PAPER-1

PART-1 : PHYSICS — ANSWER KEY

SECTION-I	Q.	1	2	3	4	5	6	7	8	9	10
	A.	C,D	B,D	A,B	A,D	B,C	B,C	A,D	B,D	A,B	B,D
	Q.	11	12								
	A.	A,B,D	A,C,D								
SECTION-IV	Q.	1	2	3	4	5	6	7	8		
	A.	4	6	2	2	2	4	3	2		

SOLUTION

SECTION-I

1. Ans. (C,D)

Sol. $\frac{R}{L} = \frac{\rho}{\rho_w} \rightarrow$ same

$B = \rho V g_{eff}$

$p = p_0 + h\rho g_{eff}$

2. Ans. (B,D)

Sol. (A) $\mu mg = m\omega^2 r$

$= \alpha^2 r t^2$

$$t = \sqrt{\frac{\mu g}{\alpha^2 r}}$$

(C) $N = mr\alpha$

$\mu N = m\omega^2 r$

$\mu mr\alpha = m\omega^2 r$

$= \alpha^2 t^2$

$$t = \sqrt{\frac{\mu}{\alpha}}$$

3. Ans. (A,B)

Sol. $PV^{\gamma} = C \Rightarrow P \times \left(R^3\right)^{\frac{5}{3}} = C$

$TV^{2/3} = \text{constant}$

$T \times R^{3\times 2/3} = \text{constant}$

4. Ans. (A,D)

Sol. (A) $\frac{4\pi R_S^2 \sigma T_S^4}{4\pi d^2} \times \pi R_p^4 = 4\pi R_p^2 \sigma T_p^4$

$$T_p = T_s\sqrt{\frac{R_s}{2d}}$$

(C) $\frac{4\pi R_p^2 \times \sigma T_p^4}{4\pi d^2} \times \pi R_S^2 = \frac{dE}{dt}$

$$\frac{\pi R_S^2 \sigma T_S^4}{d^2} \times \frac{R_S^2}{4d^2}$$

5. Ans. (B,C)

Sol. (A) $2\pi a = \frac{\lambda}{4} \Rightarrow \lambda = \frac{340}{85} = 4m$

$\Rightarrow 2\pi a = 1$

$$a = \frac{1}{2\pi} m$$

(B) closed organ pipe

(C) Sealed end is PAN

$$2\pi a = \left(2\frac{1}{2}\right)\frac{\lambda}{2}$$

$$2\pi a = \frac{5\lambda}{4}$$

$$\lambda = \frac{8\pi a}{5}$$

$$\theta = \frac{\lambda}{2}, \lambda, \frac{3\lambda}{2}$$

$$\Rightarrow \theta = \frac{4\pi}{5}, \frac{8\pi}{5}$$

6. Ans. (B,C)

Sol. $Dx = 0.3 = n\lambda$

$$= n \times \frac{330}{f}$$

$$f = \frac{3300n}{0.3}$$

$$f_{max} = 20000$$

$$n = \frac{20000}{1100}$$

$$\Delta x = 0.3 = \left(n + \frac{1}{2}\right)\lambda$$

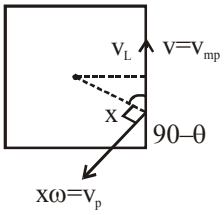
$$f = 1100\left(n + \frac{1}{2}\right)$$

$$n + \frac{1}{2} = 18.22$$

$\Rightarrow n = 0$ to 17

7. Ans. (A,D)

Sol.



$$v_m = v_{mp} + v_p$$

$$= \sqrt{v^2 + x^2\omega^2 + 2v\omega\cos(90+\theta)}$$

$$= \sqrt{v^2 + x^2\omega^2 - 2vx\omega\sin\theta}$$

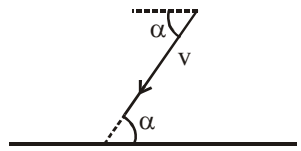
$$L_i = 0 = L_f$$

$$= -\frac{m}{12}\left(a^2 + a^2\right)\omega + m\left(v - x\omega\sin\theta\right)\frac{\alpha}{2}$$

$$\Rightarrow \frac{a^2}{6}\omega + \frac{a^2}{4}\omega = \frac{va}{2} \Rightarrow \omega = \frac{6v}{5a}$$

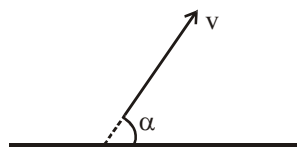
8. Ans. (B,D)

Sol.



