SEC:Sr.Super60(Incoming)_STERLING WTA-32 Date: 18-05-2025
Time: 09:00AM to 12:00PM JEE-ADV-2022_P1 Max: Marks: 180

KEY SHEET

MATHEMATICS

1	**7**	2	**8**	3	**1**	4	**2**	5	**2**	6	**1**
7	**5**	8	**6**	9	**B,C,D**	10	**A,D**	11	**A,D**	12	**D**
13	**B,C**	14	**A,B,D**	15	**A**	16	**B**	17	**D**	18	**A**

PHYSICS

19	**2**	20	**2**	21	**8**	22	**1**	23	**2**	24	**8**
25	**2**	26	**2**	27	**ABD**	28	**AD**	29	**ABC**	30	**ACD**
31	**ABCD**	32	**BD**	33	**D**	34	**A**	35	**A**	36	**C**

CHEMISTRY

37	**1.75**	38	**3.33**	39	**1.60**	40	**8.75**	41	**6.50**	42	**2.33**
43	**1.20**	44	**1.25**	45	**AB**	46	**ACD**	47	**BD**	48	**ABD**
49	**AC**	50	**AC**	51	**C**	52	**D**	53	**B**	54	**C**

SOLUTIONS
MATHEMATICS

1. $f(x) = 2\log x$

$$A = \int_0^1 (-x^3 + 6x^2 - 11x + 6 - 2\log x)dx$$

$$= \frac{17}{4} \quad \Rightarrow \quad \frac{28}{17} \times \frac{17}{4} = 7$$

2. $[x]^2 = [y]^2$

$[y] = \pm 1 \quad$ if $1 < x < 2$

$= \pm\ 2 \qquad 2 \le x < 3$

$= \pm\ 3 \qquad 3 \le x < 4$

$\pm\ 4 \qquad$ if $4 \le x < 5$

$\pm\ 5 \qquad x = 5$

Plot the graph

Required area is 2(4) = 8

3. $f(x) + f(3) = f(x+z)$

and $f(0) = 1$ and $f^1(0) = 4$

$\Rightarrow\ f(x) = 4x$

So area bounded $= \Delta = \int_0^4 (4x - x^2)dx$

4. Conceptual.

5. Required area $= 4 \int_0^1 \sqrt{x^2 - x^6}dx$

$= \ 4x\sqrt{1-x^4}\ \ dx$

Put $\ x^2 = \sin\theta$

$2x\,d\,x = \cos\theta\ \ d\theta$

$\Rightarrow\ \ 2\cos\theta\ \ \cos\theta\ \ \ d\theta$

R. A $= \int_0^{\frac{\pi}{2}} 2\cos^2\theta\ \ \ d\theta$

6. Required area $\ 4\int_0^1 \ (1 - x^{2/5})dx \ = \frac{8}{7}$

7. At $x=0 \quad y=0$.

$$x+5y-y^5=0$$

$$\Rightarrow \; 1+5y^1-5\,y^4\,y^1=0$$

at $x=0 \quad y=0$

$$y^1 = \frac{1}{5}$$

Required tangent is $y = \dfrac{-x}{5}$

$\therefore$ Area $=\dfrac{1}{2}\times 5\times 26=65$

8. Conceptual.

9. (a) $f(x)=(x-a)\,(x-b)\,(x+c)=(x-a)\,x(x+c)$

Clearly option 1 is a correct.

(b) $\int_a^c f(x)\,dx = \int_a^b f(x)\,dx+\int_b^c f(x)\,dx > 0$

So, from the graph which is incorrect

(c) $\int_a^b f(x)\,dx < 0$ and $\int_c^b f(x)\,dx<0$

But second term has large negative value

$\therefore$ option c is incorrect

(d) $\Rightarrow$ Clearly d is incorrect.

