PHYSICS DEPARTMENT

SOLUTIONS TO 535/2 TERM 1 2013.

1 (a) (i). Mechanical advantage is the ratio of the load to the effort.

(ii). Velocity ratio is the ratio of the distance moved by the effort to the distance moved by the load in the same time.

(b) (i) M.A = Load/Effort

M.A = 160/50 = 3.2

(ii) Efficiency, ŋ = (M.A x 100)/V.R

ŋ = 3.2 x100/4

ŋ = 80%

Alternatively, ŋ = work outputx100/work input

$$\eta = \frac{\text{load x distance load moves x 100}}{\text{effort x distance effort moves}}$$

ŋ = 160 x 1.2 x 100/(50 x 4.8) = 80%

(iii). Power, *P* = work input/time taken

P = 50 x 4.8/40 = 6W

(c) (i). Oiling does not affect the number of pulleys in the system hence it has no effect on velocity ratio.

(ii). Oiling causes the machine to have less friction. This reduces the effort, hence M.A. increases.

(iii). Since M.A. increases on oiling, this causes the efficiency to increases well.

(d) Pulleys are applied in

cranes to lift or lower materials on tall buildings, structures etc.

lifts to transport passengers upstairs or downstairs.

conveyor belts to move materials from one location to another. Etc.

2.(a) (i). Acceleration is the rate of change of velocity with time.

(ii). Displacement is the distance moved in a specified direction.

(b)(i). The principle of conservation of linear momentum states that when two or more bodies act upon one another, their total momentum remains constant provided no external forces are acting.

(ii). 100g = 0.1kg; 150g = 0.15kg; let v be the common velocity after collision

Total momentum before collision = total collision after collision

$0.1x10 + 0.15x0 = 0.25v$

$v = 1/0.25 = 4m^{-1}$

(c) (i). A body with an initial velocity of $20m^{-1}$ accelerates uniformly for 20s until it attains a velocity of $50m^{-1}$.

It then moves with uniform velocity of $50m^{-1}$ for 30s.

It finally decelerates uniformly for ten seconds until it comes to rest.

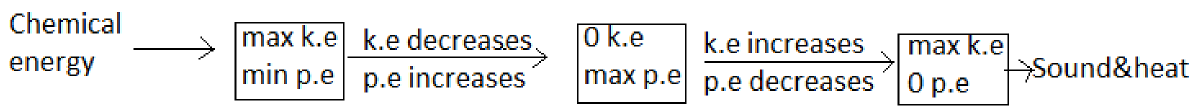
(ii) Total distance = total area between the speed-time graph and the time axis.

Distance, $s = ½(50 + 20)20 + 50 \text{ x } 30 + ½(50x10)$

$s = 700 + 1500 + 250$

$s = 2450m$

(d)

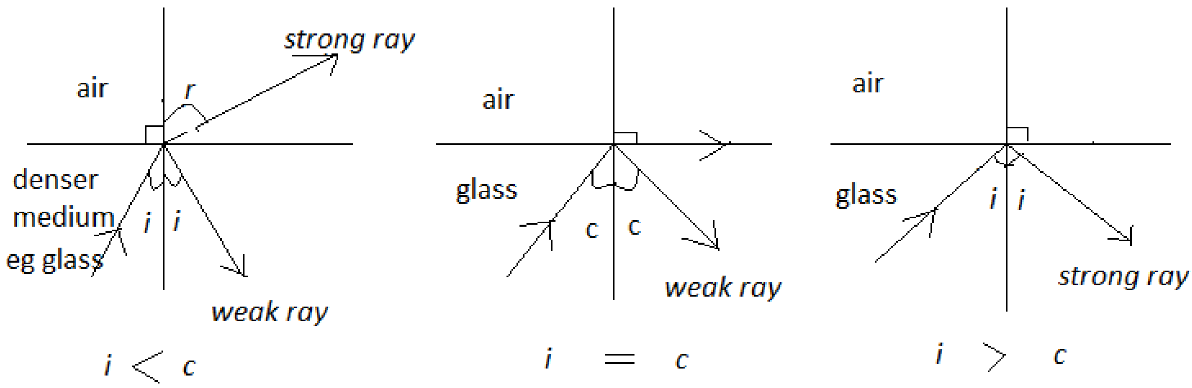


Neglect air resistance; assume the ball had some height initially;

Chronological order of events must be followed.

