

## Practice Paper 6

### Paper-I

### Part-1 (physics)

### Section-I

#### Straight Objective Type

##### Q1

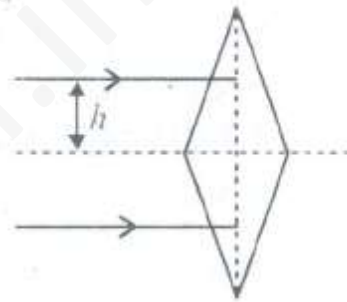
Two identical isosceles prisms of small prism angle  $A$  and refractive index  $\mu$  are placed with their bases touching each other. This system can act as a crude converging lens. Assuming a ray of light is incident on a prism at a height  $h$  from its base the focal length of this system is

a.  $\frac{A}{h(\mu-1)}$

b.  $\frac{(\mu-1)}{hA}$

c.  $\frac{A}{(\mu-1)h^2}$

d.  $\frac{h}{(\mu-1)A}$



##### Q2

The wavelength of  $K_{\alpha}$  X-ray produced by a X-ray tube is  $0.76\text{\AA}$ . The atomic number of the anode material of the tube is

a. 38

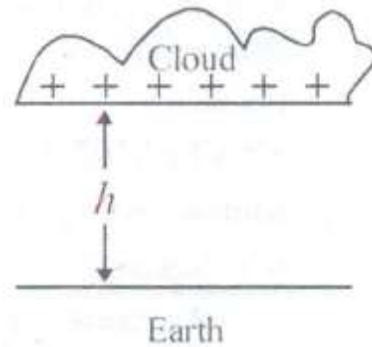
b. 40

c. 43

d. 47

**Q3**

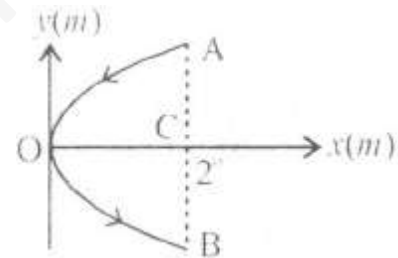
A thunder cloud and the earth's surface may be regarded as a pair of charged parallel plates separated by a distance  $h$  as shown. The capacitance of the system is  $C$ . When a lightning flash of mean current  $I$  and time duration  $t$  occurs the electric field strength between cloud and earth is reduced by



- a.  $\frac{it}{C}$
- b.  $Cit$
- c.  $\frac{Cit}{h}$
- d.  $\frac{it}{Ch}$

**Q4**

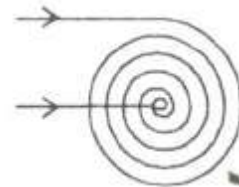
A conducting wire bent in the form of a parabola  $y^2 = 2x$  carries a current  $i = 2A$  as shown. The wire is placed in a uniform magnetic field  $\vec{B} = -4\hat{k}$  tesla. The magnetic force on the wire (in newton) is



- a.  $-16\hat{i}$
- b.  $32\hat{i}$
- c.  $-32\hat{i}$
- d.  $16\hat{i}$

**Q5**

A plane spiral with large  $N$  number of turns wound tightly to one another is located in a uniform magnetic field perpendicular to the plane of spiral. The outside radius of the spiral's turn is equal to  $a$ . magnetic field varies with time as  $B = B_0 \sin \omega t$ , where  $B_0$  and  $\omega$  are constants. The amplitude of induced emf in the spiral is



- a.  $4 \pi N a^2 B_0 \omega$
- b.  $7 \pi N a^2 B_0 2 \omega$
- c.  $\frac{1}{3} \pi N a^2 B_0 \omega$
- d.  $\frac{1}{3} \mu_0 \pi N^2 a B_0 \omega$

**Q6**

Two particle 1 and 2 move with constant velocities  $V_1$  and  $V_2$ . At initial moment their radius vectors are equal  $r_1$  and  $r_2$ . How must these four vectors be related for the particles to collide?

a.  $\frac{\vec{r}_1 - \vec{r}_2}{|\vec{r}_1 - \vec{r}_2|} = \frac{\vec{v}_1 - \vec{v}_2}{|\vec{v}_1 - \vec{v}_2|}$

b.  $\frac{\vec{r}_1 + \vec{r}_2}{|\vec{r}_1 - \vec{r}_2|} = \frac{\vec{v}_1 - \vec{v}_2}{|\vec{v}_1 + \vec{v}_2|}$

c.  $\frac{\vec{r}_1 - \vec{r}_2}{|\vec{r}_1 + \vec{r}_2|} = \frac{\vec{v}_1 - \vec{v}_2}{|\vec{v}_1 + \vec{v}_2|}$

d.  $\frac{\vec{r}_1 - \vec{r}_2}{|\vec{r}_1 + \vec{r}_2|} = \frac{\vec{v}_1 + \vec{v}_2}{|\vec{v}_1 - \vec{v}_2|}$

**Q7**

A point moves along the arc of a circle of radius R. Its velocity varies as  $v = a\sqrt{s}$  where a is constant.

