JEE MAIN April'19

PAPER WITH SOLUTION

12 April 2019 _ Morning _ Physics

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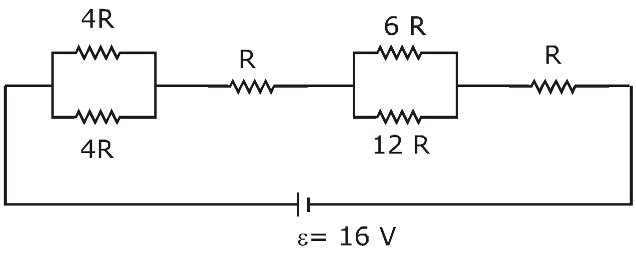
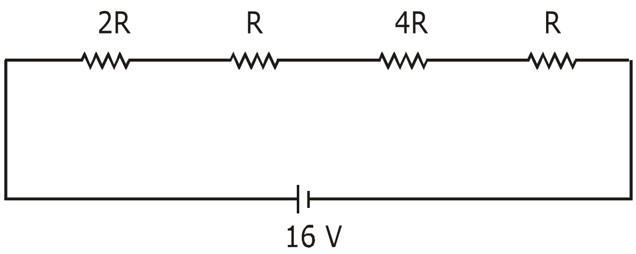
1. The resistive network shown below is connected to a D.C. source of 16 V. The power consumed by the network is 4 Watt. The value of R is :



(1) 8 Ω (2) 16 Ω (3) 6 Ω (4) 1 Ω

Sol. 1



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

$\therefore R = 8\Omega$

2. At 40° C, 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 40° C to 20° C 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} /°C and 10^{11} N/m^2, respectively ; g = 10 ms^{-2})

(1) 9 kg (2) 0.9 kg (3) 1.5 kg (4) 0.5 kg

Sol. **1**

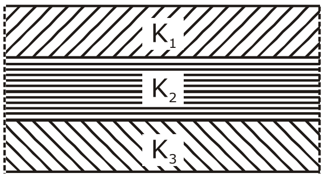
$$Mg = \left(\frac{Ay}{\ell}\right)\Delta\ell$$

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

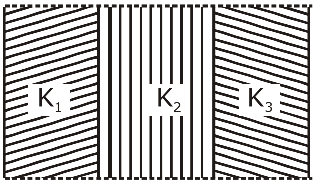
$Mg = (Ay)\,\alpha\Delta T = 2\pi$

It is closest to 9.

3. Two identical parallel plate capactiors, 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) :



(I)



(II)

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

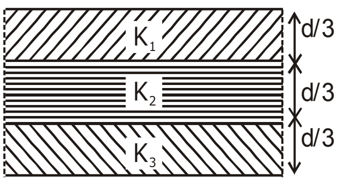
(2) $\frac{E_1}{E_2} = \frac{K_1K_2K_3}{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}$

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

Sol. 1

I.



$C_1 = \frac{3\varepsilon_0 AK_1}{d}$

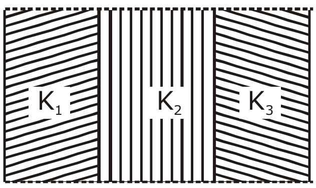
$C_2 = \frac{3\varepsilon_0 AK_2}{d}$

$C_3 = \frac{3\varepsilon_0 AK_3}{d}$

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

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

II.



$C_1 = \frac{\varepsilon_0 K_1 A}{3d}$

$C_2 = \frac{\varepsilon_0 K_2 A}{3d}$

$C_3 = \frac{\varepsilon_0 K_3 A}{3d}$

$C''_{eq} = C_1 + C_2 + C_3)$ ......(2)

Now

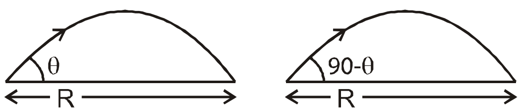
$$\frac{E_1}{E_2} = \frac{\frac{1}{2}C_{eq}V^2}{\frac{1}{2}C'eqV^2} = \frac{9K_1K_2K_3}{(K_1+K_2+K_3)(K_1K_2+K_2K_3+K_3K_1)}$$

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

Sol. **3**

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



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

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

5. 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) $0, \frac{\vec{p}}{4\pi\epsilon_0 d^3}$ (2) $\frac{|\vec{P}|}{4\pi\epsilon_0 d^2}, \frac{-\vec{P}}{4\pi\epsilon_0 d^3}$

