**Q. 1)** The amount of $U^{235}$ to be fissioned, to operate 10 kW nuclear reactor is (Approximately)

(1) $1.2 \times 10^{-5}$ g/s (2) $1.2 \times 10^{-7}$ g/s

(3) $1.2 \times 10^{-9}$ g/s (3) $1.2 \times 10^{-13}$ g/s

Steps ⇒ Q = 200 MeV

1) Assume m gm/sec of $U^{235}$ needed.

2). Moleconcept 235 gm = $N_A$ nuclei

m gm = $\frac{mN_A}{235}$ = N

3) $E_0 = N \times 200$ MeV/s = 10 kW

$\frac{m \times N_A}{235} \times 200 \times 10^6 \times 1.6 \times 10^{-19}$ J/s = $10 \times 10^3$ W (J/s)

$N_A = 6.023 \times 10^{23}$

m = $1.21 \times 10^{-7}$ gm.

Q. 2) A nuclear fusion reaction is given below :

$${}_1H^2 + {}_1H^2 \rightarrow {}_2He^3 + n + 3.2\ MeV$$

How much energy will be generated when 2 kg of deuterons are fused :- (approx)

(1) $10^{30}$ eV

(2) $5 \times 10^{23}$ MeV

(3) $10^{22}$ MeV

(4) ~~$10^{93}$~~ eV ✓ $10^{33}$ eV

Steps

1). Mole weight. $2\,gm\ D \equiv N_A\ D$

$2\times10^3\,gm\,D = \frac{2\times10^3 \times N_A}{2}\ D = N_D$

2). No of nuclear fusion rxn $= \frac{1}{2}\times N_D = 10^3 N_A/2$

3) $E_T = \frac{10^3 N_A}{2} \times 3.2\ MeV$

$= \frac{10^3 \times 6.023\times10^{23} \times 3.2\times10^6\ eV}{2}$

$= 6.023 \times 1.6 \times 10^{32} \sim 10^{33}\ eV$



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**Q. 3)** A nucleus of mass number 220, initially rest, emits an α-particle. If the Q value of the reaction is 5.5 MeV, the energy of the emitted α-particle will be.

$^{220}X \rightarrow {}^{216}Y + {}^{4}_{2}\alpha + Q$

(1) 4.8 MeV (2) 5.4 MeV ✓

(3) 7.5 MeV (4) 6.8 MeV

1). cons. of mass energy $Q = K_\alpha + K_y$

2). " " momentum. $P_\alpha = P_y$

$\sqrt{2m_\alpha K_\alpha} = \sqrt{2m_y K_y}$

$K_\alpha = \frac{M_y}{M_y + M_\alpha} Q = \frac{216}{220} \times 5.5\text{ MeV}$

$= 5.4\text{ MeV}$

**Q. 4)** A radioactive sample disintegrates by 10% during one month. How much fraction will disintegrate in four months :-

(1) 34.39% (2) 40%

(3) 38% (4) 50%

X → Y

t=0 $N_0$

t=1m $0.1N_0 = N_1$ ✗ $0.9N_0 = N_1$

t=4m $N_2$

$\frac{N_0 - N_2}{N_0} \times 100$

$N_1 = 0.9N_0$

$= N_0 e^{-\lambda \times 1} = 0.9N_0$

$N_2 = N_0 e^{-\lambda \times 4}$

$e^{-\lambda} = 0.9$

$e^{-4\lambda} = (0.9)^4$

$N_2 = N_0 (0.9)^4$

$\frac{N_0 - N_2}{N_0} \times 100 = (1 - (0.9)^4) \times 100$

$= 34.39\%$

**Q. 5)** The half life of a radioactive material is T. after T/2 time, the material left is :-

(1) 1/2 times

(2) 3/4 time

(3) $\frac{1}{\sqrt{2}}$ times ✓

(4) $(\sqrt{2}-1)/\sqrt{2}$ times

$$N = N_0 2^{-t/T_{1/2}}$$

$$= N_0 2^{-T/2T}$$

$$= \frac{N_0}{\sqrt{2}}$$

**Q. 6)** The activity of a sample of a redioactive material is $A_1$, at time $t_1$, and $A_2$ at time $t_2$, $(t_2 > t_1)$. If its mean life is T, then :

(1) $A_1 t_1 = A_2 t_2$

(2) $A_2 = A_1 e^{(t_1 - t_2)/T}$

(3) $A_1 - A_2 = t_2 - t_1$

(4) $A_2 = A_1 e^{(t_1/t_2)T}$

**Q. 7)** There are two radio nuclei A and B. A is an alpha emitter and B is a beta emitter. Their disintegration constants are in the ratio of 1:2. What should be the ratio of number of atom of A and B at any time t so that probabilities of getting alpha and beta particles are same at that instant.

$A \xrightarrow[\lambda]{\alpha}$

$B \xrightarrow[2\lambda]{\beta}$

✓(1) 2 : 1 (2) 1 : 2

(3) e (4) $e^{-1}$

Condⁿ → $\left(\frac{dN_A}{dt}\right)_t = \left(\frac{dN_B}{dt}\right)_t$

$+\lambda N_A = +2\lambda N_B$

$\frac{N_A}{N_B} = \frac{2\lambda}{\lambda} = 2/1$

Q. 8) $^{238}_{92}U$ emits 8 $\alpha$ - particle and 6 $\beta$ - particles. The neutron/proton ratio in the product nucleus is :-

(1) 60/41 (2) 61/40

(3) 62/41 ✓ (4) 61/42

$$^{238}_{92}U \xrightarrow{8\,\alpha^4_2} \xrightarrow{6\,\beta^0_{-1}} {}^{A}_{Z}X$$

