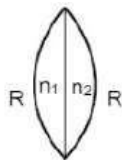


# Jee Advanced 2019 Paper 2

## PHYSICS – JEE ADVANCED PAPER – 2

### SECTION – 1

1. Consider two plane convex lens of same radius of curvature and refractive index  $n_1$  and  $n_2$  respectively. Now consider two cases:



Case – I: When  $n_1 = n_2 = n$ , then equivalent focal length of lens is  $f_0$

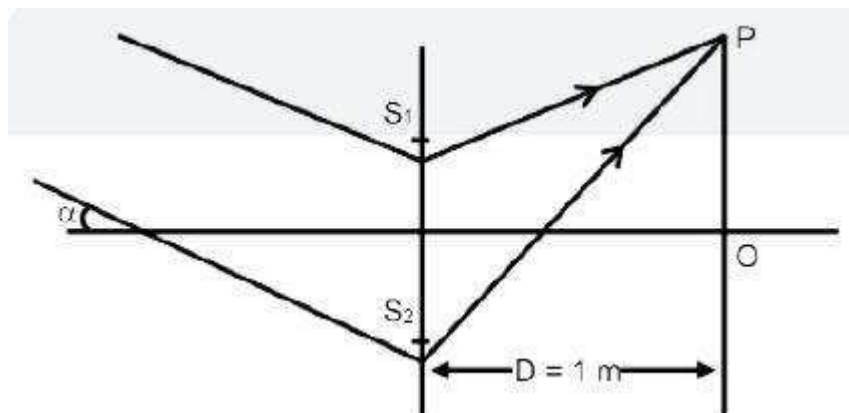
Case – II: When  $n_1 = n$ ,  $n_2 = n + \Delta n$ , then equivalent focal length of lens is  $f = f_0 + \Delta f_0$

Then correct options are:

- (a) If  $\Delta n/n > 0$ , then  $\Delta f_0/f_0 < 0$
- (b)  $|\Delta f_0/f_0| < |\Delta n/n|$
- (c) If  $n = 1.5$ ,  $\Delta n = 10^{-3}$  and  $f_0 = 20$  cm then  $|\Delta f_0| = 0.02$  cm

PHYSICS – JEE ADVANCED PAPER – 2

2. In YDSE monochromatic light of wavelength 600 nm incident of slits as shown in figure.

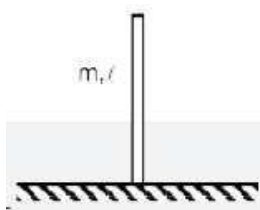


If  $S_1S_2 = 3\text{ mm}$ ,  $OP = 11\text{ mm}$  then

- (a) If  $\alpha = \frac{0.36}{\pi}$  degree then destructive interfaces at point P.
- (b) If  $\alpha = \frac{0.36}{\pi}$  degree then constructive interfaces at point O.
- (c) If  $\alpha = 0$  then constructive interfaces at O
- (d) Fringe width depends on  $\alpha$

PHYSICS – JEE ADVANCED PAPER – 2

3. A uniform rigid rod of mass  $m$  & length  $l$  is released from vertical position on rough surface with sufficient friction for lower end not to slip as shown in figure. When rod makes angle  $60^\circ$  with vertical then find correct alternative/s



(a)  $\alpha = \frac{2g}{\ell}$

(b)  $\omega = \sqrt{\frac{3g}{2\ell}}$

(c)

(d)  $a_{\text{radial}} = \frac{3g}{4}$

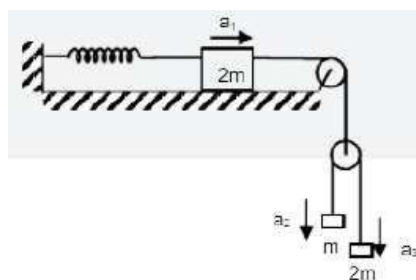
4. Monoatomic gas A having 5 mole is mixed with diatomic gas B having 1 mole in container of volume  $V_0$ . Now the volume of mixture is compressed to  $\frac{V_0}{4}$  by adiabatic process. Initial pressure and temperature of gas mixture is  $P_0$  and  $T_0$ . [given  $2^{3.2} = 9.2$ ]

Choose correct option:

- |                          |  |
|--------------------------|--|
| (a) $\gamma_{mix} = 1.6$ | (b) Final pressure is between $9P_0$ and $10P_0$ |
| (c) $ W.D  = 13RT_0$     | (d) Average Translational kinetic energy         |

5. The given arrangement is released from rest when spring is in natural length. Maximum extension in spring during the motion is  $x_0$ .  $a_1$ ,  $a_2$  and  $a_3$  are accelerations of the blocks. Make the correct options

