c. Real
d. Inverted



Case 4 : if the object is at the focus, its image is said to be formed at infinity.

Because the reflected rays travel parallel to each other, they never cross. (No image).

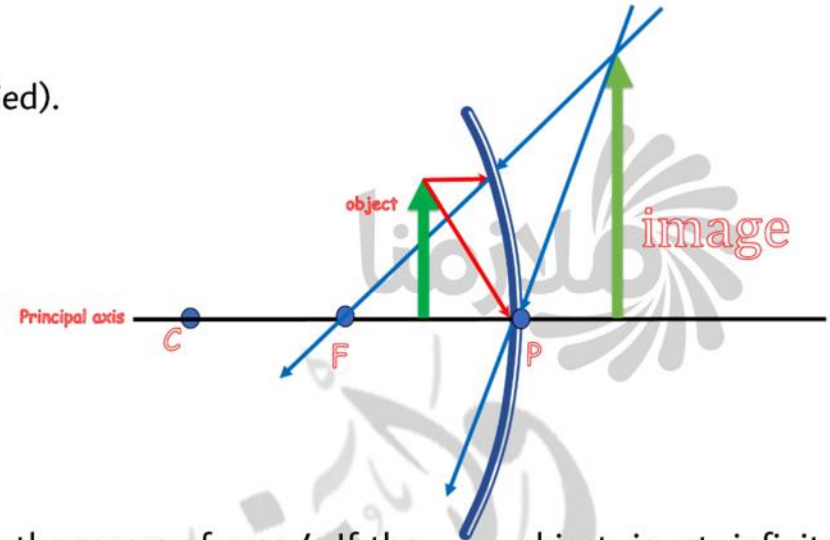
If the object is located at a distance equal to the focal length of the mirror, then the rays reflect in parallel way



Case 5 : if the object between the focus and the mirror, the image is ;

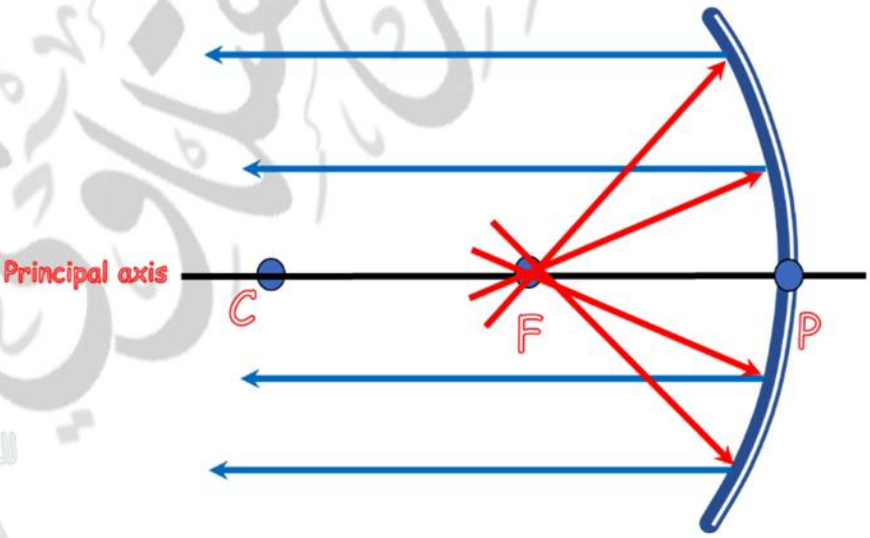
If the object is located in a distance from the mirror that's less than the focal length of the mirror

a. Behind the mirror.
b. larger than the object (magnified).
c. virtual
d. upright (erect)



Case 6 : Another type of image is the revers of case 4. If the object is at infinity (far away from the mirror)

- it image forms at the focus of the mirror.
- It image is real.



CHARACTERISTICS OF IMAGE FORMED IN CONVEX MIRROR

IMAGE FORMATION BY A CONVEX MIRROR

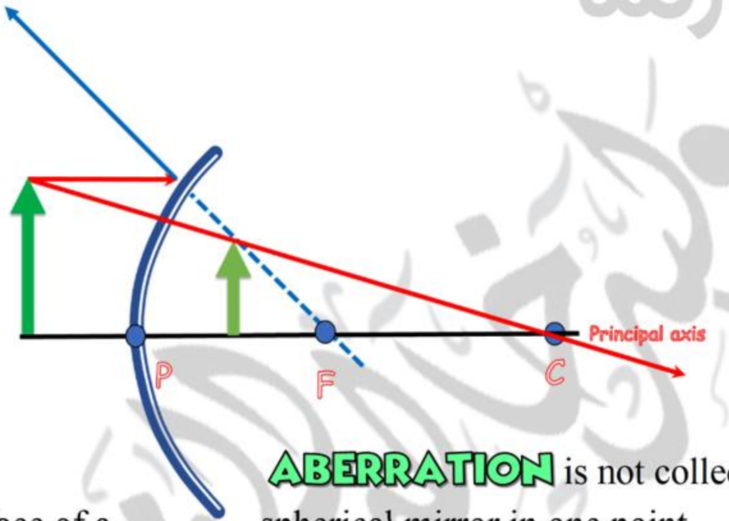
The convex mirror diverges light rays which falls on it therefore called a diverging mirror. There is only one type of image for convex mirror. The image of the object in front of a convex mirror is;

a. Behind the mirror (between F and P)

b. Smaller than the object (diminished)

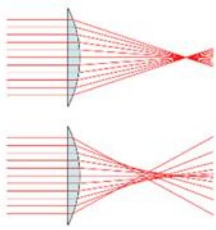
c. Virtual

d. Upright



SPHERICAL ABERRATION is not collecting the reflected radiation from the surface of a spherical mirror in one point.

الزيغ الكروي: هو عدم تجمع الاشعة المنعكسة عن سطح مرآة كروية في نقطة واحدة



To avoid the spherical aberration, the concave mirror is made as parabola with a point- focus and it's preferred to use spherical mirrors of small face, as in light reflectors and reflective astronomical telescopes

للتخلص من الزيغ الكروي تصنع المراة المقعرة بشكل قطع مكافئ ذات بؤرة نقطية ويفضل استعمال مرايا كروية صغيرة الوجه كما في عاكسات الضوء وفي التلسكوبات الفلكية العاكسة

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

f: focal length of the mirror. **البعد البؤري**

u: distance of the object from the mirror's pole.**بعد الجسم عن قطب المرآة**

v: distance of the image from the mirror's pole.**بعد الصورة عن قطب المرآة**

1. The distance of the object (u) positive if the object is real in front of the mirror and negative if the object is virtual behind the mirror, (in a system of a spherical mirror and a lens).

يكون F البعد البؤري موجبا إذا كانت المرآة مقعرة، وسالبأ إذا كانت المرآة محدبة

2. The distance of the image (V) is positive if the image is real and negative if the image is virtual.

تكون u بعد الجسم موجبة دائما لأنها امام المرآة

3. The focal length (f) is positive if the mirror is concave and negative if the mirror is convex.

تكون v بعد الصور موجبة إذا كانت الصورة حقيقية وسالبة اذا كانت الصورة وهمية (خيالية تقديرية)

MAGNIFICATION LAW IN MIRRORS

$$M = \frac{\acute{h}}{h} = -\frac{v}{u}$$

M: magnification.

h: height of the object.

$\acute{h}$: height of the image.

$\acute{h}$ ، ↑معتدلة كانت إذا موجبة الإشارة$\acute{h}$الإشارة سالبة إذا كانت مقلوبة ↓

When applying magnification law, the following should be noted:

1. Length of the image is positive for erect image (upward) and is negative for inverted image (downward).
2. Length of the object is positive for erect object (upward) and the object is negative for inverted object (downward).
3. Magnification sign is negative when the image is real and inverted to the object.
4. Magnification sign is positive when the image is virtual and erect to the object.

Also, magnification shows us the magnifying and minimizing range of the image:

a. If the magnification M>1 then the image is magnified to the object.
b. If the magnification M<1 then the image is minimized to the object.
c. If the magnification M=1 then the image is equal to the object.
d. The magnification sign is positive for image is erect (upward) and its negative for inverted real image (downward).

Example 1

A concave mirror having a focal length of (20cm) find the location of the formed image and its characteristics and the amount of magnification for an object placed at a distance (30cm) in front of the mirror.

مراة مقعرة بعدها البؤري (20cm) جد موضع الصورة المتكونة وصفاتها ومقدار التكبير لجسم موضوع على بعد(30cm) مام المرآة

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \rightsquigarrow \frac{1}{20} = \frac{1}{30} + \frac{1}{v}$$

$$\frac{1}{v} = \frac{1}{30} - \frac{1}{20} = \frac{3-2}{60} = \frac{1}{60}$$

$v = 60cm$ the real image is inverted and at a distance greater then the center of curvature

$$M = -\frac{v}{u} = -\frac{60}{30} = 2$$ means the image is magnified two times

EXAMPLE 2

A concave mirror having a focal length of (15cm) where should an object be placed in front of the mirror to form an image for it:
1. Real and three times magnified
2. Virtual and three times magnified

مراة مقعرة بعدها البؤري (15cm)أين يجب أن يوضع جسم أمامها حتى تتكون له صورة:
1- حقيقية مكبرة ثلاث مرات
2- تقديرية مكبرة ثلاث مرات

1- $M = -\frac{v}{u}$

$-3 = -\frac{v}{u}$

$v = 3u$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \rightsquigarrow \frac{1}{15} = \frac{1}{u} + \frac{1}{3u} \rightsquigarrow \frac{1}{15} = \frac{3+1}{3u}$

$3u = 15 \times 4 \rightsquigarrow u = 20cm$ distance from the object to the mirror

$v = 3u = 3(20) = 60cm$ distance from the image to the mirror.

2- $M = -\frac{v}{u}$

$+3 = -\frac{v}{u}$

$v = -3u$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \rightsquigarrow \frac{1}{15} = \frac{1}{u} + \frac{1}{-3u} \rightsquigarrow \frac{1}{15} = \frac{3-1}{3u}$

$3u = 15 \times 2 \rightsquigarrow u = 10cm$ distance from the object to the mirror

$v = -3u = -3(10) = -30cm$ the virtual image erect and magnified

EXAMPLE 3

A convex mirror has a radius curvature of (8cm), an object placed in front of the mirror of (6cm)from its pole, find the distance of the formed image? And the magnification power?

مرآة محدبة نصف قطر تكورها (8cm) وضع أمامها جسم على بعد (6cm) من قطبها جد بعد الصورة المتكونة ؟ وكذلك قوة التكبير؟

$f = \frac{1}{2}R = \frac{8}{2} = 4cm$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \rightsquigarrow -\frac{1}{4} = \frac{1}{6} + \frac{1}{v}$

$\frac{1}{v} = -\frac{1}{4} - \frac{1}{6} \rightsquigarrow \frac{1}{v} = \frac{-3-2}{12}$

$v = -\frac{12}{5} = -2.4cm$

$M = -\frac{v}{u} = -\frac{-2.4}{6} = 0.4$ magnification. Positive sign means that the image is virtual.

Application on Mirrors

Applications of plane mirror:

1.It has many uses where it exists everywhere in the house to decorate the houses and lounges as well for personal use in bedrooms and in bathroom and others, the mirror at home.

2. Use the angled mirrors to get multiple images and invest this phenomenon in embellishment and shops.

3. And in front mirror of the driver to see behind the driver when driving the car. The driving plane mirror in front of driver and sometimes it is called the driver's third eye.

Applications of concave mirror

1. To magnify the images, dentists use the concave mirror which gives a larger image of the patient's teeth to help them see the details clearly.

2. Used in car headlights

Where the light source is placed in the focus of parabola and the light rays fall on its surface and reflect from it in parallel so it lights for far distances in front of the car.

3. Collect solar energy and use concave mirror to focus sunlight in its focal point and use the energy for heating and cooking this is called the solar cooker

Application of convex mirror

Convex mirror is called driving mirror its found on both sides of the driver to give miniature and erect images and it gives a wide field of vision on both sides And it's used in shopping center to observe the customers during their shopping

QUESTIONS of CHAPTER 7

Q1. Choose the correct answer for the following questions.

1. Virtual image:

a. Is erect with to the object. b. Its inverted with to the object.

c. It can be projected on a screen. d. It's in front of the mirror.

2. The concave mirror shows an erect image of the object when it is distance from it

a. Is less than the focal length (f) of it b. Is equal to the focal length of it

c. Twice the focal length d. Very far from the mirror

3. Number of images formed in faced parallel mirrors:

a. 30. b. 180. c. Infinity. d. 0.

4. The principal axis for a spherical mirror is the straight line than passes:

a. Through the center of curvature of the mirror and another point.

b. Through the center of curvature of the mirror and its pole.
c. Through the focal point of the mirror and any point on its surface.
d. Tangential to the mirror.

5. If you look in the mirror and your image was magnifying then the mirror is:
a. Concave. b. Convex. c. Plane. d. All of the above.

