CollegeDekho

FINAL JEE–MAIN EXAMINATION – SEPTEMBER, 2020

(Held On Friday 04th SEPTEMBER, 2020) TIME : 9 AM to 12 PM

PHYSICS — TEST PAPER WITH ANSWER & SOLUTION

1. A beam of plane polarised light of large cross sectional area and uniform intensity of 3.3 Wm^{-2} falls normally on a polariser (cross sectional area 3×10^{-4} m^2) which rotates about its axis with an angular speed of 31.4 rad/s. The energy of light passing through the polariser per revolution, is close to :

(1) 1.0×10^{-5} J (2) 5.0×10^{-4} J

(3) 1.0×10^{-4} J (4) 1.5×10^{-4} J

Official Ans. by NTA (3)

Sol. Intensity, I = 3.3 Wm^{-2}

Area, A = 3 × 10–4 m^2

Angular speed, ω = 31.4 rad/s

$\because \langle\cos^2\theta\rangle = \frac{1}{2}$, in one time period

$\therefore$ Average energy = $I_0 A \times \frac{1}{2}$

$= \frac{(3.3)(3\times10^{-4})}{2}$

$\simeq 5\times10^{-4}$ J

2. Match the C_P/C_V ratio for ideal gases with different type of molecules :

Molecular type	C_P/C_V
(A) Monoatomic	(I) 7/5
(B) Diatomic rigid molecules	(II) 9/7
(C) Diatomic non-rigid molecules	(III) 4/3
(D) Triatomic rigid molecules	(IV) 5/3

(1) A-IV, B-I, C-II, D-III

(2) A-IV, B-II, C-I, D-III

(3) A-III, B-IV, C-II, D-I

Sol. $\gamma = \frac{C_p}{C_v} = 1 + \frac{2}{f}$

where 'f' is degree of freedom

(A) Monoatomic f = 3, $\gamma = 1 + \frac{2}{3} = \frac{5}{3}$

(B) Diatomic rigid molecules,

f = 5, $\gamma = 1 + \frac{2}{3} = \frac{7}{5}$

(C) Diatomic non-rigid molecules

f = 7, $\gamma = 1 + \frac{2}{7} = \frac{9}{7}$

(D) Triatomic rigid molecules

f = 6, $\gamma = 1 + \frac{2}{6} = \frac{4}{3}$

3. Choose the correct option relating wavelengths of differnet parts of electromagnetic wave spectrum :

(1) $\lambda_{x\text{-rays}} < \lambda_{\text{micro waves}} < \lambda_{\text{radio waves}} < \lambda_{\text{visible}}$

(2) $\lambda_{\text{visible}} > \lambda_{x\text{-rays}} > \lambda_{\text{radio waves}} > \lambda_{\text{micro waves}}$

(3) $\lambda_{\text{radio waves}} > \lambda_{\text{micro waves}} > \lambda_{\text{visible}} > \lambda_{x\text{-rays}}$

(4) $\lambda_{\text{visible}} < \lambda_{\text{micro waves}} < \lambda_{\text{radio waves}} < \lambda_{x\text{-rays}}$

Official Ans. by NTA (3)

Sol. Information based

$\lambda_{\text{radiowaves}} > \lambda_{\text{microwaves}} > \lambda_{\text{visible}} > \lambda_{x\text{-rays}}$

4. A air bubble of radius 1 cm in water has an upward acceleration 9.8 cm s^{-2}. The density of water is 1 gm cm^{-3} and water offers negligible drag force on the bubble. The mass of the bubble is (g = 980 cm/s^2)

(1) 3.15 gm (2) 4.51 gm

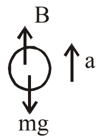
(3) 4.15 gm (4) 1.52 gm

Sol. Volume $V = \frac{4\pi}{3}r^3 = \frac{4\pi}{3}\times(1)^3 = 4.19\text{cm}^3$