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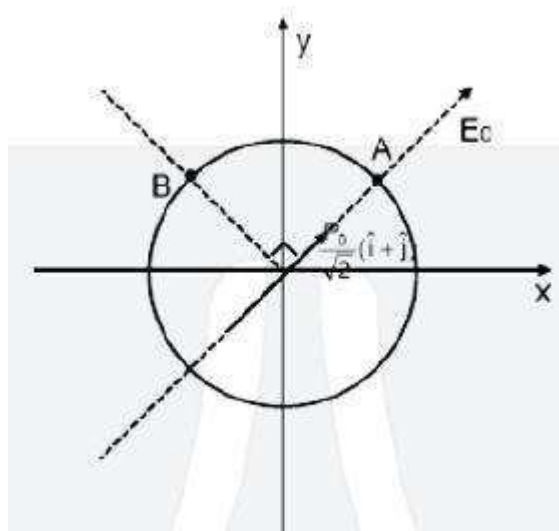
(a)  $a_2 - a_1 = a_1 - a_3$

(b)  $x_0 = \frac{4mg}{3k}$

(c) Velocity of 2m connected to spring when elongation is  $\frac{x_0}{2}$  is  $v = \frac{x_0}{2} \sqrt{\frac{3k}{14m}}$

(d) Acceleration  $a_1$  at  $\frac{x_0}{4}$  is  $\frac{3kx_0}{42m}$

6. A dipole of Dipole moment  $p = \frac{p_0}{\sqrt{2}}(\hat{i} + \hat{j})$  is placed at origin. Now a uniform external electric field at magnitude  $E_0$  is applied along direction of dipole. Two points A and B are lying on a equipotential surface of radius R centered at origin. A is along axial position of dipole and B is along equatorial position. There correct option are:



(a) Net electric field at point A is  $3E_0$

(b) Net electric field at point B is Zero

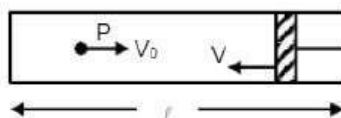
PHYSICS – JEE ADVANCED PAPER – 2

(c) Radius of equatorial surface  $R = \left( \frac{kp_0}{E_0} \right)^{1/3}$       (d) Radius of equatorial surface  $R = \left( \frac{\sqrt{2}kp_0}{E_0} \right)^{1/3}$

7. A free hydrogen atom after absorbing a photon of wavelength  $\lambda_a$  gets excited from state  $n = 1$  to  $n = 4$ . Immediately after electron jumps to  $n = m$  state by emitting a photon of wavelength  $\lambda_e$ . Let change in momentum of atom due to the absorption and the emission are  $\Delta P_a$  and  $\Delta p_e$  respectively. If  $\lambda_a / \lambda_e = 1/5$ . Which of the following is correct
- (a)  $m = 2$
  - (b)  $\Delta P_a / P_e = 1/2$
  - (c)  $\lambda_e = 418 \text{ nm}$
  - (d) Ratio of K.E. of electron in the state  $n = m$  to  $n = 1$  is  $1/4$ .

## PHYSICS – JEE ADVANCED PAPER – 2

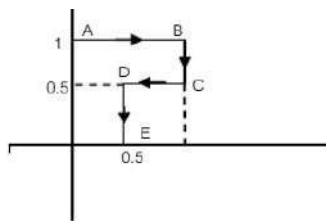
8. In a cylinder a heavy piston is moving with speed  $v$  as shown diagram and gas is filled inside it. A gas molecule is moving with speed  $v_0$  towards moving piston. Then which of the following is correct (Assume  $v \ll v_0$  and collision is elastic)



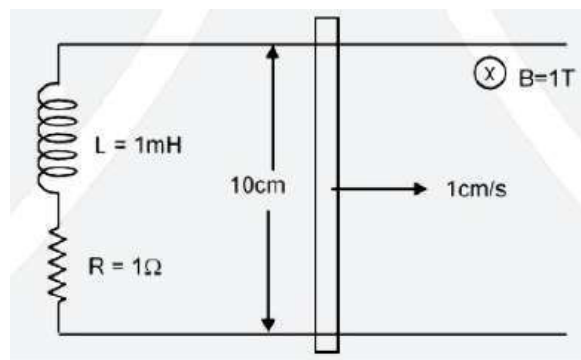
- (a) change in speed after collision is  $2v$   
 (b) change in speed after collision is  $2v_0 \frac{\Delta \ell}{\ell}$   
 (c) rate of collision is  $\frac{V}{\ell}$   
 (d) When piston is at  $\frac{\ell}{2}$  its kinetic energy will be four times

### SECTION – 2

9. If  $f = \alpha y \hat{i} + 2\alpha x \hat{j}$  calculate the work done if a particle moves along path as shown in diagram.



