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JEE MAIN 2024

JANUARY ATTEMPT

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

QUESTIONS & SOLUTIONS

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27 JANUARY, 2024

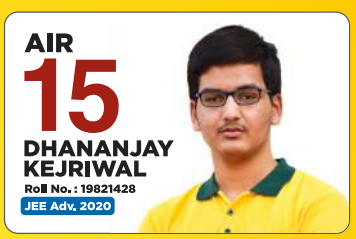
03:00 PM to 06:00 PM

Duration : 3 Hours | Maximum Marks : 300

SUBJECT - PHYSICS

LEAGUE OF TOPPERS (Since 2020)

TOP 100 AIRs IN JEE ADVANCED



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PHYSICS

1. An equation of real gas $\left(p-\frac{a}{V^2}\right)(V-b)=RT$

then dimension of $\left(\frac{a}{b^2}\right)$ is

P : Pressure

V = Volume

R = Gas constant

T = Temperature

(1) $[ML^{-1}T^{-2}]$ (2) $[MLT^{-2}]$ (3) $[ML^2T^{-2}]$ (4) $[MLT^{-1}]$

Ans. **(1)**

Sol. Basic theory

2. **Assertion:** There can be positive zero error in vernier calliper.

Reason: Due to mishandling or rough handling of instrument

(1) Assertion true, reason true and reason is correct explanation of assertion

(2) Assertion true, reason true and reason is not correct explanation of assertion

(3) Assertion true, reason false

(4) Assertion false, reason true

Ans. **(1)**

3. In a RLC series circuit R = 10Ω, L = $\frac{100}{\pi}$mH, C = $\frac{10^{-3}}{\pi}$F and frequency is 50 Hz. Find power factor.

Ans. **1**

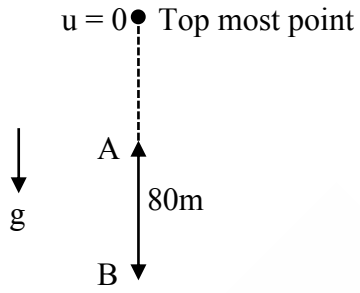
Sol. $X_L = \frac{100}{\pi}\times 2\pi\times 50\times 10^{-3} = 10\Omega$

$X_C = \frac{1}{2\pi\times 50\times\frac{10^{-3}}{\pi}} = 10\Omega$

$X_L = X_C$

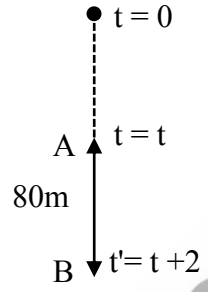
$\cos\phi = 1$

4. A stone is released and while free-fall stone covers 80 m distance in last 2 sec. Find distance of point A from top most point.



Ans. 45

Sol.



$S = ut + \frac{1}{2}gt^2$

$5(t+2)^2 - 5t^2 = 80 \Rightarrow t = 3\text{sec}$

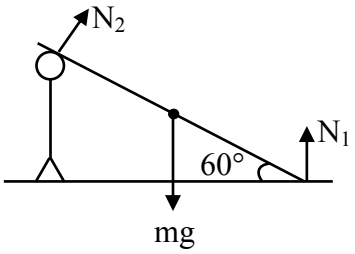
$S_A = 0 + \frac{1}{2} \times 10 \times 3^2 = 45\text{m}$

5. A person is standing on horizontal ground. A rod of mass 12 kg is touching a shoulder of person and other end is resting on ground. Angle made by rod with horizontal is 60°. Reaction force applied by person on rod is

(1) 60 N (2) 30 N (3) 90 N (4) 120 N

Ans. (2)

Sol.

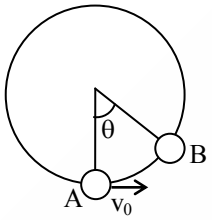


Taking torque about N_1.

$mg.\frac{\ell}{2}\cos 60° = N_2.\ell$

$N_2 = 30$ N

6. Point 'B' is at highest point of trajectory of object. Magnitude of acceleration at 'A' and 'B' is equal. Find the angle 'θ' as shown.



