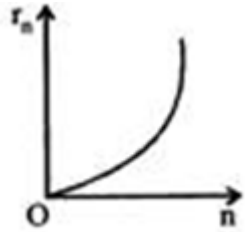
JEE Main - 2023

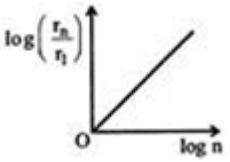
Physics

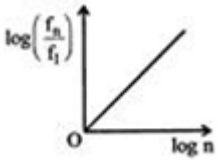
Section A

This Section A contains 20 multiple choice questions from 1 to 20. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only one is correct.

1. If in hydrogen atom, radius of n^{th} Bohr orbit is r_n frequency of revolution of electron in n^{th} $\left|\text{orbit is } f_n\right|$ choose the correct option.

(A) 

(B) 

(C) 

(D) Both B and C

2. An electron of mass 'm' and charge 'e' initially at rest gets accelerated by a constant electric field E. The rate of change of de-Broglie wavelength of this electron at time t, ignoring relativistic effects is:

(A) $\frac{-h}{eEt^2}$

(B) $\frac{-eht}{E}$

(C) $\frac{-mh}{eEt^2}$

(D) $\frac{-h}{eE}$

3. A heavy nucleus having mass number 200 gets disintegrated into two small fragments of mass number 80 and 120. If binding energy per nucleon for parent atom is $6.5\,\text{MeV}$ and for daughter nuclei is $7\,\text{MeV}$ and $8\,\text{MeV}$ respectively, then the energy released in the decay will be –

(A) $200\,\text{MeV}$

(B) $-220\,\text{MeV}$

(C) $220\,\text{MeV}$

(D) $180\,\text{MeV}$

4. In semiconductor the concentrations of electrons and holes are $8\times10^{18}/\text{m}^3$ and $5\times10^{18}/\text{m}^3$ respectively. If the mobility of electrons and hole are $2.3\text{m}^2/\text{volt}-\text{sec}$ and $0.01\text{m}^2/\text{volt}-\text{sec}$ respectively, then semiconductor is

(A) N-type and its resistivity is $0.34\,\text{ohm}-\text{metre}$

(B) P-type and its resistivity is $0.034\,\text{ohm}-\text{metre}$

(C) N-type and its resistivity is $0.034\,\text{ohm}-\text{metre}$

(D) P-type and its resistivity is $3.40\,\text{ohm}-\text{metre}$

5. Work done by a system under isothermal change from a volume V_1 to V_2 for a gas which obeys van der waals equation $(V-\beta n)\left(P+\frac{\alpha n^2}{V}\right)=nRT$

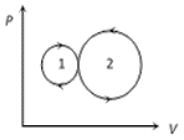
(A) $nRT\log_e\left(\frac{V_2-n\beta}{V_1-n\beta}\right)+\alpha n^2\left(\frac{V_1-V_2}{V_1V_2}\right)$

(B) $nRT\log_{10}\left(\frac{V_2-\alpha\beta}{V_1-\alpha\beta}\right)+\alpha n^2\left(\frac{V_1-V_2}{V_1V_2}\right)$

(C) $nRT\log_e\left(\frac{V_2-n\alpha}{V_1-n\alpha}\right)+\beta n^2\left(\frac{V_1-V_2}{V_1V_2}\right)$

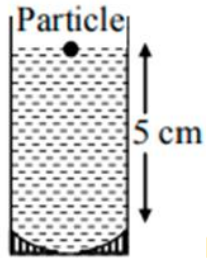
(D) $nRT\log_e\left(\frac{V_1-n\beta}{V_2-n\beta}\right)+\alpha n^2\left(\frac{V_1V_2}{V_1-V_2}\right)$

