Maharashtra State Board
Class X
Science and Technology
Paper - I Solutions

Time: 2 hrs **Max. Marks: 40**

1.
(A)

(i) False. The orbit of a planet is an ellipse with the Sun at one of the foci.

(ii) Hydrogen (H_2)

(iii) **Tungsten** has the highest melting point.

(iv) Electric bulb – Others are made using nichrome. Tungsten filament is used in an electric bulb.

(v) Telecasting of television programmes : Broadcast satellite :: Management of natural resources : **Earth observation satellite**

(B)

(i) (a) $T \alpha r^{\frac{3}{2}}$

We know that $T^2 \alpha r^3$

Thus, $T \alpha \sqrt{r^3} \Rightarrow T \alpha r^{\frac{3}{2}}$

(ii) (a); Consecutive members of a homologous series differ by the $-CH_2$ group.

(iii) (b); We know that,

P= V x I

$$\Rightarrow I = \frac{P}{V} = \frac{1000}{220} = 4.5 \text{ A}$$

(iv) (c) 2 x 108 m/s

Absolute refractive index of glass= 1.5

absolute refractive index is given by

$${}_a n_g = \frac{v_a}{v_g}$$

$$\therefore 1.5 = \frac{3 \times 10^8 \text{ m/s}}{v_g}$$

$$\therefore v_g = \frac{3 \times 10^8 \text{ m/s}}{1.5} = 2 \times 10^8 \text{ m/s}$$

(v) (a); A solution of CuSO4 is blue in colour.

2.

(i) Silver amalgam is an alloy of silver with mercury. It is a hard , non-toxic and lustrous shining substance. It melts at a comparatively low temperature and can therefore conveniently fill cavities. Hence, silver amalgam is used for filling dental cavities.

(ii) The refractive index of water with respect to air $({}_a n_w)$ = 4/3

The refractive index of air with respect to water is given by

$${}_w n_a = \frac{1}{{}_a n_w}$$

$$\therefore \ {}_w n_a = \frac{1}{\frac{4}{3}} = \frac{3}{4} = 0.75$$

Thus, the refractive index of air with respect to water = 0.75

(iii) According to the new Cartesian sign conventions,

a) All distances parallel to the principal axis are measured from the optical centre.

b) The distances measured to the right of the optical centre are taken to be positive, while those measured to the left are taken to be negative.

c) Distances perpendicular to the principal axis and above it are taken to be positive, while those measured below the principal axis are taken to be negative.

d) The focal length of a convex lens is positive, while that of a concave lens is negative.

(iv)

a) Endothermic reaction: The reaction in which heat is absorbed is called an endothermic reaction.

b) Exothermic reaction: The reaction in which heat is given out is called an exothermic reaction.

(v) IUPAC names:

a) n-Butane

b) Ethanal

(vi) Thermal decomposition: The reaction in which a compound is decomposed by heating it to a high temperature is called thermal decomposition.

Example: At high temperature, calcium carbonate decomposes into calcium oxide and carbon dioxide.

$$CaCO_{3(s)} \xrightarrow{heat} CaO_{(s)} + CO_{2(g)}$$

(vii)

a) The satellite is put into a particular orbit at specific height above the Earth's surface by a satellite launcher. For this, the satellite is given a specific velocity known as the critical velocity.

b) Critical velocity does not depend on the mass of a satellite but depends on the height at which the satellite will orbit around the Earth.

c) The critical velocity for a satellite to orbit at a particular height in a specific orbit is given by $V_c = \sqrt{\frac{GM}{R+h}}$

where V_c – Critical velocity

G – Gravitational constant

M – Mass of the Earth

R – Radius of the Earth

h – Height of the satellite

d) As the height of the orbit of satellite increases, the critical velocity decreases.

3.

