

RITS-47
JEE ADVANCED-2019
ANSWER KEY
Code: 120407

MATHEMATICS		CHEMISTRY		PHYSICS	
1	ABC	1	AC	1	BC
2	AB	2	BC	2	ABD
3	AC	3	ABC	3	ABC
4	BD	4	ABCD	4	AC
5	BD	5	ABD	5	BD
6	CD	6	CD	6	BCD
7	AB	7	ABCD	7	BD
8	B	8	B	8	C
9	C	9	D	9	B
10	A	10	D	10	D
11	D	11	C	11	B
12	A	12	B	12	D
13	D	13	A	13	A
1	2	1	3	1	9
2	3	2	6	2	4
3	3	3	1	3	2
4	3	4	6	4	5
5	5	5	1	5	6

PAPER-1

PART-1 : PHYSICS

SOLUTION

SECTION-I

1. Ans. (A,B,C)

$$\text{Sol. } Q = \frac{h^2}{24m\lambda^2} = K_B + K_C$$

where k is the kinetic energy

From conservation of linear momentum

$$|\vec{P}_C| = |\vec{P}_B| = P$$

$$\therefore K = \frac{P^2}{2m} \therefore Q = \frac{P^2}{2 \times 12m} + \frac{P^2}{2 \times 4m}$$

$$\frac{h^2}{24m\lambda^2} = \frac{P^2}{2} \left(\frac{1}{12m} + \frac{1}{4m} \right)$$

$$\frac{h^2}{12m\lambda^2} = P^2 \left(\frac{1+3}{12m} \right) = \frac{P^2}{3m}$$

$$\Rightarrow P^2 = \frac{h^2 \times 3m}{12m\lambda^2} \Rightarrow P = \frac{h}{2\lambda}$$

$$\Rightarrow \frac{h}{P} = 2\lambda = \text{de Broglie wavelength}$$

$$\therefore |\vec{P}_B| = |\vec{P}_C|$$

$$\text{Mass defect, } \Delta m = \frac{Q}{C^2} = \frac{h^2}{24mc^2\lambda^2}$$

$$\therefore m_A = 20m + \frac{h^2}{24mc^2\lambda^2}$$

2. Ans. (A, B)

$$\text{Sol. } qV = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{2qV}{m}}$$

Now,

$$r = \frac{mv}{qB} = \frac{m}{qB} \cdot \sqrt{\frac{2q}{m}} \cdot V$$

$$r \propto \sqrt{\frac{m}{q}}$$

Hence, A and B are connected ans.

3. Ans. (A,C)

4. Ans. (B,D)

$$\text{Sol. } \rho gh = S \left(\frac{1}{r_1} + \frac{1}{r_2} \right)$$

$$\rho gh = S \left(\frac{1}{r} + \frac{1}{\infty} \right)$$

$$R = \frac{S}{\rho gh}$$

5. Ans. (B,D)

$$\text{Sol. } KE_i = \frac{1}{2}m\omega^2(R+a)^2 + \frac{1}{2}m\omega^2(R-a)^2$$

$$= \frac{1}{2}m\omega^2(2R^2 + 2a)^2$$

$$= m\omega^2(R^2 + a^2)$$

6. Ans. (C, D)

$$\text{Sol. } \frac{dA}{dt} = \frac{L}{2m}$$

$$KE_i = \frac{GMm}{2r}$$

$$U_i = -\frac{GMm}{r}$$

$$TE_i = -\frac{GMm}{2r}$$

$$KE_f = \frac{6}{5} \frac{GMm}{2r}$$

$$V_f = \sqrt{\frac{6}{5} \frac{Gm}{r}}$$

MEC

$$\frac{1}{2} m \frac{6}{5} \frac{GM}{R} - \frac{Gmm}{R} = \frac{1}{2} mv_a^2 - \frac{GMm}{r_a}$$

AMC

$$m \sqrt{\frac{6}{5} \frac{Gm}{R}} R = mv_a r_a$$

7. Ans. (A,B)

Sol. Least count = $\frac{\text{Pitch}}{\text{Number of division}} = \frac{0.5}{50} = 0.01 \text{ mm}$

