IIT ASHRAM BRINGS....

ENGINEERING APTITUDE TEST (2020)

SCHOLARSHIP TEST

ANSWER KEY AND SOLUTION

PHYSICS		CHEMISTRY		MATHEMATICS	
Q. No.	Answer	Q. No.	Answer	Q. No.	Answers
1	B	26	C	51	C
2	B	27	D	52	A
3	C	28	B	53	B
4	A	29	C	54	B
5	C	30	A	55	D
6	C	31	A	56	C
7	B	32	D	57	B
8	C	33	D	58	A
9	A	34	D	59	D
10	B	35	B	60	D
11	A	36	A	61	D
12	D	37	A	62	B
13	A	38	B	63	A
14	B	39	A	64	A
15	C	40	B	65	D
16	D	41	B	66	B
17	A	42	A	67	A
18	D	43	D	68	D
19	A	44	D	69	B
20	D	45	B	70	D
21	90	46	0.75	71	24
22	.83	47	9	72	252
23	4	48	3.75	73	1152
24	0.033	49	112	74	6976
25	7	50	444	75	11

PHYSICS

SECTION - I

1

Sol. (b)

$T \propto P^a d^b E^c$

Pressure $[P] = [ML^{-1} T^{-2}]$

Density $[d] = [ML^{-3}]$

Energy $[E] = [ML^2 T^{-2}]$

$T \propto [ML^{-1} T^{-2}]^a [ML^{-3}]^b [ML^2 T^{-2}]^c$

$[M^0 L^0 T^1] = [M^{a+b+c} L^{-a-3b+2c} T^{-2a-2c}]$

$\Rightarrow a + b + c = 0$ ....(1)

$\Rightarrow -a - 3b + 2c = 0$ ....(2)

$\Rightarrow -2a - 2c = 1$ ....(3)

(1) and (2) $-2b + 3c = 0$ ....(4)

put in (1)

$a + \frac{3c}{2} + c = 0$ $\qquad a = -\frac{5c}{2}$

put in (3)

$-2\left(\frac{-5c}{2}\right) - 2c = 1$ $\qquad 3c = 1$ $\qquad c = \frac{1}{3}$

$a = \frac{-5}{2}c. = \frac{-5}{2}\left(\frac{1}{3}\right) = -\frac{5}{6}$ $\qquad \Rightarrow$ put $c = \frac{1}{3}$ in (4)

$b = \frac{3c}{2} = \frac{1}{2}$ $\qquad \Rightarrow T \propto P^{-5/6} d^{1/2} E^{1/3}$

2.

Sol. (b)

$[m] = [C]^x [G]^y [h]^z$

$[M^1L^0T^0] = [M^0LT^{-1}]^x [M^{-1} L^3T^{-2}]^y [ML^2T^{-2}]^z$

equating dimensions at M, L, T

$1 = -y + z$ .....(1)

$0 = x + 3y + 2z$ .....(2)

$0 = -x - 2y - z$ .....(3)

(2) and (3)

$0 = y + z$ .....(4)

by (1) and (4)

$z = \frac{1}{2}$, $\qquad y = -\frac{1}{2}$, $x = -2y - z = 1 - \frac{1}{2} = \frac{1}{2}$

$x = \frac{1}{2}$ $\qquad [m] = C^{1/2} G^{-1/2} h^{1/2}$

3.

Sol. (c)

$F = \frac{GM(M-m)}{r^2}$

For F_{min}, $\frac{dF}{dm} = 0 \Rightarrow M - 2m = 0 \Rightarrow \frac{m}{M} = \frac{1}{2}$

4.

Sol. (a)

5.

Sol. (c)

If two different bodies A and B are floating in the same liquid then $\frac{\rho_A}{\rho_B} = \frac{(f_{in})_A}{(f_{in})_B} = \frac{1/2}{2/3} = \frac{3}{4}$

6.

Sol. (c) $R = vt \Rightarrow R = \sqrt{2gD}\sqrt{\frac{2(H-D)}{g}} \Rightarrow R = 2\sqrt{D(D-h)}$.

7.

Sol. (b)

$W = T\Delta A$

$2 \times 10^{-4} = (60 - 30) \times 10^{-4}\, T \times 2$

$T = \frac{2}{30 \times 2} = \frac{1}{30} = 3.3 \times 10^{-2}$ N / m

8.