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

Ans. **(1)**

Sol. Apply work energy theorem

$mg\ell(1-\cos\theta) = \frac{1}{2} m v_0^2$

$\frac{v_0^2}{\ell} = 4g\sin^2\left(\frac{\theta}{2}\right)$ ....(1)

$g\sin\theta = \frac{v_0^2}{\ell}$ ....(2)

$\tan\left(\frac{\theta}{2}\right) = \frac{1}{2}$

$\theta = 2\tan^{-1}\left(\frac{1}{2}\right)$

7. In an adiabatic process, pressure is proportional to cube of temperature. Find the ratio C_p/C_v.

Ans. **3/2**

Sol. $PT^{\gamma/1-\gamma}$ = constant

$P \propto T^3$

$PT^{-3} = C$

$\frac{\gamma}{1-\gamma} = -3$

$\gamma = -3 + 3\gamma$

$2\gamma = 3$

$\gamma = 3/2$

8. **Assertion:** Angular velocity of earth around sun is lesser than the angular velocity of moon about earth.

Reason: Time taken by moon revolve around earth is less than time taken by earth to revolve around sun.

(1) Both Assertion (A) and Reason (R) are true & correct explanation of Assertion 'A'

(2) Both 'A' and 'R' are correct but 'R' is not correct explanation of 'A'

(3) 'A' is correct and 'R' is false

(4) 'A' is false and 'R' is correct

Ans. **(1)**

Sol. $\boxed{T = \frac{2\pi}{\omega}}$ $T_{earth} = 365$ days

$T_{moom} = 27$ days

9. If wave function of a metal is 6.68eV. Find threshold frequency.

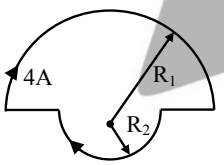
(1) 8×10^{15} Hz (2) 1.6×10^{15} Hz (3) 10×10^{15} Hz (4) 4×10^{15} Hz

Ans. **(2)**

Sol. $6.68 \times 1.6 \times 10^{-19} = 6.626 \times 10^{-34}\ v_0$

$1.6 \times 10^{15}\text{Hz} = v_0$

10. Find magnetic field strength at the centre of loop.



$R_1 = \frac{\pi}{2}$

$R_2 = \frac{\pi}{4}$

Ans. **24×10^{-7} Tesla**

Sol. $B_{centre} = \frac{\mu_0(i)}{4R_1} + \frac{\mu_0 i}{4R_2}$

$= \frac{\mu_0 \times 4}{4}\left[\frac{1}{R_1} + \frac{1}{R_2}\right]$

$= \mu_0\left[\frac{2}{\pi} + \frac{4}{\pi}\right]$

$= 4\pi \times 10^{-7}\left[\frac{6}{\pi}\right]$

$= 24 \times 10^{-7}$ Tesla

11. **Assertion:** If external force is removed, then body will try to regain its actual shape, this is called elasticity.

Reason: Due to intermolecular force, this happens

(1) Assertion True, Reason True & Reason is correct explanation of assertion

(2) Assertion True, Reason True & Reason is not correct explanation of assertion

(3) Assertion True, Reason false

(4) Assertion false, Reason True

Ans. **(1)**

12. A bullet gets embedded in a fixed target. It is found that bullet losses $1/3^{rd}$ of its velocity in traveling 4 cm into target and losses remaining kinetic energy while traveling further $d \times 10^{-3}$ m. Find d.

Ans. **32**

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

$$\left(\frac{2u}{3}\right)^2 = u^2 + 2(-a)(4cm) \quad \ldots.(1)$$

for next

$$O = \left(\frac{2u}{3}\right)^2 + 2(-a)(x)] \quad \ldots.(2)$$

using equation (i) &(ii)

$x = 32 \times 10^{-3}$ m

So d = 32

13. 1 mole of an ideal O_2 gas is at 27ºC. Find its total kinetic energy?