10. $$I_n=\frac{1}{n}\sum_{r=2n}^{2n-1}\frac{\frac{r}{n}}{1+\left(\frac{r}{n}\right)^2}$$

$$S_n=\frac{1}{n}\sum_{r=2n+1}^{3n}\frac{\left(\frac{r}{n}\right)^2}{\left(1+\frac{r}{n}\right)^2}$$

Let $f(x) = \dfrac{x}{1+x^2}$

$$\Rightarrow f^1(x)=\frac{1+x^2-2x^2}{\left(1+x^2\right)^2}$$

$\therefore$ $f(x)$ is decreasing in (2, 3)

$$I_n > \int_2^3 f(x)\,dx$$

$$S_n < \int_2^3 f(x)\,dx$$

11. $\int_6^4 (a\sqrt{x}+bx)\ dx = 8$

$\frac{2a}{3}+b=1 \quad \rightarrow \quad 1$

$a+b=2$

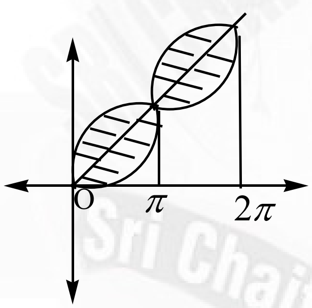
$\therefore \quad a,b,c,d$ are correct.

12. Equation of normal is $y+x=\frac{7}{4}$

$\therefore$ Required area $= \int_{\frac{-3}{2}}^{\frac{3}{2}} \left(\frac{7}{4}-x\right)-(x^2+1)\ dx$

13. Conceptual
14. Conceptual.
15. graph of

A $y=x+\sin x$ and its inverse is show in the graph



$y=x$ is function and inverse

Required area $=4\int_0^{\pi} (x+\sin x)-(x)$

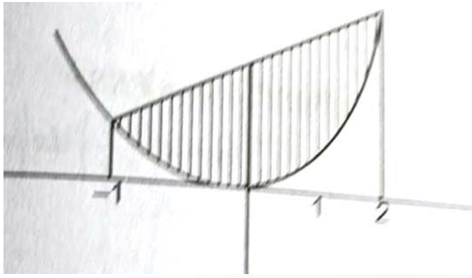
$4\int_0^{\pi} \sin x\ dx$

$4(2)=8$

$S=2$

16. The area = 2 unit

B) Area enclosed = $\int_0^{\pi} \sin x dx = 2$

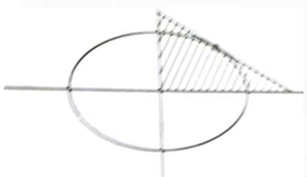


The line y = x+2 intersects $y = x^2 at x = -1$ and $x = 2$

The given region is shaded region area = $\frac{15}{2} - \int_{-1}^{2} x^2 dx = \frac{9}{2}$

D) Here, $a^2 = 9, b^2 = 5, b^2 = a^2\left(1-e^2\right) \Rightarrow e^2 = \frac{4}{9} \Rightarrow \frac{2}{3}$

Equation of tangent at $\left(2, \frac{5}{3}\right) is \frac{2x}{9} + \frac{y}{3} = 1$



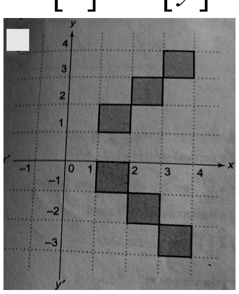
x-intercept = $\frac{9}{2}$, y-intercepts = 3

Area = $4 \times \frac{9}{2} \times 3 \times \frac{1}{2} = 27$ sq.units

17. Consider the intervals for x
$[0,1)[1,2)[2\,3)[3\,4)$
The values of y in the interval
$[0\,1)[1\,2)[2\,3)[3\,4)$
Required are 4 square units

18. $\left[x^2\right] = [y]^2$, where $1 \le x \le 4$

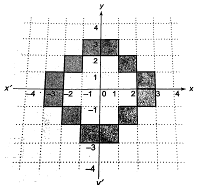
$\Rightarrow [x] = \pm[y]$



B) $\left[|x|\right]\left[|y|\right] = 2$

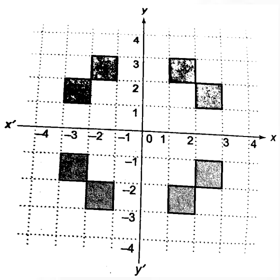
The graph is symmetrical about both the x-axis and y-axis

