

SCORE JEE (Advanced)

HOME ASSIGNMENT # 03

HEAT & THERMODYNAMICS

EXERCISE # (O)

1. **Ans. (C)**

$$\frac{T_5}{T_1 + T_9} = \frac{T_6}{T_2 + T_{10}} = \dots = \frac{1}{2}$$

2. **Ans. (D)**

$$(OR)^2 = (PR)^2 - (PO)^2 = \ell^2 - \left(\frac{\ell}{2}\right)^2 = [\ell(1 + \alpha_2 t)]^2 - \left[\frac{\ell}{2}(1 + \alpha_1 t)\right]^2 \approx \ell^2(1 + 2\alpha_2 t) - \frac{\ell^2}{4}(1 + 2\alpha_1 t)$$

$$\Rightarrow \ell^2(2\alpha_2 t) = \frac{\ell^2}{4}(2\alpha_1 t) \Rightarrow \alpha_1 = 4\alpha_2$$

3. **Ans. (B)**

$$\ell = \ell_0(1 + \alpha\Delta T) \Rightarrow \ell - \ell_0 = \ell_0\alpha\Delta T \Rightarrow \frac{\ell_0\alpha_A\Delta T}{\ell_0\alpha_B\Delta T} = \frac{104 - 100}{106 - 100} = \frac{4}{6} \Rightarrow \frac{\alpha_A}{\alpha_B} = \frac{2}{3}$$

4. **Ans. (A)**

$$\delta = \left[\left[\frac{\ell}{2}(1 + \alpha\Delta\theta) \right]^2 - \left(\frac{\ell}{2} \right)^2 \right]^{1/2} = \frac{\ell}{2} [1 + 2\alpha\Delta\theta - 1]^{1/2}$$

5. **Ans. (B)**

Increment in length of Al will be less than $\ell\alpha_{Al}\Delta\theta$. So compressive stress.

6. **Ans. (A)**

$$\text{Slope } \tan\theta = \frac{\theta}{Q} = \frac{1}{m_1 s_1} \Rightarrow (ms)_A = \frac{1}{\sqrt{3}}; (ms)_B = \sqrt{3}$$

$$\text{After mixing : } [m_B s_B (T - 20)] + [m_A s_A (T - 30)] = 0 \Rightarrow \sqrt{3} (T - 20) + \frac{1}{\sqrt{3}} (T - 30) = 0 \Rightarrow T = 22.5^\circ\text{C}$$

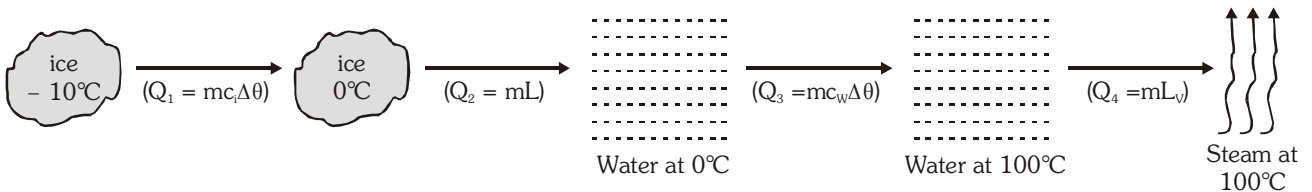
7. **Ans. (C)**

$$x \times 4 \times 4.2 = m \times 336 \times 10^3$$

$$4.2 \times x \times 2 = m \times 4200 \times \Delta\theta$$

8. **Ans. (A)**

Ice (-10°C) converts into steam as follows (c_i = specific heat of ice, c_w = specific heat of water)



$$\text{Total heat required } Q = Q_1 + Q_2 + Q_3 + Q_4$$

$$\Rightarrow Q = 1 \times 0.5(10) + 1 \times 80 + 1 \times 1(100 - 0) + 1 \times 540 = 725 \text{ cal}$$

$$\text{Hence work done } W = JQ = 4.2 \times 725 = 3045 \text{ J}$$

9. Ans. (A)

$$\text{Slope } \tan \theta = \frac{\theta}{Q} = \frac{1}{m_1 s_1} \Rightarrow (m_1 s_1)_B = \frac{1}{\sqrt{3}}; (m_2 s_2)_B = \sqrt{3}; \text{ and } (m_1 s_1)_A = \sqrt{3}; (m_2 s_2)_A = \frac{1}{\sqrt{3}}$$

$$\text{After mixing : } [m_2 s_2 (T-20)]_B + [m_2 s_2 (T-30)]_A = 0 \Rightarrow \sqrt{3}(T-20) + \frac{1}{\sqrt{3}}(T-30) = 0 \Rightarrow T = 22.5^\circ\text{C}$$

10. Ans. (C)

T = junction temperature

$$T - 0 + T - 600 + T - 600 = 0$$

$$3T = 1200$$

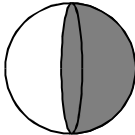
$$T = 400$$

11. Ans. (A)

Black bulb absorbs more heat in comparison with painted bulb. so air in black bulb expands more. Hence the level of alcohol in limb X falls while that in limb Y rises.

