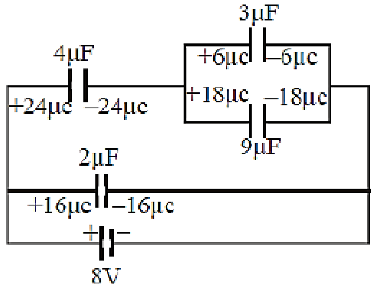
JEE MAIN - 2016

PHYSICS

ANSWER KEY AND EXPLANATIONS

Q31. Sol. (D)



$Q = 24 + 18 = 42\,\mu c$

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

$\Rightarrow \quad E = \frac{9\times10^9 \times 42\times10^{-6}}{(30)^2} = 420\,N/C$

Q32. Sol. (D)

Angular magnification is 20.

Q33. Sol. (A)

For electromagnet and transformers, we require the core that can be magnitised and demagnetized quickly when subjected to alternating current. From the given graphs, graph B is suitable.

Q34. Sol. (A)

$$t = 80\,\text{min} = 4T_A = 2T_B$$

$$\therefore \quad \text{no. of nuclei of } A \text{ decayed} = N_0 - \frac{N_0}{2^4} = \frac{15N_0}{16}$$

$$\therefore \quad \text{no. of nuclei of } B \text{ decayed} = N_0 - \frac{N_0}{2^2} = \frac{3N_0}{4}$$

$$\text{required ratio} = \frac{5}{4}$$

Q35. Sol. (A or C)

$$\vec{L} = \vec{r} \times \vec{P} \text{ or } \vec{L} = rp\sin\theta n$$

$$\text{or} \quad \vec{L} = r_{\perp}(P)\hat{n}$$

For D to A

$$\vec{L} = \frac{R}{\sqrt{2}} mV(-k)$$

For A to B

$$\vec{L} = \frac{R}{\sqrt{2}} mV(-k)$$

For C to D

$$\vec{L} = \left(\frac{R}{\sqrt{2}} + a\right) mV(k)$$

For B to C

$$\vec{L} = \left(\frac{R}{\sqrt{2}} + a\right) mV(k)$$

Q36. Sol. (B)

Q37. Sol. (B)

$$i = 35°, \delta = 40°, e = 79°$$
$$\delta = i + e - A$$
$$40° = 35° + 79° - A$$
$$A = 74°$$

and $r_1 + r_2 = A = 74°$

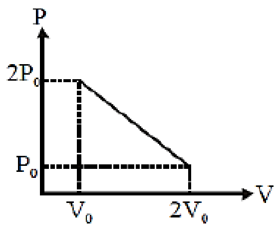
solving these, we get $\mu = 1.5$

Since $\delta_{\min} < 40°$

$$\mu < \frac{\sin\left(\frac{74+40}{2}\right)}{\sin 37}$$
$$\mu_{\max} = 1.44$$

Q38. Sol. (B)

T will be max where product of PV is max.



equation of line

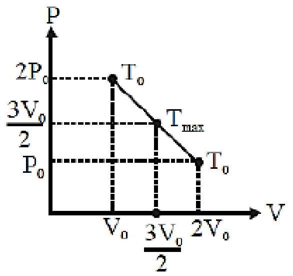
$$P = \frac{-P_0}{V_0}V + 3P_0$$

$$PV = \frac{-P_0}{V_0}V^2 + 3P_0V = x(\text{says})$$

$$\left.\begin{aligned} \frac{dx}{dV} = 0 \Rightarrow V = \frac{3V_0}{2} \\ \Rightarrow P = \frac{3P_0}{2} \end{aligned}\right\} \text{here } PV \text{ product is max}.$$

$$\Rightarrow T = \frac{PV}{nR} = \frac{9}{4}\frac{P_0V_0}{nR}$$

Alternate

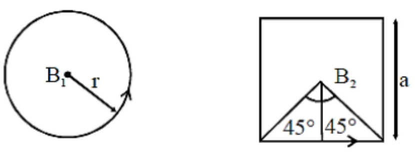


Since initial and final temperature are equal hence maximum temperature is at middle of line.

$$PV = nRT$$

$$\frac{\left(\frac{3P_0}{2}\right)\left(\frac{3P_0}{2}\right)}{nR} = T_{\max} \Rightarrow \frac{9P_0V_0}{4nR} = T_{\max}$$