For $x, y > 0; [x]+[y]=2$



$\Rightarrow [x]=0$ and $[y]=2, [x]=1$ and $[y]=1 or [x]=2$ and $[y]=0$

[C]: $[|x|][|y|]=2$



The graph is symmetrical about both the x-axis and y-axis

For $x, y > 0; [x][y]=2 \Rightarrow [x]=1$ and $[y]=2$ or $[x]=2$ and $[y]=1$

PHYSICS

19. $R = 3 + 1 = 4\Omega, e = Bl\vartheta$

$$i = \frac{e}{R} \Rightarrow i = \frac{Bl\vartheta}{R}$$

$$10^{-3^{-1}} = \frac{2\times10^{5}\times10^{-2}}{4}\vartheta \to \vartheta\frac{1}{5}\times10^{-1}$$

$$\vartheta = 0.2\times10^{-1} = 0.02m$$

20. For falling $y \to \vartheta = \sqrt{2gy}$

$$l = 2x = 2\sqrt{\frac{y}{c}}$$

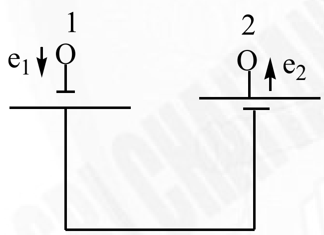
$$e = B\vartheta l$$

$$e = B\sqrt{2gy}.2\sqrt{\frac{y}{c}} = By\sqrt{\frac{8a}{c}}$$

$$= 2By\sqrt{\frac{2a}{c}}$$

21. $e_1 = B2r2\vartheta$

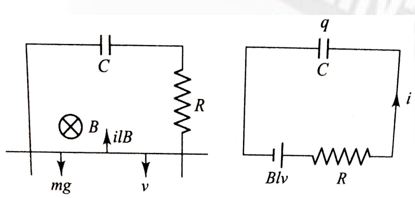
$e_2 = B4r.\vartheta$



$$e = e_1 + e_2 = 8Br\vartheta$$

22. The rate of electrical energy consumed in the bulb = rate of loss of gravitational PE of the mass = $Mgv = 100W$. Hence $M = \frac{100}{10\times10} = 1kg$

23. By Newton's law $mg - ilB = m\frac{dv}{dt}$ $\qquad (i)$



Using KVL $Blv = iR + \frac{q}{C}$ $\qquad (ii)$

Differentiating equation (ii) w.r.t time, we get

$$Bl\frac{dv}{dt} = R\frac{di}{dt} + \frac{i}{C} \qquad (iii)$$

Eliminating $\frac{dv}{dt}$ from equations (i) and (iii), we get

$$mg - ilB = \frac{m}{Bl}\left[R\frac{di}{dt} + \frac{i}{C}\right]$$

$$\Rightarrow mgBl - iB^2l^2 = m\left(R\frac{di}{dt} + \frac{mi}{C}\right) \qquad (iv)$$

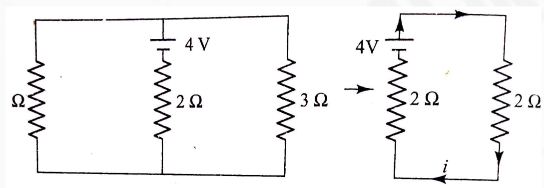
I will be maximum when $\frac{di}{dt} = 0$. Use this in equation (iv)

$$\Rightarrow \quad mgBlC = i\left(B^2l^2C + m\right)$$

$$\Rightarrow i_{\max} = \frac{mgBlC}{m + B^2l^2C}$$

24. Induced emf : B(effective length) $v = B2Rv$

25. Motional emf



$e = Bvl$

$e = (2)(2)(1) = 4V$

This acts as a cell of emf E = 4 V and internal resistance $r = 2\Omega$. The simple circuit can be drawn as follows

Therefore, current through the connector $i = \frac{4}{2+2} = 1A$

Magnetic force on connector

$F \ = 1lB = (1)(1)(2) = 2N$ (towards left)

Therefore, to keep the connector moving with a constant velocity, a force of 2N will have to be applied towards right.