Zero correction = $| (50 - 46) \times \text{L.C} | = 0.04 \text{ mm}$

8. Ans. (B)

Sol. For maxima

$$y = \frac{n\lambda D}{d} = \frac{n \times 600 \times 10^{-9} \times 1}{2 \times 10^{-3}} = n \times 3 \times 10^{-4} \quad [D = 1 \text{ m}, d = 2 \text{ mm}]$$

For $n = 4$

$y = 1.2 \times 10^{-3} \text{ m} = 1.2 \text{ mm}$

9. Ans. (C)

Sol. For minima

$$y = \frac{(2n+1)\lambda D}{2d} = \frac{2n+1}{2} \times \frac{600 \times 10^{-9} \times 2}{1.5 \times 10^{-3}} = (2n+1) \times 4 \times 10^{-4}$$

$y = 1.2 \text{ mm}$ for $n = 1$

10. Ans. (A)

$$\text{Sol. } y_5 = \frac{5\lambda D}{d}$$

Putting the values we get options 'A' as answer

11. Ans. (D)

12. Ans. (A)

13. Ans. (D)

Sol. Charge flow till time $t = q = C_{eq} E \left(1 - e^{-\frac{t}{RC}} \right)$

Charge on left plate of $C_2 = q_1 + q = Q$
Force between both plates of

$$C_2 = F = \frac{(q_1 + q)(q_1 - q)}{2A \epsilon_0}$$

$$F = \frac{(q_1 + q)(q_1 - q)}{2cd} = \frac{q_1^2 - q^2}{2cd}$$

Energy stored in capacitor

$$U = \frac{q^2}{2C}$$

For question no. 1

$$\tau = RC \text{ and } q = \frac{CE}{2} \left(1 - e^{-\frac{RC/n^2}{RC}} \right) = \frac{CE}{4} \text{ and}$$

$$Q = \frac{CE}{2}$$

For question no. 2

$$\tau = \frac{4RC}{3} \text{ and } q = \frac{2CE}{3} \left(1 - e^{-\frac{2\ell n^2}{4RC}} \right) = \frac{CE}{2}$$

for question no. 3

$$\tau = \frac{4RC}{3} \text{ and } q = \frac{2CE}{3} \left(1 - e^{-\frac{\ell n^2}{2RC}} \right) = \frac{CE}{3}$$

SECTION-III

1. Ans. 2

Sol. Water equivalent = $2 + \frac{2T}{100}$

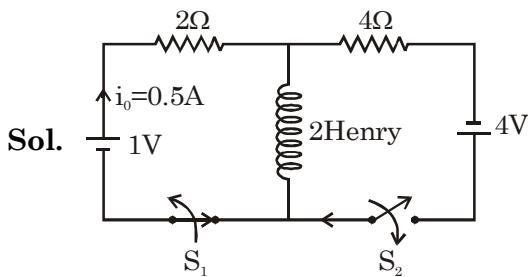
$$Q_2 = \int dQ = \int \left(2 + \frac{2T}{100} \right) dT$$

For water

$$Q_1 = 6(1)(100 - 0)$$

$$\frac{Q_1}{Q_2} = 2$$

2. Ans. 3



$$i_0 = 0.5 \text{ A}$$

When; S_2 is closed;

$$-L \frac{di}{dt} - 4i + 4 = 0$$

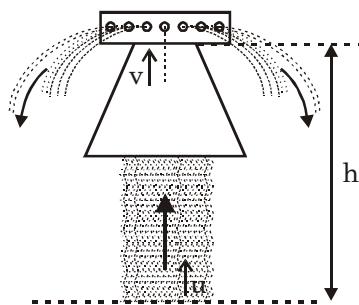
$$-2 \frac{di}{dt} - 4i_0 + 4 = 0$$

$$-2 \frac{di}{dt} + 4 \times 0.5 + 4 = 0 \quad [\because i_0 = -0.5 \text{ A}]$$

$$\frac{di}{dt} = 3$$

3. Ans. 3

$$\text{Sol. } \frac{1}{2}mu^2 = mg \times 8$$



$$\Rightarrow u^2 = 16g \quad \dots \text{(i)}$$

$$\frac{1}{2}mu^2 = mgh + \frac{1}{2} \times 8mv^2$$

$$v^2 = u^2 - 2gh$$

$$v = \sqrt{16g - 2gh} \quad \dots \text{(ii)}$$

Now;