12. Ans. (A)

Sol. Initially $T = 300$ $T_s = 500$
 $300 = \sigma e A [500^4 - 300^4]$ (1)

afterwards  half of the surface of sphere is completely blackened

$$600 = \frac{\sigma e A}{2} [500^4 - 300^4] + \frac{\sigma A}{2} [500^4 - 300^4] \quad \dots(2)$$

dividing (2) by (1)

$$2 = \frac{\left(\frac{e}{2} + \frac{1}{2}\right)}{e} \Rightarrow 2e = \frac{e}{2} + \frac{1}{2} \Rightarrow e = \frac{1}{3} \text{ Ans.]}$$

13. Ans. (C)

$$PV^x = \text{constant}$$

$$PV^{-1} = \text{constant}$$

$$C_{proc} = \frac{R}{\gamma - 1} + \frac{R}{1 - x}$$

14. Ans. (A)

$$\Delta l_1 = \Delta l_2$$

$$l_1 \alpha_1 \Delta \theta = l_2 \alpha_2 \Delta \theta$$

$$l_1 \times 2 = l_2 \times 1$$

$$l_2 - l_1 = 15$$

15. Ans. (C, D)

$$K_{translational} = 3000 \text{ J}$$

P & V both double then T will be 4 time.

Kinetic energy will become 4 time.

Degree of freedom of diatomic = 5

Degree of freedom of monoatomic = 3

16. Ans. (A, C)

Sol. At any temperature t , the lengths of the two bars are

$$l'_1 = l_1(1 + \alpha_1 t), \quad l'_2 = l_2(1 + \alpha_2 t) \quad \dots(i)$$

From the given conditions,

$$l'_2 - l'_1 = l \quad \text{and} \quad l_2 - l_1 = l \quad \dots(ii)$$

From equation (i) and (ii)

$$l'_2 - l'_1 = (l_2 - l_1) + l_2\alpha_2 t - l_1\alpha_1 t$$

$$l_2\alpha_2 = l_1\alpha_1 \quad \dots(iii)$$

$$\frac{l_2}{l_1} = \frac{\alpha_1}{\alpha_2} \quad \dots(iv)$$

From equation (ii) and (iv)

$$l_1 = \frac{l\alpha_2}{\alpha_1 - \alpha_2}, \quad l_2 = \frac{l\alpha_1}{\alpha_1 - \alpha_2}$$

17. Ans. B, C

Strain will remain same.

Stress = $Y\alpha\Delta\theta$ will remain same.

Force = $YA\alpha\Delta\theta$

$$\text{Energy} = \frac{1}{2} (\text{stress}) (\text{strain})(\text{volume})$$

18. Ans. (B)

$$PV^\gamma$$

$$\gamma_{\text{dia}} \propto \gamma_{\text{mono}}$$

19. Ans. (A, D)

$$10^{26} \times \frac{1}{6} \times 2000$$

$$P = \frac{1}{6} \times 3 \times 10^{-27} \times 2 \times 10^{26} \times (2000)^2$$

20. Ans. (A)

$$5 = W_{AB} + W_{BC} + W_{CA}$$

$$5 = 10 + 0 + W_{CA}$$

$$W_{CA} = 5\text{J}$$

21. Ans. (D)
22. Ans. (B)

Pressure increases linearly as spring comes in contact with piston.

