TOP 30 ANTICIPATED QUESTIONS-MARCH (PHYSICS)

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THE PERFECT GUIDE

BASED ON JEE-MAINS 2021 ANALYSIS (FEB ATTEMPT)

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1. A gas ($\gamma = 1.3$) is enclosed in an insulated vessel fitted with insulating piston at a pressure of 10^5 N/m^2. On suddenly pressing the piston the volume is reduced to half the initial volume. The final pressure of the gas is

(A) $2^{0.7} \times 10^5$

(B) $2^{1.3} \times 10^5$

(C) $2^{1.4} \times 10^5$

(D) None of these

Answer : (B)

Explanation :

$\because\ PV^{\gamma} = k$ (constant) $\Longrightarrow P_1V_1^{\gamma} = P_2V_2^{\gamma}$

$\Longrightarrow P_2 = P_1\left(\frac{V_1}{V_2}\right)^{\gamma} = 2^{1.3} \times 10^5 \quad \left(\because V_2 = \frac{V_1}{2}\right)$

2. At 27 °C a gas is suddenly compressed such that its pressure becomes $\frac{1}{8}$th of original pressure. Temperature of the gas will be (γ = 5/3)

(A) 420 K

(B) 327 °C

(C) 300 K

(D) –142 °C

Answer : **(D)**

Explanation :

$T^{\gamma}P^{1-\gamma} = k$ (constant) $\Longrightarrow T \propto P^{\frac{\gamma-1}{\gamma}}$

$\Longrightarrow \frac{T_2}{T_1} = \left(\frac{T_2}{T_1}\right)^{\frac{\gamma-1}{\gamma}} = \left(\frac{1}{8}\right)^{\frac{5/3-1}{5/3}}$

$T_2 = 300 \times \left(\frac{1}{8}\right)^{0.4} = 131\text{ K} = -142^{o}\text{ C}$

3. Column I contains height (in m) of a TV tower. Column II contains distance (in Km) up to which TV transmission can be received. (Radius of the earth 6.4×10^6 m

	List 1	List 2
A.	75	I. 31
B.	60	II. 28
C.	50	III. 25
D.	80	IV. 32

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

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

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

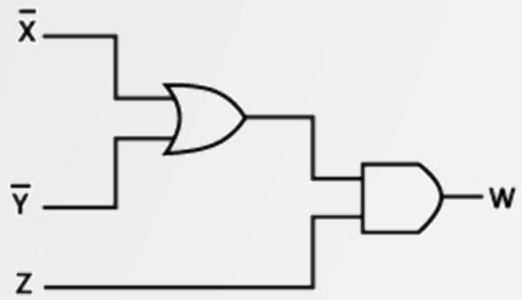
(D) A-> IV, B-> III, C -> II, D-> I

Answer : **(B)**

Explanation :

$d = \sqrt{2 \times R \times h}$

4. Output Y is given by



(A) $(\overline{X} + \overline{Y}) \cdot Z$

(B) $(X + Y) Z$

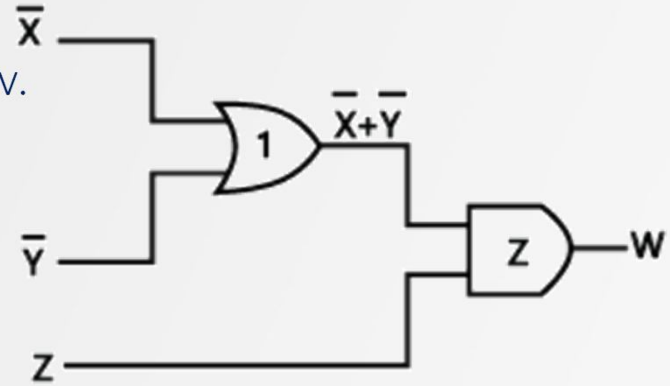
(C) $(X + Y) \overline{Z}$

(D) $\overline{X} \cdot \overline{Y} + \overline{Z}$

Answer : **(A)**

Explanation :

We can realize the combination as shown below.



Gate **-1** is OR gate while gate **-2** is AND gate.