6. In the following indicator diagram, the net amount of work done will be



(A) Positive
(B) Negative
(C) Zero
(D) Infinity

7. A concave mirror has radius of curvature of $40\,\text{cm}$. It is at the bottom of a glass that has water filled up to $5\,\text{cm}$ (see figure). If a small particle is floating on the surface of water, its image as seen, from directly above the glass, is at a distance d from the surface of water. The value of d is dose to: (Refractive index of water $=1.33$)



(A) $11.7\,\text{cm}$
(B) $6.7\,\text{cm}$
(C) $13.4\,\text{cm}$
(D) $8.8\,\text{cm}$

8. A square of side $3\,\text{cm}$ is placed at a distance of $25\,\text{cm}$ from a concave mirror of focal length $10\,\text{cm}$. The centre of the square is at the axis of the mirror and the plane is normal to the axis. The area enclosed by the image of the square is

(A) $4\,\text{cm}^2$
(B) $6\,\text{cm}^2$
(C) $16\,\text{cm}^2$
(D) $36\,\text{cm}^2$

9. In young's double slit experiment a coordinate axis is printed on the screen. the y co-ordinates of central maxima and 10^{th} maxima are 2cm and 5cm respectively. When the YDSE apparatus is immersed in a liquid of refractive index 1.5, the corresponding y co-ordinates will be:

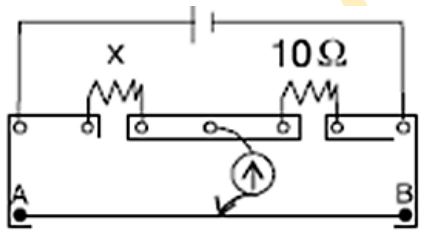
(A) $2\text{cm}, 7.5\text{cm}$

(B) $3\text{cm}, 6\text{cm}$

(C) $\frac{4}{3}\text{cm}, \frac{10}{3}\text{cm}$

(D) $2\text{cm}, 4\text{cm}$

10. A meter bridge is set up as shown, to determine an unknown resistance 'X' using a standard 10ohm resistor. The galvanometer shown null point when tapping-key is at 52cm mark. The end-corrections are 1cm and 2cm respectively for the ends A and B. The determined value of 'Y' is



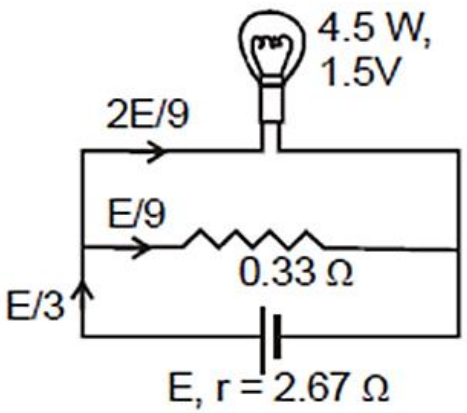
(A) 10.2ohm

(B) 10.6ohm

(C) 10.8ohm

(D) 11.1ohm

11. A torch bulb rated as $4.5\text{W}, 1.5\text{V}$ is connected as shown in fig. The e. m. f. of the cell, needed to make the bulb glow at full intensity is



(A) $4.5\,\text{V}$

(B) $1.5\,\text{V}$

(C) $2.67\,\text{V}$

(D) $13.5\,\text{V}$

12. The temperature coefficient of resistance of conductor varies as $\alpha\ (T) = 3T^2 + 2T$. If R_0 is resistance at $T = 0$ and R is resistance at T, then

(A) $R = R_0(6T + 2)$

(B) $R = 2R_0(3 + 2T)$

(C) $R = R_0(1 + T^2 + T^3)$

(D) $R = R_0(1 - T + T^2 + T^3)$

13. Directions: Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

Assertion: The electric flux of the electric field $\oint \vec{E} \cdot d\vec{A}$ is zero. The electric field is zero everywhere on the surface.

Reason: The charge inside the surface is zero.