23. Ans. (A)

$$\frac{P_0 A \ell}{\int_0^\ell (P_0 A + kx)}$$

24. Ans. (A)

Amount of heat required to vaporise

$$= ms\Delta\theta = [\pi (0.5 \times 10^{-3})^2 \times 3 \times 10^{-2} \times 2.4 \times 10^3] [0.9 \times 10^3] [2550] = 129.7 \text{ J}$$

25. Ans. (C)

$$\text{Required power of beam} = \left(\frac{97}{100}\right)^{10} \times 50 = 36.9 \text{ W}$$

26. Ans. (A)

$$\text{Required time} = \frac{129.7}{36.9} = 3.5 \text{ s}$$

27. Ans. (C)

As BC & AD are adiabatics so $Q_{BC} = Q_{DA} = 0$

For AB, $W > 0$ & $\Delta U = 0 \Rightarrow Q_{AB} > 0$; For CD, $W < 0$ & $\Delta U = 0 \Rightarrow Q_{CD} < 0$

28. Ans. (B)

$$T_1 V_B^{\gamma-1} = T_2 V_C^{\gamma-1} \Rightarrow \left(\frac{V_B}{V_C}\right)^{\gamma-1} = \frac{T_2}{T_1} \Rightarrow T_2 V_D^{\gamma-1} = T_1 V_A^{\gamma-1} \Rightarrow \left(\frac{V_A}{V_D}\right)^{\gamma-1} = \frac{T_2}{T_1} \Rightarrow \frac{V_B}{V_C} = \frac{V_A}{V_D} \Rightarrow V_A V_C = V_B V_D$$

29. Ans. (D)

$$Q_1 = nRT_1 \ln\left(\frac{V_B}{V_A}\right); Q_2 = nRT_2 \ln\left(\frac{V_D}{V_C}\right) \text{ But } \frac{V_D}{V_C} = \frac{V_A}{V_B} \text{ so } Q_2 = nRT_2 \ln\left(\frac{V_B}{V_A}\right) \Rightarrow \frac{Q_1}{Q_2} = \frac{T_1}{T_2}$$

30. Ans. (D)

31. Ans. (B)

Sol. (30 and 31)

Above adiabatic graph heat has to be supplied.

Since product of $P_0 V_0$ decreases so temperature will decrease.

32. Ans. (A)-PQ, (B)-RS, (C)-PQ, (D)-RS

(A) A - isothermal; B- Adiabatic

(B) A- Adiabatic, B - isothermal

(C) A - isothermal; B- Adiabatic

(D) A- Adiabatic, B - isothermal

In adiabatic process slope should be more.

33. Ans. (A) \rightarrow (Q); (B) \rightarrow (R); (C) \rightarrow (S); (D) \rightarrow (P) $P = \frac{\rho}{M_w} RT$

For (A) : For AB, $P \propto V \Rightarrow T \propto V^2 \Rightarrow T \propto \rho^{-2}$

For BC, $V = \text{constant} \Rightarrow \rho = \text{constant}$

For CA, $P = \text{constant} \Rightarrow \rho T = \text{constant}$

For (B) : For AB, $P \propto T \Rightarrow \rho = \text{constant}$

For BC, $T = \text{constant} \Rightarrow P \propto \rho$

For CA, $P = \text{constant} \Rightarrow \rho T = \text{constant}$

For (C) : For AB, $P = \text{constant} \Rightarrow \rho T = \text{constant}$

For BC, $T = \text{constant} \Rightarrow P \propto \rho$

For CA, $V = \text{constant} \Rightarrow \rho = \text{constant}$

For (D) : For AB, $\rho \propto T \Rightarrow P \propto T^2$

For BC, $T = \text{constant} \Rightarrow P \propto \rho$

For A, $\rho = \text{constant} \Rightarrow P \propto T$

34. Ans. (A) PS; (B) PQST; (C) RS; (D) Q

For (A) : Process is isobaric, volume increases : $\Delta W \rightarrow +ve$; $\Delta U \rightarrow +ve$; $\Delta Q \rightarrow +ve$

For (B) : Volume of the gas as well as pressure both increases :

$\Delta W \rightarrow +ve$; $\Delta U \rightarrow +ve$; $\Delta Q \rightarrow +ve$

For (C) : Process is adiabatic expansion : $\Delta W \rightarrow +ve$; $\Delta U \rightarrow -ve$; $\Delta Q \rightarrow +ve$

For (D) : Process is isothermal compression : $\Delta W \rightarrow -ve$; $\Delta U = 0$; $\Delta Q \rightarrow -ve$

EXERCISE # (S)

1. **Ans. 5**

If x is length of mercury in tube then pressure of gas

$$P' = P_0 + \rho g \ell_0 + \rho g x = 3\rho g \ell_0 + \rho g x$$

$$W = - \int_{3\ell_0}^0 (3\rho g \ell_0 + \rho g x) A dx = 13.5 \rho g A \ell_0^2 = 5$$