Output of OR gate, $W_1 = \overline{X} + \overline{Y}$

Thus, output of AND gate,

$W = W_1 \cdot Z = (\overline{X} + \overline{Y}) \cdot Z$

5. The approximate ratio of resistances in the forward and reverse bias of the PN-junction diode is

(A) $10^2 : 1$

(B) $10^{-2} : 1$

(C) $1 : 10^{-4}$

(D) $1 : 10^4$

Answer : **(D)**

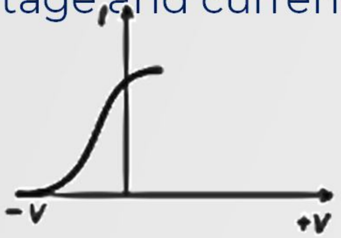
Explanation :

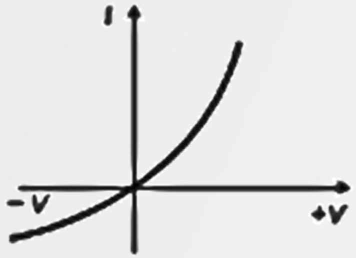
Resistance in forward biasing $R_{\text{forward}} \approx 10\ \Omega$

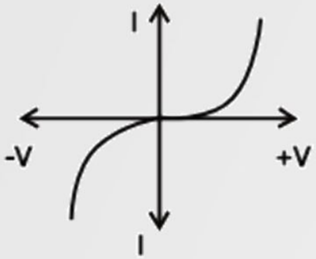
And resistance in reverse biasing $R_{\text{reverse}} \approx 10^5\ \Omega$

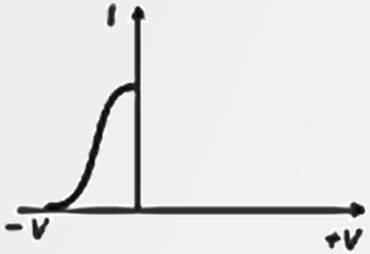
$$\Rightarrow \frac{R_{\text{forward}}}{R_{\text{reverse}}} = \frac{10}{10^5} = \frac{1}{10^4}$$

6. Different voltages are applied across a P-N junction and the currents are measured for each value. Which of the following graphs is obtained between voltage and current

(A)


(B)


(C)


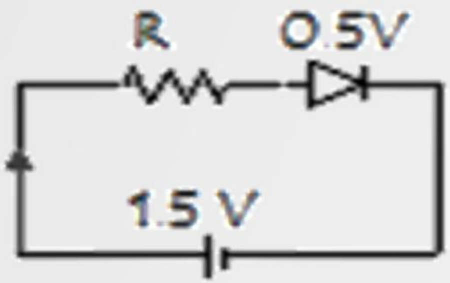
(D)


Answer : (C)

Explanation :

P-N junction has low resistance in one direction of potential difference +V, so a large current flows (forward biasing). It has a high resistance in the opposite potential difference direction -V, so a very small current flows (reverse biasing)

7. The diode used **in** the circuit shown in the figure has a constant voltage drop of 0.5 V at all currents and a maximum power rating of 100 mW. What should be the value of the resistor R, connected in series with the diode for obtaining maximum current?



(A) 1.5 Ω

(B) 5 Ω

(C) 6.67 Ω

(D) 200 Ω

Answer : (B)

Explanation :

Current through circuit,

$$I = \frac{P}{V} = \frac{(100 \times 10^{-3})}{0.5} = 0.02\ A$$

Voltage drop across R = 1.5 – 0.5 = 1.0 V

Hence, $R = \frac{1}{0.2} = 5\ \Omega$

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8. If for hydrogen $C_p - C_V = m$ and for nitrogen $C_p - C_v = n$, where C_p and C_v refer to specific heats per unit mass respectively at constant pressure and constant volume, the relation between m and n is (molecular weight of hydrogen = 2 and molecular weight of nitrogen = 14)

(A) $n = 14m$

(B) $n = 7m$

(C) $m = 7n$

(D) $m = 14n$

Answer : **(C)**

Explanation :