The angle  $\alpha$  between the vector of total acceleration and the vector of velocity is given by

a.  $\tan^{-1} \left( \frac{R}{s} \right)$

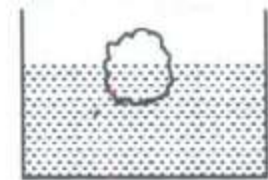
b.  $\tan^{-1} \left( \frac{R}{2s} \right)$

c.  $\tan^{-1} \left( \frac{2s}{R} \right)$

d.  $\tan^{-1} \left( \frac{s}{R} \right)$

**Q8**

A body floats In a liquid contained in a beaker. If the whole system as shown in figure falls freely under gravity then the up thrust on the body due to liquid is



a. zero

b. equal to the weight of liquid displaced.

c. equal to the weight of the body in air.

d. equal to the weight of the immersed portion of the body.

A plate of mass  $M$  remains in equilibrium in air when  $n$  bullets are fired per second on it. The mass of each bullet is  $m$  and it strikes the plate with speed  $v$ . If the coefficient of restitution is  $e$ , then ( $M \gg m$ )

a.  $M = \frac{nm(e+e)v}{g}$

b.  $M = \frac{nmv}{g}$

c.  $M = \frac{2nm(e+e^2)}{g}$

c.  $M = 2nmg$

### Section-II

#### Q10

##### **Statement-1:**

A body of mass  $m_1$  collides head on elastically with another stationary body of mass  $m_2$ . After the collision, velocity of mass  $m_2$  is maximum, when  $m_1 \ll m_2$ .

##### **Statement-2:**

Velocity of second body is always maximum, when its mass  $m_2$  is greater than mass of the hitting body.

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is True, Statement-2 is True

**Statement-1:**

A uniform solid cylinder rolling with angular velocity  $\omega$  along a plane surface strikes a vertical rigid wall. Angular velocity of cylinder when it begins to roll up a wall is less than the initial Angular velocity ( $\omega$ ) because

**Statement-2:**

After striking the vertical wall angular velocity increases.

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is True, Statement-2 is True

Q12**Statement-1:**

A current carrying conductor of any arbitrary shape in uniform magnetic field experiences a force given by  $\vec{F} = i(\vec{l}' \times \vec{B})$  where  $l'$  is the length vector joining initial to final points. because

**Statement-1:**

Force on a current carrying conductor is given by  $F = i(\int \vec{dl}) \times \vec{B}$  when for a conductor  $\int \vec{dl}$  represents vector sum of all the length elements from initial to final points.

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is True, Statement-2 is True

**Statement-1:**

Ionization energy of atomic hydrogen is greater than atomic deuterium. because

**Statement-2:**

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is True, Statement-2 is True

**Section-III**

**Linked Comprehension Type**

**M<sub>14-16</sub>: Paragraph for Question Nos. 14 to 16**

**Q14**

Number of photoelectrons released per second is :

- a.  $\frac{PR^2}{E}$
- b.  $\frac{P}{R}$
- c.  $\frac{PR^2}{r^2}$
- d.  $\frac{Pr^2}{R^2}$

**Q15**

The wavelength of incident photon is :

- a.  $\frac{hc}{NE}$
- b.  $\frac{hc}{E}$
- c.  $\frac{Nhc}{E}$
- d. None of these

The electric potential of the sphere:

- a. remains unchanged
- b. increases
- c. decreases
- d. cannot be found

**M<sub>17-19</sub>: Paragraph for Question Nos. 17 to 19**

Vectors are those which have both magnitude and direction and also satisfy the law of vector addition. Unit vectors  $\hat{i}$ ,  $\hat{j}$  and  $\hat{k}$  point along x, y and z- directions. It is very essential to subtract or add vectorially while dealing with vector quantities. The resultant vector may be in the plane of the ground or in perpendicular plane. Use of the directions of poles is a common practice.

**Q17**

A man walks 30 m north, 20 m East and  $30\sqrt{2}$  South west. The displacement is

- a.  $80\sqrt{2}$  m North West
- b. 10 m West
- c. 10 m East
- d. zero

**Q18**

A man rotates a frame  $45^\circ$  and then  $30^\circ$  clockwise. He repeats them in reverse. The angular displacement involved is/are

- a. vectors
- b. scalars
- c. tensor
- d. axial vectors.

**Q19**

A stone to a string of length 'l' is whirled in vertical circle. If its speed at the lower-most position is u, the magnitude of the change in velocity as it reaches the horizontal position is

- a.  $\sqrt{u^2 - 2gl}$
- b.  $\sqrt{2gl}$
- c.  $\sqrt{u^2 - gl}$
- d.  $\sqrt{2(u^2 - gl)}$

**Section-IV**

**Matrix-Match Type**

If the correct matches are A – P, A – S, B – Q, B – R, C – P, C – Q and D – S then the correctly 4 x 4 matrix should be as given

	P	Q	R	S
A	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
B	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
C	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
D	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

**Q20**

Considering a projectile motion

**Column I**

- a. Change in magnitude momentum.
- b. Maximum angular momentum about the point of projection.
- c. Minimum velocity.
- d. Magnitude of change in momentum.

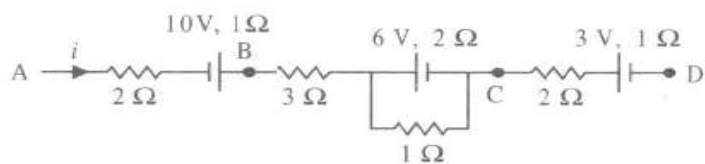
**Column II**

- p. At highest point of the parabolic path.
- q.  $2mv \sin \theta$  between the point of projection and target.
- r.  $L = \frac{mv^3 \sin^2 \theta \cos \theta}{2g}$
- s. Present along vertical direction



**Q21**

Circuit shown is a part of complicated circuit. The potential difference between A and B is – 1 volt.



