DPP – 2

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Q 1. Find the radiation pressure of solar radiation on the equator of earth (assuming radiation is completely absorbed). Solar constant is 1.4 kW/m^2

(a) 4.7×10^{-5} Pa (b) 4.7×10^{-6} Pa
(c) 2.37×10^{-6} Pa (d) 9.4×10^{-6} Pa

Q 2. Parallel beam of Light of intensity I is falling on a perfect mirror of area A. If angle of incidence is 60^0 , Find radiation force on mirror?

(a) IA/2c (b) IA/4c
(c) IA/8c (d) None of these

Q 3. Light of intensity I is incident on a fixed plane surface at an angle 30° with normal to the surface. If 50 % light is reflected and remaining light is absorbed then radiation pressure on the plate is: [Speed of light is c]

(a) $\frac{2I}{C}$ (b) $\frac{9I}{8C}$
(c) $\frac{3I}{8C}$ (d) $\frac{I}{4C}$

Q 4. A radiation of 200W is incident on a surface which is 60% reflecting and 40% absorbing. Find the net Force acting on the surface.

(a) 1.3×10^{-6} N (b) 1.07×10^{-6} N
(c) 1.07×10^{-7} N (d) 1.3×10^{-7} N

Q 5. A monochromatic beam of light (λ = 4900 Å) incident normally upon a surface produces a pressure of 5 x 10^{-7} N/m^2 on it. Assuming that 25% of the light incident is reflected and the rest absorbed, find the number of photons falling per second on a unit area of thin surface.

(a) $6 \times 10^{20} m^{-2} s^{-1}$ (b) $9 \times 10^{20} m^{-2} s^{-1}$
(c) $3 \times 10^{20} m^{-2} s^{-1}$ (d) $12 \times 10^{20} m^{-2} s^{-1}$

Q.6 A point source of light of power 300 watt is placed at centre of Blackbody hemispherical shell of radius 1 meter. Find radiation force on hemisphere ?

(a) 5 $\times 10^{-7}$ N
(b) 6 $\times 10^{-7}$ N
(c) 3 $\times 10^{-7}$ N
(d) 2.5 $\times 10^{-7}$ N

Q 7. A horizontal plane mirror of mass 2 mg is balanced in air by a vertical beam of light having intensity 1000 W/m^2. Assuming 100% reflection, find area of mirror ?

(a) 2 m^2 (b) 3 m^2

(c) 6 m^2 (d) None of these

Q 8. Parallel beam of intensity I is falling on a blackbody sphere of radius R. Radiation force on sphere is

(a) (I/c) × $4\pi R^2$ (b) (I/c) × $2\pi R^2$

(c) (I/c) × πR^2 (d) None of these

Q 9. How many photons of wavelength λ = 6600 nm must strike a totally reflecting screen per second at normal incidence so as to exert a force of 1N?