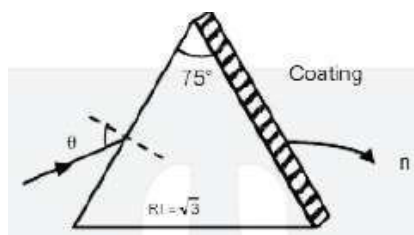
10. In a given circuit inductor of  $L = 1\text{mH}$  and resistance  $R = 1\Omega$  are connected in series to ends of two parallel conducting rods as shown. Now a rod of length  $10\text{ cm}$  is moved with constant velocity of  $1\text{ cm/s}$  in magnetic field  $B = 1\text{ T}$ . If rod starts moving at  $t = 0$  then current in circuit after  $1\text{ millisecond}$  is  $x \times 10^{-3}\text{ A}$ . Then value of  $x$  is: (given  $e^{-1} = 0.37$ )



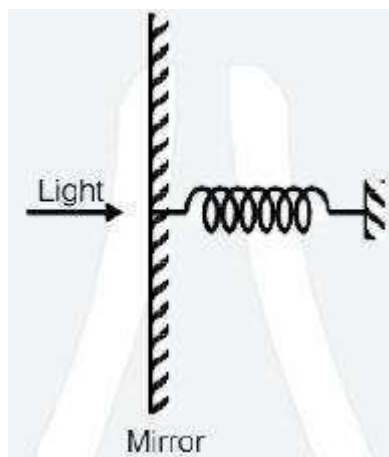
11. A prism is shown in the figure with prism angle  $75^\circ$  and refractive index  $\sqrt{3}$ . A light ray incidents on a surface at incident angle  $\theta$ . Other face is coated with a medium of refractive index  $n$ . For  $\theta \leq 60^\circ$  ray suffers total internal reflection find value of  $n^2$ .



PHYSICS – JEE ADVANCED PAPER – 2



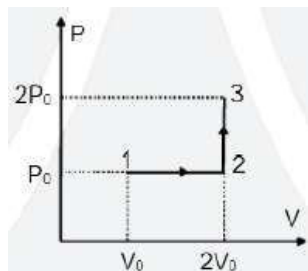
12. Perfectly reflecting mirror of mass  $M$  mounted on a spring constitute a spring mass system of angular frequency  $\Omega$  such that  $\frac{4\pi M\Omega}{h} = 10^{24} m^{-2}$  where  $h$  is plank constant.  $N$  photons of wavelength  $\lambda = 8\pi \times 10^{-6} m$  strikes the mirror simultaneously at normal incidence such that the mirror gets displaced by  $1 \mu m$ . If the value of  $N$  is  $x \times 10^{12}$ , then find the value of  $x$ .



13. A particle is projected with speed  $v_0$  at an angle  $\theta$  ( $\theta \neq 90^\circ$ ) with horizontal and it bounces at same angle with horizontal. If average velocity of journey is  $0.8 v_0$  where  $v_0$  is average velocity of first projectile then  $\alpha$  is.



15. The sample of monoatomic gas undergoes a process as represented by  $P - V$  graph (if  $P_0 V_0 = 1/3 RT_0$ ) then



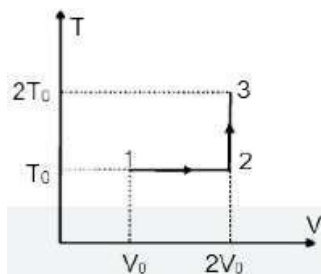
(P)  $W_{1 \rightarrow 2} = 1/3 RT_0$     (Q)  $Q_{1 \rightarrow 2 \rightarrow 3} = 11/6 RT_0$     (R)  $U_{1 \rightarrow 2} = RT_0 / 2$     (S)  $W_{1 \rightarrow 2 \rightarrow 3} = 1/3 RT_0$

# PHYSICS – JEE ADVANCED PAPER – 2

Which of the following options are correct

- (a) P, Q, R, S are correct
- (b) Only P, Q are correct
- (c) Only R, S are correct
- (d) Only P, R, S correct

16. A sample of monoatomic gas undergoes a process as represented by  $T - V$  graph (if  $P_0V_0 = 1/3 RT_0$ ) then



(P)  $W_{1 \rightarrow 2} = \frac{1}{3} RT_0 \ln 2$

(Q)  $Q_{1 \rightarrow 2 \rightarrow 3} = \frac{RT_0}{6} (2 \ln(2) + 3)$

(R)  $U_{1 \rightarrow 2} = 0$

(S)  $W_{1 \rightarrow 2 \rightarrow 3} = \frac{RT_0}{3} \ln 2$

Which of the following option are correct:

- (a) P, Q are incorrect
- (b) R, S are incorrect
- (c) P, Q, S are incorrect
- (d) none of these

17. Length of string of a musical instrument is varied from  $L_0$  to  $2L_0$  in 4 different cases. Wire is made of different materials of mass per unit length  $\mu$ ,  $2\mu$ ,  $3\mu$ ,  $4\mu$  respectively. For first case (string – 1) length is  $L_0$ , Tension is  $T_0$  then fundamental frequency is  $f_0$ , for second case length of the string is  $\frac{3L_0}{2}$  ( $3^{\text{rd}}$  Harmonic), for third case length of the string is  $\frac{5L_0}{4}$  ( $5^{\text{th}}$  Harmonic) and for the fourth case length of the string is  $\frac{7L_0}{4}$  ( $14^{\text{th}}$  harmonic). If frequency of all is same then tension in strings in terms of  $T_0$  will be:

- |                |                            |
|----------------|----------------------------|
| (a) String – 1 | (P) $T_0$                  |
| (b) String – 2 | (Q) $\frac{T_0}{\sqrt{2}}$ |
| (c) String – 3 | (R) $\frac{T_0}{2}$        |
| (d) String – 4 | (S) $\frac{T_0}{16}$       |
|                | (T) $\frac{3T_0}{16}$      |

