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DPP – 2 (EM Waves)

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Q 1. The sun delivers $10^4 \text{W}/m^2$ of electromagnetic flux to earth's surface. The total power that is incident on a roof dimensions $(10\times10)m^2$ will be:
(a) 10^4 W (b) 10^5 W
(c) 10^6 W (d) 10^7 W

Q 2. The sun delivers about 1.4 $\text{KW}m^{-2}$ of electromagnetic flux to the earth's surface. Calculate the solar energy in joules incident on the roof of dimensions 8m×20m in 1 hour
(a) 205.6 MJ (b) 806.4 MJ
(c) 122 J (d) 102.3 MJ

Q 3. The sun delivers $10^3 \text{W}/m^2$ of electromagnetic flux to the earth's surface. The total power that is incident on a roof of dimensions 8m×20m is 1.6×10^5W, the radiation force on the roof will be- (The whole incident electromagnetic flux is absorbed by the earth)
(a) 53 N (b) 5.3 N
(c) 5.3×10^{-4} N (d) 5.3×10^{-6} N

Q 4. Electromagnetic radiation with energy flux 50 $\text{W}cm^{-2}$ is incident on a totally absorbing surface normally for 1 hour. If the surface has an area of 0.05 m^2, then the average force due to the radiation pressure, on it is,
(a) 8.3×10^{-7} N (b) 8.3×10^{-5} N
(c) 1.2×10^{-7} N (d) 1.2×10^{-5} N

Q 5. Light with an energy flux of 25×10^4 $\text{W}m^{-2}$ falls on a perfectly reflecting surface at normal incidence. If the surface area is 15 cm^2, the average force exerted on the surface is
(a) 1.25×10^{-6} N (b) 2.5×10^{-6} N
(c) 1.20×10^{-6} N (d) 3×10^{-6} N

Q 6. Light with energy flux of 18 W/cm^2 falls on a non reflecting surface of area 20 cm^2 at normal incidence the momentum delivered in 30 minutes is
(a) 1.2×10^{-6} Kg-m/s (b) 2.16×10^{-3} Kg-m/s
(c) 1.18×10^{-3} Kg-m/s (d) 3.2×10^{-3} Kg-m/s

Q 7. Light with energy flux 18 $\text{W}cm^{-2}$ is incident on a mirror of size 2cm×2cm normally. The momentum delivered in one minute is
(a) 28.8 μKg-m/s (b) 2.88 μKg-m/s
(c) 4.8 μKg-m/s (d) 48 μKg-m/s

Q 8. Light with energy flux of 24 Wm^{-2} is incident on a well polished disc of radius 3.5 cm for one hour. The momentum transferred to the disc is

(a) 1.1 μKg-m/s (b) 2.2 μKg-m/s
(c) 3.3 μKg-m/s (d) 4.4 μKg-m/s

Q 9. Find the amplitude of the electric field in a parallel beam of light of intensity 8.0 W/m^2

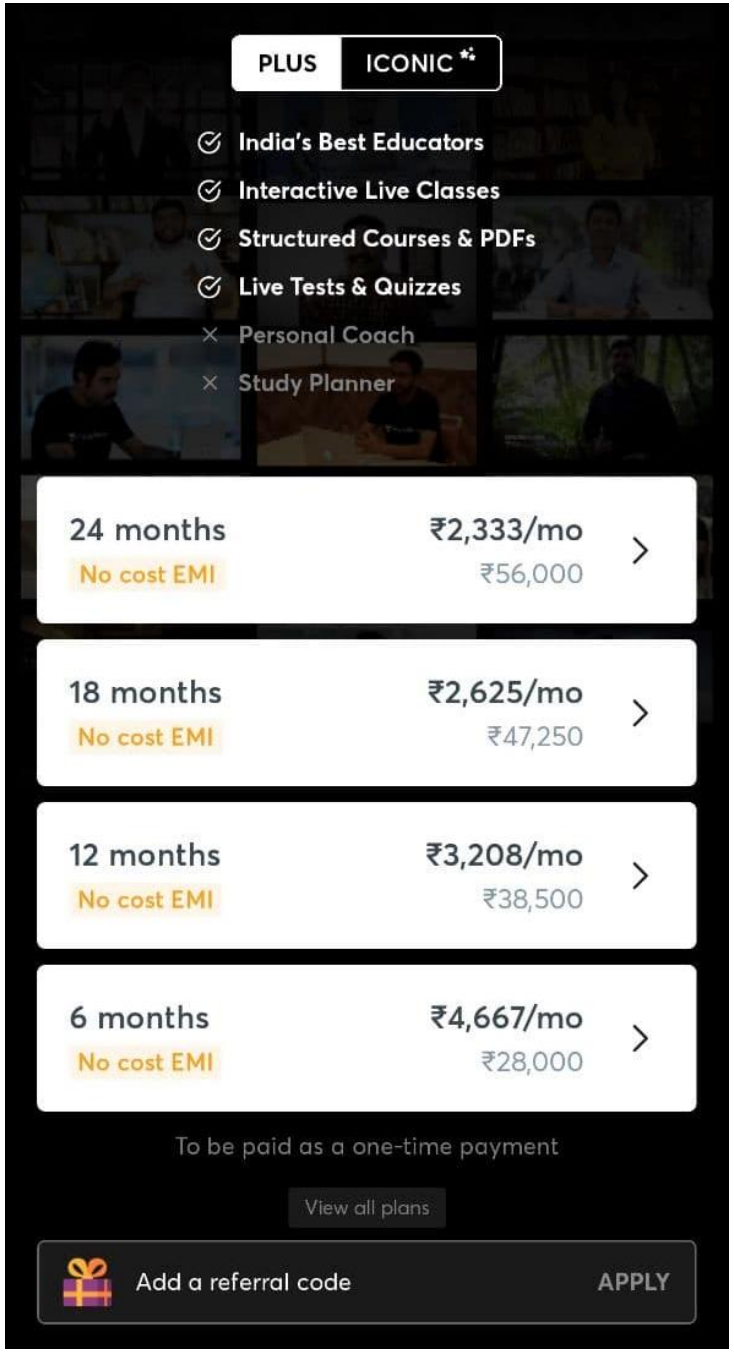
(a) 77.7 N/C (b) 33.3 N/C
(c) 28.8 N/C (d) 83.6 N/C

