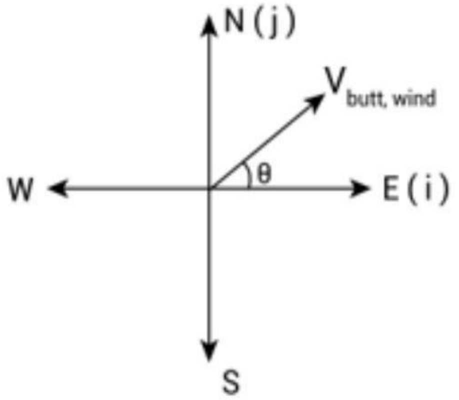
1. (a)



$\vec{V}_{\text{butt}} = 4m/s\hat{\imath} + 4m/s\hat{\jmath}$

$\vec{V}_{\text{wind}} = -1m/s\hat{\jmath}$

$\vec{V}_{\text{butt,wind}} = 4m/s\hat{\imath} + 3m/s\hat{\jmath}$

Displacement of bird in three second.

$D = \sqrt{(4 \times 3)^2 + (3 \times 3)^2}$

$D = 15m$

Direction $\theta = \tan^{-1}\left(\frac{3}{4}\right)$

$\theta = 37°$

$\therefore$ 15 m, 37° North to East.

2. (c) $y(x, 0) = \frac{1}{1+x^2}$

$y(x, 3) = \dfrac{1}{1 + (x + 1)^2}$

If v is the velocity of the wave, then,

$y(x, t) = y(x + vt, 0)$

Therefore,

$y(x, 3) = (x + 3v, 0)$

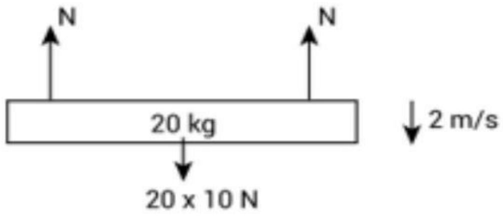
Replacing values we get

$$\frac{1}{1 + (x + 1)^2} = \frac{1}{1 + (x + 3v)^2}$$

$x + 1 = x + 3v$

$x = +\dfrac{1}{3}$ cm/s

3. (c)



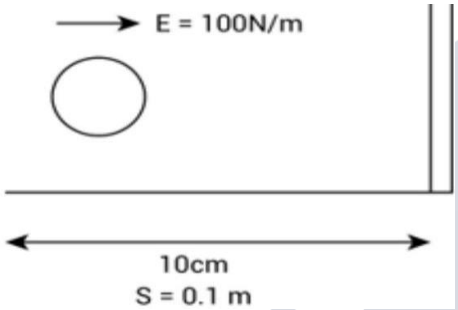
20 kg is rest w.r.t platform.

$2N = 200 + 20 \times 2$

$2N = 240N$

$N = 120N$

4. (b) $\frac{q}{m} = 8\mu c/g$



$F = qE$

$a = \frac{qE}{m}$

$a = \frac{8 \times 10^{-6}}{1 \times 10^{-3}} \times 100$

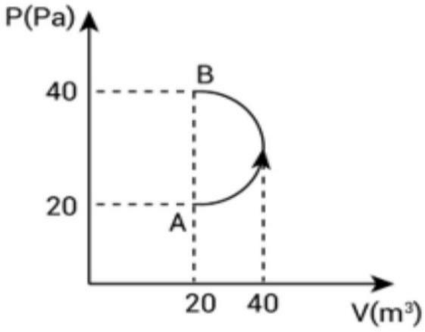
$a = 0.8\ \mathrm{m/s^2}$

Time period (T) $= 2\sqrt{\frac{2S}{a}}$

$= 2 \times \sqrt{\frac{2 \times 0.1}{8}}$

T = 1sec

5. (a)



