MODERN QUESTION AND ANSWERS

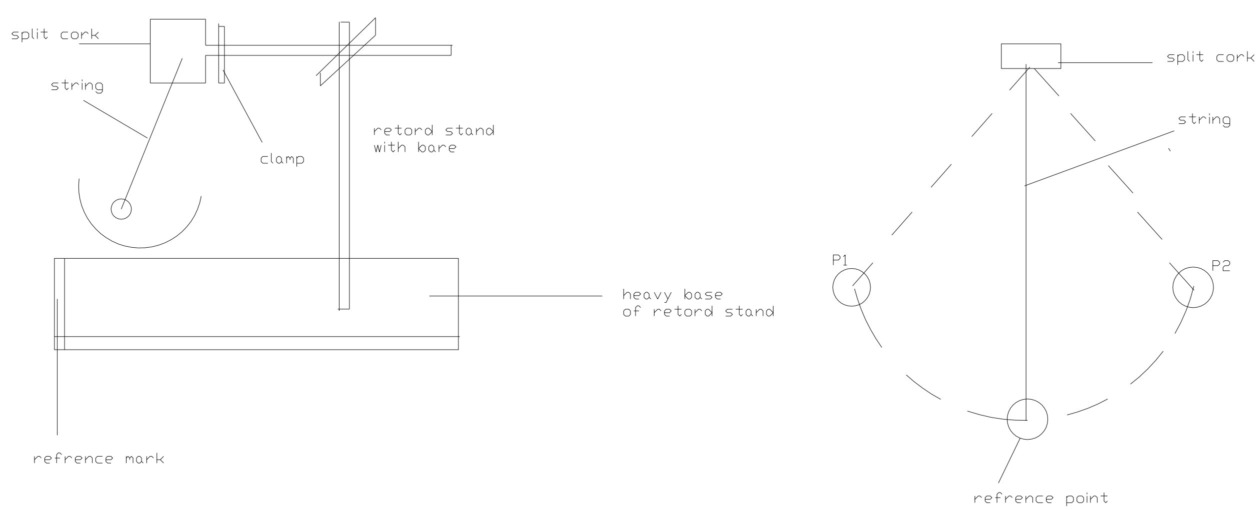
MAY/JUNE 2009 PHYSICS

Question 1 (a) i Define uniform acceleration

Answer 1 (a)i Uniform accelerating is when the velocity of a moving object increases by equal amounts in equal intervals of time, no matter how small the time interval may be.

Question 1a (ii) Describe an experiment to determine acceleration due to gravity.

Answer 1a (ii) Apparatus: Retort stand, split cork, long string (about 2m Long), a metal bob, a stop watch or clock, a metre rule, and clamps.



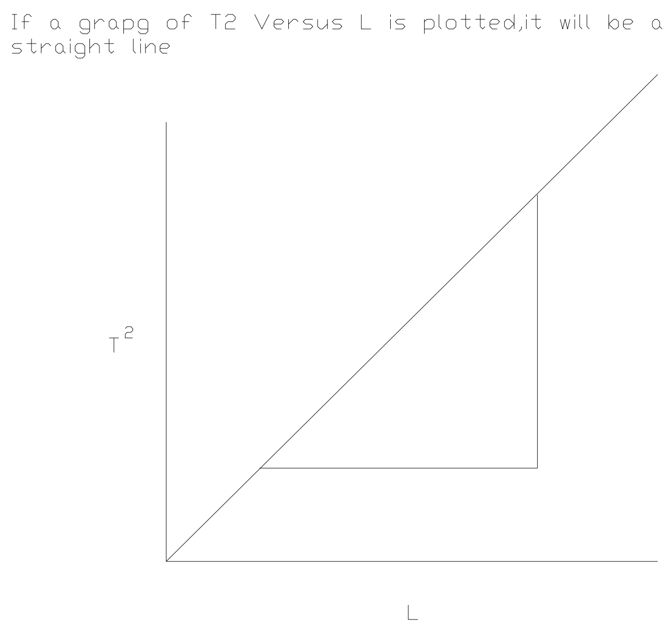
Workability: No bob, thread, score zero

<u>Procedure:</u> The string with the bob placed at one end is clamped in between the corks as shown in the diagram above. It is allowed to hang vertically. A reference mark is placed on the retort stand base (or where convenient) to denote this position. The length of the string from the clamped cork to the bob is measured and recorded L_1. The bob with string taunt is gently displaced about 10^0 to one side and allowed to freely swing. As it passes the reference point, a stop watch/stop is started and its to and fro motion passing through this same point, 0 in the same direction as at start for 20 oscillation is timed and recorded T_1. This is repeated for additional 5 different lengths of the string shortening the string by 20cm in each case with the last timing being T_6