26. $de = B\vartheta dx = \frac{\mu}{2\pi}\frac{i_o}{x}\vartheta dx$

$$e = \int de = \frac{\mu_o}{2\pi} i\vartheta \int_a^b \frac{dx}{x}$$

$$e = \frac{\mu_o}{2\pi} i\vartheta \ln(x)_a^b = \frac{\mu_o}{2\pi} i\vartheta \ln\left(\frac{b}{a}\right)$$

$$F = \frac{p}{\vartheta} = \frac{e^2}{R\vartheta} = \frac{\vartheta}{R}\left(\frac{\mu_o}{2\pi} i_o \ln\left(\frac{b}{a}\right)\right)^2$$

27. Conceptual

28. PQ does not cut lines of force so $e_{pq} = 0$

In RQ $e = Bl\vartheta = Ba\ (a\,w)$

$e = Ba^2\omega$

29. $\phi = BA = B_o t\pi\left(r_o t\right)^2$

$\rightarrow e = \frac{d\phi}{dt} = B_o \pi r_0^2 3t^2$

$\rightarrow e\,\alpha t^2$ so, parabola

$\rightarrow \frac{B_o}{r_o} = \frac{e}{\pi r_0^3 3t^2}$

$\frac{de}{dt} = B_o \pi r^2 6t$

$\frac{de}{dt}\alpha t$

30. Potential difference = $\frac{1}{2}B\omega l^2$

From energy conservation: $mg\frac{l}{2}\sin\theta = \frac{1}{2}I\omega^2$, where $I = \frac{ml^2}{3}$

$mg\frac{l}{2}\sin\theta = \frac{1}{2}\frac{mi^2}{3}w^2$

$\omega = \sqrt{\frac{3g}{l}\sin\theta}$

$e = \frac{2}{2}Bl^2\sqrt{\frac{3g\sin\theta}{l}}$

$e\alpha B; e\alpha l^{3/2} e\alpha \sin\theta^{1/2}$

31. Due to rotation, $emf = \frac{Br^2\omega}{2}$

Due to translation indeed emf = Bvr

Where r is the separation.

32. $i = \frac{dq}{dt} = \frac{d}{dt}\left(CvBl\right) = CBl\frac{dv}{dt} = CBla$

$\therefore F - CB^2l^2a = ma$

$\Rightarrow a = \frac{F}{m + B^2l^2C}$

$\Rightarrow$ emf increases

$\Rightarrow$ charge increases

33. We know that $e=-\dfrac{d\phi}{dt}=-A\dfrac{dB}{dt}$. If we take area vector in the upward direction, then anticlockwise direction will be positive From 0 to t_1 and t_5 to t_6 dB/dt is +ve. Hence induced emf e is –ve. So induced current will be in clockwise direction. From t_2 to $t_4 dB/dt$ is –ve. Hence induced emf e is +ve. So induced current will be in anticlockwise direction. From $t_1\ to\ t_2$ and $t_4\ to\ t_5$ dB/dt is zero. Hence, no emf is induced. Induced emf or current is maximum from 0 to t_1 and $t_5\ to\ t_6$ because here magnitude of dB/dt is maximum.