3(a) (i). Critical angle is the angle of incidence in the denser medium for which the angle of refraction is 90^0.

(ii).



Consider a ray of light incident on a glass- air boundary from glass at a small angle of incidence *i*. A strong refracted ray and a weak internally reflected ray are observed. When angle i is increased, at one stage, the refracted ray grazes the glass-air interface. The angle of incidence is now equal to the critical angle, c. The reflected ray is still weak. When $i > c$, all the light energy is totally internally reflected. The reflected ray is strong.

(b). $n_w \sin i = n_g \sin r$ where n_w = refractive index of water.

n_g = refractive index of glass

i = angle of incidence

r = angle of refraction.

$1.33\sin 42^0 = 1.52\sin r$

$\sin r = \frac{1.33 \times 0.6691}{1.52}$

$r = 35.84^0$

(c). see scale drawing.

(d). Applications of converging lenses;

They are used in,

Spectacles for correction of long sightedness

Lens cameras for focussing images on the film

Projectors for focussing images on the screen

Simple and compound microscopes and telescopes for magnifying and viewing images of near and far objects.

4(a) (i) The e.m.f. of a cell is the total work done in joules per coulomb of electricity conveyed in a circuit in which the cell is connected while terminal p.d. is the total work done in joules per coulomb of electricity conveyed through the external resistors.

(ii) Polarisation is the formation of hydrogen layer on copper plate causing a back e.m.f. and partially insulating the plate resulting in a fall in current. Polarisation is minimised by addition of a depolarising agent e.g. potassium dichromate solution to the acid.

Local action is the formation of hydrogen bubbles on the zinc plate caused by the presence of impurities in the zinc plate which set up tiny local cells in which the impurities act as the positive plates, hence the formation of hydrogen resulting in a fall in current.

Local action is minimised by rubbing a layer of mercury on the zinc plate to absorb only pure zinc from the plate to the surface, a process called amalgamation.

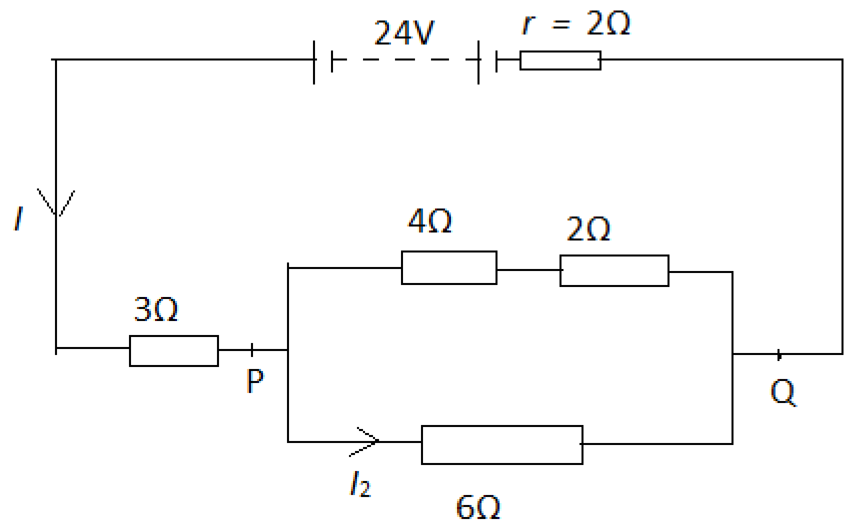
(b) Secondary cells, unlike primary cells, undergo a reversible chemical reaction, hence can be recharged.

They have low internal resistance.

They give large currents.

They have longer life time.

(c)



Consider the circuit between P and Q.

Consider 4Ωand 2Ω in series.