(1) 1250 J (2) 6250 J (3) 645 J (4) 1025 J

Ans. **(2)**

Sol. **Kinetic Energy** = $\frac{n}{2}fRT$

KE = $\frac{1}{2} \times 5 \times \frac{25}{3} \times 300$

= 6250 J

14. Light of intensity $I = 6 \times 10^8 \frac{W}{m^2}$ is incident on an object kept in medium of refractive index, $\mu = 3$ assuming 100% absorption. Find radiation pressure (N/m^2)?

Ans. **6**

Sol. $\text{Radiation} = \frac{IA}{\left(\frac{hv}{\lambda}\right)}\left(\frac{h}{\lambda}\right)\frac{1}{A} = \frac{I}{v} = \frac{I}{C}\mu = \frac{6 \times 10^8 \times 3}{3 \times 10^8} = 6$

15. A ring and a solid sphere of same mass and radius are released from same point of inclined plane. Find the ratio of their KE when they reach to bottom without slipping

(1) 1 : 7 (2) 1 : 3 (3) 1 : 5 (4) 1 : 1

Ans. **(4)**

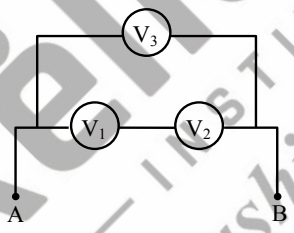
Sol. EC

$mgh = k_f - k_i$

$k_f = mgh$

so $KE_{Ring} = K.E._{\cdot solid\ sphere}$

16. Three voltmeters of different internal resistances are connected as shown in figure and a certain voltage is applied across AB. State which is true?



(1) $V_1 + V_2 > V_3$ (2) $V_1 + V_2 \neq V_3$ (3) $V_1 + V_2 = V_3$ (4) $V_1 + V_2 < V_3$

Ans. **(3)**

Sol. By series and parallel combination

$V_1 + V_2 = V_3$

17. Specific resistance S is given as $S = \frac{RA}{\ell}$. If length is doubled, find corresponding change in S.

(1) S is halved

(2) S is doubled

(3) S is quadrupled

(4) No change in S

Ans. (4)

18. **Assertion :** Static friction depends on area of contact but independent of material.

Reason : Kinetic friction is independent of area of contact but depends on material.

(1) Assertion true, reason true and reason is correct explanation of assertion.

(2) Assertion true, reason true and reason is not correct explanation of assertion.

(3) Assertion true, reason false.

(4) Assertion false, reason true.

Ans. **(4)**

19. **Assertion :** Work done by electrostatics force on an object when moved on equipotential surface is always zero.

Reason : Electric field lines falls perpendicular to the equipotential surface

(1) Assertion true, reason true and reason is correct explanation of assertion.

(2) Assertion true, reason true and reason is not correct explanation of assertion.

(3) Assertion true, reason false.

(4) Assertion false, reason true.

Ans. **(1)**

Sol. **Assertion is true and reason is true and correct explanation.**

20. A nucleus of C^{13} breaks into C^{12} and neutron. Find energy released.

Atomic mass of $C^{12} = 12.000$ u

$C^{13} = 13.013975$ u

$n = 1.008665$ u

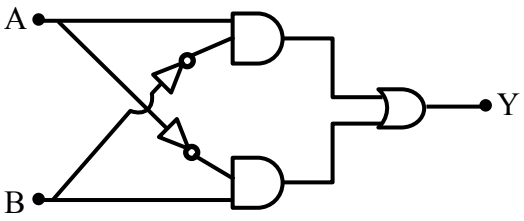
(1) 3.04 MeV (2) 4.1 MeV (3) 4.94 MeV (4) 6 MeV

Ans. **(3)**

Sol. Mass defect = $13.013975 - (12 + 1.008665) = 0.00531$ U

Energy released = $0.00531 \times 931 = 4.94$ MeV

21. For given logic circuit. The truth table will be



(1)

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

(2)

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

(3)

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

(4)

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

Ans. **(4)**

Sol. Using Boolean algebra

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

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

22. In a transformer, ratio of turns in primary to secondary coil is 10 : 1. If primary side voltage is 230 volt and frequency is 50 Hz and resistance of secondary side is 46 Ω, then find power output.

