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Unleashing Potential

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

JEE (Main) 2021

Question & Solutions

(Reproduced from memory retention)

Date : 25 February, 2021 (SHIFT-2) Time ; (3.00 pm to 6.00 pm)

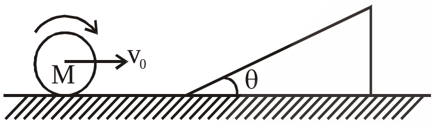
Duration : 3 Hours | Max. Marks : 300

SUBJECT : PHYSICS

JEE-MAIN 2021 FEBRUARY ATTEMPT

PHYSICS

1. A solid sphere as shown is rolling without slipping. Find maximum length travelled on an inclined plane?



(1) $\frac{7v^2}{10g\sin\theta}$ (2) $\frac{10v^2}{7g\sin\theta}$ (3) $\frac{5v^2}{7g\sin\theta}$ (4) $\frac{7v^2}{5g\sin\theta}$

Ans. (1)

Sol. $Mg\,(\ell\sin\theta) = \frac{1}{2}MV_0^2 + \frac{1}{2}\times\frac{2}{5}MV_0^2$

$\therefore\ Mg\ell\sin\theta = \frac{7}{10}MV^2 \quad \therefore \ell = \frac{7v^2}{10g\sin\theta}$

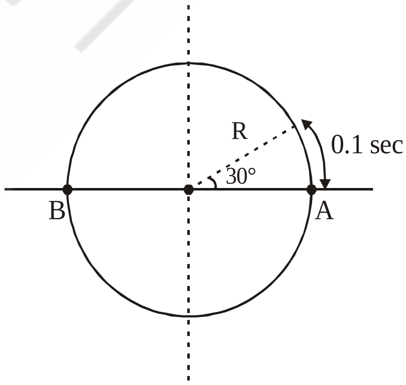
2. In an amplitude modulated wave, message wave frequency f_m and carrier wave frequency f_c. Find out wavelength of amplitude modulated wave.

(1) $\frac{c}{f_c}$ (2) $\frac{c}{f_m}$ (3) $\frac{c}{f_c+f_m}$ (4) $\frac{c}{f_c-f_m}$

Ans. (1)

Sol. Using theory $\lambda = \frac{c}{f_c}$

3. A unit mass particle is moving in a circle of radius R such that its projection on diameter executes SHM. In 0.1 sec interval, particle undergoes angular displacement of 30°. Find force acting on particle at position B. If it starts from A. (R = 0.36m)



(1) 9.7 (2) 0.1 (3) 100 (4) 53.2

Ans. (1)

Sol. Particle is in uniform circular motion.

$$\therefore \quad \omega = \frac{\frac{\pi}{6}}{0.1} = \frac{10\pi}{6} = \frac{5\pi}{3}$$

$$\therefore \quad F = m\omega^2 R = 1 \times \frac{25\pi^2}{9} \times 0.36 = \pi^2$$

4. Sun light is diffracted through a circular aperture of diameter $0.1\mu m$. If diameter is slightly increased then

(1) Size of circular fringe will increase, intensity decrease.

(2) Size of circular fringe will decrease, intensity increase.

(3) Size of circular fringe will increase, intensity increase.

(4) Size of circular fringe will decrease, intensity decrease.

Ans. **(2)**

Sol. $\sin\theta = \frac{1.22\lambda}{D} \Rightarrow$ If D is increased $\Rightarrow \sin\theta$ decreased

$\therefore$ size of circular fringe will decrease

Intensity will increase.

5. Proton and electron are moving along circular path with same speed. Find out ratio of debroglie wavelength that is $\frac{\lambda_e}{\lambda_p}$. If $m_p = 1836\ m_e$.

(1) 1836 (2) 1837 (3) $\frac{1}{1836}$ (4) $\frac{1}{1837}$

Ans. (1)

Sol. $\lambda = \frac{h}{mv}$

$$\frac{\lambda_e}{\lambda_p} = \frac{m_p}{m_e} = 1836$$

6. Find out dimension of $\frac{1}{4\pi\varepsilon_0}\frac{e^2}{hc}$ where e : electronic charge, ε_0 = permittivity of free space, h : plank constant, c : speed of light

(1) $M^1L^1T^{-2}C^2$ (2) $M^2L^2T^{-3}C^2$ (3) $M^1L^1T^{-2}C^2$ (4) Dimension less

Ans. (4)

Sol. $\frac{1}{4\pi\varepsilon_0}\frac{e^2}{hc} = \frac{Ke^2 \times \lambda^2}{\lambda^2 \times hc} = \frac{F \times \lambda}{E} = \frac{E}{E}$ **:** dimension less

7. In a given AC series circuit containing elements R, L and C & source voltage = 220v, it is known that if L alone is removed or if C alone is removed, phase difference between current & voltage remains 45º. Find i_{RMS} ? (R = 110 Ω)

(1) 2A (2) 2.5A (3) 1A (4) 1.5A

Ans. (1)

Sol. Since ϕ remains same,

circuit is in resonance.

$$\therefore i_{RMS} = \frac{V_{RMS}}{Z} = \frac{220}{110} = \boxed{2A}$$

8. **Statement-1 :** Rotational KE of a gas molecule follows Maxwell's speed distribution curve.

