IMPORTANT PROBLEMS AND SOLUTIONS

1.A Charge of 10 coulomb flows through a bulb in 5second. What is the current through the bulb?

Sol: Q=10C $t = 5s$

$I = \frac{Q}{t}$ $I = \frac{10}{5}$ =2

Ans: I=2A

2.How many electrons are passing per second in a circuit in which there is a current of 5 A?

Sol: Given : I=5A $t = 1s$

$$I = \frac{Q}{t}$$

$Here\ Q = ne$ $charge\ of\ an\ electron\ (e) = 1.6 \times 10^{-19}c$

$$I = \frac{ne}{t}$$

$$n = \frac{It}{e} \qquad n = \frac{5 \times 1}{1.6 \times 10^{-19}} = 3.125 \times 10^{19}$$

Ans: No of electrons = 3.125×10^{19}

3.Calculate the PH of 0.01 M HNO_3

Sol: Given $(H^+) = 0.01 = 1 \times 10^{-2}$

$$PH = -log_{10}(H^+)$$

$$P^H = -log_{10}(1 \times 10^{-2})$$

$$P^H = -(-2)log_{10}(10)$$

$$P^H = -(-2) \times 1$$

$$P^H = 2$$

4.A source of sound is moving with a velocity of 50m/s towards a stationary listener.The listener measures the frequency of the source as 1000HZ .What will be the apparent frequency of the source when it is moving away from the listener after crossing him?(velocity of the sound in the medium is 330m/s)

Sol: Given Velocity of the sound (v)=330m/s

Velocity of the source(v_s)=50m/s

When the source is moving towards the stationary listener, the expression for apparent frequency is

$$n' = \left(\frac{v}{v - v_s}\right) n$$

$$1000 = \left(\frac{330}{330-50}\right) \times n$$

$$n = \frac{1000 \times 280}{330} = 848.48Hz$$

When the source is moving away from the stationary listener, the expression for apparent frequency is

$$n' = \left(\frac{v}{v + v_s}\right) n$$

$$n' = \left(\frac{330}{330+50}\right) 848.48$$

$$n' = 736.84Hz$$

5.calculate the velocity of the moving body of mass 5Kg whose linear momentum is 2Kgm/s

Sol: Given $mass(m) = 5kg$ $momentum(p) = 2kg\ m/s$

$$p = m \times v$$

$$v = \frac{p}{m}$$

$$v = \frac{2}{5} = 0.4m/s$$

6.Calculate the mass of 1.51×10^{23} molecule of H_2O

Sol: Given: $no\ of\ molecules = 1.51 \times 10^{23}$

$$molecular\ mass\ of\ H_2O = 18g$$

$$no\ of\ moles = \frac{no\ of\ molecules}{avagadro's number}$$

$$no\ of\ moles = \frac{1.51 \times 10^{23}}{6.023 \times 10^{23}}$$

$$no\ of\ moles = 0.25$$

$$no\ of\ moles = \frac{mass}{molecular\ mass} \quad , \quad 0.25 = \frac{mass}{18}$$

$$mass = 0.25 \times 18 = 4.5\ g$$

7.Calculate the no of moles of 46 g sodium

Sol: Given: $mass\ of\ sodium = 46g$

$atomic\ mass\ of\ sodium = 23$

$no\ of\ moles = \frac{given\ mass}{atomic\ mass}$

$no\ of\ moles = \frac{46}{23} = 2$

$no\ of\ moles = 2$

8.Calculate the number of molecules present in the 36g of water

Sol: given : $mass\ of\ water = 36g$

$molecular\ mass\ of\ water = 18g$

$no\ of\ moles = \frac{no\ of\ molecules}{avagadro's\ no}$

$no\ of\ molecules = \frac{given\ mass \times avagadro's\ no}{molecular\ mass}$

$no\ of\ molecules = \frac{36 \times 6.023 \times 10^{23}}{18}$

$no\ of\ molecules = 2 \times 6.023 \times 10^{23}$

$no\ of\ molecules = 12.046 \times 10^{23}$

9.The focal length of the concave lens is 7 m .calculate the power of the lens.