**SECTION – 3**

18. The free length of all four string is varied from  $L_0$  to  $2L_0$ . Find the maximum fundamental frequency of 1, 2, 3, 4 in terms of  $f_0$  (tension is same in all strings)

(a) String – 1

(P) 1

(b) String – 2

(Q)  $\frac{1}{2}$

(c) String – 3

(R)  $\frac{1}{\sqrt{2}}$

(d) String – 4

(S)  $\frac{1}{\sqrt{3}}$

(T)  $\frac{1}{16}$

(U)  $\frac{3}{16}$

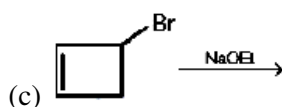
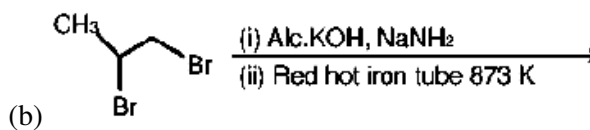
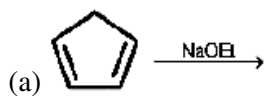
**PHYSICS – JEE ADVANCED PAPER – 2**

## CHEMISTRY – JEE ADVANCED PAPER – 2

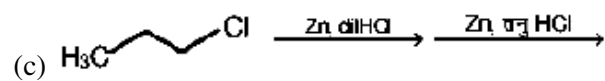
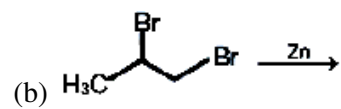
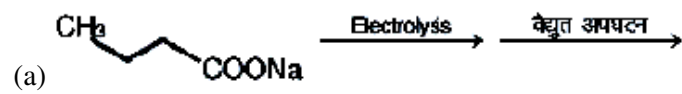
### SECTION – 1

1. With reference to aqua regia, choose the correct option(s):
- (a) Aqua regia is prepared by mixing conc. HCl and conc.  $\text{HNO}_3$  in 3: 1 molar ratio.
  - (b) Reaction of gold with aqua regia produces an anion having Au in +3 oxidation state.
  - (c) Reaction of gold with aqua regia produces  $\text{NO}_2$  in the absence of air
  - (d) The yellow colour of aqua regia is due to the presence of  $\text{NOCl}$  &  $\text{Cl}_2$ .

2. Choose the correct option that gives aromatic compound as major product:



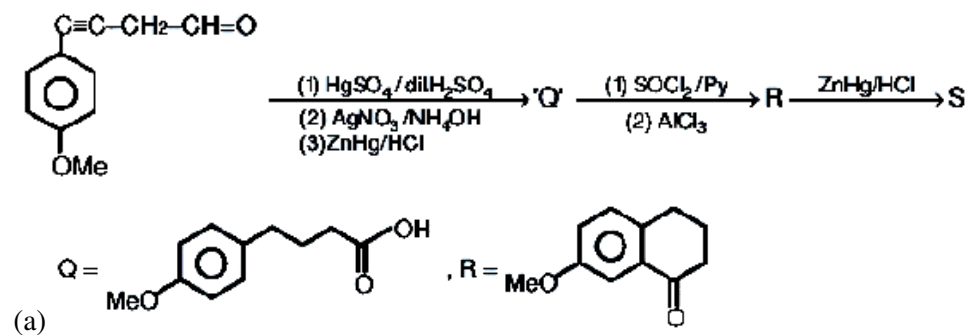
3. Which of the following reaction produce propane as major product?



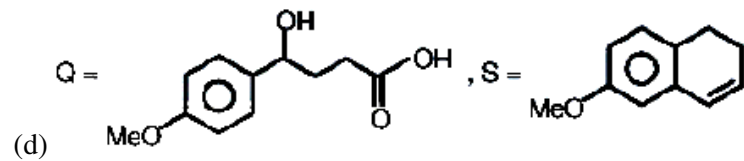
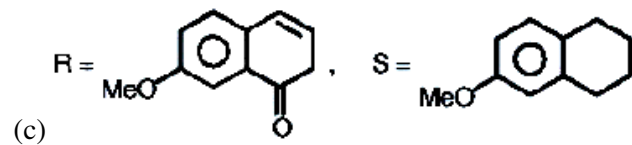
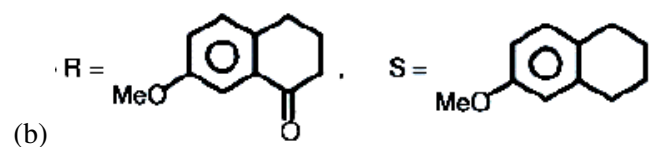


4. Which of the following is/are correct
- (a) Teflon is formed by polymerization of tetrafluoroethene.
  - (b) Natural rubber is the trans form of polyisoprene.
  - (c) Cellulose contains only  $\alpha$ -D-glucose linkage
  - (d) Nylon-6 contains amide linkage.

5.