Their effective resistance is R_1:

$R_1 = 4 + 2 = 6\Omega$

Now consider R_1 with 6Ω in parallel. The resistance between P and Q is R_{PQ}:

$1/R_{PQ} = 1/6 + 1/6 = 2/6$

$R_{PQ} = 3\Omega$the resistance of the entire circuit is R:

$R = 2 + 3 + 3 = 8\ \Omega$

The main current, $I = V/R$

$I = 24/8 = 3A$

The p.d across PQ is V: $V = I R_{PQ}$

$V = 3 \times 3 = 9V$

Hence current, I_2 through 6 Ω is: $I_2 = 9/6 \quad 1.5A$

(ii) Power, $P = I^2R$

Consider external resistors.

$$P = 3^2 \text{ x } 3 + 3^2 \text{ x } 3 = 54\text{W}$$

(d) Precautions to be taken to protect an accumulator:

- The acid level should always be maintained by refilling with distilled water only.
- Never add acid to the cell.
- The cell should be regularly charged by giving it a top-up charge.
- It should not be left in discharged condition for any length of time.
- Never connect a wire directly between the terminals of the cell (short circuit), to avoid swelling and buckling of the plates.

5(a) (i). Specific latent heat of fusion of a substance is the quantity of heat required to convert unit mass of the substance from the solid to the liquid state without change of temperature. Its unit is Jkg^{-1}.

OR; Specific latent heat of fusion of a substance is the quantity of heat required to convert 1kg mass of the substance from the solid to the liquid state without change of temperature.

(ii).

- Place an immersion heater of known power rating, *p* in a funnel clamped on a stand.
- Place a dry beaker of known mass m_1 under the funnel.
- Fill the funnel with ice to completely cover the heater.
- Switch on the heater and as soon as the starts to melt switch on the stop clock.
- After collecting a reasonable amount of water from melting ice, switch off the heater and immediately stop the clock.

- Read and record the time, t, taken to collect the water.
- Weigh the beaker to determine its new mass m_2.

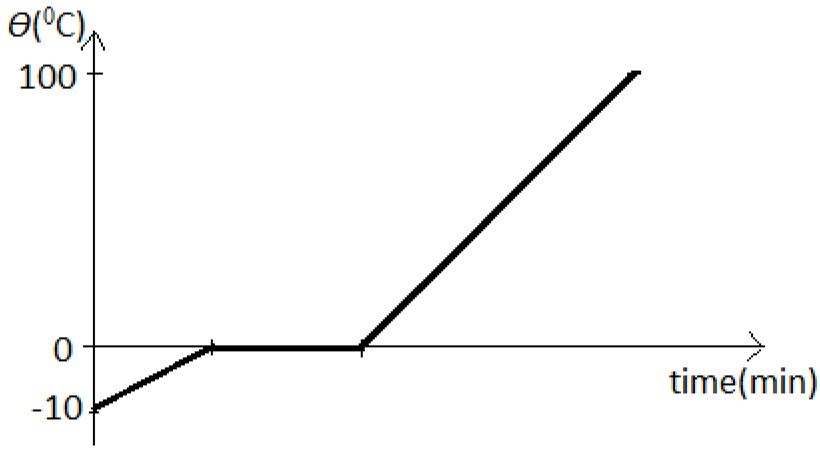
Heat supplied by the heater = heat absorbed by melting ice.

$Pt = (m_2. - m_1)l$, where l is the specific latent heat of fusion of ice.

Hence $l = Pt/(m_2. - m_1)$

Substitutions are made, and a value of l, calculated

(b) (i)



