SAKSHAM

JEE | NEET | GUJCET | KVPY | FOUNDATION

LEARN TOGETHER, GROW FOREVER

JEE ADVANCED (PAPER - 1) **DATE: 25.05.2023**

KEY SHEET

PHYSICS

1	**B**	2	**C**	3	**B**	4	**C**	5	**5**
6	**10**	7	**120**	8	**9**	9	**1.5**	10	**3**
11	**AD**	12	**AC**	13	**AC**	14	**ABCD**	15	**ACD**
16	**AB**	17	**2**	18	**4**	19	**1**		

CHEMISTRY

20	**B**	21	**B**	22	**B**	23	**C**	24	**67.2**
25	**34**	26	**9**	27	**2**	28	**1**	29	**14.70 TO 14.80**
30	**ACD**	31	**ACD**	32	**BC**	33	**ABCD**	34	**CD**
35	**BCD**	36	**3**	37	**6**	38	**1**		

MATHEMATICS

39	**A**	40	**B**	41	**B**	42	**C**	43	**99**
44	**19**	45	**1.20**	46	**4**	47	**25**	48	**3.14**
49	**AC**	50	**AD**	51	**AD**	52	**ABC**	53	**ABC**
54	**CD**	55	**2**	56	**1**	57	**2**		

SOLUTIONS
PHYSICS

1. $m = \dfrac{f}{f+u}$

$\dfrac{h_i}{h_0} = \dfrac{+f}{+f+(-30)} = \dfrac{f}{f-30}$

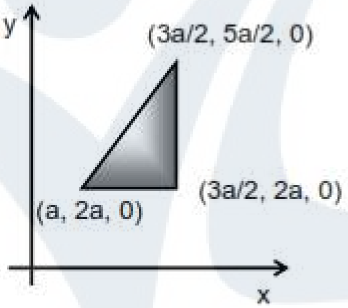
$\Rightarrow \dfrac{h + \frac{d-h}{2}}{\left(\frac{h}{2}\right)} = \dfrac{f}{f-30} \Rightarrow \dfrac{d+h}{h} = \dfrac{f}{f-30}$

$\Rightarrow \dfrac{d}{h} = \dfrac{f}{f-30} - 1$

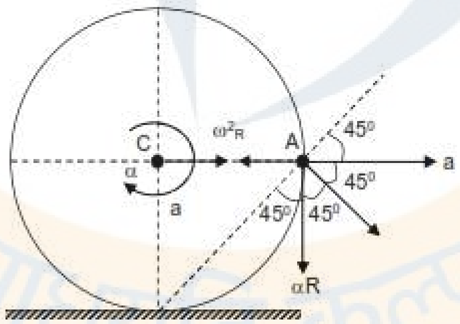
$\Rightarrow 3 = \dfrac{f-f+30}{f-30}$ [$\because$ slope of d – h graph from figure is 3]

$\Rightarrow 3f - 90 = 30 \quad \Rightarrow f = 40cm$

2. If a point charge is at $\left(a, 2a, \dfrac{a}{2}\right)$ then given surface is 1/8th of a square surface of side a



3. Velocity of point 'A' $V_A = \sqrt{V^2 + \omega^2 R^2} = V\sqrt{2}$



Normal acceleration of point A,

$a_A(n) = \omega^2 R\cos 45^0 + \alpha R\cos 45^0 - a\cos 45^0$

$a_{A(n)} = \dfrac{\omega^2 R}{\sqrt{2}} = \dfrac{V^2}{\sqrt{2}R}$

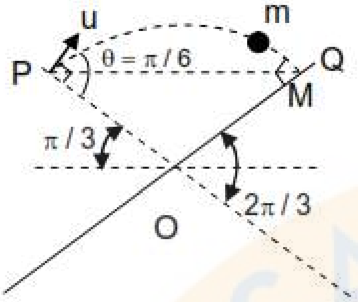
$\therefore$ radius of curvature of trajectory of point 'A' relative to the ground is

$r = \dfrac{(V_A)^2}{a_{A(n)}} = \dfrac{\left(V\sqrt{2}\right)^2}{\dfrac{V^2}{\sqrt{2}R}} = 2\sqrt{2}R$

4. $$K.E_{\alpha} = \frac{(Q-\Delta E)Y}{Y+4}$$

$$= \frac{(8-2.4)220}{224} = 5.5$$

5 & 6.