$W_{\text{external}} + W_{\text{gas}} = 0$

$W_{\text{external}} = -W_{\text{gas}}$

$= -\left\{-\frac{\pi \times 20 \times 20}{2}\right\} J$

$W_{\text{external}} = 200\pi J$

6. (c) $\vec{A} \cdot \vec{B} = |\vec{A} \times \vec{B}|$

$AB\cos\theta = AB\sin\theta$

$\cos\theta = \sin\theta$

$\Rightarrow \theta = \frac{\pi}{4}$

then

$|\vec{A} - \vec{B}| = \sqrt{A^2 + B^2 - 2AB\cos 45^\circ}$

$|\vec{A} - \vec{B}| = \sqrt{A^2 + B^2 - \sqrt{2}AB}$

7. (a) Let one charge be q_1 and other be $\theta - q_1$

$F = K\frac{q_1(Q - q_1)}{r_2}$

For maximum force $\frac{dF}{dq_1} = 0$

and $\frac{d^2F}{dq_1^2} < 0$

$\frac{dF}{dq_1} = \frac{K(Q - q_1)}{r^2} - \frac{Kq_1}{r^2}$

$\frac{dF}{dq_1} = 0$

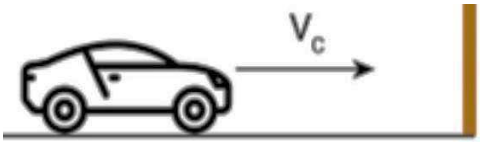
$Q - q_1 - q_1 = 0 \Rightarrow q_1 = \frac{Q}{2}$

$\frac{d^2F}{dq_1^2} = -\frac{K}{r^2} - \frac{K}{r^2} = \frac{-2K}{r^2}$

$-\frac{2K}{r^2} < 0$ for all values of q_1

So, the value of $q_1 = \frac{Q}{2}$ and $Q - q_1 = \frac{Q}{2}$

8. (c)



f′ be the frequency heard at wall.

$$f' = \left(\frac{V_S}{V_S - V_C}\right) f$$

Then this f' reflected back and the frequency heard by the driver is f''

$$f'' = \left(\frac{V_S + V_C}{V_S}\right) f'$$

From equation (1) and (2)

$$f'' = \left(\frac{V_S + V_C}{V_S - V_C}\right) f$$

$$f'' = \left(\frac{V + V_C}{V - V_C}\right) f$$

$$500 = \left(\frac{V + V_C}{V - V_C}\right) \times 400$$

$$\frac{5}{4} = \frac{V + V_C}{V - V_C}$$

$$5V - 5V_C = 4V + 4V_C$$

$$9V_C = V$$

$$V_C = \frac{V}{9}$$

9. (b) Energy of photon emitted by Hydrogen atom is

$$E = -13.6\left[\frac{1}{3^2} - \frac{1}{2^2}\right]$$

$$E = -13.6\left[\frac{1}{9} - \frac{1}{4}\right]$$

$$E = -13.6\frac{(-5)}{36} = \frac{13.6 \times 5}{36}\,\text{eV}$$

$$E = 1.889\text{eV}$$

Now we have equation for kinetic energy

$$\left(\frac{1}{2}mv^2\right)_{\max} = hv - \phi$$

If radius of electron R

$$R = \frac{mv}{qB}$$

Squaring both side

$$R^2 = \frac{m^2v^2}{q^2B^2}$$

$$R^2 = \frac{2m(KE)}{q^2B^2}$$

$$KE = \frac{q^2B^2R^2}{2m}$$

$$KE = \frac{[1.6 \times 10^{19} \times 5 \times 10^{-4} \times 7 \times 10^{-3}]^2}{2 \times 9.1 \times 10^{-31}}$$

$$KE = \frac{3136 \times 10^{-52}}{2 \times 9.1 \times 10^{-31}}$$

$$KE = 172.30 \times 10^{-21} J$$

$$KE = 107.68 \times 10^{-2}\text{eV}$$

$$KE = 1.077\text{eV}$$

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

$$1.077 = 1.889 - \phi$$

$$\phi = 0.811\text{eV} \sim 0.81\text{eV}$$

10. (a) $[S] = [ML^2T^{-2}K^{-1}]$

$$n = [\text{mol}]$$

$$[k] = [ML^2T^{-2}K^{-1}]$$

$$[J] = [M^0L^0T^0]$$

$$[R] = [M^1L^2T^{-2}K^{-1}\ \text{mol}^{-1}]$$

$$S = \alpha^2\beta\ln\left[\frac{nkR}{J\beta^2} + 1\right]$$

The quantity inside log must be dimensionless.

