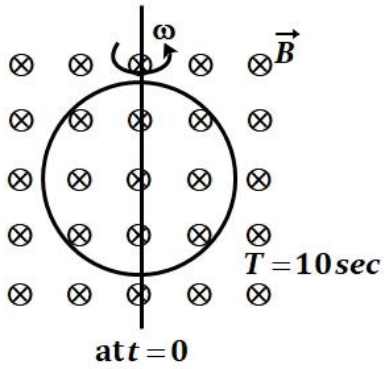
14. A ring is rotated about diametric axis in a uniform magnetic field perpendicular to the plane of the ring. If initially the plane of the ring is perpendicular to the magnetic field. Find the instant of time at which EMF will be maximum & minimum respectively:



A) 2.5 sec, 5 sec B) 5 sec, 7.5 sec C) 2.5 sec, 7.5 sec D) 10 sec, 5 sec

Ans. A)

Sol. $\therefore \omega = \frac{2\pi}{T} = \frac{\pi}{5}$

When $\omega t = \frac{\pi}{2}$

$\because \phi$ will be minimum

$\therefore e$ will be maximum

$t = \frac{\frac{\pi}{2}}{\frac{\pi}{5}} = 2.5\ sec$

When $\omega t = \pi$

$\because \phi$ will have maximum

$\because e$ will be minimum

$t = \frac{\pi}{\pi/5} = 5\ sec.$

15. Electric field in space is given by $\vec{E}(t) = E_0 \frac{(\hat{\imath}+\hat{\jmath})}{\sqrt{2}} \cos(\omega t + Kz)$. A positively charged particle at $\left(0,0,\frac{\pi}{K}\right)$ is given velocity $v_0\hat{k}$ at $t = 0$. Direction of force acting on particle is

A) $f = 0$ B) Antiparallel to $\frac{\hat{\imath}+\hat{\jmath}}{\sqrt{2}}$

C) Parallel to $\frac{\hat{\imath}+\hat{\jmath}}{\sqrt{2}}$ D) $\hat{k}$

Ans. B)

Sol. Force due to electric field is in direction $-\frac{(\hat{\imath}+\hat{\jmath})}{\sqrt{2}}$

Because at $t = 0, E = -\frac{(\hat{\imath}+\hat{\jmath})}{\sqrt{2}} E_0$

Force due to magnetic field is in direction $q(\vec{v} \times \vec{B})$ and $\vec{v} \parallel \hat{k}$

$\therefore$ it is parallel to $\vec{E}$

$\therefore$ net force is antiparallel to $\frac{(\hat{\imath}+\hat{\jmath})}{\sqrt{2}}$

16. Focal length of convex lens in air is 16 cm $(\mu_{\text{glass}} = 1.5)$. Now the lens is submerged in liquid of refractive index 1.42. Find the ratio of focal length in medium to focal length in air has closest value

A) 9 B) 17 C) 1 D) 5

Ans. A)

Sol. $\frac{1}{f_a} = \left(\frac{\mu_g}{\mu_a} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f_m} = \left(\frac{\mu_g}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\Rightarrow \frac{f_a}{f_m} = \frac{\left(\frac{\mu_g}{\mu_m} - 1\right)}{\left(\frac{\mu_g}{\mu_a} - 1\right)} = \frac{\left(\frac{1.50}{1.42} - 1\right)}{\left(\frac{1.50}{1} - 1\right)} = \frac{0.08}{(1.92)(0.5)}$

$\frac{f_m}{f_a} = \frac{(1.42)(0.5)}{0.08} = 8.875 \approx 9$

17. A lift of mass 920 kg has a capacity of 10 persons. If average mass of person is 68 kg. Friction force between lift and lift shaft is 6000 N. The minimum power of motor required to move the lift upward with constant velocity 3 m/s is $[g = 10\ m/s^2]$

A) 66000 W B) 63248 W C) 48000 W D) 56320 W

Ans. A)

Sol. Net force on motor will be

$F_m = [920 + 68(10)]g + 6000$

$= 22000\ N$

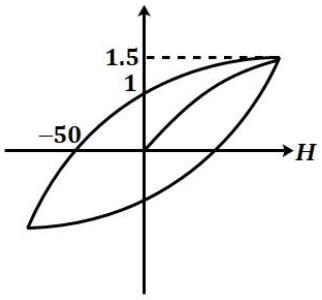
So, required power for motor

$P_m = \vec{F}_m \cdot \vec{v}$

$= 22000 \times 3$

$= 66000\ watt$

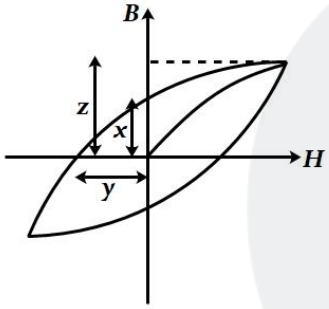
18. The hysteresis curve for a material is shown in the figure. Then for the material retentivity, coercivity and saturation magnetization respectively will be



A) 50 $A/m, 1T, 1.5\ T$ B) $1.5\ T, 50\ A/m, 1T$

C) $1T, 50\ A/m, 1.5\ T$ D) $50\ A/m, 1.5\ T, 1T$

Ans. C)



Sol.