Statement-2 : Rotational KE & translational KE of a diatomic gas molecule is same.

(1) 1-true 2-false (2) 1-false 2-true

(3) 1-false 2-false (4) 1-true 2-true

Ans. **(3)**

Sol. Maxwell's Boltzmann distribution curve is always drawn for no. of molecules (N) vs velocity of molecules. so statement-1 is false.

T.K.E. of diatomic molecule = $\frac{3}{2}$KT

R.K.E. of diatomic molecule = $\frac{2}{2}$KT

Statement-2 is false.

9. If an electron of a hydrogen atom jumps from n = 2 to n = 1 then find the wavelength of released photon.

(1) 121.5 nm (2) 123.15 nm (3) 125.15 nm (4) 128.15 nm

Ans. (1)

Sol. $13.6 \times \left(1 - \frac{1}{4}\right) = \frac{1240}{\lambda(nm)}$

$\lambda = \frac{4 \times 1240}{13.6 \times 3}$ nm = 121.5 nm

10. In photoelectric effect of a certain metal the stopping potential is 0.71 V if the wavelength of incident radiation is 491 nm. Now the stopping potential comes out to be 1.43 V if the wavelength of incident radiation is:

(1) 390 nm (2) 382 nm (3) 275 nm (4) 392 nm

Ans. (2)

Sol. $\frac{hc}{\lambda} = \phi + eV_s$.

$$\frac{1240}{491} = \phi + 0.71$$

$$\frac{1240}{\lambda} = \phi + 1.43$$

$$1240\left(\frac{1}{\lambda} - \frac{1}{491}\right) = 0.72$$

$\lambda = 382$ nm

11. Two particles having mass $M_1 = 4$ gm, $M_2 = 16$ gm. If kinetic energy of both the particle is equal then ratio of their momentum is n : 2 then n is:

(1) 2 (2) 1/2 (3) 4 (4) 1/4

Ans. **(2)**

Sol. $K_1 = \frac{P_1^2}{2m_1}$ & $K_2 = \frac{P_2^2}{2m_2}$

$$\therefore \frac{K_1}{K_2} = \left(\frac{P_1}{P_2}\right)^2 \times \left(\frac{M_2}{M_1}\right)$$

$$\therefore \left(\frac{P_1}{P_2}\right)^2 = \frac{M_2}{M_1} \quad \Rightarrow \frac{P_1}{P_2} = \sqrt{\frac{M_2}{M_1}} = \frac{1}{2}.$$

12. An electron enters in a capacitor making an angle α with one plane having kinetic energy K_1 and comes out with kinetic energy K_2 making an angle β with other plane. Find ratio of K_1 and K_2

(1) $\frac{\cos^2\beta}{\cos^2\alpha}$ (2) $\frac{\cos^2\alpha}{\cos^2\beta}$ (3) $\frac{\sin^2\alpha}{\sin^2\beta}$ (4) $\frac{\sin^2\beta}{\sin^2\alpha}$

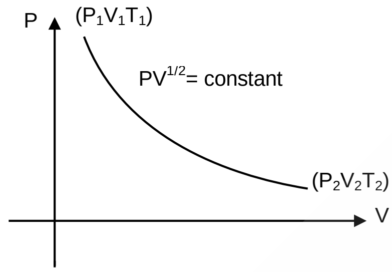
Ans. **(1)**

Sol. $v_1 \cos\alpha = v_2 \cos\beta$

$$v_1^2 \cos^2\alpha = v_2^2 \cos^2\beta$$

$$\frac{K_1}{K_2} = \frac{\cos^2\beta}{\cos^2\alpha}$$

13. A gas follows $PV^{1/2}$ = constant as shown. If $V_2 = 2V_1$, find $\frac{T_2}{T_1}$?



(1) $\frac{1}{\sqrt{2}}$ (2) $\sqrt{2}$ (3) $\sqrt{3}$ (4) $\frac{1}{\sqrt{3}}$

Ans. (2)

