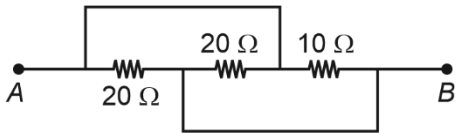
PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. The effective resistance in the following circuit across terminal *A* and *B* is equal to

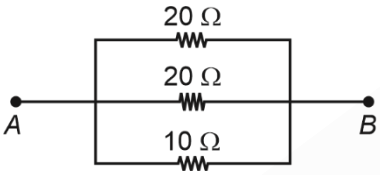


(1) 5 Ω (2) 10 Ω

(3) 20 Ω (4) 40 Ω

Answer (1)

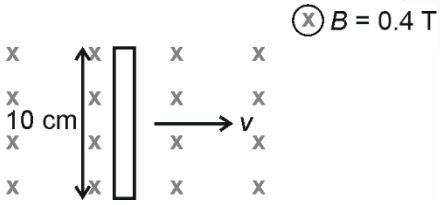
Sol. Equivalent circuit



$$\frac{1}{R}=\frac{1}{10}+\frac{1}{20}+\frac{1}{20}$$

$$\Rightarrow R = 5\ \Omega$$

2. If the emf generated in the moving rod in uniform magnetic field *B* is 0.08 V, then find the speed (*v*) of the rod.



(1) 1 m/s (2) 2 m/s

(3) 3 m/s (4) 4 m/s

Answer (2)

Sol. $\varepsilon = Blv$

$$v=\frac{\varepsilon}{Bl}=\frac{0.08\times100}{0.4\times10}=\ 2\ \text{m/s}$$

3. Which of the following expressions give the value of acceleration due to gravity (g') at the altitude *h* above the surface of earth. (*R*: radius of earth, *g*: acceleration due to gravity at surface of earth)

(1) $g'=g\frac{h^2}{R^2}$ (2) $g'=\frac{gR^2}{(R+h)^2}$

(3) $g'=g\left(1-\frac{h}{R}\right)$ (4) $g'=g\left(1-\frac{h^2}{R^2}\right)$

Answer (2)

Sol. $g'=\frac{GM_e}{(R+h)^2}$

$$g'=\frac{gR^2}{(R+h)^2}$$

4. Find the distance from a point charge of magnitude 5×10^{-9} C, where the electric potential is 50 V

(1) 90 cm (2) 70 cm

(3) 60 cm (4) 50 cm

Answer (1)

Sol. $V=\frac{kQ}{r}$

$$50=\frac{9\times10^9\times5\times10^{-9}}{r}$$

$r = 0.9$ m

5. Match column I with column II and choose the correct option.

	Column I		Column II
I.	Torque	a.	M^0LT^{-2}
II.	Stress	b.	$ML^{-1}T^{-1}$
III.	Coefficient of viscosity	c.	$ML^{-1}T^{-2}$
IV.	Gravitational potential gradient	d.	ML^2T^{-2}

(1) I → a, II → c, III →b, IV → d

(2) I → d, II → b, III → c, IV → a

(3) I → d, II → c, III → b, IV → a

(4) I → a, II → c, III → d, IV → b

Answer (3)

Sol. Torque = $r \times F = ML^2T^{-2}$

Stress = $\frac{F}{A}=ML^{-1}T^{-2}$

Coefficient of viscosity = $ML^{-1}T^{-1}$

Gravitational potential gradient = M^0LT^{-2}

6. Which of the following is the highest energy electromagnetic wave?

(1) X-rays (2) Infra Red

(3) Microwaves (4) Radiowave

Answer (1)

Sol. Since out of the given options, X-rays have the highest frequency.

$\Rightarrow$ Option (1) is correct

7. A carnot engine working between 27°C and 127° performs 2 kJ of work. The amount of heat energy rejected is equal to

(1) 4 kJ (2) 6 kJ

(3) 8 kJ (4) 12 kJ

Answer (2)

Sol. $2\text{ kJ} = x\left(1-\frac{300}{400}\right)$

$2\text{ kJ} = \frac{x}{4}$

$\Rightarrow x = 8\text{ kJ}$

$\Rightarrow$ Heat lost = 6 kJ

8. **Statement-I:** Electromagnet are made of soft iron.

Statement-II: Soft iron has lower permeability and high retentivity.

Choose the correct option related to statements.

(1) Statement-I is true and statement-II is true

(2) Statement-I is true and statement-II is false

(3) Statement-I is false and statement-II is true

(4) Statement-I is false and statement-II is false

Answer (2)

Sol. Soft iron has low retentivity and high permeability.