(ii) To raise the temperature from -10^{0}C to 0^{0}C

$Q = mc\theta$

$Q_1 = 2 \times 2.1 \times 10^3 \times 10 = 4.2 \times 10^4 J$

To melt the ice,

$Q = ml$

$Q = 2 \times 3.36 \times 10^5 = 6.72 \times 10^5 J$

To raise the temperature from 0^{0}C to 100^{0}C

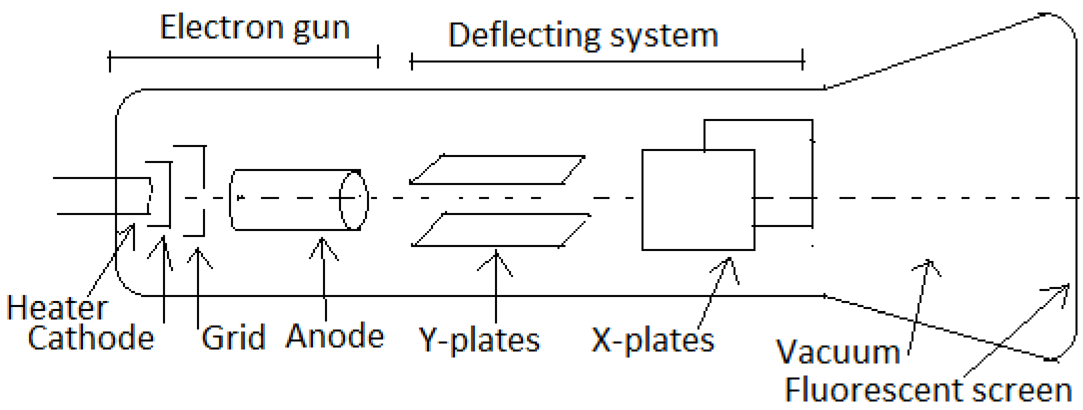
$Q_3 = 2 \times 4200 \times 100 = 8.4 \times 10^5 J$

6(a) (i) Cathode rays are a stream of fast moving electrons.

(ii). Cathode rays

- Are deflected by both electric and magnetic fields.
- Are negatively charged particles.
- Cause ionisation of gases
- Possess kinetic energy
- Travel in straight lines.
- Cause certain materials to fluoresce.

(b) (i)



(ii)Heater: To heat the cathode.

Cathode: To produce electrons by thermionic emission.

Grid: To control the number of electrons passing through it per second.

Anode: To accelerate the electrons along the tube and to focus them into a fine beam.

Y-plates: To deflect the beam of electrons vertically.

X-plates: To deflect the electron beam horizontally.

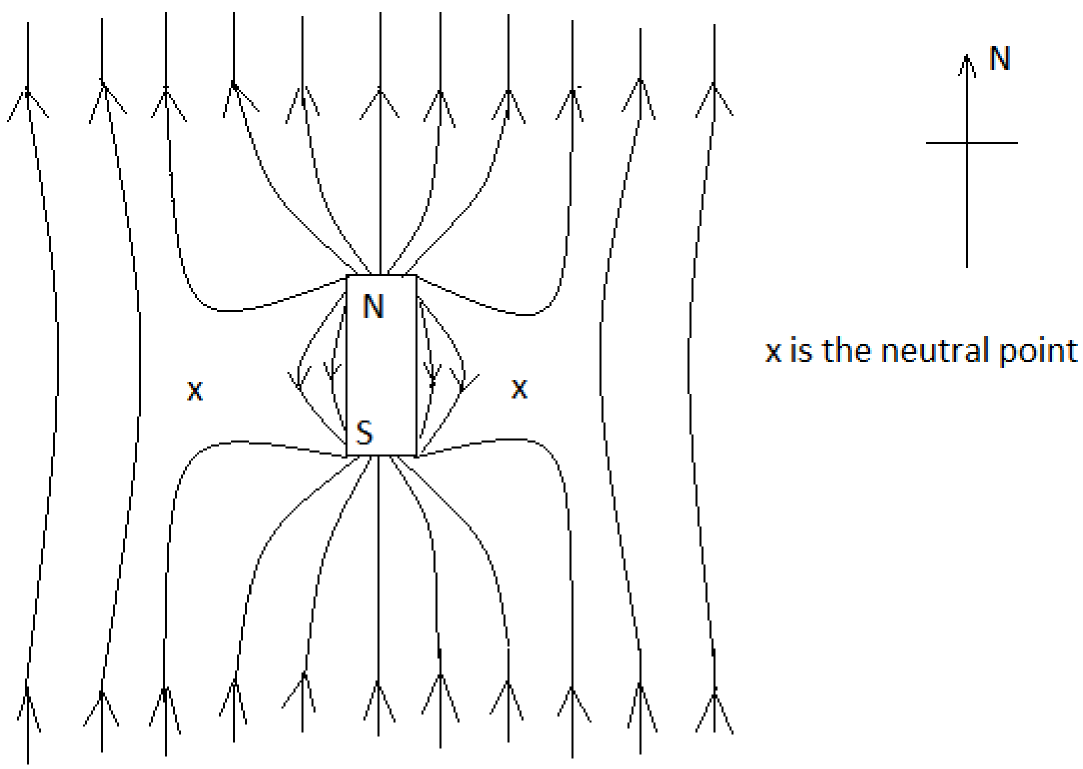
Fluorescent screen: To display the pattern according to the signals applied.