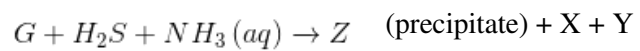
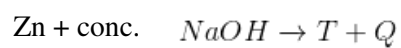
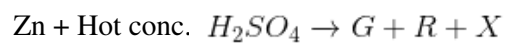


CHEMISTRY – JEE ADVANCED PAPER – 2



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6. Consider the following reaction (unbalanced)



Choose the correct option(s)

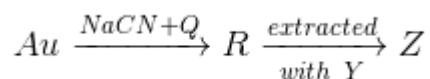
(a) R is a V-shaped molecule

(b) Z is dirty white in colour

## CHEMISTRY – JEE ADVANCED PAPER – 2

- (c) Bond order of Q is 1 in its ground state      (d) The oxidation state of Zn in T is +1.

7. In the Mac. Arthur process of extraction



- (a) R is  $[Au(CN)_4]^{(-)}$       (b) Z is  $[Zn(CN)_4]^{2-}$       (c) Q is  $O_2$       (d) Y is Zn
8. For  $He^+$  the electron is in orbit with energy equal to 3.4eV. The azimuthal quantum number for that orbit is 2 and magnetic quantum number is 0. Then which of the following is/are correct.
- (a) The subshell is 4d.  
(b) The number of angular nodes in it is 2.  
(c) The numbers of radial nodes in it is 3.  
(d) The nuclear charge experienced in  $n = 4$  is  $2e$  less than that in  $n = 1$ , where  $e$  is electric charge.

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**SECTION – 2**

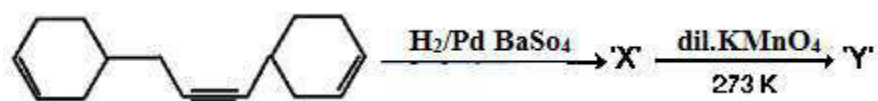
9. Calculate the total number of cyclic ether (including stereo) having formula  $C_4H_8O$

**CHEMISTRY – JEE ADVANCED PAPER – 2**

10. 1 mole of Rhombic sulphur is treated with conc.  $\text{HNO}_3$ . Find the mass of  $\text{H}_2\text{O}$  formed.

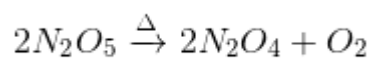
11. Mole fraction of urea in 900 gram water is 0.05. Density of Solution is  $1.2 \text{ g/cm}^3$ . Find molarity of Solution.

12. Number of hydroxyl group in compound 'Y' is:



CHEMISTRY – JEE ADVANCED PAPER – 2

13. In following reaction the value of K is  $5 \times 10^{-4} \text{ S}^{-1}$ .



Initial pressure was 1 atm, while the final pressure was 1.45 atm at time  $y \times 10^3$  sec calculate 'y'.

## CHEMISTRY – JEE ADVANCED PAPER – 2

14. Number of N-Mn-Cl bonds [N-Mn bonds is cis to Mn-Cl bond] in cis  $[\text{Mn(en)}_2\text{Cl}_2]$  are .....

### SECTION – 3

Match the column

	List 1		List 2
P	Radius	I	$I \propto n^{-1}$
Q	Angular momentum	II	$II \propto n^{-2}$
R	Kinetic energy	III	$III \propto n^0$
S	Potential energy	IV	$IV \propto n^1$
		V	$V \propto n^2$

15. Which of the following is correct

(a) P I

(b) P II

(c) P V

(d) P III



**CHEMISTRY – JEE ADVANCED PAPER – 2**

16. Which of following is correct.

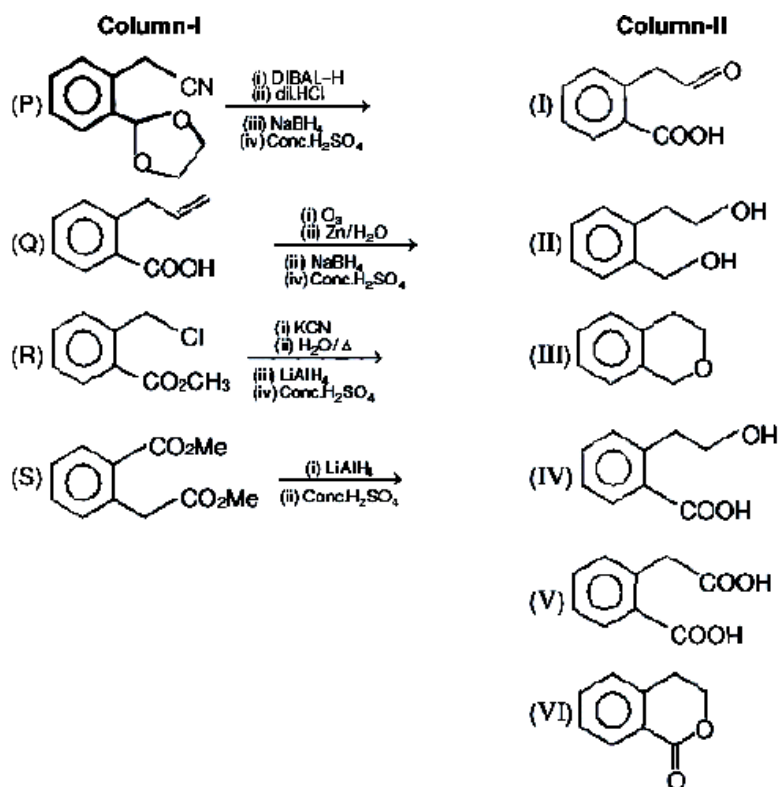
(a) S IV

(b) R I

(c) R II

(d) S III

Answer the question no. 17 & 18 on the basis of information given in Column – I & Column – II. Match the reactant in column – I with the possible intermediates and products of Column – II.