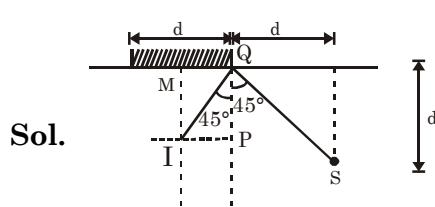
$$v \frac{dm}{dt} = mg$$

$$\Rightarrow \sqrt{16g - 2gh} \times 0.2 = 0.2 g$$

$$\Rightarrow 16g - 2gh = g^2$$

$$\Rightarrow 16 - 2h = g \Rightarrow h = 3 \text{ m}$$

4. Ans. 3



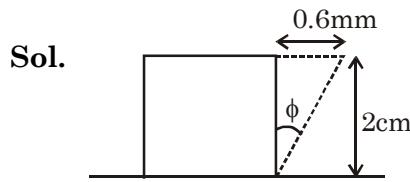
$$\tan 45^\circ = \frac{PI}{PQ}$$

$$\Rightarrow PQ = PI = d/2$$

$$\Rightarrow PQ = \frac{6}{2}$$

$$\Rightarrow PQ = 3 \text{ m}$$

5. Ans. 5



$$n = \frac{\text{stress}}{\text{strain}} = \frac{\mu N}{A} = \frac{\frac{0.6 \times 5}{4 \times 10^{-4}}}{\frac{0.6 \times 10^{-3}}{\phi}} = \frac{0.6 \times 5}{2 \times 10^{-2}}$$

$$= \frac{0.6 \times 5}{4 \times 10^{-4}} \times \frac{2 \times 10^{-2}}{0.6 \times 10^{-3}}$$

$$n = 2.5 \times 10^5 \text{ Pa}$$

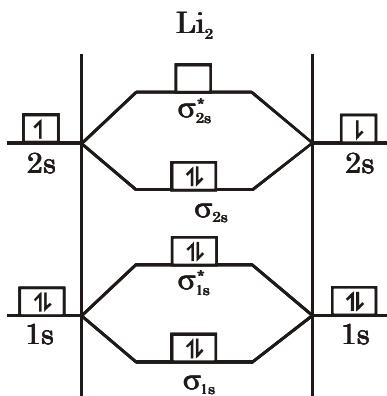
$$\therefore x = 2.5$$

$$2x = 5$$

SECTION-I

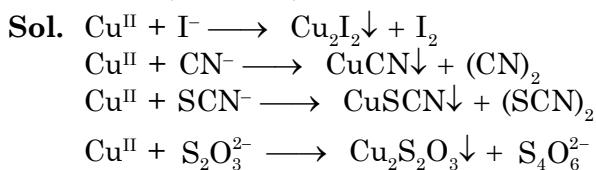
1. Ans. (A,C)
2. Ans. (B,C)
3. Ans. (A, B, C)

Sol.

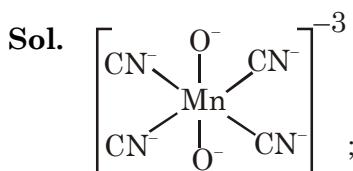


$\sigma^*_{2s} \left(\begin{array}{c} (+ \cdot) \\ (- -) \end{array} \right)$ M.O. is vacant in ground state

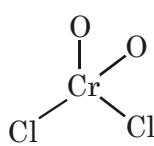
4. Ans. (A,B,C,D)



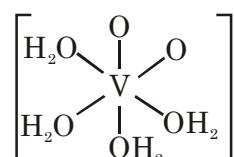
5. Ans.(A,B,D)