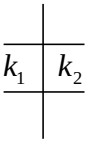
(A) Assertion is correct; reason is correct; reason is a correct explanation for assertion.

(B) Assertion is correct; reason is correct; reason is not a correct explanation for assertion

(C) Assertion is correct; reason is incorrect

(D) Assertion is incorrect, reason is correct.

14. A parallel plate condenser is filled with two dielectrics as shown. Area of each plate is $A\,m^2$ and the separation is $t\,m$. The dielectric constants are k_1 and k_2 respectively. Its capacitance in farad will be



(A) $\frac{\varepsilon_o A}{t}(k_1+k_2)$

(B) $\frac{\varepsilon_o A}{t}\cdot\frac{k_1+k_2}{2}$

(C) $\frac{2\varepsilon_o A}{t}(k_1+k_2)$

(D) $\frac{\varepsilon_o A}{t}\cdot\frac{k_1+k_2}{2}$

15. Directions: Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.
Assertion: Figure shows a current carrying circular loop.
The magnetic field at the centre of loop is zero.

Reason: Magnetic field at the centre of loop is given by $B=\frac{\mu_0 ni}{2R}$

(A) Assertion is correct; reason is correct; reason is a correct explanation for assertion.
(B) Assertion is correct; reason is correct; reason is not a correct explanation for assertion
(C) Assertion is correct; reason is incorrect
(D) Assertion is incorrect, reason is correct.

16. The coactivity of a small magnet where the ferromagnet gets demagnetized is $3\times10^3\,\mathrm{Am}^{-1}$. The current required to be passed in a solenoid of length $10\,\mathrm{cm}$ and number of turns 100, so that the magnet gets demagnetized when inside the solenoid, is:
(A) $30\,\mathrm{mA}$
(B) $60\,\mathrm{mA}$
(C) $3\,\mathrm{A}$
(D) $6\,\mathrm{A}$

17. A boy recalls the relation almost correctly but forgets where to put the constant c (speed of light). He writes; $m = \frac{m_0}{\sqrt{1-\upsilon^2}}$. Where m and m_0 stand masses and v for speed. Right place of c is

(A) $m = \frac{cm_0}{\sqrt{1-\upsilon^2}}$

(B) $m = \frac{m_0}{c\sqrt{1-\upsilon^2}}$

(C) $m = \frac{m_0}{\sqrt{c^2-\upsilon^2}}$

(D) $m = \frac{m_0}{\sqrt{1-\frac{\upsilon^2}{c^2}}}$

18. If rain falls vertically with a velocity V_r and wind blows With a velocity v_w from east to west, then a person standing on the roadside should hold the umbrella in the direction

(A) $\tan\theta = \frac{V_w}{V_r}$

(B) $\tan\theta = \frac{V_r}{V_w}$

(C) $\tan\theta = \frac{V_{rw}}{\sqrt{Vr^2+Vw^2}}$

(D) $\tan\theta = \frac{V_r}{\sqrt{Vr^2+Vw^2}}$

19. $50\,\mathrm{W/m^2}$ energy density of sunlight is normally incident on the surface of a solar panel. Some part of incident energy (25%) is reflected from the surface and the rest is absorbed. The force exerted on $1\mathrm{m}^2$ surface area will be close to $\left(c = 3\times10^8\ \mathrm{m/s}\right)$

(A) $20\times10^{-8}\,\mathrm{N}$

(B) $10\times10^{-8}\,\mathrm{N}$

(C) $35\times10^{-8}\,\mathrm{N}$

(D) $15\times10^{-8}\,\mathrm{N}$

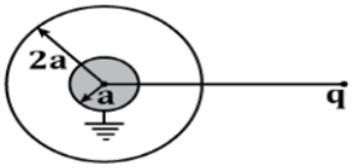
20. Directions: Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.
Assertion: A pure semiconductor has negative temperature coefficient of resistance.
Reason: In a semiconductor on raising the temperature, more charge carriers are released, conductance increases and resistance decreases.