2. **Ans. 7**

$$w = \int P dV; P = \frac{nRT}{V}; P = \alpha nRV \Rightarrow n\alpha R \int_{V_0}^{6V_0} V dv = \frac{n\alpha R}{2} [(6V_0)^2 - (V_0)^2]$$

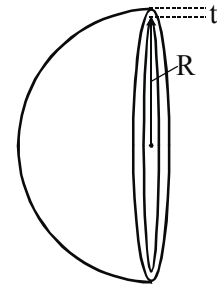
$$w = \frac{h\alpha R}{2} (35) V_0^2 = \frac{P_0 V_0 \times 35}{2}; \left(\because \alpha = \frac{P_0}{nRV_0} \right)$$

3. **Ans. 300**

$$|dP| = \beta \left| \frac{dv}{V} \right|$$

$$\text{Balancing force, } dP \pi R^2 = \sigma 2\pi R t \Rightarrow \sigma = \frac{dP}{2} \frac{R}{t} = \frac{\beta \gamma \Delta \theta R}{2t}$$

- where
- β = bulk modulus
 - γ = coefficient of thermal expansion
 - $\Delta \theta$ = change in temperature
 - R = radius of sphere
 - t = thickness of sphere



4. **Ans. 023**

$$\text{Let the mercury goes down by } x \text{ then for gas } \frac{75 \times 10}{nR \times 300} = \frac{(75 + 2x)(10 + x)}{nR \times 510}$$

$$2x^2 + 95x - 525 = 0; x = 5 \text{ cm}$$

$$W = W_{\text{atm}} + W_g = P_{\text{atm}} AX + (\Delta m)g [X]$$

$$W = (0.75 \times 13.6 \times 10^3 \times 10) A \times \frac{5}{100} - \left(\frac{13.6 \times 10^3 \times 5}{100} \right) \times 10 \times \frac{5}{100}$$

$$W = 544 \text{ J}; \Delta U = nC_v \Delta T; n = \frac{PV}{RT} = \frac{408}{100} \text{ A}; \Delta U = 1785 \text{ J}$$

$$\text{Net heat} = W + \Delta U \approx 23 \times 10^2 \text{ J}$$

5. Ans: (a) $C = C_p + RT_0/\alpha V$; (b) $Q = \alpha C_p (V_2 - V_1) + RT_0 \ln(V_2/V_1)$
 6. Ans. 0.5 kg
 7. Ans. 0.00457°C
 8. Ans. 1001 cc, 10.006 cm, 10.004 cm

Volume of liquid : $V = V_0 (1 + \gamma_L \Delta T) = (10) (100) [1 + 5 \times 10^{-5} \times 20] = 1000 (1 + 0.001) = 1001 \text{ cm}^3 = 1001 \text{ cc}$

Cross sectional area of vessel at 40°C

$$A = A_0(1 + 2 \alpha_g \Delta T) = 100 (1 + 2 \times 10^{-5} \times 20) = 100.04 \text{ cm}^2$$

$$\text{Actual height of liquid} = \frac{\text{Actual volume of liquid}}{\text{cross-sectional area of vessel}} = \frac{1001}{100.04} = (1001) (100 + 0.04)^{-1}$$

$$= \left(\frac{1001}{100}\right) \left(1 + \frac{0.04}{100}\right)^{-1} = \frac{(1001)}{100} \left(1 - \frac{0.04}{100}\right) = \frac{1}{100} (1001 - 0.4) = \frac{1000.6}{100} = 10.006 \text{ cm}$$

Reading of scale $TV = SR (1 + \alpha_g \Delta T)$

$$\therefore SR = (TV) (1 + \alpha_g \Delta T)^{-1} = (TV) (1 - \alpha_g \Delta T) = (10.006) (1 - 10^{-5} \times 20) = 10.006 - 0.002 = 10.004 \text{ cm}$$

9. Ans (a) 1200 R, (b) $Q_{AB} = -2100 \text{ R}$, $Q_{BC} = 1500 \text{ R}$, $Q_{CA} = 1200 \text{ R} \ln 2$
 10. Ans (a) 600 K (b) 1500 R, 1200 R ln 2, -900R, -1200 R ln 2 (c) 600 R
 11. Ans. 160 K, $3.3 \times 10^{-21} \text{ J}$, 0.3 gm