Paramagnetic
Angle $\rightarrow 180^\circ$
Oxidation State = +5



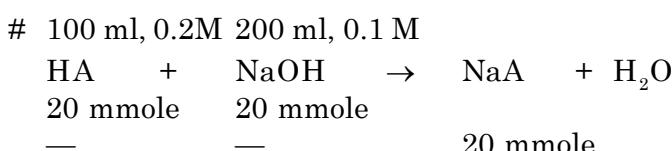
Diamagnetic
Angle $\approx 109^\circ$
Oxidation State = +6



Diamagnetic
Angle $\approx 90^\circ$
Oxidation State = +5

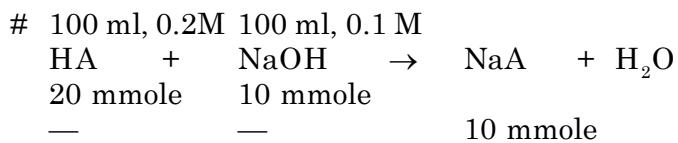
6. Ans. (C,D)
7. Ans. (A,B,C,D)
8. Ans. (B)
9. Ans. (D)
10. Ans. (D)

Solution for Q. No. 8, 9 and 10

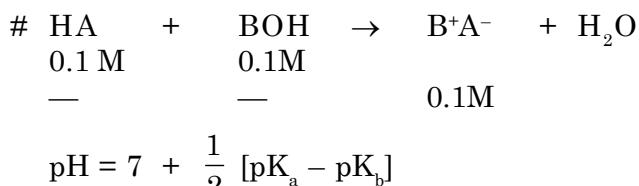
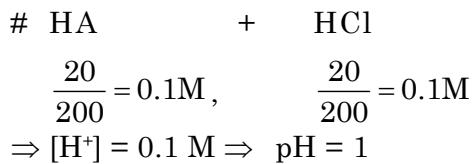


$$a_0 = \frac{20}{300} = \frac{1}{15} \text{ M}$$

$$\text{pH} = 7 + \frac{1}{2} [5 - \log 15] = 7 + \frac{1}{2} [5 - 0.7 - 0.48]$$

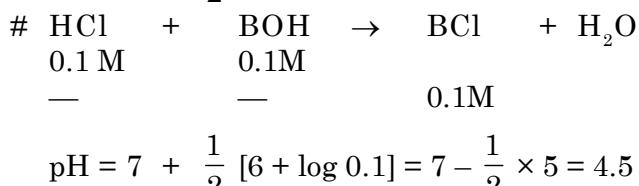


$$\text{pH} = 5 + \log \frac{10}{10} = 5$$



$$\text{pH} = 7 + \frac{1}{2} [\text{pK}_a - \text{pK}_b]$$

$$\text{pH} = 7 + \frac{1}{2} [5 - 6] = 6.5$$



$$\text{pH} = 7 + \frac{1}{2} [6 + \log 0.1] = 7 - \frac{1}{2} \times 5 = 4.5$$

11. Ans.(C)
12. Ans.(B)
13. Ans.(A)

SECTION-III

1. Ans.(75) OMR ANS (3)

$$K = Ae^{-\left(\frac{E_a}{R \times 500}\right)} = Ae^{-\left(\frac{E_a - 30}{R \times 300}\right)}$$

$$\Rightarrow \frac{E_a}{5} = \frac{E_a - 30}{3}$$

$$\Rightarrow 3E_a = 5E_a - 150$$

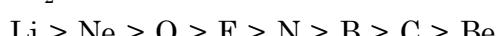
$$E_a = 75 \text{ kJ/mole}$$

2. Ans.(6)

Sol. $\text{Al}_2\text{Cl}_6, \text{Be}_2\text{Cl}_4, \text{I}_2\text{Cl}_6, \text{B}_2\text{H}_6, \text{Na}_2[\text{Pt}_2\text{Cl}_6], (\text{BeH}_2)_n$