$C_p - C_V = m,$

For hydrogen $(M_1 = 2)$ $C_p - C_V = n,$

For nitrogen $(M_2 = 14)$

For hydrogen, $C_p - C_V = \frac{1}{M_1}\frac{dQ}{dT} = m$

For nitrogen, $C_p - C_V = \frac{1}{M_2}\frac{dQ}{dT} = n$

$$\therefore \frac{m}{n} = \frac{\left(\frac{1}{M_1}\frac{dQ}{dT}\right)}{\frac{1}{M_2}\frac{dQ}{dT}} = \frac{M_2}{M_1} = \frac{14}{2} = 7$$

$\therefore \quad m = 7\,n$

9. $\frac{2.5}{\pi}$ μF capacitor and 3000-ohm resistance are joined in series to an ac source of 200 volt and 50 sec^{-1} frequency. The power factor of the circuit and the power dissipated in it will respectively

(A) 0.6, 0.06 W

(B) 0.06, 0.6 W

(C) 0.6, 4.8 W

(D) 4.8, 0.6 W

Answer : (C)

Explanation :

$$Z = \sqrt{R^2 + \left(\frac{1}{2\pi\nu C}\right)^2} = \sqrt{(3000)^2 + \frac{1}{\left(2\pi\times 50\times\frac{2.5}{\pi}\times 10^{-3}\right)^2}}$$

$$\Rightarrow Z = \sqrt{(3000)^2+(4000)^2} = 5\times 10^3\ \Omega$$

So power factor $\cos\phi = \frac{R}{Z} = \frac{3000}{5\times 10^3} = 0.6$ and

Power $V_{rms} i_{rms} \cos\phi = \frac{V_{rms}^2 \cos\phi}{Z}$

$$\Rightarrow P = \frac{(200)^2\times 0.6}{5\times 10^3} = 4.8\ W$$

10. The self inductance of a choke coils is 10 mH. When it is connected with a 10V dc source, then the loss of power is 20 watt. When it is connected with ac source loss of power is 10 watt. The frequency of ac source will be

(A) 50 Hz

(B) 60 Hz

(C) 80 Hz

(D) 100 Hz

Answer : (C)

Explanation :

With d c : $P = \frac{V^2}{R} \Rightarrow R = \frac{(10)^2}{20} = 5\,\Omega$

With a c : $P = \frac{(V_{rms}{}^2 R)}{Z^2} \Rightarrow Z^2 = \frac{(10)^2 \times 5}{10} = 50\,\Omega^2$

Also $Z^2 = R^2 + 4\pi^2 V^2 L^2$

$\Rightarrow 50 = (5)^2 + 4(3.14)^2 V^2 (10^2 \times 10^{-3})^2$

$\Rightarrow V = 80$ Hz

11. In the relation x = cos (ωt + kx), the dimensions of ω are

(A) $[M^0LT]$

(B) $[M^0L^{-1}T^0]$

(C) $[M^0L^0T^{-1}]$

(D) $[M^0LT^{-1}]$

Answer : **(C)**

Explanation :

$x = \cos(\omega t + kx)$

Here, $(\omega t + kx)$ is an angle

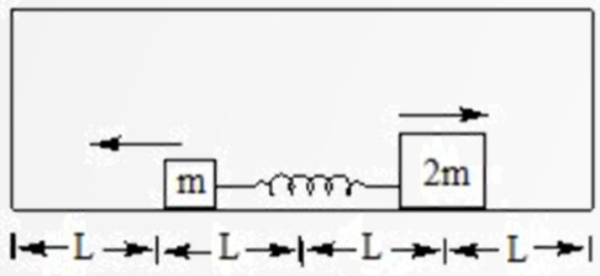
So the dimension of $(\omega t + kx) = [M^0L^0T^0]$

Or dimensions of $\omega t = [M^0L^0T^0]$

Or dimensions of $\omega = \frac{[M^0L^0T^0]}{[T]}$

Or $= [M^0L^0T^{-1}]$

12. Two small blocks of mass m and 2m are held against a massless compressed spring within a box of mass 3m and length 4L whose centre is at x = 0 (see fig.). All the surfaces are frictionless. After the blocks are released they are each at a distance L from the ends of the box when they lose contact with the spring. What is the shift in position of centre of mass of the box after both blocks collide with and stick to it?