$A = 238 - 8\times4 = 206$

$Z = 92 - 8\times2 + 6\times1 = 82 = p$

$n = 206 - 82 = 124$
$= A - Z$

$n/p = \frac{124}{82} = \frac{62}{41}$

**Q. 9)** What is energy released in the β-decay of $^{32}P \rightarrow {}^{32}S$ ? (Given : atomic masses : 31.97391 u for $^{32}P$ and 31.97207 u for $^{32}S$)

(1) - 1.2 MeV

(2) + 1.7 MeV

(3) + 2.1 MeV

(4) - 0.9 MeV

$Q = \Delta m c^2$

$= (31.97391 - 31.97207)$ amu $c^2$

$= (\quad'' \quad)\ \frac{931.5\ MeV}{c^2} \cdot c^2 = 1.7\ MeV$

**Q. 10)** Two radioactive materials $X_1$ and $X_2$ decay constants $6\lambda$ and $3\lambda$ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of $X_1$ to that of $X_2$ will be $\frac{1}{e}$ after a time.

(1) $\frac{1}{6\lambda}$

(2) $\frac{1}{3\lambda}$ ✓

(3) $\frac{3}{6\lambda}$

(4) $\frac{6}{9\lambda}$

$X_1 \xrightarrow{6\lambda} Y_1 \qquad X_2 \xrightarrow{3\lambda} Y_2$

$t = 0$: $N_0 \qquad N_0$

$t = t$: $N_0 e^{-6\lambda t} \qquad N_0 e^{-3\lambda t}$

$$\frac{N_0 e^{-6\lambda t}}{N_0 e^{-3\lambda t}} = \frac{1}{e} \Rightarrow e^{-3\lambda t} = e^{-1}$$

$$\Rightarrow t = \frac{1}{3\lambda}$$

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 2 | 4 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 2 |

# Session - 1 - Geometrical Optics & wave Optics

(Ray).

→ what are the phenomena light (visible light) exhibits?.

→ what is the nature of light?

- particle
- wave.

→ reflection & refraction

dispersion, scattering, tindal effect.

Interference, diffraction, polarization

↓

Only wave nature.

Huygen's Principle.

# Session-1 - Geometrical Optics & wave Optics

## ① Reflection :—

## ② Refraction :—

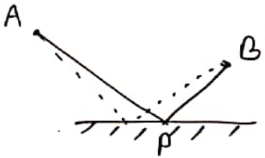
**Law v/s principle**

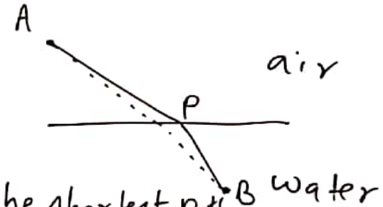
Law ↓ i = r (derived quantity)

principle ↓ More fundamental.

### Fermat's Principle

Light chooses the path of shortest duration.




1). Light travels the shortest path.

2). — " — largest "

3). - " — largest time

4). — " — shortest time

# Session-1 - Geometrical Optics & wave Optics

## ① Reflection & Refraction for plane surfaces.

- plane Mirror
  - Laws of ref.
    - two mirrors
      - no. of images
      - rotn of mirror
      - angle of deviation
  - obj. & image
  - vel. of image
  - size of mirror.
  - Sign convention.
- plane surface.
  - Snell's law
  - Apparent depth & shift
  - plane surface + mirror.
  - vel. of image.
  - lateral shift
  - T I Reflection.

## ② Reflection & Refraction for curved surfaces:

- Spherical Mirrors
  - concave
  - convex
  - Ray diagrams (pt. of switching ∞)
  - Newton's formula
  - Mirror formula
  - Magnification.
  - power, vel. of image.
- Curved surfaces
- Lenses
- Optical instruments
  - eyes
  - Microscope
  - Telescope.

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# Session-1- Geometrical Optics & wave Optics

## (1) Reflection & Refraction for plane surfaces.

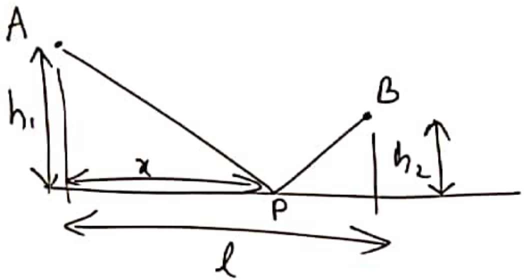
- plane Mirror
  - Laws of ref.
  - two mirrors
    - no. of images
    - rotn of mirror
    - angle of deviation
  - obj. & image
  - vel. of image
  - size of mirror.
  - Sign convention.
- plane surface.
  - Snell's law
  - Apparent depth & shift
  - plane surface + mirror.
  - vel. of image.
  - lateral shift
  - T I Reflection.
- prism
  - Dispersion
  - Dispersive power
  - Combination of prisms.
  - $\delta_{min}/\delta_{max}$.

## (2) Reflection & Refraction for Curved surfaces.

- Concave, convex lenses & combination
  - Displacement method
  - Chromatic aberration.
  - Power of Lens
  - vel of img
- Ray diagram
- Sign convention, terminology.
- Lens maker formula, magnification, f-R relation.
- Optical instruments
  - eyes
  - Microscope
    - Simple
    - Compound.
  - Telescope (3 kinds)
  - Natural phenomena.

# Session - 1 - Geometrical Optics & Wave Optics

## (1) Reflection & Refraction




$$APB = \sqrt{h_1^2 + x^2} + \sqrt{h_2^2 + (\ell - x)^2}$$

$$t = \frac{APB}{c} \quad \left(\frac{dt}{dx} = 0\right) \rightarrow \text{Law of reflection.}$$