(a) 1.5×10^{27} (b) 2.5×10^{27}

(c) 5×10^{27} (d) 5.5×10^{27}

Q 10. Light rays are incident on an opaque sheet. Then they

(a) exert a force on the sheet

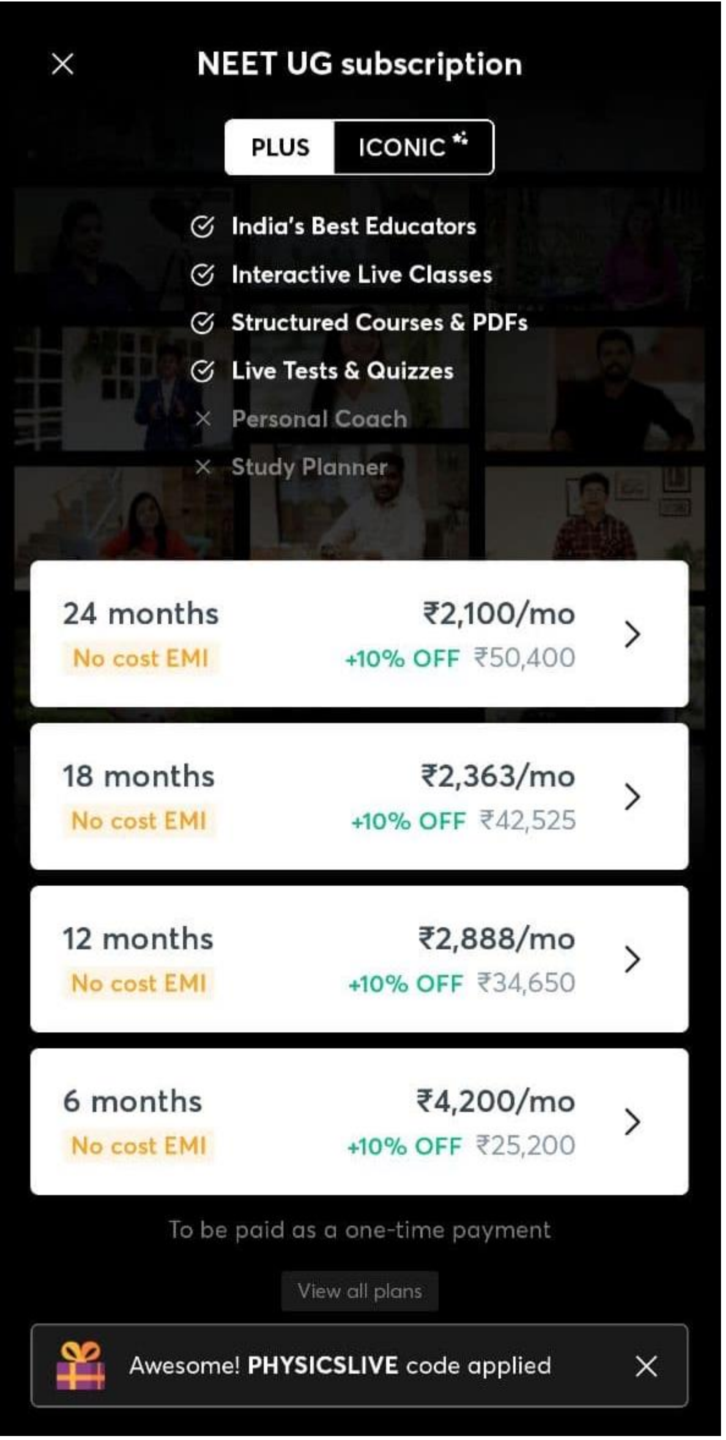
(b) transfer an energy to the sheet

(c) transfer momentum to the sheet

(d) All of above are correct

Answer Key

Q.1 b	**Q.2 a**	**Q.3 b**	**Q.4 b**	**Q.5 c**
Q.6 d	**Q.7 b**	**Q.8 c**	**Q.9 c**	**Q.10 d**