6. The radius of curvature of spherical mirror is:
a. Half of the focal length. b. Twice of the focal length.
c. Three times of the focal length. d. of the focal length.

7. The characteristics of the image formed in the convex mirror:
a. Real, erect and miniature.
b. Virtual, erect and miniature.
c. Real, magnifying and inverted.
d. Virtual, inverted and magnifying.

8. A spherical mirror of 15 cm focal length then its radius of curvature is :
a. 15 cm. b. 7.5 cm. c. 60 cm. d. 30 cm.
R=2f=2x15=30cm

9. A ruler having a length of 10 cm was placed perpendicular in front of a concave mirror that's focal length is (+ 50cm) and at a distance of 100 cm from the pole of the mirror then the length of the formed image is:
a. 3cm erect b. 10 cm erect c. 3 cm inverted d. 10 cm inverted

$$\frac{1}{f}=\frac{1}{u}+\frac{1}{v} \rightsquigarrow \frac{1}{50}=\frac{1}{100}+\frac{1}{v}$$

$$\frac{1}{v}=\frac{1}{50}-\frac{1}{100} \rightsquigarrow \frac{1}{v}=\frac{2-1}{100}$$

$$v=100cm$$

$$M=-\frac{v}{u}=\frac{h'}{h}=-\frac{100}{100}=\frac{h'}{10} \rightsquigarrow h'=-10cm$$ negative for inverted real image (downward).

Answer the following question:

Q1. Someone is suggesting to place a concave mirror on both sides of the car instead of convex mirror? Do you see that his suggestion is true? And why?

-No, it's not true because the concave mirror doesn't reflect the real size of object while the convex give mimiature and erect.
-No, its false because the image that's formed on the concave mirror is always inverted. (upside down).
-No, your suggestion is incorrect because the driver's side mirror is a convex mirror that gives a mimiature and erect image and gives a wider and broader field of vision on either side.

Q2. Ahmed stood in front of a plane mirror wearing a sports shirt with a number (81) written on it. What do you read the image of number (81)?

It will be reflecting as: 18
becuase one of the characteristics of a plane mirror is that the image formed on it is always inverted (right side of the object is the left side of the image).

Q3. The next shape represents a clock image placed in front of a plane mirror what time the clock is referring to?

It's referring to 7:10

Q4. Why no image form for an object placed in the focal point of a concave mirror?

because the light rays travel parallel to each other so they do not cross (no image is formed).

Q5. What is real and virtual focus?

The real focus is at a concave mirror where the light rays cross
The virtual focus is in the covex mirror where the extension of the light rays cross

Q6. Distinguish between convex mirror and concave mirror in terms of the reflective surface and the characteristics of images formed in each of them?

1. A concave mirror it uses the inner face as a reflective surface
2. A convex mirror uses the outer face as a reflective surface

Q7. Show by drawing the image's location of an object that's at a distance greater than the radius of curvature of:

a. concave mirror. b. convex mirror.

PROBLEMS of CHAPTER 7

Q1. An erect image formed by using a concave mirror having a curvature radius of (36 cm), if the magnification power was = 3. Calculate the location of the object with respect to the mirror.

Answer: u = 12 cm

$$f = \frac{1}{2}R = \frac{36}{2} = 18cm$$
$$M = -\frac{v}{u}$$
$$3 = -\frac{v}{u}$$
$$v = -3u$$
$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \rightsquigarrow \frac{1}{18} = \frac{1}{u} + \frac{1}{-3u}$$
$$\frac{1}{18} = \frac{-1+3}{3u}$$
$$u = \frac{2 \times 18}{3} = 12\ cm$$

Q2. Two plane mirrors the angle between them is 120 °. Calculate the number of images formed in the mirrors.

Answer: n = 2

$$n = \frac{360°}{\theta} - 1 = \frac{360°}{120°} - 1 = 3 - 1 = 2 \text{ number of images}$$

Q3. An object was placed an object 4cm away from a mirror and a virtual and three times magnified image formed for it. What is the kind of the mirror and what is the focal length of it?

Answer: f = +6 cm concave mirror.

a virtual and magnified image the mirror is concave

$$M = -\frac{v}{u}$$
$$3 = -\frac{v}{4}$$
$$v = -12\ cm$$
$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \rightsquigarrow \frac{1}{f} = \frac{1}{4} + \frac{1}{-12}$$
$$\frac{1}{f} = \frac{3-1}{12}$$
$$f = 6\ cm\ concave\ mirror$$

Q4. An object was placed in front of a concave mirror that's focal length is (12cm), then a real four times magnified image formed for it. Find the distance of the object from the

mirror and also its image distance from it (consider the object is perpendicular on the principal axis of the mirror).

Answer: u = 15cm V = 60 cm

$$M = -\frac{v}{u}$$

$$-4 = -\frac{v}{u}$$

$$v = 4u$$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \rightsquigarrow \frac{1}{12} = \frac{1}{u} + \frac{1}{4u}$$

$$\frac{1}{12} = \frac{1+4}{4u}$$

$$u = \frac{12 \times 5}{4} = 15\ cm$$

$$v = 4u = 4 \times 15 = 60cm$$

Q5. An object of 4 cm long was placed in front of a convex mirror that's radius of curvature is (20cm), if the object was (40cm) away from the mirror. Then find the type of the formed image and its length and clarify your answer by drawing.

Answer h` = 0.8 cm virtual erect miniature image.

$$f = \frac{1}{2}R = \frac{-20}{2} = -10\ cm$$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \rightsquigarrow \frac{1}{-10} = \frac{1}{40} + \frac{1}{v}$$

$$\frac{1}{v} = -\frac{1}{40} - \frac{1}{10} = \frac{-1-4}{40}$$

$$v = -\frac{40}{5} = -8\ cm$$

$$M = \frac{\acute{h}}{h} = -\frac{v}{u} \rightsquigarrow \frac{\acute{h}}{4} = -\frac{-8}{40}$$

$$\acute{h} = \frac{-8 \times 4}{40} = -0.8\ cm$$

CHAPTER 8 الفصل الثامن

THIN LENSES

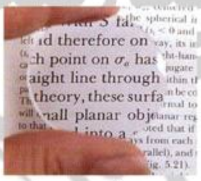
07740133377 07718597632

وليد خالد الفتلاوي

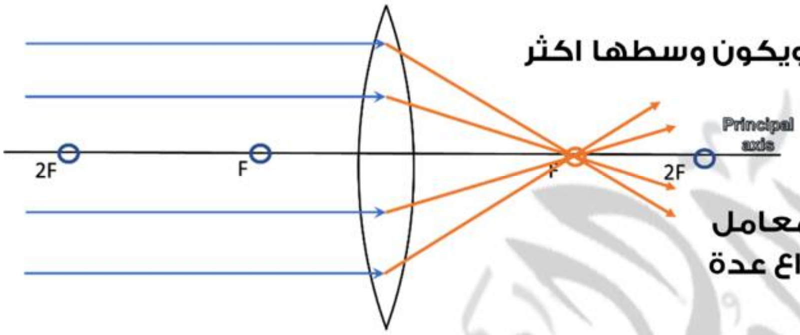
CHAPTER 8 THIN LENSES

LENSES HAVE TWO TYPES

1. **Convex lenses**: or called (Converging lens) and it is center is thicker than its edge, used to converge the incident rays on it after its passes from the lens when the refraction coefficient of the lens material is greater than the refraction coefficient of the medium it's found in it, and exist on several types
   a. Biconvex.
   b. Convex - Concave.
   c. Plano – convex.

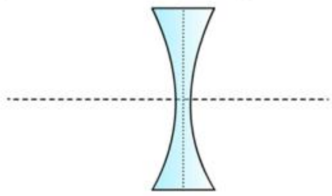


والعدسات نوعان:



1-عدسة محدبة أو تسمى عدسة لامة ويكون وسطها اكثر سمكا من حافتها ،و تعمل على تجميع الأشعة الساقطة عليها بعد نفوذها من العدسة عندما يكون معامل إنكسار مادة العدسة أكبر من معامل إنكسار الوسط المتواجدة فيه وتوجد على انواع عدة

2. **Concave lens:** called (diverging lens): its center is less thick than its edge, used to diverge the incident light rays that passes from the lens, and exist on several types:
   a. Double-concave.
   b. Convex Concave.
   c. Plane – concave.

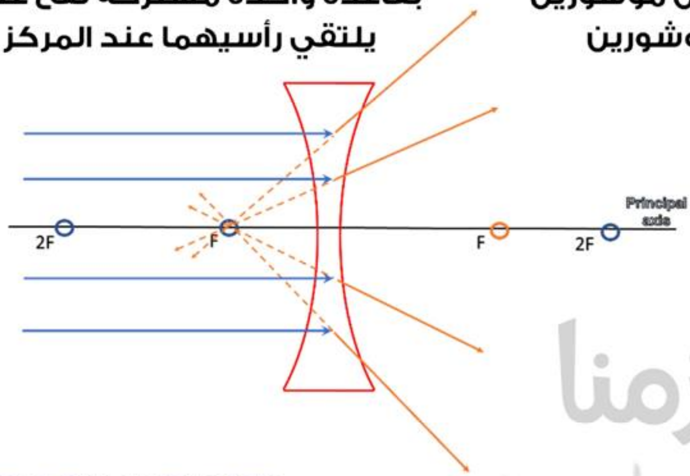


2- عدسة مقعرة تسمى عدسة مفرقة ويكون وسطها اقل سمكا من حافتها، وتعمل على تفريق الأشعة الضوئية الساقطة عليها بعد نفوذها من العدسة، وتوجد على انواع عدة

REMEMBER

A convex lens (Converging lens) is like two prisms placed base to base located at the optical center, diverging lens is like two prisms placed head to head located at the optical center.

تعمل العدسة اللامة عمل موشورين بقاعدة واحدة مشتركة تقع عند المركز البصري، تعمل العدسة المفرقة عمل موشورين يلتقي رأسيهما عند المركز البصري.



SOME BASIC CONCEPTS IN LENSES

1. Optical Center: C P

Is a point at the center of the lens if a light ray passes through it transmit straightly without deviation because the two sides of the lens at the optical center are approximately parallel mean the passed ray diverges slightly from its original path which can be neglected because the lens is thin?

المركز البصري: هي نقطة عند مركز العدسة إذا مر خلالها شعاعاً ضوئياً ينفذ على إستقامته من غير إنحراف والسبب هو ان جانبي العدسة عند المركز البصري متوازيان تقريباً، أي ان الشعاع النافذ ينزاح قليلاً عن مساره الأصلي بمقدار يمكن إهماله بسبب كون العدسة رقيقة

2. Principal Axis:

A straight line passes through optical center of the lens and its two focuses

محور الأساس: هو المستقيم المار في المركز البصري للعدسة وبؤرتيها

3. Focus: F

Is the point placed on the principal axis of the lens, that any ray emitted from it or going toward it travels after refraction parallel to the principal axis

البؤرة:هي نقطة تقع على المحور الاساس للعدسة، تتصف بأن اي شعاع صادر منها او متجه نحوها يسير بعد الانكسار موازياً للمحور الأساس

4. Focal Length f

The distance between the focus and the optical center for the lens

البعد البؤري : البعد بين موقع البؤرة والمركز البصري للعدسة

A lens has two focal points because light can enter the lens from both sides. Twice the focal length is represented as 2F

5. Secondary Axis:

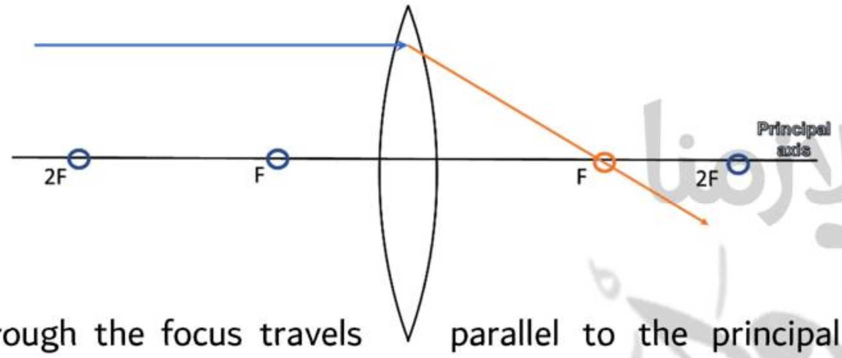
The straight line that passes through the optical center for the lens is called the secondary axis