Theory:

From period $T = 2\Pi\sqrt{L/g}$

$$T^2 = \frac{(4\Pi^2)}{g} L$$



The shape of the graph $S = \frac{(4\Pi^2)}{g}$; from which $g = 4\Pi^2/S$; acceleration due to gravity at the place the experiment was performed.

The value of g can be obtained from the slope of the graph.

Question 1 b (i) Define range of projectile and time of flight.

Answer 1 (i) Range of projectile (R) is the horizontal distance from the point of projection to the point where it hits the ground.

Time of flight of a projectile (T) is the time it takes the projectile to return to the same level or plane of projection.

Question 1 b(ii) A ball of mass 100g is thrown vertically upward with an initial speed of 72km/h. calculate the (a) time taken to return to thrower (b) maximum height reached and the kinetic and potential energy of the ball half way up.

Answer 1 b(ii) Mass of ball 100g = 0.1kg

Speed of ball = 72km/h = $\frac{72 \times 1000}{60 \times 60}$ = 20m/s

Time of flight T = $\frac{2u\sin \propto}{g}$ = $\frac{2x20xSin90}{10}$

max height = H = $\frac{U^2 Sin^2 \propto}{2g}$ = $\frac{20^2 Sin^2 90}{2 \times 10}$

= 20m

Kinetic and potential energy of the ball half way up. They are equal.

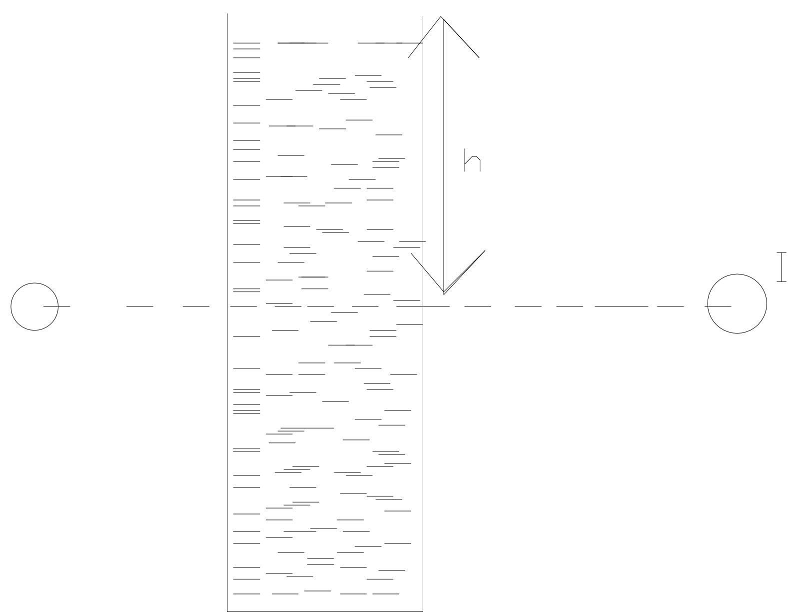
$E_k = E_p$ = mgh = 0.1 x 10 x $\frac{20}{2}$ = 10J

Question 2 (a) State the principle of transmission of fluid pressure.

Answer 2 (a) PASCAL'S principle states that pressure applied to an enclosed fluid is transmitted uniformly to every part of the fluid and the containing walls.

Question 2 (b) Show that the pressure exerted on liquid of depth h, can be found from p = h*e*g where h*e*g have their usual notation.

Answer 2 (b) consider a long column of liquid in a cylindrical container as shown below.