Sol. $PV^{1/2} = C$

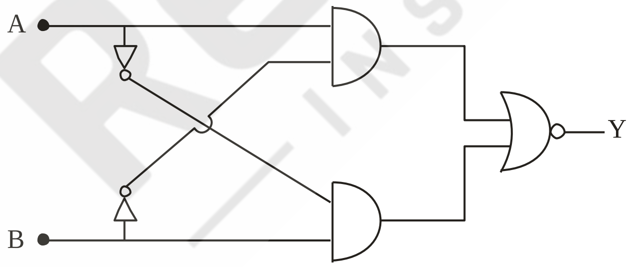
$\therefore\ TV^{-1/2} = C$

$\therefore\ \frac{T_1}{\sqrt{V_1}} = \frac{T_2}{\sqrt{V_2}}$

$\therefore\ \left(\frac{T_2}{T_1}\right)^2 = \frac{V_2}{V_1} = 2$

$\therefore\ \frac{T_2}{T_1} = \sqrt{2}$

14. For given logic gates circuit, which truth table is right.



(1)

A	B	Y
0	0	1
1	0	0
0	1	0
1	1	1

(2)

A	B	Y
0	0	0
1	0	1
0	1	0
1	1	0

(3)

A	B	Y
0	0	0
1	0	0
0	1	0
1	1	1

(4)

A	B	Y
0	0	0
1	0	1
0	1	1
1	1	1

Ans. **(1)**

Sol. $Y = \overline{A\bar{B} + \bar{A}B}$

$Y = \overline{A\bar{B}} \cdot \overline{\bar{A}B}$

$Y = (\bar{A} + B) \cdot (A + \bar{B})$

$Y = \bar{A} \cdot A + \bar{A}\,\bar{B} + A \cdot B + B\bar{B}$

$Y = AB + \bar{A}\,\bar{B}$

15. Match the column I and column II.

Column I	**Column II**
(A) Transformer	(P) AC to DC
(B) Rectifier	(Q) Step up – Step down
(C) Filter	(R) Ripple is removed
(D) Stabiliser	(S) For any input, output would be same

(1) A→Q B→P C→R D→S

(2) A→Q B→P C→S D→R

(3) A→P B→Q C→R D→S

(4) A→P B→Q C→S D→R

Ans. (1)

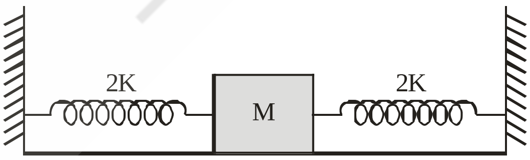
Sol. Transformer → Step up – Step down

Rectifier → AC to DC

Filter → Ripple is removed

Stabiliser → For any input, output would be same

16. Find time period of oscillation of mass M, assume surface to be smooth.



(1) $2\pi\sqrt{\frac{M}{K}}$ (2) $2\pi\sqrt{\frac{M}{4K}}$ (3) $2\pi\sqrt{\frac{2M}{K}}$ (4) $2\pi\sqrt{\frac{3M}{2K}}$

Ans. **(2)**

Sol. $K_{eff} = 2K + 2K = 4K$

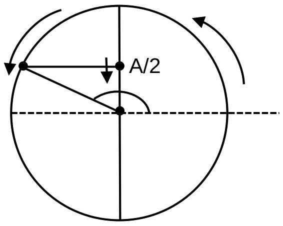
$\therefore\ T = 2\pi\sqrt{\frac{M}{4K}}$

17. **A** particle starts performing SHM on a smooth horizontal plane and it is released from $x = \frac{A}{2}$ & it's moving in –ve x-direction then ϕ = ?

(1) $\frac{\pi}{6}$ (2) $\frac{5\pi}{6}$ (3) $\frac{2\pi}{3}$ (4) $\frac{\pi}{3}$

Ans. (2)

Sol.



$\phi = \frac{\pi}{2} + \frac{\pi}{3}$

$\phi = \frac{5\pi}{6}$

18. For an extrinsic semiconductor if doping concentration is increases then.

(1) For N type and P-type fermi level will increase if $T > T_f$ (T=temp of semi-conductor, T_f = fermi Temp.)

(2) For N type fermi level will increase and for P type fermi level will decrease.

(3) For N-type fermi level will decrease and for P-type fermi level will increase.

(4) For N-type fermi level will decrease and for P-type fermi level will decrease.

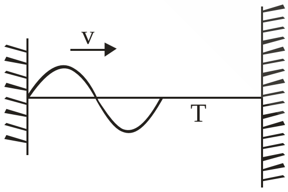
Ans. 2

Sol. The variation of the fermi level obeys two conditions.

$\rightarrow$ The mass action law

$\rightarrow$ The neutrality equation.