Observer moving away from source.

$$\nu = \frac{C - v\sin\alpha}{C}\nu_0$$



Observer moving towards source.

$$\nu_1 = \frac{C - v\sin\alpha}{C}\nu_0$$

9. Ans. (A,B)

10. Ans. (B,D)

11. Ans. (A,B,D)

Sol. $p_0 + h_1\rho_1 g = p_0 + h_2\rho_1 g + h_3\rho_3 g$

12. Ans. (A,C,D)

Sol. $p_{in} = 10^5 + 5 \times 0.8 \times 10^3 \times 10 + 10 \times 10^3 \times 10$

$$= 10^5 + 4 \times 10^4 + 10^5$$

$$= 2.4 \times 10^5$$

$$p_{out} = 10^5 + 0.8 \times 15 \times 10^3 \times 10 = 2.2 \times 10^5$$

$$p_{out} + \frac{1}{2}\rho v^2 = p_{in}$$

$$\frac{1}{2} \times 10^3 \times v^2 = 0.2 \times 10^5$$

$v = \sqrt{40}$ m/s

$\sqrt{40} \times 10^{-6} = 100 \times 10^{-4}\ v_s$

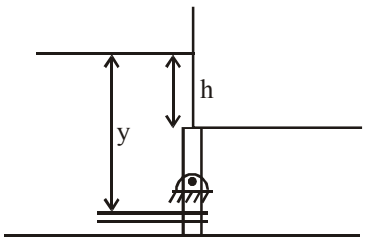
$v_s = \sqrt{40} \times 10^{-4}$ m/s

$= \sqrt{\frac{40}{10}}$ mm/s $= \sqrt{\frac{40}{100}}$ mm/s $= \sqrt{\frac{2}{5}}$ mm/s

SECTION-IV

1. Ans. 4

Sol.



$$\int_h^{h+2} \rho g y dy \times 6 \times \left(y - (h+1)\right)$$

$$= 10^4 \times 6\left[\frac{y^3}{3} - (h+1)\frac{y^2}{2}\Big|_h^{h+2}\right]$$

$$= 6\times10^4\left[\frac{1}{3}\left((h+2)^3 - h^3\right) - \frac{(h+1)}{2}\left((h+2)^2 - h^2\right)\right]$$

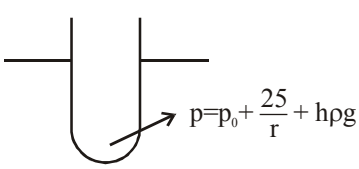
$$= 6\times10^4\left[\frac{1}{3}\left[6h^2 + \frac{6h}{12} + 8 - \frac{(h+1)}{2}\left[4^2h + 4^2\right]\right]\right]$$

$$= 6\times10^4\left[\frac{1}{3}\left(6h^2 + 12h + 8\right) - 2\left(h^2 + 2h + 1\right)\right]$$

$$= 6\times10^4\left[\frac{8}{3} - 2\right] = 4\times10^4\,\text{Nm}$$

2. Ans. 6

Sol.



$$\Delta p = \frac{25}{r} + h\rho g$$

$$= \frac{2\times7\times10^{-3}}{0.35\times10^{-3}} + 2\times10^{-2}\times10^4 = 240$$

$$\frac{\Delta p}{40} = 6$$

3. Ans. 2

Sol. $t_1 = \frac{2u\sin\theta}{g} \Rightarrow u = \frac{10}{2\sin\theta}$

$$-h = d\tan\theta - \frac{1}{2}g\frac{d^2}{u^2\cos^2\theta}$$

$$-10 = 10\tan\theta - \frac{1}{2}\times\frac{10\times10}{25}\tan^2\theta$$

$2\tan^2\theta - \tan\theta - 1 = 0$

$$\tan\theta = \frac{1\pm\sqrt{1+8}}{4} = \frac{1+3}{4}, \frac{1-3}{4} = 1, -\frac{1}{2}$$