3. Ans.(1)

Sol. IE₂ order



$$n = 1$$

4. Ans.(6)

Sol. conc. H_2SO_4 , conc. HNO_3 , Cl_2 water, $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$, KMnO_4/H^+ , Δ with PbO_2/H^+

5. Ans.(1)

PART-3 : MATHEMATICS

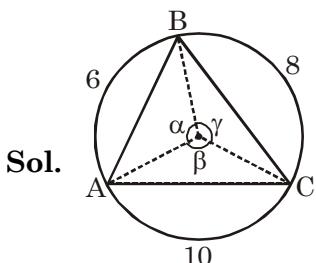
SOLUTION

SECTION-I

1. Ans. (B,C)

Sol. $|2A^3| = 2^{12} \Rightarrow |A|^3 = 2^9 \Rightarrow |A| = 8$
 $\Rightarrow (\alpha + \beta)^2(\alpha - \beta) = 8$
 $(\alpha + \beta)^2 = 4 \text{ & } \alpha - \beta = 2$
 $\Rightarrow \alpha + \beta = \pm 2 \text{ and } \alpha - \beta = 2$
 $\Rightarrow \alpha = 2, \beta = 0 \text{ or } \alpha = 0, \beta = -2$

2. Ans. (A,B,D)



Sol. $6 + 8 + 10 = 2\pi R \Rightarrow R = \frac{12}{\pi}$

$$\& \alpha = \frac{6}{R} = \frac{\pi}{2}, \beta = \frac{10}{R} = \frac{5\pi}{6}, \gamma = \frac{8}{R} = \frac{2\pi}{3}$$

$$\Rightarrow \angle A = \frac{\gamma}{2} = \frac{\pi}{3}, B = \frac{\beta}{2} = \frac{5\pi}{12}, C = \frac{\alpha}{2} = \frac{\pi}{4}$$

Area of $\triangle ABC$

$$= \frac{1}{2} R^2 \sin \alpha + \frac{1}{2} R^2 \sin \beta + \frac{1}{2} R^2 \sin \gamma$$

$$= \frac{72}{\pi^2} \left(1 + \frac{1}{2} + \frac{\sqrt{3}}{2} \right) = \frac{36(3 + \sqrt{3})}{\pi^2}$$

3. Ans. (A,B,C)

Sol. $f(t)$ is periodic with period 20.

(A) $\int_{5}^{65} f(t) dt = \int_{0}^{60} f(t) dt = 3I$

(B) $\int_{40}^{100} f(t) dt = 3 \int_{0}^{20} f(t) dt = 3I$

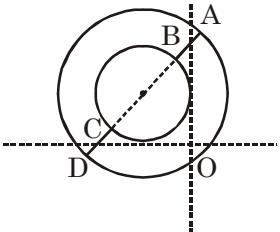
(C) $\because f(x) = f(x + 20)$
 $\therefore f(0) = f(20)$
 $\therefore f'(x) = 0$ has atleast one root in $(0, 20)$

4. Ans. (A,C)

Sol. $a = (x + 2 + iy)(x - iy + 2i)$
 $= (x + 2)x + y(y - 2) + i(2x - 2y + 4)$
 $\therefore a$ is purely real

$$\therefore x - y + 2 = 0 \text{ & } -1 \leq x^2 + y^2 + 2x - 2y \leq 2$$

$$\Rightarrow 1 \leq (x + 1)^2 - (y - 1)^2 \leq 4$$



$$|z|_{\max} = OA = \sqrt{2+4} = \sqrt{6}$$

$$|z|_{\min} = OB = \sqrt{2+1} = \sqrt{3}$$

5. Ans. (B,D)

Sol. $\alpha + \frac{\beta^2}{\alpha} = \frac{(\alpha + \beta)^2 - 2\alpha\beta}{\alpha} = \frac{a^2 - 2b}{\alpha}$

quadratic whose roots are

$$\frac{a^2 - 2b}{\alpha} \text{ & } \frac{a^2 - 2b}{\beta} \text{ is}$$

$$\left(\frac{a^2 - 2b}{x} \right)^2 - a \left(\frac{a^2 - 2b}{x} \right) + b = 0$$