12. Ans. 0100

Sol. $P_2 V_2 = P_1 V_1$

$$V_1 = 20000 \text{ cc.} \quad P_1 = 10^5 \text{ Pa}$$

$$V_2 = Ax$$

$$P_2 = P_0 + \frac{kx}{A}$$

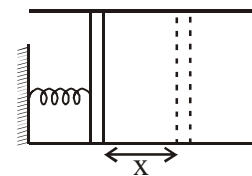
$$\Rightarrow 10^5 \times 20000 \times 10^{-6} = \left(10^5 + \frac{1000x}{100 \times 10^{-4}}\right) 10^{-4} \times 100x$$

$$\Rightarrow 2000 = 1000 [x (1 + x)]$$

$$x^2 + x - 2 = 0$$

$$x = \frac{-1 \pm \sqrt{1+8}}{2} = 1 \text{ m}$$

$$x = 100 \text{ cm.}$$



13. Ans. 1

$$V_0 (1 + \gamma \times 1) - V_0 = h(A_0) \Rightarrow h = \frac{V_0 \gamma}{A_0} = \frac{1.8 \times 10^{-4}}{1.8 \times 10^{-4}} = 1 \text{ cm}$$

14. **Ans. 22**

Initial pressure of the gas = $P_0 = (P_{\text{atm}} - 40)$ cm of Hg = 36 cm Hg

Final pressure of the gas = $1.5 P_0 = 54$ cm of Hg (since process is isochoric)

Difference in height = $(76 - 54) = 22$ cm of Hg

15. **Ans. 5**

Given at 50°C : Newton's Law of cooling

$$\text{Power Loss} = 100 = k(50 - 10) \Rightarrow k = \frac{10}{4} = \frac{5}{2}$$

$$\therefore \text{At } 30^\circ\text{C } P_{\text{Loss}} = k(30 - 10) = \frac{5}{2} \times 20 = 50 \text{ W}$$

16. **Ans: 60%**

17. **Ans. 450**

Temperature as a function of time $T = \frac{1}{10}t^\circ\text{C}$

$$\frac{dQ}{dt} = kA \frac{dT}{dx} \Rightarrow \int_0^Q dQ = \int_0^{(10 \times 60)} \left(\frac{kA}{0.4} \right) 0.1t dt = \frac{100 \times 1 \times 10^{-4} \times 0.1t^2}{0.8} \Big|_0^{600} = 450$$

18. **Ans: 0.39cm/h**

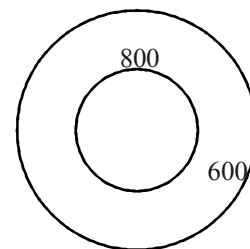
19. **Ans. 0516**

Sol. $\frac{dQ}{dt} = \sigma \times 0.8 \times 4\pi r_1^2 [800^4 - 600^4]$

$$= k \times \frac{4\pi r_2 r_2'}{r_2' - r_2} \times (600 - T)$$

$$r_2 r_2' \approx r_2^2$$

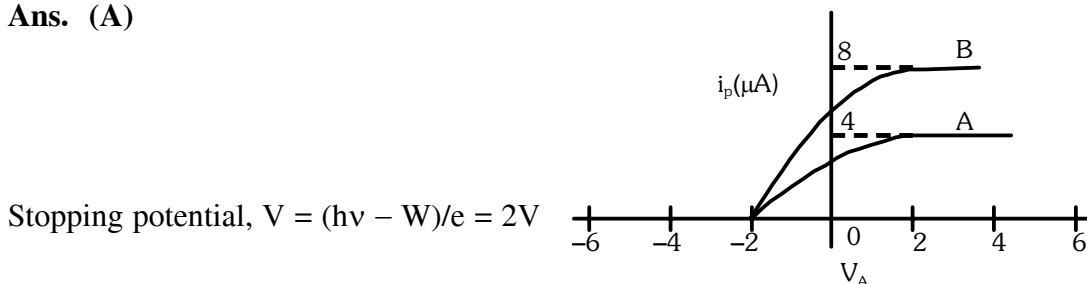
$$600 - T = \frac{\frac{17}{3} \times 10^{-8} \times \frac{0.9}{10} \times \frac{1}{100} \times 10^8 \times 100 \times 28 \times 10^3 \times \frac{5}{100}}{0.085} \Rightarrow T = 516 \text{ K}$$



MODERN PHYSICS

EXERCISE # (O)

1. **Ans. (A)**



Stopping potential, $V = (h\nu - W)/e = 2V$

In each case, the stopping potential is 2V as energy of incident photon is the same. As the photon intensity is doubled, the saturation current is also doubled. The variation of i_p against V_a is sketched in the figure