4. Ans. 2

Sol $T_a = 2\pi\sqrt{\frac{2mR^2}{mgR}}$

$$T_b = 2\pi\sqrt{\frac{\frac{3}{2}mR^2}{mgR}} = \sqrt{3}$$

$$\Rightarrow 2\pi\sqrt{\frac{mR^2}{2mgR}} = 1$$

$T_a = 2$ sec

5. Ans. 2

Sol. $W = \Delta KE + \Delta H_{friction}$

as seen from belt frame

$$\Delta H_{friction} = \frac{1}{2}m\left(0^2 - v^2\right)$$

$\Rightarrow W = mv^2$

$= 0.5 \times 2^2 = 2J$

6. Ans. 4

Sol. $mg - N = ma = m\frac{\ell}{2}\alpha$

$$mg\frac{\ell}{2} = \frac{m\ell^2}{3}\alpha$$

$$\alpha = \frac{3g}{2\ell}$$

$$mg - \frac{m\ell}{2}\times\frac{3g}{2\ell} = N$$

$$N = \frac{mg}{4}$$

7. Ans. 3

Sol. $mv_0 = 2mv_2 + mv_1$

$e = 1 = \dfrac{v_2 - v_1}{v_0}$

$v_2 - v_1 = v_0$

$2v_2 + v_1 = v_0$

$3v_2 = 2v_0$

$v_2 = \dfrac{2v_0}{3}$

$\dfrac{1}{2}2mv_2^2 = \dfrac{1}{2}kd^2$

$v_2 = \sqrt{\dfrac{k}{2m}}d$

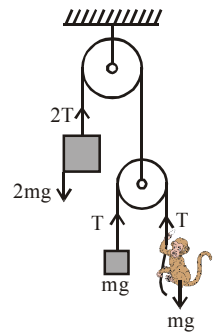
$v_0 = \dfrac{3}{2}d\sqrt{\dfrac{k}{2m}}$

$= \dfrac{3}{2} \times 0.1\sqrt{\dfrac{400}{0.5 \times 2}}$

$v_0 = 3$

8. Ans. 2

Sol.



$T - mg = ma_b = ma_m$

$2T - 2mg = 2ma_B$

$\Rightarrow a_B = a_b = a_m \Rightarrow v_B = v_b = v_m = v$

$v_p = -v$

$v_R - v_b = 2v_p$

$v_R = -2v - v = -3v$

$v_{mR} = v - (-3v) = 4v = 8$

PART-2 : CHEMISTRY — ANSWER KEY

	Q.	1	2	3	4	5	6	7	8	9	10
SECTION-I	A.	C	B	A,B,D	A,D	A	A,C,D	B	A,D	C	D
	Q.	11	12								
	A.	C	C								
SECTION-IV	Q.	1	2	3	4	5	6	7	8		
	A.	1	6	4	9	2	1	3	5		

SOLUTION

SECTION - I

1. Ans. (C)

$282 \times \dfrac{33.33}{100} = 96 \Rightarrow$ 3 'S' atoms per molecule.

2. Ans. (B)

$H_2 + Br_2 \rightleftharpoons 2HBr$

aM aM –

a -x a-x 2x

$= \dfrac{25.92/81}{20} = \dfrac{0.32}{20} = 0.016\,M$

$64 = \dfrac{(2x)^2}{(a-x)^2}$

$8a - 0.064 = 0.016$

$8a = 0.08$

$a = 0.01$ M

$n_{H_2} = 0.01 \times 20 = 0.2$ mol $\equiv 0.4$ gm

$n_{Br_2} = 0.01 \times 20 = 0.2$ mol $\equiv 32$ gm

3. Ans. (A, B, D)

(A) $P \times 1 = 5 \times 0.08 \times 320 \Rightarrow P = 128$ atm

(B) $\left(P + \dfrac{4 \times 5^2}{1^2}\right)(1 - 0) = 5 \times 0.08 \times 320$

$\Rightarrow P = 28$ atm

(C) $\left(P + \dfrac{4 \times 5^2}{12}\right)(1 - 0.04 \times 5) = 128 \Rightarrow P = 60$ atm

(D) $P\,(1 - 0.04 \times 5) = 128 \Rightarrow P = 160$ atm

4. Ans.(A, D)

$$4H^+ + 3MnO_4^- + 5Mo^{3+} \rightarrow 3Mn^{2+} + 5\overset{+6}{M}o\ O_2^{2+}$$

20 ml $\quad n_f = 3$

0.2M $\quad$ 0.5 M

(nf = 5) $\quad$ 10 ml

$$H_2O + 2\overset{+7}{M}nO_4^- + \overset{-1}{I^-} \longrightarrow IO_3^- + 2\overset{+4}{M}nO_2 + 2OH^-$$

0.1N

1 mmol $\quad$ 0.5 mmol

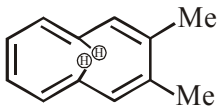
($n_f = 3$) $\quad n_f = 6$

V = 30 ml

5. Ans. (A)

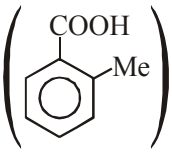
6. Ans. (A,C,D)

7. Ans. (B)



Non-planar, therefore conjugation over complete ring isn't possible.