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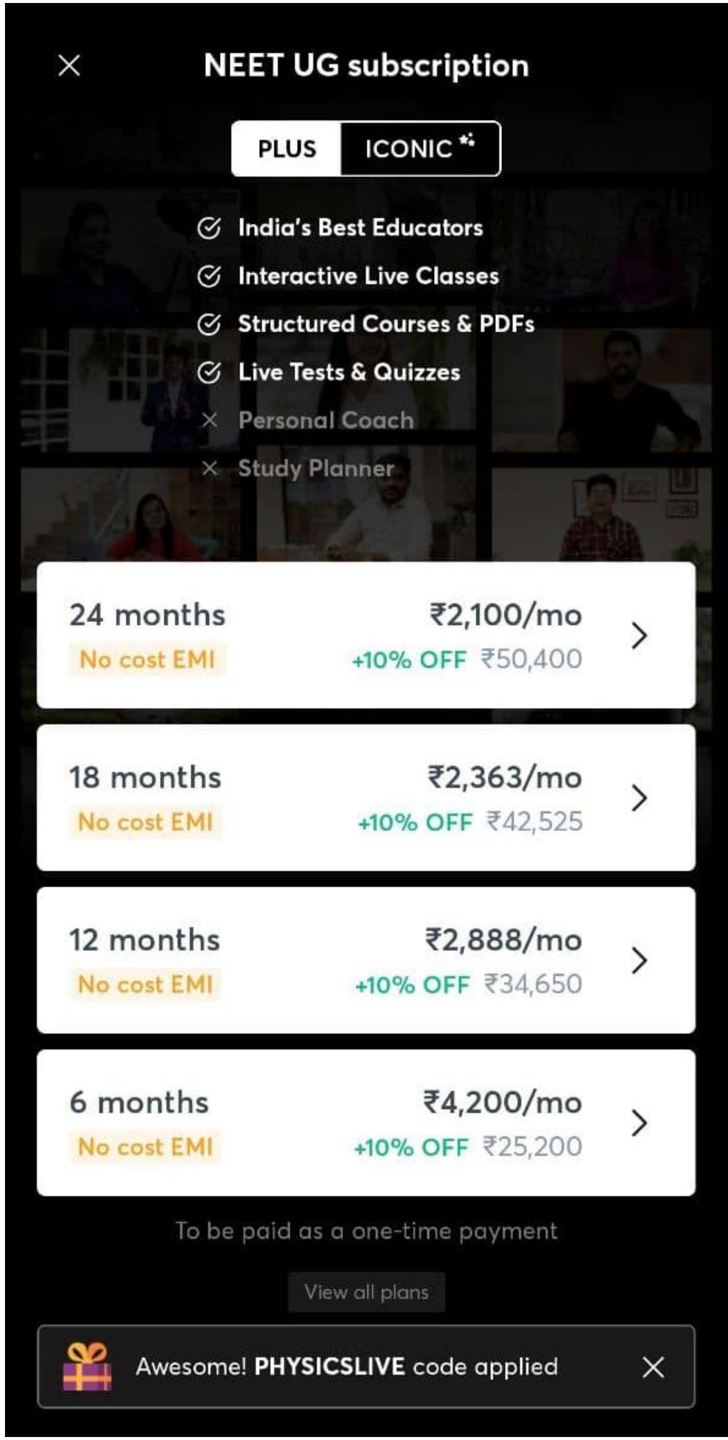