**Column I**

- Current  $i$  in the circuit
- Current through  $1 \Omega$  resistor
- Potential difference between A and D
- Potential difference between C and D

**Column II**

- 4 A
- 3 A
- 12 V
- 24 V

**Q22**

Match the following :

**Column I**

- Range and least count of ammeter
- Least count and sensitivity of ammeter
- Range and accuracy of ammeter
- Range and multiplication factor of a voltmeter

**Column II**

- Inverse relation
- Linear relation

**Part-II (Chemistry)**

**Section-I**

**Straight Objective Type**

**Q23**

The pH of a buffer solution of  $0.1 \text{ M HCOONH}_4$  [ $pK_b = 5, pK_a = 4$ ] is equal to

- 6.5
- 7.0
- 7.5
- 8.0

**Q24**

The room where you live is spread with a radioactive element.

Its half-life is 60 days. Its activity is 100 times the permissible value.

After how many days will it be advisable to enter the room?

- a. 10 days
- b. 398 days
- c. 600 days d. 39.8 days

**Q25**

The average oxidation number of 'C' in  $C_3O_2$  and  $Mg_2C_3$  are.....respectively.

- a.  $-\frac{4}{3}, +\frac{4}{3}$
- b.  $+\frac{4}{3}, -\frac{4}{3}$
- c. 4, 4
- d.  $+\frac{2}{3}, -\frac{2}{3}$

**Q26**

Which of the following is the most stable?

- a. But -1-ene
- b. But-2-ene
- c. Pent-1-ene
- d. Ethane

**Q27**

An engine absorbs heat of 5000 kcal from source at  $127^\circ C$ . The efficiency of the engine when it is connected to a sink at  $27^\circ C$  will be

- a. 0.75
- b. 0.25
- c. 0.85
- d. 0.15

**Q28**

The time required for 99% of 1st order reaction to complete is 100 min. How much time will it take to 99% completion?

- a. 100 min
- b. 200 min
- c. 300 min
- d. 400 min

**Q29**

Which of the following will produce  $H_2$ ?

- (i).  $Fe + H_2SO_4(dil) \rightarrow$
- (ii).  $Mg + HN_3(5\%) \rightarrow$
- (iii).  $Sn + HCl(dil) \rightarrow$
- (iv).  $Cu + H_2SO_4(conc.) \rightarrow$

- a. (i) and (iv)
- b. (i), (ii) and (iv)
- c. (i), (ii), (iii) and (iv)
- d. (i), (ii) and (iii)

**Q30**

The gold numbers of P, Q, R and S are 0.04, 0.002, 10 and 25 respectively. The protecting powers of P, Q, R and S are in the order

- a.  $P > Q > R > S$
- b.  $Q > P > R > S$
- c.  $Q > S > R > P$
- d.  $S > R > Q > P$

**Q31**

The product of  $\text{I}^-$  with  $\text{O}_4^{2-}$  in alkaline medium is

- a.  $\text{I}_2$
- b.  $\text{IO}_3^-$
- c.  $\text{IO}^-$
- d.  $\text{IO}_4^-$

**Section-II****Assertion-Reason Type****Q32****Statement-1:**

The energy of an electron is mainly determined by the value of principle quantum number. Because

**Statement-2:**

The principle quantum number 'n' is measure of the most probable distance of finding the electron around the nucleus.

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is True, Statement-2 is True

**Q33****Statement-1:**

At isoelectric point of an amino acid, the solubility of amino acid becomes minimum. because

**Statement-2:**

It is because +ve and -ve charge on Zwitter ion is equal at isoelectric point.

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is True, Statement-2 is True

**Statement-1:**

Phenoxide ion is stronger base as compared to ethoxide ion.

because

**Statement-2:**

Phenol is stronger acid in comparison to ethanol.

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is True, Statement-2 is True

**Q35**

**Statement-1:**

Most of the endothermic reactions are not spontaneous at room temperature but become spontaneous at higher temperature.

Because.

**Statement-2:**

Entropy of system increase with increase in temperature and  $T\Delta S$  becomes greater than  $\Delta H$ .

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is True, Statement-2 is True