8. Ans. (A,D)

Ortho substituted benzoic acid 

is most acidic

$\overset{4}{C}H_3-\overset{3}{C}H_2-\overset{2}{C}H_2-\overset{1}{C}ONH_2$ & $\overset{3}{C}H_3-\overset{2}{C}H(\underset{1}{C}ONH_2)-CH_3$: Chain isomer

9. Ans.(C)

$$Fe^{3+}(aq) + 3H_2C_2O_4 \rightleftharpoons [Fe(C_2O_4)_3]^{3-} + 6H^+$$

$$Hg^{2+} + 4SCN^- \rightleftharpoons [Hg(SCN)_4]^{2-}$$

10. Ans.(D)

For exothermic equilibrium on increasing temperature Keq decreases.

11. Ans. (C)

12. Ans. (C)

Phenol, Alcohol , 2º-amine, Ketone, Cyclic amide

SECTION - IV

1. Ans. (307)

OMR ANS (1)

$$2C_{10}H_{17}N_3O_6\overset{-2}{S} \longrightarrow C_{20}H_{32}N_6O_{12}\overset{-1}{S} + 2H^+ + 2e^-$$

($n_f = 1$)

2. Ans. (6)

3. Ans. (4)

Except 3, 5 & 7 all are correct

4. Ans. (9)

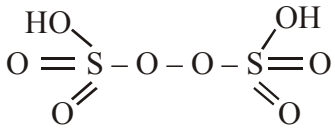
$$\frac{6.4}{1.6\times10^{-19}} = \frac{1240}{310}\times N \Rightarrow N = 10^{19}.$$

$$\text{Q. E.} = \frac{9\times10^{17}}{10^{19}}\times100 = 9\%$$

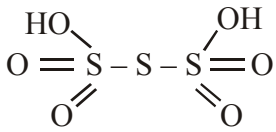
5. Ans. (2)

6. Ans. (1)

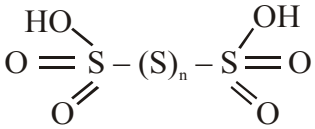
$X = H_2S_2O_8$ peroxodisulphuric acid



$Y = H_2S_3O_6$ trithionic acid



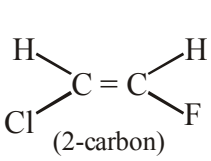
$Z = H_2S_{n+2}O_6$



7. Ans. (3)

8. Ans. (5)

b , c , e , f , h



Show G.I.

$\overset{3}{C}H_3-\overset{2}{C}H(\underset{1}{C}H_3)-OCH_3$ & $\overset{3}{C}H_3-\overset{2}{C}H_2-\overset{1}{C}H_2-OCH_3$:

Position isomer

PART-3 : MATHEMATICS — ANSWER KEY

	Q.	1	2	3	4	5	6	7	8	9	10
SECTION-I	A.	B,C	A,B,C	A,B,C	A,B,C	A,B,C,D	A,B,C,D	A,B,D	A,B	B	A,B
	Q.	11	12								
	A.	A,C	B								
SECTION-IV	Q.	1	2	3	4	5	6	7	8		
	A.	5	7	0	7	2	2	2	3		

SOLUTION

SECTION-I

1. Ans. (B,C)

$\cos^2 x = \sin x$

$\cos^4 x = 1 - \cos^2 x$

$\cos^4 x + \cos^2 x - 1 = 0$

$$\cos^2 x = \frac{-1+\sqrt{5}}{2}$$

$$\frac{1}{\sin x} + \cos^4 x = \frac{1}{\cos^2 x} + \cos^4 x$$

$$= \frac{2}{\sqrt{5}-1} + \frac{3-\sqrt{5}}{2} = \frac{\sqrt{5}+1}{2} + \frac{3-\sqrt{5}}{2} = 2$$

(B) & (C) are correct.

2. Ans. (A,B,C)

$$f(n) = \sum_{n=1}^{n} \tan^{-1}\left(\frac{2.3^{n-1}}{1+3^n.3^{n-1}}\right)$$

$$= \sum_{n=1}^{n} \tan^{-1}(3^n) - \tan^{-1}(3^{n-1})$$

$$f(n) = \tan^{-1} 3^n - \frac{\pi}{4}$$

Now check option.