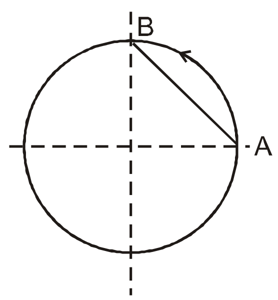
Sol. (c)

9.

Sol. (a)

Displacement $d_1 = \sqrt{2}\,r$

Distance from A to B $d_2 = \left(\frac{\pi r}{2}\right)$



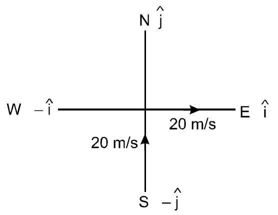
$\frac{d_2}{d_1} = \frac{\frac{\pi r}{2}}{\sqrt{2}\,r} = \left(\frac{\pi}{2\sqrt{2}}\right)$

10.

Sol. (b) $\vec{V_1} = 20\hat{j}$

$\vec{V_2} = 20\hat{i}$

Change in velocity



$\Delta \vec{V} = \vec{V_2} - \vec{V_1}$

$\vec{V} = +20\hat{i} - 20\hat{j}$

$|\vec{V}| = 20\sqrt{2}$

Direction south - east

11.

Sol. (a) mass m = $\frac{|\vec{F}|}{|\vec{a}|} = \frac{\sqrt{200}}{1} = 10\sqrt{2}$

12.

Sol. (d)

a = gsin 45º – μg cos 45º

$a = \frac{g}{\sqrt{2}}\left(1-\frac{1}{2}\right) = \frac{g}{2\sqrt{2}}$

13.

Sol. (a) W = $\bar{F} \cdot (\bar{r}_2 - \bar{r}_1)$ = 100 J

14.

Sol. (b) Torque about O

F × 40 + F × 80 – (F × 20 + F × 60)

In clockwise direction

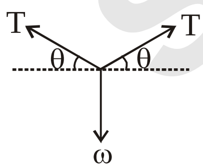
= F × 40

15.

Sol. (c)

16.

Sol. (d)

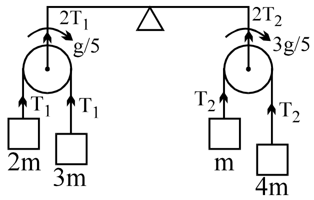


$2T \sin\theta = W$

$T = \frac{W}{2\sin\theta}$ as $\theta \to 0$, $T \to \infty$ so not possible

17.

Sol. (a) $T_1 - 2mg = \frac{2mg}{5}$



$T_1 = \frac{12mg}{5}$ $T_2 - mg = m \times \frac{3g}{5}$

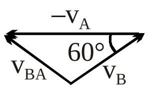
$T_2 = \frac{8mg}{5}$

$\because T_1 < T_2 \therefore$ left are will move downward

18.

Sol. (d) $a_B = \frac{v_B^2}{r} = \frac{225}{250} = \frac{9}{10} = 0.9\ m/s^2$

$\vec{v}_{BA} = \vec{v}_B - \vec{v}_A$

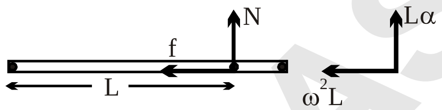


$v_{BA} = \sqrt{v_{A^2} + v_{B^2} - 2v_A v_B \cos 60°}$

$v_{BA} = \sqrt{900 + 225 - 900 \times 1/2} = 26$

19.

Sol. (a)



$f = mL\omega^2$

$N = mL\alpha$

If $\mu \frac{\omega^2}{\alpha} \Rightarrow \mu N = mL\omega^2$

20.

Sol. (d) $mv\frac{L}{2} = \frac{1}{12}ML^2\omega^2$ ....(i)

$mv = MV_0$ ....(ii)

$\frac{v_0 + \omega L/2 - 0}{0 - V} = -1$ ....(iii)

SECTION - II

21.

Sol. 90 M

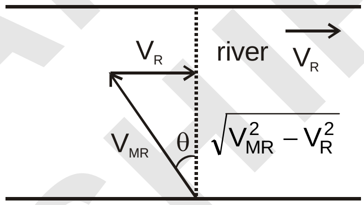
22.

Sol. (.83)

15 min = 1/4 hr.

