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) FEB 2021 RESULT
Legacy of producing Best Results Proved again

100%tile in MATHS
PRANAV JAIN
Roll No. : 2071421
99.993%tile Overall

100%tile in MATHS & PHYSICS
KHUSHAGRA GUPTA
Roll No. : 2075433

RESULT HIGHLIGHTS
21 Students Secured 100%tile in Maths / Physics
138 students secured above 99%tile (Overall)
All are from KOTA CLASSROOM only

TARGET JEE (MAIN+ADV) 2021
SHAKTI COMPACT COURSE
for XII passed students

Course Duration 250+ hrs
Starting from 22nd Mar 2021
Course will be available in both Offline & Online mode

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**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?

   ![Circuit Diagram]

   **Ans.** 70.00
Sol. \[ R_{eq} = \frac{10}{50} \times 20 + \frac{10}{50} \times 20 \]
\[ = \frac{170}{7} \Omega \]
\[ I = \frac{V}{R_{eq}} = \frac{170}{170} \times 7 = 7amp \]
\[ V_{10\Omega} = IR \]
\[ = 7 \times 10 = 70v \]

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 \( i_{max} \).

\[ \text{R} \]
\[ \sim \]
\[ 220 \text{ v, 50 Hz} \]

   (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 \( t = 0, \ i = i_{rms} \)
   \[ i_{rms} = \sqrt{2} \ (i_{rms}) \sin 0 \]
   \[ \theta = \frac{\pi}{4} \]
\[ i = i_{\text{max}} \sin \left( \frac{\omega t + \pi}{4} \right) \]

at \( t = t_1 \), \( i = i_{\text{max}} \)

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

\[ \frac{\omega t_1 + \pi}{4} = \frac{\pi}{2} \]

\[ \frac{\omega t_1 + \pi}{4} = \frac{\pi}{4} \]

\[ \frac{2\pi}{T} t_1 = \frac{\pi}{4} \]

\[ t_1 = \frac{T}{8} \]

\[ t_1 = \frac{1(1)}{8 \left( \frac{1}{50} \right)} = \frac{1}{8 \left( \frac{1}{50} \right)} \]

\[ t_1 = \frac{1000}{400} \text{ m sec} = 2.5 \text{ m sec} \]

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. \( \omega = \frac{1}{\sqrt{LC}}, Q = \frac{1}{\frac{R}{\sqrt{LC}}}, \text{ Band width} = \frac{R}{L} \)

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

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

Ans. (1)

Sol. Distance between 1\(^{st}\) & 3\(^{rd}\) maxima will be 3\( \beta \).

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

\[ = 11780 \times 10^{-7} \text{ m} \]
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 mₑ) revolves around hydrogen nucleus. Find its ionisation energy?
   \[m_e = \text{mass of electron}\]
   (1) 13.6 eV (2) 27.2 eV (3) 13.6 × 207 eV (4) 331.8 eV
Ans. (Bonus)
Sol. \[E_n = -13.6 \times \frac{\mu}{m_e} \text{ eV}\]
   \[\mu = \frac{(1836m_e)(207m_e)}{(1836 + 207)m_e} = \frac{1836 \times 207}{2043} = 186 m_e\]
   \[\therefore \text{Ionisation energy} = 13.6 \times 186 \text{ eV}\]

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

Ans. (4)
11. A ring of mass M is rotating with constant angular velocity $\omega$ 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.

$$\begin{align*}
(1) & \left( \frac{M+2m}{M} \right)^\omega \\
(2) & \left( \frac{M\omega}{M+2m} \right) \\
(3) & \left( \frac{M-2m}{M} \right)^\omega \\
(4) & \left( \frac{m\omega}{M+2m} \right)
\end{align*}$$

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 $\vec{B} = 2 \times 10^{-8} \text{T}\hat{k}$. What will be the value and direction of electric field.

$$\begin{align*}
(1) & 0.6 \hat{j} \\
(2) & 6 \hat{j} \\
(3) & 0.6 \hat{k} \\
(4) & 6 \hat{k}
\end{align*}$$

Ans. (2)

Sol. $E = CB$

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

$E = 6$

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

$i = j \times k$

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

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

$$\begin{align*}
(1) & t^{3/2} \\
(2) & t^{1/2} \\
(3) & t^{3/2} \\
(4) & t^{-1/2}
\end{align*}$$

Ans. (3)

Sol. $P = Fv$

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

$m \frac{v^2}{2} = Pt$
\[
v = \left(\frac{2Pt}{m}\right)^{1/2}
\]
\[
\frac{dx}{dt} = \left(\frac{2Pt}{m}\right)^{1/2}
\]
\[
x = \left(\frac{2P}{m}\right)^{1/2} \frac{t^{3/2}}{\frac{3}{2}}
\]
\[
x \propto t^{3/2}
\]

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 \(\frac{A}{2}\)

\[
time = \frac{T}{12} \text{ sec}
\]
\[
\frac{2}{12} = \frac{1}{6} \text{ sec}
\]