Physics DPP

DPP 2 – Radiation Pressure

By Physicsaholics Team

Solution: 1

Radiation Pressure = momentum gain per Sec per unit Area

$$= \frac{\text{Energy absorbed}}{c} \quad '' \quad '' \quad ''$$

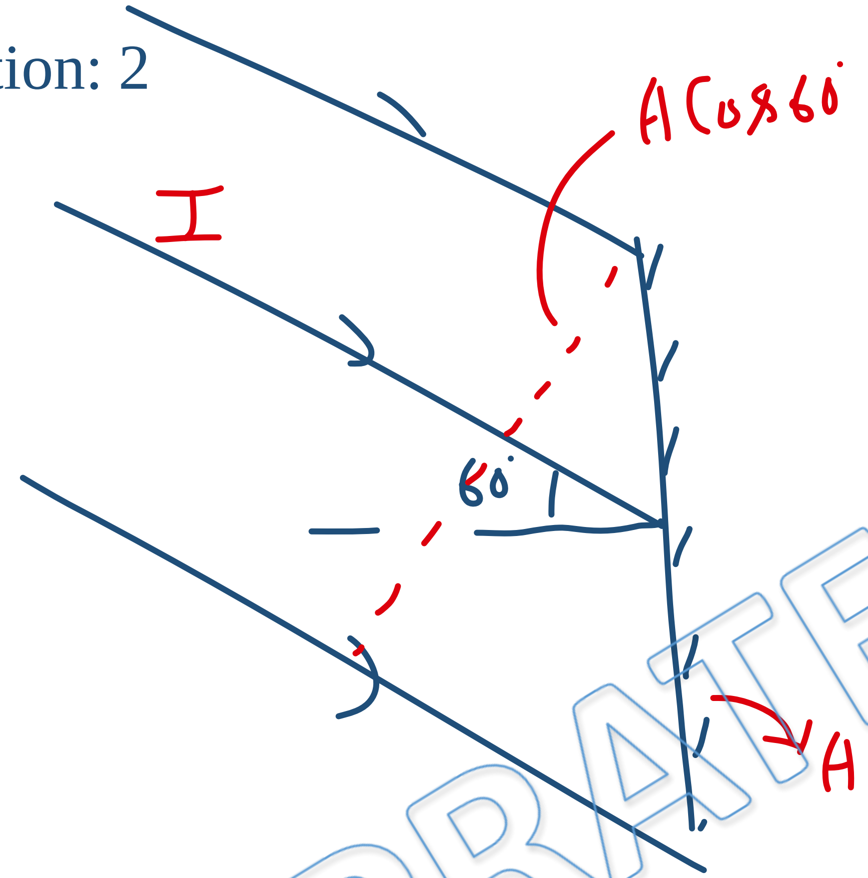
$$= \frac{I}{c} = \frac{1.44 \times 10^3}{3 \times 10^8}$$

$$= .48 \times 10^{-5}\ Pa$$

$$= 4.8 \times 10^{-6}\ Pa$$

Ans (b)

Solution: 2



momentum incident/Sec = $\frac{IA\cos 60°}{c}$

momentum reflected/Sec = $\frac{IA\cos 60°}{c}$

Change in momentum/Sec

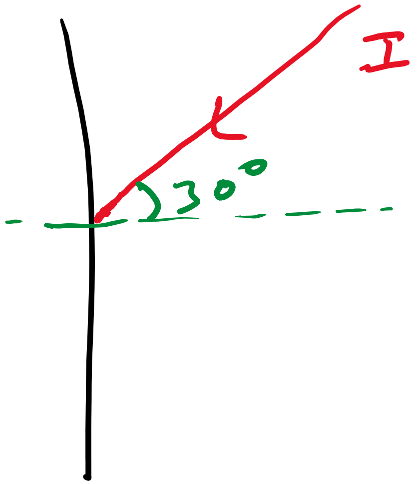
$= 2\left(\frac{IA}{c}\cos 60°\right)\cos 60°$

$= \frac{2IA}{c}\cos^2 60°$

$= \frac{IA}{2c}$

Ans (a)

Solution: 3



$$P = P_a + P_r$$

$$= a\frac{I\cos^2\theta}{c} + r\left(\frac{2I\cos^2\theta}{c}\right)$$

$$= (0.5)\left(\frac{I\cos^2 30^\circ}{c}\right) + (0.5)\left(\frac{2I\cos^2 30^\circ}{c}\right)$$

$$= (0.5)\left(\frac{I\cos^2 30^\circ}{c}\right)(1+2)$$

$$= \frac{1}{2} \times \frac{I\left(\sqrt{3}/2\right)^2}{c}(3)$$

$$= \frac{I}{c} \times \frac{3}{2} \times \left(\frac{\sqrt{3}}{2}\right)^2 = \frac{I}{c} \times \frac{3}{2} \times \frac{3}{4}$$

$$\boxed{P = \frac{9I}{8c}}$$ Ans

Ans. b

Solution: 4

$F_{abs.} = \frac{P_1}{c}$, $F_{reft} = \frac{2P_2}{c}$

P_1 = Power absorbed

P_2 = Power reflected

$F = F_{abs.} + F_{ref.} = (0.4)\frac{P}{c} + \frac{2(0.6P)}{c} = \frac{1.6P}{c}$

$= \frac{1.6 \times 200}{3 \times 10^8} = \frac{1.6 \times 2}{3} \times 10^{-6}$

$F = 1.06 \times 10^{-6} N$ Ans.

