SAKSHAM
JEE | NEET | GUJCET | KVPY | FOUNDATION
LEARN TOGETHER, GROW FOREVER

JEE ADVANCED (PAPER - 2) **DATE: 25.05.2023**

KEY SHEET

PHYSICS

1	**AC**	2	**BD**	3	**AD**	4	**ACD**	5	**AC**
6	**AC**	7	**34.5**	8	**800**	9	**0.9**	10	**918.1**
11	**178.28**	12	**64**	13	**B**	14	**A**	15	**D**
16	**C**	17	**2**	18	**4**	19	**2**		

CHEMISTRY

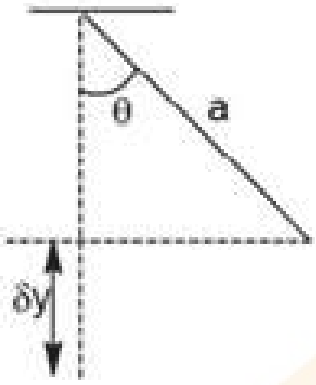
20	**ABC**	21	**ABC**	22	**ABD**	23	**ABCD**	24	**ABD**
25	**ABCD**	26	**6**	27	**0.05**	28	**3**	29	**3**
30	**0.6**	31	**22.4**	32	**B**	33	**C**	34	**C**
35	**D**	36	**5**	37	**3**	38	**1**		

MATHEMATICS

39	**AC**	40	**B**	41	**AD**	42	**BC**	43	**BD**
44	**ABCD**	45	**3**	46	**1**	47	**215**	48	**43**
49	**15**	50	**8**	51	**A**	52	**B**	53	**B**
54	**B**	55	**4**	56	**2**	57	**7**		

SOLUTIONS
PHYSICS

1.



$$\delta y = a(1-\cos\theta) = \frac{a\theta^2}{2}$$

$$and\ \ \theta a = \frac{b\phi}{2}$$

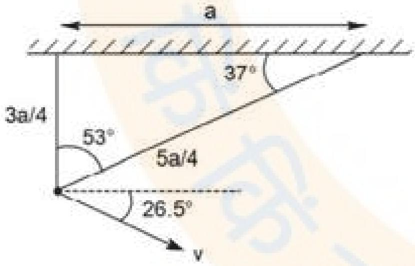
$$\Rightarrow \delta y = \frac{a}{2}\left(\frac{b\phi}{2}\right)^2 = \frac{b^2}{8a}\phi^2$$

$$\Rightarrow \delta y = \frac{b^2}{8a}\left(\omega\delta t\right)^2$$

$$acc.\ ot\ rod's\ centre = \frac{b^2}{4a}\omega^2$$

$$\Rightarrow \delta F = \frac{mb^2}{4a}\omega^2$$

2.



$$h = \frac{3a}{4}$$

$$v_0 - \sqrt{2gh}$$

$$v_0 = \sqrt{1.5ag}\ \ and\ \ v = v_0\cos(90^0 - 26.5^0)$$

$$= v_0 \sin(26.5^0)$$

$$\Rightarrow v = \sqrt{1.5ag}\ \sin(26.5^0)$$

3.

$$\frac{2mx_B+mx_A}{3m}=\frac{a}{3}\Rightarrow X_A=a\text{-}2X_8$$

$$\frac{2mx_B+mx_A}{3m}=0\Rightarrow Y_A=\text{-}2Y_8$$

$$\text{Trajectory of B is}\ \frac{(a\text{-}2x)^2}{a^2}+\frac{(2y)^2}{b^2}=1$$

4. For observer O_1,

$$\lambda_1=\frac{v\text{-}v_s}{f}=\frac{v\text{-}v/5}{f}=\frac{4v}{5f}$$

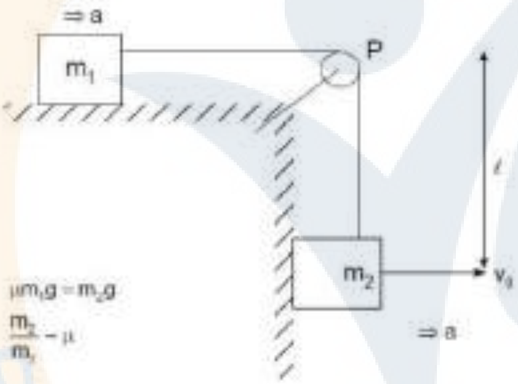
For O_2, there is change of medium hence at the surface of water keeping frequency unchanged