Q39. Sol. (A)



$$B_1=\frac{\mu_0 i}{2r} \qquad B_2=4\times\frac{\mu_0}{4\pi}\times\frac{i}{\left(\frac{a}{2}\right)}\left(\frac{1}{\sqrt{2}}+\frac{1}{\sqrt{2}}\right)$$

$$\frac{B_1}{B_2}=\frac{\pi a}{4\sqrt{2}r} \qquad \ell=2\pi r=4a$$

$$\frac{B_1}{B_2}=\frac{\pi}{4\sqrt{2}}\frac{\pi}{2} \qquad \frac{a}{r}=\frac{2\pi}{4}=\frac{\pi}{2}$$

$$=\frac{\pi^2}{8\sqrt{2}}$$

Q40. Sol. (C)

$$\text{Least count}=\frac{\text{pithch}}{\text{no. of divion on circularc sale}}=\frac{0.5\,\text{mm}}{50}$$

$$LC=0.001\,\text{mm}$$

$$-ve\ \text{zero errow}=-5\times LC=-0.005\,\text{mm}$$

Measured value =

main scale reading + screw gauge reading – zero error

$$=0.5\,\text{mm}+\{25\times 0.001-(-0.05)\}\,\text{mm}$$

$$=0.8\,\text{mm}$$

Q41. Sol. (A or C)

$$\alpha=\frac{I_C}{I_e},\ \beta=\frac{I_C}{I_b}$$

$$I_e=I_b+I_c$$

$$\Rightarrow \frac{I_e}{I_c}=\frac{I_b}{I_c}+1 \qquad \Rightarrow \frac{1}{\alpha}=\frac{1}{\beta}+1$$

$$\alpha=\frac{\beta}{1+\beta}$$

Q42. Sol. (D)

Spot size (diameter) $b = 2\left(\frac{\lambda L}{2a}\right) + 2a$

$a^2 + \lambda L - ab = 0 \quad \ldots\text{(i)}$

For Real roots $b^2 - 4L\lambda \geq 0$

$b_{min} = \sqrt{4\lambda L}$

by eq.(i) $\quad a = \sqrt{\lambda L}$

Q43. Sol. (A)

Work done against gravity = (mgh)1000 in lifting 1000 times

$= 10 \times 9.8 \times 10^3$

$= 9.8 \times 10^4$ Joule

= 9.8×10^4 Joule

20% efficiency is to converts fat into energy.

$[20\% \, of \; 3.8 \times 107\text{J}] \times (m) = 9.8 \times 10^4$

(Where m is mass)

$m = 12.89 \times 10^{-3}$ kg

Q44. Sol. (B)

$$\text{Energy} = \frac{hc}{\lambda}$$

Order of wavelength

x ray,	VIBGYOR,	Radiowaves
C	$(A)(B)$	(D)

$\therefore$ order of energy

$$D < B < A < C$$

Q45. Sol. (C)

Specific heat $C = \frac{R}{1-n} + C_V$ for polytropic process

$$\therefore \frac{R}{1-n} + C_V = C$$

$$\frac{R}{1-n} = C - C_V \Rightarrow \frac{R}{C - C_V} = 1 - n$$

(Where $R = C_p - C_V$)

$$\Rightarrow n = \frac{C - C_p}{C - C_V}$$

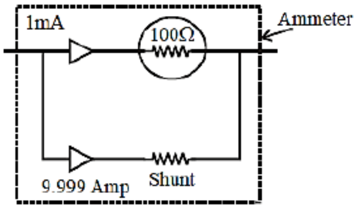
Q46. Sol. (A)

$$V_0 = \sqrt{\frac{GM}{R}} \text{ or } \sqrt{gR}$$

$$V_e \sqrt{\frac{2GM}{R}} \text{ or } \sqrt{2gR}$$

$$\therefore \text{ Increase in velocity} = \sqrt{gR}\left[\sqrt{2}-1\right]$$

Q47. Sol. (B)



P.D should remain same

$$1\text{mA} \times 100 = 9.999\, R$$

$$R = \frac{1}{99.99} = 0.01\Omega$$

Q48. Sol. (B)

$$E = (KE)_{\max} + f$$

$$\left[\frac{hc}{\lambda} = (KE)_{\max} + \phi\right] \ldots (1)$$

$$\frac{4}{3}\frac{hc}{\lambda} = \left(\frac{4}{3}KE_{\max} + \frac{\phi}{3}\right) + \phi$$

$(KE)_{\max}$ for fastest emitted electrom $= \frac{1}{2}mV'^2 + \phi$

$$\frac{1}{2}mV'^2 = \frac{4}{3}\left(\frac{1}{2}mV^2\right) + \frac{\phi}{3}$$

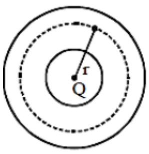
$$\boxed{V' > V\left(\frac{4}{3}\right)^{1/2}}$$

Q49. Sol. (D)

Output of OR gate is 0 when all inputs are 0 & output is 1 when atleast one of the input is 1. Observing output x :- It is 0 when all inputs are 0 & it is 1 when atleast one of the inputs is . $\therefore$ OR gate

Q50. Sol. (B)

Gaussian surface at distance r from center



$$\frac{Q + \int_a^r \frac{A}{r} 4\pi r^2 dr}{\epsilon_0} = E4\pi r^2$$

$$E = \frac{Q + 2\pi A r^2 - 2\pi A a^2}{4\pi r^2 \epsilon_0}$$

Make E independent of r then

$$Q - 2\pi a^2 A = 0 \Rightarrow A = \frac{Q}{2\pi a^2}$$

Q51. Sol. (B)

