VIDYAPEETH ACADEMY
IIT JEE | NEET | OLYMPIAD | KVPY | NTSE

JEE MAIN 2021

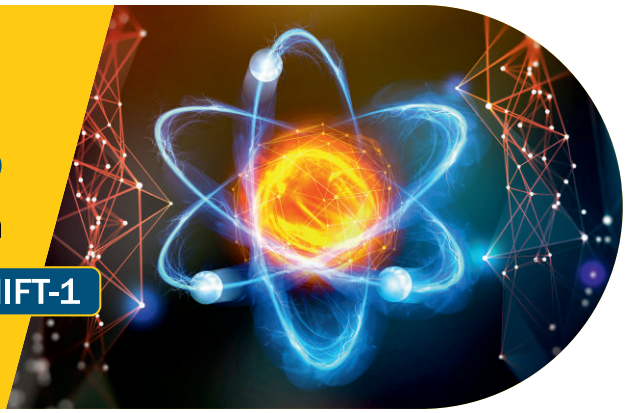
PAPER-1 (B.E. / B.TECH)

QUESTIONS & SOLUTIONS

Reproduced from Memory Retention

18 March, 2021 SHIFT-1

09:00 am to 12 Noon



Duration : 3 Hours Max. Marks : 300

SUBJECT - PHYSICS

JEE(MAIN) 2021 (18 MARCH ATTEMPT) SHIFT-1

PHYSICS

1. If a simple pendulum completes 200 oscillation in 100 sec. Least count of watch is 1 sec., length of simple pendulum is 100 cm and it's least count is 1 mm then find max. possible percentage error in measuring acceleration due to gravity.

(1) 3.2 (2) 5.2 (3) 2.1 (4) 4.1

Ans. (3)

Sol. $T = 2\pi\sqrt{\frac{\ell}{g}}$

$T^2 = 4\pi^2\left(\frac{\ell}{g}\right)$

$g = 4\pi^2\left(\frac{\ell}{T^2}\right)$

$\frac{\Delta g}{g} = \frac{\Delta \ell}{\ell} + 2\frac{\Delta T}{T}$

$\frac{\Delta g}{g}\times 100 = \frac{0.1\text{cm}}{100\text{cm}}\times 100\% + 2\left(\frac{1\text{sec}}{100\text{sec}}\right)\times 100\%$

$\frac{\Delta g}{g}\times 100 = 2.1\%$

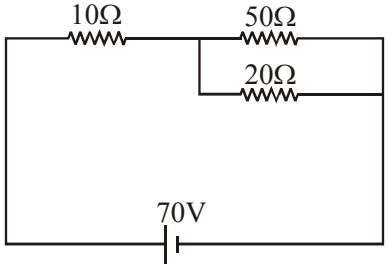
2. A girl is looking at the distant rectangular window, she finds window to be blurred & non-uniformly curved. What eye defect she may have?

(1) Myopia & Astigmatism (2) Myopia & Hypermetropia

(3) Astigmatism (4) Hypermetropia & Astigmatism

Ans. (1)

3. In the circuit shown evaluate potential difference across 10Ω in volts?



Ans. 70.00

Sol. $R_{eq} = 10 + \frac{10\times 20}{50\times 20}$

$= \frac{170}{7}\Omega$

$I = \frac{v}{R_{eq}} = \frac{170}{170}\times 7 = 7amp$

$V_{10\Omega} = IR$

$= 7 \times 10 = 70v$

4. A satellite revolves in a circular orbit of radius R around earth with time period T. Find its time period if it starts revolving in radius 9R?

(1) 3T (2) 6T (3) 9T (4) 27T

Ans. (4)

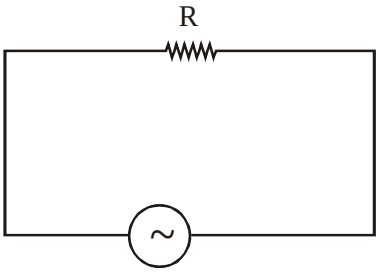
Sol. $T^2 \propto R^3$

$\therefore \left(\frac{T_2}{T_1}\right)^2 = \left(\frac{R_2}{R_1}\right)^3$

$\therefore \left(\frac{T_2}{T_1}\right)^2 = 9^3$

$\therefore \frac{T_2}{T_1} = 27$

5. AC circuit diagram is shown. Find time taken to reach it's current from i_{rms} to i_{max}.



220 v, 50 Hz

(1) 10 milli sec. (2) 1 milli sec. (3) 2.5 milli sec. (4) 5 milli sec.