Ans. b

Solution: 5

Let $n \rightarrow$ no of photons incident/$\sec - m^2$

$\Rightarrow \frac{n}{4}$ are reflected & $\frac{3n}{4}$ are absorbed

$\Rightarrow$ change in momentum/$\sec - m^2 = \frac{n}{4} \times \frac{2h}{\lambda} + \frac{3n}{4} \times \frac{h}{\lambda}$

$= \frac{5nh}{4\lambda} = 5 \times 10^{-7}$

$\Rightarrow n = \frac{4 \times 4900 \times 10^{-10} \times 10^{-7}}{6.6 \times 10^{-34}} = \frac{98}{3.3} \times 10^{19}$

$= 3 \times 10^{20}$

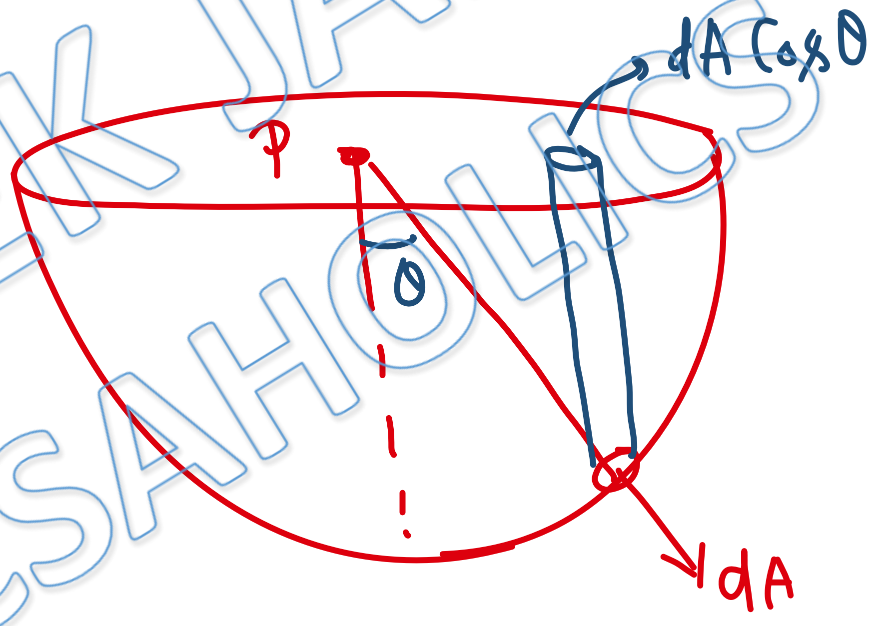
Ans (c)

Solution: 6

Power of source $P = 300\,\text{Watt}$

intensity at surface

$$I = \frac{P}{4\pi R^2}$$



momentum absorbed by dA per

$$\text{Second} = \frac{I\,dA}{c}$$

$$\text{force on } dA = \frac{I\,dA}{c}$$

$$\text{net force on spherical surface} = \int \frac{I\,dA\cos\theta}{c} = \frac{I}{c} \times \pi R^2 = \frac{P}{4c}$$

$$F = \frac{P}{4c}$$

$$= \frac{300}{4 \times 3 \times 10^{8}}$$

$$= 25 \times 10^{-8}\ N$$

$$= 2.5 \times 10^{-7}\ N$$

Ans(d)