المحورِ الثانوي : المستقيم المارِ في المركزِ البصري للعدسة يسمى المحورِ الثانوي

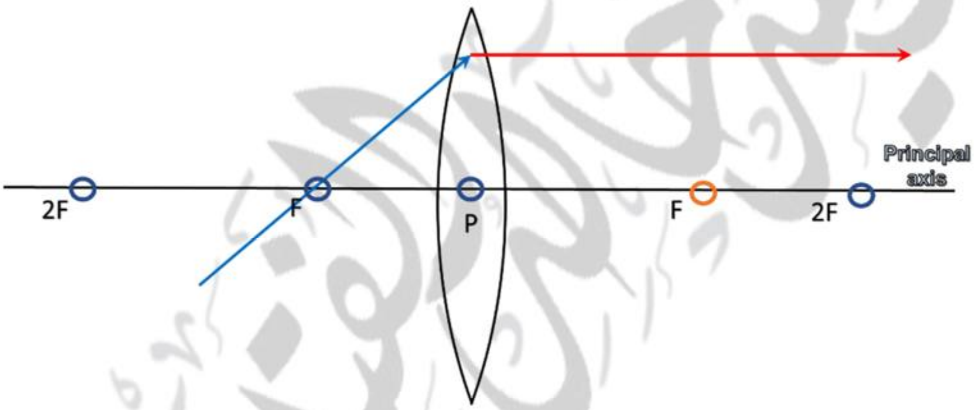
SPECIAL RAYS OF LIGHT FOR CONVERGING LENSES

There are some special rays for lenses, as there are for spherical mirrors:

1 A light ray **parallel** to the principal axis. passes through the **focus** after being refracted by the lens.



2 A light ray through the focus travels parallel to the principal axis after being refracted by the lens.



3 A light ray passing through the optical centre travels without changing its direction.

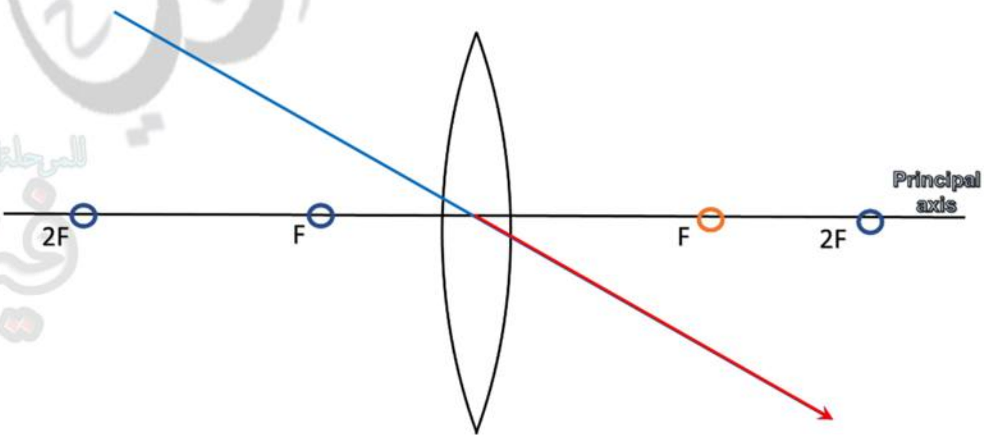
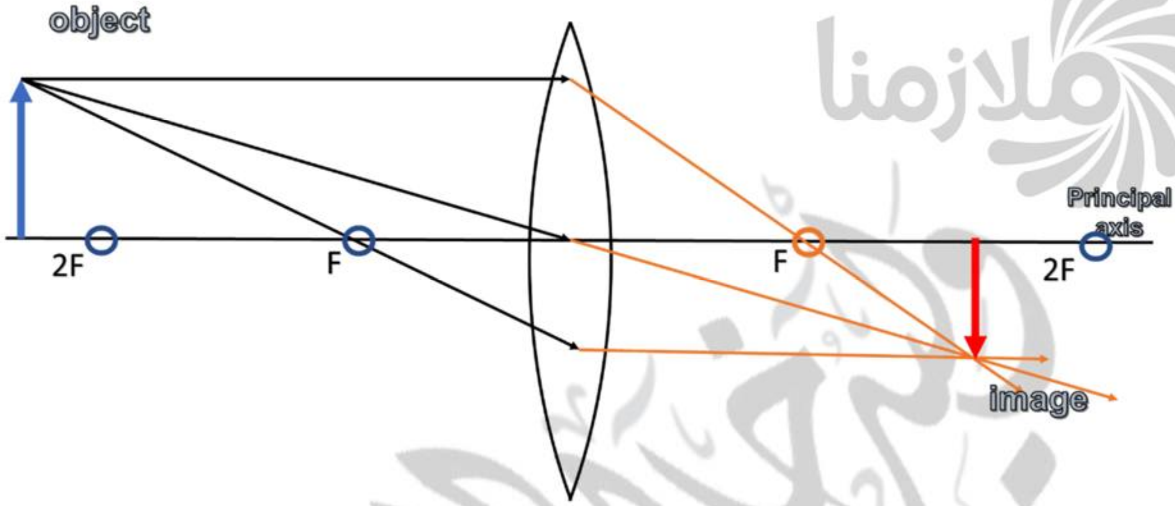


IMAGE FORMATION BY A CONVERGING LENS

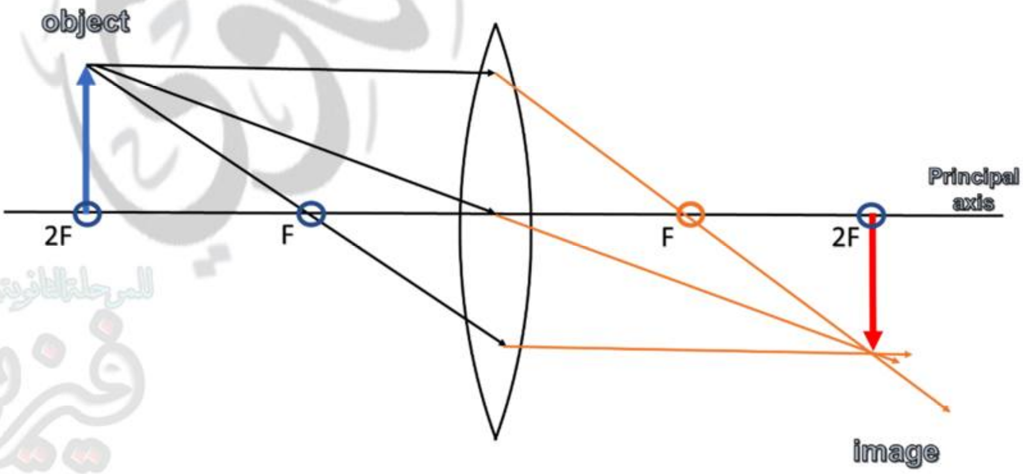
Case 1: the object is beyond 2F from the lens, the image is;

a. between F and 2F on the other side of the lens b. smaller than the object (diminished) c. real d. inverted



Case 2: If the object is at 2F. the image is:

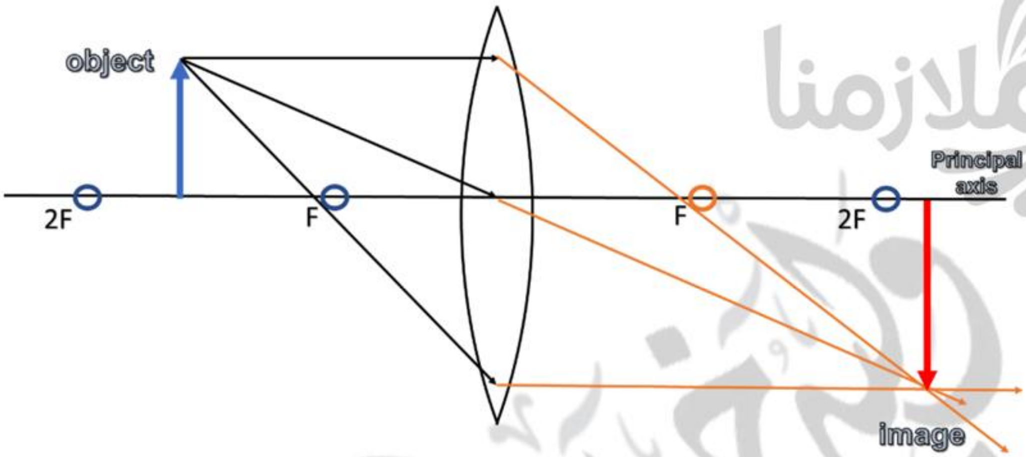
a. at 2F on the other side of the lens b. the same size as the object c. real d. inverted



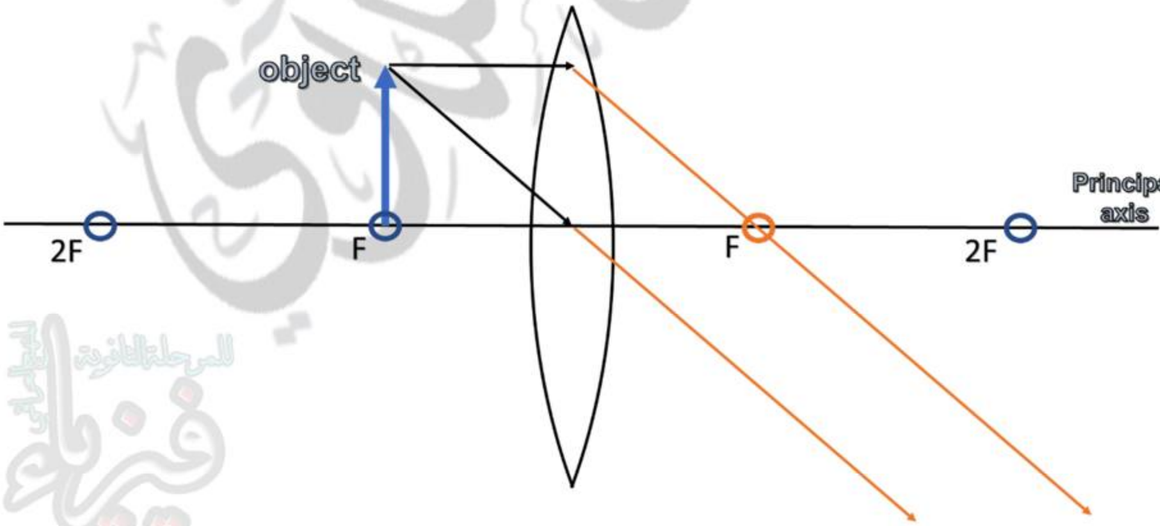
Case 3: if the object is between 2F and F, the image is;

When the object is placed between the focus of the lens and twice its focal length,

a. beyond 2F on the other side of the lens b. larger than the object (magnified) c. real d. inverted



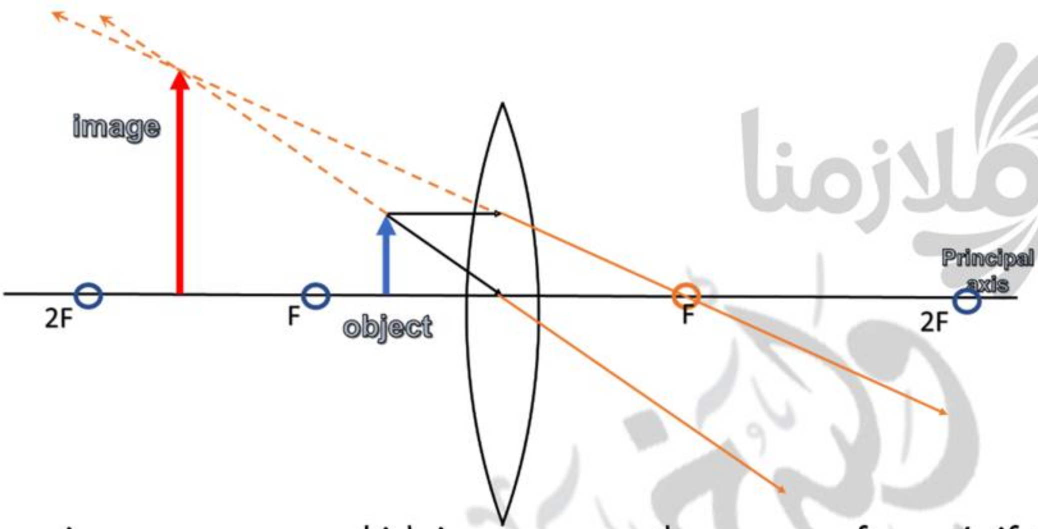
Case 4: if the object is at the focus then the image is said to be formed at infinity. Thus. if we place a light bulb at the focus of a converging lens we can obtain parallel light rays. Laboratory light sources include a converging lens and a bulb located at its focus.