(iii). The C.R.O.is used for:

- Studying wave forms.
- Measuring potential differences both a.c. and d.c.
- Measuring frequency using the time base
- Used in T.V. sets.
- In radar systems (as timing device).

7(a)(i). A neutral point is the point in a magnetic field where the resultant magnetic flux density is zero.

(ii).

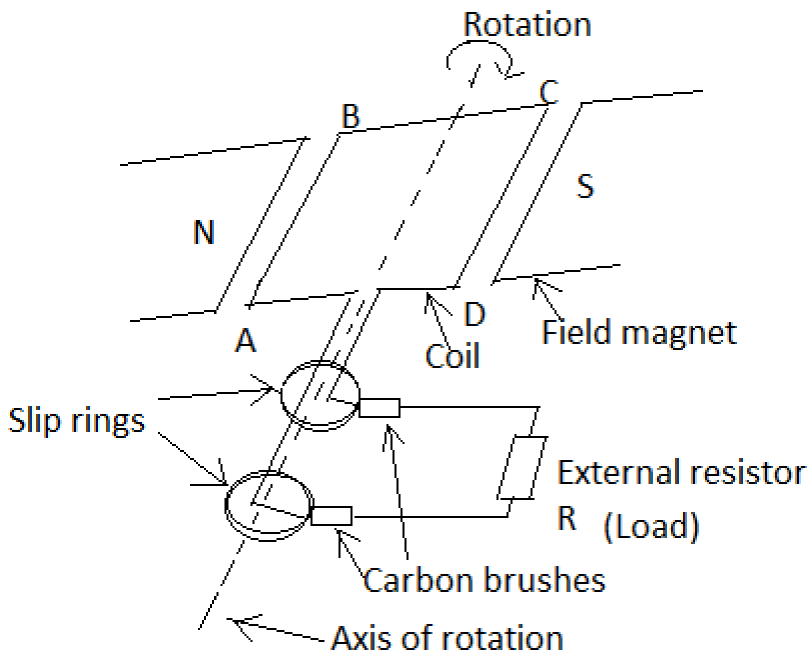


(b) (i). A magnetic material is under magnetic saturation when all its dipoles in the domains have been aligned with the applied magnetizing force and any further increase of the applied field strength has no more effect.

ii). Demagnetization occurs when the magnetic dipoles have been disturbed resulting in the subsequent direction in which the dipoles point to vary from domain to domain.

(c) (i). Lenz's law states that the direction of the induced current is always such as to oppose the change producing it.

(ii).

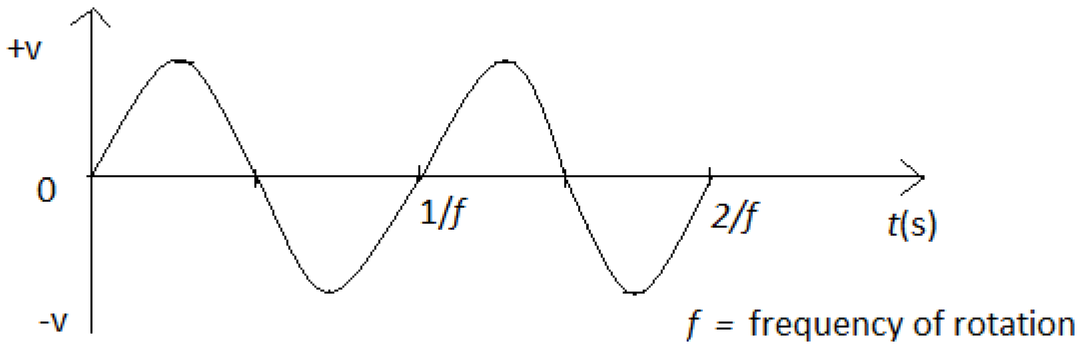


When the coil rotates uniformly in the magnetic field its sides AB and CD cut the magnetic field lines making the magnetic flux linking it to change. An *e.m.f* is therefore induced in it. The direction of the induced current is in accordance to Fleming's Left Hand Rule.