$$\frac{v}{\lambda_a}=\frac{4v}{\lambda_2}$$

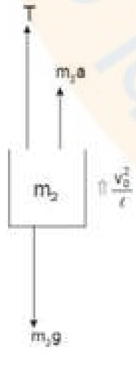
$$\Rightarrow \lambda_w=4\lambda_a=\frac{16v}{5f}$$

$$f''=\frac{\text{velo.of wave relative to observer}}{\lambda_w}=\frac{4v+\frac{v}{5}}{\lambda_w}=\frac{21v}{5}\frac{5f}{16v}=\frac{21f}{16}$$

5.



Lets observe the motion of m_2 from an observer fixed at P (point on string)



$$T+m_2a-m_2g-\frac{m_2{v^2}_0}{l} \qquad ....(1)$$

$for\ m_1$

$$T-\mu m_1g=m_1a \qquad ....(2)$$

$$from(1)\ and\ m_1a+\mu m_1g-m_2g=\frac{m_2{v^2}_0}{l}$$

$$a = \frac{m_2 \frac{v^2{}_0}{l}}{(m_1 + m_2)} = \left(\frac{\mu m_1}{1+\mu}\right)\frac{v^2{}_0}{l}$$

$ROC \quad of \quad m_2$

$$T - m_2 g = \mu m_{1g} + \left(\frac{\mu m_1}{1+\mu}\right)\frac{v^2{}_0}{l} - m_2 g$$

$$= \left(\frac{\mu m_1}{1+\mu}\right)\frac{v^2{}_0}{l} = m_2 \frac{v^2{}_0}{R}$$

$$R = \left(\frac{m_2}{\mu m_1}\right)(1+\mu)l = l(1+\mu)$$

7 & 8. When point A reaches the wall, pressure will become 16 Pascal; beyond that detector will work. Thus after moving 80+4=84m(v=400 m/s)

It will keep detecting, for 138 m ; $\Delta t = \frac{138}{400} = 34.5 \times 10^{-2}$

$F = P_{max} \times Area = 200 \times 2 \times 2 = 800N$

9 & 10. The total mechanical energy of the system after firing the rocket will increase by 10% Note : $-0.9\,E_0 > -E_0$

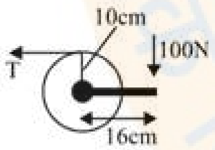
Because the mechanical energy is negative, a decrease in magnitude is increase in energy

$$\frac{E_{cll}}{E_{cir}} = \frac{-\frac{GMm}{2a}}{-\frac{GMm}{2r}} = \frac{r}{a} \Rightarrow 0.9 = \frac{(6400+300)}{a}$$

$$\Rightarrow a = 1.11 \times 6700 = 7437\,km$$

11 & 12.

As angular velocity of disc is constant i.e.



$\sum r = 0$

$100N \times 16cm = T \times 10cm$

$T = 160N$

$Power\ delivered = \vec{F}.\vec{v}$

$where\ \vec{v}\ is\ velocity\ of\ the\ point\ of\ application\ of\ the\ force.$

$v = 16\,cm \times 2\pi.2 (= R\omega)$

$= 0.64\pi\ m/s$

$P = 100 \times 0.64\pi = 64\pi W$

$ALT: P = r\omega$

$As\ \sum r = 0$

$160N \times 4\,cm = f \times 35cm$

$$f = \frac{160 \times 4cm}{35cm} = 18.3N$$

13. Finally, the capacitors are in parallel and total charge(=q_0) distributes between then in direct ratio of capacity.

$\therefore \quad q_{C_2} = \left(\frac{C_2}{C_1+C_2}\right) q_0 \rightarrow$ in steady state.

But this charge increases exponentially.