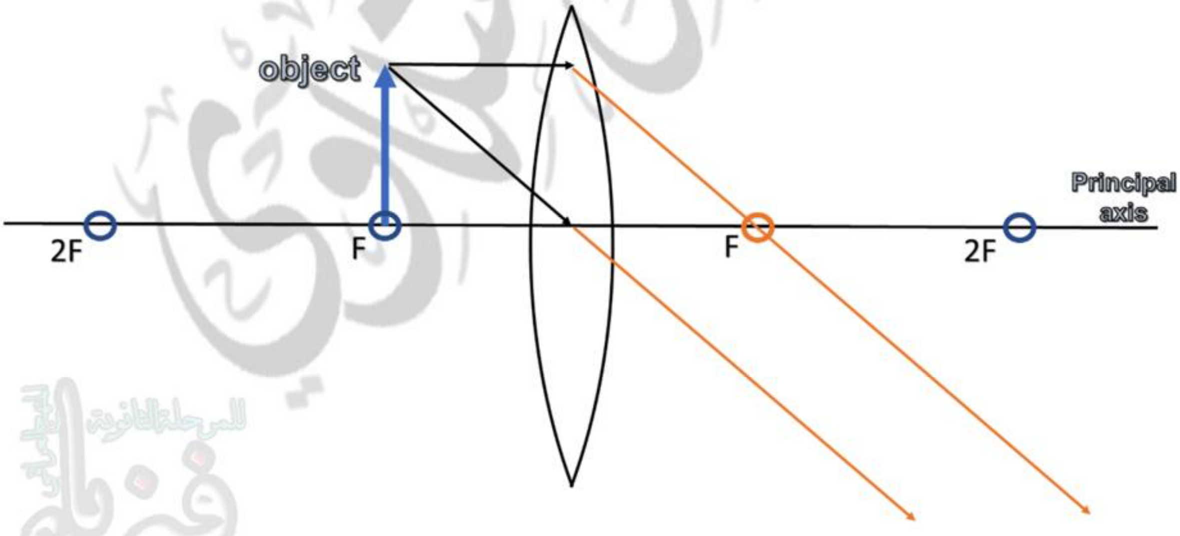
Case 5: if the object is between the focus and the lens, the image is;

a. behind the object b. larger than the object (magnified) c. virtual d. upright (erect)

Due to these properties converging lenses are known as magnifying lenses.



Case 6: There is one more case which is the reverse of case 4. if the object is far away (at infinity) from the lens. the rays are al-most parallel. the image forms nearly at the principal focus. It is real and invented. For this reason, a real image be formed on a screen.

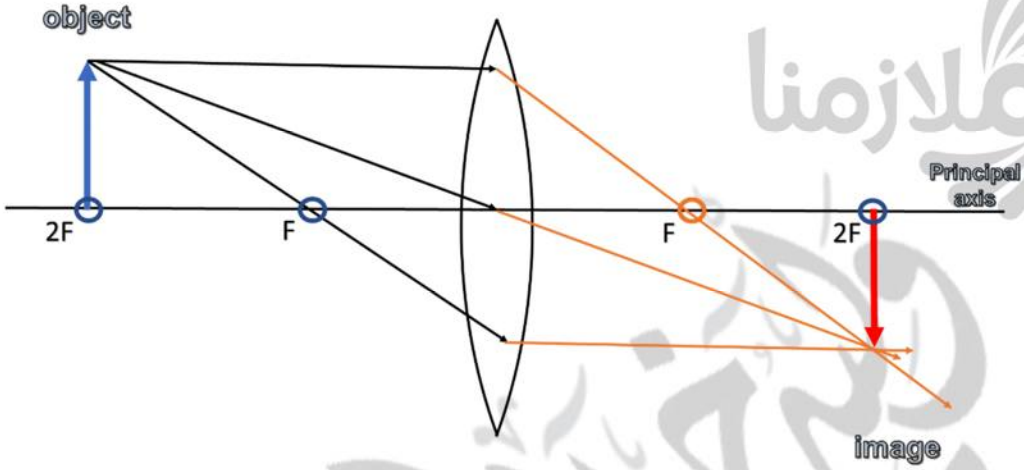


Example

The figure below shows an object which is placed at a distance of 2F from the converging lens.

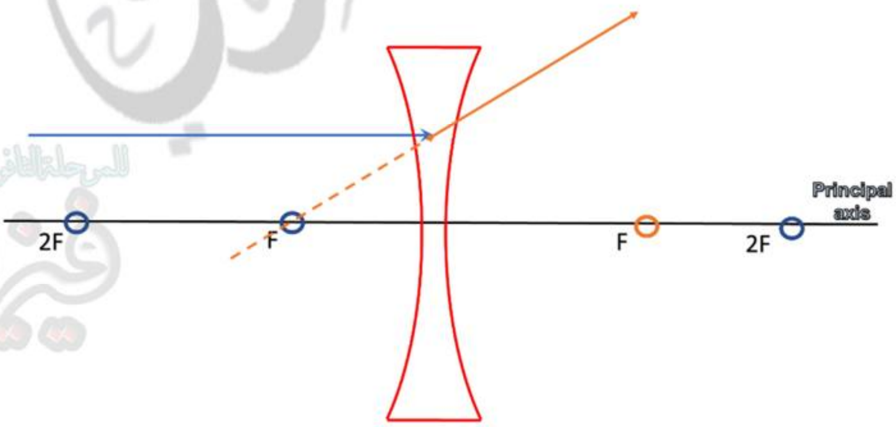
a. Where is the image formed? at 2F on the other side of the lens

b. List the image properties. the same size as the object, real, inverted

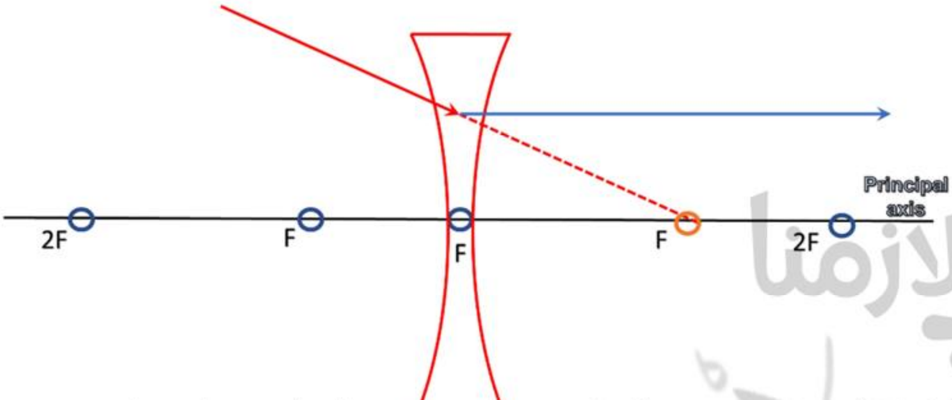


SPECIAL RAYS OF LIGHT FOR A DIVERGING LENS

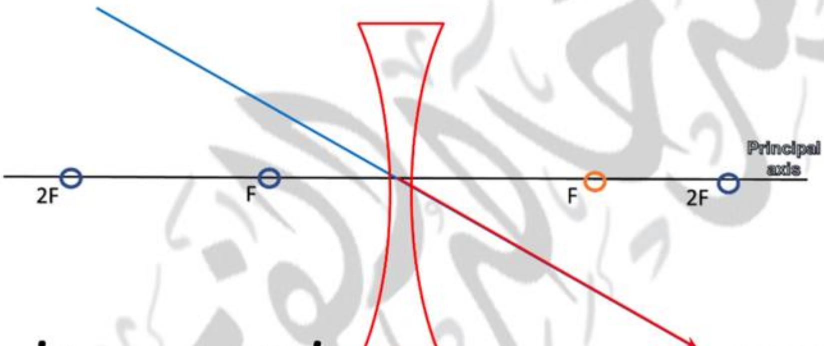
1 A light ray parallel to the principal axis is refracted so that it appears to come from the principal focus behind the lens.



2 A ray directed towards F on the other side of the lens bends. so that it becomes parallel to the principal focus.



3 A light ray passing through the optical centre travels without changing its direction.



Law of lenses and magnification

$$\frac{1}{F} = \frac{1}{u} + \frac{1}{v}$$

$$M = \frac{\acute{h}}{h} = -\frac{v}{u}$$

$$\frac{\acute{A}}{A} = \frac{V^2}{u^2}$$

$$P = (n-1)(\frac{1}{R_2} - \frac{1}{R_2})$$

The general law of lenses is applied whether the lens is convex or concave with regard to the sign of each quantity when the light incident on the lens moves from left to right as follows:

1.The object's distance (u) is positive if the object was real located on the left of the lens takes negative sign if the object was located on the right of lens.

2. The image's distance (v) is positive if the image was real and located on the right of the lens and takes negative sign if the image was virtual located on left of lens.

3. The focal length (f) is positive for converging lens (convex lens) and negative sign for diverging lens (concave lens).

4. The length of the erect object (upward) have positive sign and the length of the inverted object (downward). have negative sign.

5. The length of the erect image (upward) have positive sign and the length of the inverted image (downward), have negative sign.

ويطبق القانون العام للعدسات سواء كانت العدسة محدبة او مقعرة مع مراعاة اشارة كل كمية عندما

ينتقل الضوء الساقط على العدسة من اليسار الى اليمين وكما يلي:

يكون بعد الجسم u موجباً اذا كان الجسم حقيقياً واقعاً على يسار العدسة وباشارة سالبة اذا كان الجسم واقعاً على يمينها

1. **يكون بعد الصورة v موجباً اذا كانت الصورة حقيقية واقعة على يمين العدسة وباشارة سالبة اذا كانت الصورة خيالية واقعة على يسارها يكون البعد البؤري f موجباً للعدسة اللامة العدسة محدبة وباشارة سالبة للعدسة المفرقة (العدسة مقعرة)**
2. **طول الجسم يكون باشارة موجبة للجسم المعتدل نحو الاعلى وباشارة سالبة للجسم المقلوب (نحو الاسفل)**
3. **طول الصورة يكون باشارة موجبة للصورة المعتدلة نحو الاعلى وباشارة سالبة للصورة المقلوبة (نحو الاسفل)**

And for the magnification (M) sign:

1. **Positive:** the image is virtual and erect according to the object.
2. **Negative**: the image is real and inverted according to the object.

اما بالنسبة لاشارة التكبير M فعندما تكون:

1. **موجبة: تكون الصورة تقديرية (خيالية) معتدلة بالنسبة للجسم.**
2. **سالبة: تكون الصورة حقيقية مقلوبة بالنسبة للجسم.**

The value of magnification tells us the following:

a. If M>1 then the image is magnified according to the object.

b. If M <1 then the image is minimized according to the object.

c. If M=1 then the image is equal to the object.

وتدلنا قيمة التكبير على ما ياتي:

a) **اذا كان $M > 1$ ، فان الصورة تكون مكبرة بالنسبة للجسم**

b) **اذا كان $M < 1$ ، فان الصورة تكون مصغرة بالنسبة للجسم**

c) **اذا كان $M = 1$ ، فان الصورة تكون مساوية للجسم**

The ratio between two areas of image and the object equals to the ratio between the square of distance from the optical center of lens.

$$\frac{\acute{A}}{A} = \frac{v^2}{u^2}$$

Example 1

A converging lens of (10 cm) focal length, formed images for objects that are away from it in the distances:
u=30cm.
u=10cm.
u=5cm.
From on of the sides of the lens. Find the image distance, magnification and its properties in each case.

A

$$\frac{1}{F} = \frac{1}{u} + \frac{1}{v}$$

$$\frac{1}{10} = \frac{1}{30} + \frac{1}{v}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{30} = \frac{3-1}{30} = \frac{2}{30} = \frac{1}{15}$$

$v = 15cm$ **distance of the image from the lens.**

The positive sign for the image distance means that the image is located in the second side on the right of the lens and its real.

B

$$M = -\frac{v}{u} = -\frac{15}{30} = -0.5$$

The negative sign for magnification means that the image is inverted and its minimized because the magnification is less than one.

When the distance (u) of the object equals to the focal length of the lens (10 cm), means the object is located in the focus of the lens so the image is located in infinity.

C

$$\frac{1}{F} = \frac{1}{u} + \frac{1}{v}$$

$$\frac{1}{10} = \frac{1}{5} + \frac{1}{v}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{5} = \frac{1-2}{10} = \frac{2}{10} = -\frac{1}{10}$$

$v = -10cm$ **sign of the image distance is negative means the image is virtual.**

$$M = -\frac{v}{u} = -\frac{-10}{5} = +2$$

The positive sign for magnification means the image is erect and number (2) means the image is magnified.

EXAMPLE 2

An object was placed (12 cm) away in front of a diverging lens (6 cm) focal length. What are the properties of the formed image?

$$\frac{1}{F}=\frac{1}{u}+\frac{1}{v}$$

$$\frac{1}{-6}=\frac{1}{12}+\frac{1}{v}$$

$$\frac{1}{v}=-\frac{1}{6}-\frac{1}{12}=\frac{-2-1}{12}=\frac{-3}{12}=-\frac{1}{4}$$

$v=-4cm$ **the negative sign of (v) means that the image is virtual (in the same of the object side)**

$$M=-\frac{v}{u}=-\frac{-4}{12}=+\frac{1}{3}$$

The positive magnification means the image is erect and virtual

Combination of Thin Lenses

Many optical devices contain two or more thin lenses.