We want the pressure at the depth 00, pressure = $\frac{\text{force}}{\text{Area cross section}}$

The downward force on the area defined by 00' is the weight by the column of liquid given by W = mg, m = volume x density. Let the density of the liquid by P and radius of tube r. mass = $\prod r^2$h x P. W = $\prod r^2$ h*e*g. Area of 00' = $\prod r^2$ ∴ Pressure on 00^1 = $\underline{W}$

Pressure $= \frac{\prod r^2 h\rho g}{\prod r^2} = h\rho g$ area

The same is true for any depth H below the liquid surface. $P = h\rho g$.

Question 2(c) A rectangular solid block has sides 4 x 10 x 10 cm and a density of $8000kg/m^3$. If it rests on a horizontal flat surface, calculate the maximum pressure it can exert in N/M^2.

Answer 2 (c) Dimension of block = $4 \times 10 \times 10^3 = 400 \times 10^{-6} m^3$

Density of block = $8000kg/m^3$

Mass of block = Pv = $400 \times 10^{-6} \times 8000$

M = 3.2kg

The maximum pressure will be when the block rests on the smallest area which is 4 x 10cm = $40 \times 10^{-2} m^2$

Weight of block = mg = 3.2 x 10 = 32N

Max pressure $P = \frac{mg}{A} = \frac{32}{40 \times 10^{-2}} = 8 \times 10^3 N/m^2$

Question 3(a) Mention two factors that affect the melting point of a substance.

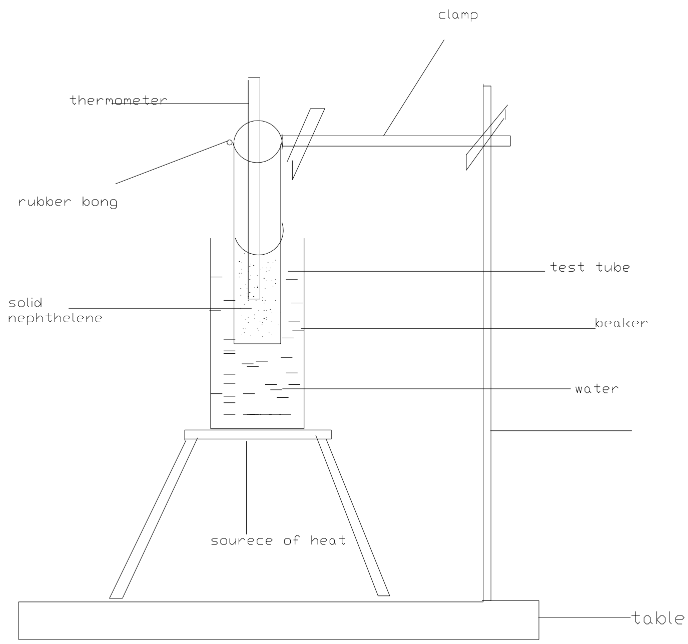
Answer 3 (a) The two factors are:

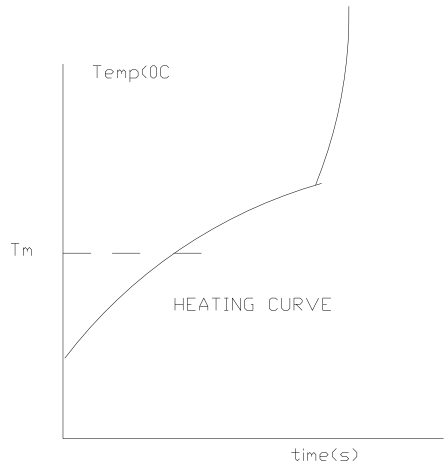
i. Prevailing pressure
ii. Purity of the substance

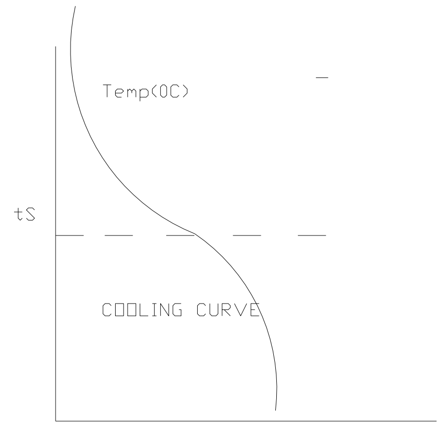
Question 3(b) Describe an experiment which could be performed in the laboratory to measure the melting point of naphthalene. State one precaution which should be taken to achieve accurate result.