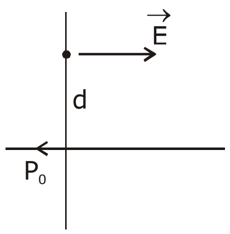
(3) $\frac{|\vec{P}|}{4\pi\epsilon_0 d^2}, \frac{\vec{P}}{4\pi\epsilon_0 d^3}$ (4) $0, \frac{-\vec{p}}{4\pi\epsilon_0 d^3}$

Sol. **4**

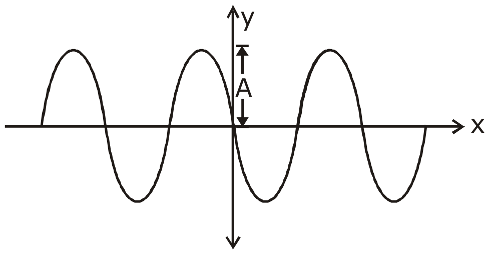
V = 0

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

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



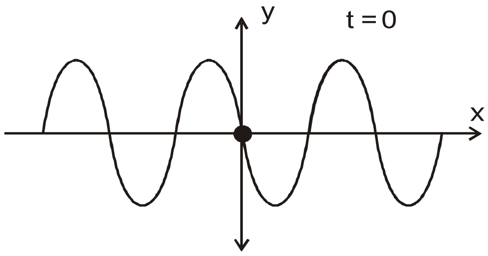
6. A progressive wave travelling along the positive x-direction is represented by $y(x,t) = A \sin(kx - \omega t + \phi)$. Its snapshot at t = 0 is given in the figure.



For this wave, the phase ϕ is :

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

Sol. **3**



$y = A \sin(kx - wt + \phi)$
at x = 0, t = 0, y = 0 and slope is negative
$\Rightarrow \phi = \pi$

7. 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 seperation between two points, to be seen as distinct, will be :
(1) 0.24 μm (2) 0.48 μm (3) 0.38 μm (4) 0.12 μm

Sol. **1**
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

$$d = \frac{0.61\lambda}{NA} = \frac{(0.61)\times(5000\times10^{-10})}{1.25}$$

$= 2.4 \times 10^{-7}$m
$= 0.24$ μm

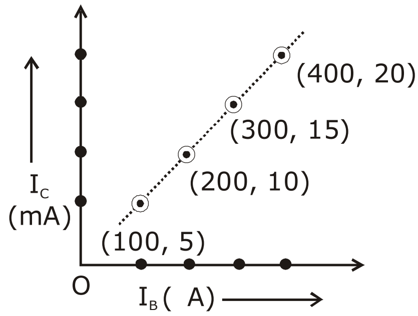
8. A thin ring of 10 cm radius carries a uniformly distributed charge. The ring rotates at a constant angular speed of 40 π rad s^{-1} about its axis, perpendicular to its plane. If the magnetic field at its centre is 3.8×10^{-9} T, then the charge carried by the ring is close to ($\mu_0 = 4\pi \times 10^{-7}$ N/A^2)
(1) 3×10^{-5} C (2) 7×10^{-6} C (3) 2×10^{-6} C (4) 4×10^{-5} C

Sol. **1**

$$B = \frac{\mu_0 i}{2R} = \frac{\mu_0 q\omega}{2R2\pi}$$

$$\Rightarrow q = 3\times10^{-5}C$$

9. The transfer characteristic curve of a transitor, 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, 2.5×10^6 (2) 2.5×10^4, 2.5×10^6
(3) 5×10^4, 5×10^6 (4) 5×10^4, 5×10^5

Sol. **3**

$V_{gain} = (\frac{\Delta I_c}{\Delta I_B})\frac{R_{out}}{R_{in}}$

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

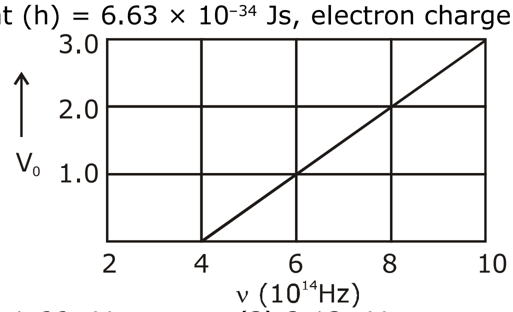
$= \frac{1}{20} \times 10^6 = 5 \times 10^4$