$a = 9.8\ \text{cm/s}^2$

$B - mg = ma$

$m = \frac{B}{g+a}$



$m = \frac{(V\rho_\omega g)}{g+a} = \frac{V\rho_\omega}{1+\frac{a}{g}}$

$= \frac{(4.19)\times 1}{1+\frac{9.8}{980}} = \frac{4.19}{1.01} = 4.15\text{gm}$

5. Dimensional formula for thermal conductivity is (here K denotes the temperature)

(1) $MLT^{-3}K$ (2) $MLT^{-2}K$

(3) $MLT^{-2}K^{-2}$ (4) $MLT^{-3}K^{-1}$

Official Ans. by NTA (4)

Sol. $\because \frac{d\theta}{dt} = kA\frac{dT}{dx}$

$k = \frac{\left(\frac{d\theta}{dt}\right)}{A\left(\frac{dT}{dx}\right)}$

$[k] = \frac{[ML^2T^{-3}]}{[L^2][KL^{-1}]} = [MLT^{-3}K^{-1}]$

6. On the x-axis and a dsitance x from the origin, the gravitational field due to a mass distribution is given by $\frac{Ax}{(x^2+a^2)^{3/2}}$ in the x-direction. The magnitude of gravitational potential on the x-axis at a distance x, taking its value to be zero at infinity, is :

(1) $\frac{A}{(x^2+a^2)^{1/2}}$ (2) $\frac{A}{(x^2+a^2)^{3/2}}$

(3) $A(x^2 + a^2)^{3/2}$ (4) $A(x^2 + a^2)^{1/2}$

Sol. Given $E_G = \frac{Ax}{(x^2+a^2)^{3/2}}, V_\infty = 0$

$\int_{V_\infty}^{V_x} dV = -\int_\infty^x \vec{E}_G.\vec{d}_x$

$V_x - V_\infty = -\int_\infty^x \frac{Ax}{(x^2+a^2)^{3/2}}dx$

put $x^2 + a^2 = z$

$2x\,dx = dz$

$V_x - 0 = -\int_\infty^x \frac{A\,dz}{2(z)^{3/2}} = \left[\frac{A}{z^{1/2}}\right]_\infty^x = \left[\frac{A}{(x^2+a^2)^{1/2}}\right]_\infty^x$

$V_x = \frac{A}{(x^2+a^2)^{1/2}} - 0 = \frac{A}{(x^2+a^2)^{1/2}}$

7. Starting from the origin at time t = 0, with initial velocity $5\hat{j}\ \text{ms}^{-1}$, a particle moves in the x-y plane with a constant acceleration of $(10\hat{i}+4\hat{j})\text{ms}^{-2}$. At time t, its coordinates are (20 m, y_0 m). The values of t and y_0, are respectively :

(1) 4s and 52 m (2) 2s and 24 m

(3) 2s and 18 m (4) 5s and 25 m

Official Ans. by NTA (3)

Sol. Given $\vec{u} = 5\hat{j}\,m/s$, $\vec{a} = 10\hat{i}+4\hat{j}$, final coordinate $(20, y_0)$ in time t

$S_x = 4_x t + \frac{1}{2}a_x t^2$

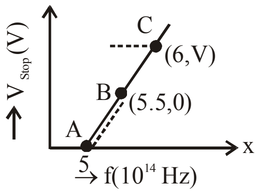
$20 - 0 = 0 + \frac{1}{2} \times 10 \times t^2$

$t = 2\text{sec}$

$S_y = u_y \times t + \frac{1}{2}a_y t^2$

$y_0 = 5 \times 2 + \frac{1}{2}4 \times 2^2 = 18\text{m}$

8. Given figure shows few data points in a photo electric effect experiment for a certain metal. The minimum energy for ejection of electron from its surfface is : (Plancks constant $h = 6.62 \times 10^{-34}$ J.s)



(1) 2.27 eV (2) 2.59 eV

(3) 1.93 eV (4) 2.10 eV

Official Ans. by NTA (1)

Sol. Graph of V_s and f given (B 5.5, 0)

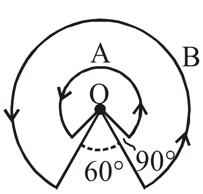
$h\nu = \phi + eV_s$

at B $V_s = 0$, $\nu = 5.5$

$\Rightarrow h \times 5.5 \times 10^{14} = \phi$

$$\phi = \frac{6.62 \times 10^{-34} \times 5.5 \times 10^{14}}{1.6 \times 10^{-19}} \text{eV} = 2.27\text{eV}$$