(i)

$$g = \frac{GM}{R^2}$$

$$g_1 = \frac{GM_1}{R_1^2}$$

$$g_2 = \frac{GM_1}{R_2^2}$$

$$\frac{g_2}{g_1} = \frac{M_2}{M_1}\left(\frac{R_1^2}{R_2^2}\right) = \frac{2M_1}{M_1}\left(\frac{4R_1^2}{R_1^2}\right) = 2(2)^2 = 8$$

$$...(\because M_2 = M_1 \text{ and } R_2 = \frac{R_1}{2})$$

(ii) Latent heat of melting ice = 100 cal/g

Latent heat of vaporisation of water = L_{vap} = 540 cal/g

Mass of steam = m_{steam} = 100 g

Temperature of steam = 95°C

Temperature of ice = T_{ice} = 0°C

Heat released condensation = m_{steam} x L_{vap}

= 100 x 540

= 54000 cal… (1)

Heat released during the conversion of water of 95°C into water at 0°C

= m_{steam} x ΔT x c

= 100 x (95 - 0) x 1 = 100 x 95

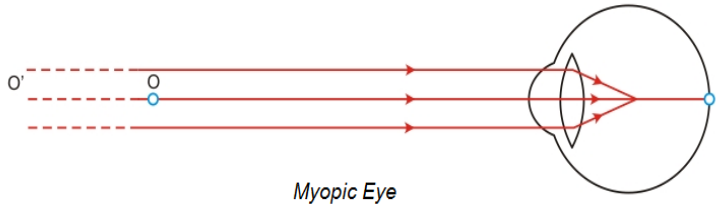
= 9500 cal … (2)

Total heat gained by ice = 100 x 540 + 100 x 95
= 54000 + 9500
= 63500 cal … (3)

Mass of ice will melt because of heat gained, then
m_{ice} x L_{melt} = 63500 cal
m_{ice} x 100 = 63500 cal
m_{ice} = 635 g
Thus, 635 g ice will melt and 63500 cal of energy is transferred to it.

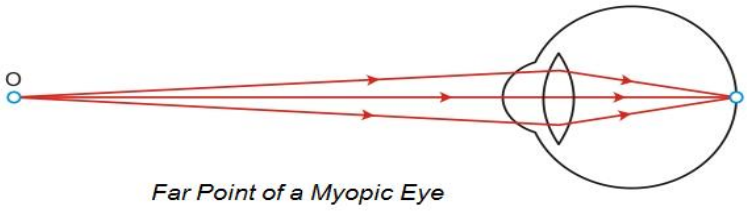
(iii)

a) This defect may arise because of excessive curvature of the eye lens.



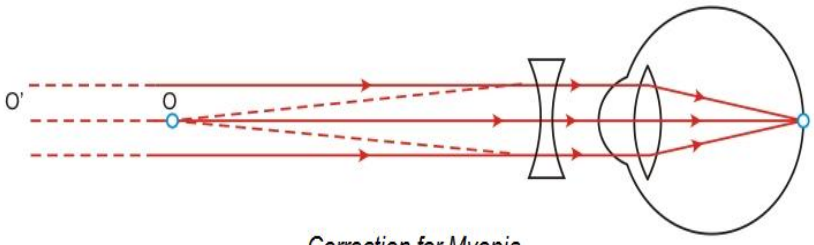
Myopic Eye

b) Elongation of the eyeball.



Far Point of a Myopic Eye

To correct myopia, the person must wear spectacles with a concave lens of the focal length equal to the distance of the far point of the myopic eye. The focal length of a concave lens is negative.



Correction for Myopia

(iv)

a) A rainbow is a combined effect of several natural processes.
b) It is the combined effect of dispersion, refraction and total internal reflection of light.
c) When sunlight is incident on a water droplet, there is refraction and dispersion of light when it passes from air to water, internal reflection of light inside water droplet and again refraction when it passes from water to air.
d) Dispersion of sunlight takes place as the tiny water droplet acts as a prism.
e) Thus, a rainbow is seen when the Sun is behind the observer and water droplets are in the front.