When the coil is in vertical plane, its sides AB and CD are moving parallel to the magnetic field and therefore no current is induced. When the coil turns over, the direction of flow of the current is reversed since the side that was cutting through the field upwards is now cutting downwards. If rotation goes on uniformly, a.c. is produced.

The induced current is transmitted to the load resistance via the carbon brushes which are pressing lightly against the slip rings.

(iii)



(iv). Modifications:

Replace the load resistance *R*, with a d.c. source.

Replace the slip rings with commutators.

8. (a) (i). A radioisotope is a nuclide with the same number of protons as the mother atom but different number of neutrons and is able to decay by emission of β-particles with a release of high energy γ-radiation.

(ii). Uses; Biological; Treatment of cancer,

Used as tracers to locate diseased tissues.

Industrial; Investigating flow of liquids in chemical plants,

Studying of wear in machinery,

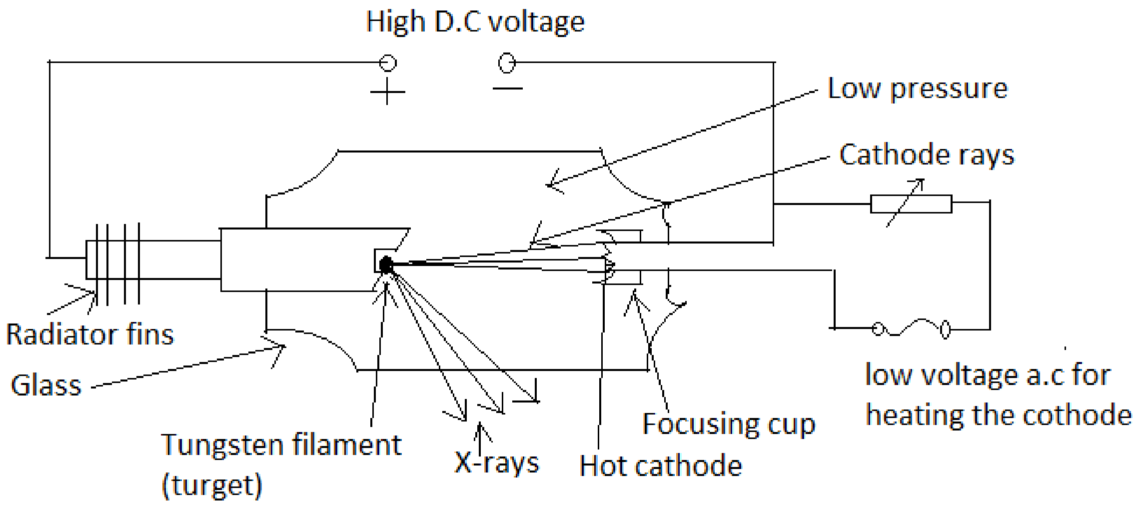
Automatic control of thickness of paper, plastic and metallic sheets.

(b) Differences between nuclear fusion and nuclear fission.

I. In nuclear fission the material should be of a certain critical mass in order for fission to continue as a chain reaction while in nuclear fusion, high temperature is necessary for the reaction to continue.

II. In nuclear fission there should be an initial neutron to bombard the heavy atom to induce the reaction while in nuclear fusion there should be initial heat supply to start the reaction.

(c). (i).



Electrons are emitted thermionically by the cathode and are accelerated by a high voltage as cathode rays towards the tungsten target.

Most of the kinetic energy of the electron beam is converted to heat and the rest to X-rays when the electrons have struck the target.

The heat produced is conducted by the copper tube and radiated away by the copper fins.

(ii) Properties: X-rays,

- travel in straight lines
- readily penetrate matter
- are not deflected by electric and magnetic fields
- cause ionisation of gas molecules
- cause certain materials to fluoresce

- affect photographic emulsion just as light does
- are electromagnetic in nature and therefore possess all the associated properties.

(iii)Precautions in X-ray laboratories:

- Avoid unnecessary exposure to X-rays.
- When exposure is necessary, keep the time as short as possible.
- All the lab staff should wear shielding jacket containing a layer of lead.
- Exposures should be limited.
- Exposure for the unborn and young babies should be avoided.

(iv) Hazards: X-rays,

- Destroy body cells particularly hard X-rays.
- Cause genetic mutation (and changes).
- Cause damage to eye sight.
- Produce deep heated skin burns.

END