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

\[
W = \frac{nR\Delta T}{1-\gamma} = \frac{P_2V_2 - P_1V_1}{1-\gamma} = \frac{200 \times 3 - 4 \times 100}{1-1.4} = -500 \text{J}
\]

(1) –400 J  (2) –500 J  (3) 200  (4) 400

Ans. (2)

Sol. \[
W = \frac{nR\Delta T}{1-\gamma} = \frac{P_2V_2 - P_1V_1}{1-\gamma} = \frac{200 \times 3 - 4 \times 100}{1-1.4} = -500 \text{J}
\]
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. \( B_A = \mu_0 n I = 3T \)

\[ B_C = \mu_0 n \frac{1}{3} \]

\[ B_C = 1T \]

17. In a wire \( V = 5.0V, I = 2.00A, L = 10.0 \text{ cm} \) and diameter \( d = 5.00 \text{ mm} \). 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. \[-\frac{dN_A}{dt} = \lambda_B N_A + \lambda_C N_A\]
\[= (\lambda_B + \lambda_C) N_A = \lambda_{eq} N_A\]
\[\lambda_{eq} = \lambda_B + \lambda_C\]
\[\ln 2 \quad T_{eq} = \ln \frac{2}{T_{1/2B} + T_{1/2C}} \Rightarrow \frac{1}{T_{eq}} = \frac{1}{T_{1/2B}} + \frac{1}{T_{1/2C}}\]
\[T_{eq} = \frac{T_{1/2B} \times T_{1/2C}}{T_{1/2B} + T_{1/2C}}\]

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. \[\frac{F}{A} = Y \frac{\Delta L}{L}\]
\[\frac{F}{\pi A^2} = Y \frac{\Delta L_A}{L_A} \quad \text{(i)}\]
\[\frac{F}{\pi B^2} = Y \frac{\Delta L_B}{L_B} \quad \text{(ii)}\]
\[\left(\frac{r_B}{r_A}\right)^2 = \frac{\Delta L_A}{\Delta L_B} \times \frac{L_A}{L_B} \quad \frac{r_B}{r_A} = 4\]
\[16 = \frac{2}{4} \times \frac{L_B}{L_A} \quad \frac{r_B}{r_A} = 4\]
\[L_B \quad L_A = 32\]
\[\frac{a}{b} = \frac{1}{32}\]
\[x = 32\]

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
Net speed perpendicular to line.
AB must be zero.
\[ \therefore v_m \sin 30 = V_R \]
\[ \therefore v_t = 5 \text{ m/s} \]

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)

22. In the millikan oil drop experiment radius of drop is \( r = 2 \text{ mm} \) and density \( \rho = 3 \text{ gm/cm}^3 \). If the applied electric field is \( E = 3.55 \times 10^5 \text{ N/C} \). Find excess electrons.
(1) \( 1.769 \times 10^{10} \)
(2) \( 1.567 \times 10^{10} \)
(3) \( 1.769 \times 10^{12} \)
(4) \( 1.567 \times 10^{12} \)

Ans. (1)
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 m² and distance between plates is 10 m is given as \( x \) pF. Find \( x \)? \( (\varepsilon_0 = 8.85 \times 10^{-12}) \)

\[
C_1 = 10 \times \frac{\varepsilon_0 \times 100}{5} = 200\varepsilon_0 \\
C_2 = \frac{\varepsilon_0 \times 100}{5} = 20\varepsilon_0 \\
C_{eq} = \frac{C_1 \times C_2}{C_1 + C_2} \\
C_{eq} = \frac{4000 \varepsilon_0}{220} = 160.90 \times 10^{-12} = 161 \text{ pF}
\]

**Ans.** 161.00

**Sol.**

\[
C_{eq} = \frac{C_1 \times C_2}{C_1 + C_2} = \frac{4000 \varepsilon_0}{220} = 160.90 \times 10^{-12} = 161 \text{ pF}
\]

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

\[
m \cdot g(5) = \frac{1}{2} m v^2
\]

\[V = 10 \text{ m/s}.
\]

**Ans.** 10.00

**Sol.**

\[
m \cdot g(5) = \frac{1}{2} m v^2
\]

\[V = 10 \text{ m/s}.
\]

25. Initially a body of mass 10 kg is moving along x-axis with velocity \( 10\sqrt{3} \text{ m/s} \). 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
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 50 cm. If the force exerted by wooden block on bullet is x newton, then find x.

**Ans.** 10.00

**Sol.**

\[ v^2 = u^2 + 2as \]

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

\[ a = 100 \text{ m/s}^2 \]

\[ F = ma = (0.1) (100) \]

\[ F = 10 \text{ N} \]

27. A capacitor of capacitance 3 \( \mu \text{F} \) has charge 30 nC is connected to a resistance of 5 \( \Omega \). If current in circuit just after closing the switch is x A. Then x is:

**Ans.** 2.00

**Sol.**

\[ q = Qe^{-\frac{t}{RC}} \]

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

\[ I(t = 0) = \frac{Q}{RC} = \frac{30}{5 \times 3} = 2 \text{ A} \]