$t_{PQ} = \frac{T}{2} = 1\text{sec}$

$$t_{PQ} = \frac{2u\sin\theta}{g}$$

$$\frac{2u\left(\frac{1}{2}\right)}{10} = 1$$

$$u = 10ms^{-1}$$

At the highest point velocity of the ball is $u\cos\theta = 5\sqrt{3}m/s$

Since POQ is an equilateral triangle

Range of the ball is $\frac{L}{2} = PQ = \frac{u^2\sin 2\theta}{g}$

$$= 10\times\frac{\sqrt{3}}{2} = 5\sqrt{3}$$

$$\Rightarrow L = 10\sqrt{3}$$

7 & 8.There is a path difference between rays before incidence on the slit and it is equal to

$$\Delta x_1 = d\sin 30^o = \frac{d}{2} = \frac{10^{-4}}{2} = 50\times10^{-6}m = 50\mu m$$

Also path difference introduced by upper slab = $20.4(1.5-1) = 10.2\mu m$

Let thickness of lower slab is ‘t’, then path difference introduced = $t(\mu-1) = \frac{t}{2}$

It is given that central maxima is above ‘O’

$\therefore \Delta x_1 + 10.2 - \frac{t}{2} =$ Path difference at ‘O’

By Intensity relation $3I = 4I + I + 2\cdot\sqrt{4I\cdot I}\cos\theta,\ \theta =$ phase difference

$$\cos\theta = -\frac{1}{2}$$

For maximum thickness for lower slab

$$\therefore \theta = \frac{2\pi}{3}$$

$$\therefore \frac{2\pi}{\lambda}\cdot\Delta x = \frac{2\pi}{3}$$

$$\Delta x = \frac{\lambda}{3} = 0.2\,\mu m \Rightarrow 0.2\mu m = 60.2\mu m - \frac{t}{2}$$

$$\therefore t = 120\,\mu m$$

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\theta$$

$$\therefore I_{\max} = 4I + I + 4I = 9I$$

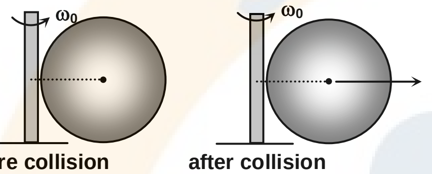
$$I_{\min} = 4I + I - 4I = I$$

9 & 10. Using conservation of mechanical energy

$$mg\frac{L}{2} = \frac{1}{2}\frac{ML^2}{3}\omega_0^2$$

$$\Rightarrow \quad \omega_0 = \sqrt{\frac{3g}{L}},\ \omega = \sqrt{\frac{3g}{2L}} = \sqrt{\frac{3g}{2\sqrt{2}r}}$$

$$L = \sqrt{2}r$$



Using the definition of e

$(L - r)\omega_0 = v - \omega(L - r)$

$$v = (L - r)(\omega_0 + \omega) = (L - r)\omega(\sqrt{2} + 1) = r\omega = \sqrt{\frac{3gr}{2\sqrt{2}}}$$

$$r = \frac{6\sqrt{2}}{10}m$$

$$v = \sqrt{\frac{3\times 10\times 6\times\sqrt{2}}{2\sqrt{2}\times 10}} = 3\text{ m/s}$$