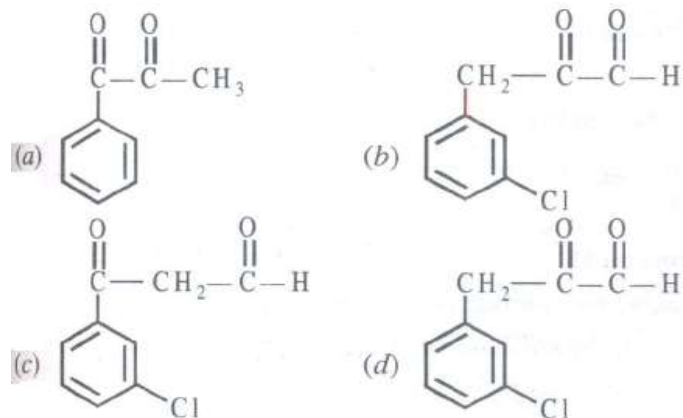
**Section-III**

**Linked Comprehension Type**

**C<sub>36-38</sub>: Paragraph for Question Nos. 36 to 38**

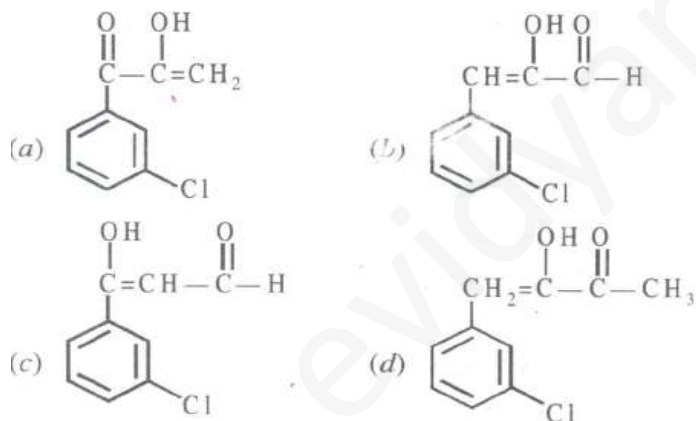
Compound 'A' of molecular formula  $C_9H_7O_2Cl$  exists in keto form and predominantly in enolic form 'B'. On oxidation with  $KMnO_4$  'A' gives m- chlorobenzoic acid.

The structure 'A' in keto form is



**Q37**

The structure of enol form of 'A' is



**Q38**

Out of 'A' and 'B' which will give violet color with  $\text{FeCl}_3$ ?

- Both 'A' and 'B'
- Only 'B'
- Only 'A'
- Neither 'A' nor 'B'

**C<sub>39-41</sub>: Paragraph for Question Nos. 39 to 41**

Hydrogen is the most abundant element in the universe because it is present in the Sun and the stars. It has 7 isotopes discovered so far:  ${}^1_1\text{H}$ ,  ${}^2_1\text{H}$ ,  ${}^3_1\text{H}$ ,  ${}^4_1\text{H}$ ,  ${}^5_1\text{H}$ ,  ${}^6_1\text{H}$ ,  ${}^7_1\text{H}$ . The half-life of  ${}^4_1\text{H}$ ,  ${}^5_1\text{H}$ ,  ${}^6_1\text{H}$  are  $9.93 \times 10^{-23}$ ,  $8.01 \times 10^{-23}$ ,  $3.26 \times 10^{-22}$  second respectively. In 2003, hydrogen -7 was produced at the Riken lab in Japan. By colliding a high energy beam of He-8 atoms with cryogenic hydrogen target and detecting tritons, the Nuclei of tritium atom and neutrons from break up of hydrogen -7, the same method is used to produce Hydrogen -5. It can be liquefied at low temperature. It can be solidified at  $-196^\circ\text{C}$  and 2.5 million atm Pressure to a black metal like solid. It is the lightest gas. Due to its controversial position in periodic table, It is known as rogue element. Ortho hydrogen and para hydrogen are allotropes of hydrogen.

**Q39**

The half-life of  ${}^3_1\text{H}$  is

- a. 12.32 years
- b. 12.32 month
- c. 12.32 min
- d. 12.32 s.

**Q40**

$2\text{Na} + \text{H}_2 \xrightarrow{\text{heat}} 2\text{NaH}$  (sodium hydride) In the above reaction,  $\text{H}_2$  acts as

- a. Oxidising agent
- b. Reducing agent
- c. Both (a) and (b)
- d. None of these

**Q41**

Which of the following isotope of hydrogen is radioactive ?

- a.  ${}^1_1\text{H}$
- b.  ${}^2_1\text{H}$
- c.  ${}^3_1\text{H}$
- d. None of these.

**Section-IV**

**Matrix-Match Type**

If the correct matches are A – P, A – S, B – Q, B – R, C – p < C – q and D – S, then the correctly bubbled matrix should be as follows:

	P	Q	R	S
A	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
B	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
C	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
D	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

**Q42**

**Column I**

- Fusion mixture
- Diborane
- Nitric oxide
- Producer gas

**Q43**

**Column I**

- $\text{Ni}^{2+} + \text{DMG} \rightarrow (\text{dimethyl glyoxime})$
- $\text{Co}^{2+} + (\text{NH}_4)\text{SCN} \xrightarrow{\text{Acetone}}$
- $\text{Ba}^{2+} + \text{CrO}_4^{2-} \rightarrow$
- $\text{Ca}^{2+} + \text{C}_2\text{C}_4^{2-} \rightarrow$

**Q44**

**Column I**

- Baeyer's reagent
- Ammoniacal curpous chloride
- Aqueous KOH + dil.  $\text{HNO}_3$  +  $\text{AgNO}_3$
- Aqueous KHO + 2, 4- DNP

**Column II**

- $\text{CO} + \text{N}_2$
- $\text{K}_2\text{CO}_3 + \text{Na}_2\text{CO}_3$
- reducing agent
- Colorless, paramagnetic

**Column II**

- White ppt.
- Scarlet red ppt.
- Blue coloration
- Yellow ppt.