Q 10. Find the amplitude of magnetic field in parallel beam of light of intensity 4.0W/m^2

(a) 18.3×10^{-5} T (b) 1.83×10^{-6} T
(c) 28.3×10^{-7} T (d) 1.83×10^{-7} T

Answer Key

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



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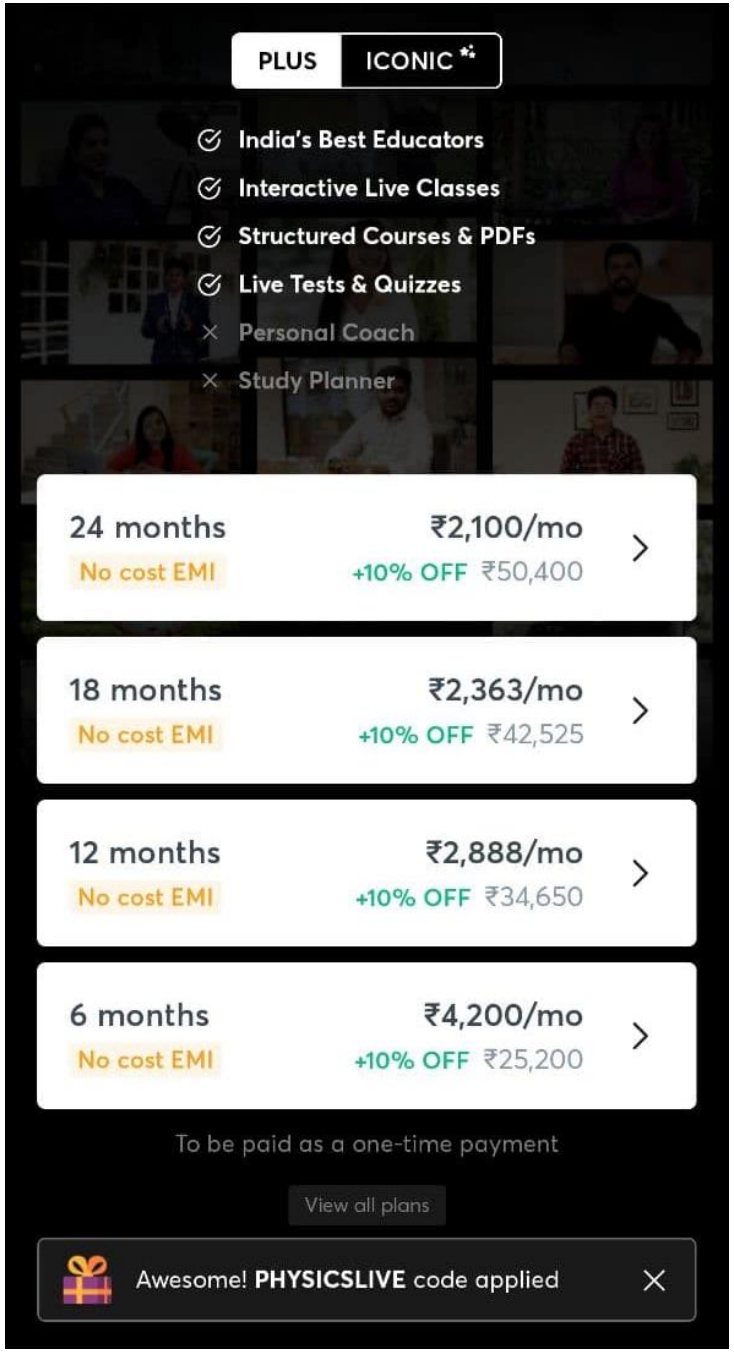

Written Solution

DPP-2 EM Wave: Intensity, Momentum & Force

By Physicsaholics Team

Solution: 1

$I = 10^4 \ w/m^2$

$P = IA$

$P = 10^4 \times (10 \times 10)$

$\boxed{P = 10^6 \ w}$ Ans.