34. Conceptual

35. Since $\phi = 2t$

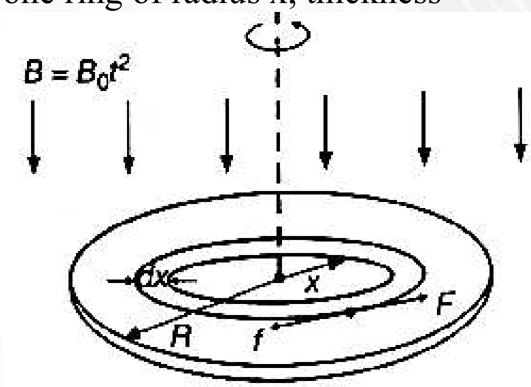
$$E=\frac{d\phi}{dt}=2v$$

$$i=\frac{E}{R}=\frac{2}{2}=1A$$

$$\Delta q = iot = 1\times 2 = 2c$$

$$H = i^2Rt = 1^2\times 2\times 2 = 4J$$

36. Assume the disc to be made of a number of infinitesimal concentric rings. Consider one ring of radius x, thickness



dx having mass dm. Then the frictional force on this infinitesimal elements is

$$df = \mu(dN) = \mu(dm)g \qquad \{\because dN = (dm)g\}$$

where $dm = (2\pi x dx)\dfrac{M}{\pi R^2} = \left(\dfrac{2M}{R^2}\right)(xdx)$

infinitesimal torque due this frictional force is

$$d\tau = (df)x$$

$$\Rightarrow\ d\tau = \mu\left(\frac{2M}{R^2}xdx\right)gx$$

$$\Rightarrow\ d\tau = \frac{2\mu Mg}{R^2}x^2dx$$

$$\Rightarrow \quad \tau = \int d\tau = \frac{2\mu Mg}{R^2}\int_0^R x^2 dx$$

$$\Rightarrow \quad \tau = \frac{2\mu Mg}{R^2}\left(\frac{R^3}{3}\right) = \frac{2}{3}(\mu MgR)$$

This expression is independent of τ. So

(B) $\rightarrow$ (p)

Now, let us calculate the torque due to the varying magnetic field.

The varying magnetic field which will be tangential to the disc (or the infinitesimal element). If dq be the charge on the infinitesimal element, then

$$dq = \left(\frac{Q}{\pi R^2}\right)(2\pi x dx) = \left(\frac{2Q}{R^2}\right)x dx$$

Electrostatic force on this element in the presence of tangential electric field E_t is

$dF = (dq)E_t$

So, if $d\tau_m$ is the torque due to the magnetic field, then

$$\tau_m = \int d\tau_m = \int x dF = \int\left(\frac{2Q}{R^2}x^2 dx\right)E_t \qquad .....(1)$$

From Faraday's Laws, we know that

$$\left|\oint \vec{E}_t . d\bar{\ell}\right| = \left|\frac{d\phi_B}{dt}\right|$$

$$\Rightarrow \ (2\pi x)E_t = (\pi x^2)\frac{dB}{dt}$$

$$\Rightarrow \ E_t = \frac{x}{2}(2B_0 t) = (B_0 t)x$$

$$\Rightarrow \quad \tau_m = \frac{(2QB_0)t}{R^2}\int_0^R x^3 dx$$

$$\Rightarrow \quad \tau_m = \frac{(2QB_0)t}{R^2}\left(\frac{R^4}{4}\right) = \left(\frac{QB_0R^2}{2}\right)t$$

$$\Rightarrow \ \tau_m = \left(\frac{QB_0R^2}{2}\right)t \qquad ....(2)$$

The disc will start rotating $t = t_0$, when

$\tau_m = \tau_f$

$$\Rightarrow \left(\frac{QB_0R^2}{2}\right)t_0 = \frac{2}{3}\mu MgR$$

$$\Rightarrow t_0 = \frac{4}{3}\left(\frac{\mu Mg}{QB_0R}\right)$$

So, we get (A) $\rightarrow$ (s)

Also, from (2), we observe that torque due to magnet field at t = 0 is zero

at $t = t_0$ is $\left(\frac{QB_0R^2}{2}\right)t_0 = \frac{2}{3}\mu MgR$

at $t = 3t_0$ is $\frac{3}{2}(QB_0R^2)$

$t_0 = 2\mu MgR$

So, (C) $\rightarrow$ (p, r, t)