**Column II**

- Ethylidene chloride and ethylene chloride
- Benzyl chloride and benzyl bromide
- But-1-yne and but-2-yne
- Benzene and cyclohexene



**Part-III (Mathematics)****Section-I****Straight Objective Type****Q45**

If  $f(x) = \log\left(\frac{1+x}{1-x}\right)$  then  $f(x) + f(y)$  is

- a.  $f(x + y)$
- b.  $f\left(\frac{x+y}{1+xy}\right)$
- c.  $(x + y) f\left(\frac{1}{1+xy}\right)$
- d.  $f(x) + \frac{f(y)}{1+xy}$

**Q46**

The smallest positive solution of the equation  $(81)^{\sin^2 x} + (81)^{\cos^2 x} = 30$  is

- a.  $\frac{\pi}{12}$
- b.  $\frac{\pi}{6}$
- c.  $\frac{\pi}{3}$
- d. None of these

**Q47**

Let length of the common chord of two circles of radii 15 cm and 20 cm, whose centres are 25 cm apart, is (in cm)

- a. 16
- b. 24
- c. 15
- d. 20

Let A be the fixed point (0, 4). And B be a moving point (2t, 0). Let M be the mid-point of AB and let the perpendicular bisector of AB meet the y-axis at R. The locus of the mid-point P of MR is

- a.  $y + x^2 = 2$
- b.  $x^2 + (y - 2)^2 = 1/4$
- c.  $(y - 2)^2 - x^2 = 1/4$
- d. None of these

**Q49**

The number of tangents that can be drawn from the point (2, 3) to the parabola  $y^2 = 8x$  is

- a. 1
- b. 2
- c. 0
- d. 3

**Q50**

If the two tangents drawn from a point P to the parabola  $y^2 = 4x$  are at right angles, then the locus of P is

- a.  $x - 1 = 0$
- b.  $2x + 1 = 0$
- c.  $x + 1 = 0$
- d.  $2x - 1 = 0$

**Q51**

The maximum distance between two points of the unit cube is

- a.  $\sqrt{2} + 1$
- b.  $\sqrt{2}$
- c.  $\sqrt{3}$
- d.  $\sqrt{2} + \sqrt{3}$

A variable plane passes through a fixed point  $(a, b, c)$  and cuts the co-ordinate axes at P, Q, R. Then the co-ordinates  $(x, y, z)$  or the centre of the sphere passing through P, Q, R and the origin satisfy the equation

a.  $\frac{a}{x} + \frac{b}{y} + \frac{c}{z} = 2$

b.  $\frac{x}{y} + \frac{y}{b} + \frac{z}{c} = 3$

c.  $ax + by + cz = 1$

d.  $ax + by + cz = a^2 + b^2 + c^2$

### **Q53**

If  $f(x) = \frac{1-x}{1+x}$  then  $f(f(\cos x))$  equal

a.  $x$

b.  $\cos x$

c.  $\tan^2(x/2)$

d. None of these

## **Section-II**

### **Assertion-Reason Type**

#### **Q54**

##### **Statement-1:**

Let  $P_n$  be the probability that 2 balls drawn from a bag containing  $n$  white and  $n$  black balls will be of the same color. Then  $\lim_{n \rightarrow \infty} p_n = \frac{1}{2}$  because

##### **Statement-2:**

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

a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1

b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1

c. Statement-1 is True, Statement-2 is False

d. Statement-1 is True, Statement-2 is True

**Statement-1:**

If  $I_n = \int_0^{\frac{\pi}{2}} \log \cos x \cdot \cos 2nx \, dx$   $I_n = -\frac{n-1}{n} I_{n-1}$

because

**Statement-2**

$$I_n = \frac{1}{2n} \int_0^{\pi/2} \tan x \sin 2nx.$$

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is False, Statement-2 is True

**Q 56.**

**Statement-1**

In a triangle ABC,  $A - B = 120^\circ$ .  $R = 8r$  then  $\cos c = \frac{7}{8}$  because

**Statement-2**

If a triangle  $R = 8r$  and  $A - B = 120^\circ$ , then  $\sin \frac{c}{2} = \frac{1}{4}$ .

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is False, Statement-2 is True

**Q 57.**

**Statement-1:**  $\lim_{x \rightarrow \infty} \frac{x + \log \sqrt{1+x^2}}{x^2} = \frac{1}{6}$ . Because

**Statement-2:**  $\lim_{x \rightarrow \infty} \frac{1 - \frac{1}{\sqrt{1+x^2}}}{3x^2} = \frac{1}{6}$

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is False, Statement-2 is True

## Section-III

**Linked Comprehension Type****M<sub>58-60</sub> : Paragraph for Question Nos. 58 to 60**

The graph of a function  $f(x)$  in the first quadrant is said to be convex if  $f''(x) > 0$ . We can also say that in such a graph chord is above the curve. A graph which is not convex is said to be concave. Answer the following questions:

**Q 58.**

Let  $x_1, x_2$  be the abscissae of two points in the first quadrant which lie on the graph of a convex function  $f(x)$  then

- $f\left(\frac{x_1+x_2}{2}\right) \leq \frac{f(x_1)+f(x_2)}{2}$
- $f\left(\frac{x_1+x_2}{2}\right) \geq \frac{f(x_1)+f(x_2)}{2}$
- $f\left(\frac{x_1+x_2}{2}\right) = 0$  for all  $x_1, x_2$
- None of these