$$[nkR] = [J\beta^2]$$

$$[mol][ML^2T^{-2}K^{-1}][ML^2T^{-2}K^{-1}][mol^{-1}] = [\beta]^2$$

$$[ML^2T^{-2}K^{-1}]^2 = [\beta]^2$$

$\beta = [ML^2T^{-2}K^{-1}]$

Now

$[S] = [\alpha^2\beta]$

$[ML^2T^{-2}K^{-1}] = \alpha^2[ML^2T^{-2}K^{-1}]$

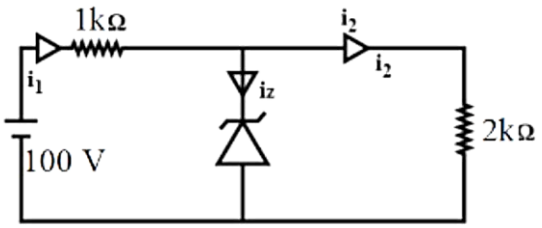
$\alpha = [M^0L^0T^0K^0]$

11. (b)

$$\frac{mv^2}{R} = qvB$$
$$R = \frac{mv}{qB} = \frac{\sqrt{2mE}}{qB}$$
$$R_d = \frac{\sqrt{2m_dE}}{q_dB}, R_\alpha = \frac{\sqrt{2m_\alpha E}}{q_\alpha B}$$

$$R_\alpha : R_d = \frac{\sqrt{m_\alpha}}{q_\alpha} : \frac{\sqrt{m_d}}{q_d} = \frac{\sqrt{4}}{2} : \frac{\sqrt{2}}{1} = 1 : \sqrt{2}$$

12. (a)



For zener breakdown, potential difference across $2k\Omega$ resistor will be 5.0 V

$V_z = 50$ V

$$i_2 = \frac{V_z}{2k} = \frac{50}{2k} = 25 \text{ mA}$$

ΔV across $1k\Omega = 100 - 50 = 50$ V

$$i_1 = \frac{50}{1k} = 50 \text{ mA}$$

$i_1 = i_2 + i_z$

$i_z = 50mA - 25mA = 25mA$

13. (a)

$$E = J\rho$$
$$= \frac{I}{A\cos\theta}\rho$$
$$= \frac{5}{2\cos 60} \times 11 \times 10^{-4}$$
$$= 55 \times 10^{-4} \text{ V/m}$$

14. (c) K.E. of body $= \left(\frac{1}{2}\right) mv^2 = \left(\frac{1}{2}\right) m \left(\frac{E}{m} c\right)^2 = \frac{E^2}{2mc^2}$

Energy emitted by photon $= E$

Total decrease in internal energy $= E + \frac{E^2}{2mc^2}$

$= E\left(1 + \frac{E}{2mc^2}\right)$

$= hv\left(1 + \frac{hv}{2mc^2}\right) \ (as E = hv)$

15. (a)

16. (c) $g \propto \frac{1}{(\text{ distance })^2}$

Weight of the man goes from $W_o = mg$ on surface of earth to zero somewhere in the path (where gravitational pull from both planets is equal to opposite) and finally to $\frac{W_o}{2.5}$ on surface of mass

g on earth $= 10$

g on mars $4 = \frac{10}{2.5} = \frac{g}{2.5}$

From (1) the decline from W_o to zero and rise from o to $W_o/4$ is non-linear Hence (c) is the right answer.