$$\Rightarrow bx^2 - a(a^2 - 2b)x + (a^2 - 2b)^2 = 0$$

compare with $bx^2 - 4x + 4 = 0$

$$\Rightarrow a^2 - 2b = \pm 2 \text{ & } a(a^2 - 2b) = 4$$

$$\begin{cases} a = 2 \text{ & } b = 1 \\ a = -2 \text{ & } b = 3 \end{cases}$$

6. Ans. (B,C,D)

Sol. $y = mx - 6 + 4m$ is tangent to $y^2 = 4ax$

$$\Rightarrow -6 + 4m = \frac{a}{m}$$

$$\Rightarrow 4m^2 - 6m - a = 0 \begin{cases} m_1 \\ m_2 \end{cases}$$

$$\frac{1}{m_1} + \frac{1}{m_2} = -\frac{3}{2} \Rightarrow \frac{6}{-a} = -\frac{3}{2} \Rightarrow a = 4$$

$$(B) 2m^2 - 3m - 2 = 0 \begin{cases} m_1 = 2 \\ m_2 = -\frac{1}{2} \end{cases}$$

(D) Slope of normal at one end of focal chord is equal to slope of tangent at other end.

7. Ans. (B,D)

$$\text{Sol. } \left(\frac{d^2y}{dx^2} \right)^2 = \left(\frac{dy}{dx} \right)^2$$

$$\Rightarrow \frac{d^2y}{dx^2} = \pm \frac{dy}{dx}$$

$$\Rightarrow f(x) = e^x + 1 \text{ & } g(x) = 3 - e^{-x}$$

$$\begin{aligned} \text{Area} &= \int_0^{\ln 2} (e^x + 1 - (3 - e^{-x})) dx \\ &= (e^x - e^{-x} - 2x) \Big|_0^{\ln 2} = \left(\frac{3}{2} - \ln 4 \right) \end{aligned}$$

Solution for Q. No. 8, 9 and 10

$$(I) \quad f(x) = x^2 \ln x$$

$$f'(x) = x + 2x \ln x$$

$$\begin{array}{c} \text{--- --- + + + +} \\ \text{--- --- + + + +} \\ \hline e^{-\frac{1}{2}} \text{ min} \end{array}$$

$$(II) \quad f(x) = e^2 \ln x \text{ strictly increasing}$$

$$\forall x > 0$$

$$(III) \quad h(x) = \sin(\ln x) + \cos(\ln x)$$

$$h'(x) = \frac{\cos(\ln x) - \sin(\ln x)}{x}$$

$$\begin{array}{ccccccccc} + + + + + + + + & - - - & + + + \\ e^{-\pi/4} & e^{-1/2} & e^{-1/3} & e^{1/2} & e^{\pi/4} & e^{5\pi/4} & e^{2\pi} \\ \text{max} & & & \text{min} & & & \end{array}$$

$$(IV) \quad p(x) = (x^2 - 3e) e^{\ln x} = x(x^2 - 3e)$$

$$p'(x) = (3x^2 - 3e)$$

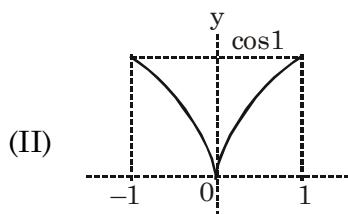
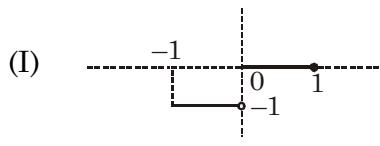
$$\begin{array}{c} \text{--- --- + + +} \\ \text{--- --- + + +} \\ \hline 0 & e^{1/2} \\ \text{min} & \end{array}$$

8. Ans. (C)

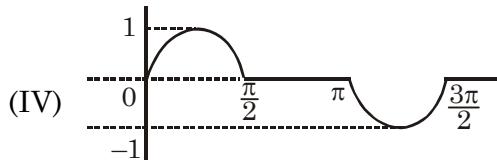
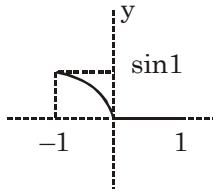
9. Ans. (B)