$x =$ retentivity

$y =$ coercivity

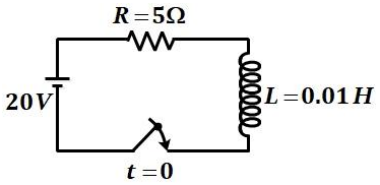
$z =$ saturation magnetization

19. An inductor of inductance 10 mH and a resistance of 5Ω is connected to a battery of 20 V at $t = 0$. Find the ratio of current in circuit at $t = \infty$ to current at $t = 40\ sec$.

A) 1.06 B) 1.48 C) 1.15 D) 0.84

Ans. A)

Sol. $i = i_0\left(1 - e^{\frac{-t}{\frac{L}{R}}}\right)$



$= \frac{20}{5}\left(1 - e^{\frac{-t}{\frac{0.01}{5}}}\right)$

$= 4(1 - e^{-500\,t})$

$i_\infty = 4$

$i_{40} = 4(1 - e^{-500} \times 40)$

$= 4\left(1 - \frac{1}{(e^2)^{10000}}\right) = 4\left(1 - \frac{1}{7.29^{10000}}\right)$

$\frac{i_\infty}{i_{40}} \approx 1$ slightly greater than one

20. Find the dimension of $\frac{B^2}{2\mu_0}$

A) $ML^{-1}T^{-2}$ B) ML^2T^{-2} C) $ML^{-1}T^2$ D) $ML^{-2}T^{-1}$

Ans. A)

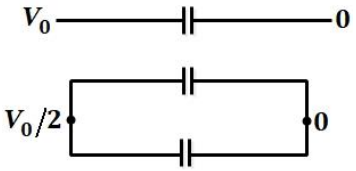
Sol. Energy density in magnetic field $= \frac{B^2}{2\mu_0}$

$= \frac{\text{Force} \times \text{Displacement}}{(\text{displacement})^3} = \frac{MLT^{-2}L}{L^3} = ML^{-1}T^{-2}$

21. A capacitor of 60 pF charged to 20 $volt$. Now battery is removed and then this capacitor is connected to another identical uncharged capacitor. Find heat loss in nJ.

Ans. 6

Sol.



$V_0 = 20\ V$

Heat loss $= U_i - U_f$

$= \frac{1}{2}CV_0^2 - 2\left[\frac{1}{2}C\left(\frac{V_0}{2}\right)^2\right]$

$= \frac{CV_0^2}{4}$

$= \frac{(60 \times 10^{-12})(20)^2}{4} J$

$= 6 \times 10^{-9} J = 6\ nJ$

22. When m gram of steam at $100°C$ is mixed with 200 gm of ice at $0°C$. It results in water at $40°C$. Find the value of m in gram.

(Given: Latent heat of fusion $(L_f) = 80\ cal/gm$, Latent heat of vaporization $(L_v) = 540\ cal/gm$, specific heat of water $(C_w) = 1\ cal/gm/°C$)

Ans. 40

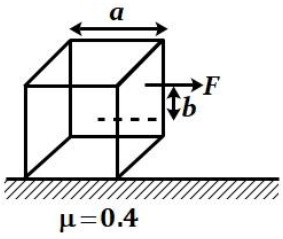
Sol. $M_{\text{ice}}L_f + m_{\text{ice}}(40-0)C_w = m_{\text{steam}}L_v + m_{\text{steam}}(100-40)C_w$

$\Rightarrow 200[80 + 40(1)] = m[540 + 60(1)]$

$\Rightarrow 200(120) = m(600)$

$m = 40\ gm$

23. A solid cube of side 'a' is shown in the figure. Find maximum value of $100\frac{b}{a}$ for which the block does not topple before sliding.



Ans. 50.00

Sol. For no toppling

$F\left(\frac{a}{2} + b\right) \le mg\frac{a}{2}$

$\mu\frac{a}{2} + \mu b \le \frac{a}{2}$

$0.2\ a + 0.4\ b \le 0.5\ a$

$b \le \frac{3a}{4}$

$b \le 0.75\ a$ (in limiting case)

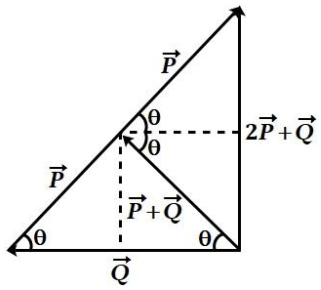
But it is not possible as b can maximum be equal to $0.5\ a$

$\therefore \left(100\frac{b}{a}\right)_{\max} = 50.00$

24. Magnitude of resultant of two vectors $\vec{P}$ and $\vec{Q}$ is equal to magnitude of $\vec{P}$. Find the angle between $\vec{Q}$ and resultant of $2\vec{P}$ and $\vec{Q}$.

Ans. 90°

Sol.



So angle between $(2\vec{P}+\vec{Q})$ and $\vec{Q}$ is 90°

25. A battery of unknown emf connected to a potentiometer has balancing length 560 cm. If a resistor of resistance 10Ω is connected in parallel with the cell the balancing length change by 60 cm. If the internal resistance of the cell is $\frac{n}{10}\Omega$, the value of 'n' is

Ans. 12

Sol. Let the emf of cell is ε internal resistance is 'r' and potential gradient is x.

only cell connected:

$\varepsilon = 560\,x$ (1)

After connecting the resistor

$\frac{\varepsilon\times 10}{10+r} = 500\,x$ (2)

From (1) and (2)

$$\frac{560\times 10}{10+r} = 500\,s$$

$$56 = 50 + 5r$$

$$r = \frac{6}{5} = 1.2\ \Omega$$

$$n = 12$$