Answer 3(b) Apparatus: Beater, Test tube, Water, Nephthalene, Thermometer, Bunsen Burner (or source of heat), Tripod stand and Retort Stand, rubber band, stop watch/clock.

Procedure: put some solid Nephthalene into a test tube placed in a beaker of hot water. Insert a thermometer into the test tube. Read the temperature of the melting Nephthalene at 2mins interval as the water is heated. When all the solid naphthalene has melted, remove the beaker of hot water and allow the molten naphthalene to cool slowly undisturbed. Again record the temperature at intervals of 2mins. Plot a graph of temperature against time as it cools.







Precautions:- (1) Thermometer must always be in the midst of the Nephthalene. (2) Nephthalene must be of the highest purity (3) prevent parallax error in reading thermometer.

Question 3(c) An iron of mass 5kg is heated to 300^0C and is then quickly transferred to a block of mass 1kg at -2^0C. Neglecting heat losses to the surrounding, calculate the equilibrium temperature attained.

Specific heat capacity of iron = 500J/kgk

Specific heat capacity of ice = Ice = 2000J/kgk
Specific heat capacity of water = 4200J/kgk
Specific latent heat of ice = 330000J/kg

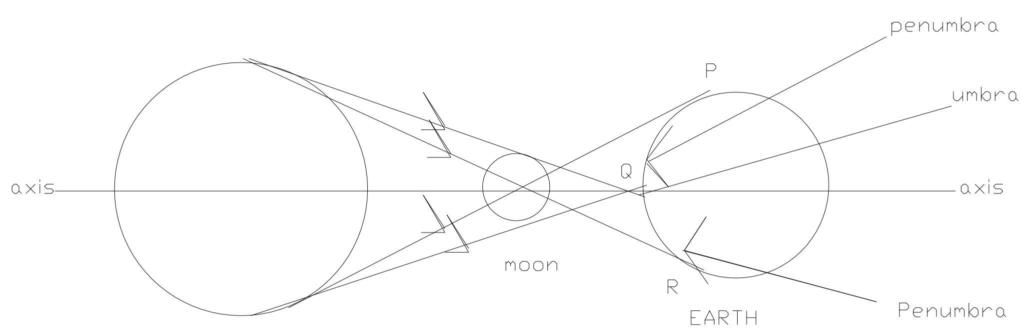
Answers 3(c) Mass Iron = 5Kg initial temp of iron = 300^0C
Mass of Ice = 1kg initial temp of ice = -2^0C
Let final temp = $T_f{}^0$C
Heat lost = Heat gained.

Heat lost by iron = Heat gained by ice from -2^0C to 0^0C
+ heat gained by ice to melt at 0^0C
+ heat gained by water formed from 0^0C to $T_f{}^0$C
i.e $M_sC_s\ (300 - T_f) = M_iC_i\ (0^0 - -2^0C) + M_iL_i + M_iC_W(T_f - 0_i)$
$5 \times 500\ (300 - T_f) = 1 \times 2000\ (2) + 1 \times 330000 + 4200 \times 1\ (T_f - 0)$
$750{,}000 - 2500T_f = 334000 + 4200T_f$
$750{,}000 - 334{,}000 = 6700T_f$

$$T_f = \frac{416000}{6700} = 62.09^0C = \underline{62.1^0C}$$

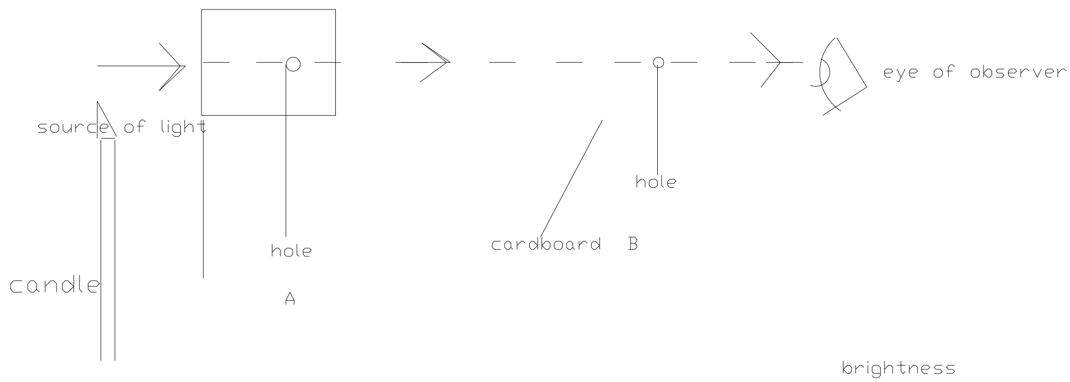
Question 4(a) Explain what is meant by "Eclipse of the Sun".