17. Which of the following is correct?

(a) P – II, III; S – II, III (b) P – II, IV; S – II, III (c) P – III, VI; S – II, III (d) P – I, III; S – IV, V

18. Which of the following is correct?

(a) Q – I, IV, VI; R – II, III, V

(b) Q – I, III, VI; R – II, IV, V

(c) Q – I, II, VI; R – II, III, VI

(d) Q – I, IV, V; R – III, I, V

**CHEMISTRY – JEE ADVANCED PAPER – 2**

MATHS

JEE ADVANCE PAPER 2

**SECTION - 1**

1. Let  $f: \mathbb{R} \rightarrow \mathbb{R}$  be given by  $f(x) = (x - 1)(x - 2)(x - 5)$ . Define  $F(x) = \int_0^x f(t) dt, x > 0$ . Then which of the following options is/are correct?
- (a)  $F$  has a local minimum at  $x = 1$                       (b)  $F$  has a local maximum at  $x = 2$
- (c)  $F(x) \neq 0$  for all  $x \in (0, 5)$                       (d)  $F$  has two local maxima and one local minimum in  $(0, \infty)$

2. For  $a \in \mathbb{R}, |a| > 1$ , let  $\lim_{n \rightarrow \infty} \left( \frac{1 + \sqrt[3]{2} + \dots + \sqrt[3]{n}}{n^{7/3} \left( \frac{1}{(an+1)^2} + \frac{1}{(an+2)^2} + \dots + \frac{1}{(an+n)^2} \right)} \right) = 54$ . Then the possible value(s) of  $a$  is/are:
- (a) 8                      (b) -9                      (c) -6                      (d) 7

3. Three lines

$$L_1 : \vec{r} = \lambda \hat{i}, \lambda \in R,$$

$$L_2 : \vec{r} = \vec{k} + \mu \hat{j}, \mu \in R \text{ and}$$

$$L_3 : \vec{r} = \hat{i} + \hat{j} + v \hat{k}, v \in R$$

are given. For which point(s) Q and  $L_2$  can we find a point P on  $L_1$  and a point R on  $L_3$  so that P, Q and R are collinear?

(a)  $\hat{k} + \hat{j}$

(b)  $\hat{k}$

(c)  $\hat{k} + \frac{1}{2} \hat{j}$

(d)  $\hat{k} - \frac{1}{2} \hat{j}$

# MATHS

## JEE ADVANCE PAPER 2

4. Let  $F: \mathbb{R} \rightarrow \mathbb{R}$  be a function. We say that  $f$  has

PROPERTY 1 if  $\lim_{h \rightarrow 0} \frac{f(h) - f(0)}{\sqrt{|h|}}$  exists and is finite and

PROPERTY 2 if  $\lim_{h \rightarrow 0} \frac{f(h) - f(0)}{h^2}$  exists and is finite

Then which of the following options is/are correct?

- |                                    |                                     |
|------------------------------------|-------------------------------------|
| (a) $f(x) = x x $ has PROPERTY 2   | (b) $F(x) = x^{2/3}$ has PROPERTY 1 |
| (c) $f(x) = \sin x$ has PROPERTY 2 | (d) $f(x) =  x $ has PROPERTY 1     |

5. For non-negative integers  $n$ , let

$$f(n) = \frac{\sum_{k=0}^n \sin\left(\frac{k+1}{n+2}\pi\right) \sin\left(\frac{k+2}{n+2}\pi\right)}{\sum_{k=0}^n \sin^2\left(\frac{k+1}{n+2}\pi\right)}$$

Assuming  $\cos^{-1} x$  takes value in  $[0, \pi]$ , which of the following options is/are correct?

- |  |  |
|--|--|
| (a) $\sin(7 \cos^{-1} f(5)) = 0$                     | (b) $f(4) = \frac{\sqrt{3}}{2}$  |
| (c) $\lim_{n \rightarrow \infty} f(n) = \frac{1}{2}$ | (d) If $\alpha = \tan(\cos^{-1} f(6))$ , then $\alpha^2 + 2\alpha - 1 = 0$ |

**MATHS**

**JEE ADVANCE PAPER 2**

MATHS

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6. Let  $P_1 = I = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ ,  $P_2 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix}$ ,  $P_3 = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ ,  $P_4 = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix}$ ,  $P_5 = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$ ,  
 $P_6 = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$  and  $X = \sum_{k=1}^6 P_k \begin{bmatrix} 2 & 1 & 3 \\ 1 & 0 & 2 \\ 3 & 2 & 1 \end{bmatrix} P_k^T$

Where  $P_k^T$  denotes the transpose of the matrix  $P_k$ . Then which of the following options is/are correct?