Sol: given $f = 7m$

$p = \frac{1}{f}$. $power\ of\ cincave\ lens(p) = -\frac{1}{7}$

$p = -0.14D$

10.Three resisters 5 ohm , 3ohm and 2 ohm are connected in series with 10 V battery. Calculate their effective resistance and the current flowing through the circuit

Sol: Given $R_1 = 5ohm$ R_2=3ohm $R_3 = 2ohm$ $V = 10V$

$i) Effective\ resistance\ (R_s) = R_1 + R_2 + R_3$

R_S=5+3+2=10ohm

$R_S = 10\ ohms$

$ii)\ R_S = \frac{V}{I}$

$I = \frac{V}{R_S} = \frac{10}{10} = 1A$

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11. Calculate the PH of 1.0×10^{-4} $molar\ solution\ of\ \ HNO_3$

Sol: Given $(H^+) = 1 \times 10^{-4}$

$$PH = -log_{10}(H^+)$$

$$P^H = -log_{10}(1 \times 10^{-4})$$

$$P^H = -(-4)log_{10}(10)$$

$$P^H = -(-4) \times 1$$

$$P^H = 4$$

12.A piece of wire of resistance 10 ohm is drawn out so that its length is incrased to three times its original length. Calculate the new resistance

Sol: Given

$$Resistance\ (R) = 10ohm$$

$$Length\ is\ increased\ by\ 3times\ , ie; L = 3L$$

$$R = \frac{\rho \times L}{A}$$

$$10 = \frac{\rho \times L}{A}$$

$$When\ length\ is\ increased\ by\ 3\ times\ its\ area\ will\ be\ reduced\ by\ 3\ times$$

$$threfore\ \ new\ lehgth\ (L) = 3L\ \ , New\ area\ (A) = \frac{A}{3}$$

$$New\ resistance\ (R) = \frac{\rho \times 3L}{\frac{A}{3}}$$

$$R = 9 \times \frac{\rho \times L}{A} = 9 \times 10 = 90$$

$$New\ Resistance\ (R) = 10\ ohm$$

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13. Calculate the mass of 6.023×10^{20} molecules of H_2O

Sol: Given $no\ of\ molecules\ of\ H_2O = 6.023 \times 10^{20}$

$$mass\ of\ water = \frac{no\ of\ molecules \times molecular\ mass}{avagadro's\ no}$$

$$mass\ of\ water = \frac{6.023 \times 10^{20\times}}{6.023 \times 10^{23}} \times 18$$

$$mass\ of\ water = 18 \times 10^{-3} g$$

14.Calculate the no of moles of 12 g of magnesium

Sol: Given mass of magnesium=12g

Atomic mass of magnesium=24

$$no\ of\ moles = \frac{given\ mass}{atomic\ mass}$$

$$no\ of\ moles = \frac{12}{24} = 2$$

$$no\ of\ moles = 2$$

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15. Calculate the number of atoms present in 50g of Fe

SOL: Given : mass of iron=50g

Atomic mass of iron=56g

$$no\ of\ atoms = \frac{given\ mass \times avagadro's\ no}{atomic\ mass}$$

$$no\ of\ atoms = \frac{50 \times 6.023 \times 10^{23}}{56}$$

$$no\ of\ atoms = \frac{301.15 \times 10^{23}}{56} = 5.377 \times 10^{23}$$

$$no\ of\ atoms = 5.377 \times 10^{23}$$

16.Calculate the PH value of 1.0×10^{-5} M KOH solution

Sol: given: $(OH^-) = 1.0 \times 10^{-5}$M

$$P^{OH} = -log_{10}(OH^-)$$

$$P^{OH} = -log_{10}(1.0 \times 10^{-5})$$

$$P^{OH} = -(-5)log_{10}(10)$$

$$P^{OH} = 5 \times 1 = 5$$

$$P^H + P^{OH} = 14$$

$$P^H = 14 - P^{OH}$$

$$P^H = 14 - 5$$

$$P^H = 5$$

17.A container of capacity 70ml is filled with liquid up to 50ml. when it is heated the liquid level falls to 48.5ml and then rises to 51.2 ml. Find the apparent and real expansion