Ans. (3)

Sol. $i = i_{max} \sin(\omega t + \theta)$

at $t = 0$, $1 = i_{rms}$

$i_{rms} = \sqrt{2}\ (i_{rms}) \sin\theta$

$\theta = \frac{\pi}{4}$

$i = i_{max} \sin\left(\omega t + \frac{\pi}{4}\right)$

at $t = t_1$, $i = i_{max}$

$i_{max} = i_{max} \sin\left(\omega t_1 + \frac{\pi}{4}\right)$

$\omega t_1 + \frac{\pi}{4} = \frac{\pi}{2}$

$\omega t_1 + \frac{\pi}{4}$

$\frac{2\pi}{T} t_1 = \frac{\pi}{4}$

$t_1 = \frac{T}{8}$

$t_1 = \frac{1}{8}\left(\frac{1}{f}\right) = \frac{1}{8}\left(\frac{1}{50}\right)$

$t_1 = \frac{1000}{400}$ m sec = 2.5 m sec

6. In LCR circuit L and C are constant and R is increased then:

(1) Quality factor and resonant frequency both are unchanged.

(2) Quality factor is increased.

(3) Band width is increased.

(4) Quality factor remains unchanged

Ans. (3)

Sol. $\omega = \frac{1}{\sqrt{LC}}, Q = \frac{1}{R}\sqrt{\frac{L}{C}}$, Band width $= \frac{R}{L}$

7. In YDSE setup, distance between slits is 0.5 mm & separation between slits plane & screen is 0.5 m. Find the distance between 1st maxima & 3rd maxima if light used has wave length 5890 Å.

(1) 1178×10^{-6} m (2) 1178×10^{-7} m (3) 1178×10^{-8} m (4) 5890×10^{-7} m

Ans. (1)

Sol. Distance between 1st & 3rd maxima will be 3β.

$\therefore 2 \times \frac{\lambda D}{d} = 2 \times 5890 \times 10^{-10} \times \frac{0.5}{0.5 \times 10^{-3}}$

$= 11780 \times 10^{-7}$ m

8. A closed current carrying loop is placed in uniform magnetic field. Then in equilibrium shape of wire will be :

(1) straight

(2) unchanged

(3) circular and plane perpendicular to magnetic field

(4) Circular and plane parallel to magnetic field

Ans. (3)

9. A muon particle (mass = 207 m_e) revolves around hydrogen nucleus. Find its ionisation energy.? [m_e = mass of electron]

(1) 13.6 eV (2) 27.2 eV (3) 13.6 × 207 eV (4) 331.8 eV

Ans. (Bonus)

Sol. $E_n = -13.6 \times \frac{\mu}{m_e} eV$

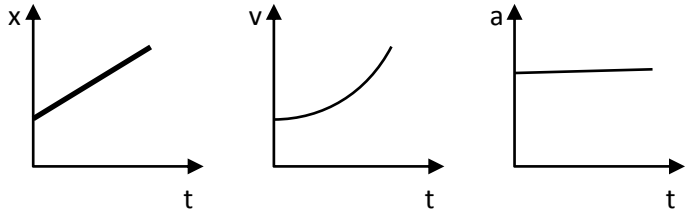
$$\mu = \frac{(1836 m_e)(207 m_e)}{(1836 + 207) m_e}$$

$$= \frac{1836 \times 207}{2043} = 186\ m_e.$$

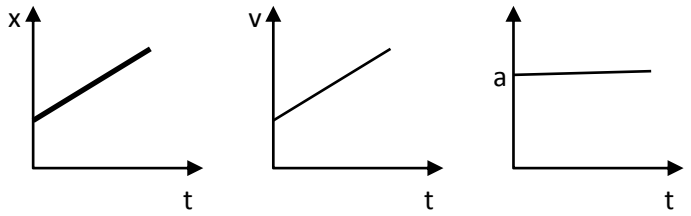
$\therefore$ Ionisation energy = 13.6 × 186 eV

10. An object is moving with constant acceleration. Choose the correct option.

(1)



(2)



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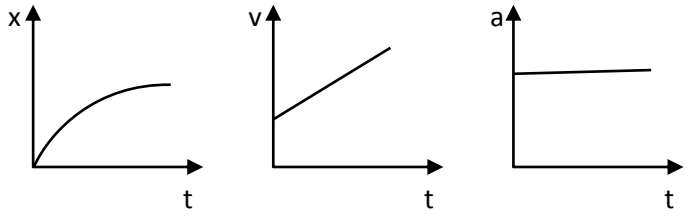
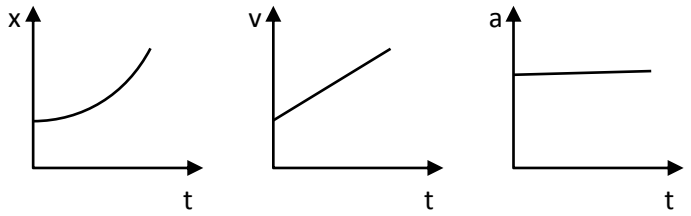