2. **Ans. (B)**

$$\lambda_{\max} = \frac{hc}{\phi} = \frac{12400}{3.1} = 4000 \text{ \AA}$$

so only 3100 Å will emit electrons. Then $\frac{I}{2} = n \left(\frac{hc}{\lambda} \right) \Rightarrow n = \frac{12.8}{2} \left(\frac{\lambda}{hc} \right) = 10^{19}$

3. **Ans. (A)**

$\mu \propto \frac{1}{\lambda}$ so TIR occur for $\lambda = 310 \text{ nm}$ so $\lambda = 620 \text{ nm}$ will eject electron only.

4. **Ans. (B)**

$$\text{Kinetic energy maximum} = \frac{hc}{\lambda} - w_0 \Rightarrow 1.7 \text{ eV}$$

Electron reaching to collector plate have maximum KE = 1.7 + eV₀

5. **Ans. (A)**

$$\text{KE} + w_0 = E = 12.1 \text{ eV}$$

$$E_3 - E_1 = 12.1 \text{ eV}$$

6. **Ans. (C)**

$$E \text{ becomes two times : } E_2 - E_3 = \frac{hc}{\lambda}$$

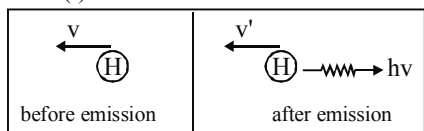
$$2 \left(\frac{Rhc}{2^2} \right) - 2 \left(\frac{Rhc}{3^2} \right) = \frac{hc}{\lambda}$$

7. **Ans. (B)**

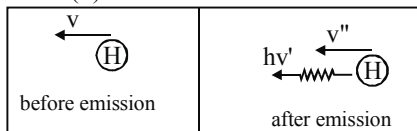
$$\text{Frequency} \propto \frac{1}{n^3}; \text{ Current} = ef \propto \frac{1}{n^3}; r \propto n^2; \vec{B} = \frac{\mu_0 i}{2r} \propto \frac{1}{n^5}$$

8. **Ans. (B)**

Case (i)



Case (ii)



From momentum conservation, $v' > v''$ Thus $E_2 > E_1$

9. **Ans. (A)**

According to Mosley's law, frequency of K_{α} X-ray $\nu = \eta(Z-1)^2$

$$\text{Hence } \eta \rightarrow \text{constant } \frac{\nu_{cd}}{\nu_{ca}} = \left(\frac{47}{19}\right)^2 \Rightarrow \nu_{cd} = \left(\frac{47}{19}\right)^2 \nu_{ca}; \nu_{cd} = 5.46 \times 10^{18} \text{ Hz}$$

10. **Ans. (B,D)**

As X-ray tube operates at 15 kV so characteristics X-rays of K series will be emitted only for cobalt & copper.

$$\text{For continuous X-ray, } \lambda_{\min} = \frac{hc}{eV_0}$$

11. **Ans. (B)**

$$V = \frac{12400}{66.3 \times 10^{-2}} \text{ Volt}$$

12. **Ans. (A,B,C,D)**

$$E \propto \frac{z^2}{n^2}; P \propto \frac{z}{n}; r \propto \frac{n^2}{z}$$

13. **Ans. (A, C, D)**

$$122.4 = 13.6 z^2$$

$$z = 3$$

$$E_1 = 122.4 \quad \dots(i)$$

$$E_2 = 30.6 \quad \dots(ii)$$

$$E_3 = 13.6 \quad \dots(iii)$$

$$\text{Equation (i)-(iii) : } E_1 - E_3 = 108.8$$

$$\text{Equation (i)-(ii) : } E_1 - E_2 = 91.8$$

14. **Ans. (A,B,C)**

Do yourself

15. **Ans. (C)**

Energy is released in a process when total binding energy of the nucleus (= binding energy per nucleon \times number of nucleons) is increased or we can say when total binding energy of products is more than the reactants.

16. **Ans. (B, D)**

17. **Ans. (C)**

18. **Ans. (B)**

$$\text{Released energy} = 2 \times 4 \times 7 - 2 \times 1 - 7 \times 5.4 = 16 \text{ MeV}$$

19. **Ans. (A)**

20. **Ans. (A)**

21. **Ans. (B)**

$$P = \frac{h}{\lambda} = \frac{h}{\sqrt{2meV}}; \beta = \frac{D\lambda}{d}; \beta \propto \frac{1}{\sqrt{V}}$$

22. **Ans. (B)**

Time just small than 4 half life.