Let us calculate the net torque τ on the disc at ti $t(> t_0)$

$$\tau = \tau_m - \tau_f = \left(\frac{QB_0R^2}{2}\right)t - \frac{2}{3}(\mu MgR)$$

$$\Rightarrow \quad 1\alpha = \left(\frac{QB_0R^2}{2}\right)t - \frac{2}{3}(\mu MgR)$$

$$\Rightarrow \quad 1\frac{d\omega}{dt} = \left(\frac{QB_0R^2}{2}\right)t - \frac{2}{3}(\mu MgR)$$

$$\Rightarrow \quad \frac{1}{2}MR^2\frac{d\omega}{dt} = \left(\frac{QB_0R^2}{2}\right)t - \frac{2}{3}(\mu MgR)$$

$$\Rightarrow d\omega = \frac{QB_0}{M}\int_{t_0}^{2t_0} tdt - \frac{4\mu g}{3R}\int_{t_0}^{2t_0} dt$$

$$\Rightarrow \omega = \left(\frac{QB_0}{2M}\right)(3t_0^2) - \left(\frac{4\mu g}{3R}\right)t_0$$

Substituting $t_0 = \frac{4}{3}\left(\frac{\mu Mg}{QB_0R}\right)$ in (3), we get

$$\omega = \frac{8}{9}\left(\frac{M\mu^2 gh2}{QB_0R^2}\right)$$

So, (D) $\rightarrow$ (q)

CHEMISTRY

37. $$\underset{(A)}{XeF_6 + H_2O(1mole) \longrightarrow XeOF_4} + 2HF$$

$P = 5, Q = 1, R = 1, \qquad \dfrac{P+Q+R}{4} = \dfrac{7}{4} = 1.75$

38. $x = 6, y = 4$

$\dfrac{x+y}{3} = \dfrac{10}{3} = 3.33$

39. $HClO_x = HClO_2 \; and \; x = y = z = 2$

$\therefore \dfrac{2x+y+z}{5} = \dfrac{8}{5} = 1.60$

40.

	XeF_4	XeF_5^+	XeF_5^-	XeF_6	XeF_8^{2-}
Bond pair	4	5	5	6	8
Lone pairs	2	1	2	1	1

$\therefore P = 28, Q = 7 \; and \; \dfrac{P+Q}{4} = \dfrac{35}{4} = 8.75$

41. $Xe + 2O_2F_2 \longrightarrow XeF_4 + 2O_2$

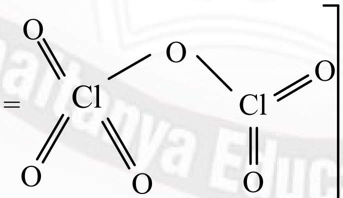
$3XeF_4 + 6H_2O \longrightarrow 2Xe + XeO_3 + 3/2 \; O_2 + 12HF$

$\therefore X =$ moles of $XeO_3 = 1$

$Y = moles \; of \; HF = 12$

and $\dfrac{x+y}{2} = \dfrac{1+12}{2} = \dfrac{13}{2} = 6.50$

42. $2ClO_2 + 2O_3 \longrightarrow Cl_2O_6 + 2O_2$

[Cl_2O_6 Structure = ]

A = No.of $\pi -$bonds = 5

B = Average oxidation state of Cl in P = 6

$\dfrac{2B-A}{3} = \dfrac{12-5}{3} = \dfrac{7}{3} = 2.33$

43. $3Cl_2 + 6NaOH \longrightarrow 5NaCl + NaClO_3 + 3H_2O$

$x = 6, y = 5 \; and \; \frac{x}{y} = 1.20$

44. % of Cl_2 available = $\frac{3.55 \times N \times V}{W} = \frac{3.55 \times 0.25 \times 5}{3.55}$

=1.25

45. Conceptual
46. $X = XeO_3$ (Explosive) $Y = XeO_2F_2$
47. Conceptual
48. In polar solvents, PCl_5 on reaction with

F_2 giveS $[PCl_4]^+[PCl_4F_2]^{\Theta}$ *and* $[PCl_4]^+[PF_6]^{\Theta}$

49. Conceptual
50. $XeF_6 + H_2O \longrightarrow XeOF_4 + 2HF$

$XeF_6 + 2H_2O \longrightarrow XeO_2F_2 + 4HF$

51. Conceptual
52. Conceptual
53. Conceptual
54. Conceptual