**Q 59.**

Which of the following function's graph is convex in the first quadrant

- $\log x$
- $\sin x$
- $x^3$
- None of these

**Q 60.**

In the first quadrant, the graph of the function  $y = x^2 \log x$

- is convex only
- is concave only
- can be both convex and concave
- None of these

**M<sub>61-63</sub> : Paragraph for Question Nos. 61 to 63**

An inequality  $f(a, b, c) \geq g(a, b, c)$  is said to be a superior inequality as compared of  $f(a, b, c) \geq h(a, b,$

c) if  $g(a, b, c) > h(a, b, c)$ . Further an inequality  $f(a, b, c) \geq g(a, b, c)$  is said to be a better result as

compared to  $f(a, b, c) \geq h(a, b, c)$  if whenever former is true, the later is essentially true. The functions

$f(a, b, c), g(a, b, c), h(a, b, c)$  may also contain two or one variable. Answer the following questions:

For  $0 < x < \frac{\pi}{2}$ ,  $\sin x = \tan x \cdot \cos x$

$$= \tan x \left(1 - 2\sin^2 \frac{x}{2}\right) > x \left(1 - 2 \cdot \frac{x^2}{4}\right)$$

$$\left(\because \tan x > x, \sin \frac{x}{2} < \frac{x}{2}, -2\sin^2 \frac{x}{2} > -2 \frac{x^2}{4}\right)$$

Thus  $\sin x > x - \frac{x^3}{2}$ .

Which if the following is a superior inequality than  $\sin x > x - \frac{x^2}{2}$  ?

- a.  $\sin x > x + \frac{x^2}{2}$
- b.  $\sin x > x - \frac{x^3}{8}$
- c.  $\sin x > x - \frac{x^3}{4}$
- d. None of these

**Q 62.**

Which of the following is a superior inequality than  $\sin x > x - \frac{x^2}{4}$  ( $0 < x < \frac{\pi}{2}$ ) ?

- a.  $\sin x > x + \frac{x^2}{4}$
- b.  $\sin x > x - \frac{x^3}{6}$
- c.  $\sin x < x$
- d. None of these

**Q 63.**

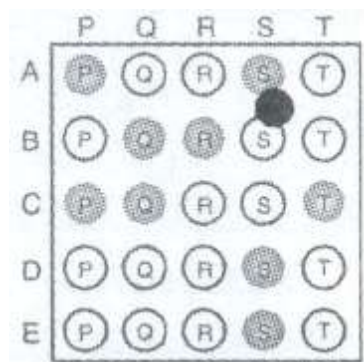
Consider a true statement, if a, b, c are sides of a triangle then  $abc \geq (a + b - c)(b + c - a)$ . Which of the following is a better(true) result than this ?

- a. If a, b, c are real numbers there then.  $abc \geq (a + b - c)(b + c - a)(c + a - b)$
- b. If a, b, c are positive then  $abc \geq (a + b - c)(b + c - a)(c + a - b)$
- c. If a, b, c are negative numbers then  $abc \geq (a + b - c)(b + c - a)(c + a - b)$
- d. None of these

**Section-IV**

**Matrix-Match Type**

If the correct matches are A – P, A – S, B – Q, B – R, C – P, C – Q, D – S and C – T, then the correctly bubbled 5 x 5 matrix should be as follow



**Q 64.**

Match the following events with their probabilities when 4 balls are drawn from bag containing  $4n$  balls of four different color. (Balls of same color are identical and number of balls of each color is  $n$ ,  $n \geq 4$ ).

a. Balls drawn are of same color

P.  $\frac{3n^3}{(2n-1)(4n-1)(4n-3)}$

b. Balls drawn are of different colors

Q.  $\frac{3n(n-1)(7n+1)}{(4n-1)(2n-1)(4n-3)}$

c. Balls drawn are of two colors

R.  $\frac{3n(n-1)}{(4n-1)(2n-1)(4n-3)}$

d. Balls drawn are of three colors

S.  $\frac{(4-1)(n-2)(n-3)}{(4n-1)(4n-2)(4n-3)}$

**Q 65.**

Match the following :

a. If  $\beta$  be a root of the equation  $x^5 - 1 = 0$  then  $\beta^{15} + \beta^{16} + \dots + \beta^{50}$  must be equation p. 4

b. If  $2f(x^2) + 3f\left(\frac{1}{x^2}\right) = x^2 - 1$ , then  $f(1)$  is equal to q. 1

c. The number of solutions of  $|x + 1| = |x - 1|$  is r. 3

d. The least positive integer for which  $4^x + 8^{\frac{2}{3}(x-2)} - 72 - 4^{x-\frac{3}{2}}$  is non-negative s. 0

Q 66.