Using COAM

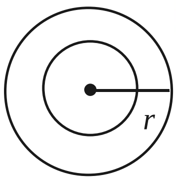
$I\omega_0 = I\omega + mv(L - r)$

$I(\omega_0 - \omega) = m(\omega_0 + \omega)(L - r)^2$

$$\frac{ML^2}{3}(\omega_0 - \omega) = m(\omega_0 + \omega)(L - r)^2$$

$$\frac{M}{m} = \frac{3(L - r)^2(\omega_0 + \omega)}{L^2(\omega_0 - \omega)} = \frac{3}{2}$$

11. Acceleration due to gravity at any point is the magnitude of gravitaitonal intensity at that point.



$$dm = 4\pi r^2 dx\frac{\sigma_0}{r}$$

$$= 4\pi\sigma_0\, r\, dr$$

$$m = 4\pi\sigma_0\left(\frac{r^2}{2}\right)^r$$

$$m = 2\pi\sigma_0\left(x^2 - R^2\right)$$

$$\Rightarrow E\left(4\pi r^2\right) = 4\pi G\left(M + m\right)$$

$$E\left(r^2\right) = G\left[M + 2\pi\sigma_0 r^2 - 2\pi\sigma_0 R^2\right]$$

$$E = \frac{G}{r^2}\left[M + 2\pi\sigma_0 r^2 - 2\pi\sigma_0 R^2\right]$$

$$E = G\left[\frac{M}{r^2} + 2\pi\sigma_0 - \frac{2\pi\sigma_0 R^2}{r^2}\right]$$

$$E = G\left[2\pi\sigma_0 + \frac{1}{r^2}\left(M - 2\pi\sigma_0 R^2\right)\right]$$

$\Rightarrow$ if $\sigma_0 = \dfrac{M}{2\pi R^2}$, E is independent of r

12. For smaller sphere, before (covering $P_{Point\,Source} = P_{radiated}$)

$$\therefore P = \sigma\left(4\pi R^2\right)T_0^4$$

After covering, for outer shell : $P_{Point\,Source} = P_{radiated}$

$$\therefore \sigma\left(4\pi R^2\right)T_0^4 = \sigma\left(4\pi\left(2R\right)^2\right)T^4$$

$$\therefore T_0^4 = 4T^4 \Rightarrow T = \frac{T_0}{\sqrt{2}}$$

After covering, temperature of inner sphere will be greater than T_0

13. Current through the inductor 'L_0' in the steady state after closing the switch-2 will be $I_s = \dfrac{\varepsilon}{R}$

Now, $2L\dfrac{di_2}{dt} = L\dfrac{di_1}{dt} + i_1 R_0$

$$2L\int_0^{\varepsilon/R} di_2 - L\int_{\varepsilon/2R}^{0} di_1 = R_0 \int i_1 dt$$

$$2L\frac{\varepsilon}{R} - L\left(0 - \frac{\varepsilon}{2R}\right) = R_0 \Delta q$$

$$\frac{5\varepsilon L}{2R} = R_0 \Delta q \Rightarrow \Delta q = \frac{5\varepsilon L}{2RR_o}$$

$$\Delta q = \frac{5\varepsilon L}{2R^2}$$

14. Immediately after the first collision between upper bar and the wall, direction of motion of upper bar is reversed and both the bars are moving with their initial speeds in opposite directions. Now slipping starts. They have equals speed in opposite direction before the lower bar collides with wall. Work done by friction on both the bars is equal to their change in K.E.

Final speed of the bars is zero if $u \le \sqrt{2\mu g l_0}$ as both the bars come to rest before the lower bar collides with the wall.

If $u \ge \sqrt{2\mu g l_0}$,

$$2\times\frac{1}{2}m\left(v^2-u^2\right)=-2\left(\mu mgl\right)$$

$$v=\sqrt{u^2-2\mu gl}$$

After the lower bar collides with the wall. They have equal speed in the direction away from the wall.