Total Magnification M = Magnification of the first lens M_1 x Magnification of the second lens M_2

$$M_{Total}=M_1\times M_2$$

$$\frac{1}{F}=\frac{1}{u}+\frac{1}{v}-\frac{d}{f_1f_2}$$

d represents the distance between the two optical centers of the two lenses while the special case that's when the two lenses are placed in contact each other (d = zero).

Lens Power

Optometrists and ophthalmologists use diopter unit to measure the power of the eye lens. Which is the inverse of the focal length of the lens measured by meters:

$$Lenspower\ P = \frac{1}{f\ (meter)}$$

a lens power (+) **Positive** for converging lenses,

a lens power (-) **Negative** for diverging lenses.

Its unit is the dioptre (D).

Dioptre (D): is a unit of measurement of the optical power of a lens or curved mirror

We can find the lens power by the equation that **The lens makers**

$$P = (n-1)(\frac{1}{R_2} - \frac{1}{R_2})$$

EXAMPLE 3

A system consists of two convex lenses the focal lengths of the first one is (10cm) and the second one is (5cm), the distance between them is (40cm). An object was placed (15cm) to the left of the first lens find the location the final formed image and its magnification?

$$\frac{1}{f_1} = \frac{1}{u_1} + \frac{1}{v_1}$$

$$\frac{1}{10} = \frac{1}{15} + \frac{1}{v_1}$$

$$\frac{1}{v_1} = \frac{1}{10} - \frac{1}{15} = \frac{3-2}{30} = \frac{1}{30}$$

$$v_1 = 30cm$$

$$M_1 = -\frac{v_1}{u_1} = -\frac{30}{15} = -2$$

Since the image formed in the first lens is real and formed in front of (left) of the second lens therefore it's considered a real object for the second lens and is located on a distance (u_2).

$$u_2 = 40 - 30 = 10cm$$

$$\frac{1}{f_2} = \frac{1}{u_2} + \frac{1}{v_2}$$

$$\frac{1}{5} = \frac{1}{10} + \frac{1}{v_2}$$

$$\frac{1}{v_2} = \frac{1}{5} - \frac{1}{10} = \frac{2-1}{10} = \frac{1}{10}$$

$$v_2 = 10cm$$

$$M_2 = -\frac{v_2}{u_2} = -\frac{10}{10} = -1$$

$M_{Total} = M_1 \times M_2 = -2 \times -1 = +2$ **the positive sign means image is erect.**

◇ الزيغ الكروي Spherical Aberration

1. تعريف العيب:
   عدسة يحدث فيها أن الأشعة الموازية لمحورها الرئيسي لا تتجمع عند نقطة واحدة.
   A lens defect where parallel rays to the principal axis do not converge at a single focal point.
2. السبب:
   اختلاف انكسار الأشعة بناءً على بعد نقطتها عن المحور؛ الأشعة البعيدة تنكسر أكثر من القريبة.
   Caused by different refraction angles for rays depending on their distance from the axis; off-axis rays refract more than paraxial rays.
3. التصحيح:
   - تركيب حاجز أمام حافة العدسة لحجب الأشعة الشاذة.
   - استخدام عدسة محدبة-مستوية (Plano-convex) كموضوعة موضوعية.
     – Place a diaphragm at the lens edge to block marginal rays.
     – Use a plano-convex lens oriented correctly.

◇ الزيغ اللوني Chromatic Aberration

1. تعريف العيب:
   انحراف مختلف لأطوال موجية ضوئية مختلفة؛ يتجمع البنفسجي أقرب والأحمر أبعد من العدسة.
   Different wavelengths focus at different points; violet focuses closer and red farther from the lens.
2. السبب:
   اختلاف معامل انكسار الزجاج مع تغير الطول الموجي للضوء الأبيض.
   Dispersion: the glass's refractive index varies with wavelength.

3. التصحيح:

ومتماسكة مع عدسة متباعدة (crown) استخدام عدسة مقاربة من زجاج تاج لتلغي انحرافات بعضهما بعضًا (flint) من زجاج فلينت.

Combine a positive crown-glass lens with a negative flint-glass lens (achromatic doublet) to cancel dispersion.

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

Uses of lenses

 The eye,  cameras,  telescopes and  Microscopes

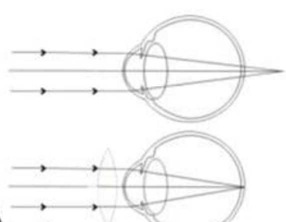
Application on Lenses

Eye defects (defects of vision)

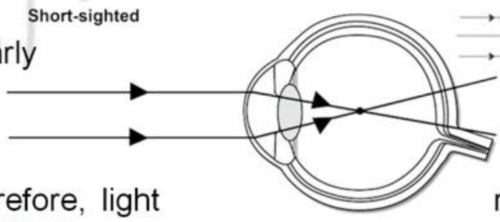
1. Long-sightedness Hyperopia)

Some people see distant objects clearly but **can`t see nearby** objects with the same clarity. This is because their eyeballs are shorter than normal, or their eye lenses are too thin. These people are said to be Longsighted. Therefore, light rays entering their eyes from a near object are focused **behind the retina**.

A converging lens can correct this defect. It combines the rays so that the eye lens forms an image exactly on the retina.



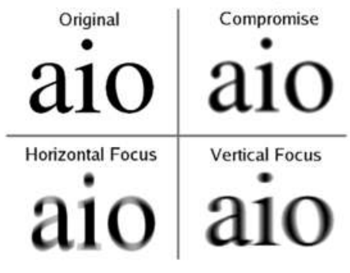
2 Near-sightedness (Myopia)

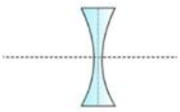


Some people see nearby objects clearly but **cannot see distant** objects with the same clarity. These people are said to be near-sighted. Their eyeballs are longer than normal, or their eye lenses are too thick. Therefore, light rays from a distant object are **focused in front of the retina**.

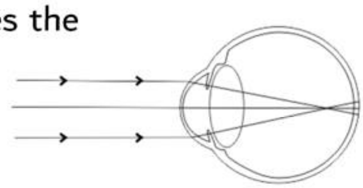
3 Astigmatism

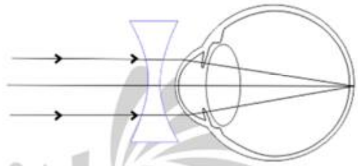
This results from an irregularly shaped cornea or eye-lens. if the eye-lens or cornea is not perfectly spherical, the eye can form a correct image only in some directions, but not in others. A cylindrical lens can correct this defect.





A diverging lens is used to correct this defect. It diverges the rays so that the eye-lens forms an image exactly on the retina.





In photographic devices

Optical instruments

A. **Objects magnifying instruments**
   1. **Simple magnifier 2. Compound microscope**

B. **Telescope (Refracting telescope - Galileo telescope- Reflecting telescope)**

QUESTIONS of CHAPTER 8

Q1. Select the correct answer for the following questions.

1. The focal length for a thin lens doesn't depend on:
a. Diffraction coefficient of the lens's material.
b. Diffraction coefficient of the medium surrounding the lens.
c. Two radius of curvature of the lens.
d. Diameter of the lens.

2. To get a inverted, real image and magnified than object using a converging lens, the object should be placed at a distance from lens
a. Greater than twice the focal length of the lens.
b. Between the focus and twice the focal length of the lens.
c. Less than the focal length of the lens.
d. Equals twice the focal length of the lens.

3. To get an erect virtual magnified image of the object using a converging lens the object should be placed at a distance from lens
a. Equals to the focal length of the lens.
b. Equals twice the focal length of the lens.
c. Less than the focal length of the lens.
d. Greater than twice the focal length of the lens.

4. To get an erect virtual magnified image we should use:
a. Diverging lens (two side concaved).
b. Diverging lens (concave – plane).
c. Converging lens and the object is placed within its focal length.
d. Converging lens and the object is placed at a distance greater than its focal length.

5. To get a virtual minimized image to the object a diverging lens should be used and the object should be placed at a distance:
a. Less than its focal length.

b. At any distance from the lens.
c. Greater than its focal length.
d. Equal to twice of its focal length.

6. An object is placed at infinity distance from a converging lens an image formed for it and was:
a. Real b. Virtual c. Erect d. Greater than the object

7. A converging lens of 15 cm focal length (f) the distance of the image formed for an object on this lens depends on:
a. Distance of the object from the lens.
b. Height of the object.
c. Weather the object is erect or reversed.
d. All of the above.

8. A diverging lens of (10cm) focal length, an object was placed (40cm) away from it then the location of the image of that object will be at a distance of:
a. +16 cm b. – 10 cm c. +20 cm d. – 8 cm

9. An object was placed (40cm) away from a converging lens that's focal length is (20cm) so an image formed at a distance of:
a. 30cm b. 20cm c. 15 cm d. 40 cm

10. If the magnification of a converging lens is (-3) then the properties of the image is:
a. Virtual, erect and having a length that's three times the object's length.
b. Virtual, inverted and having a length that's three times the object's length.
c. Real, inverted and having a length that's three times the object's length.
d. Real, inverted and having a length that's one third the object's length.

11. An object was placed 80 cm away on the left side of a diverging lens, a virtual minimized and erect image formed for it and at 16 cm away from the lens and on the left side also, then the power of the lens equals:
a. -5D b. -4D c. -2D d. -1.25D

Answer the following question:
Q1. Give reason for the following.

a. The focal length for a lens differs depending on the color of the light that fells on it?
The lens has some resemblance to the prism, when white light falls on it, it is dispersed, because violet light is refracted in it more than the rest of the lights and it collects in a focus further away from the lens than the dimensions of the rest of the focus where the rest of the colors collect. This means that the red light whose refraction in the lens is less than the rest of the colors will collect in a focus further from the lens than the focal lengths of the rest of the colors
b. The change in the focal length of the converging lens when moved from the air to the water?

the focal length of a lens remains the same as it works on the principle of reflection and reflection is independent of the medium.

However, in case of a lens, the principle is that of refraction. The refractive index of the material of the lens depends on the medium from which the ray is approaching the lens and that to which if goes after refraction.

When a ray of light in incident on the lens parallel to the principal axis, it gets refracted and meets the principal axis at the focus.

When the lens is immersed in water the refractive index of the lens reduces. If the refractive indices of water and the lens.

Since the refractive index is lesser, as compared to not being immersed in water, the ray of light would be deviated to a lesser extent. Hence, the point where the refracted ray would meet the principal axis would be farther away from the lens as compared to not being immersed in water. The focal length of the lens would be increased when immersed in water.

$${}_1n_2 = \frac{n_2}{n_1}$$

c. Light rays those pass through the optical center of the thin lenses goes out from the lens at the same direction?

Because the sides of the lens at the optical center are almost parallel

That is, the ray goes slightly from its original path so that it can be neglected because the lens is thin

Q2. What is the reason for chromatic aberration in lenses? and how is it treated?

Q3. What is the reason of spherical aberration in lenses? and how is it treated?

PROBLEMS of CHAPTER 8

1. An object was placed in front of a diverging lens that's focal length is (12cm) an image formed for it that's length is one third the length of the object, what is the distance of the object from the lens, and what is the distance of its image?

Answer: u = 24 cm v = -8 cm

$$M = \frac{\acute{h}}{h} = -\frac{v}{u}$$

$$\frac{\acute{h}}{h} = -\frac{v}{u} \rightsquigarrow \frac{\frac{1}{3}h}{h} = -\frac{v}{u} \rightsquigarrow u = -3v$$

$$\frac{1}{-12} = \frac{1}{-3v} + \frac{1}{v} \rightsquigarrow \frac{1}{-12} = \frac{-1+3}{3v} \rightsquigarrow \frac{1}{-12} = \frac{2}{3v}$$

$$v = -\frac{2 \times 12}{3} = -8\ cm$$

$$u = -3 \times -8 = 24cm$$

2. A magnifying lens (converging lens) of (15cm) focal length, on what distance from it an object should be placed to get an erect and three times magnified image?

Answer: u =10 cm

$$M = -\frac{v}{u} \rightsquigarrow 3 = -\frac{v}{u}$$

$$v = -3u$$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \rightsquigarrow \frac{1}{15} = \frac{1}{u} + \frac{1}{-3u} \rightsquigarrow \frac{1}{15} = \frac{3-1}{3u} \rightsquigarrow \frac{1}{15} = \frac{2}{3u}$$

$$u = \frac{2 \times 15}{3} = 10cm$$

3. A model used slides to get an image on a barrier that's is (6 m) away, if the height of the image was (1.5m) and the height of the slide was (5cm), what is the focal length of the projectors lens?