(A) $\frac{L}{3}$

(B) $\frac{L}{6}$

(C) $\frac{L}{12}$

(D) $\frac{L}{4}$

Answer : **(B)**

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Explanation :

$\Delta X_m = (X - L)$

$\Delta X_{2m} = (X + L)$

$\Delta X_{3m} = X$

$\Longrightarrow m(X - L) + 2m(X + L) + 3mx = 0$

$\Longrightarrow 6mx - mL = 0$

$\Longrightarrow x = \frac{L}{6}$

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13. A parallel plate capacitor is charged to 60μC. Due to a radioactive source, the plate loss charge at the rate of $1.8 \times 10^{-8}\ Cs^{-1}$. The magnitude of displacement current is

(A) $1.8 \times 10^{-8}\ Cs^{-1}$

(B) $3.6 \times 10^{-8}\ Cs^{-1}$

(C) $3.6 \times 10^{-11}\ Cs^{-1}$

(D) $1.8 \times 10^{-12}\ Cs^{-1}$

Answer : **(A)**

Explanation :

Displacement current is given by

$$I_d = \frac{dq}{dt} = 1.8 \times 10^{-8}\ Cs^{-1}$$

14. Calculate the moment of inertia of a wheel about its axis which having rim of mass 24M and twenty four spokes each of mass M and length l.

(A) 24 Ml^2

(B) 32 Ml^2

(C) 64 Ml^2

(D) 16 Ml^2

Answer : **(B)**

Explanation :

$$I = 24\,Ml^2 + 24\left(\frac{Ml^2}{3}\right)$$

$$= 24\,Ml^2 + 8\,Ml^2$$

$$= 32\,Ml^2$$

15. Two point charges repel each other with a force of 100 N. One of the charges is increased by 10% and other is reduced by 10%. The new force of repulsion at the same distance would be

(A) 100 N

(B) 121 N

(C) 99 N

(D) None of these

Answer : **(C)**

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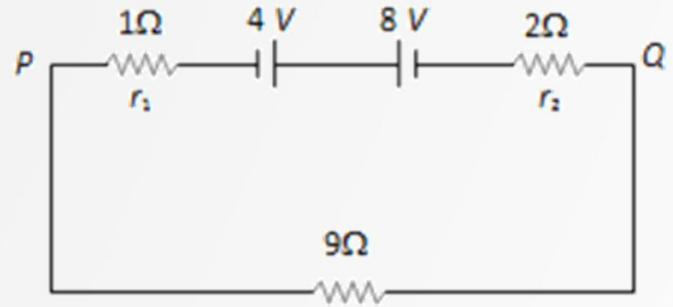
Explanation :

$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2} = \left(\frac{110}{100}\right)\left(\frac{90}{100}\right)$ times

i.e., $\frac{99}{100}$ times

Therefore, net force = $\frac{90}{100} \times 100 = 99$ N

16. Two batteries of e.m.f. 4V and 8V with internal resistance $1\,\Omega$ and $2\,\Omega$ are connected in a circuit with a resistance of $9\,\Omega$ as shown in figure. The current and potential difference between the points P and Q are.



(A) $\frac{1}{3}$ A and 3 V

(B) $\frac{1}{6}$ A and 4 V

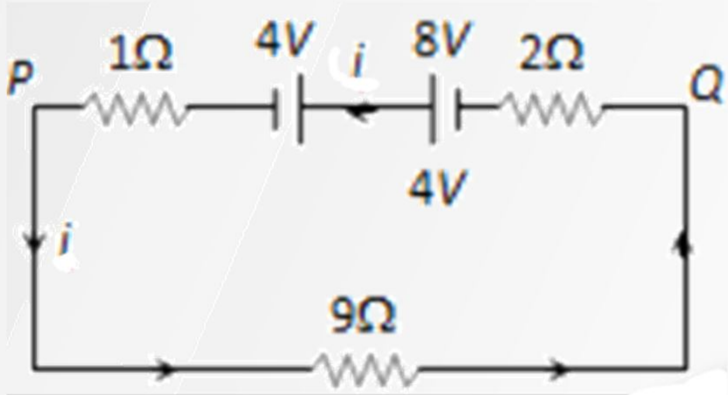
(C) $\frac{1}{9}$ A and 9 V

(D) $\frac{1}{2}$ A and 12 V

Answer : **(A)**

Explanation :