17. (a) Change in internal energy

$du = nC_v dT$

C_v for a diatomic gas is

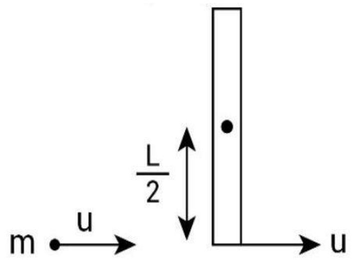
$\frac{5}{2} R$ ($\therefore$ temp given is not very high, so neglect vibrational degree of freedom)

Given $n = 4; C_v = \frac{5}{2} R$ and $dT = 50$

$\therefore du = 4(5/2R)(50)$

$= 500R$

18. (a) Conserving angular momentum about the hinge at the center



$\vec{L}$ before collision $= mu(L/2)$

$\vec{L}$ after collision $= I\omega$

$\omega = \frac{u}{(L/2)}$

$\therefore \text{mu}\left(\frac{L}{2}\right) = \frac{ML^2}{12}\left(\frac{u}{L/2}\right)$

$\frac{mu}{2} = \frac{Mu}{6}$

$\therefore \frac{m}{m} = \frac{1}{3}$

19. (c) We know that the number of atoms left after half-lives is given by

$N = N_0\left(\frac{1}{2}\right)^n$

where n = no of half lives

Now decay constant
$(\lambda) = \left(\frac{\ln 2}{T_{1/2}}\right)$

For a material containing 2 radioactive substances effective disintegration constant (λ_{eff})

$\lambda_{\text{eff}} = \lambda_A + \lambda_B$ [A and B are the substances]

$\Rightarrow \frac{\ln 2}{T_{eff}} - \frac{\ln 2}{T_{1/2A}} + \frac{\ln 2}{T_{1/2B}}$

$\Rightarrow \frac{1}{T_{eff}} = \frac{1}{T_{1/2A}} + \frac{1}{T_{1/2B}}$

Here T_{eff} = Effective or equivalent half-life of the material.

Given $T_{1/2A} = 1400$ yrs

&$T_{1/2B} = 700$yrs

We get

$T_{\text{eff}} = \frac{1400 \times 700}{1400 + 700}$

$= \frac{1400}{3} yrs.$

$\therefore$ no. of half-lives $(n) = \frac{t}{(1400/3)}$

where t is time required for material to become one-third.

Now, $N = N_o\left(\frac{1}{2}\right)^n$

$\frac{N}{N_o} = \left(\frac{1}{2}\right)^{t/(1400/3)}$

$\Rightarrow \left(\frac{1}{3}\right) = \left(\frac{1}{2}\right)^{t/(1400/3)}$

$\Rightarrow 3 = 2^{3t/1400}$

$\Rightarrow \ln 3 = (3t/1400)\ln 2 \Rightarrow t = \frac{\ln 3}{\ln 2}\left(\frac{1400}{3}\right) yrs$

20. (a) 2700 kJ of energy → 180 g of glucose

1 kJ of energy → $\frac{180}{2700}$ g of glucose

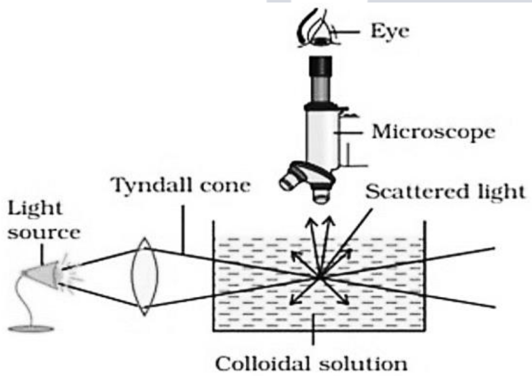
10000 kJ of energy → $\frac{180}{2700} \times 10000 = 666.67$ g

21. (c) Energy in 2^{nd} orbit $= -13.6\frac{z^2}{n^2} = -13.6\frac{2^2}{2^2} = -13.6\text{eV}$

Energy in 3^{nd} orbit $= -13.6\frac{z^2}{n^2} = -13.6\frac{2^2}{3^2} = -13.6\text{eV} \times \frac{4}{9} = -6.04\text{eV}$

∴ Energy difference $= E_3 - E_2 = 7.54\text{eV}$

22. (a) Tyndall effect is observed only when the following two conditions are satisfied. (i) The diameter of the dispersed particles is not much smaller than the wavelength of the light used; and (ii) The refractive indices of the dispersed phase and the dispersion medium differ greatly in magnitude.