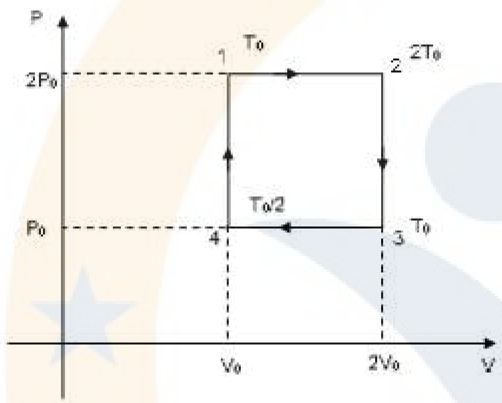
15. $\frac{\lambda}{4}=0.1\Rightarrow\lambda=0.4m$

From the graph time period is $T=0.2s$ and amplitude of stationary wave is $2A=4cm$

Equation of the standing wave is $y(x,t)=-2A\cos\left(\frac{2\pi}{0.4}x\right)\sin\left(\frac{2\pi}{0.2}t\right)$

Transverse velocity of the particle is given by $V_y=\frac{\partial y}{\partial t}$

16.



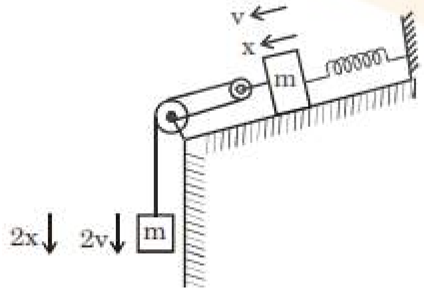
(4) $\left|\frac{\Delta Q_{1\to2}}{\Delta Q_{3\to4}}\right|=\left|\frac{NC_P\Delta T_{1\to2}}{NC_P\Delta T_{3\to4}}\right|=\frac{T_0}{T_o/2}=2$

(2) $\left|\frac{\Delta Q_{1\to2}}{\Delta Q_{2\to3}}\right|=\left|\frac{NC_P\Delta T_{1\to2}}{NC_V\Delta T_{2\to3}}\right|=\frac{C_P}{C_V}=\frac{5}{3}$

(1) $W_{cycle}=P_0V_o=nR\left[\frac{T_0}{2}\right]$ using point No-4

(3) wrong as no adiabatic process is involved

17.



$$E=\frac{1}{2}mv^2+\frac{1}{2}m\left(2v\right)^2+\frac{1}{2}kx^2$$

$$E = 5\left(\frac{1}{2}mv^2\right) + \frac{1}{2}kx^2$$

$$T = 2\pi\sqrt{\frac{5m}{k}}$$

18. When the switch S is open

Energy $U_1 = U_0 + \frac{kQ^2}{2R} + \frac{kQ^2}{4R} + \frac{kQ^2}{R} - \frac{kQ^2}{2R} - \frac{kQ^2}{2R}$

$$= U_0 + \frac{3kQ^2}{4R}$$

Energy $U_2 = U_0 + \frac{kQ^2}{2R} + \frac{kQ^2}{4R} - \frac{kQ^2}{R} + \frac{kQ^2}{2R} - \frac{kQ^2}{2R}$

$$= U_0 - \frac{kQ^2}{4R}$$

Loss of energy= $= U_1 - U_2 = \frac{kQ^2}{R}$

$$= \frac{9\times10^9 \times 400\times10^{-12}}{9\times10^{-2}} = 40J$$

19. $E = \sigma T^4$

$$\Rightarrow \frac{E_2}{E_1} = \frac{T_2^4}{T_1^4} = 256 = 4^4$$

$$\Rightarrow T_2 = 4T$$

Also, $\lambda_1 T_1 = \lambda_2 T_2$ gives $\lambda_2 = \frac{\lambda_1}{4} = 1000A^0$

$$KE_{\max} = \frac{hc}{\lambda_2} - \phi$$

$$\Rightarrow \frac{12400}{1000} - \phi = 12.4 - \phi ---(1)$$

$$\Delta E_{2\to4} = 13.6\times\left[\frac{1}{2^2} - \frac{1}{4^2}\right] = 13.6\times4\times\frac{3}{16} = 10.2eV ---(2)$$