$P_{gain} = (\frac{\Delta I_c}{\Delta I_b})(V_{gain})$

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

2.5×10^6

10. 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 : Plank's constant (h) = 6.63×10^{-34} Js, electron charge e = 1.6×10^{-19}C)



(1) 1.95 eV (2) 1.66 eV (3) 2.12 eV (4) 1.82 eV

Sol. **2**

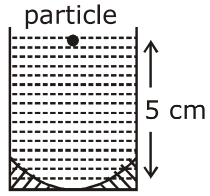
$hv = \phi + ev_0$

V_0 is zero for v = 4×10^{14} Hz

$V_0 = \frac{hv}{e} - \frac{\phi}{e} \Rightarrow \phi = hv$

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

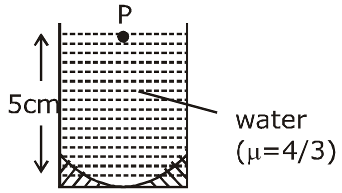
11. A concave mirror has radius of curvature of 40 cm. it is at the bottom of a glass that has water filled up to 5 cm (see figure). If a small particle is floating on the surface of water, its image as seen, from directly above the glass, is at a distance d from the surface of water. The value of d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



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

Sol. **4**

Light incident from particle P will reflected at mirror



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

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

$\boxed{y_1 = +\frac{20}{3}\text{cm}}$

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

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

below water surface.

After refraction, final image is at

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

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

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

≈ 8.8 cm

12. An electromagentic wave is represented by the electric field $\vec{E} = E_0\hat{n}\sin\left[\omega t + (6y - 8z)\right]$. Taking unit vectors in x, y and z directions to be $\hat{i}$, $\hat{j}$, $\hat{k}$ the direction of propogration $\hat{s}$, is :

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

Sol. **2**

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

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

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

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

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

13. When M_1 gram of ice at –10°C (specific heat = 0.5 cal g^{-1} °C^{-1}) is added to M_2 gram of water at 50°C, finally no ice is left and the water is at 0°C. 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) $\frac{5M_2}{M_1} - 5$

Sol. **3**

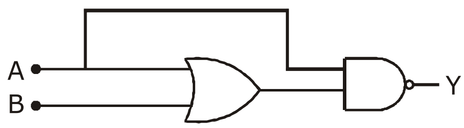
Heat lost = Heat gain

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

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

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

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



(1)

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

(2)

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

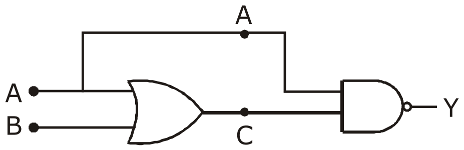
(3)

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

(4)

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

Sol. **3**

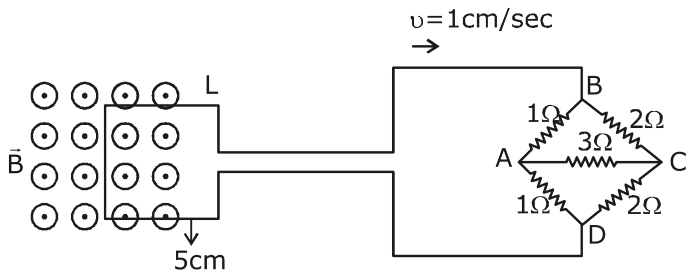


C = A + B

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

A	B	C=(A+B)	A.C.	Y=A.C
0	0	0	0	1
0	1	1	0	1
1	0	1	1	0
1	1	1	1	0

15. The figure shows a squre 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 cm s^{-1}. At some instant, a part of L is in a uniform magnetic field of 1 T, perpendicular to the palne 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) 60 μA (2) 150 μA (3) 115 μA (4) 170 μA

Sol. **4**

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

$\varepsilon = Blv = 5 \times 10^{-4} v$

so total resistance

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

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

16. 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 $E = \frac{1240\,eV}{\lambda(in\,nm)}$)

(1) n = 5 (2) n = 6 (3) n = 7 (4) n = 4

Sol. 1

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

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

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

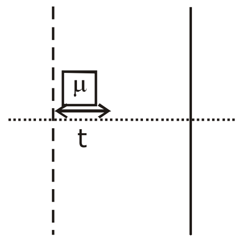
$\therefore$ m = 2

$\therefore$ N = 5

17. 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)