3. Ans. (A,B,C)

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

$$x + 1 = \tan\theta \quad \left(-\frac{\pi}{2} < \theta < \frac{\pi}{2}\right)$$

$$y = \cos^{-1}\cos 2\theta$$

$$= \begin{cases} -2\tan^{-1}(x+1), & x < -1 \\ 2\tan^{-1}(x+1), & x \ge -1 \end{cases}$$

4. Ans. (A,B,C)

5. Ans. (A,B,C,D)

$$r_n = \frac{n}{r^{n-1}}$$

$$f(r) = 1 + \frac{2}{r} + \frac{3}{r^2} + \frac{4}{r^3} + ...\infty \qquad .....(1)$$

$$\frac{f(r)}{r} = \frac{1}{r} + \frac{2}{r^2} + \frac{3}{r^3} + ...\infty \qquad .....(2)$$

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

Now check options.

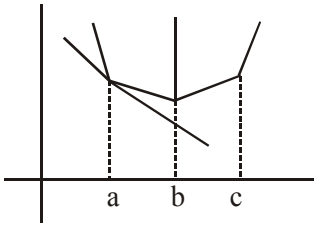
6. Ans. (A,B,C,D)

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

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

Now check options.

7. Ans. (A,B,D)



By compairing the slopes, condition in problem is satisfied for $(a, b+c-2a)$ to lie on the line. Putting in line we get

$b + c = 2003$

$b_{max} = 1004$

$c_{min} = 1002$

8. Ans. (A,B)

Let P denotes total number of ways of selecting even number of red balls and Q denotes total number ob ways of selecting odd number of red balls.

$(2-1)(4-1)(6-1)(8-1)(10-1) = P - Q$

$(2+1)(4+1)(6+1)(8+1)(10+1) = P + Q$

Now solve to get P & Q.

Paragraph for Question 9 to 10

$N = 2^a 3^b 5^c 7^d$

$$a = \sum_{m=2}^{10}\sum_{n=1}^{\infty}\left[\frac{m}{2^n}\right] = 38$$

similarly b = 17, c = 7, d = 4

$N = 2^{38}\ 3^{17}\ 5^7\ 7^4$

obviously $P = 7$

$Q = 13 \times 6 \times 3 \times 2$

$= 2^2.3^2 \times 13'$

9. Ans. (B)

10. Ans. (A,B)

Paragraph for Question 11 to 12

$$y = \sqrt[3]{x+\sqrt{x^2+1}} + \sqrt[3]{x-\sqrt{x^2+1}}$$

Image in y = x & then cubing

$$x^3 = \left(\sqrt[3]{y+\sqrt{y^2+1}} + \sqrt[3]{y-\sqrt{y^2+1}}\right)^3$$

$x^3 = 2y + 3(-1)x$

$$f^{-1}(x) = \frac{x^3+3x}{2}$$

11. Ans. (A,C)

12. Ans. (B)

SECTION-IV

1. Ans. 5

Replace x by 1 – x f solve to get $f(x)$

2. Ans. 7

$H_1 - H_2 - H_3 - H_4 = \lfloor 4 = 24$

$\boxed{H_1H_2} - H_3 - H_4 = {}^4C_2 \lfloor 3 = 36$

$\boxed{H_1H_2} - \boxed{H_3H_4} = \frac{{}^4C_2}{2}\lfloor 2 = 6$

$\boxed{H_1H_2H_3} - H_4 = {}^4C_3 . \lfloor 2 = 8$

$H_1H_2H_3H_4 = 1 \Rightarrow 75$

3. Ans. 0

$$s = \sum_{r=1}^{3}\frac{\cos(2.3^{r-1}\theta)}{\sin 3^r\theta} \qquad \left(\theta = \frac{\pi}{28}\right)$$