19. If tension is increased by 4% in vibrating string, find % change in speed of wave?



Tension = T

Ans. **2**

Sol. $v = \sqrt{\frac{T}{\mu}}$

$$\therefore \ \ell nv = \frac{1}{2}\ell nT - \frac{1}{2}\ell n\mu$$

$$\%\frac{dv}{v} = \%\frac{1}{2}\frac{dT}{T}$$

$$\therefore \ \%\frac{dv}{v} = \frac{1}{2}\times 4 = 2\%$$

20. If $\vec{p}\times\vec{g}=\vec{g}\times\vec{p}$ and angle between $\vec{p}$ & $\vec{g}$ is θ where $\theta \in (0, 360°)$ then value of θ is:

Ans. 180°

Sol. $\vec{p}\times\vec{g} = \vec{g}\times\vec{p}$ only if $\vec{p}=0$ or $\vec{g}=0$ or angle between them is 0° or 180°.

$\therefore \theta = 180°$

21. A satellite is projected from surface of earth so that it can attain 10R height from surface of earth. Its speed at surface of earth is $v = V_{escape}\ x\sqrt{\frac{x}{11}}$ find x.

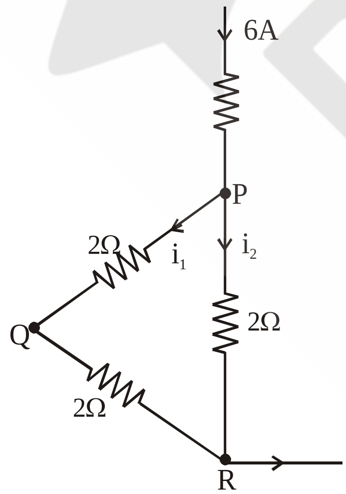
Ans. 10

Sol. $$-\frac{GMm}{R}+\frac{1}{2}mv^2 = -\frac{GMm}{11R}$$

$$\frac{1}{2}mv^2 = \frac{10GMm}{11R}$$

$$v = V_{escape}x\sqrt{\frac{10}{11}}$$

$x = 10$

22. 

Find i_1 = ?

Ans. **2 A**

23. For Carnot engine $\frac{W}{Q_{in}} = \frac{1}{4}$. If sink temperature is decreased by 52°C then $\frac{W}{Q_{in}} = \frac{1}{2}$. Find out source temperature in °C.

Ans. 208 °C

Sol. $\frac{W}{Q_{in}} = \frac{1}{4} = 1 - \frac{T_2}{T_1}$

$$\frac{T_2}{T_1} = \frac{3}{4} \qquad \text{...(i)}$$

$$\frac{W}{Q_{in}} = \frac{1}{2} = 1 - \frac{(T_2 - 52°)}{T_1}$$

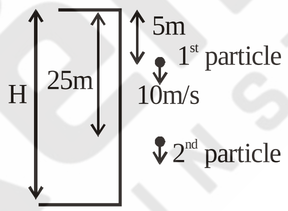
$$\frac{T_1}{2} = T_2 - \frac{3}{4}T_1 + 52°$$

T_1 = 208 °C

24. A particle is dropped from the top of a tower. When it has travelled a distance of 5m, another particle is dropped from a distance of 25m below the top of tower. If both of them reach the bottom of tower simultaneously, then find the height of tower.

Ans. 45 m

Sol. At the instant 2nd particle is dropped 1st particle is moving at 10 m/s & has moved for time 1s.



Time for particles to meet, $\Delta t = \frac{S_{rel}}{V_{rel}} = \frac{20}{10} = 2s$

$\therefore$ Time taken by first particle to reach ground = 3s

H = $\frac{1}{2}g(3)^2 = 45m$

25. For a x-ray if it's wavelength is 10A° & mass of a particle having same energy and same wavelength as x-ray is $\frac{xh}{3}$ where h is plank's constant then value of x is:

Ans. 5

Sol. $\frac{hc}{\lambda} = \frac{1}{2}mv^2$

$$\frac{hc}{\lambda} = \frac{m^2v^2}{2m}$$

$$\frac{hc}{\lambda} = \frac{h^2}{\lambda^2(2m)}$$

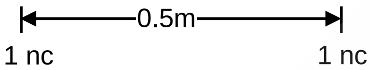
$$m = \frac{h}{2c\lambda} = \frac{h}{2(3\times10^8)(10\times10^{-10})}$$

$$m = \frac{5h}{3}$$

26. Two conducting charge particles of negligible volume whose charges are 2.1 nc and –0.1 nc respectively are brought in contact and then separated by 0.5 m. If force of interaction between them is x × (10^{-9})N then x is :-

Ans. 36

Sol.



$$F = \frac{K(1\times10^{-9})(1\times10^{-9})}{(0.5)^2} = 36 \times 10^{-9}N$$

x = 36

27. Coming soon.

Ans.

Sol.

28. Coming soon.

Ans.

Sol.

29. Coming soon.

Ans.

Sol.

30. Coming soon.

Ans.

Sol.