Answer: f = 19.4 cm

$$M = \frac{h'}{h} = \frac{1.5}{0.05} = 30$$

$$M = -\frac{v}{u} \rightsquigarrow 30 = -\frac{-v}{u} \rightsquigarrow v = +30u \rightsquigarrow 6 = +30u$$

$$u = \frac{6}{30} = \frac{1}{5} = 0.2m$$

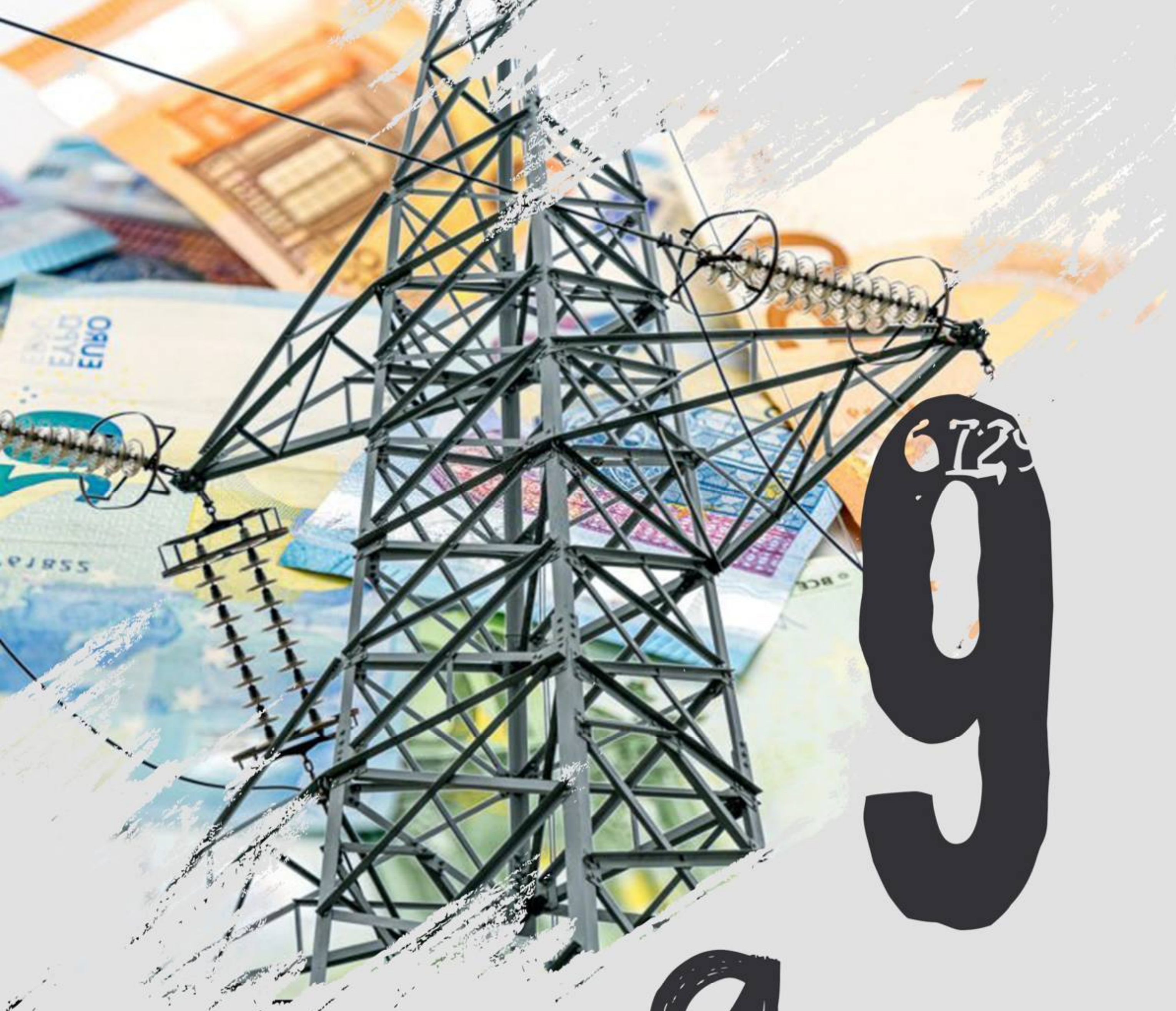
$$v = +30(0.2) = 6m$$

$$\frac{1}{F} = \frac{1}{u} + \frac{1}{v} = \frac{1}{0.2} + \frac{1}{6} = \frac{30+1}{6} = \frac{31}{6} \rightsquigarrow f = \frac{6}{31} = 0.194\ m$$

4. A pencil that's length is 10 cm was placed at (70cm) away from the left of a lens that's focal length is (+50 cm), find the properties of the formed image:

Answer: h = - 25 cm length of the image (Real, magnified, inverted according to the object).

$$\frac{1}{F} = \frac{1}{u} + \frac{1}{v} \rightsquigarrow \frac{1}{50} = \frac{1}{70} + \frac{1}{v} \rightsquigarrow \frac{1}{v} = \frac{1}{50} - \frac{1}{70} = \frac{7-5}{350} = \frac{2}{350} \rightsquigarrow v = 175cm$$



CHAPTER 9 الفصل التاسع

ELECTROSTATIC

CHAPTER 9 ELECTROSTATIC

$$\frac{\acute{h}}{h} = -\frac{v}{u} \rightsquigarrow \frac{\acute{h}}{10} = -\frac{175}{70} \rightsquigarrow \acute{h} = \frac{-175\times10}{70} = -25\ cm$$

Electrical charges are characterized by:

1. Unlike charges attract each other while like charges repel each other.
2. The electric charge is conserved.
3. The smallest amount for the electric charge is the electron charge, any charged object will be the multiples of the electron charge. When an object is charged, its charge is a multiple of one electron charge (e) unit, this is meaning the charge is quantized, that charge equals integer number for electron charge.

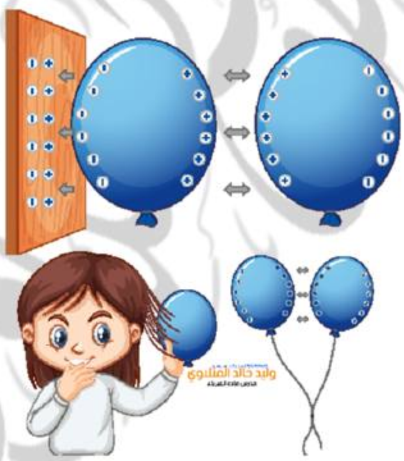
And the total electric charge is given by the following relation:

Where

n : represents a positive integer number (n =1,2,3,4 ...)

e : electron charge and it's equal to (1.6×10^{-19} C).

It has been found lately that there are six types of particles inside the nucleus called quarks three of them have a charge equals to + 2/3 of the proton's charge and the other three have a charge equal



Total electric charge (Q) = positive integer number (n)# electron charge (e)

تتميز الشحنات الكهربائية بالخصائص الاتية:

1- الشحنات المختلفة بالنوع تجذب كل منها الاخرى والشحنات المتشابهة تتنافر بعضها مع البعض الاخر.

2- الشحنة الكهربائية محفوظة.

3- ان اصغر قيمة للشحنة الكهربائية هي شحنة الالكترون, وان أي جسم مشحون تكون شحنته مضاعفات لشحنة الالكترون اي ان الشحنة الكهربائية مكممة ، اي انها تساوي اعداد صحيحة من شحنة الالكترون وتعطى الشحنة الكهربائية الكلية بالعلاقة التالية:

$$Q = ne$$

COULOMB S LAW

Coulomb's law: the mutual electric force between two-point charge is direct proportional to the amount of the charges and inverse proportional to square of the distance between them

تتناسب القوة الكهربائية المتبادلة بين شحنتين نقطيتين تناسباً طردياً مع مقدار كل من الشحنتين وعكسياً مع مربع البعد بينهما

$$F = \frac{Kq_1q_2}{r^2}$$

$k=9\times10^9 N.m^2/C^2$ **ثابت كولوم في الفراغ**

Where (ϵ_0) (the Greek letter epsilon) represents the air or vacuum permittivity and its vale is

السماحية في الفراغ او الهواء $\epsilon_o = 8.85 \times 10^{-12} \frac{C^2}{N.m^2}$

EXAMPLE 2

A point charge of (+2 μC) was placed at (90cm) from another positive point charge of (+5 μC) calculate the mutual force between the two-point charges identifying the type of the force and the reason?

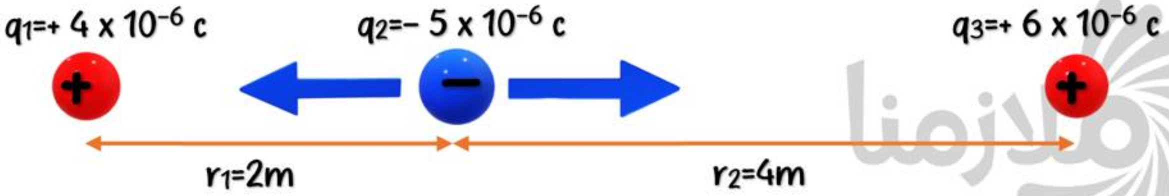
وضعت شحنة نقطية كهربائية مقدارها (+2 μC) على بعد (90cm) من شحنة نقطية موجبة اخرى مقدارها (+5 μC) احسب القوة المتبادلة بين الشحنتين النقطيتين مبينا نوع القوة مع ذكر السبب؟

$$F = \frac{Kq_1q_2}{r^2} = \frac{(9\times10^9)(2\times10^{-6})(5\times10^{-6})}{(9\times10^{-1})^2} = \frac{10^{1+9-6-6+2}}{9} = \frac{1}{9}N$$

So, the force between the two-point charges is a repulsion force since the have the same charge which is positive charge.

Example 2

In the following figure there is (3 point) charges placed on the same line. Calculate the amount of the resultant force that affects the negative charge.



$$F_1 = \frac{Kq_1q_2}{r^2} = \frac{(9\times10^9)(+4\times10^{-6})(-5\times10^{-6})}{(2)^2} = -45\times10^{9-6-6} = -45\times10^{-3}N$$

$$F_2 = \frac{Kq_1q_2}{r^2} = \frac{(9\times10^9)(+6\times10^{-6})(-5\times10^{-6})}{(4)^2} = -16.9\times10^{9-6-6} = -16.9\times10^{-3}N$$

$$F_R = F_1 - F_2 = -45\times10^{-3} - (-16.9\times10^{-3}) = -28.1\times10^{-3}N$$

The resultant force is toward left side and in the direction of the bigger force (F_1).

ELECTRIC CONDUCTIVITY

Materials are divided according to their ability to conduct electricity into insulators, conductors and semi-conductors.

Insulating material in which the electrons are closely connected to the nuclei of their atoms and cannot move freely within the material. If we bring a charged object near an insulating material, no charge will be induced on it.

Examples of insulating materials rubber, glass, mica, dry silk, distilled water and others.

The **conducting** materials are completely different. If we bring a charged object near a conducting material, the valence electrons present in the outer part of the conductor's atoms (Electrons that are weakly attached to the nuclei of their atoms) will be affected by the charge of the charged object that is close to it.

So it will affect the electrons and move them inside the conducting material transferring the electric through it means it allow electric charges to pass through it immediately and metals are considered that conduct electricity and the best one is silver, followed by copper and aluminum.

While **semi-conductors** are those materials that have intermediate properties between conductors and insulators in terms of their ability to conduct electric and the most common is the silicon (Si) and germanium (Ge) and these two materials have a special importance in technology since they are used in the manufacture of transistors, crystalline diodes and solar cells.

تنقسم المواد حسب قابليتها للتوصيل الكهربائي الى موصلات وعوازل وأشباه موصلات

. فالمواد **العازلة** تكون فيها الالكترونات على ارتباط وثيق بنوى ذراتها ولاتستطيع الحركة بحرية داخل المادة. فلو قربنا جسماً مشحوناً من مادة عازلة فلا تتولد عليها شحنة محتثة. من امثلة المواد العازلة المطاط، الزجاج، المايكا، الحرير الجاف، والماء المقطر وغيرها.

اما المواد **الموصلة** فسلوكها مختلف تماما. فلو قربنا جسماً مشحوناً من مادة موصلة فان الكترونات التكافؤ الموجودة في الجزء الخارجي لذرات الموصل) وهي الكترونات ضعيفة الارتباط بنوى ذراتها (ستتاثر بشحنة الجسم المشحون المقرب اليها. لذا فانها ستؤثر على الالكترونات وتحركها داخل المادة الموصلة ناقلة الكهربائية خلالها أي تسمح بمرور الشحنات الكهربائية خلالها في الحال.

وتعتبر المعادن من اجود المواد ايصالاً للكهربائية وعلى رأسها الفضة يليهِ النحاس فالالمنيوم

اما **اشباه الموصلات** فهي تلك المواد التي لها خواص وسطية بين الموصلات والعوازل من حيث قابليتها في التوصيل الكهربائي ومن اشهرها) السليكون Si والجرمانيوم(Ge ولهذين العنصرين اهمية خاصة في التكنولوجيا لأستعمالها في تصنيع الترانزستورات والثنائيات البلورية والخلاية الشمسية.