Sol: given $Level\ of\ liquid\ L_1 = 50ml$

$Level\ of\ liquid\ L_2 = 48.5ml$

$Level\ of\ liquid\ L_3 = 51.2ml$

$apparent\ expansion = L_3 - L_1$

$= 51.2 - 50$

$apparent\ expansion = 1.2ml$

$real\ expansion = L_3 - L_2$

$= 51.2 - 48.5$

$real\ expansion = 2.7ml$

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18. At what height from the centre of the earth surface, the acceleration due to gravity will be 1/4 th of its value on the surface of the earth

Sol: data

$Height\ from\ the\ centre\ of\ earth\ R' = (R + h)$

$acceleration\ due\ gravity\ at\ that\ height\ g' = \frac{g}{4}$

Formula

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

$$g' = \frac{GM}{(R+h)^2}$$

$$\frac{g}{g'} = \frac{\frac{GM}{R^2}}{\frac{GM}{(R+h)^2}}$$

$$\frac{g}{\frac{g}{4}} = \frac{(R+h)^2}{R^2}$$

$4 = \left(1 + \frac{h}{R}\right)^2$ $Squaring\ on\ both\ sides$

$$2 = 1 + \frac{h}{R}$$

$2 - 1 = \frac{h}{R}$ $, R = h\ ,\ \ R' = 2R$

From the centre of the Earth, the object is placed at twice the radius of the earth.

19.A source producing a sound of frequency 500HZ , is moving towards astatic listener with a velocity of 30m/s. The speed of sound is 330m/s . What will be the frequency heard by listener?

SOL: DATA

$n = 500Hz$, $v_s = 30m/s$ $v = 330m/s$

$$n' = \left(\frac{v}{v - v_s}\right) \times n$$

$$n' = \left(\frac{330}{330 - 30}\right) \times 500$$

$$n' = \frac{330}{300} \times 500$$

$$n' = 1.1 \times 500 = 550Hz$$

20.A weight of a man is 686N on the surface of the earth. Calculate the weight of the same person on moon ("g" value of moon is1.625 ms^{-2}

Sol: Given w=686N

$$w = mg\ , \qquad m = \frac{w}{g} \quad , \quad m = \frac{686}{9.8} = 70kg$$

$$weight\ of\ the\ person\ on\ the\ moon = mg$$

$$w = 70 \times 1.625 = 113.75N$$

21.Calculate the mass percentage of each element present in calcium carbonate molecule(mass number: C-12 , O-16 , Ca-40)

Sol:

$$Molar\ mass\ of\ caco_3 = 1 \times ca + 1 \times c + 3 \times o$$

$$= 1 \times 40 + 1 \times 12 + 3 \times 16$$

$$= 100$$

$$mass\%\ of\ calcium = \frac{mass\ of\ that\ element\ present\ in\ that\ compound}{molar\ mass\ of\ calcium\ carbonate} \times 100$$

$$= \frac{40}{100} \times 100 = 40\%$$

$$mass\ \%\ of\ carbon = \frac{12}{100} \times 100 = 12\%$$

$$mass\%\ of\ oxygen = \frac{16}{100} \times 100 = 16\%$$

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22. Calculate the percentage of oxygen in $Al_2(SO_4)_3$ compound (Mass number values are: Al-27 ,O-16 , S-32)

Sol:

$$molar\ mass\ of\ Al_2(so_4)_3 = 2 \times Al + 3 \times s + 12 \times o$$

$$= 2 \times 27 + 3 \times 32 + 12 \times 16$$

$$= 54 + 96 + 192 = 342$$

$$mass\%\ of\ oxygen = \frac{mass\ of\ the\ element\ present\ in\ that\ compound}{molar\ mass\ of Al_2(so_4)_3} \times 100$$

$$= \frac{16}{342} \times 100 = \frac{1600}{342} = 4.67\%$$

$$mass\%\ of\ oxygen = 4.67\%$$

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23. 3.5 Liters of ethanol is present in 15 litres of aqueous solution of ethanol . Calculate the volume percentage of ethanol.