9. A wire A, bent in the shape of an arc of a circle, carrying a current of 2A and having radius 2 cm and another wire B, also bent in the shape of arc of a circle, carrying a current of 3A and having radius of 4 cm, are placed as shown in the figure. The ratio of the magnetic fields due to the wires A and B at the common centre O is :



(1) 4 : 6 (2) 6 : 4

(3) 6 :5 (4) 2 : 5

Sol. Given $i_A = 2$, $r_A = 2$ cm, $\theta_A = 2\pi - \frac{\pi}{2} = \frac{3\pi}{2}$

$i_B = 3$, $r_B = 4$ cm, $\theta_B = 2\pi - \frac{\pi}{3} = \frac{5\pi}{3}$

$$B = \frac{\mu_0 I\theta}{4\pi R}$$

$$\frac{B_A}{B_B} = \frac{I_A}{I_B} \times \frac{\theta_A R_B}{\theta_B R_A} = \frac{6}{5}$$

10. For a transverse wave travelling along a straight line, the distance between two peaks (crests) is 5 m, while the distance between one crest and one trough is 1.5 m. The possible wavelengths (in m) of the waves are :

(1) 1, 2, 3, ... (2) $\frac{1}{2}, \frac{1}{4}, \frac{1}{6}, ...$

(3) 1, 3, 5, ... (4) $\frac{1}{1}, \frac{1}{3}, \frac{1}{5}, ...$

Official Ans. by NTA (4)

Sol. Given T to C 1.5 m

C to C 5m

T to C = $(2n_1 + 1)\frac{\lambda}{2}$

C to C = $n_2\lambda$

$$\frac{1.5}{5} = \frac{(2n_1 + 1)}{2n_2} \Rightarrow 3n_2 = 10n_1 + 5$$

$n_1 = 1$, $n_2 = 5 \rightarrow \lambda = 1$

$n_1 = 4$, $n_2 = 15 \rightarrow \lambda = 1/3$

$n_1 = 7$, $n_2 = 25 \rightarrow \lambda = 1/5$

11. A small bar magnet placed with its axis at 30° with an external field of 0.06 T experiences a torque of 0.018 Nm. The minimum work required to rotate it from its stable to unstable equilibrium position is :

(1) 9.2×10^{-3} J (2) 6.4×10^{-2} J

(3) 11.7×10^{-3} J (4) 7.2×10^{-2} J

Sol. Torque on a bar magnet : I = MB sin θ

Here, θ = 30°, I = 0.018 N-m, B = 0.06 T

$\Rightarrow 0.018 = M \times 0.06 \times \sin 30°$

$\Rightarrow 0.018 = M \times 0.06 \times \frac{1}{2}$

$\Rightarrow M = 0.6\ A\text{-}m^2$

Now v = – MB cos θ

Position of stable equilibrium (θ = 0°) : $u_i = -MB$

Position of unstable equilibrium (θ = 180°) : $u_f = MB$

⇒ work done : ΔU

⇒ W = 2MB

⇒ W = 2 × 0.6 × 0.06

$\Rightarrow W = 7.2 \times 10^{-2}$ J

option (4) is correct

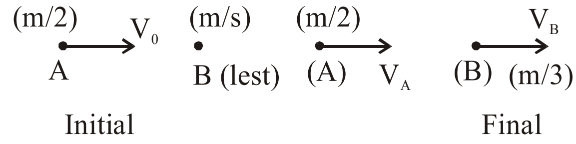
12. Particle A of mass $m_A = \frac{m}{2}$ moving along the x-axis with velocity v_0 collides elastically with another particle B at rest having mass $m_B = \frac{m}{3}$. If both particles move along the x-axis after the collision, the change Δλ in de-Broglie wavelength of particle A, in terms of its de-Broglie wavelength (λ_0) before collision is :

(1) $\Delta\lambda = 4\lambda_0$ (2) $\Delta\lambda = \frac{5}{2}\lambda_0$

(3) $\Delta\lambda = 2\lambda_0$ (4) $\Delta\lambda = \frac{3}{2}\lambda_0$

Official Ans. by NTA (1)

Sol.