(4)



Ans. (4)

Sol. a = constant

$v \propto t$

$x \propto t^2$

11. A ring of mass M is rotating with constant angular velocity ω about axis of rotation passing through centre and perpendicular to the plane of ring. Two particles each of mass m are placed gently diametrically at opposite position. Find new angular velocity.

(1) $\left(\frac{M+2m}{M}\right)\omega$ (2) $\left(\frac{M\omega}{M+2m}\right)$ (3) $\left(\frac{M-2m}{M}\right)\omega$ (4) $\left(\frac{m\omega}{M+2m}\right)$

Ans. (3)

Sol. Using angular momentum conservation

$L_i = MR^2\omega$

$L_f = (MR^2 + 2mR^2)\omega'$

$\omega' = \left(\frac{M\omega}{M+2m}\right)$

12. Electromagnetic wave is propagating in x direction. Magnetic field in space is given by $\vec{B} = 2\times10^{-8}(T)\hat{k}$. What will be the value and direction of electric field.

(1) 0.6 $\hat{j}$ (2) 6 $\hat{j}$ (3) 0.6 $\hat{k}$ (4) 6 $\hat{k}$

Ans. (2)

Sol. E = CB

$E = 3 \times 10^8 \times 2 \times 10^{-8}$

E = 6

direction of $\vec{v}$ is $\vec{E}\times\vec{B}$

$\hat{i} = \hat{j}\times\hat{k}$

so $\vec{E} = 6\hat{j}$

13. A machine staring from Rest delivers constant Power 'P'. Then distance travelled by it in time 't' is proportional to:-

(1) $t^{-3/2}$ (2) $t^{1/2}$ (3) $t^{3/2}$ (4) $t^{-1/2}$

Ans. (3)

Sol. P = Fv

P = mav

$P\int dt = m\int v\,dv$

$m\frac{v^2}{2} = Pt$

$$v = \left(\frac{2Pt}{m}\right)^{1/2}$$

$$\frac{dx}{dt} = \left(\frac{2Pt}{m}\right)^{1/2}$$

$$x = \left(\frac{2P}{m}\right)^{1/2} \frac{t^{3/2}}{\frac{3}{2}}$$

$$x \propto t^{3/2}$$

14. An object is preforming SHM with time period 2 sec. If time taken by it to move from mean position to half of amplitude is $\frac{1}{K}$ sec. Then value of K is.

(1) 3 (2) 6 (3) 4 (4) 2

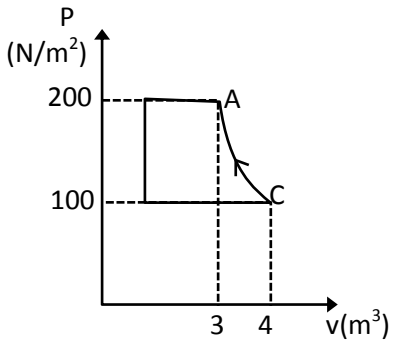
Ans. (2)

Sol. from 0 to $\frac{A}{2}$

time = $\frac{T}{12}$sec

$\frac{2}{12} = \frac{1}{6}$sec

15. In given P-V graph process CA is adiabatic. Find work done in process CA if gas is diatomic (γ = 1.4) :

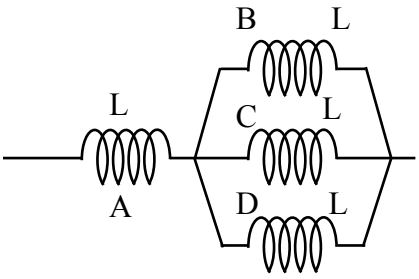


(1) –400 J (2) –500 J (3) 200 (4) 400

Ans. (2)

Sol. $W = \frac{nR\Delta T}{1-\gamma} = \frac{P_2V_2 - P_1V_1}{1-\gamma} = \frac{200\times3 - 4\times100}{1-1.4} = -500J$

16. Four identical solenoids are connected as shown in figure



If magnetic field in A is 3T, evaluate magnetic field in C

(1) 1T (2) 9T (3) 12T (4) 6T

Ans. (1)