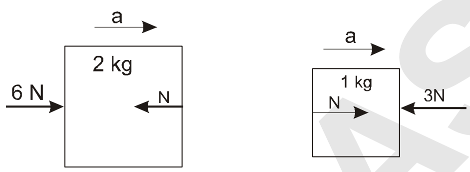
$$t = \frac{d}{V_y} \Rightarrow \frac{1}{4} = \frac{1}{\sqrt{V_{MR}^2 - V_R^2}} = \frac{1}{4} = \frac{1}{\sqrt{5^2 - V_R^2}}$$

$$\Rightarrow V_R = 3\ \text{km/h} \quad \frac{3 \times 1000}{3600} = .83$$



23.

Sol. (4)



Both blocks are constrained to move with same acceleration.

6 – N = 2a [Newtons II law for 2 kg block]

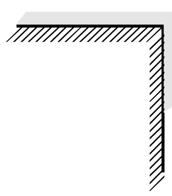
N – 3 = 1a

[Newtons II law for 1 kg block] $\Rightarrow$ N = 4 Newton

24.

Sol. 0.033

Apply system equation



$$\frac{m}{4} g = \frac{3m}{4} g \times \mu$$

$$\Rightarrow \mu = \frac{1}{3} = 0.33$$

25.

Sol. (7I)

M.I of both spheres about common tangent

CHEMISTRY

SECTION - I

26.

Sol. (c)

27.

Sol. (d)

28.

Sol. (b)

HF < HCl < HBr < HI (on moving top to bottom, bond dissociation energy decreases, so acidic strength increases).

B < C < O < N (on moving left to right, Z_{eff} increases, so first ionization enthalpy increases ; N > O because N is half filled).

$CO_2 < SiO_2 < SnO_2 < PbO_2$ (on moving top to bottom, + 4 oxidation state becomes less stable due to inert pair effect). So oxidising power increases.

Since, (1), (3) and (4) are correct, so (2) is the answer.

In hydrides of 15^{th} group elements, the basic strength decreases down the group and the correct order is :

$SbH_3 < AsH_3 < PH_3 < NH_3$

29.

Sol. (c)

Order of increasing ΔH_{IE_1} : Ba < Ca < Se < S < Ar

Ba < Ca ; Se < S : On moving top to bottom in a group, size increases. So ionisation enthalpy decreases.

Ar : Maximum value of ionisation enthalpy, since it is an inert gas.

30.

Sol. (a)

31.

Sol. (a)

32.

Sol. (d)

33.

Sol. (d)

34.

Sol. (d)

35.

Sol. (b)

36.
Sol. (a)
37.
Sol. (a)
38.
Sol. (b)
39.
Sol. (a)
40.
Sol. (b)
41.
Sol. (b)
42.
Sol. (a)
43.
Sol. (d)
44.
Sol. (d)
45.
Sol. (b)

SECTION - II

46.
Sol. 0.75
47.
Sol. 9
48.
Sol. 3.75
49.
Sol. 112kj
50.
Sol. 444

MATHEMATICS

SECTION - I

51

Sol. (c)

Let $\tan\theta = x$.

Then $x = \cfrac{1}{2+\cfrac{1}{2+\cfrac{1}{2+.....\infty}}}$

$\Rightarrow x = \frac{1}{2+x}$

$\Rightarrow x^2 + 2x - 1 = 0$

$\Rightarrow x = \frac{-2\pm\sqrt{8}}{2} = \left(\sqrt{2}-1\right)$

$\therefore \tan\theta = \sqrt{2}-1 \Rightarrow \theta = \frac{\pi}{8} \text{ or } \frac{9\pi}{8}$

52.

Sol. (a) A : {2, 4, 6} ; B = {2, 3, 5}

A ´ *B* contains $3\times 3 = 9$ elements.

Hence, number of relations from *A* to *B* $= 2^9$.

53.

Sol. (b) $-\sqrt{7^2+5^2} \le (7\cos x + 5\sin x) \le \sqrt{7^2+5^2}$

So, for solution $-\sqrt{74} \le (2k+1) \le \sqrt{74}$

or $-8.6 \le (2k+1) \le 8.6$ or $-9.6 \le 2k \le 7.6$

or $-4.8 \le k \le 3.8$. So, integral values of *k* are $-4, -3, -2, -1, 0, 1, 2, 3$ (eight values).

54.