Applying momentum conservation

$$\frac{m}{2} \times V_0 + \frac{m}{3} \times (0) = \frac{m}{2}V_A + \frac{m}{3}V_B$$

$$= \frac{V_0}{2} = \frac{V_A}{2} + \frac{V_B}{3} \quad .... (1)$$

Since, collision is elastic (e = 1)

$$e = 1 = \frac{V_B - V_A}{V_0} \Rightarrow V_0 = V_B - V_A \quad ... (2)$$

On solving (1) & (2) : $V_A = \frac{V_0}{5}$

Now, De-Broglie wavelength of A before collision :

$$\lambda_0 = \frac{h}{m_A V_0} = \frac{h}{\left(\frac{m}{2}\right)V_0}$$

$$\Rightarrow \lambda_0 = \frac{2h}{mV_0}$$

Final De-Broglie wavelength :

$$\lambda_f = \frac{h}{m_A V_0} = \frac{h}{\frac{m}{2} \times \frac{V_0}{5}} \Rightarrow \lambda_f = \frac{10h}{mV_0}$$

Now $\Delta\lambda = \lambda_f - \lambda_0$

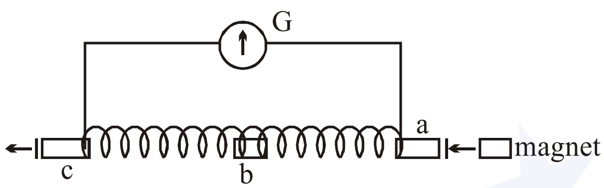
$$\frac{10h}{\ } - \frac{2h}{\ }$$

$\Rightarrow \Delta\lambda = \frac{8h}{mv_0} \quad \Rightarrow \Delta\lambda = 4 \times \frac{2h}{mv_0}$

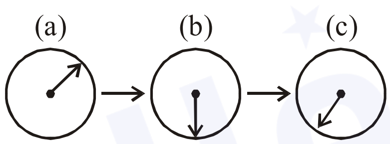
$\Rightarrow \Delta\lambda = 4\lambda_0$

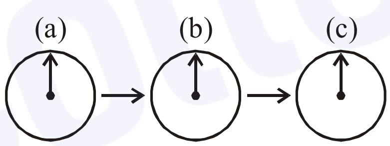
option (1) is correct.

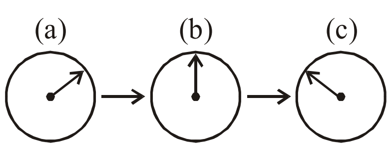
13. A small bar magnet is moved through a coil at constant speed from one end to the other. Which of the following series of observations wil be seen on the galvanometer G attached across the coil ?

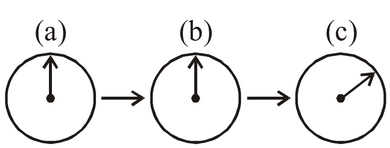


Three positions shown describe : (a) the magnet's entry (b) magnet is completely inside and (c) magnet's exit.

(1) 

(2) 

(3) 

(4) 

Official Ans. by NTA (3)

Sol. When bar magnet is entering with constant speed, flux will change and an e.m.f. is induced, so galvanometer will deflect in positive direction.

When magnet is completely inside, flux will not change, so reading of galvanometer will be zero.

When bar magnet is making on exit, again flux will change and on e.m.f. is induced in opposite direction to not of (a), so galvanometer will deflect in negative direction.

Looking at options, option (3) is correct.

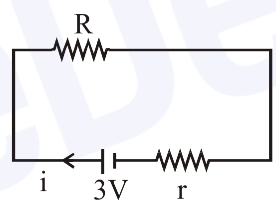
14. A battery of 3.0 V is connected to a resistor dissipating 0.5 W of power. If the terminal voltage of the battery is 2.5 V, the power dissipated within the internal resistance is :

(1) 0.50 W (2) 0.125 W

(3) 0.072 W (4) 0.10 W

Official Ans. by NTA (4)

Sol.



$P_R = 0.5W$

$\Rightarrow i^2R = 0.5W$

Also, $V = E - ir$

$2.5 = 3 - ir$

$\Rightarrow ir = 0.5$

Power dissipated across 'r' : $P_r = i^2r$

Now $iR = 2.5$

$ir = 0.5$

On dividing : $\frac{R}{r} = 5$

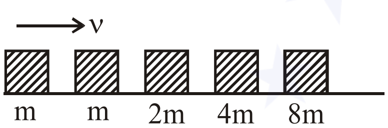
Now $\frac{P_R}{P_r} = \frac{i^2R}{i^2r} \Rightarrow \frac{P_R}{P_r} = \frac{R}{r} \Rightarrow \frac{P_R}{P_r} = 5$

$\Rightarrow P_r = \frac{P_R}{5}$

$\Rightarrow P_r = \frac{0.50}{5} \Rightarrow P_r = 0.10$ W

option (4) is correct.

15. Blocks of masses m, 2m, 4m and 8m are arranged in a line on a frictionless floor. Another block of mass m, moving with speed v along the same line (see figure) collides with mass m in perfectly inelastic manner. All the subsequent collisions are also perfectly inelastic. By the time the last block of mass 8m starts moving the total energy loss is p% of the original energy. Value of 'p' is close to :

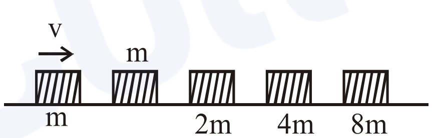


(1) 77 (2) 37

(3) 87 (4) 94

Official Ans. by NTA (4)

Sol.



All collisions are perfectly inelastic, so after the final collision, all blocks are moving together. So let the final velocity be v', so on applying momentum conservation:

mv = 16m v' $\Rightarrow$ v' = v/16

Now initial energy $E_i = \frac{1}{2}mv^2$

$1 \quad \left(v\right)^2$

$\Rightarrow E_f = \frac{1}{2}m\frac{v^2}{16}$

Energy loss : $E_i - E_f$

$\Rightarrow \frac{1}{2}mv^2 - \frac{1}{2}m\frac{v^2}{16}$

$\Rightarrow \frac{1}{2}mv^2\left[1-\frac{1}{16}\right] \Rightarrow \frac{1}{2}mv^2\left[\frac{15}{16}\right]$

$\%p = \frac{\text{Energy loss}}{\text{Original energy}} \times 100$

$= \frac{\frac{1}{2}mv^2\left[\frac{15}{16}\right]}{\frac{1}{2}mv^2} \times 100 = 93.75\%$

$\Rightarrow$ Value of P is close to 94.

16. The specific heat of water = 4200 J kg^{-1} K^{-1} and the latent heat of ice = 3.4 × 10^5 J kg^{-1}. 100 grams of ice at 0°C is placed in 200 g of water at 25°C. The amount of ice that will melt as the temperature of water reaches 0°C is close to (in grams) :

(1) 61.7 (2) 63.8

(3) 69.3 (4) 64.6

Official Ans. by NTA (1)

Sol. Here the water will provide heat for ice to melt therefore

$m_w s_w \Delta\theta = m_{ice} L_{ice}$

$m_{ice} = \frac{0.2 \times 4200 \times 25}{3.4 \times 10^5}$

= 0.0617 kg

= 61.7 gm

Remaining ice will remain un-melted

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17. A Tennis ball is released from a height h and after freely falling on a wooden floor it rebounds and reaches height $\frac{h}{2}$. The velocity versus height of the ball during its motion may be represented graphically by :

(graph are drawn schematically and on not to scale)

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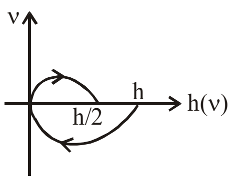

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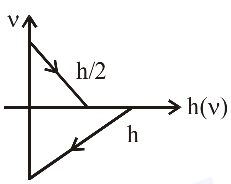

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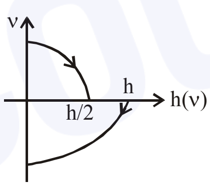

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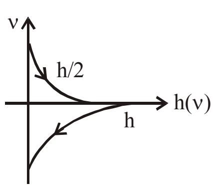


Sol. Velocity at ground (means zero height) is non-zero therefore one is incorrect and velocity versus height is non-linear therefore two is also incorrect.

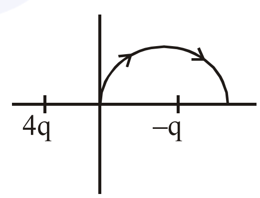
$v^2 = 2gh$

$$v\frac{dv}{dh} = 2g = \text{const.}$$

$$\frac{dv}{dh} = \frac{\text{constant}}{v}$$

Here we can see slope is very high when velocity is low therefore at Maximum height the slope should be very large which is in option 3 and as velocity increases slope must decrease there for option 3 is correct.

18. A two point charges 4q and –q are fixed on the x-axis at $x = -\frac{d}{2}$ and $x = \frac{d}{2}$, respectively. If a third point charge 'q' is taken from the origin to x = d along the semicircle as shown in the figure, the energy of the charge will :



(1) increase by $\frac{2q^2}{3\pi\varepsilon_0 d}$

(2) increase by $\frac{3q^2}{4\pi\varepsilon_0 d}$

(3) decrease by $\frac{4q^2}{3\pi\varepsilon_0 d}$

(4) decrease by $\frac{q^2}{4\pi\varepsilon_0 d}$

Official Ans. by NTA (3)

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Sol. Potential of –q is same as initial and final point of the path therefore potential due to 4q will only change and as potential is decreasing the energy will decrease

Decrease in potential energy = q $(V_i - V_f)$

Decrease in potential energy

$$= q\left[\frac{k4q}{d/2} - \frac{k4q}{3d/2}\right] = \frac{4q^2}{3\pi\varepsilon_0 d}$$

Therefore correct answer is 3.

19. Two charged thin infinite plane sheets of uniform surface charge density σ_+ and σ_- where $|\sigma_+| > |\sigma_-|$ intersect at right angle. Which of the following best represents the electric field lines for this system :

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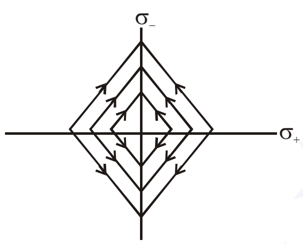

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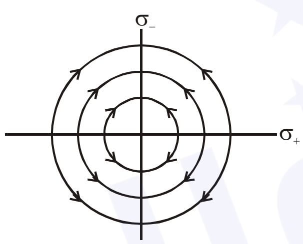

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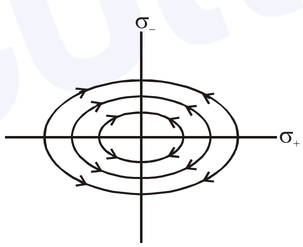

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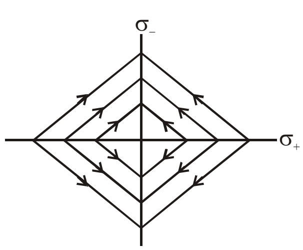
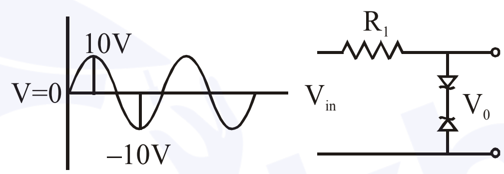
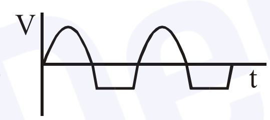


Sol. Thin infinite uniformly charged planes produces uniform electric field therefore option 2 and option 3 are obviously wrong.

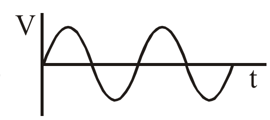
And as positive charge density is bigger in magnitude so its field along Y direction will be bigger than field of negative charge in X direction and this is evident in option 1 so it is correct.

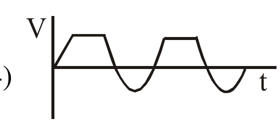
20. Take the breakdown voltage of the zener diode used in the given circuit as 6V. For the input voltage shown in figure below, the time variation of the output voltage is : (Graphs drawn are schematic and not to scale)



(1)


(2)


(3)


(4)


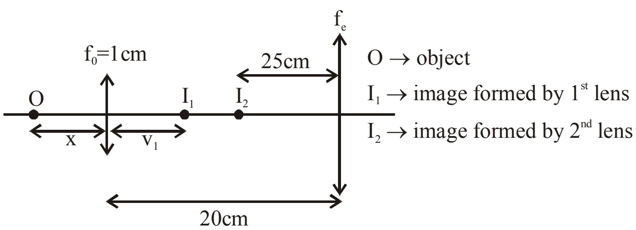
Official Ans. by NTA (2)

Sol. As there are two zener diodes in reverse polarity so if one is in forward bias the other will be in reverse bias and above 6V the reverse bias will too be in conduction mode. Therefore when voltage is more than 6V the output will be constant. And when it is less than 6V it will follow the input voltage so correct answer is

21. In a compound microscope, the magnified virtual image is formed at a distance of 25 cm from the eye-piece. The focal length of its objective lens is 1 cm. If the magnification is 100 and the tube length of the microscope is 20 cm, then the focal length of the eye-piece lens (in cm) is ________.

Official Ans. by NTA (6.25)

Sol.



for first lens = $\frac{1}{v_1} - \frac{1}{-x} = \frac{1}{1} \Rightarrow v_1 = \frac{x}{x-1}$

also magnification $|m_1| = \left|\frac{v_1}{u_1}\right| = \frac{1}{x-1}$

for 2nd lens this is acting as object

so $u_2 = -(20 - v_1) = -\left(20 - \frac{x}{x-1}\right)$

and $v_2 = -25\text{cm}$

angular magnification $|m_A| = \left|\frac{D}{u_2}\right| = \frac{25}{|u_2|}$

Total magnification $m = m_1 m_A = 100$

$$\left(\frac{1}{x-1}\right)\left(\frac{25}{20 - \frac{x}{x-1}}\right) = 100$$

$$\frac{25}{20(x-1)-x} = 100 \Rightarrow 1 = 80(x-1) - 4x$$

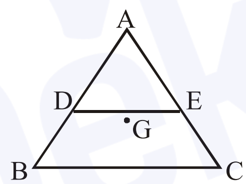
$$\Rightarrow 76x = 81 \Rightarrow x = \frac{81}{76}$$

$$\Rightarrow u_2 = -\left(20 - \frac{81/76}{81/76 - 1}\right) = \frac{-19}{5}$$

now by lens formula

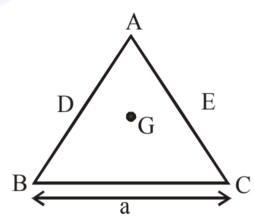
$$\frac{1}{-25} - \frac{1}{-19/5} = \frac{1}{f_e} \Rightarrow f_e = \frac{25 \times 19}{106} \approx 4.48\text{cm}$$

22. ABC is a plane lamina of the shape of an equilateral triagnle. D, E are mid points of AB, AC and G is the centroid of the lamina. Moment of inertia of the lamina about an axis passing through G and perpendicular to the plane ABC is I_0. If part ADE is removed, the moment of inertia of the remaining part about the same axis is $\frac{NI_0}{16}$ where N is an integer. Value of N is _____.



Official Ans. by NTA (11)

Sol. Let side of triangle is a and mass is m



MOI of plate ABC about centroid

$$I_0 = \frac{m}{3}\left(\left(\frac{a}{2\sqrt{3}}\right)^2 \times 3\right) = \frac{ma^2}{12}$$

triangle ADE is also an equilateral triangle of side a/2.

Let moment of inertia of triangular plate ADE about it's centroid (G') is I_1 and mass is m_1

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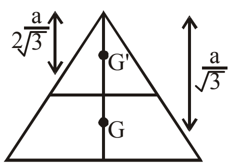
$$m_1 = \frac{m}{\frac{\sqrt{3}a^2}{4}} \times \frac{\sqrt{3}}{4}\left(\frac{a}{2}\right)^2 = \frac{m}{4}$$

$$I_1 = \frac{m_1}{12}\left(\frac{a}{2}\right)^2 = \frac{m}{4\times 12}\frac{a^2}{4} = \frac{ma^2}{192}$$



distance $GG' = \frac{a}{\sqrt{3}} - \frac{a}{2\sqrt{3}} = \frac{a}{2\sqrt{3}}$

so MOI of part ADE about centroid G is

$$I_2 = I_1 + m_1\left(\frac{a}{2\sqrt{3}}\right)^2 = \frac{ma^2}{192} + \frac{m}{4}.\frac{a^2}{12}$$

$$= \frac{5ma^2}{192}$$

now MOI of remaining part

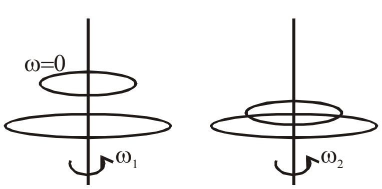
$$= \frac{ma^2}{12} - \frac{5ma^2}{192} = \frac{11ma^2}{12\times 16} = \frac{11I_0}{16}$$

$\Rightarrow \quad N = 11$

23. A circular disc of mass M and radius R is rotating about its axis with angular speed ω_1. If another stationary disc having radius $\frac{R}{2}$ and same mass M is dropped co-axially on to the rotating disc. Gradually both discs attain constant angular speed ω_2. The energy lost in the process is p% of the initial energy. Value of p is ______.

Official Ans. by NTA (20)

Sol.



$$\frac{MR^2}{}$$

$\Rightarrow$ MOI of small disc $I_2 = \frac{M\left(\frac{R}{2}\right)^2}{2} = \frac{I}{4}$

by angular momentum conservation

$$I\omega_1 + \frac{I}{4}(0) = I\omega_2 + \frac{I}{4}\omega_2 \Rightarrow \omega_2 = \frac{4\omega_1}{5}$$

initial kinetic energy $K_1 = \frac{1}{2}I\omega_1^2$

final kinetic energy K_2

$$= \frac{1}{2}\left(I + \frac{I}{4}\right)\left(\frac{4\omega_1}{5}\right)^2 = \frac{1}{2}I\omega_1^2\left(\frac{4}{5}\right)$$

$$P\% = \frac{K_1 - K_2}{K_1}\times 100\% = \frac{1-4/5}{1}\times 100 = 20\%$$

24. A closed vessel contains 0.1 mole of a monoatomic ideal gas at 200 K. If 0.05 mole of the same gas at 400 K is added to it, the final equilibrium temperature (in K) of the gas in the vessel will be closed to ______.

Official Ans. by NTA (266.00 to 267.00)

Official Ans. by (266.67)

Sol. As work done on gas and heat supplied to the gas are zero,

total internal energy of gases remain same

$u_1 + u_2 = u_1' + u_2'$

$(0.1)\, C_v\, (200) + (0.05)\, C_v\, (400) = (0.15) C_v\, T$

$$T = \frac{800}{3}k = 266.67k$$

25. In the line spectra of hydrogen atom, difference between the largest and the shortest wavelengths of the Lyman series is 304 Å. The corresponding difference for the Paschan series in Å is : ______.

Official Ans. by NTA (10553 to 10554)

Sol. $$\lambda = \frac{c}{\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)}$$

for lyman series

$$\lambda_1 = \frac{c}{\frac{1}{1^2} - \frac{1}{\infty^2}} = c \ (n = \infty \text{ to } n = 1)$$

$$\lambda_2 = \frac{c}{\frac{1}{1^2} - \frac{1}{2^2}} = \frac{4c}{3} \ (n = 2 \text{ to } n = 1)$$

$$\Delta\lambda = \lambda_2 - \lambda_1 = \frac{c}{3} = 304\text{Å} \Rightarrow c = 912\text{Å}$$

for paschen series

$$\lambda_1 = \frac{c}{\frac{1}{3^2} - \frac{1}{\infty^2}} = 9c \ \ (n = \infty \text{ to } n = 3)$$

$$\lambda_2 = \frac{c}{\frac{1}{3^2} - \frac{1}{4^2}} = \frac{144c}{7} \ (n = 4 \text{ to } n = 3)$$

$$\Delta\lambda = \lambda_2 - \lambda_1 = \frac{144c}{7} - 9c = \frac{81c}{7} = \frac{81 \times 912}{7}$$

= 10553.14 Å