9. If a satellite is orbiting the earth at a height h has angular momentum 'L'. Then, the same satellite at a height 10 times 'h' will have angular momentum equal to

(1) $\sqrt{10}\,L$ (2) $\sqrt{5}\,L$

(3) $3L$ (4) $\sqrt{20}\,L$

Answer (1)

Sol. $\because \quad \frac{mv^2}{r} = \frac{GMm}{r^2}$

$\Rightarrow m^2v^2r^2 = GMmr$

$L^2 \propto r$

$\therefore \quad \frac{L_1}{L_2} = \sqrt{\frac{h}{10h}}$

$\Rightarrow L_2 = \sqrt{10}L$

10. Consider 2 statements:

Statement 1: We can get displacement from acceleration-time graph.

Statement 2: We can get acceleration from velocity-time graph.

Then

(1) Both statements are true

(2) Both statements are false

(3) Statement 1 is true and statement 2 is false

(4) Statement 1 is false and statement 2 is true

Answer (4)

Sol. To get displacement from acceleration-time graph, we will need 1 initial value (for velocity).

Also, $a = \frac{dv}{dt}$

$\Rightarrow$ Slope will give a.

11. A projectile launched on a horizontal surface follows a trajectory given by $y = x - \frac{x^2}{20}$ where y-axis is in vertical upward direction. Maximum height attained by projectile is (All units are in SI)

(1) 10 m (2) 5 m

(3) 20 m (4) 40 m

Answer (2)

Sol. $y = x - \frac{x^2}{20}$

at maximum height $\frac{dy}{dx} = 0$

$\Rightarrow x = 10\text{ m}$

at $x = 10$ m, $y = 10 - 5 = 5$ m

12. An antenna of length l emits radiation of wavelength λ. The power emitted by the antenna is proportional to:

(1) $\left(\frac{l}{\lambda}\right)^2$ (2) $\frac{l}{\lambda}$

(3) $\frac{\lambda}{l}$ (4) $\frac{1}{l\lambda}$

Answer (1)

Sol. Since $P \propto \left(\frac{l}{\lambda}\right)^2$

$\Rightarrow$ Option (1) is correct.

13. In a radioactive process, $\frac{1}{8}$th of the initial amount of the element is decayed. If in 5 days further, 8×10^{-3} kg of the element decayed, find the original amount of element.

(1) 128 grams (2) 64 grams

(3) 256 grams (4) 32 grams

Answer (2)

Sol. $\frac{1}{8}=\frac{1}{2^3}$

$\Rightarrow$ 3 half lives = 3 days

$\Rightarrow \frac{b}{2}$ = 1 day

Let m: initial mass

$\Rightarrow \frac{m}{8}-\frac{m}{8\times32}$ =8 grams

$\Rightarrow m=\frac{64\times32}{32-1}\simeq 65$g.

14. Find the change in energy stored in a capacitor of 600 *pF* capacitance charged at 50 *V*, once connected with another 600 *pF* uncharged capacitor.

(1) 0.56 μJ (2) 0.4 μJ

(3) 0.86 μJ (4) 0.32 μJ

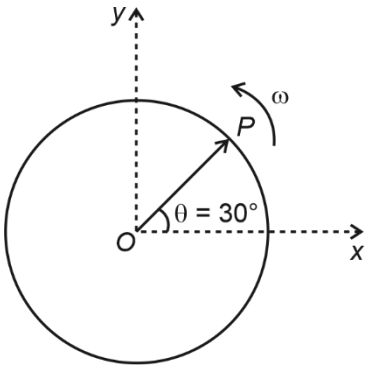
Answer (1)

Sol. $U_i=\frac{1}{2}Cv^2$, $U_f=\frac{1}{2}C\left(\frac{v}{2}\right)^2$

$\Delta U=\frac{3}{8}Cv^2$

$=\frac{3}{8}\times600\times10^{-12}\times(50)^2$

15. Phasor of a particle performing SHM is as shown in the diagram. The SHM has angular frequency ω and at t = 0 the phasor lies along *OP*. At any time t further the projection of phasor along *y*-axis is given by



(1) $R\sin\left(\omega t+\frac{\pi}{6}\right)$ (2) $R\cos\left(\omega t+\frac{\pi}{6}\right)$

(3) $R\sin\left(\omega t-\frac{\pi}{6}\right)$ (4) $R\cos\left(\omega t-\frac{\pi}{6}\right)$

Answer (1)

Sol. θ at any time t

$=\omega t=30°$

$\Rightarrow y_{projection}=R\sin\theta$

$=R\sin\left(\omega t+\frac{\pi}{6}\right)$

16.