(1) 11.5 W (2) 12 W (3) 12.5 W (4) 23 W

Ans. **(1)**

Sol. $\frac{N_1}{N_2} = \frac{V_1}{V_2}$

$\frac{10}{1} = \frac{230}{V_2}$

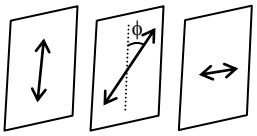
$V_2 = 23\ V$

$P_2 = \frac{V_2^2}{R_2} = \frac{23 \times 23}{46} = \frac{23}{2} = 11.5W$

23. Between two polaroid placed in crossed position, a third polaroid is introduced. By what angle (in degree) the introduced polaroid placed should be rotated to get maximum intensity of the out coming light.

Ans. **45**

Sol.



$I = I_0 \cos^2\phi \sin^2\phi$

I_{max} at $\phi = 45°$

24. If their fundamental frequencies are sounded together, beat frequency is 7 Hz. Find velocity (in m/s) of sound in air?

Ans. **24**

Sol. $f_1 = \frac{v}{4\ell_1}$ $\quad f_2 = \frac{v}{2\ell_2}$

$f_1 = \frac{v \times 100}{4 \times 150}$ $\quad f_2 = \frac{v \times 100}{2 \times 350}$

$f_1 = \frac{v}{6}$ $\quad f_2 = \frac{v}{7}$

$\frac{v}{6} - \frac{v}{7} = 7$

$\frac{v}{42} = 7$, $\quad v = 42 \times 7$

$v = 294$ m/sec

25. For 200 μA current galvanometer deflects by π/3 radians. For what value of current, it will deflect by π/10 radians ?

Ans. **60**

Sol. $i \propto \theta$ (angle of deflection)

$\frac{i_1}{i_2} = \frac{\theta_1}{\theta_2}$

$\frac{200\mu A}{i_2} = \frac{\pi/3}{\pi/10} = \frac{10}{3}$

$60\ \mu A = i_2$

26. Two charges of magnitude –4 μC kept at (1, 0, 4) and another charge of +4 μC kept at (2, –1, 5) in the presence of external electric field $E = 0.2\,\hat{i}$ V/cm. The torque on the system of charges is $8\sqrt{\alpha}\times10^{-5}$ N – m. Find α.

Ans. **2**

Sol. $\vec{\tau} = \vec{P}\times\vec{E}$

$\vec{P} = P\hat{r} = 4\times10^{-6}\times\sqrt{3}\dfrac{(\hat{i}-\hat{j}+\hat{k})}{\sqrt{3}}$

$\vec{P} = 4\times10^{-6}(\hat{i}-\hat{j}+\hat{k})$

$\vec{E} = 0.2\times10^{2}\hat{i} = 20\hat{i}\ \text{V/m}$

$\vec{\tau} = 4\times10^{-6}\times20[(\hat{i}-\hat{j}+\hat{k})\times\hat{i}]$

$\vec{\tau} = 8\times10^{-5}(\hat{k}+\hat{j})$

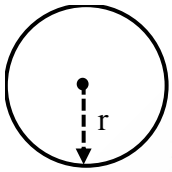
$|\vec{\tau}| = 8\sqrt{2}\times10^{-5}$ Nm

$\alpha = 2$

27. A nucleus with atomic number '50' and having radius of nucleus is 9×10^{-13} cm. Calculate the potential (in MV) at the surface of the nucleus.

Ans. **8**

Sol.



$V_{surface} = \dfrac{kQ}{r} = \dfrac{9\times10^{9}\times50\times1.6\times10^{-19}}{9\times10^{-15}}$

$= 80\times10^{5}$ volt

$V_{surface} = 8$ MV

28. A pressure inside wall pipe before hole is 4.5×10^{4} N/m^2. When a small hole is made in pipe, pressure is changed to 2.0×10^{4} N/m^2. If speed of water flux after hole is $\sqrt{v}$ m/s. Find out v :

Ans. **50**

Sol. $\Delta P = \dfrac{1}{2}\rho v^2$

$2.5\times10^{4} = \dfrac{1}{2}\times10^{3}v_0^2$

$v_0 = \sqrt{50}$ m/s

$v = 50$

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SATYAM CHAKRAVORTY

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