(A) Assertion is correct; reason is correct; reason is a correct explanation for assertion.
(B) Assertion is correct; reason is correct; reason is not a correct explanation for assertion
(C) Assertion is correct; reason is incorrect
(D) Assertion is incorrect, reason is correct.

Section B

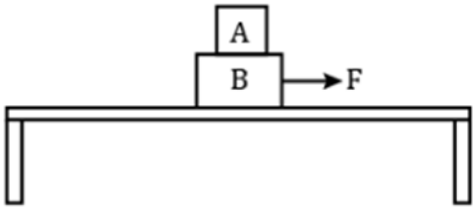
This Section B contains 10 Integer Type Questions from 21 to 30. Attempt any 5 Questions.

21. A solid conduction sphere of radius 'a' is surrounded by a thin uncharged concentric conducting shell or radius $2a$. A point charge q is placed at a distance $4a$ from common centre of conducting sphere and shell. The inner sphere is then grounded. The charge on the solid sphere is $\frac{-q}{n}$. Find the value of n

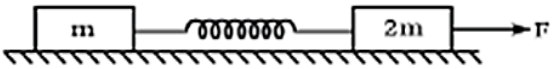


22. What amount of heat (in J) is to be transferred to nitrogen in the isobaric heating process for that gas to perform the work $A = 2.0\,\mathrm{J}$?

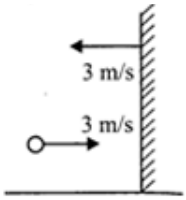
23. Two blocks A and B of mass $m_A = 1\ \mathrm{kg}$ and $m_B = 3\ \mathrm{kg}$ are kept on the table as shown in figure. The coefficient of friction between A and B is 0.2 and between B and the surface of the table is also 0.2. The maximum force F (in newton) that can be applied on B horizontally, so that the block A does not slide over the block B is [Take, $\mathrm{g} = 10\,\mathrm{m/s^2}$]



24. Two blocks of masses m and $2m$ are kept on a smooth horizontal surface. They are connected by an ideal spring of force constant k. Initially the spring is unstretched. A constant force of $10\,\mathrm{N}$ is applied to the heavier block in the direction shown in figure. Suppose at time $2\mathrm{s}$ displacement of smaller block is $2m$, then displacement (in m) of the heavier block at this moment would be: $(m = 1\mathrm{kg})$



25. A highly elastic ball moving at a speed of 3m/s approaches a wall moving towards it with a speed of 3m/s. After the collision, the speed (in m/s) of the ball will be



26. A rigid body can be hinged about any point on the x-axis. When it is hinged such that the hinge is at x, the moment of inertia is given by $I = 2x^2 - 12x + 27$. The x-coordinate of centre of mass is

27. Two satellites, A and B, have masses m and $2m$ respectively. A is in a circular orbit of radius R, and B is in a circular orbit of radius $2R$ around the earth. The ratio of their kinetic energies, T_A/T_B, is:

28. Two pendulums have time period T and $5T/4$. They start SHM at the same time from the mean position. What will be the phase difference (in degree) between them at the moment, when bigger pendulum completes one oscillation?

29. A wooden rod of a uniform cross section and of length $120\,\text{cm}$ is hinged at the bottom of the tank which is filled with water to a height of $40\,\text{cm}$. In the equilibrium position, the rod makes an angle of $60°$ with the vertical. The centre of buoyancy is located on the rod at a distance (in cm, from the hinge) of

30. A plane loop shaped as two squares of sides $a = 1\text{m}$ and $b = 0.4\text{m}$ is introduced into a uniform magnetic field $\perp$ to the plane of loop (figure). The magnetic field varies as $B = 10^{-3}\sin(100t)T$. The amplitude of the current (in A) induced in the loop if its resistance per unit length is $r = 5\times10^{-3}\Omega\text{m}^{-1}$ is: