FINAL JEE–MAIN EXAMINATION – APRIL,2019

(Held On Friday 12th APRIL, 2019) TIME : 9 : 30 AM To 12 : 30 PM

PHYSICS

TEST PAPER WITH ANSWER & SOLUTION

1. The value of numerical aperature of the objective lens of a microscope is 1.25. If light of wavelength 5000 Å is used, the minimum separation between two points, to be seen as distinct, will be :

(1) 0.24 μm (2) 0.48 μm

(3) 0.12 μm (4) 0.38 μm

Official Ans. by NTA (1)

Sol. Numerical aperature of the microscope is given as

$$NA = \frac{0.61\lambda}{d}$$

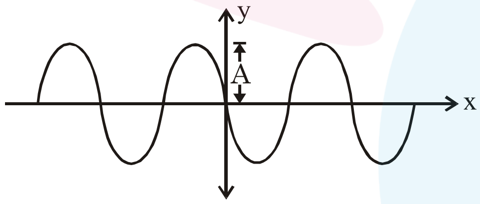
Where d = minimum sparation between two points to be seen as distinct

$$d = \frac{0.61\lambda}{NA} = \frac{(0.61)\times(5000\times 10m^{-10})}{1.25}$$

$= 2.4 \times 10^{-7}$ m

= 0.24 μm

2. A progressive wave travelling along the positive x-direction is represented by $y(x, t) = A \sin (kx - \omega t + \phi)$. Its snapshot at t = 0 is given in the figure:

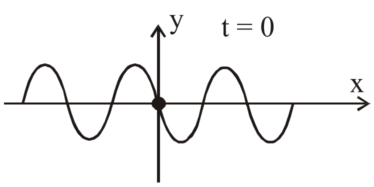


For this wave, the phase ϕ is :

(1) 0 (2) $-\frac{\pi}{2}$ (3) π (4) $\frac{\pi}{2}$

Official Ans. by NTA (3)

Sol.

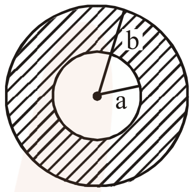


$y = A \sin (kx - wt + \phi)$

at x = 0, t = 0, y = 0 and slope is negative

$\Rightarrow \phi = \pi$

3. A circular disc of radius b has a hole of radius a at its centre (see figure). If the mass per unit area of the disc varies as $\left(\frac{\sigma_0}{r}\right)$, then the radius of gyration of the disc about its axis passing through the centre is :

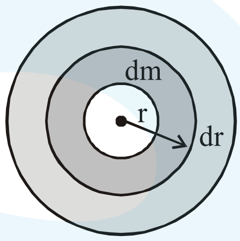


(1) $\frac{a+b}{2}$ (2) $\frac{a+b}{3}$

(3) $\sqrt{\frac{a^2+b^2+ab}{2}}$ (4) $\sqrt{\frac{a^2+b^2+ab}{3}}$

Official Ans. by NTA (4)

Sol.



$dI = (dm)r^2$

$= (\sigma\, dA)r^2$

$$= \left(\frac{\sigma_0}{r} 2\pi r dr\right) r^2$$

$= (\sigma_0\, 2\pi) r^2 dr$

$$I = \int dI = \int_a^b \sigma_0 2\pi r^2 dr$$

$$= \sigma_0 2\pi \left(\frac{b^3 - a^3}{3}\right)$$

$$m = \int dm = \int \sigma dA$$

$$= \sigma_0 2\pi \int_a^b dr$$

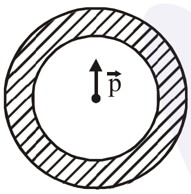
$m = \sigma_0 \, 2\pi \, (b-a)$

Radius of gyration

$$k = \sqrt{\frac{I}{m}} \quad = \sqrt{\frac{(b^3 - a^3)}{3(b-a)}}$$

$$= \sqrt{\left(\frac{a^3 + b^3 + ab}{3}\right)}$$

4. Shown in the figure is a shell made of a conductor. It has inner radius a and outer radius b, and carries charge Q. At its centre is a dipole $\vec{p}$ as shown. In this case :



(1) Electric field outside the shell is the same as that of a point charge at the centre of the shell.

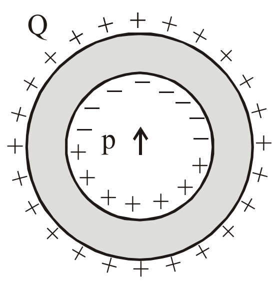
(2) Surface charge density on the inner surface of the shell is zero everywhere.

(3) Surface charge density on the inner surface is uniform and equal to $\frac{(Q/2)}{4\pi a^2}$.

(4) Surface charge density on the outer surface depends on $|\vec{p}|$

Official Ans. by NTA (1)

Sol.



Total charge of dipole = 0, so charge induced on outside surface = 0.

But due to non uniform electric field of dipole, the charge induced on inner surface is non zero and non uniform.

So, for any observer outside the shell, the resultant electric field is due to Q uniformly distributed on outer surface only and it is equal to.

$$\boxed{E = \frac{KQ}{r^2}}$$

5. A person of mass M is, sitting on a swing of length L and swinging with an angular amplitude θ_0. If the person stands up when the swing passes through its lowest point, the work done by him, assuming that his centre of mass moves by a distance ℓ ($\ell << L$), is close to :

(1) $Mg\ell$

(2) $Mg\ell\ (1 + \theta_0^2)$

(3) $Mg\ell\ (1 - \theta_0^2)$

(4) $Mg\ell\left(1 + \frac{\theta_0^2}{2}\right)$

Official Ans. by NTA (2)

Sol. Angular momentum conservation.

$$\cancel{M}V_0L = \cancel{M}V_1(L-\ell)$$

$$V_1 = V_0\left(\frac{L}{L-\ell}\right)$$

$$w_g + w_p = \Delta KE$$

$$-mg\ell + w_p = \frac{1}{2}m\left(V_1^2 - V_0^2\right)$$

$$w_p = mg\ell + \frac{1}{2}mV_0^2\left(\left(\frac{L}{L-\ell}\right)^2 - 1\right)$$

$$= mg\ell + \frac{1}{2}mV_0^2\left(\left(1 - \frac{\ell}{L}\right)^{-2} - 1\right)$$

Now, $\ell << L$

By, Binomial approximation

$$= mg\ell + \frac{1}{2}mV_0^2\left(\left(1 + \frac{2\ell}{L}\right) - 1\right)$$

$$= mg\ell + \frac{1}{2}mV_0^2\left(\frac{2\ell}{L}\right)$$

$$W_p = mg\ell + mv_0^2\frac{\ell}{L}$$

here, V_0 = maximum velocity
= $\omega \times A$

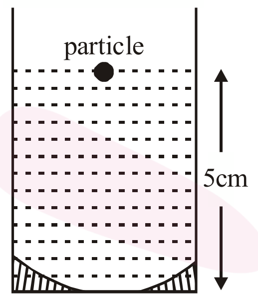
$$= \left(\sqrt{\frac{g}{L}}\right)(\theta_0 L)$$

$$V_0 = \theta_0\sqrt{gL}$$

$$\text{so, } w_p = mg\ell + m\left(\theta_0\sqrt{gL}\right)^2\frac{\ell}{L}$$

$$= mg\ell\left(1+\theta_0^2\right)$$

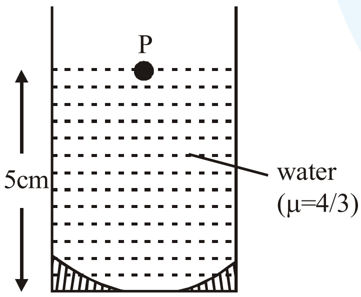
6. A concave mirror has radius of curvature of 40 cm. It is at the bottom of a glass that has water filled up to 5 cm (see figure). If a small particle is floating on the surface of water, its image as seen, from directly above the glass, is at a distance d from the surface of water. The value of d is close to : (Refractive index of water = 1.33)



(1) 8.8 cm (2) 11.7 cm
(3) 6.7 cm (4) 13.4 cm

Official Ans. by NTA (1)

Sol. Light incident from particle P will be reflected at mirror



$$u = -5\text{cm},\ f = -\frac{R}{2} = -20\text{cm}$$

$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$$

$$\boxed{v_1 = +\frac{20}{3}\text{cm}}$$

This image will act as object for light getting refracted at water surface

So, object distance $d = 5+\frac{20}{3}=\frac{35}{3}$cm

below water surface.
After refraction, final image is at

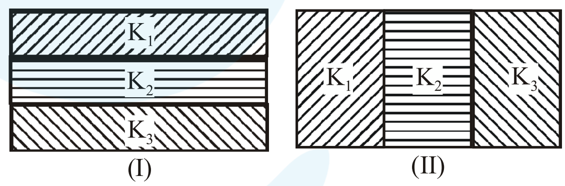
$$d' = d\left(\frac{\mu_2}{\mu_1}\right)$$

$$= \left(\frac{35}{3}\right)\left(\frac{1}{4/3}\right)$$

$$= \frac{35}{4} = 8.75\text{cm}$$

$$\approx 8.8\text{cm}$$

7. Two identical parallel plate capacitors, of capacitance C each, have plates of area A, separated by a distance d. The space between the plates of the two capacitors, is filled with three dielectrics, of equal thickness and dielectric constants K_1, K_2 and K_3. The first capacitor is filled as shown in fig. I, and the second one is filled as shown in fig. II.
If these two modified capacitors are charged by the same potential V, the ratio of the energy stored in the two, would be (E_1 refers to capacitor (I) and E_2 to capacitor (II)) :



(1) $\frac{E_1}{E_2}=\frac{9K_1K_2K_3}{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}$

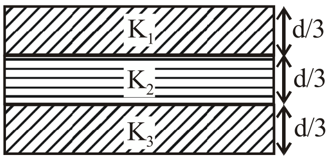
(2) $\frac{E_1}{E_2}=\frac{K_1K_2K_3}{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}$

(3) $\frac{E_1}{E_2}=\frac{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}{K_1K_2K_3}$

(4) $\frac{E_1}{E_2}=\frac{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}{9K_1K_2K_3}$

Official Ans. by NTA (1)

Sol. I.

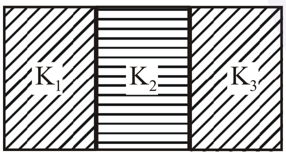


$$C_1 = \frac{3\varepsilon_0 AK_1}{d}$$
$$C_2 = \frac{3\varepsilon_0 AK_2}{d}$$
$$C_3 = \frac{3\varepsilon_0 AK_3}{d}$$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$\Rightarrow C_{eq} = \frac{3\varepsilon_0 AK_1K_2K_3}{d(K_1K_2 + K_2K_3 + K_3K_1)} \quad ....(1)$$

II.



$$C_1 = \frac{\varepsilon_0 K_1 A}{3d}$$
$$C_2 = \frac{\varepsilon_0 K_2 A}{3d}$$
$$C_3 = \frac{\varepsilon_0 K_3 A}{3d}$$

$C'_{eq} = C_1 + C_2 + C_3$

$$= \frac{\varepsilon_0 A}{3d}(K_1 + K_2 + K_3) \quad ....(2)$$

Now,

$$\boxed{\frac{E_1}{E_2} = \frac{\frac{1}{2}C_{eq}.V^2}{\frac{1}{2}C'_{eq}V^2} = \frac{9K_1K_2K_3}{(K_1+K_2+K_3)(K_1K_2+K_2K_3+K_3K_1)}}$$

8. A point dipole $\vec{p} = -p_0\hat{x}$ is kept at the origin. The potential and electric field due to this dipole on the y-axis at a distance d are, respectively: (Take V = 0 at infinity) :

(1) $\frac{|\vec{p}|}{4\pi\varepsilon_0 d^2}, \frac{-\vec{p}}{4\pi\varepsilon_0 d^3}$

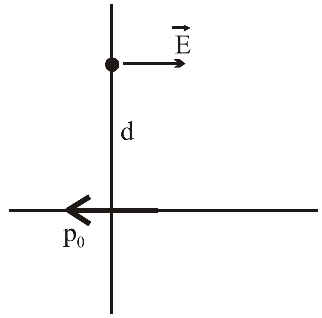
(2) $0, \frac{\vec{p}}{4\pi\varepsilon_0 d^3}$

(3) $\frac{|\vec{p}|}{4\pi\varepsilon_0 d^2}, \frac{\vec{p}}{4\pi\varepsilon_0 d^3}$

(4) $0, \frac{-\vec{p}}{4\pi\varepsilon_0 d^3}$

Official Ans. by NTA (4)

Sol. V = 0



$$E = -\frac{K\vec{P}}{r^3}$$

$$= -\frac{\vec{p}}{4\pi\varepsilon_0 d^3}$$

9. When M_1 gram of ice at –10ºC (specific heat = 0.5 cal g^{-1}ºC^{-1}) is added to M_2 gram of water at 50ºC, finally no ice is left and the water is at 0ºC. The value of latent heat of ice, in cal g^{-1} is:

(1) $\frac{5M_1}{M_2} - 50$

(2) $\frac{50M_2}{M_1}$

(3) $\frac{50M_2}{M_1} - 5$

(4) $\frac{5M_2}{M_1} - 5$

Official Ans. by NTA (3)

Sol. Heat lost = Heat gain

$\Rightarrow M_2 \times 1 \times 50 = M_1 \times 0.5 \times 10 + M_1.L_f$

$$\Rightarrow L_f = \frac{50M_2 - 5M_1}{M_1}$$

$$= \frac{50M_2}{M_1} - 5$$

10. The trajectory of a projectile near the surface of the earth is given as $y = 2x - 9x^2$. If it were launched at an angle θ_0 with speed v_0 then ($g = 10\ ms^{-2}$) :

(1) $\theta_0 = \cos^{-1}\left(\frac{1}{\sqrt{5}}\right)$ and $v_0 = \frac{5}{3}ms^{-1}$

(2) $\theta_0 = \sin^{-1}\left(\frac{1}{\sqrt{5}}\right)$ and $v_0 = \frac{5}{3}ms^{-1}$

(3) $\theta_0 = \sin^{-1}\left(\frac{2}{\sqrt{5}}\right)$ and $v_0 = \frac{3}{5}ms^{-1}$

(4) $\theta_0 = \cos^{-1}\left(\frac{2}{\sqrt{5}}\right)$ and $v_0 = \frac{3}{5}ms^{-1}$

Official Ans. by NTA (1)

Sol. Equation of trajectory is given as

$y = 2x - 9x^2$ .... (1)

Comparing with equation :

$$y = x \tan\theta - \frac{g}{2u^2\cos^2\theta}.x^2 \quad \text{........ (2)}$$

We get;

$\tan\theta = 2$

$$\therefore \boxed{\cos\theta = \frac{1}{\sqrt{5}}}$$

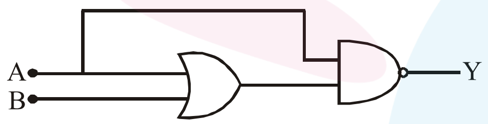
Also, $\frac{g}{2u^2\cos^2\theta} = 9$

$$\Rightarrow \frac{10}{2\times 9\times\left(\frac{1}{\sqrt{5}}\right)^2} = u^2$$

$$\Rightarrow u^2 = \frac{25}{9}$$

$$\Rightarrow \boxed{u = \frac{5}{3}\,m/s}$$

11. The truth table for the circuit given in the fig. is:



(1)

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

(2)

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

(3)

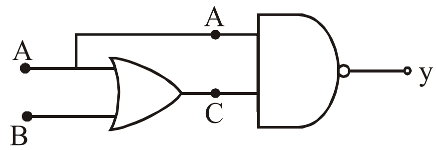
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

(4)

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

Official Ans. by NTA (1)

Sol.



$C = A + B$

and $y = \overline{A.C}$

A	B	$C=(A+B)$	A.C.	$y=\overline{A.C}$
0	0	0	0	1
0	1	1	0	1
1	0	1	1	0
1	1	1	1	0

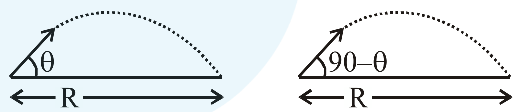
12. A shell is fired from a fixed artillery gun with an initial speed u such that it hits the target on the ground at a distance R from it. If t_1 and t_2 are the values of the time taken by it to hit the target in two possible ways, the product t_1t_2 is:

(1) R/g (2) R/4g

(3) 2R/g (4) R/2g

Official Ans. by NTA (3)

Sol. Range will be same for time t_1 & t_2, so angles of projection will be 'θ' & '90° – θ'



$$t_1 = \frac{2u\sin\theta}{g} \qquad t_2 = \frac{2u\sin(90°-\theta)}{g}$$

$$\text{and } R = \frac{u^2\sin 2\theta}{g}$$

$$t_1t_2 = \frac{4u^2\sin\theta\cos\theta}{g^2} = \frac{2}{g}\left[\frac{2u^2\sin\theta\cos\theta}{g}\right]$$

$$= \frac{2R}{g}$$

13. A submarine (A) travelling at 18 km/hr is being chased along the line of its velocity by another submarine (B) travelling at 27 km/hr. B sends a sonar signal of 500 Hz to detect A and receives a reflected sound of frequency ν. The value of ν is close to :

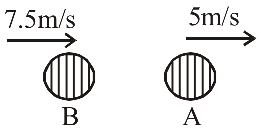
(Speed of sound in water = 1500 ms^{-1})

(1) 499 Hz (2) 502 Hz

(3) 507 Hz (4) 504 Hz

Official Ans. by NTA (2)

Sol.



f_0 = 500 Hz

frequency recieved by A

$$\Rightarrow \left(\frac{1500-5}{1500-7.5}\right) f_0 = f_1$$

and frequency recieved By B again =

$\longleftarrow$ 1500

(B) (A) & $\Rightarrow$

7.5 m/s $\longrightarrow$ $\longrightarrow$ 5 m/sec

$$f_2 = \left(\frac{1500+7.5}{1500+5}\right) \times \left(\frac{1500-5}{1500-7.5}\right) f_0 = 502 \text{ Hz.}$$

14. Two moles of helium gas is mixed with three moles of hydrogen molecules (taken to be rigid). What is the molar specific heat of mixture at constant volume ? (R = 8.3 J/mol K)

(1) 21.6 J/mol K

(2) 19.7 J/mol K

(3) 17.4 J/mol K

(4) 15.7 J/mol K

Official Ans. by NTA (3)

Sol. $$f_{mix} = \frac{n_1 f_1 + n_2 f_2}{n_1 + n_2} = \frac{2\times 3 + 3\times 5}{5} = \frac{21}{5}$$

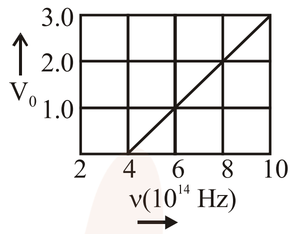
$$C_V = \frac{fR}{2} = \frac{21}{5} \times \frac{R}{2} = 17.4 \text{ J/mol K}$$

15. The stopping potential V_0 (in volt) as a function of frequency (ν) for a sodium emitter, is shown in the figure. The work function of sodium, from the data plotted in the figure, will be :

(Given : Planck's constant

(h) = 6.63 × 10^{-34} Js, electron

charge e = 1.6 × 10^{-19} C)



(1) 1.95 eV (2) 1.82 eV

(3) 1.66 eV (4) 2.12 eV

Official Ans. by NTA (3)

Sol. $h\nu = \phi + ev_0$

$$v_0 = \frac{h\nu}{e} - \frac{\phi}{e}$$

v_0 is zero for ν = 4 × 10^{14} Hz

$$0 = \frac{h\nu}{e} - \frac{\phi}{e} \Rightarrow \phi = h\nu$$

$$= \frac{6.63\times 10^{-34} \times 4 \times 10^{14}}{1.6\times 10^{-19}} = 1.66 \text{ ev.}$$

16. At 40ºC, a brass wire of 1 mm radius is hung from the ceiling. A small mass, M is hung from the free end of the wire. When the wire is cooled down from 40ºC to 20ºC it regains its original length of 0.2 m. The value of M is close to :

(Coefficient of linear expansion and Young's modulus of brass are 10^{-5}/ºC and 10^{11} N/m^2, respectively; g = 10 ms^{-2})

(1) 1.5 kg (2) 9 kg

(3) 0.9 kg (4) 0.5 kg

Official Ans. by NTA (2)

Sol. $$Mg = \left(\frac{Ay}{\ell}\right)\Delta\ell$$

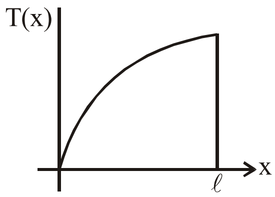
$$\frac{\Delta\ell}{\ell} = \alpha\Delta T$$

Mg = (Ay)αΔT = 2π

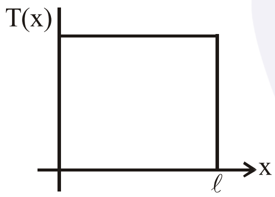
It is closest to 9.

17. A uniform rod of length ℓ is being rotated in a horizontal plane with a constant angular speed about an axis passing through one of its ends. If the tension generated in the rod due to rotation is T(x) at a distance x from the axis, then which of the following graphs depicts it most closely?

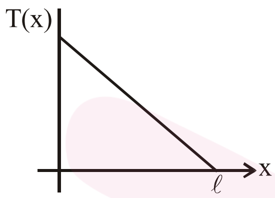
(1)



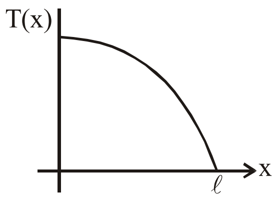
(2)



(3)

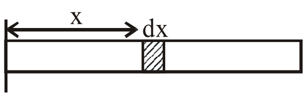


(4)



Official Ans. by NTA (4)

Sol.



$$T = \int_{x=x}^{x=\ell} dm\omega^2 x = \int_{x=x}^{x=\ell} \frac{m}{\ell} dx\, \omega^2 x$$

$$= \frac{m\omega^2}{2\ell}\left(\ell^2 - x^2\right)$$

$$\boxed{T = \frac{m\omega^2}{2\ell}\left(\ell^2 - x^2\right)}$$

18. Which of the following combinations has the dimension of electrical resistance (ε_0 is the permittivity of vacuum and μ_0 is the permeability of vacuum) ?

(1) $\sqrt{\frac{\varepsilon_0}{\mu_0}}$ (2) $\frac{\mu_0}{\varepsilon_0}$

(3) $\sqrt{\frac{\mu_0}{\varepsilon_0}}$ (4) $\frac{\varepsilon_0}{\mu_0}$

Official Ans. by NTA (3)

Sol. $[\varepsilon_0] = M^{-1}\ L^{-3}\ T^4\ A^2$

$[\mu_0] = M\ L\ T^{-2}\ A^{-2}$

$[R] = M\ L^2\ T^{-3}\ A^{-2}$

$$[R] = \left[\sqrt{\frac{\mu_0}{\varepsilon_0}}\right]$$

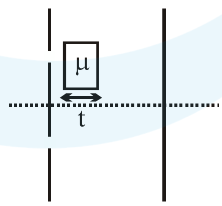
19. In a double slit experiment, when a thin film of thickness t having refractive index μ is introduced in front of one of the slits, the maximum at the centre of the fringe pattern shifts by one fringe width. The value of t is (λ is the wavelength of the light used) :

(1) $\frac{\lambda}{2(\mu-1)}$ (2) $\frac{\lambda}{(2\mu-1)}$

(3) $\frac{2\lambda}{(\mu-1)}$ (4) $\frac{\lambda}{(\mu-1)}$

Official Ans. by NTA (4)

Sol.



$\Delta X = (\mu - 1)t = 1\lambda$

for one maximum shift

$$\boxed{t = \frac{\lambda}{\mu - 1}}$$

20. An electromagnetic wave is represented by the electric field

$\vec{E} = E_0\hat{n}\sin[\omega t + (6y - 8z)]$. Taking unit vectors in x, y and z directions to be $\hat{i}, \hat{j}, \hat{k}$, the direction of propogation $\hat{s}$, is :

(1) $\hat{s} = \frac{4\hat{j} - 3\hat{k}}{5}$ (2) $\hat{s} = \frac{3\hat{i} - 4\hat{j}}{5}$

(3) $\hat{s} = \left(\frac{-3\hat{j} + 4\hat{k}}{5}\right)$ (4) $\hat{s} = \frac{-4\hat{k} + 3\hat{j}}{5}$

Official Ans. by NTA (3)

Sol. $\vec{E} = E_0\hat{n}\sin(\omega t + (6y - 8z))$

$= E_0\hat{n}\sin(\omega t + \vec{k}.\vec{r})$

where $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$

and $\vec{k}.\vec{r} = 6y - 8z$

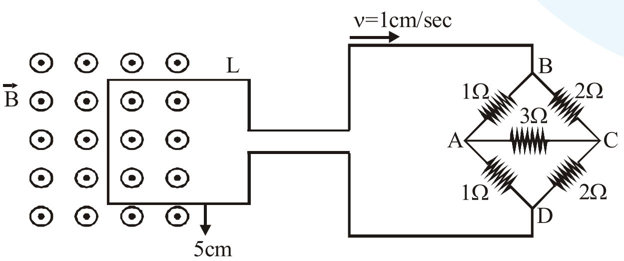
$\Rightarrow \vec{k} = 6\hat{j} - 8\hat{k}$

direction of propagation

$\hat{s} = -\hat{k}$

$= \left(\frac{-3\hat{j} + 4\hat{k}}{5}\right)$

21. The figure shows a square loop L of side 5 cm which is connected to a network of resistances. The whole setup is moving towards right with a constant speed of 1 cms^{-1}. At some instant, a part of L is in a uniform magnetic field of 1T, perpendicular to the plane of the loop. If the resistance of L is 1.7 Ω, the current in the loop at that instant will be close to :



(1) 115 μA (2) 170 μA

(3) 60 μA (4) 150 μA

Official Ans. by NTA (2)

Sol. Since it is a balanced wheatstone bridge, its equivalent resistance = $\frac{4}{3}\Omega$

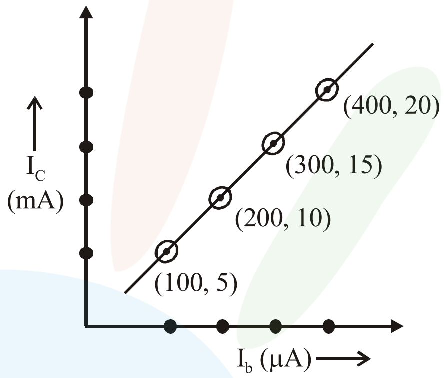
$\varepsilon = B\ell v = 5 \times 10^{-4}$ V

So total resistance

$R = \frac{4}{3} + 1.7 \approx 3\Omega$

$\therefore i = \frac{\varepsilon}{R} \approx 166\mu A \approx 170\mu A$

22. The transfer characteristic curve of a transistor, having input and output resistance 100 Ω and 100 kΩ respectively, is shown in the figure. The Voltage and Power gain, are respectively :



(1) 5×10^4, 5×10^5

(2) 5×10^4, 5×10^6

(3) 5×10^4, 2.5×10^6

(4) 2.5×10^4, 2.5×10^6

Official Ans. by NTA (3)

Sol. $V_{gain} = \left(\frac{\Delta I_C}{\Delta I_B}\right)\frac{R_{out}}{R_{in}}$

$= \left(\frac{5 \times 10^{-3}}{100 \times 10^{-6}}\right) \times 10^3$

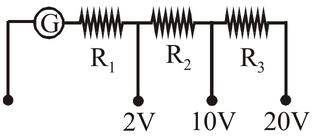
$= \frac{1}{20} \times 10^6 = 5 \times 10^4$

$P_{gain} = \left(\frac{\Delta I_C}{\Delta I_b}\right)(V_{gain})$

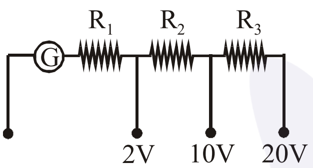
$= \left(\frac{5 \times 10^{-3}}{100 \times 10^{-6}}\right)(5 \times 10^4)$

$= 2.5 \times 10^6$

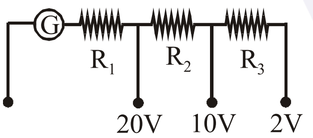
23. A galvanometer of resistance 100Ω has 50 divisions on its scale and has sensitivity of $20\ \mu A$/division. It is to be converted to a voltmeter with three ranges, of 0–2 V, 0–10 V and 0–20 V. The appropriate circuit to do so is :

(1) 

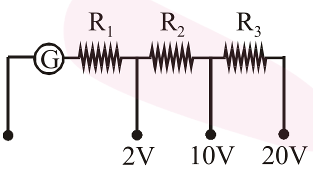
$R_1 = 1900\ \Omega$
$R_2 = 9900\ \Omega$
$R_3 = 19900\ \Omega$

(2) 

$R_1 = 2000\ \Omega$
$R_2 = 8000\ \Omega$
$R_3 = 10000\ \Omega$

(3) 

$R_1 = 19900\ \Omega$
$R_2 = 9900\ \Omega$
$R_3 = 1900\ \Omega$

(4) 

$R_1 = 1900\ \Omega$
$R_2 = 8000\ \Omega$
$R_3 = 10000\ \Omega$

Official Ans. by NTA (4)

Sol. $20 \times 50 \times 10^{-6} = 10^{-3}$ Amp.

$$V_1 = \frac{2}{10^{-3}} = 100 + R_1$$

$1900 = R_1$

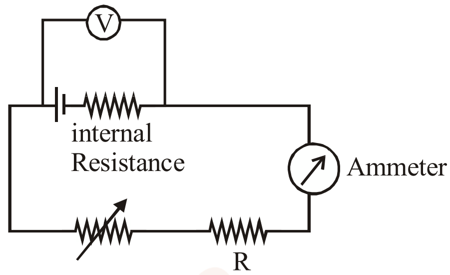
$$V_2 = \frac{10}{10^{-3}} = (2000 + R_2)$$

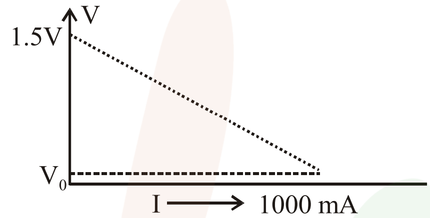
$R_2 = 8000$

$$V_3 = \frac{20}{10^{-3}} = 10 \times 10^3 + R_3$$

$10 \times 10^3 = R_3$

24. To verify Ohm's law, a student connects the voltmeter across the battery as, shown in the figure. The measured voltage is plotted as a function of the current, and the following graph is obtained:





If V_0 is almost zero, identify the correct statement:

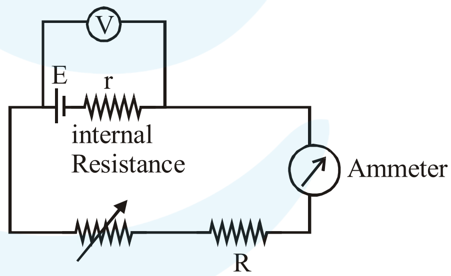
(1) The value of the resistance R is 1.5 Ω

(2) The emf of the battery is 1.5 V and the value of R is 1.5 Ω

(3) The emf of the battery is 1.5 V and its internal resistance is 1.5 Ω

(4) The potential difference across the battery is 1.5 V when it sends a current of 1000 mA.

Official Ans. by NTA (3)

Sol. 

$V = E - Ir$

when $V = V_0 = 0 \Rightarrow 0 = E - Ir$

$\therefore\ E = r$

when $I = 0,\ V = E = 1.5V$

$\therefore\ r = 1.5\Omega.$

25. An excited He^+ ion emits two photons in succession, with wavelengths 108.5 nm and 30.4 nm, in making a transition to ground state. The quantum number n, corresponding to its initial excited state is (for photon of wavelength λ, energy

$E = \frac{1240 eV}{\lambda(\text{in nm})}$) :

(1) n = 5 (2) n = 4

(3) n = 6 (4) n = 7

Official Ans. by NTA (1)

Sol. $\frac{1}{\lambda} = R\left(\frac{1}{m^2} - \frac{1}{n^2}\right)z^2$

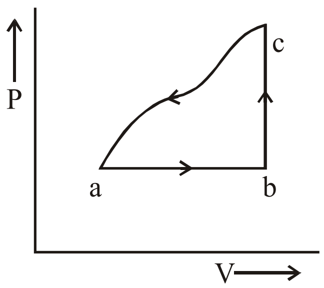
$$\frac{1}{1085} = R\left(\frac{1}{m^2} - \frac{1}{n^2}\right)2^2$$

$$\frac{1}{304} = R\left(\frac{1}{1^2} - \frac{1}{m^2}\right)2^2$$

$\therefore$ m = 2

$\therefore$ n = 5

26. A sample of an ideal gas is taken through the cyclic process abca as shown in the figure. The change in the internal energy of the gas along the path ca is –180J. The gas absorbs 250 J of heat along the path ab and 60 J along the path bc. The work done by the gas along the path abc is :



(1) 100 J (2) 120 J

(3) 140 J (4) 130 J

Official Ans. by NTA (4)

Sol.

	ΔE	ΔW	ΔQ
ab			250
bc		0	60
ca	–180		

	ΔE	ΔW	ΔQ
ab	120	130	250
bc	60	0	60
ca	–180		

27. A thin ring of 10 cm radius carries a uniformly distributed charge. The ring rotates at a constant angular speed of 40 π rad s^{-1} about its axis, perpendicular to its plane. If the magnetic field at its centre is 3.8×10^{-9} T, then the charge carried by the ring is close to ($\mu_0 = 4\pi \times 10^{-7}$ N/A^2) :

(1) 2×10^{-6} C (2) 3×10^{-5} C

(3) 4×10^{-5} C (4) 7×10^{-6} C

Official Ans. by NTA (2)

Sol. $B = \frac{\mu_0 i}{2R} = \frac{\mu_0 q\omega}{2R\, 2\pi}$

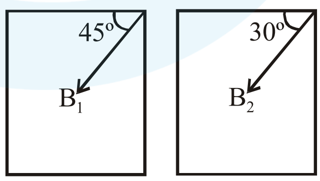
$\Rightarrow$ q = 3×10^{-5} C

28. A magnetic compass needle oscillates 30 times per minute at a place where the dip is 45º, and 40 times per minute where the dip is 30º. If B_1 and B_2 are respectively the total magnetic field due to the earth at the two places, then the ratio B_1/B_2 is best given by :

(1) 2.2 (2) 1.8 (3) 0.7 (4) 3.6

Official Ans. by NTA (3)

Sol.



$$f_1 = \frac{1}{2\pi}\sqrt{\frac{\mu B_1 \cos 45^o}{I}} \qquad f_2 = \frac{1}{2\pi}\sqrt{\frac{\mu B_2 \cos 30^o}{I}}$$

$$\frac{f_1}{f_2} = \sqrt{\frac{B_1 \cos 45^o}{B_2 \cos 30^o}} \qquad \therefore \frac{B_1}{B_2} \approx 0.7$$

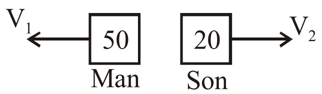
29. A man (mass = 50 kg) and his son (mass = 20 kg) are standing on a frictionless surface facing each other. The man pushes his son so that he starts moving at a speed of 0.70 ms^{-1} with respect to the man. The speed of the man with respect to the surface is :

(1) 0.20 ms^{-1} (2) 0.14 ms^{-1}

(3) 0.47 ms^{-1} (4) 0.28 ms^{-1}

Official Ans. by NTA (1)

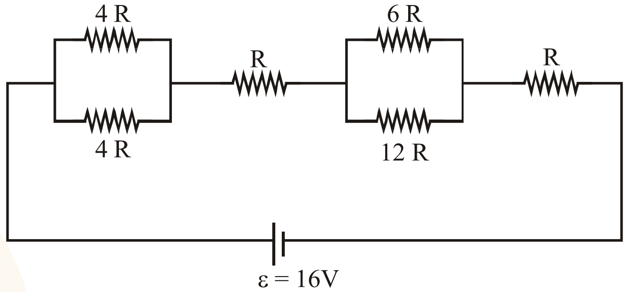
Sol.



$\Rightarrow 0 = 50V_1 - 20V_2$ and $V_1 + V_2 = 0.7$

$\Rightarrow V_1 = 0.2$

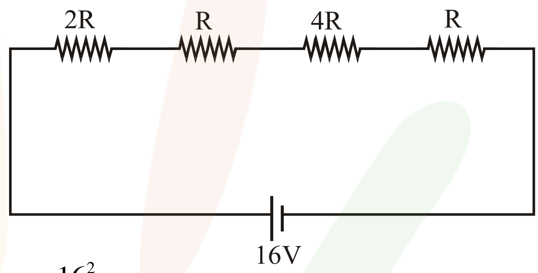
30. The resistive network shown below is connected to a D.C. source of 16V. The power consumed by the network is 4 Watt. The value of R is :



(1) 8Ω (2) 6Ω (3) 1Ω (4) 16Ω

Official Ans. by NTA (1)

Sol.



$$P = \frac{16^2}{8R} = 4 \quad \therefore R = 8\Omega$$