Sol: Given

$$volume\ of\ ethanol = 3.5\ litres$$

$$volume\ of\ the\ solution = 15 litres$$

$$volume\ percentage\ of\ ethanol = \frac{volume\ of\ the\ ethnol}{volume\ of\ the\ solution} \times 100$$

$$= \frac{3.5}{15} \times 100 = \frac{350}{15} = 23.33\%$$

$$volume\ percentage\ of\ ethanol = 23.33\%$$

24.A lift is moving downwards with an acceleration of 1.8 ms^{-2}. What is the apparent weight realized by man of mass 50 Kg?

Sol: Given $a = 1.8m/s^2$, $m = 50kg$, $g = 9.8m/s^2$

$$apparent\ weight(R) = m(g - a)$$

$$R = 50(9.8 - 1.8)$$

$$= 50 \times 8 = 400$$

$$R = 400N$$

25.The length of aluminium rod at the temperature of 303K is 50m . What would be its increase in length when it is heated to 323K ? (The linear co-efficient of aluminium is 23×10^{-6} K^{-1})

Sol: Given $initial\ temperature\ t_1 = 303K$

$$final\ temperature\ t_2 = 323K$$

$$initial\ length\ (L_0) = 50m$$

$$linear\ co-efficient\ of\ aluminium(\alpha_L) = 23 \times 10^{-6}K^{-1}$$

$$\frac{\Delta L}{L_0} = \alpha_L \Delta T \quad , \quad \Delta L = L_0 \alpha_L \Delta T \quad , \quad \Delta L = 50 \times 23 \times 10^{-6} \times (323 - 303)$$

$$\Delta L = 50 \times 23 \times 10^{-6} \times 20 = 100 \times 23 \times 10^{-6}$$

$$\Delta L = 23 \times 10^{-4} m$$

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26. A piece of wire having a resirtance of 5 ohms cut into five equal parts . If the five parts of the wire are connected in parallel , then find the effective resistance of the combination.

Sol:$resistance\ of\ each\ part = \frac{R}{5}$ ie; $R_1 = \frac{R}{5}$, $R_2 = \frac{R}{5}$, $R_3 = \frac{R}{5}$, $R_4 = \frac{R}{5}$, $R_5 = \frac{R}{5}$

$$Since\ the\ 5\ parts\ are\ connected\ in\ parallel$$

Therefore; $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}$

$$\frac{1}{R_P} = \frac{1}{\frac{R}{5}} + \frac{1}{\frac{R}{5}} + \frac{1}{\frac{R}{5}} + \frac{1}{\frac{R}{5}} + \frac{1}{\frac{R}{5}}$$

$$\frac{1}{R_P} = \frac{5}{R} + \frac{5}{R} + \frac{5}{R} + \frac{5}{R} + \frac{5}{R} + = = \frac{25}{R}$$

There fore; $Effective\ resistance(R_P) = \frac{R}{25}$ohm

27.Keeping the temperature as constant , if a gas in a container is compressed four times of its initial pressure . The volume of gas changing from 20cc (V_1CC) to V_2CC. Find the final volume V_2 .

Sol:

$$initial\ pressure(P_1) = P$$

$$final\ pressure(P_2) = 4P$$

$$initial\ volume(V_1) = 20cc$$

$finial\ volume(V_2)$=?