Ans. c

Solution: 2

$I = 1.4 \times 10^3 \ w/m^2$

$P = IA$

$\frac{E}{t} = IA$

$E = IAt$

$E = 1.4 \times 10^3 \times (8 \times 2) \times (60 \times 60)$

$E = 8064 \times 10^5$

$E = 806.4 \times 10^6 \ J$

$\boxed{E = 806.4 \ MJ}$ Ans.

Ans. b

Solution: 3

$I = 10^3 \ w/m^2$; $P = 1.6 \times 10^5 \ W$

$$F = \frac{P}{C}$$

$$F = \frac{1.6 \times 10^5}{3 \times 10^8}$$

$$F = 0.53 \times 10^{-3}$$

$$\boxed{F = 5.3 \times 10^{-4} \ N} \quad \text{Ans.}$$

Ans. c

Solution: 4

$$I = 50\ w/cm^2 = 50\ w/10^{-4}m^2$$

$$I = 5 \times 10^5\ w/m^2$$

$$P = IA$$

$$F = \frac{P}{C} = \frac{IA}{C}$$

$$F = \frac{5 \times 10^5 \times 0.05}{3 \times 10^8} = \frac{25 \times 10^3}{3 \times 10^8}$$

$$\boxed{F = 8.3 \times 10^{-5}\ N}$$ Ans.

Ans. b

Solution: 5

For reflecting surface

$$F = \frac{2IA}{C} \text{ or } \frac{2P}{C}$$

$$F = \frac{2 \times 25 \times 10^{-4} \times 15 \times 10^{-4}}{3 \times 10^{8}}$$

$$F = \frac{750}{3 \times 10^{8}}$$

$$\boxed{F = 25 \times 10^{-7}\ N} \quad \text{Ans}$$

or

$$\boxed{F = 2.5 \times 10^{-6}\ N} \quad \text{Ans}$$

Ans. b

Solution: 6

$$p = \frac{U}{c} = \frac{IAt}{c}$$

$$p = \frac{(18\ W/m^2) \times (20\ cm^2) \times (30 \times 60)}{3 \times 10^8}$$

$$p = \frac{360 \times 1800}{3 \times 10^8} = \frac{120 \times 180}{10^8} = 1.2 \times 1.8 \times 10^{-3}$$

$$\boxed{p = 2.16 \times 10^{-3}\ kg\text{-}m/s}$$

Ans. b

Solution: 7

$I = 18\ W/cm^2$ $\quad A = 4\ cm^2$

For reflective surface

$$p = \frac{2U}{c} = \frac{2IAt}{c}$$

$$p = \frac{2 \times (18\ W/cm^2) \times (4\ cm^2) \times (1 \times 60)}{3 \times 10^8}$$

$$p = \frac{144 \times 60}{3 \times 10^8} = 2880 \times 10^{-8}$$

$$p = 28.8 \times 10^{-6}\ kg\text{-}m/s$$

$$\boxed{p = 28.8\ \mu kg\text{-}m/s}$$ Ans

Ans. a

Solution: 8

$I = 24\ w/m^2$ $\quad A = \pi r^2 = \pi (3.5 \times 10^{-2})^2$

$A = 38.5 \times 10^{-4}\ m^2$

For reflecting surface

$$p = \frac{2U}{C} = \frac{2IAt}{C}$$

$$p = \frac{2 \times 24 \times 38.5 \times 10^{-4} \times (60 \times 60)}{3 \times 10^8}$$

$$p = \frac{664.7}{3 \times 10^8} = 221.5 \times 10^{-8} = 2.21 \times 10^{-6}$$

$$\boxed{p = 2.21\ \mu kg\text{-}m/s}$$ Ans

Ans. b

Solution: 9

$$I = \frac{1}{2}\epsilon_0 E_0^2 c$$

$$8 = \frac{1}{2} \times 8.85 \times 10^{-12} (E_0^2) \times 3 \times 10^8$$

$$8 = \frac{1}{2} \times 8.85 \times 3 \times 10^{-4} \times E_0^2$$

$$E_0^2 = \frac{16}{8.85 \times 3} \times 10^4$$

$$E_0 = \frac{4 \times 10^2}{5.15}$$

$$\boxed{E_0 = 77.7 \text{ N/C}} \quad \text{Ans}$$

Ans. a

Solution: 10

$$I = \frac{1}{2}\varepsilon_0 E_0^2 c$$

$$4 = \frac{1}{2} \times 8.85 \times 10^{-12} \times 3 \times 10^8 \times E_0^2$$

$$E_0^2 = \frac{8}{8.85 \times 3} \times 10^4 = 3013.18$$

$$\boxed{E_0 = 54.89 \text{ V/m}} \quad \text{Ans}$$

$$E_0 = cB_0$$

$$B_0 = \frac{E_0}{c} = \frac{54.89}{3 \times 10^8}$$

$$B_0 = 18.29 \times 10^{-8}$$

$$\boxed{B_0 = 1.83 \times 10^{-7} \text{ T}} \quad \text{Ans.}$$

Ans. d

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