17.

18.

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g., 06.25, 07.00, –00.33, –00.30, 30.27, –27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. A body of mass 5 kg has the linear momentum of 100 kg ms^{-1} and acted upon by the force of 2 N for 2 seconds, then change in kinetic energy in Joule is

Answer (81.60)

Sol. $F\times t=\Delta P$

$\Rightarrow 2\times2=P_f-100$

$P_f=104$ kg ms^{-1}

$\Delta K=\frac{P_f^2}{2m}-\frac{P_i^2}{2m}=\frac{1}{2\times5}\times\left(104^2-100^2\right)$

$=\frac{1}{10}\times4\times204=81.6$ J

22. In a YDSE experiment, fringe width is 2 mm when wavelength of light used is λ = 400 nm. Find the fringe width (in mm) when wavelength is 600 nm.

Answer (3)

Sol. $\beta = \frac{\lambda D}{d}$

$\Rightarrow \frac{\beta'}{\beta} = \frac{600}{400} = 1.5$

$\Rightarrow \beta' = 3 \text{ mm}$

23. A block moving with speed 1 m/s comes to rest after moving for 20 cm over a rough surface. The coefficient of friction between the block and surface is___

Answer (00.25)

Sol. $\because \quad v^2 - u^2 = 2aS$

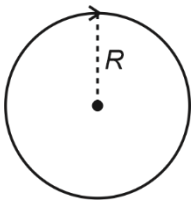
$0^2 - 1^2 = 2(-\mu g)\frac{20}{100}$

$\mu = \frac{1}{4} = 0.25$

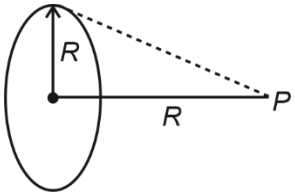
24. The ratio of magnetic field due to coil at centre and at a distance of R from the centre on the axis passing through the centre and perpendicular to the plane of ring is $\sqrt{x}:1$ (R is the radius of coil), find the value of x.

Answer (8)

Sol.



$B_C = \left(\frac{\mu_0 i}{2R}\right)$

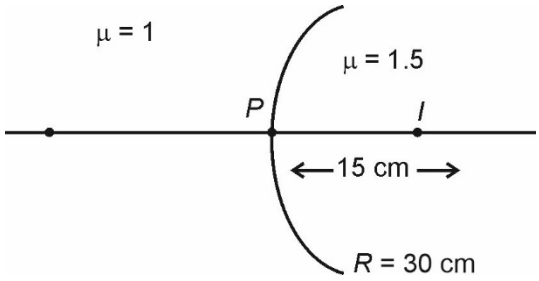


$B_P = \frac{\mu_0}{4\pi} \times \frac{2 \times i \times \pi R^2}{(R^2 + R^2)^{3/2}}$

$= \frac{\mu_0}{2R}\frac{i}{2\sqrt{2}} = \left(\frac{\mu_0 i}{4\sqrt{2}R}\right)$

$\frac{B_C}{B_P} = \frac{4\sqrt{2}}{2} = \sqrt{8}:1$

25. In the given diagram image forms at a distance of 15 cm inside the



medium of refractive index 1.5. Find the object distance (in cm) from point P.

Answer (12.00)

Sol. $\frac{1.5}{15} - \frac{1}{u} = \left(\frac{1.5-1}{30}\right) = \frac{0.5}{30} = \frac{1}{60}$

$\frac{1}{10} - \frac{1}{u} = \frac{1}{60} \Rightarrow \frac{1}{10} - \frac{1}{60} = \frac{1}{u}$

$\frac{1}{u} = \frac{5}{60} \Rightarrow u = \frac{60}{5} = 12 \text{ cm}$

26. Ratio of wavelengths of photons corresponding to first and second line of Balmer series in an emission spectrum is given by $\frac{x}{20}$ for a hydrogen like species. Value of x is equal to

Answer (27)

Sol. $\frac{1}{\lambda_1} = -R\left(\frac{1}{9} - \frac{1}{4}\right)$

$\frac{1}{\lambda_2} = -R\left(\frac{1}{16} - \frac{1}{4}\right)$

$\Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{36}{5} \times \frac{3}{16} = \frac{27}{20}$

$\Rightarrow x = 27$

27.

28.

29.

30.