From (1) and (2) $12.4 - \phi = 10.2$

$$\Rightarrow \phi = 2.2eV$$

CHEMISTRY

20. Conceptual

21. $A(OH)_2 \rightleftharpoons \underset{x}{A^{2+}} + \underset{(2x+3y)}{2\,OH^-};\ K_{sp} = 4\times10^{-12}$

$B(OH)_3 \rightleftharpoons \underset{y}{B^{3+}} + \underset{(2x+3y)}{3\,OH^-};\ K_{sp} = 1\times10^{-33}$

$\because (Ksp)_{A(OH)_2} >>> (Ksp)_{B(OH)_3}$ $\qquad \frac{x}{y} = 8\times10^{17}$

$\therefore y <<< x$

22. Stable free radical

23. Anti group migration

24 & 25. $2NaN_3 \rightarrow 2Na + 3N_2$

$2NaNO3 + 10\ Na \rightarrow 6Na_2O + N_2$

26. 6AgI

27. 2-Chloro-buta-1,3-diene

28. Let the reaction to be of 1st order

$$K = \frac{2.303}{10}\log\frac{25.6}{16} = 0.047$$

$$K = \frac{2.303}{20}\log\frac{25.6}{10} = 0.047$$

29. $t_{1/2} = \frac{0.693}{0.047} = 14.745\,\text{min}$

30. (A) Cl_2O_6 contain $ClO_2^+\, ClO_4^-, ClO_2^+$ is planar

(B) Due to the back bonding $N(SiH_3)_3$ weak base

(C) Both HNO_2 and $HClO_3$ disproportional on heating

(D) In both NO_2 and ClO_2 central atoms are in sp^2 hybridisation

31. $\underbrace{CrO_4^{2-} \text{ or } Cr_2O_7^{2-}}_{(x)} + H_2O_2 + H^+ \longrightarrow \underset{(Y)}{CrO_5} + H_2O$

$CrO_5 + H^+ \longrightarrow \underset{(\text{Green Soln Z})}{Cr^{3+}} + \underset{(M)}{O_2(g)} + H_2O$

34. Nitrobenzene cannot give Friedel-Crafts reaction

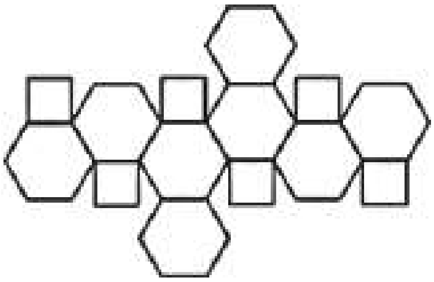
35. Blanc rule

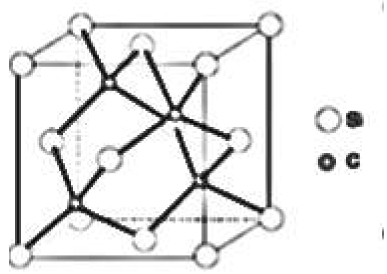
36. in (b) N_2O is released

In (e) H_2 is released

In (f) NH3 is released

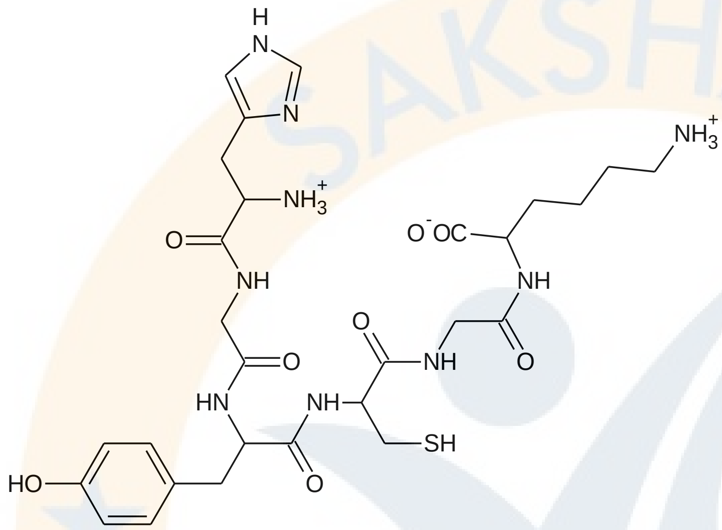
37.