23. (a) Order of intensity: $Ni(CN)_4 > Ni(H_2O)_4 > NiCl_4$

The intensity of colour depends on the strength of the ligand attached with the central metal atom. And strength of ligand is in the order:

$CN^- > H_2O > Cl^-$

24. (a)

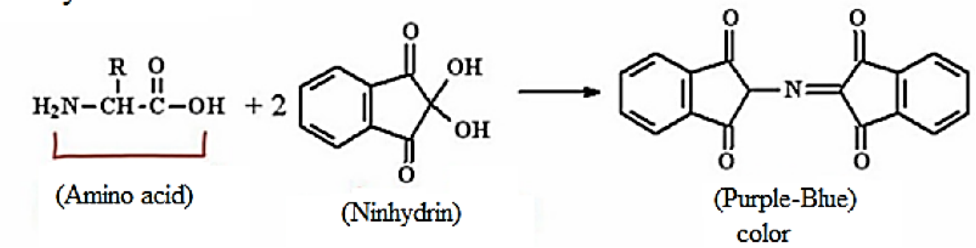
Ga: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^1$

Ga: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$

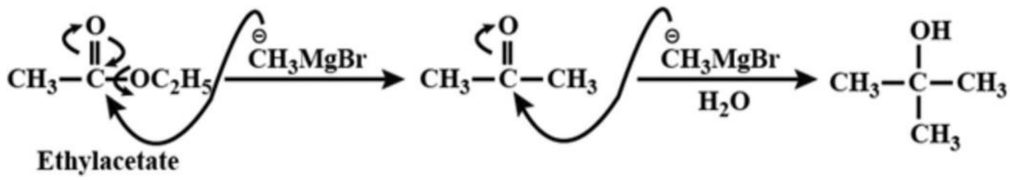
↓
$l = 0$

25. (d)

Ninhydrin test



26. (d)



27. (b) KO_2 (yellowish colour) $\rightarrow K^+ + O_2^-$(paramagnetic)

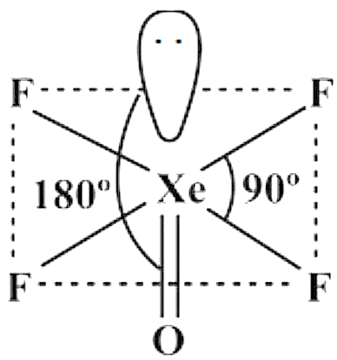
28. (c) Extraction of zinc oxide

The reduction of zinc oxide is done using coke. The temperature in this case is higher than that in case of copper. For the purpose of heating, the oxide is made into briquettes with coke and clay.

$$ZnO + C \xrightarrow{\text{coke, 1673 K}} Zn + CO$$

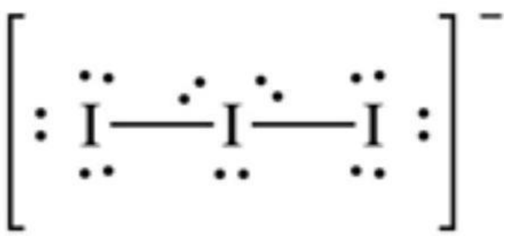
The metal is distilled off and collected by rapid chilling

29. (c)



Hybridisation of Xe in $XeOF_4$ is $sp^3\ d^2$

30. (d)



31. (b)

$Be(OH)_2$&$Al(OH)_3$ are amphoteric.

$B(OH)_3$&H_2PO_3 are acidic.

$Ca(OH)_2$ & $NaOH$ are basic.

32. (b) Gaseous phase

$X'_{\text{Benzene}} = ?$

Liquid phase

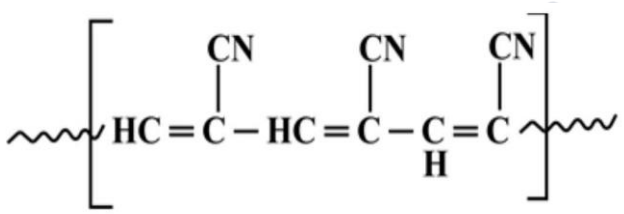
$P_T = P_{Benzene} X_{benzene} + P_{methylbenzene} X_{methylbenzene}$

$= 70 \times 1/2 + 20 \times 1/2$

$= 35 + 10 = 45$

$X'_{\text{Benzene}} = \frac{35}{45} = 0.77$

33. (c)