Hence, charge on C_2 at any time t is

$$q_{C_2} = \left(\frac{C_2 q_0}{C_1+C_2}\right)\left(1-e^{-t/r_C}\right)$$

Initially, C_2 is uncharged so, whatever is the charge on C_2 it is charge flown through switches

14. Common potential in steady state when they finally come in parallel is

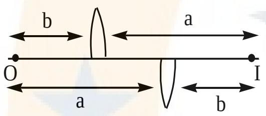
$$v = \frac{Total\ charge}{Total\ capacity} = \frac{q_0}{C_1+C_2}$$

Total heat dissipated $U_i - U_f$

$$= \frac{q_0^{\ 2}}{2C_1} - \frac{1}{2}(C_1+C_2)\left(\frac{q_0}{C_1+C_2}\right)^2$$

$$= \left(\frac{q^2{}_0}{2C_1}\right)\left(\frac{C_1C_2}{C_1+C_2}\right)^2$$

17.



$a - b = 60$

$\frac{a/b}{b/a} = 9 \Rightarrow \frac{a}{b} = 3$

$\therefore\ a = 90;\ b = 30$

$\therefore\ f = \frac{30\times 90}{30+90} = \frac{90}{4}$

$\therefore\ x = 2$

18. $Apg \times \left(1+\sin 30^0\right) - ApR\left[\frac{\pi}{2} + \cos cc30^0\right]\frac{d^2x}{dt^2}$

$$\Rightarrow \frac{d^2x}{dt^2} = -\left(\frac{gx}{R}\right)\left(\frac{3/2}{\frac{\pi}{2}+2}\right)$$

$$\Rightarrow T = \pi\sqrt{\frac{4R(\pi+4)}{3g}}$$

19. $l = \frac{hc}{ev}\ ;\ l_c = \frac{hc}{\mu\ z^2}$

$$4\left[\frac{hc}{\mu\ z^2} - \frac{hc}{ev}\right] = \frac{hc}{\mu\ \left(\frac{z}{k}\right)^2} - \frac{hc}{e\frac{v}{4}}$$

$\Rightarrow\ k = 2$

CHEMISTRY

20. Blister copper is refined by electro refining.

21. A) $\left[O-\overset{\overset{O}{|}}{\underset{\underset{O}{|}}{Si}}-O-\overset{\overset{O}{|}}{\underset{\underset{O}{|}}{Si}}-O-\overset{\overset{O}{|}}{\underset{\underset{O}{|}}{Si}}-O \right]^{8-}$

B) HF reacts with glass, so it is used to make marking on the glass (etching).

C) Since Fe^{3+} reacts with KCNS to produce red colour. So, it can be used as an indicator in the titration of Fe^{3+} with Sn^{2+}.

D) $PlO_3O_4 + HCl \longrightarrow PbCl_2 + H_2O + \underset{(\text{Greenish yellow})}{Cl_2} \uparrow$

22. $k = Ae^{-\frac{E_a}{RT}}$

23. At the point of Maxima $\dfrac{dP}{dr} = 0$

$\left(2r - \dfrac{2Zr^2}{a_0}\right) = 0\,;\ r = \dfrac{a_o}{Z};\ \ for\ Li^{2+}, He^{+}\ and\ for\ H,\ r = \dfrac{a_0}{3}, r = \dfrac{a_0}{2}, r = a_o$

24. Both the reactions proceed through anti addition

25. NCERT text book

26 &27 . Mg + air $\longrightarrow$ MgO + Mg3N2

0.25 mol 0.1 0.05

MgO + 2HCl $\longrightarrow$ MgCl2 + H2O.

0.1 0.2mol

Mg3N2 + 8HCl $\longrightarrow$ 3MgCl2 + 2NH4Cl.

28. Aldol condensation

29. Oxidation by rearrangement

30. Let x mole C be converted into CO. Hence,

$x \times 26 + (1-x) \times 94 = 53.2 \Rightarrow x = 0.6$

Hence, moles of C formed=0.6

31. $O_2\,\text{Consumed} = \left[\dfrac{x}{2} + (1-x)\right]32 = 22.4\,gm$

32. $P = Cr_2(SO_4)_3\ Q = Na_2CrO_4\ R = PbCrO_4\ S = Na_2Cr_2O_7$

$Cr_2(SO_4)_3 + O_2 + Na_2CO_3 \xrightarrow{\Delta} Na_2CrO_4 + Na_2SO_4 + CO_2$

33. $CrO_4^{2-} + Ag^{+} \longrightarrow Ag_2CrO_4(\text{red ppt})$

$CrO_4^{2-} + Hg_2^{2+} \longrightarrow Hg_2CrO_4(\text{red ppt})$

$CrO_4^{2-} + Pb^{2+} \longrightarrow PbCrO_4(\text{Yellow ppt})$

34. NCERT text book

35. NCERT text book

36.