(a)  $X - 30I$  is an invertible matrix

(b) The sum of diagonal entries of  $X$  is 18

(c) If  $X \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \alpha \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$ , then  $\alpha = 30$

(d)  $X$  is a symmetric matrix



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7. Let  $x \in \mathbb{R}$  and let  $P = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 2 & 2 \\ 0 & 0 & 3 \end{bmatrix}$ ,  $Q = \begin{bmatrix} 2 & x & x \\ 0 & 4 & 0 \\ x & x & 6 \end{bmatrix}$  and  $R = PQP^{-1}$

Then which of the following options is/are correct?

(a) For  $x = 1$ , there exists a unit vector  $\alpha \hat{i} + \beta \hat{j} + \gamma \hat{k}$  for which  $R \begin{bmatrix} \alpha \\ \beta \\ \gamma \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$

(b) There exists a real number  $x$  such that  $PQ = QP$

(c)  $\det R = \det \begin{bmatrix} 2 & x & x \\ 0 & 4 & 0 \\ x & x & 5 \end{bmatrix} + 8$ , for all  $x \in \mathbb{R}$

(d) for  $x = 0$ , if  $R \begin{bmatrix} 1 \\ a \\ b \end{bmatrix} = 6 \begin{bmatrix} 1 \\ a \\ b \end{bmatrix}$ , then  $a + b = 5$

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8. Let  $f(x) = \frac{\sin \pi x}{x^2}, x > 0$

Let  $x_1 < x_2 < x_3 < \dots < x_n < \dots$  be all the points of local maximum of  $f$   
and  $y_1 < y_2 < y_3 < \dots < y_n < \dots$  be all the points of local minimum of  $f$ .

Then which of the following options is/are correct?

(a)  $|x_n - y_n| > 1$  for every  $n$

(b)  $x_1 < y_1$

(c)  $x_n \in \left(2n, 2n + \frac{1}{2}\right)$  for every  $n$

(d)  $x_{n+1} - x_n > 2$  for every  $n$

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**SECTION – 2**

1. The value of  $\sec^{-1}\left(\frac{1}{4}\sum_{k=0}^{10}\sec\left(\frac{7\pi}{12}+\frac{k\pi}{2}\right)\sec\left(\frac{7\pi}{12}+\frac{(k+1)\pi}{2}\right)\right)$  in the interval  $\left[-\frac{\pi}{4},\frac{3\pi}{4}\right]$  equals

2. Let  $|X|$  denote the number of elements in set  $X$ . Let  $S = \{1,2,3,4,5,6\}$  be a sample space, where each element is equally likely to occur. If  $A$  and  $B$  are independent events associated with  $S$ , then the number of ordered pairs  $(A,B)$  such that  $1 \leq |B| < |A|$ , equals.

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3. Five person A, B, C, D and E are seated in a circular arrangement. If each of them is given a hat of one of the three colours red, blue and green, then the number of ways of distributing the hats such that the persons seated in adjacent seats get different coloured hats is

4. Suppose

$$\det \begin{bmatrix} \sum_{k=0}^n k & \sum_{k=0}^n {}^nC_k k^2 \\ \sum_{k=0}^n {}^nC_k k & \sum_{k=0}^n {}^nC_k 3^k \end{bmatrix} = 0, \text{ holds for some positive integer } n. \text{ Then } \sum_{k=0}^n \frac{{}^nC_k}{k+1} \text{ equals}$$

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5. The value of the integral  $\int_0^{\pi/2} \frac{3\sqrt{\cos \theta}}{(\sqrt{\cos \theta} + \sqrt{\sin \theta})^5} d\theta$  equals

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6. Let  $\vec{a} = 2\hat{i} + \hat{j} - \hat{k}$  and  $\vec{b} = \hat{i} + 2\hat{j} + \hat{k}$  be two vectors. Consider a vector  $\vec{c} = \alpha\vec{a} + \beta\vec{b} + \gamma$ ,  $\alpha, \beta, \gamma \in \mathbb{R}$ . If the projection of  $\vec{c}$  on the vector  $(\vec{a} + \vec{b})$  is  $3\sqrt{2}$ , then the minimum value of  $(\vec{c} - (\vec{a} \times \vec{b})) \cdot \vec{c}$  equals

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**SECTION – 3**

1. Answer the following by appropriately matching the lists based on the information given in the paragraph  
Let  $f(x) = \sin(\pi \cos x)$  and  $g(x) = \cos(2\pi \sin x)$  be two functions defined for  $x > 0$ . Define the following sets whose element are written in the increasing order:

$$X = \{x : f(x) = 0\} , \quad Y = \{x : f'(x) = 0\}$$

$$Z = \{x : g(x) = 0\} , \quad W = \{x : g'(x) = 0\}$$

List –I contains the sets X,Y,Z and W. List – II contains some information regarding these sets.