$accordin\ to\ boyel's\ law$

$P_1V_1 = P_2V_2 \quad , \quad \frac{P_1V_1}{P_2} = V_2$

$\frac{P\times 20}{4P} = V_2$

$V_{2=}5CC$

28.A source producing sound of frequency 90 HZ is approaching a stationary listener with a speed equal to (1/10) of the speed of sound. What will be the frequency heard by the listener ?

Sol: Given $n = 90Hz$ $v_{s=}(\frac{1}{10})v$

$n' = \left(\frac{v}{v-v_s}\right)$n

$$n' = \left(\frac{v}{v-\frac{1}{10}v}\right)\times 90$$

$$n' = \left(\frac{v}{v(1-\frac{1}{10})}\right)\times 90 \ , \quad = \frac{10}{9}\times 90 = 100$$

$n' = 100Hz$

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29. From the value of ionic product of water at $25^{\circ}c$, find out the concentration of hydroxyl ions.(at $25^{\circ}c$ concentration of hydrogen ions in water is 10^{-7} mol/dm^3

Sol: Given $[H^+] = 10^{-7}$ mol/dm^3

$Ionic\ product\ of\ wateris$

$[H^+][OH^-] = 1\times 10^{-14}$

$[OH^-] = \frac{1\times 10^{-14}}{H^+} \ ,= \frac{10^{-14}}{10^{-7}} \quad = 10^{-7}$

$(OH^-) = 10^{-7}mol/dm^3$

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30. The power of the lens is -2D . Find the focal length of the lens

Sol: Given $P = -2D$

$$P = \frac{1}{f}$$

$$f = \frac{1}{-2} = -0.5m$$

31.An electric heater of resistance 5 ohms is connected to an electric source . If a current of 6A flows through the heater , then find the amount of heat produced in 5 minutes

Sol: Given $R = 5ohm \;\; I = 5A \;\; t = 5min = 300s$

$$H = I^2Rt \; = 5 \times 5 \times 5 \times 300 = 37500j$$

$$H = 37500J$$

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32. How many grams are there in the following substances i) 2 moles of hydrogen molecule ii) 3 moles of chlorine molecule iii) 5 moles of sulpher molecule iv) 4 moles of phosphorous molecule

Sol:

$$i) \;\; no\ of\ moles = \frac{mass}{molecular\ mass}$$

$$mass = no\ of\ moles \times molecular\ mass = 2 \times 2 = 4g$$

$$ii) \;\; no\ of\ moles = \frac{mass}{molecular\ mass}$$

$$mass = no\ of\ moles \times molecular\ mass = 3 \times 71 = 213g$$

$$iii) \;\; no\ of\ moles = \frac{mass}{molecular\ mass}$$

$$mass = no\ of\ moles \times molecular\ mass = 5 \times 256 = 1280g$$

$$iv) \;\; no\ of\ moles = \frac{mass}{molecular\ mass}$$

$$mass = no\ of\ moles \times molecular\ mass = 4 \times 124 = 496g$$

33.The hydroxide ion concentration of a solution is 1×10^{-11} M. Find the PH of the solution

Sol: given: $(OH^-) = 1.0 \times 10^{-11}\mathrm{M}$

$$P^{OH} = -log_{10}(OH^-)$$

$$P^{OH} = -log_{10}(1.0 \times 10^{-11})$$

$$P^{OH} = -(-11)log_{10}(10)$$

$$P^{OH} = 11 \times 1 = 11$$

$$P^{H} + P^{OH} = 14$$

$$P^{H} = 14 - P^{OH}$$

$$P^{H} = 14 - 11$$

$$P^{H} = 3$$

34.A strong ultrasonic sound signal is sent from a ship towards the bottom of the sea. It is recived by the receiver after 2s .Calculate the depth of the sea ? The speed of sound in water is 1450 m/s

Sol: given $time\ (t) = 2s \quad speed\ of\ sound\ in\ water = 1450m/s$

$$velocity\ (v) = \frac{2 \times distance\ travelled}{t}$$

$$distance\ (d) = \frac{v \times t}{2} = \frac{1450 \times 2}{2} = 1450m$$

$$depth\ of\ the\ sea = 1450m$$

35.A force of 5N applied on a body produces an acceleration 5 cm s^{-2} . Calculate the mass of the body?