10. Ans. (D)

Solution for Q. No. 11, 12 and 13



$$(III) \quad h(x) = [x] \sin x = \begin{cases} -\sin x & -1 \leq x < 0 \\ 0 & 0 \leq x < 1 \end{cases}$$



11. Ans (B)

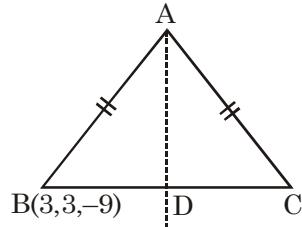
12. Ans (D)

13. Ans (A)

SECTION-III

1. Ans. 9

Sol. Let D is $(\lambda + 1, 2\lambda + 2, 3\lambda - 3)$



$$\vec{BD} \cdot (\hat{i} + 2\hat{j} + 3\hat{k}) = 0 \Rightarrow \lambda = -1$$

\therefore D is mid point of BC

\therefore C is $(-3, -3, -3)$

2. Ans. 4

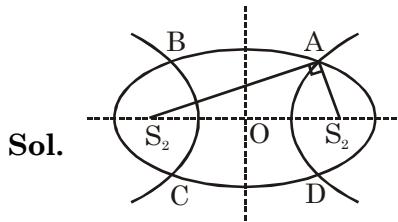
Sol. Locus of $(\mu - 1, \mu + 3)$ is $y - x = 4$

centre is always $\left(\frac{\lambda}{2}, \frac{\lambda}{2} \right)$ & $r = \frac{|\lambda|}{\sqrt{2}}$

If points are concyclic, then line $y - x = 4$ must be chord/tangent of circle

$$\Rightarrow \frac{4}{\sqrt{2}} \leq \frac{|\lambda|}{\sqrt{2}} \Rightarrow |\lambda| \geq 4$$

3. Ans. 2



Sol.

$$\begin{aligned}
 AS_1 + AS_2 &= 2a = 10 \\
 AS_2 - AS_1 &= 2A = 6 \\
 AS_2 &= 8 \quad \& \quad AS_1 = 2 \quad \& \quad S_1 S_2 = \sqrt{68} \\
 \text{for ellipse } 2ae_1 &= 2\sqrt{17} \Rightarrow e_1 = \frac{\sqrt{17}}{5} \\
 \text{for hyperbola } 2Ae_2 &= 2\sqrt{17} \Rightarrow e_2 = \frac{\sqrt{17}}{3}
 \end{aligned}$$

4. Ans. 5

$$\begin{aligned}
 \text{Sol. } 8[\vec{a} \times \vec{b} \vec{b} \times \vec{c} \vec{c} \times \vec{a}] &= 800 \\
 \Rightarrow [\vec{a} \vec{b} \vec{c}]^2 &= 100 \\
 \vec{b} \cdot (\vec{a} \times (\vec{b} \times (\vec{c} \times \vec{b}))) \\
 &= \vec{b} \cdot \left(\vec{a} \times \left(|\vec{b}|^2 \vec{c} - (\vec{b} \cdot \vec{c}) \vec{b} \right) \right)
 \end{aligned}$$

$$\begin{aligned}
 &= |\vec{b}|^2 [\vec{b} \vec{a} \vec{c}] - 0 \\
 \Rightarrow |\vec{b}|^2 &= 25 \\
 |\vec{b}| &= 5
 \end{aligned}$$

5. Ans. 6

Sol.	(1)	(2)	(3)
Red balls	20%	40%	40%
Black balls	25%	45%	30%

$$\begin{aligned}
 P &= \frac{\frac{15}{35} \times \frac{40}{100}}{\frac{15}{35} \times \frac{40}{100} + \frac{20}{35} \times \frac{45}{100}} \\
 P &= \frac{40}{40+60} = \frac{2}{5}
 \end{aligned}$$