**List I**

(I) X

(II) Y

(III) Z

(IV) W

**List – II**

$$(P) \supseteq \left\{ \frac{\pi}{2}, \frac{3\pi}{2}, 4\pi, 7\pi \right\}$$

(Q) an arithmetic progression

(R) Not an arithmetic progression

$$(S) \supseteq \left\{ \frac{\pi}{6}, \frac{7\pi}{6}, \frac{13\pi}{6} \right\}$$

$$(T) \supseteq \left\{ \frac{\pi}{3}, \frac{2\pi}{3}, \pi \right\}$$



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$$(U) \supseteq \left\{ \frac{\pi}{6}, \frac{3\pi}{4} \right\}$$

Which of the following is the only correct combination?

- (a) (II), (R), (S)                      (b) (I), (P), (R)                      (c) (II), (Q), (T)                      (d) (I), (Q), (U)

2. Answer the following by appropriately matching the lists based on the information given in the paragraph  
Let  $f(x) = \sin(\pi \cos x)$  and  $g(x) = \cos(2\pi \sin x)$  be two functions defined for  $x > 0$ . Define the following sets whose element are written in the increasing order:

$$X = \{x : f(x) = 0\} \quad , \quad Y = \{x : f'(x) = 0\}$$

$$Z = \{x : g(x) = 0\} \quad , \quad W = \{x : g'(x) = 0\}$$

List –I contains the sets X,Y,Z and W. List – II contains some information regarding these sets.

### List I

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(Q) an arithmetic progression

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$$(T) \supseteq \left\{ \frac{\pi}{3}, \frac{2\pi}{3}, \pi \right\}$$

$$(U) \supseteq \left\{ \frac{\pi}{6}, \frac{3\pi}{4} \right\}$$

Which of the following is the only correct combination?

- (a) (IV), (Q), (T)                      (b) (IV), (P), (R), (S)                      (c) (III), (R), (U)                      (d) (III), (P), (Q), (U)

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3. Answer the following by appropriately matching the lists based on the information given in the paragraph

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Let the circles  $C_1 : x^2 + y^2 = 9$  and  $C_2 : (x - 3)^2 + (y - 4)^2 = 16$ , intersect at the points  $X$  and  $Y$ . Suppose that another circle  $C_3 : (x - h)^2 + (y - k)^2 = r^2$  satisfies the following conditions:

- (i) centre of  $C_3$  is collinear with the centres of  $C_1$  and  $C_2$
- (ii)  $C_1$  and  $C_2$  both lie inside  $C_3$ , and
- (iii)  $C_3$  touches  $C_1$  at  $M$  and  $C_2$  at  $N$

Let the line through  $X$  and  $Y$  intersect  $C_3$  at  $Z$  and  $W$ , and let a common tangent of  $C_1$  and  $C_3$  be a tangent to the parabola  $x^2 = 8\alpha y$ .

There are some expression given in the List – I whose values are given in List – II below:

List – I	List – II
(I) $2h + k$	(P) 6
(II) $\frac{\text{Length of } ZW}{\text{Length of } XY}$	(Q) $\sqrt{6}$
(III) $\frac{\text{Area of triangle } MZN}{\text{Area of triangle } ZMW}$	(R) $\frac{5}{4}$
(IV) $\alpha$	(S) $\frac{21}{5}$
	(T) $2\sqrt{6}$
	(U) $\frac{10}{3}$

Which of the following is the only INCORRECT combination?

- (a) (IV), (S)
- (b) (IV), (U)
- (c) (III), (R)
- (d) (I), (P)

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4. Answer the following by appropriately matching the lists based on the information given in the paragraph  
Let the circles  $C_1 : x^2 + y^2 = 9$  and  $C_2 : (x - 3)^2 + (y - 4)^2 = 16$ , intersect at the points X and Y. Suppose that another circle  $C_3 : (x - h)^2 + (y - k)^2 = r^2$  satisfies the following conditions:

- (i) centre of  $C_3$  is collinear with the centres of  $C_1$  and  $C_2$
- (ii)  $C_1$  and  $C_2$  both lie inside  $C_3$ , and
- (iii)  $C_3$  touches  $C_1$  at M and  $C_2$  at N

Let the line through X and Y intersect  $C_3$  at Z and W, and let a common tangent of  $C_1$  and  $C_3$  be a tangent to the parabola  $x^2 = 8\alpha y$ .

There are some expression given in the List – I whose values are given in List – II below:

- | List – I  | List – II          |
|---|--------------------|
| (I) $2h + k$  | (P) 6              |
| (II) $\frac{\text{Length of } ZW}{\text{Length of } XY}$                  | (Q) $\sqrt{6}$     |
| (III) $\frac{\text{Area of triangle } MZN}{\text{Area of triangle } ZMW}$ | (R) $\frac{5}{4}$  |
| (IV) $\alpha$   | (S) $\frac{21}{5}$ |
|   | (T) $2\sqrt{6}$    |
|   | (U) $\frac{10}{3}$ |

Which of the following is the only INCORRECT combination?

- (a) (II), (T)                      (b) (I), (S)                      (c) (I), (U)                      (d) (II), (Q)

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