Sol: Given $F = 5N \;\; a = 5cm/s^2 = 0.5\ m/s^2$

$$F = ma \quad , \quad m = \frac{F}{a} = \frac{5}{0.5} = 10kg$$

$$mass\ (m) = 10kg$$

36.An object of height 3cm placed at 10cm from a convex lens which produces an image at 20cm from its optical centre . Calculate the magnification and height of the image produced

Sol: Given $h_o = 3cm \ , \ u = 10cm \ , v = 20cm$

$$magnification\ (m) = \frac{image\ distance}{object\ distance} = \frac{v}{u} = \frac{20}{10} = 2$$

$$magnification\ (m) = 2$$

also

$$m = \frac{height\ of\ the\ image}{height\ of\ the\ object} = \frac{h_i}{h_o}$$

$$2 = \frac{h_i}{3} \quad , \quad h_i = 6cm$$

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37 . Calculate the amount energy released when a radioactive substance undergoes fusion and results in a mass defect of 1 Kg

Sol:

$E = mc^2 \ = 1 \times (3 \times 10^8)^2$

$$E = 9 \times 10^{16} J$$

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38. Calculate the number of moles in a) 27 g of aluminium b)1.51×10^{23} molecules of NH_4Cl

$$a)\ no\ of\ moles = \frac{given\ mass}{atomic\ mass}$$

$$= \frac{27}{27} = 1$$

$$no\ of\ moles = 1$$

$$b) no\ of\ moles = \frac{no\ of\ molecules}{avagadro's\ no}$$

$$= \frac{1.51 \times 10^{23}}{6.023 \times 10^{23}} = \frac{1}{4} = 0.25$$

$$no\ of\ moles = 0.25$$

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39. At what speed should a source of sound move away from a stationary observer so that observer finds the apparent frequency equal to half of the original frequency ?

Sol: When the source is moving away from the stationary listener, the expression for the apparent frequency is

$$n' = \left(\frac{v}{v + v_s}\right) n$$

$$\frac{n}{2} = \left(\frac{v}{v + v_s}\right) n$$

$$\frac{1}{2} = \left(\frac{v}{v + v_s}\right)$$

$$v + v_s = 2v$$

$$v_s = v$$

40. Calculate the frequency of visible light having wave length 3000A^0 travelling in vaccum

Sol: given $wave\ length(\lambda) = 3000A^O$ $,velocity\ of\ visible\ light = 3 \times 10^8 m/s$

$$Velocity = frequency \times wave\ length$$

$$frequency = \frac{velocity}{wave\ length}$$

$$= \frac{3 \times 10^8}{3000 \times 10^{-10}} = \frac{3 \times 10^8}{3 \times 10^{-7}} = 10^{15} Hz$$

$$frequency = 10^{15} Hz$$

41.Calculate the solubility of a solute at 300K by dissolving 10 g of solute in 50g of solvent

Sol: Given $mass\ of\ the\ solute = 10g$, $mass\ of\ the\ solvent = 50g$

$$solubility\ of\ a\ solute = \frac{mass\ of\ the\ solute}{mass\ of\ the\ solvent} \times 100$$

$$= \frac{10}{50} \times 100 = \frac{1000}{50} = 20\%$$

$$solubility\ of\ the\ solute = 20\%$$

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42. Convert 80^0 F temperature into Kelvin scale

Sol: $K = (F + 460) \times \frac{5}{9}$

$$K = (80 + 460) \times \frac{5}{9}$$

$$= 540 \times \frac{5}{9} = 60 \times 5 = 300K$$

$$K = 300K$$