23. **Ans. (B)**

All nucleus will decay through mole T_3

24. Ans. (B)

Sol. $x \xrightarrow{\hspace{2cm}} y$

$t = 0$	$16\% = N_0$	0
$t = t2\% = N$	14%	

$$N = \frac{N_0}{8} \Rightarrow \frac{1}{8} = \frac{1}{2^n} \Rightarrow n = 3$$

$$t = 3T_{1/2} = 135 \text{ yrs.}$$

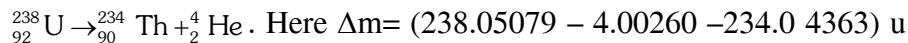
25. Ans. (A, C)

26. Ans. (C)

Given $\frac{N_0(1 - 2^{-2/t_{1/2}})}{N_0(1 - 2^{-4/t_{1/2}})} = \frac{n}{(0.25 + 1)n}$

{No. of β -particles emitted = No. of nuclei decayed} $\Rightarrow t_{1/2} = 1 \text{ sec}$

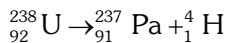
27. Ans. (A)



$$E = \Delta mc^2 = 4.24764 \text{ MeV}$$

28. Ans. (B)

If it emits proton spontaneously, the equation is not balanced in terms of atoms & mass number.



$$\Delta m = (238.05079 - 237.065121 - 1.007834) \text{ u} = -0.022165 \text{ u}$$

$\therefore \Delta m$ is negative, so reaction is not spontaneous.

29. Ans. (B)

$$\Delta P \Delta x = \frac{h}{2\pi}$$

$$(10^{-1})(V)(1) = 10^{-34}$$

30. Ans. (C)

$$\Delta E = \frac{6.6 \times 10^{-16}}{4.4 \times 10^{-24}}; \frac{E}{\Delta E} = \frac{1.5 \times 10^8}{750 \times 10^6}$$

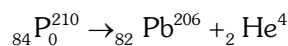
31. Ans. (D)

Since $\Delta P_y = 0$ so $\Delta y = \infty$

32. Ans.(A)

33. Ans.(C)

34. Ans.(A)



Mass converted to energy per reaction is

$$\Delta m = m({}_{84}\text{Pb}^{210}) - [m({}_{82}\text{Pb}^{206}) + m({}_2\text{He}^4)]$$

$$= 5.25 \text{ MeV} = 8.4 \times 10^{-13} \text{ Joule}$$

Total amount of energy required = 1.2×10^7 Joule

$$\text{Input Energy} = 1.2 \times 10^7 \times 10 = 1.2 \times 10^8 \text{ J}$$

Number of reaction required per day

$$n = \frac{dN}{dt} = \frac{1}{7} \times 10^{21} \text{ per day}$$

If N is the number of polonium atoms required the

$$-\frac{dN}{dt} = \lambda N = n = \lambda N$$

$$N = \frac{n}{\lambda} = \frac{nT}{0.693} = \frac{200}{7} \times 10^{21}$$

Mass of each P_0 - atom = 210 amu

$$\text{Mass of } P_0 \text{ required after 693 days} = \left(\frac{200}{7}\right) \times 10^{21} \times 210 \text{amu} = 1.0 \text{ gm}$$

$$\text{Initial mass (} m_0 \text{) of } P_0 \left(\frac{m}{m_0}\right) = \left(\frac{1}{2}\right)^{t/T}$$

$$\frac{t}{T} = \frac{693}{138.6} = 5 \Rightarrow m_0 = (2)^5 \times 1\text{g} = 32\text{gm}$$

Initial number of P_0 atoms

$$= N_0 = (2)^{5T} \cdot N = \frac{64}{7} \times 10^{23}$$

Initial activity of P_0 :

$$R = -\frac{dN}{dt} = \lambda N_0 = \frac{0.693}{T} N_0 = 4.57 \times 10^{21} \text{ per day}$$

35. **Ans. (B)**

36. **Ans. (C)**

37. **Ans. (B)**

38. **Ans. (A)**

$$n_{Rn} = \frac{222}{222} = 1 \text{ mole}; N_t = \frac{N_0}{2^{t/1/2}} = \frac{N_0}{2^{7/3.5}} = \frac{N_0}{4} \therefore \text{Number of nuclei decayed} = \frac{3N_0}{4}$$