DISTRIBUTION OF ELECTRICAL CHARGES ON CONDUCTOR SURFACES

that electric charges stay on the outer surfaces of the charged isolated conductors due to the repulsion of these charges when placed inside the conductor's object because they are of the same type.

ان الشحنات الكهربائية تستقر على السطوح الخارجية للموصلات المشحونة والمعزولة بسبب تنافرهذه الشحنات عند وضعها في داخل الجسم الموصل لأنها من النوع نفسه

ELECTRIC CHARGE DENSITY.

The amount of electric charge per unit area of the charged isolated conductor's surface and the charge density on the spherical mineral surface is calculated as follows:

كثافة الشحنه الكهربائية مقدار الشحنة الكهربائية لوحدة المساحة من سطح الموصل المشحون والمعزول. وتحسب كثافة الشحنه على السطح المعدني الكروي كالاتي:

$$\sigma = \frac{q}{A}$$

σ = is the charge density (a Latin letter called sigma) measured by $(\frac{C}{m^2})$

REMEMBER

Electrical charges are concentrated on sharp headers from the charges and isolated conductors' surface with greater charge density.

ان الشحنات الكهربائية تتركز على الرؤوس المدببة من سطح الموصلات المشحونة والمعزولة بكثافة شحنة أكبر.

THE ELECTRIC FIELD is the space around the electric charge where the effect of an electric force shows on a positive test charge placed at any point in the field.

هو الحيز المحيط بالشحنة الكهربائية والذي يظهر فيه تاثير القوة الكهربائية على شحنة اختبارية موجبة موضوعة في اي نقطة من المجال

THE ELECTRIC FIELD LINE: is the path taken by a free positive test charge when placed in the field.

خط المجال الكهربائي بأنه: المسار الذي تسلكه شحنة اختبارية موجبة حرة الحركة عند وضعها في المجال.

And electric field lines are characterized by:

1. Its generated from the positive charge and perpendicularly over the charged surface and its directed towards the negative charge perpendicularly over the charged surface by the negative charge.

تنبع من الشحنة الموجبة وبصورة عمودية على السطح المشحون وتتجه نحو الشحنة السالبة عمودياً على السطح المشحون بالشحنة السالبة

2. The tangential of the force line at any point represents the direction of the electric field at that point.

المماس لخط القوةفي اية نقطة يمثل اتجاهالمجال الكهربائي في تلك النقطة

Electric field lines don't intersect with each other but they repel and tension to take the shortest possible length.

$$E = \frac{F}{\acute{q}}$$

$$E = \frac{Kq}{r^2}$$

3.

خطوط القوة الكهربائية لاتتقاطع مع بعضها البعضبل تتنافر وتتوتر لتأخذ أقصر طول ممكن لها

HOMOGENEOUS AND NON HOMOGENEOUS ELECTRIC FIELD

Homogeneous electric field: is the field that has constant amount and direction at every point of its points and the electric force lines in it are parallel and of constant density and homogeneous, electric field can be made by charging two wide parallel plates with two equal and opposite charges and the electric field lines in the area between the two plates and the distances between them is equal, (Neglecting effect of bending edges) and that means the field have same amount and same direction at all points

المجال الكهربائي المنتظم : هو المجال الثابت المقدار والاتجاه عند كل نقطة من نقاطه وخطوط القوةالكهربائية فيه تكون متوازية ومنتظمة الكثافة ويمكن الحصول على المجال الكهربائي المنتظم عند شحن لوحين متوازيين واسعين بشحنتين متساويتين ومختلفتين بالنوع ان خطوط المجال الكهربائي في المنطقة بين اللوحين متوازية ، والابعاد بينهما متساوية (باهمال تأثير الحافات المقوسة). وهذا يعني ان للمجال المقدارنفسه وكذلك الاتجاه نفسه عند جميع النقاط

Non-homogeneous electric field: Is the field that's amount changes from a point to another. Like the field generated from a point charge or around a charged spherical conductor. where the field decreases as we get far from it due to decrease in the density of electric force lines.

المجال الكهربائي غير المنتظم: فهو ذلك المجال الذي يتغير مقداره بين نقطة واخرى . مثل المجال المتولدعن شحنة نقطية او حول كره موصلة مشحونة اذ يقل مقدار المجال كلما ابتعدنا عنها، بسبب نقصان كثافة خطوط القوة الكهربائية

EXAMPLE 1

Two identical parallel plates are charged with two charges of same amount and different type. A charge of (2×10^{-6} C) at point (a), see figure bellow, between the plates and it was affected by an electrical force of (6×10^{-4} N) in the direction of the field lines.

1. What is the type of the point charge?
2. Calculate the amount of the electric field at point (a).
3. If the charge was moved to point (b) what is the amount of the affecting force on it?

1. Since the electric force is in the direction of the field then the point charge is positive.

2. $E = \frac{F}{\acute{q}} = \frac{6 \times 10^{-4}}{2 \times 10^{-6}} = 3 \times 10^{2} N/c$

3. When the charge is moved to point (b) it will be affected by the same amount of force ($F=6\times10^{-4}N$) in the direction of the field (E) because the electric field between the plates is homogeneous.

EXAMPLE 2

A charged spherical conductor of (100pC) charge and (1cm) radius calculate:

1. The electric field at a point that's (50cm) from its center.
2. The electric field on its surface.
3. The electric field at a point inside the sphere.

$$1Pc = 10^{-12}c \rightsquigarrow 100Pc = 100 \times 10^{-12}c = 10^{-10}c$$

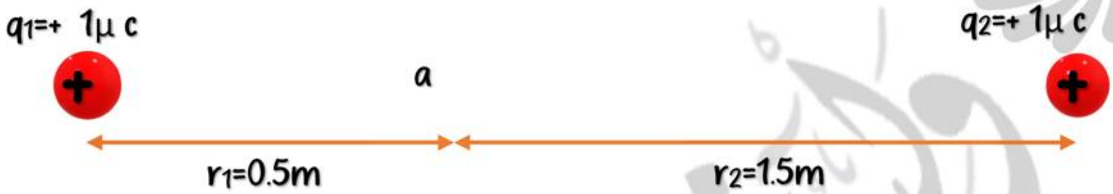
1- $E = \frac{Kq}{r^2} = \frac{(9\times10^{9})(10^{-10})}{(5\times10^{-1})^2} = \frac{9\times10^{9-10+2}}{25} = 0.36 \times 10^{+1} = 3.6N/C$

2- $E = \frac{Kq}{r^2} = \frac{(9\times10^{9})(10^{-10})}{(10^{-2})^2} = 9 \times 10^{9-10+4} = 9 \times 10^{+3} = 9000\frac{N}{C}$

3- The electric field inside the conducting sphere equals to zero since there is no charges, hence all charges are on the external surface of the sphere: E = 0

EXAMPLE 3

The following figure shows two-point charges of (1μc) and the distance between them is (2m), calculate the amount of the electric field at a point on the line connecting the two charges that's at (0.5m) from the first charge and (1.5m) from the second charge.



$$E_1 = \frac{Kq}{r^2} = \frac{(9\times10^9)(10^{-6})}{(5\times10^{-1})^2} = \frac{9\times10^{9-6+2}}{25} = 0.36\times10^{+5} = 36\times10^{+3}N/C$$

$$E_2 = \frac{Kq}{r^2} = \frac{(9\times10^9)(10^{-6})}{(15\times10^{-1})^2} = \frac{9\times10^{9-6+2}}{225} = 0.04\times10^{+5} = 4\times10^{+3}N/C$$

Since the direction of (E_1) is opposite to the direction of (E_2) then the resultant electric field (E_R) is in the direction of the greater field.

$$E_R = E_1 - E_2 = 36\times10^{+3} - 4\times10^{+3} = 32\times10^{+3}N/C$$

THE ELECTRIC FLUX

The electric field in a particular area depends on the density of the electric force lines passing by that area, so it increases as the density increase and therefore the density of the electric force lines is a measure of the electric field. The number the electric force lines that intersect the surface perpendicularly is called the electric flux and is symbolized by the Greek symbol (Φ). we find that the amount of electric flux increases by increasing the number of the electric force lines penetrating the surface (A) perpendicularly, as well as by increasing the area of the penetrated surface.
And from that we can conclude the relation between the electric flux and the electric field as:

يتوقف المجال الكهربائي في منطقة معينة على كثافة خطوط القوة الكهربائية المارة من تلك المنطقة فتزداد بزيادتها ولذلك تعد كثافة خطوط القوة الكهربائية مقياساً للمجال الكهربائي. إن عدد خطوط القوة الكهربائية التي تقطع السطح عمودياً يدعى بالفيض الكهربائي ويرمز له بالرمز الاغريقي Φ نجد ان مقدار الفيض الكهربائي يزداد بزيادة عدد خطوط القوة الكهربائية التي تخترق السطح A عمودياً، وكذلك بزيادة مقدار مساحة السطح المخترق.

$$\Phi = E_{\perp}A$$

Φ =The Electric Flux $\frac{N.m^2}{C}$

Example 1

Calculate the electric flux through a charged and isolated spherical conductor that's radius is one meter and there is a (1μC) charge on its surface.

$$E = \frac{Kq}{r^2} = \frac{(9\times10^9)(10^{-6})}{(1)^2} = 9 \times 10^{9-6} = 9 \times 10^{+3} N/C$$

$$\Phi = E_{\perp}A = 9 \times 10^{+3} \times 4 \times 3.14 \times 1^2 = 113.04 \times 10^3 N.m^2/C$$

Example 2

An electric charge of $(+2\times10^{-6}\ C)$ was placed in a homogeneous electric field that shows a force of $(8\times10^{-2}\ N)$ what's the amount of the electric field?

$$E = \frac{F}{\acute{q}} = \frac{8 \times 10^{-2}}{2 \times 10^{-6}} = 4 \times \frac{10^4 N}{C}$$

ELECTRIC POTENTIAL

the potential electrical energy of the charge unit at a point inside the electric field and its scalar quantity means that:

الطاقة الكامنة الكهربائية لوحدة الشحنة في نقطة داخل المجال الكهربائي وهو كمية غير اتجاهية

$$V = \frac{W}{q}$$

$$V = \frac{Kq}{r}$$

the potential is positive if it's generated from a positive charge and negative if it's generated from negative charge.

ويكون الجهد موجباً اذا تولد من شحنة موجبة ويكون سالباً اذا تولد من شحنة سالبة

POTENTIAL DIFFERENCE is the amount of work required to move the positive electric charge from one of the point to the other divided by the amount of that charge.

وهو مقدار الشغل اللازم لنقل الشحنة الكهربائية الموجبة من احدى النقطتين الى الاخرى مقسوماً على مقدار تلك الشحنة

$$V_{AB} = V_B - V_A = \frac{W_{AB}}{q}$$

$$E = \frac{V_{AB}}{d}$$

REMEMBER تذكر

* Electric force affecting a positive electric charge point to the direction that potential energy is low.
* The electric field is always in the direction of low potential

WALID AL FATLAIWI المدرس وليد الفتلاوي

DO YOU KNOW هل تعلم ?

The stress test used to examine heart patients is performed by calculating the relationship between potential differences between two metal poles as a function of time. This test shows if the heart is functioning normally or not.

WALID AL FATLAIWI المدرس وليد الفتلاوي

EQUIPOTENTIAL SURFACE is the surface that's surface point have the same amount of electric potential means the potential difference between any two points of its points equals to zero.

سطح تساوي الجهد هو ذلك السطح الذي تكون نقاط سطحه جميعاً بنفس قيمة الجهد الكهربائي اي ان فرق الجهد بين اي نقطتين من نقاطه يساوي صفراً

Most important properties of equipotential surfaces:

1. Don't intersect with each other.
2. Electric force lines are perpendicular on the equipotential surfaces.
3. Equipotential surfaces get close to each other at the areas of high electric field (E) so the density of the electric force lines also increases and for that reason the equipotential surfaces get close to each other near the sharp ends of the charged and isolated objects.