Answer: 4 (a) Eclipse of the sun which is also called Solar Eclipse occurs when the Sun, the Moon and the Earth are in alignment with the Moon being in between the sun and the Earth as shown below.



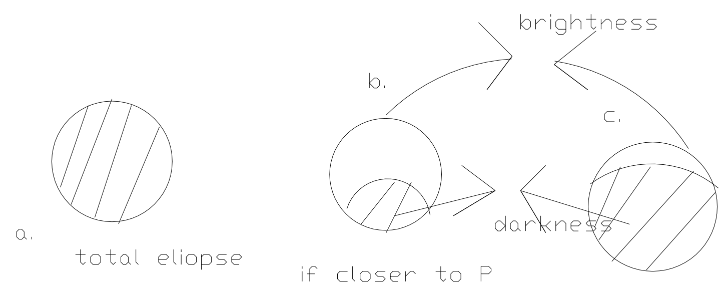
Since light travel in a straight line, the shadow of the moon will be cast on the Earth at Q. That place will be in total darkness because the light from the sum is cut-off from sight. People living in this area called umbra experiences total Eclipse while people living in the region PQ and QR, the penumbra experiences **Partial** Eclipse. The sun is only partially
covered. The area appears to be light grey in contrast to the umbra region which is in total darkness.

Question 4(b) Describe an experiment to show how light travels in a straight line.

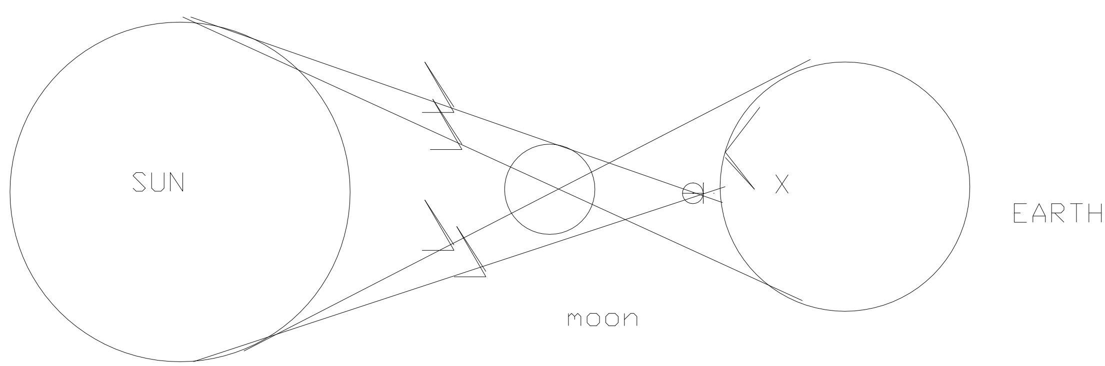


A small hole is punched in each of the cardboards A and b. They are placed in a straight line together with a light source. An observer is situated on the other side B. it will be found that the observer can only see light if the cardboards are well aligned. Light will pass through both holes.
Question 4 (c) With the aid of Diagrams, explain what is meant by (i) total (ii) partial and (iii) annular eclipse of the sun. Stating in each case where an observer should be.

Answer 4(c)   Referring to diagram in 4(a) above, the observer in position Q will observe a total eclipse formed at the umbra. He will see a black disc in the sky. An observer between P and Q will see partial eclipse.



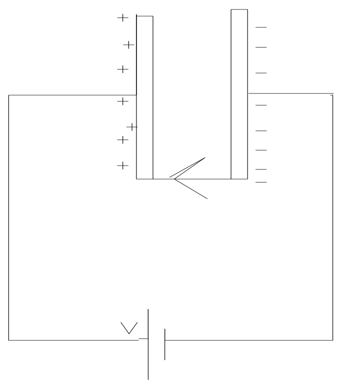
Both figures b and c above are referred to as partial eclipse formed at the penumbra. However if the Sun, the Moon and Earth are positioned as shown below, annular Eclipse will occur.