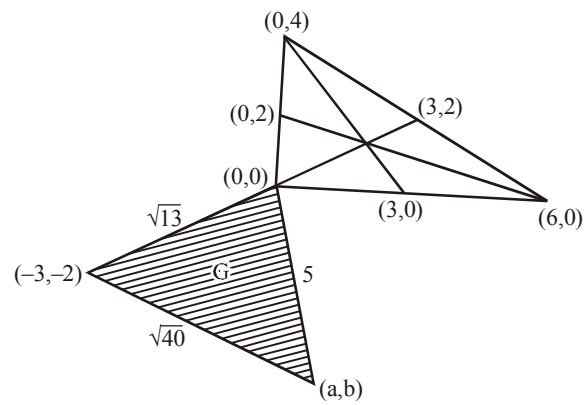
$$\Rightarrow \quad s = \sum_{r=1}^{3}\frac{\sin(3^{r-1}\theta)\cos(2.3^{r-1}\theta)}{\sin(3^r\theta)\sin(3^{r-1}\theta)}$$

$$= \frac{1}{2}\sum_{r=1}^{3}\frac{\sin 3^r\theta - \sin 3^{r-1}\theta}{\sin 3^r\theta \sin 3^{r-1}\theta}$$

$$S = \sum_{r=1}^{3}\operatorname{cosec}(3^{r-1}\theta) - \operatorname{cosec}(3^r\theta)$$

$$= \operatorname{cosec}\theta - \operatorname{cosec}27\theta = 0 \quad \{\because\ \theta + 27\theta = \pi\}$$

4. Ans. 7



$a^2 + b^2 = 25$ .....(1)

$(a+3)^2 + (b+2)^2 = 40$

$6a + 4b = 2$ .....(2)

Solving (1) & (2)

possible value of a is 3

$\Rightarrow$ b = 4

$$\frac{G}{S} = \frac{3}{4}$$

5. Ans. 2

$$\left.\begin{array}{l} 2f(x) + f\left(\dfrac{x+1}{x-1}\right) = x \\ x \to \dfrac{x+1}{x-1} \\ \Rightarrow f(x) + 2f\left(\dfrac{x+1}{x-1}\right) = \dfrac{x+1}{x-1} \end{array}\right\} \begin{array}{l} \text{Solving} \\ 3f(x) = 2x - \dfrac{x+1}{x-1} \\ 3f(x) + \dfrac{x+1}{x-1} = 2x \\ \Rightarrow \lambda = 2 \end{array}$$

6. Ans. 2

$y = \sin^2\alpha(1-\sin^2\alpha)^3$

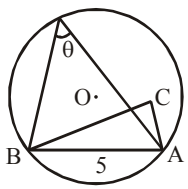
$y = t(1-t)^3 \qquad 0 < t \le 1$

$$\frac{t+\frac{3(1-t)}{3}}{4} \ge \sqrt[4]{\frac{t(1-t)^3}{27}}$$

$$\frac{t(1-t)^3}{27} \le \frac{1}{4^4}$$

$$t(1-t)^3 \le \frac{3^3}{256}$$

7. Ans. 2

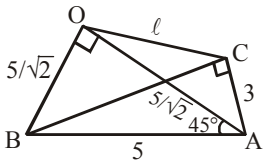


$$\frac{5}{2\sin\theta} = \frac{5}{\sqrt{2}}$$

$\theta = 45°$

$\Rightarrow$ BOA = 90°

ACO = 135°



$$-\frac{1}{\sqrt{2}} = \frac{9+\ell^2-\frac{25}{2}}{6\ell}$$

$$-3\sqrt{2}\ell = \ell^2 - \frac{7}{2}$$

$$\ell^2 + 3\sqrt{2}\ell - \frac{7}{2} = 0$$

$$\ell = \frac{-3\sqrt{2}+\sqrt{18+14}}{2} = \frac{1}{\sqrt{2}}$$

8. Ans. 3

$s = (1+x)^{1000} + 2x(1+x)^{999} + 3x^2(1+x)^{998} + \ldots\ldots + 1001x^{1000}(1+x)^0$

$$\frac{xs}{(1+x)} = x(1+x)^{999} + 2x^2(1+x)^{998} + \ldots\ldots + 1001x^{1000} + \frac{1001+x^{1001}}{(1+x)}$$

$$\frac{s.1}{(1+x)} = (1+x)^{1000} + x(1+x)^{999} + \ldots\ldots + x^{1000}(1+x)^0 - \frac{1001x^{1001}}{(1+x)}$$

$$\frac{s}{(1+x)} = (1+x)^{1000}\left\{\frac{\left(\frac{x}{1+x}\right)^{1001}-1}{\frac{x}{1+x}-1}\right\} - \frac{1001x^{1001}}{(1+x)}$$

$$\frac{s}{(1+x)} = \frac{x^{1001}-(1+x)^{1001}}{-1} - \frac{1001x^{1001}}{(1+x)}$$

$s = (1+x)^{1002} - x^{1001}(1+x) - 1001x^{1001}$

coeff. of $x^{50} = {}^{1002}C_{50}$