Applying Kirchhoff's voltage law in the given loop



$-2i + 8 - 4 - 1 \times i - 9i = 0$

$\Rightarrow i = \frac{1}{3} A$

Potential difference across

PQ $= \frac{1}{3}$ A and 3 V

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17. An e.m.f. of 12 volt is produced in a coil when the current in it changes at the rate of 45 amp/minute. The inductance of the coil is

(A) 0.25 henry

(B) 1.5 henry

(C) 9.6 henry

(D) 16.0 henry

Answer : **(D)**

Explanation :

$$e = L\frac{di}{dt}$$

$$\Rightarrow L \times \frac{45}{60} \Rightarrow L = 16\ H$$

18. If the radius of the earth were to shrink by two percent, its mass remaining the same, the acceleration due to gravity on the earth's surface would

(A) Decrease by 2%

(B) Increase by 2%

(C) Increase by 4%

(D) Decrease by 4%

Answer : **(C)**

Explanation :

$g = \frac{GM}{R^2}$;

If R decreases then g increases. Taking logarithm of both the sides ;

Log g = log G + log M - 2 log R

Differentiating it we get; $\frac{dg}{g} = 0 + 0 - \frac{2dR}{R} = -2\left(\frac{-2}{100}\right) = \frac{4}{100}$

$\therefore$ % increase in g $= \frac{dg}{g} \times 100 = \frac{4}{100} \times 100 = 4\%$

19. The equation of motion of a particle is $\frac{d^2y}{dt^2} + ky = 0$, where k is positive constant. The time period of the motion is given by

(A) $\frac{2\pi}{K}$

(B) $2\pi K$

(C) $\frac{2\pi}{\sqrt{k}}$

(D) $2\pi\sqrt{k}$

Answer : **(C)**

Explanation :

On comparing with standard equation $\frac{d^2y}{dt^2} + \omega^2 y = 0$

We get $\omega^2 = K \implies \omega = \frac{2\pi}{T} = \sqrt{k}$

$\implies T = \frac{2\pi}{\sqrt{k}}$

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20. For hydrogen atom electron in nth Bohr orbit, the ratio of radius of orbit to its de-Broglie wavelength is

(A) $\frac{n}{2\pi}$

(B) $\frac{n^2}{2\pi}$

(C) $\frac{1}{2\pi n}$

(D) $\frac{1}{2\pi n^2}$

Answer : (A)

Explanation :

For nth Bohr orbit, $r = \frac{(\varepsilon_0 n^2 h^2)}{(\pi m Z e^2)}$

De – Brogile wavelength $\lambda = \frac{h}{mv}$

Ration of both r and λ, we have

$$\frac{r}{\lambda} = \frac{(\varepsilon_0 n^2 h^2)}{(\pi m Z e^2)} \times \frac{mv}{h} = \frac{(\varepsilon_0 n^2 hv)}{(\pi m Z e^2)}$$

But $V = \frac{Ze^2}{2h\varepsilon_0 n}$ for nth orbit

Hence, $\frac{r}{\lambda} = \frac{n}{2\pi}$

21. A gas mixture consists of 2 moles of oxygen and 4 moles argon at temperature T. Neglecting all vibrational modes, the total internal energy of the system is(N + 7)RT. The value of N is.

Answer : **(4)**

Explanation :

Oxygen is diatomic gas, hence its energy of two moles = $2 \times \frac{5}{2}RT = 5RT$

Argon is a mono atomic gas, hence its internal energy of 4 moles = $4 \times \frac{3}{2}RT = 6RT$

Total Internal energy = (6 + 5)RT = 11 RT

22. A wire of length l = (6 ± 0.06) radius r = (0.5 ± 0.005) cm and mass m = (0.3 ± 0.003) gm, the maximum percentage error in density is x %, where x =

Answer : (4)

Explanation :

$\rho = \frac{m}{\pi r^2 l} \Rightarrow \frac{\Delta\rho}{\rho}\% = \frac{\Delta m}{m}\% + 2\frac{\Delta r}{r}\% + \frac{\Delta l}{l}\%$

$\Rightarrow \frac{0.003}{0.3} \times 100 + 2 \times \frac{0.005}{0.5} \times 100 + \frac{0.06}{0.6} \times 100$