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

Sol. 3

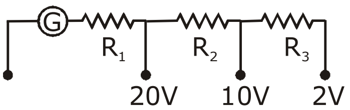


$\Delta x = (\mu-1)t = 1\lambda$

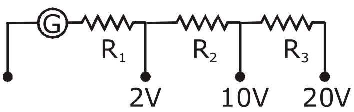
For one maximum shift

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

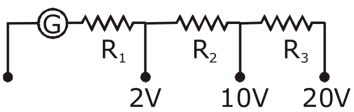
18. A galvanometer of resistance 100 W has 50 divisions on its scale and has sensitity of 20 μA/division. It is to be converted to a voltmeter with three ranges, of 0–2V, 0–10 V and 0–20V. The appropriate circuit to do so is :

(1)


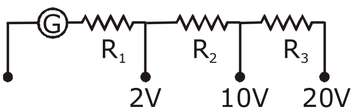
R_1 = 19900 Ω
R_2 = 9900 Ω
R_3 = 1900 Ω

(2)


R_1 = 1900 Ω
R_2 = 9900 Ω
R_3 = 19900 Ω

(3)


R_1 = 1900 Ω
R_2 = 8000 Ω
R_3 = 10000 Ω

(4)


R_1 = 2000 Ω
R_2 = 8000 Ω
R_3 = 10000 Ω

Sol. **3**

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

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

$1900 = R_1$

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

$R_2 = 8000$

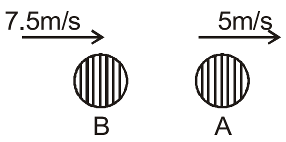
$V_3 = \frac{20}{10^{-3}} = 10 \times 10^3 + R_3$

$10 \times 10^3 = R_3$

19. A submarine (A) travelling at 18 km / hr is being chased along the line of its velocity by another submarine (B) travelling at 27km / 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) 502 Hz (2) 499 Hz (3) 507 Hz (4) 504 Hz

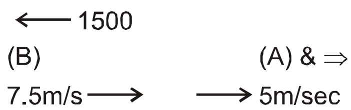
Sol. **1**



f_0 = 500 Hz
frequency received by A

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

and frequency received By B again =

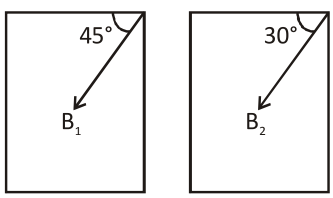


$f_2 = \left(\frac{1500 + 7.5}{1500 + 5}\right) \times \left(\frac{1500 - 5}{1500 - 7.5}\right) f_0 = 502\text{Hz}$

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

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

Sol. **1**



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

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

21. 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) $\frac{\epsilon_0}{\mu_0}$ (2) $\sqrt{\frac{\mu_0}{\epsilon_0}}$ (3) $\sqrt{\frac{\epsilon_0}{\mu_0}}$ (4) $\frac{\mu_0}{\epsilon_0}$

Sol. **2**

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

$[\mu_0] = MLT^{-2}A^{-2}$

$[R] = ML^2T^{-3}A^{-2}$

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

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

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

Sol. **2**

Equation of trajectory is given as

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

Comparing with equation :

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

We get;

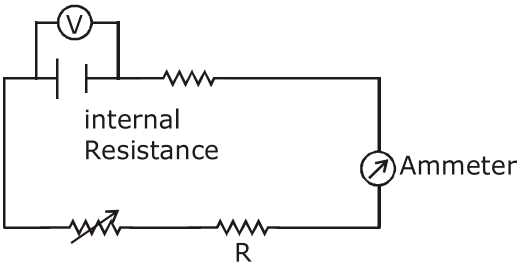
$\tan\theta = 2$

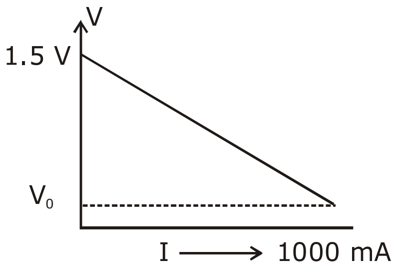
$\therefore \boxed{\cos\theta = \frac{1}{\sqrt{5}}}$

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

$\Rightarrow u^2 = \frac{25}{9} \Rightarrow \boxed{u = \frac{5}{3} m/s}$

23. 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 :