Match the following :

- a. The distance between circumcentre and Incentre of triangle, the affixes of whose vertices are  $1, w, w^2$  is p. 6
- b. If  ${}^{2n}C_4, {}^{2n}C_5, {}^{2n}C_6$  are in A.P then n is q. 3
- c. On  $[0, 2]$  the maximum value of  $f(x) = \max\{x^2, x - 1, 3x\}$  is r. 0
- d. If  $f(x) = [x] + \sum_{r=1}^{2008} \frac{x+r-[x+r]}{2008}$  then  $f(3) =$  s. 7



## Paper – II

### Part-I (physics)

#### Section-I

#### Straight Objective Type

##### Q1

The ratio of de-Broglie wavelength of molecules of Hydrogen and Helium which are at  $27^{\circ}\text{C}$  and  $127^{\circ}\text{C}$  respectively is

a.  $\sqrt{\frac{5}{3}}$

b.  $\sqrt{\frac{8}{3}}$

c.  $\sqrt{\frac{3}{5}}$

d.  $\sqrt{\frac{3}{8}}$

##### Q2

A uniform rod of length  $l$  is placed with one end in contact with the horizontal table and is then inclined to an angle  $\alpha$  to the horizontal and allowed to fall. When it becomes horizontal, its angular velocity will be.

a.  $\omega = \sqrt{\frac{3g \sin\alpha}{l}}$

b.  $\omega = \sqrt{\frac{2l}{3g \sin\alpha}}$

c.  $\omega = \sqrt{\frac{g \sin\alpha}{l}}$

d.  $\omega = \sqrt{\frac{l}{g \sin\alpha}}$

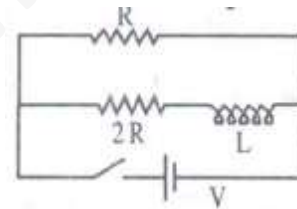
Two wires A and B of same material but radii  $r_1$  and  $r_2$  support a mass  $M$  as shown. If a force of  $\frac{Mg}{3}$  is applied at the free end, then :

- a. for  $r_1 = r_2$ , string B breaks before A
- b. for  $r_1 < 2r_2$ , string B breaks before A
- c. string B breaks always first
- d. for  $r_1 = 2r_2$ , any of them may break

Q4

A plane mirror is made of glass slab of refractive index  $\mu = 1.5$ , thickness 2.5 cm and silvered on the back. A point object is placed 5 cm in front of the un-silvered face of the mirror. The position of final image is from front face.

- a. 12 cm.
- b. 14.6 cm.
- c. 5.67 cm.
- d. 8.33 cm.

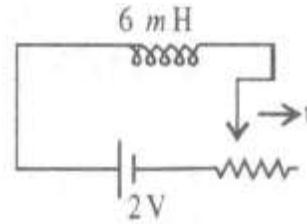


Q5

The ratio of time constant during charging and discharging in the circuit shown is

- a. 1 : 1
- b. 3 : 2
- c. 2 : 3
- d. 1 : 3

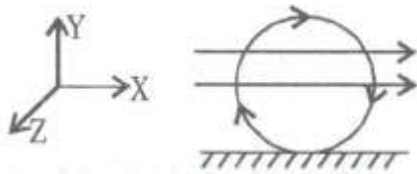
Sliding contact in circuit shown, moves with uniform velocity towards right. Value of resistance at an instant is  $4 \Omega$ . Then at that instant



- Current in the circuit  $0.5A$
- Current in the circuit is greater than  $0.5A$
- Current in the circuit is less than  $0.5 A$
- There is a small current of  $6mA$  in the circuit

**Q7**

A conducting ring of mass  $2 \text{ kg}$  and radius  $0.5 \text{ m}$  is placed on a smooth horizontal plane. The ring carries a current of  $4 \text{ A}$ . A horizontal magnetic field  $b= 10T$  is switched on at time  $t = 0$ . The initial angular acceleration of the ring will be



- $40 \pi \text{ rad/s}^2$
- $20 \pi \text{ rad/sec}^2$
- $5 \pi \text{ rad/s}^2$
- $15 \pi \text{ rad/sec}^2$

**Q8**

A particle is projected with a speed  $u_0$  at an angle  $\theta$  with the horizontal. Radius of curvature of the highest point is :

- $\frac{u^2 \cos^2 \theta}{g}$
- $\frac{u^2 \sin^2 \theta}{g}$
- $\frac{u^2}{g}$
- $\frac{u^2}{g \cos \theta}$

**Q9**

In as Isothermal expansion of ideal gas

- a.  $\Delta T = 0$
- b.  $\Delta U = 0$
- c. the work done by gas is equal to heat supplied to the gas.
- d.  $W = \Delta U$

**Section-II****Assertion-Reason Type****Q10****Statement-1:**

Kirchhoff's rule law represents conservation of energy. because

**Statement-2:**

If the sum of potential changes around a closed loop is not zero, unlimited energy could be gained b repeatedly carrying a charge around a loop

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is False, Statement-2 is True

**Q11****Statement-1:**

Internal energy change is zero if the temperature is constant, irrespective of the process being cyclic or non-cyclic. because

**Statement-2:**

$dU = nC_v dT$  for all processes and is independent of path.

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is False, Statement-2 is True

**Q12****Statement-1:**

Rise of water level in capillary tube should be accounted vertically and not on the length of the pipe in which it has raised.

because

**Statement-2:**

More the radius, the rise will decrease for different liquids tested.

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is False, Statement-2 is True

**Q13****Statement-1:**

An iron ball and a wooden ball are both released at the same height. In the presence of a medium both the balls reach the ground with different velocities and different times. because

**Statement-2:**

Both the balls reach the ground simultaneously.

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is False, Statement-2 is True

### Section-III

#### Linked Comprehension Type

#### M<sub>14-16</sub>: Paragraph for Question Nos. 14 to 16

A potentiometer wire of length 10 m shows null points shifted by 60 cm for two cells with a emf difference of 0.4 volt.