$\Rightarrow 1 + 2 + 1 = 4\%$

$\Rightarrow x = 4$

23. The displacement y of a particle in a medium can be expressed as $y = 10^{-6}\left(100t + 20x + \frac{\pi}{4}\right)$ m where, t is in second and x in metre. The speed of the wave is (in ms^{-1})

Answer : **(5)**

Explanation :

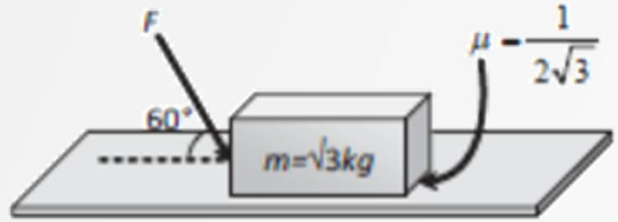
As given $y = 10^{-6}\left(100t + 20x + \frac{\pi}{4}\right)$

Comparing it with $y = a \sin(\omega t + kx + \phi)$,

We obtain $\omega = 100 \text{ rad s}^{-1}$, $k = m^{-1}$

$$\therefore \quad V = \frac{\omega}{K} = \frac{100}{20} ms^{-1}$$

24. What is the maximum value of the force F such that the block shown in the arrangement, does not move



Answer : **(20)**

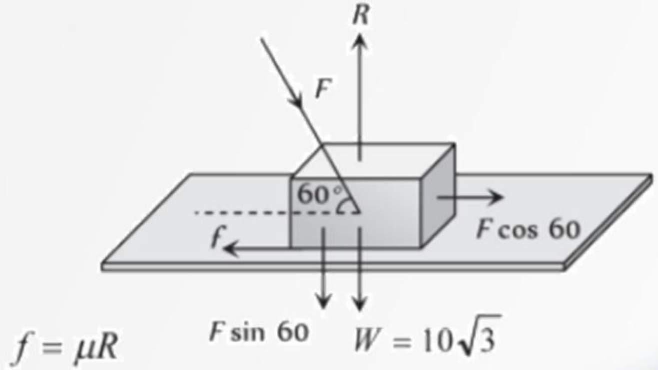
Explanation :

$F\cos 60^o = \mu(W + F\sin 60^o)$

Substituting $\mu = \frac{1}{2\sqrt{3}}$ & $W = 10\sqrt{3}$

We get F = 20 N

Hence the answer is (20).



25. Imagine an atoms made up of a proton and a hypothetical particle of double the mass of the electron but having the same charge as the electron. Apply the Bohr atom model and consider all possible transitions to the first excited level. The longest wavelength photon that will be emitted has wavelength λ given $\frac{2x}{5R}$, where 'R' is the Rydberg's constant. Find the value of 'x'.

Answer : **(9)**

Explanation :

$\lambda \times \frac{1}{m}$ and $\frac{1}{\lambda} = r\left[\frac{1}{2^2} - \frac{1}{3^3}\right] = \frac{5R}{36}$ (or) $\lambda = \frac{36}{5R}$

For hypothetical atom $\lambda' = \frac{\lambda}{2} = \frac{18}{5R} = \frac{2\times 9}{5R} \Rightarrow x = 9$

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26. An infinite collection of equal masses of 2kg are kept on x- axis at positions x = 1m, 2m, 4m, 8m ...... The gravitational potential at x = 0 is -nG. Find n.

Answer : (4)

Explanation :

$$V = -\frac{Gm}{r}$$

$$-nG = -2G\left[\frac{1}{1} + \frac{1}{2} + \frac{1}{2^2} + \frac{1}{3^3} + \cdots\right] - nG$$

$$= -2G(2)\left[S_\infty = \frac{W}{1-r} = \frac{1}{1-\frac{1}{2}} = 2\right]$$

n = 4

27. Interference fringes were produced by Young's double slit method, the wavelength of light used being 6000A°. The separation between the two slits is 2mm.The distance between the slits and screen is 10cm. When a transparent plate of thickness 0.5mm is placed over one of the slits, the fringe pattern is displaced by 5mm. If μ be the refractive index of the material of the plate, then find 5 μ.