Si forms CCP and
C occupies alternate THV

38.



MATHS

40. $P(x)=-x^3+5x+5$

41. $\cos^2\beta-\cos^2\alpha=\sin(\alpha+\beta)\sin(\alpha-\beta)$, $a_n=\frac{1}{\sin\left(\frac{\pi}{2n}\right)}\left(\frac{1}{\cos^2\left(\frac{(n-1)\pi}{2n}\right)}-1\right)$

$$a_n=\left(\frac{1}{\sin^3\frac{\pi}{2n}}-\frac{1}{\sin\left(\frac{\pi}{2n}\right)}\right)$$

45.

The equations of the bisectors are given by $x-y=0$ and $x+y+2=0$.

These bisectors intersect at the point P (–1, –1)

Focus S, is the foot of $\perp$ from P to MN i.e. point of intersection of lines MN $(3x-y-2=0)$ and PS $(x+3y+4=0)$.

$\therefore$ Focus $S\equiv\left(\frac{1}{5},-\frac{7}{5}\right)$

Circle passing through PMN is $(x-0)(x-1)+(y-1)(y+2)=0$

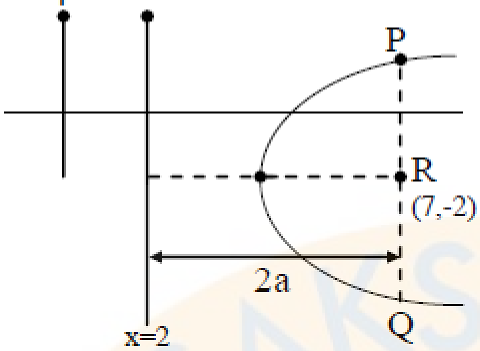
or $x^2+y^2-x+y-2=0$

Hence, equation of tangent at (–1, –1), which is also the equation of directrix is $3x+y+4=0$.

47.

Sol. $(x-2)=\sqrt{(x-7)^2+(y+2)^2}$

It is parabola



$(PR)(RQ)=4a^2$

$=4\times\left(\frac{5}{2}\right)^2$

$=25$

48. $\arg\left(\frac{z_1-(7-2i)}{z_2-(7-2i)}\right)=\pi$

49. $(1,0)$ lies on hyperbola

Equation of tangent to hyperbola at $(1,0)$ is $x+y-1=0$

Homogenize the circle $x^2+y^2+2gx+2fy=0$ with $x+y-1=0$ and compare that with given pair of asymptotes

50. $(3+4)\left(\frac{(\sin^{-1}x)^2}{3}+\frac{(\cos^{-1}x)^2}{4}\right)\geq\frac{25\pi^2}{4}$

$\Rightarrow\sin^{-1}x=\frac{15\pi}{14},\cos^{-1}x=\frac{20\pi}{14}$

51. $a_n^2-b_n^2=\text{Re}(2+i)^{2n},a_nb_n=\frac{1}{2}\text{Im}\left((2+i)^{2n}\right)$

52. $\max\{f(x),g(x)\}=\frac{f(x)+g(x)+|f(x)-g(x)|}{2}$

$f(x)=2\max\{|x-1|+|x-3|,|2x-1|\}$

53. $I_1=\int_0^1\cos\left(\pi-\pi\cos^2x\right)dx=-I_1$

$I_2=\int_0^1\cos\left(\pi\left(2\cos^2x\right)\right)dx$, $I_2=-\int_0^1\cos(\pi\cos 2x)=-I_3$

54. $f_n=f_{n-1}+f_{n-2}$, $f_1=2,f_2=3$