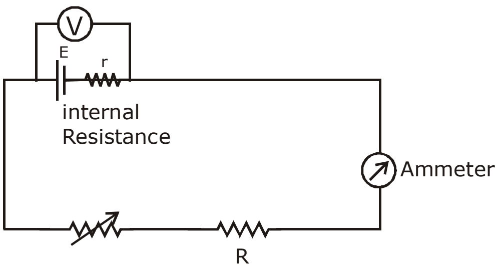
(1) The emf of the battery is 1.5 V and its internal resistance is 1.5 Ω

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

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

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

Sol. **1**



$V = E - Ir$

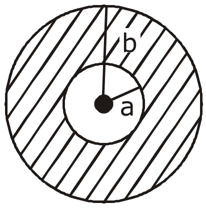
When $V = V_0 = 0 \Rightarrow 0 = E - Ir$

$\therefore E = r$

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

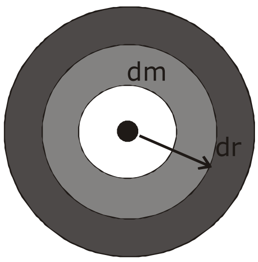
$\therefore\ r = 1.5\Omega$

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

Sol. **4**



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

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

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

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

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

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

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

$m = \sigma_0\ 2\pi\ (b\text{-}a)$

Radius of gyration

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

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

25. 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)

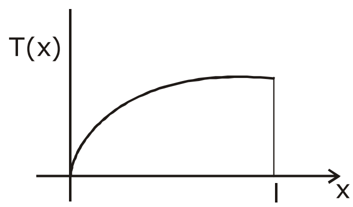
(1) 17.4 J/ Mol k (2) 21.6 J/ Mol k (3) 15.7 J/ Mol k (4) 17.7 J/ Mol k

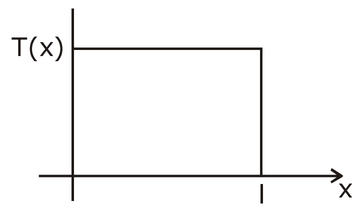
Sol. **1**

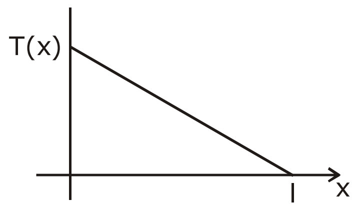
$$f_{mix} = \frac{n_1 f_1 + n_1 f_2}{n_1 + n_2} = \frac{2 \times 3 + 3 \times 5}{5} = \frac{21}{5}$$

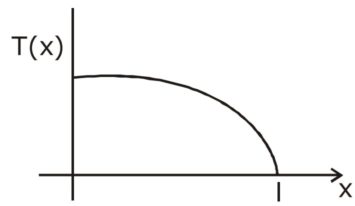
$$C_V = \frac{fR}{2} = \frac{21}{5} \times \frac{R}{2} = 17.4J/molK$$

26. 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 ?

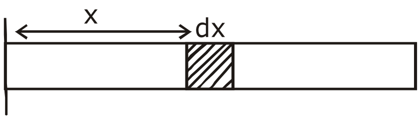
(1)


(2)


(3)


(4)


Sol. **4**



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

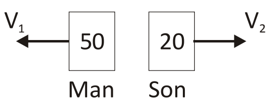
$$= \frac{m\omega^2}{2l}(l^2 - x^2)$$

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

27. A man (mass = 50 kg) and his son (mass = 20 kg) are standing on a frictionless sufrace 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) 0.47 ms^{-1} (2) 0.14 ms^{-1} (3) 0.28 ms^{-1} (4) 0.20 ms^{-1}

Sol. **4**



$\Rightarrow 0 = 50V_1 - 20V_2$ and $v_1 + v_2 = 0.7$

$\Rightarrow V_1 = 0.2$

28. 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(l<<L), is close to :

(1) $mgl(1+\theta_0^2)$ (2) $mgl(1-\theta_0^2)$ (3) $mgl\left(1+\frac{\theta_0^2}{2}\right)$ (4) mgl

Sol. **1**

Angular momentum conservation.