(v) Demerits of Mendeleev's Periodic Table

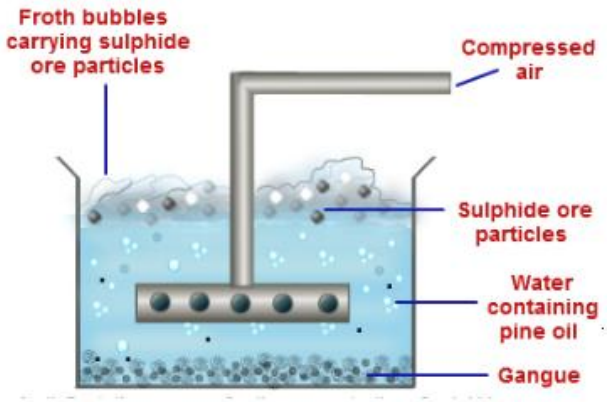
a) Hydrogen resembles alkali metals and halogens. So, a correct position could not be assigned to hydrogen in the periodic table.
b) The position of isotopes could not be explained. Isotopes are atoms of the same element having similar chemical properties but different atomic masses. If the elements are arranged according to atomic masses, then the isotopes should be placed in different groups of the periodic table.
c) At certain places, an element of higher atomic mass was placed before an element of lower atomic mass.
Example: Cobalt (Co = 58.93) was placed before nickel (Ni = 58.71).
d) Some elements placed in the same sub-group had different properties.
Example: Manganese is placed with the halogens which are totally different in their properties.

(vi) Froth Flotation

Principle*:* Separation of

ORE - Preferentially wetted by the oil and hence floats on top as foam.
GANGUE – Preferentially wetted by the water and settles down.

Process: The method is generally applied for sulphide ores. The ore is taken in a large tank containing oil and water and is agitated with a current of compressed air. The ore is wetted by the oil and separates from the gangue in the form of froth.



(vii)

a) $SO_{2(g)} + 2H_2S_{(aq)} \longrightarrow 3S_{(s)} + 2H_2O_{(l)}$

b) $2Ag_{(s)} + 2HCl_{(l)} \longrightarrow 2AgCl\downarrow + H_2\uparrow$

c) $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

(viii)

Calcination: An ore is converted to its oxide by heating it strongly below its melting point either in a limited supply or in the absence of air. This method is commonly used for converting carbonates and hydroxides to their respective oxides. During calcination, moisture and volatile impurities are also removed.

Example: Calcium carbonate is converted to calcium oxide by calcination.

Roasting: An ore is converted to its oxide by heating it strongly in excess of air. This method is commonly used for sulphide ores. During roasting, moisture and non-metallic impurities are also removed as volatile gases.

Example: Zinc sulphide is converted to zinc oxide by roasting.

Difference between roasting and calcination: Roasting is done in excess of air, while calcination is done in a limited supply or in the absence of air.

4.

(i) Characteristics of a Homologous Series

a) Each member of the series differs from the preceding one by adding a $-CH_2$ group and by 14 amu.

b) All the members of a homologous series have the same general formula.

Example: The general formula for alkanes is C_nH_{2n+2} and that for alkenes is C_nH_{2n}.

c) The physical properties of the members show a gradation in properties as their molecular mass increases.

d) The chemical properties also show a gradient similarity.

Example: Methane and ethane react with chlorine to form methyl chloride and ethyl chloride, respectively.

$CH_4 + Cl_2 \rightarrow CH_3Cl$

$C_2H_6 + Cl_2 \rightarrow C_2H_5Cl$

e) All the members of a homologous series can be prepared by the same general method of preparation.

Example: Alcohols can be prepared from alkyl halides.

$$CH_3Br + KOH \xrightarrow{\text{Boil}} CH_3OH + KBr$$

$$C_2H_5Br + KOH \xrightarrow{\text{Boil}} C_2H_5OH + KBr$$

(ii) If V is the potential difference applied across a metallic conductor of resistance R, then the current through the conductor is given by

I = V/R ----- (1) (Ohm's law)

The charge passing through a conductor in the time interval t when current I flows in the conductor is

Q= I x t ----- (2)

The work done in the process is

W = VQ ----- (3)

From (1), (2) and (3),

$W = (IR) \times (It) = I^2 R t = V \times I \times t$

$$W = V\left(\frac{V}{R}\right)t = \frac{V^2}{R}t$$

This work is converted to heat.

Heat energy (H) is expressed in calorie.

Using the relation 4.18 J = 1 cal,

$$H = \frac{I^2Rt}{4.18}(\text{cal})$$