This occurs when the extreme rays at the moon's edge intersect before reaching the Earth as shown above. A ring of light is formed round the moon's shadow. The observer can be anywhere inside the region X on the Earth.

Question 5(a) Explain the following terms.
(i) Capacitor (ii) Capacitance (iii) the farad and highlight the relationship between them.

Answer 5 (a) (i) A capacitor is a device for storing electric charges. In its simplest form. it consists of two parallel plates electrical conductors placed at close proximity to one another as shown below.



An Insulator called a dielectric may be placed in the space between the plates in close contact with them.

(ii) Capacitance: this is the amount of charge that can be stored in a capacitor per unit potential difference (or voltage) established across its terminals. It is denoted by letter c and given as:

$$C = Q/_v = \frac{\text{charge stored}}{\text{P.d. across plates}}$$

(iii) Its unit is the farad (F) = $\frac{\text{Coulomb}}{\text{Volt}}$

1 farad = 1 Coulomb/1 volt. It is a large quantity. In practice we deal in Microfarad ($\mu f = 10^{-6}$ farad) and Picofarad ($Pf = 10^{-12}$ farad).

Question 5(b) Explain what will happen to the capacitance of a capacitor when the:

i. Inside is filled with a dielectric material
ii. Surface area of its plates is increased
iii. Spacing between its plates is decreased.

Answer 5(b) From $C = Q/_v$, the capacitance of parallel plate capacitor

$$C = \frac{E_0 E_r A}{d}$$

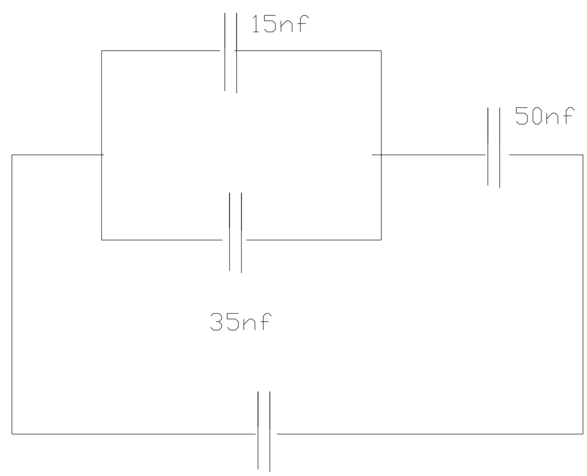
where E_0 = Permittivity of free space
E_r = dielectric constant
d = plate spacing. A = Cross Sectional Area

i. If the inside is filled with a dielectric material, it follows that E_r is introduced. Therefore capacitance will increase.
ii. If the surface area of plates is increased, the capacitance will also increase.
iii. If the spacing between the plates are decreased, then the capacitance will increase.

Question 5 (c) Two capacitors of values 15μf and 35μf are connected in parallel while a third capacitor of value 50μf is connected in series with the two combination. Find the:

i. Capacitance of the parallel circuit
ii. Total capacitance
iii. Voltage across each capacitor when the ends are connected to a 1200 volt source.

Answer 5(c)



i. Capacitance of parallel circuit is $C_T = C_I + C_2 = 15μf + 35μf = 50μf$
ii. Total Capacitance. Arrangement; AB is in series with BC.

Total capacitance is given by:

$$\frac{1}{C_T} = \frac{1}{C_{AB}} + \frac{1}{C_{BC}} = \frac{I}{50μf} + \frac{1}{50μf}$$

$$\frac{1}{C_T} = \frac{2}{50μf} \quad \therefore \quad C_T = \frac{50μf}{2} = 25μf$$

iii. In this case, V in the diagram = 1200 volts. The same charge that is across BC is across AB.

Further the Pd across 35μf is also across 15μf total $Q = C_T V$ = 25μf x 1200 C.
= 3.0×10^{-2} coulomb.

½ is across BC and the other ½ is across AB. Since capacitance of BC = 50 μf and that of AB = 50 μf

V across BC = Q/C_{BC} = <u>25μf x 1200</u>

2 x 50 µf

V across BC = 300 Volts

∴ Pd across the parallel Combination is

900 Volts