39. **Ans. (D)**

$$PV = nRT \Rightarrow P \times 10^{-3} = \frac{3}{4} \times \frac{25}{3} \times 300$$

40. **Ans. (C)**

$$13.6 \times 2^2 \left(1 - \frac{1}{2^2}\right)$$

41. **Ans. (A) → (P,Q) ; (B) → (R,S,T) ; (C) → (R,S,T) ; (D) → (R,S,T)**

42. **Ans. (A) → (P,R) ; (B) → (Q,S) ; (C) → (Q, S) ; (D) → (P,R)**

$$\text{For (A) : } \because v \propto \frac{Z}{n} \text{ and } r \propto \frac{n^2}{Z} \Rightarrow v = \frac{v}{2\pi r} \propto \frac{Z^2}{n^3}$$

$$\text{For (B) : } mvr = \frac{nh}{2\pi} \propto n$$

$$\text{For (C) : } \vec{M} = Ai = (\pi r^2) \frac{e}{T} = \frac{\pi r^2 e}{2\pi r} = \frac{erv}{2} \propto n$$

$$\text{For (D) : Average current } I = \frac{e}{T} = \frac{e}{2\pi r} = \frac{e}{2\pi} \times \frac{v}{r} \propto \frac{Z^2}{n^3}$$

EXERCISE # (S)

1. **Ans. 6**

$$\text{Energy of incident photon} = 13.6 \left[\frac{1}{2^2} - \frac{1}{4^2} \right] = 13.6 \left[\frac{1}{4} - \frac{1}{16} \right] = 13.6 \times \frac{3}{16} = 2.55 \text{ eV}$$

$$\text{Energy of photon} = \text{work function (W)} + (\text{K.E.})_{\text{max}}$$

$$\text{Deflection } 180^\circ - 60^\circ = 120^\circ \text{ (from geometry) Radius } \frac{mv^2}{R} = qvB \Rightarrow R = mv/qB$$

circumference of part inside the magnetic field

$$= \frac{\pi R \theta}{180^\circ} = \frac{120^\circ}{180^\circ} \pi R = \frac{2}{3} \pi R = \frac{2}{3} \pi \frac{mv}{qB} = \frac{2\pi \sqrt{2mkE_{\text{max}}}}{3qB} = 6 \times 10^{-6} \text{ m.}$$

2. **Ans. 9**

$$F = -\frac{\partial U}{\partial r} = -\frac{\partial}{\partial r} \left(-\frac{ke^2}{3r^3} \right) \& \frac{ke^2}{r^4} = \frac{mv^2}{r} \dots \text{(i)}$$

$$mvr = \frac{nh}{2\pi} \dots \text{(ii)}$$

3. **Ans. 2**

$$E \propto \frac{Z^2}{n^2}$$

In series limit of bracket axis, transition is for $n=\infty$ to $n=4$

In series limit of Balmer series, transition for $n=\infty$ to $n=2$

$$h\nu_{\text{bracket}} = 13.6Z^2 \left[\frac{1}{16} \right] \Rightarrow h\nu_{\text{Balmer}} = 13.6 \left[\frac{1}{4} \right]$$

$$\frac{13.6Z^2}{16} = \frac{13.6}{4} = Z = 2$$

4. **Ans. $\Delta T = \frac{0.2E_0 \left[\alpha t - \frac{\alpha}{\lambda} (1 - e^{-\lambda t}) \right]}{m S}$**

5. **Ans. 3**

$$A = A_0 e^{-\lambda t} \text{ and } I = I_0 e^{-\lambda t}; \frac{I_0}{A_0} e^{\left(\frac{1}{\tau} + \lambda \right) t} = \frac{i}{A}$$

$$\text{for constant value of } \frac{i}{A}, \lambda - \frac{1}{\tau} = 0 \quad \therefore \lambda = \frac{1}{\tau}; T_{\text{mean}} = 3 \text{ sec}$$

6. **Ans. 8**

$$P = 700 \times 10^3 \times 1.6 \times 10^{-19} \times \frac{dN}{dt} = 10 \times 10^{-3}; \frac{dN}{dt} = \frac{10^{-2}}{10^{-14}} \times \frac{1}{7 \times 16} = \frac{10^{12}}{11.2} = \lambda N_0$$

$$\lambda = \frac{\ln 2}{14 \times 86400} \Rightarrow N_0 = \frac{14 \times 86400 \times 10^{12}}{11.2 \ln 2} = 160 \times 10^{15}$$