$MV_0L = MV_1(L - \ell)$

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

$$w_g + w_p = \Delta KE$$

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

$$w_p = mg\ell + \frac{1}{2}MV_0^2\left(\left(\frac{L}{L-\ell}\right)^2 - 1\right)$$

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

Now ℓ << L

By, Binomial approximation

$$mg\ell + \frac{1}{2}mv_0^2\left(\left(1+\frac{2\ell}{L} - 1\right)\right)$$

$$= mg\ell + \frac{1}{2}\ \frac{1}{2}V_0^2\left(\frac{2\ell}{L}\right)$$

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

here, V_0 = maximum velocity

$= \omega \times A$

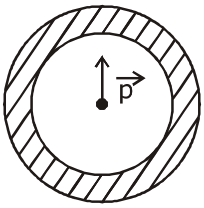
$$= \left(\sqrt{\frac{g}{L}}(\theta_0 L\right)$$

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

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

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

29. 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 :



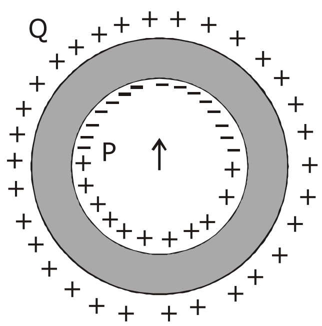
(1) Electric field outside the shell is the same as that of a point charge at the centre of the shell

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

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

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

Sol. **1**



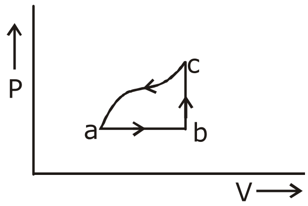
Total charge of dipole = 0, so charge induced on outside surface = 0.

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

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

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

30. A sample of an ideal gas is taken through the cylic process abca as shown in the figure. The change in the internal energy of the gas along the path ca is –180 J. The gas absords 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) 130 J (4) 140 J

Sol. **3**

	ΔE	ΔW	ΔQ
ab			250
bc		0	60
ca	-180		

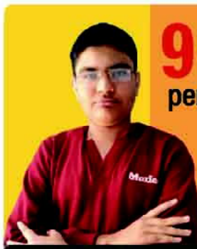
	ΔE	ΔW	ΔQ
ab	120	130	250
bc	60	0	60
ca	-180		

मोशन ने बनाया साधारण को असाधारण

JEE Main Result Jan'19

4 RESIDENTIAL COACHING PROGRAM (DRONA) STUDENTS ABOVE 99.9 PERCENTILE

99.9 percentile
PHYSICS 100 percentile
Nitin Gupta
Exp. Score 335 Last yr Score 149



99.9 percentile
Shiv Modi
Exp. Score 318 Last yr Score 153

99.9 percentile
Ritik Bansal
Exp. Score 308 Last yr Score 218

99.9 percentile
Shubham Kumar
Exp. Score 300 Last yr Score 153

Total Students Above 99.9 percentile - **17**

Total Students Above 99 percentile - **282**

Total Students Above 95 percentile - **983**

% of Students Above 95 percentile $\frac{983}{3538}$ = **27.78%**

Scholarship on the Basis of 12th Class Result

Marks PCM or PCB	Hindi State Board	State Eng OR CBSE
70%-74%	30%	20%
75%-79%	35%	25%
80%-84%	40%	35%
85%-87%	50%	40%
88%-90%	60%	55%
91%-92%	70%	65%
93%-94%	80%	75%
95% & Above	90%	85%

New Batches for Class 11th to 12th pass
17 April 2019 & 01 May 2019

हिन्दी माध्यम के लिए पृथक बैच

Scholarship on the Basis of JEE Main Percentile

Score	JEE Mains Percentile	English Medium Scholarship	Hindi Medium Scholarship
225 Above	Above 99	Drona Free (Limited Seats)	
190 to 224	Above 97.5 To 99	100%	100%
180 to 190	Aboev 97 To 97.5	90%	90%
170 to 179	Above 96.5 To 97	80%	80%
160 to 169	Above 96 To 96.5	60%	60%
140 to 159	Above 95.5 To 96	55%	55%
74 to 139	Above 95 To 95.5	50%	50%
66 to 73	Above 93 To 95	40%	40%
50 to 65	Above 90 To 93	30%	35%
35 to 49	Above 85 To 90	25%	30%
20 to 34	Above 80 To 85	20%	25%
15 to 19	75 To 80	10%	15%

सैन्य कर्मियों के बच्चों के लिए 50% छात्रवृत्ति | प्री-मेडिकल में छात्राओं को 50% छात्रवृत्ति