Sol. $B_A = \mu_0 nI = 3T$

$$B_C = \mu_0 n \frac{I}{3}$$

$$B_C = 1T$$

17. In a wire V = 5.0V, I = 2.00A, L = 10.0 cm and diameter d = 5.00 mm. Evaluate $\frac{\Delta\rho}{\rho} \times 100$?

(1) 3.9% (2) 1.9% (3) 2.9% (4) 3%

Ans. (1)

Sol. $$\frac{\Delta\rho}{\rho} = \frac{\Delta R}{R} + \frac{\Delta\ell}{\ell} + \frac{2\Delta d}{d}$$

$$\frac{\Delta\rho}{\rho} = \frac{\Delta V}{V} + \frac{\Delta I}{I} + \frac{\Delta\ell}{\ell} + \frac{2\Delta d}{d}$$

$$\frac{\Delta\rho}{\rho}\% = \left(\frac{0.1}{5} + \frac{0.01}{2} + \frac{0.1}{10} + 2\times\frac{0.01}{5}\right) \times 100$$

$= 2 + 0.5 + 1 + 0.4 = 3.9\%$

18. A is forming B and C independently if A $\rightarrow$ B with half life = $T_{1/2}(B)$ and if A $\rightarrow$ C with half life $T_{1/2}(C)$ then what will be overall half life:

(1) $\frac{T_{1/2}(B)\times T_{1/2}(C)}{T_{1/2}(B)+T_{1/2}(C)}$ (2) $\frac{T_{1/2}(B)+T_{1/2}(C)}{T_{1/2}(B)\times T_{1/2}(C)}$

(3) $\frac{T_{1/2}(B)\times T_{1/2}(C)}{T_{1/2}(B)-T_{1/2}(C)}$ (4) $\frac{T_{1/2}(B)+T_{1/2}(C)}{T_{1/2}(B)-T_{1/2}(C)}$

Ans. (1)

Sol. $-\frac{dN_A}{dt} = \lambda_B N_A + \lambda_C N_A$

$= (\lambda_B + \lambda_C)N_A = \lambda_{eq} N_A$

$\lambda eq = \lambda B + \lambda C$

$\frac{\ln 2}{T_{eq}} = \frac{\ln 2}{T_{1/2B}} + \frac{\ln 2}{T_{1/2C}} \Rightarrow \frac{1}{T_{eq}} = \frac{1}{T_{1/2B}} + \frac{1}{T_{1/2C}}$

$T_{eq} = \frac{T_{1/2B} \times T_{1/2C}}{T_{1/2B} + T_{1/2C}}$

19. Two wires A and B of same material having elongation 2 mm and 4 mm respectively on applying 2N take. If radius of B is four times the radius of A and ratio of length of A is to B in the form of $\frac{1}{x}$ then the value of x is

Ans. 32.00

Sol. $\frac{F}{A} = Y\frac{\Delta L}{L}$

$\frac{F}{\pi r_A^2} = Y\frac{\Delta L_A}{L_A}$ _____(i)

$\frac{F}{\pi r_B^2} = Y\frac{\Delta L_B}{L_B}$ _____(ii)

$\left(\frac{r_B}{r_A}\right)^2 = \frac{\Delta L_A}{\Delta L_B} \times \frac{L_A}{L_B}$ $\quad r_B = 4r_A$

$16 = \frac{2}{4} \times \frac{L_B}{L_A}$ $\quad \frac{r_B}{r_A} = 4$

$\frac{L_B}{L_A} = 32$

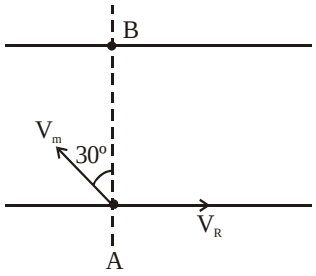
$\frac{a}{b} = \frac{1}{32}$

x = 32

20. A man is swimming in a river at an angle 120º with river flow. Speed of man in still water is 10m/s. If he reaches the other bank exactly opposite to origin point, find speed of flow of river (in m/s)

Ans. 5.00

Sol.



Net speed perpendicular to line.

AB must be zero.

$\therefore v_m \sin 30 = V_R$

$\therefore v_r = 5$ m/s

21. If ratio of de-Broglie wavelength of particle and electron is 2 : 1 and ratio of their velocity is 4 : 1. Then

(1) mass of particle is 8 times that of electron

(2) mass of electron is 8 times that of particle

(3) mass of electron is 16 times that of particle

(4) mass of particle is 16 times that of electron

Ans. (2)

Sol. $$\frac{\lambda_p}{\lambda_e} = \frac{\frac{h}{m_p v_p}}{\frac{\lambda}{m_e v_e}} \Rightarrow \frac{2}{1} = \frac{m_e v_e}{m_p v_p} = \frac{m_e}{m_p} \times \frac{1}{4}$$

$$\frac{m_e}{m_p} = 8$$

22. In the millikan oil drop experiment radius of drop is r = 2 mm and density $\rho = 3 gm/cm^3$. If the applied electric field is $E = 3.55 \times 10^5$ N/C. Find excess electrons.