Solution: 7 radiation force = mg

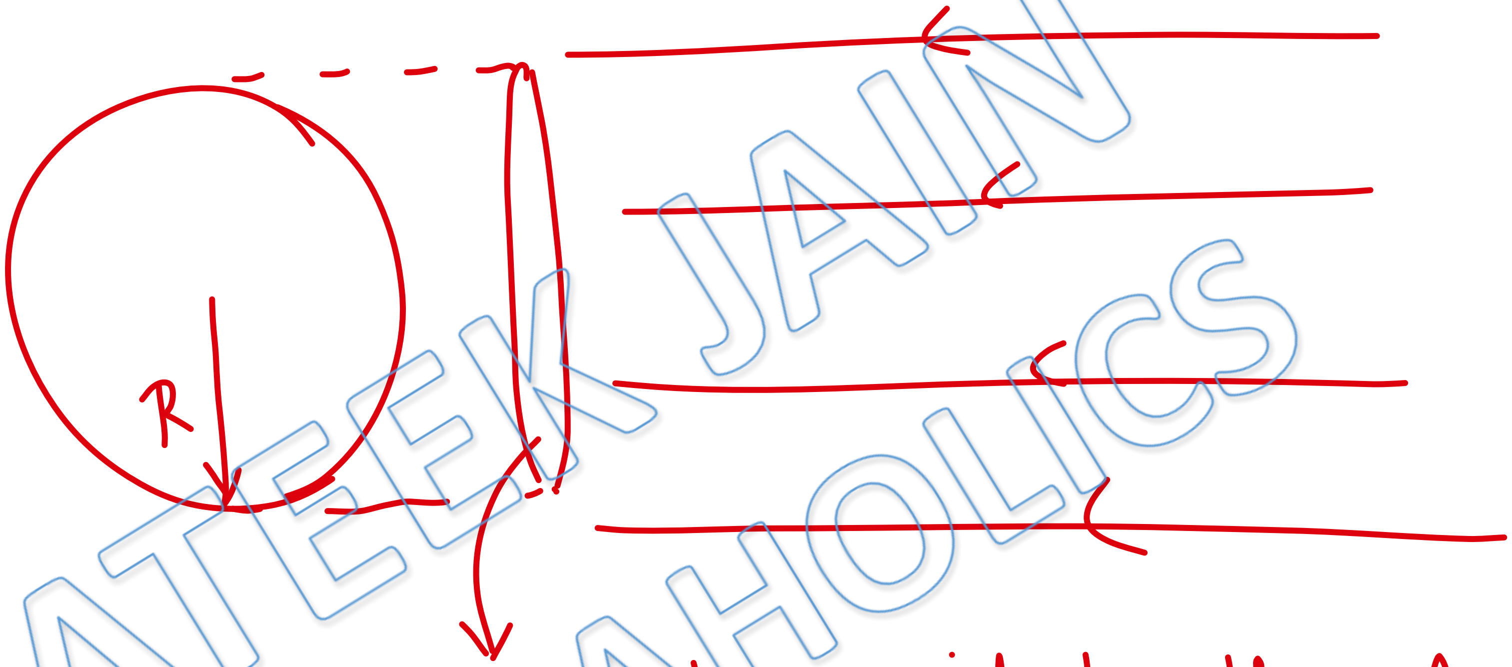
$$\Rightarrow \quad \frac{2IA}{c} = mg$$

$$\Rightarrow \quad A = \frac{mgc}{2I} = \frac{2\times10^{-6}\times10\times3\times10^{8}}{2\times10^{3}}$$

$$= 3\ m^2$$

Ans (b)

Solution: 8



momentum incident in this Area is absorbed by sphere.

$$\Rightarrow \text{Radiation force} = \frac{I \cdot \pi R^2}{c}$$

Ans (c)

Solution: 9

momentum of one photon $= \frac{h}{\lambda}$

If n photons ar striking/sec

Radiation force $= 2n\frac{h}{\lambda} = 1$

$$\Rightarrow n = \frac{\lambda}{2h} = \frac{6600 \times 10^{-9}}{2 \times 6.6 \times 10^{-34}}$$

$$= \frac{1000}{2} \times 10^{25}$$

$$= 5 \times 10^{27}$$

Ans (c)

Solution: 10

Light has energy as well as momentum.

So it can exert force, transfer momentum

& transfer energy to a sheet.

Ans (d)

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Chalo Niklo