$T_{AV} = 92\,s$
$(|\Delta T|)_{mean} = 1.5\,s$

Since uncertainty is $1.5\,s$

so digit 2 in 92 is uncertain.

so reported mean time should be

92 ± 2

Q52. Sol. (D)

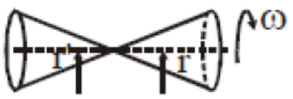
Factual

Cu is conductor so with increase in temperature, resistance will increase Si is semiconductor so with increase in temperature resistance will decrease

Q53. Sol. (B)

Factual

Q54. Sol. (B)



Say the distance of central line from instantaneous axis of rotation is r. Then r from the point on left becomes lesser than that for right. So
$v$left point $= \omega r' < \omega r = v$right point So the roller will turn to left.

Q55. Sol. (B)

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$$\frac{\Delta T}{T} = \frac{1}{2}\frac{\Delta \ell}{\ell}$$

When clock gain $12\,\text{sec}$

$$\frac{12}{T} = \frac{1}{2}\alpha(40-\theta) \quad \ldots(1)$$

When clock lose $4\,\text{sec}$

$$\frac{4}{T} = \frac{1}{2}\alpha(\theta-20) \quad \ldots(2)$$

From equation $(1)\&(2)$

$$3 = \frac{40-\theta}{\theta-20}$$

$$3\theta - 60 = 40 - \theta$$

$$4\theta = 100$$

$$\boxed{\theta = 25°\text{C}}$$

From equation (1)

$$\frac{12}{T} = \frac{1}{2}\alpha(40-25)$$

$$\frac{12}{24\times 3600} = \frac{1}{2}\alpha\times 15$$

$$\alpha = \frac{24}{24\times 3600\times 15}$$

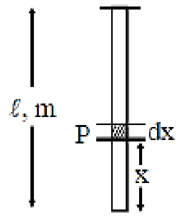
$$\alpha = 1.85\times 10^{-15}/°C$$

Q56. Sol. (D)

Velocity at point $P = \sqrt{\dfrac{\frac{m}{L} gx}{m/L}}$

$v = \sqrt{gx}$

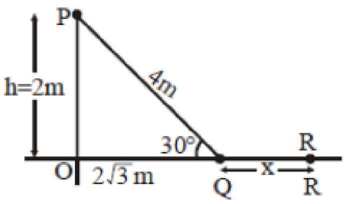
$\dfrac{dx}{dt} = \sqrt{gx}$



$\int_0^{20} \dfrac{dx}{\sqrt{x}} = \int_0^t \sqrt{g}\,dt$

$\boxed{t = 2\sqrt{2} \text{ sec}}$

Q57. Sol. (D)



Energy lost over path PQ is $= \mu \text{mg} \cos \mu \times 4$

Energy lost over path QR is $= \mu \text{mg}\, x$

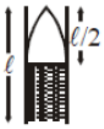
$\mu \text{mg}\, x = \mu \text{mg} \cos \theta \times 4$

$x = 2\sqrt{3} = 3.45 \text{m}$

From Q to R energy loss is half of the total energy loss.

$$\mu mgx = \frac{1}{2} \times mgh \Rightarrow \mu = 0.29$$

Q58. Sol. (A)



$$\frac{\lambda}{2} = \ell \qquad \frac{\lambda}{4} = \frac{\lambda\ell}{2}$$

$$\boxed{\lambda = 2\ell} \qquad \boxed{\lambda = 2\ell}$$

$$v = f\lambda \qquad v = f\lambda$$

$$\boxed{f = \frac{v}{\lambda} = \frac{v}{2\ell}} \qquad \boxed{f' = \frac{v}{\lambda} = \frac{v}{2\ell} = f}$$

$$\boxed{f' = f}$$

Q59. Sol. (A)

Let new amplitude is A' initial velocity

$$v^2 = \omega^2 \left(A^2 - \left(\frac{2A}{3} \right)^2 \right) \quad \ldots(1)$$

Where A is initial amplitude & ω is angular frequency.

Final velocity

$$(3v)^2 = \omega^2\left(A'^2 - \left(\frac{2A}{3}\right)^2\right) \quad \ldots(2)$$

From equitation & equitation (2)

$$\frac{1}{9} = \frac{A^2 - \frac{4A^2}{9}}{A'^2 - \frac{4A^2}{9}}$$

$$\boxed{A' = \frac{7A}{3}}$$

Q60. Sol. (A)

$$I = 10\text{A}$$

$$V = 80v$$

$$R = 8\Omega$$

$$10 = \frac{220}{\sqrt{8^2 + X_L^2}}$$

$$X_L{}^2 + 64 = 484$$

$$X_L = \sqrt{420}$$

$$2\pi \times 50L = \sqrt{420}$$

$$L = \frac{\sqrt{420}}{100\pi}$$

$$\boxed{L = 0.065\text{H}}$$