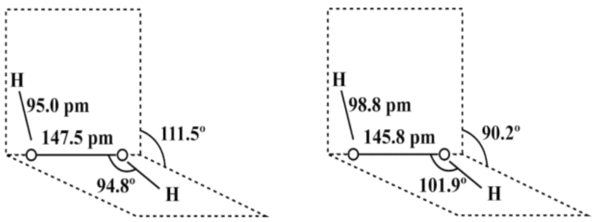


Orlon is the name that is used in trade purposes for Polyacrylonitrile (PAN). It is a polymer of acrylonitrile which is commonly known as vinyl cyanide (VCN)

34. (a) While CO_2 is a main greenhouse gas, no new CO_2 is generated with this technology, so it does not contribute to global warming. Liquid CO_2 companies recapture the CO_2 that's already a by-product of several manufacturing processes, and they then recycle it into the liquid solvent for cleaning clothes. The main drawback is that, while the CO_2 itself is both cheap and abundant, the cost of a CO_2 dry cleaning machine is very high. Few dry cleaners are adopting this technique for this reason.

35. (b)

36. (a) Hydrogen peroxide has a non-planar structure. The molecular dimension in the gas phase and solid are shown in figure In solid-state, there are stronger intermolecular forces. So, the angle is less.



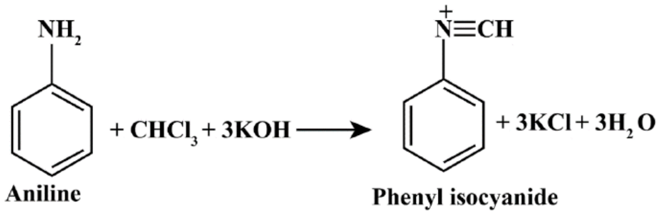
(a) H_2O_2 structures in gas phase, dihedral angle is $111.5°$

(b) H_2O_2 structure in solid phase at 110 K, dihedral angle is $90.2°$

37. (a) Primary amine on reaction with $CHCl_3$ & KOH gives isocyanide or isonitrile.

$$CH_3CH_2NH_2 + CHCl_3 + 3KOH \longrightarrow CH_3CH_2NC + 3KCl + 3H_2O$$

Ethyl Amine alcoholic Ethyl isocyanide

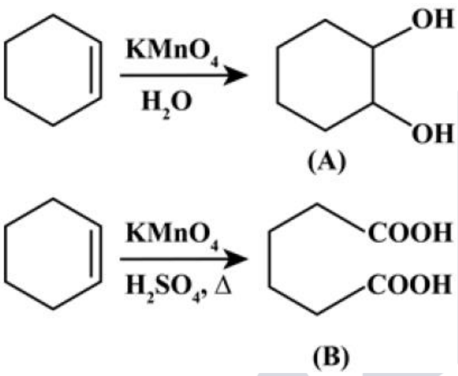


38. (d) In BrO_4^- the oxidation state of Br is +7 is the maximum possible oxidation state of Br.So, it can only undergo reduction.

39. (a) The reaction as follows

$$4HNO_3 + P_4O_{10} \rightarrow 2\ N_2O_5 + 4HPO_3$$

40. (a)



41. (225.85) Base (NaOH)

$n = 0.5M \times 250ml$

$= 125$ millimoles

$= 0.125$ moles

Acid (HCl)

$N = 1M \times 500ml$

$= 500$ millimoles

$= 0.5$ moles

Remaining moles of HCl $= 0.5 - 0.125 = 0.375$ moles

1 mole $\equiv N_A$ molecules

0.375 moles $\equiv N_A \times 0.375$ molecules $= 225.825 \times 10^{21}$ molecules

42. (b)
43. (b)
44. (a)
45. (b)
46. (c)
47. (a)

48. (c)
49. (c)
50. (c)
51. (a)
52. (b)
53. (d)
54. (d)
55. (d)
56. (b)
57. (a)
58. (b)
59. (b)
60. (b)
61. (a)
62. (4)
63. (910)
64. (81)
65. (21)
66. (6)
67. (1)
68. (a)
69. (777)
70. (34)
71. (3)