(1) 1.769×10^{10} (2) 1.567×10^{10} (3) 1.769×10^{12} (4) 1.567×10^{12}

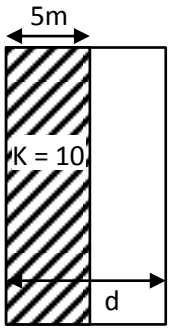
Ans. (1)

Sol. $mg = qE$

$$q = \frac{mg}{E}$$

$$N = \frac{mg}{eE} = \frac{3 \times 10^{-3} \times 10 \times \frac{4}{3}\pi \times 8 \times 10^{-9}}{10^{-6} \times 3.55 \times 10^5 \times 1.6 \times 10^{-19}} = 1.769 \times 10^{10}$$

23. A partially filled capacitor has half of its space filed with dielectric of relative permittivity 10. Equivalent capacitance if area of plates is 100 m^2 and distance between plates is 10 m is given as x pF. Find x? ($\varepsilon_0 = 8.85 \times 10^{-12}$)



Ans. 161.00

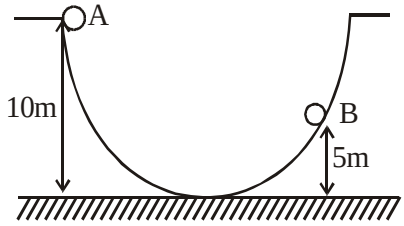
Sol. $C_2 = \frac{\in_0 \times 100}{5} = 20\varepsilon_0$

$C_1 = 10 \times \frac{\in_0 \times 100}{5} = 200\varepsilon_0$ $\qquad C_{eq} = \frac{c_1 c_2}{c_1 + c_2}$

$C_{eq} = \frac{4000 \in_0}{220}$

$= 160.90 \times 10^{-12} = 161$ pF

24. A ball is released from point A. Evaluate its velocity (m/s) when it reaches to point B (assume frictionless surface):



Ans. 10.00

Sol. $mg(5) = \frac{1}{2}mv^2$

$V = 10$ m/s.

25. Initially a body of mass 10 kg is moving along x-axis with velocity $10\sqrt{3}$ m/s. It collides with another body of mass 20 kg and comes to rest. The 20 kg mass object disintegrates in 2 parts each of mass 10 kg. One part moves along y-axis with velocity 10 m/s and another at 30° with x-axis. Evaluate the velocity of the object which moves at angle 30° with x-axis.

Ans. 20.00

Sol. $|\vec{v}| = 20\,m/s$

$$10\times10\sqrt{3}\hat{i} = 10\times10\hat{j} + 10\vec{v}$$

$$\frac{100\sqrt{3}\hat{i} - 100\hat{j}}{10} = \vec{v}$$

$$\vec{v} = 10\sqrt{3}\hat{i} - 10\hat{j}$$

26. A bullet of mass 0.1 kg initially moving with a velocity 10 m/sec and then passes through a wooden block and comes to rest with uniform deceleration by travelling 50cm. If the force exerted by wooden block on bullet is x newton, then find x.

Ans. 10.00

Sol. $v^2 = u^2 + 2as$

$$0 = 100 + 2(-a)\left(\frac{1}{2}\right)$$

$a = 100\ m/s^2$

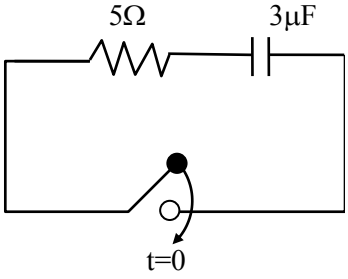
$F = ma = (0.1)(100)$

$F = 10\ N$

27. A capacitor of capacitance 3 μF has charge 30 nC is connected to a resistance of 5Ω. If current in circuit just after closing the switch is x A. Then x is :

Ans. 2.00

Sol.



$$q = Qe^{\frac{-t}{RC}}$$

$$I = \frac{Q}{RC}e^{\frac{-t}{RC}}$$

$$I(t=0) = \frac{Q}{RC} = \frac{30}{5\times3} = 2A$$

28. Coming soon.

29. Coming soon.

30. Coming soon.