وأهم خواص سطوح تساوي الجهد هي:

1. لاتتقاطع بعضها مع البعض الآخر.
2. خطوط القوة الكهربائية تكون عمودية على سطوح تساوي الجهد.
3. تتقارب سطوح تساوي الجهد فيما بينها في المناطق التي يكون المجال الكهربائي E فيها كبيراً فتزداد كثافة خطوط القوة الكهربائية ايضاً ولهذا السبب فأن سطوح تساوي الجهد تتقارب قرب النهايات المدببة للاجسام المشحونة المعزولة

Example 1

A metallic isolated sphere that's radius is (5cm) and a (20 μC) charge is placed on it, find the electric potential at the point:

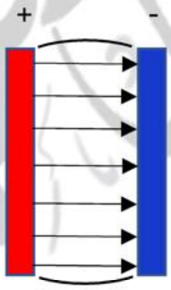
1. On its surface
2. At (15 cm) from its surface

$q = (20\ \mu C) = (20\times10^{-6}\ c)$

Example 2

The following figure shows two parallel plates of equipotential surfaces, the potential of one of them is (– 5V) and the potential of the other is (+3V) and the distance between them is (4m). calculate the electric field between them.

$$E = \frac{\Delta V}{x} = \frac{V_2 - V_1}{x} = \frac{3-(-5)}{4} = \frac{8}{4} = 2\frac{V}{m}$$ **amount of electric field**



Example 3

The point (A) is (30cm) away from a sphere's center that's radius is (1cm) and its charged by (2×10^{-9} C) and point (B) is (90cm) from the center of the same sphere, calculate the work needed to move a charge of (1μc) from point (B) to (A).

$$V_A = \frac{Kq}{r} = \frac{9\times10^9\times2\times10^{-9}}{3\times10^{-1}} = 60 volt$$

$$V_b = \frac{Kq}{r} = \frac{9\times10^9\times2\times10^{-9}}{9\times10^{-1}} = 20 volt$$

$$V_{AB} = V_A - V_B = 60 - 20 = 40 volt$$

$$W_{AB} = qV_{AB} = 10^{-6}\times40 = 40\times10^{-6}\ Joule$$

THE EARTH ELECTRIC POTENTIAL

The electric potential of earth is zero, and this doesn't mean the earth doesn't contain electric charges but due to its very large surfaces that doesn't allow any charge that's taken from it or given to it to change its potential since its considered a very big storage of positive and negative charges.

الجهد الكهربائي للارض: يعد الجهد الكهربائي للأرض صفرا. وهذا لا يعني ان الارض خالية من الشحنات الكهربائية وانما لان سطحهاكبير جدا الى حد لايسمح لأية شحنة تعطى لها او تؤخذ منها ان تغير من جهدها اذ تعد خزانا كبيرا للشحنات الموجبة والسالبة.

Conductors those are charged by positive charges and away from electrical effect have positive potential, if the reach the earth negative charges will move to it from the earth and equalize it thus its potential become zero like the earths potential but if the conductor was negatively charged then when connected to the earth then negative charges will move from the conductor to the earth and its potential will become zero like the earth's.

فالموصلات المشحونة بشحنة موجبة وبعيد عن المؤثرات الكهربائية يكون جهدها موجبا فإذا وصلتبالارض انتقلت اليها شحنات سالبة من الارض فتعادلها ويصبح جهدها صفر كجهد الارض أما إذا كانالموصل سالب الشحنة فان جهده يكون سالب فاذا وصل بالارض انتقلت الشحنات السالبة من الموصل الى الارض ويصبح جهده صفرا مثل جهد الأرض.

LIGHTNING when the clouds become electrified and their charge is positive in the upper layers and negative in the lower layers of the cloud, if a discharge occur (in the form of close strikes) between the different parts of the same cloud, or between two different clouds.

THUNDER is the sound caused by lightning when increase in temperature leads to the sudden expansion of air generating a sound that's echo is repeated between the clouds.

APPLICATIONS OF STATIC ELECTRIC

Electrostatic filters
Photocopier machine

QUESTIONS of CHAPTER 9

Q1. Choose the correct answer for the following questions.

1. The electric charge density for a charged isolated conductor that have sharp heads is:

a. The greater on its sharp heads.
b. The smaller on its sharp heads.
c. Equal in all points.
d. All of the above.

2. In the case of homogeneous electric field:

a. The field amount is changing in all of its points.
b. The field amount and direction constant in all of its points.
c. The field direction is constant in all of its points.
d. The field amount and direction are changing in all of its points.

3. The electric potential of points located between two parallel plates those are charged by equal but different charge is:

a. Always positive b. Always negative
c. Positive or negative d. Maybe positive, negative or zero

4. If you place a free electric charge in an electric field than it will move:

a. In the direction of the field always.
b. Inverse the direction of the field always.
c. In the direction of the field if it was positive and inverse to it if it was negative.
d. Perpendicular to the field.

5. The potential of a point of an isolated charged conducting sphere is one volt, the potential of its center is:

a. One-volt b. Zero
c. Less than one and greater than zero-volt d. Greater than zero volt

Q2. Put the right sign for the correct statement and wrong sign for the false statement and correct the false statement without changing the under lined part:

1. The electrical attraction or repulsion force between two charged objects is greater than the gravitational force attraction between their masses.✓
2. The electron attracts the nucleus's proton in the atom with a force smaller than the force that the proton attracts the electron. × equal
3. All the point of charged conducting sphere have the same potential. ✓
4. Semi-conductor are always good electric conductors. × Sometimes

5. Coulomb's law applies for electric charges those are equal only. × equal and Different
6. Coulomb's law applies for electric charges of large volume. × poit charge
7. The electric charge is distributed on a conducting surface in homogeneous way. × Non-homogeneous
8. The surface of charged isolated conduction sphere is an equipotential surface. ✓
9. Electric force lines are parallel in the homogeneous electric field. ✓
10. The earth can be charged by a positive electric charge. × cann't
11. Electric force lines cannot intersect. ✓
12. If a certain electric charge was placed in a homogeneous electric field then the electric force that act on it will be constant in magnitude and direction. ✓

Q3. Can two electric force lines intersect? And why?

No, if true, there will be two directions for the electric field at the point of intersection, and this contradicts the concept of the vector, because each vector has one amount and one direction.

Q4. How do you explain the equal potential for all the points of the isolated charged conductor?

Because the electric field is perpendicular to the surface of the conductor, charged and isolated, there is no electric field installed parallel to the surface at any of its points, meaning that the field parallel to the surface is equal to zero V_{AB} / d = 0 for any two points A, B on the surface and this means (V_A-V_B) = zero ∴ $V_A = V_B$

Q5. Give a reason for the absence of electric field inside a charged isolated metallic ball?

Because similar charges will repel each other and appear on the outer surface of the conducting ball.

Q6. If the potential of a certain point is zero, then is it necessary that the electric field is also zero?

$$\text{No}, V = \frac{Kq}{r}, E = \frac{Kq}{r}$$

$$V = 0 \rightsquigarrow r \longrightarrow \infty, E \neq 0$$

Q7. Which one is bigger, the potential of a point inside a charged metallic ball or the potential of a point at its surface, and why?

the potential of a point inside a charged metal ball is equal to the potential of a point on its surface

Equipotential surface is the surface that's surface point have the same amount of electric potential means the potential difference between any two points of its points equals to zero.

Q8. What is lightning stroke? And what is lightning arrester? And how does it work to protect buildings and facilities?

Lightning stroke is the electrical discharging occurs between a charged cloud and any other object that have different charge with it on the earth.

Work: If the atmosphere is charged with negative charges then positive charges are generated on the surface of the earth and transferred to the sharp head of the lightning arrester.

Then goes away from it resulting in a step-by-step discharging due to the potential difference between the earth and the atmosphere surrounding the sharp head and thus decreases the danger of external discharging.

Q9. What's lightning and how does it happen?

Lightning: when the clouds become electrified and their charge is positive in the up¬per layers and negative in the lower layers of the cloud, If a discharge occur (in the form of close strikes) between the different parts of the same cloud, or between two different clouds.

Thunder is the sound caused by lightning when increase in temperature leads to the sudden expansion of air generating a sound that's echo is repeated between the clouds.

Q10. Why we see the lightning before hearing the sound of the thunder that result from it.

Because the speed of light is very large when compared to the speed of sound in the air

Q11. The electric field inside a charged isolated hallow metallic ball equals to zero, does that mean the potential inside the ball is also zero?

No, the potential of the points inside this sphere is the same as the potential of the points on its surface

PROBLEMS of CHAPTER 9

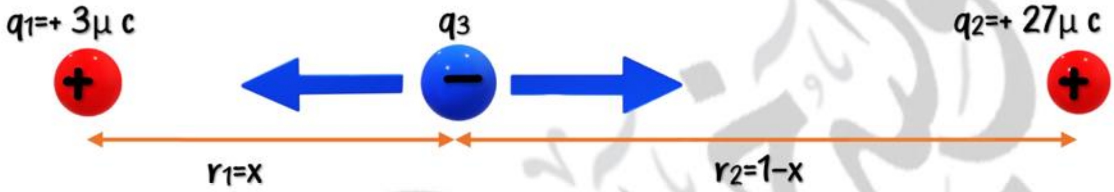
Q1. What is the magnitude of the repulsion force between two equal point charges, the magnitude of each one of them is (1μc) and they are (10 cm) away from each other?

Answer: F = 0.9N

$$F = \frac{Kq_1q_2}{r^2} = \frac{(9\times10^9)(10^{-6})(10^{-6})}{(10^{-1})^2} = 10^{9-6-6+2} = 0.9N$$

Q2. The two point charges (+3 μc) (+27 μc)were placed on a straight line separated by one meter distance, then where should the third point charge be placed until the resultant force on it due to the two charges is zero.

Answer: X = 25 cm distance of the point charge (q_3) from the point charge (q_1)



$$\frac{F_2}{F_1} = \frac{K\frac{q_1q_2}{r_2^2}}{K\frac{q_1q_2}{r_1^2}} = \frac{r_1^2}{r_2^2} \Rightarrow F_2 = F_1\frac{(3)^2}{(6)^2} = F_1\frac{9}{36} = F_1\frac{1}{4}$$

$$F_1 = F_2 \rightsquigarrow K\frac{q_1q_3}{r_1^2} = K\frac{q_2q_3}{r_2^2} \rightsquigarrow \frac{3\times10^{-6}}{x^2} = \frac{27\times10^{-6}}{(1-x)^2}$$

$$27x^2 = 3(1-x)^2$$

$$9x^2 = (1-x)^2$$

$$3x = 1 - x$$

$$4x = 1$$

$$x = 0.25m = r_1$$

$$r_2 = 1 - 0.25 = 0.75m$$

Q3. If the potential difference between two points (B,A) is (60 v) then what is the work needed to move

a. A proton (q=+ e) from (A) to (B)

b. A electron (q= -e) from (A) to (B)

Answer: a. W_{AB}=(-9.6×10^{-18} J) b.WAB=($+9.6\times10^{-18}$ J)

$$\Delta V = \frac{W}{q} \rightsquigarrow -W = \Delta V \times q = 60\times1.6\times10^{-19} = -96\times10^{-19}Joule$$

$$\Delta V = \frac{W}{q} \rightsquigarrow -W = \Delta V \times -q = 60\times1.6\times10^{-19} = +96\times10^{-19}Joule$$

Q4. Two parallel surfaces of equipotential surfaces. the potential of point (a) in it equals to (10v) and the potential of point (b) in it equals to (-2v) and the distance between them is (4mm) calculate the electric field between the two points?

Answer: E = 3000N/C

$$E = \frac{\Delta V}{d} = \frac{10-(-2)}{4\times 10^{-3}} = \frac{12}{4\times 10^{-3}} = 3\times 10^{3}\ N/C$$

Q5. Point (A) is (0.5m) away from the center of a charged ball that's charge is (1×10^{-3} µc) and the point (B) is (0.9m) away from the center of the same ball, calculate the required work to move a (2 µc) charge from point (B) to (A) ?

Answer: W = 16×10^{-6} J

The positive work equals to the energy transferred to the charged object.

$$V_A = \frac{Kq}{r} = \frac{9\times 10^{9}\times 10^{-3}\times 10^{-6}}{5\times 10^{-1}} = 1.8\times 10^{9-3-6+1} = 18\ volt$$

$$V_B = \frac{Kq}{r} = \frac{9\times 10^{9}\times 10^{-3}\times 10^{-6}}{9\times 10^{-1}} = 1\times 10^{9-3-6+1} = 10\ volt$$

$$V_{AB} = V_A - V_B = 18 - 10 = 8volt$$

$$V_{BA} = V_B - V_A = 10 - 18 = -8volt$$

$$\Delta V = -\frac{W}{q} \rightsquigarrow W = \Delta V \times q = 8\times 2\times 10^{-6} = 16\times 10^{-6} Joule$$

Q6. A charge of (6 µc) was placed at (1.2 m) away from another charge of (5 µc) in vacuum, calculate the required work to move the second charge to be at (0.9m) from the first charge?

Answer: W = +0.075 J

The positive work equals to the energy transferred to the charge.

$$V_A = \frac{Kq}{r} = \frac{9\times 10^{-9}\times 6\times 10^{-6}}{12\times 10^{-1}} = 4.5\times 10^{9-6+1} = 4.5\times 10^{4}\ volt$$

$$V_B = \frac{Kq}{r} = \frac{9\times 10^{-9}\times 6\times 10^{-6}}{9\times 10^{-1}} = 6\times 10^{9-6+1} = 6\times 10^{4}\ volt$$

$$V_{AB} = V_A - V_B = 4.5\times 10^{4} - 6\times 10^{4} = 1.5\ \times 10^{4}\ volt$$

$$\Delta V = -\frac{W}{q} \rightsquigarrow W = \Delta V \times q = 1.5\ \times 10^{4}\times 5\times 10^{-6} = 7.5\times 10^{-2} Joule$$