$$\underset{\frac{25}{3}\text{mmoles}}{5KI} + KIO_3 + \underset{10\text{ mmoles}}{6HCl} \longrightarrow \underset{5\text{mmoles}}{3I_2} + 6KCl + 3H_2O$$

$$\underset{5\text{ millimoles}}{I_2} + \underset{10\text{ millimoles}}{2Na_2S_2O_3} \longrightarrow 2NaI + Na_2S_4O_6$$

$x = \frac{25}{3}$ and $y = 10$

$3X - 2Y = 5$

37.

(A) $Z = \frac{PM}{dRT} = \frac{10 \times 32}{20 \times \frac{1}{12} \times 300} = \frac{16}{25}$

$\therefore$ O_2 shows negative deviation

(B) $Z = \frac{6}{11.2} \Rightarrow Z < 1$

$\therefore$ N_2 shows negative deviation.

(C) A shows negative deviation at $T = T_C$ and $P < P_C$.

(D) P = low, $T = T_B$

$\therefore$ $Z = 1$ or $PV = nRT$

$\because$ $T > T_C$, so gas cannot be liquefied at any pressure at given temperature.

MATHS

39. $\tan\theta_1, \tan\theta_2, \tan\theta_3, \tan\theta_4$ are real numbers

40. $\cos^4 x + \sin^2 x = \sin^4 x + \cos^2 x$ and $1 + \sin^2 x + \cos^4 x$ lies in second quadrant

41. $g(x) = \frac{(x+1)^{x+1}}{x^x}$

42. $2a + b - 2 \geq 0$

43.

$$S_k = \sum_{j=0}^{k} 2^{k-j}\left({}^{k+j-1}C_j + {}^{k+j-1}C_{j-1}\right)$$

$$= 2\sum_{j=0}^{k-1} 2^{k-1-j}\,.\,{}^{k-1+j}C_j + {}^{2k-1}C_k + \frac{1}{2}\sum_{j=1}^{k} 2^{k-j+1}\,.\,{}^{k+j-1}C_{j-1}$$

$$= 2\sum_{j=0}^{k-1} 2^{k-1-j}\,.\,{}^{k-1+j}C_j + \frac{1}{2}\sum_{j=1}^{k+1} 2^{k-j+1}\,.\,{}^{k+j-1}C_{j-1}$$

$$= 2.S_{k-1} + \frac{S_k}{2}$$

$$\Rightarrow S_k = 4S_{k-1}$$

Since $S_0 = 1$. So solving we get $S_k = 4^k \; \forall \; k \in w$

44. (A) $\int_0^1 x\tan x dx \ge \int_0^1 x\left(x+\frac{x^3}{3}\right)dx \ge \frac{2}{5}$

(B) $\int_0^1 x^2 COSx \le \int_0^1 x^2 dx \le \frac{1}{3}$

(C) $\int_0^1 x^3 \sin x \ge \int_0^1 x^3\left(x-\frac{x^3}{3!}\right) \ge \frac{37}{210}$

(D) x sin x is an even function

$$\therefore \int_{-1}^{0} x\sin x = \int_0^1 x\sin x \ge \int_0^1 x\left(x-\frac{x^3}{3!}\right)dx \ge \frac{3}{10}$$

45 & 46. A is commute with $\begin{pmatrix} 2 & 2 & 0 \\ 0 & 2 & 2 \\ 0 & 0 & 2 \end{pmatrix}$, let $A=\begin{pmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{pmatrix}$,

$$\begin{pmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{pmatrix}\begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{pmatrix}=\begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{pmatrix}\begin{pmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{pmatrix} \Rightarrow a_2=a_3=b_3=0, a_1=b_2=c_3, b_1=c_2$$

$$A=\begin{pmatrix} a & b & c \\ 0 & a & b \\ 0 & 0 & a \end{pmatrix},\ tr(A^{2019}+A)=6,\ A^{2019}=\begin{pmatrix} a^{2019} & - & - \\ - & a^{2019} & - \\ - & - & a^{2019} \end{pmatrix},\ \Rightarrow a^{2019}+a=2 \Rightarrow a=1$$

47 & 48. $a_n a_{n-1} = na_{n-1}+(n-1)a_n$, $(a_n-n)\left(a_{n-1}-(n-1)\right)=n(n-1)$

$$a_n=\begin{cases} nt+n & if \quad n \quad is \quad odd \\ \frac{n}{t}+n & if \quad n \quad is \quad even \end{cases}$$ Where $t=\frac{20}{23}$

51.