Sol. (b) Given, $(\cos x + \sin x)^2 + k\sin x\cos x - 1 = 0, \ \forall \ x$

$\Rightarrow \cos^2 x + \sin^2 x + 2\cos x\sin x + k\sin x\cos x - 1 = 0, \forall x \quad \Rightarrow (k+2)\cos x\sin x = 0, \forall x \quad \Rightarrow k+2=0 \quad \Rightarrow k=-2$.

55.

Sol. (d)

Director circle of the circle $2x^2 + 2y^2 - 12x - 16y + 25 = 0$ passes through origin

$\Rightarrow$ Angle between tangents is 90º

56.

Sol. (c)

57.

Sol. (b) $|x^2 - x - 6| = x + 2$, then

Case I : $x^2 - x - 6 < 0$

Þ $(x-3)(x+2) < 0$ Þ $-2 < x < 3$

In this case, the equation becomes

$x^2 - x - 6 = -x - 2$ or $x^2 - 4 = 0 \Rightarrow x = \pm 2$

Clearly $x = 2$ satisfies the domain of the equation in this case. So is a solution.

Case II : $x^2 - x - 6 \geq 0$. So $x \leq -2$ or $x \geq 3$

Then equation reduces to

$x^2 - x - 6 = 0 = x + 2$

i.e. $x^2 - 2x - 8 = 0$ or $x = -2,\ 4$

Both these values lies in the domain of the equation in this case, so $x = -2,\ 4$ are the roots.

Hence roots are $x = -2,\ 2,\ 4$.

58.

Sol. (a)

$$\log_{0.6}\left(\log_6 \frac{x^2 + x}{x + 4}\right) < 0$$

$$\Rightarrow \log_6\left(\frac{x^2 + x}{x + 4}\right) > 1$$

$$\Rightarrow \frac{x^2 + x}{x + 4} > 6 \Rightarrow \frac{x^2 + x}{x + 4} - 6 > 0$$

$$\Rightarrow \frac{x^2 - 5x - 24}{x + 4} > 0$$

$$\Rightarrow \frac{(x-8)(x+3)}{x+4} > 0$$

$$\Rightarrow x \in (-4, -3) \cup (8, \infty)$$

59.

Sol. (d)

We have letters C, C,O, O, N, U, T
Required number of ways
= Total number of ways – Number of ways when no C comes at odd place (when C's come at even places)

$$= \frac{7!}{2!2!} - {}^3C_2 \times \frac{5!}{2!} = 1080$$

60.

Sol. (d)

61.

Sol. (d) Required number of ways are = ${}^4P_2 \times {}^6P_3$.

{After selecting by women there are 6 chairs remaining}.

62.
Sol. (b)

(b) $\frac{1}{x+p}+\frac{1}{x+q}=\frac{1}{r}$

$\frac{x+p+x+q}{(x+p)(x+q)}=\frac{1}{r}$

$(2x+p+q)\,r=x^2+px+qx+pq$

$x^2+(p+q-2r)\,x+pq-pr-qr=0$

Let α and β be the roots.

$\therefore \alpha+\beta=-(p+q-2r)$ ....(i)

& $\alpha\beta=pq-pr-qr$ ....(ii)

$\because \alpha=-\beta$ (given)

∴ in eq. (1), we get

$\Rightarrow -(p+q-2r)=0$ ...(iii)

Now, $\alpha^2+\beta^2=(\alpha+\beta)^2-2\alpha\beta$

$=(-(p+q-2r))^2-2(pq-pr-qr)$ .... (from (i) and (ii))

$=p^2+q^2+4r^2+2pq-4pr-4qr-2pq+2pr+2qr$

$=p^2+q^2+4r^2-2pr-2qr$

$=p^2+q^2+2r(2r-p-q)$ ...(from (iii))

$=p^2+q^2+0$

$=p^2+q^2$

63.

Sol: (A)

We have $|z-(-1+i)|=1$

$\Rightarrow |z+1-i|=1$

Now, $\omega=\frac{z+i}{1-i}$

$\Rightarrow (1-i)\omega=z+i$

$\Rightarrow (1-i)\omega-2i+1=z+1-i$

$\Rightarrow |(1-i)\omega-2i+1|=|z+1-i|$

$\Rightarrow |1-i|\left|\omega+\frac{1-2i}{1-i}\right|=1\Rightarrow\left|\omega+\frac{(1-2i)(1+i)}{(1+i)(1-i)}\right|=\frac{1}{\sqrt{2}}$

$\Rightarrow \left|\omega-\frac{-3+i}{2}\right|=\frac{1}{\sqrt{2}}$

64.