Answer : (6)

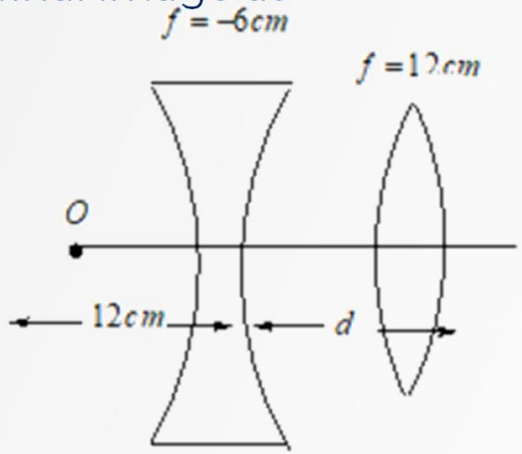
Explanation :

Here, $d = 2mm = 2 \times 10^{-3}$, $D = 10\ cm = 0.10\ m$, $T = 0.5\ mm = 0.5 \times 10^{-3}\ m$, $\Delta x = 5\ mm = 5 \times 10^{-3}\ m$, $\lambda = 6 \times 10^{-7}\ m$

Since, $\Delta x = \frac{D}{d}(\mu - 1)t \Rightarrow \mu - 1 = \frac{(\Delta x)d}{Dt} = \frac{5\times10^{-3}\times2\times10^{-3}}{0.10\times0.5\times10^{-3}} = 0.2$

$\mu = 1.2 \Rightarrow 5\mu = 6$

28. An object is placed 12cm to the left of a diverging lens of focal length -6cm . A converging lens with a focal length of 12cm is placed at a distance d to the right of the diverging lens. Find the distance d, in cm, that corresponds to a final image at infinity..



Answer : **(8)**

Explanation :

Applying lens formula $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$ twice we get

$$\frac{1}{v_1}-\frac{1}{-12}=\frac{1}{-6} \quad ...(1)$$

$$\frac{1}{\infty}-\frac{1}{v_1-d}=\frac{1}{12} \quad ...(2)$$

Solving equations (1) and (2) ,

we get $v_1 = -4$ cm and d = 8 cm

29. Intensity of gravitational field $\bar{E}$ in space at a point depends on co-ordinates (x, y, z) of the point as $\bar{E} = \frac{-x\hat{i}-y\hat{j}}{x^2+y^2}$. If the total mass m inside an imaginary sphere of radius a with its centre at origin is n times $\frac{a}{2G}$ [G universal gravitational constant], then n is

Answer : (2)

Explanation :

$\oint \bar{E}\,\overline{ds} = -4\pi G$ [M enclose]

$\Rightarrow \oint \left(\frac{-x\hat{i}-y\hat{j}}{x^2+y^2}\right).ds.\frac{x\hat{i}+y\hat{j}+z\hat{k}}{a} = -4\pi G[M] \Rightarrow \oint \frac{(x^2+y^2)ds}{(x^2+y^2)a} = 4\pi G[M]$

$\Rightarrow \frac{1}{a}.4\pi a^2 = 4\pi GM \Rightarrow M = \frac{a}{G} = \frac{na}{2G} \Rightarrow n = 2$

30. A wheel rotates through an angle of θ_1 with a uniform acceleration starting from rest in the first 1 sec. The wheel rotates through an additional angle of θ_2 in the next 1 sec. Find the ratio $\frac{\theta_2}{\theta_1}$.

Answer : **(3)**

Explanation :

$\omega_0 = 0,\ t_1 = 1$ sec

$\theta_1 = \omega_0 t_1 + \frac{1}{2}\alpha t_1^2$

$\theta_1 = \frac{\alpha}{2}$ ...(1)

$\theta_1 + \theta_2 = \omega_0 t_2 + \frac{1}{2}\alpha t_2^2$,

$t_2 = 2$ sec

$\theta_1 + \theta_2 = \frac{1}{2}\alpha(2)^2$, $\theta_1 + \theta_2 = 2\alpha$

$\theta_2 = \left(\frac{3}{2}\right)\alpha$ ....(2)

(from eqn (1))

From eqn $\frac{(2)}{(1)} \Rightarrow \frac{\theta_2}{\theta_1} = 3$