Writing $\sin^2\theta = x$, we get $2\sin\theta\cos\theta\, d\theta = dx$, and hence the given integral is equal to

$$\frac{1}{2}\int_0^{\pi/2}\cos^{2m-1}\sin^{2n-1}\theta\,(2\sin\theta\cos\theta)\,d\theta$$

$$=\frac{1}{2}\int_0^1\left(\cos^2\theta\right)^{\frac{2m-1}{2}}\left(\sin^2\theta\right)^{\frac{2n-1}{2}}dx=\frac{1}{2}\int_0^1(1-x)^{m-1/2}x^{n-1/2}dx=\frac{1}{2}\beta\left(m+\frac{1}{2},\ n+\frac{1}{2}\right).$$

52.

Writing $\frac{x}{1+x}=z$, we get $x=\frac{z}{1-z}$, $1+x=\frac{1}{1-z}$ and $dx=\frac{dz}{(1-z)^2}$.

$$\text{L.H.S.}=\int_0^1\frac{z^{m-1}}{(1-z)^{m-1}}(1-z)^{m+n}\frac{dz}{(1-z)^2}=\int_0^1 z^{m-1}(1-z)^{n-1}dz=\beta(m,n)$$

$$=\int_0^\infty\frac{x^{n-1}}{(1+x)^{m+n}}dx.$$

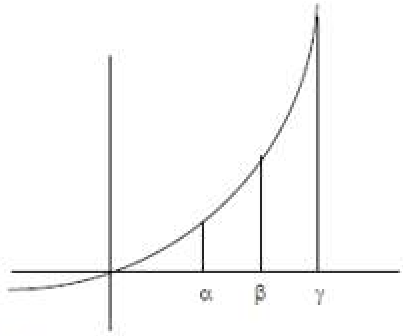
53.

Consider $g(x) = \frac{f(x)}{x}$

$g'(x) = \frac{f'(x)x - f(x)}{2} = \frac{f'(x)}{x^2}\left(x - \frac{f(x)}{f'(x)}\right)$

as $\frac{f'(x)}{x^2} > 0$

Let $h(x) = x - \frac{f(x)}{f'(x)}$



$h'(x) = 1 - \frac{f'(x)^2 - f(x)f''(x)}{f'(x)^2}$

$= \frac{f(x)f''(x)}{f'(x)^2} > 0$

$\therefore x - \frac{f(x)}{f'(x)}$ is increasing function.

$x - \frac{f(x)}{f'(x)} > 0 - \frac{f(0)}{f'(0)} = 0$

$\therefore g'(x) > 0.$

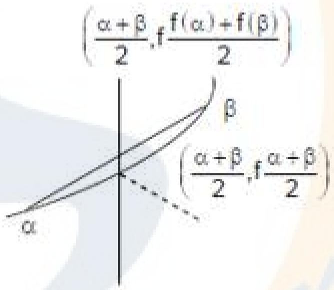
$\therefore \frac{f(\gamma)}{\gamma} > \frac{f(\beta)}{\beta} > \frac{f(\alpha)}{\alpha}$

satisfies A, C, D

54.

As the function is concave up

$\frac{f(\alpha)+f(\beta)}{2} > f\left(\frac{\alpha+\beta}{2}\right)$



55. $\min(S).\max(S) < 0$ we must have min(S)=-a and max(S)=b for some positive integers a and b. Given a and b, there are $|S| - 2$ = ab-2 elements left to choose, which must come from the set $\{-a+1, -a+2, ...b-2, b-1\}$ which has size a+b-1.

Therefore the number of possibilities for a given a , b are ${}^{a+b-1}C_{ab-2}$

56. $\frac{m}{n} = \frac{99}{101}$

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