Sol. (a)

Both R_1 and R_2 are symmetric as
For any $(x, y) \in R_1$, we have
$(y, x) \in R_1$ and similarly for R_2
Now, for R_2, $(b, a) \in R_2, (a, c) \in R_2$ but $(b, c) \notin R_2$.
Similarly, for R_1, $(b, c) \in R_1, (c, a) \in R_1$ but $(b, a) \notin R_1$.
Therefore, neither R_1 nor R_2 is transitive.

65.

Sol. (d)

Here $1^{1/3} = 1, \omega, \omega^2$

For the equation $(x-2)^3 + 27 = 0$

$\Rightarrow (x-2)^3 = -27 = -3^3$

$\Rightarrow x - 2 = -3(1)^{1/3} = -3(1, \omega, \omega^2) = -3, -3\omega, 3\omega^2$

$\Rightarrow x = -1, 2 - 3\omega, 2 - 3\omega^2$.

66.

Sol. (b) Let the coordinates of axes are A $(a, 0)$ and B $(0, b)$, but the point (–5,4) divides the line AB in the ratio of 1 : 2. Therefore, the coordinates of axes are $\left(\frac{-15}{2}, 0\right)$ and $(0, 12)$. Therefore, the equation of line passing through these coordinate axes is given by $8x - 5y + 60 = 0$.

67.

Sol. (a)

68.

Sol. (d)

69.

Sol. (b)

Given curve is $\frac{a}{x^2} + \frac{b}{y^2} = 1$ compare with $\cos^2\theta + \sin^2\theta = 1$

$\Rightarrow \frac{a}{x} = \cos\theta, \frac{b}{y} = \sin\theta$

$\Rightarrow x = a\sec\theta$ and $y = b\operatorname{cosec}\theta$

Minimum distance of the curve from the origin $= \sqrt{x^2 + y^2}$

$$= \sqrt{a^2\sec^2\theta + b^2\operatorname{cosec}^2\theta}$$
$$= \sqrt{a^2 + b^2 + a^2\tan^2\theta + b^2\cot^2\theta}$$
$$= \sqrt{a^2 + b^2 + (a\tan\theta - b\cot\theta)^2 + 2ab}$$
$$= \sqrt{(a+b)^2 + (a\tan\theta - b\cot\theta)^2}$$
$$\geq a + b$$

Therefore, the correct answer is (2).

70.

Sol. (d)

$\left(\log_b a\right) < 0$ if $a > 1, 0 < b < 1$ (or) $0 < a < 1, b > 1$

Number of pairs $(a, b) = \left({}^9C_1 \times {}^9C_1\right) \times 2 = 162$

$\left(\log_b a\right) = 0$ if $a = 1, b \neq 1, b > 0$

Number of pairs $(a, b) = 18$

$\left(\log_b a\right) \leq 0 \Rightarrow$ number of ordered pairs $(a, b) = 180$

$\left(\log_b a\right) > 0$ if $a > 1, b > 1$ (or) $0 < a < 1, 0 < b < 1$

Number of ordered pairs $= (9 \times 9) \times 2 = 162$

Therefore, the correct answer is (D).

SECTION - II

71.

Sol. 24.

The arrangement can be done in ${}^4P_4 = 24$ ways.

72.

Sol. 252

Given $2^n = 1024$, \ $n = 10$

$\therefore$ The greatest coefficient is ${}^{10}C_5 = 252$.

73.

Sol: (1152)

$$\sum_{r=2}^{10} \frac{r(r-1)}{2} \cdot \frac{10!}{r!(10-r)!}$$
$$= \sum_{r=2}^{10} \frac{1}{2} \cdot \frac{10!}{(r-2)!(10-r)!}$$
$$= 45 \sum_{r=2}^{10} \frac{8!}{(r-2)!(10-r)!}$$
$$= 45 \sum_{r=2}^{10} {}^8C_{r-2}$$
$$= 45 \times ({}^8C_0 + {}^8C_1 + \ldots.. + {}^8C_8)$$
$$= 45 \times 2^8$$

74.

Sol: (6976)

Required number of ways = $10^5 - {}^{10}P_5 = 100000 - 10 \times 9 \times 8 \times 7 \times 6 = 69760$

75.

Sol. 11.