#### Q14

Potential gradient along the potentiometer wire is, (in V/m)

a.  $\frac{2}{3}$

b.  $\frac{3}{2}$

c.  $\frac{20}{3}$

d.  $\frac{4}{5}$

#### Q15

Potential across the potentiometer wire is, (in volt)

a.  $\frac{2}{3}$

b.  $\frac{20}{3}$

c.  $\frac{3}{2}$

d.  $\frac{30}{2}$

#### Q16

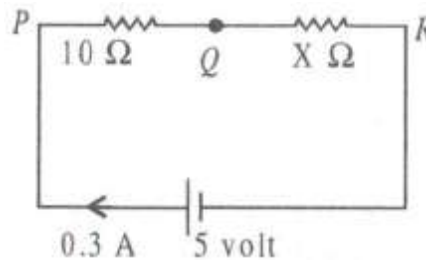
If the point  $P$  is connected to the +ve end of the potentiometer wire and  $Q$  is connected to the galvanometer, the balancing length is

a. 30 cm

b. 60 cm

c. 90 cm

d. 45 cm



**M<sub>17-19</sub>: Paragraph for Question Nos. 17 to 19**

A particle of mass 3 kg is moving under the action of central force, whose potential energy is given by  $U(r) = 10 r^3$  Joule.

**Q17**

For the particle to move in a circle of radius 10 m, the velocity is :

- a. 10 m/s
- b. 1 m/s
- c. 100 m/s
- d. 1000m/s

**Q18**

The angular momentum for the particle to orbit in the circle, is :

- a. 3 kg m<sup>2</sup>/sec
- b. 30 kg m<sup>2</sup>/sec
- c. 300 kg m<sup>2</sup>/sec
- d. 3000 kg m<sup>2</sup>/sec

**Q19**

The total energy in circular motion is :

- a. 5 J
- b.  $25 \times 10^3$  J
- c.  $5 \times 10^3$  J
- d. 0.5 J

Section-IV

**Matrix-Match Type**

	P	Q	R	S
A	(P)	(Q)	(R)	(S)
B	(P)	(Q)	(R)	(S)
C	(P)	(Q)	(R)	(S)
D	(P)	(Q)	(R)	(S)

**Q20**

**Column I**

- Area between  $V = 0, t = 0$  and a constant  $V \neq 0, t \neq 0$
- Intersecting straight line  $x - t$  graphs for two bodies.
- Intersecting straight line  $V - t$  graphs for two bodies.
- Equations of Motion.

**Column II**

- Uniform motion
- Uniform Acceleration.
- Displacement of the body on motion.
- Equal velocity at a time.
- Same position.

**Q21**

**Column I**

- Wires made of some material
- Work done in stretching a wire
- poisson's ratio = 0.5
- Extension is more

**Column II**

- Elasticity is less
- Volume = constant
- Modulus of elasticity is constant
- $\frac{1}{2} \times \text{Volume} \times \text{Stress} \times \text{Strain}$
- $\frac{dr}{r} = -\frac{1}{2} \frac{dl}{l}$

**Q22**

**Column I**

- Rocket Propulsion
- Area under force-time graph
- change in speed of a 5 kg mass from say 2 to 5  $\text{ms}^{-1}$
- Equal masses under collision

**Column II**

- Impulse
- For one being at rest oblique collision will move them at right angles
- Acceleration with reducing mass.
- Have some velocity when coefficient of restitution is zero



## Part-II (Chemistry)

## Section-I

## Straight Objective Type

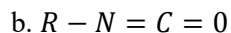
Q23

On heating one mole  $\text{KClO}_3$ , one mole of  $\text{O}_2$  is formed. Calculate the mole fraction of  $\text{KClO}_4$  in the final mixture containing only  $\text{KCl}$  and  $\text{KClO}_4$ ,  $\text{KClO}_4$  is obtained by parallel reaction.

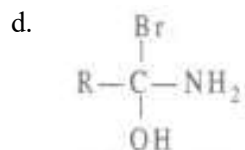
- a. 0.50
- b. 0.25
- c. 0.33
- d. 0.20

Q24

The different intermediates formed during Hofmann bromamide synthesis are



c. Both (a) and (b)

Q25

Pb and Sn can be extracted from their sulphide and oxide ore respectively by

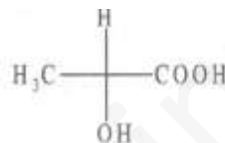
- a. Froth floatation, roasting, self-reduction; Hydraulic washing, calcination, carbon reduction
- b. Hydraulic washing, calcination, electrolysis; Froth floatation, roasting, carbon reduction
- c. Froth floatation, roasting, carbon reduction; Hydraulic washing, roasting, self-reduction
- d. None of these

$\text{KO}_2$  (Potassium superoxide) is used in oxygen cylinders in space and submarines because it

- Absorbs  $\text{CO}_2$  and increase  $\text{O}_2$  content
- Eliminates moisture
- Absorbs  $\text{CO}_2$
- Produces ozone

**Q27**

The Fischer projection formula of (+)-lactic acid is as



Which of the following is correct ?

- $\text{H}_3\text{C}$ - and  $-\text{COOH}$  groups are coming out of the plane.
- H-0 and  $-\text{OH}$  are coming out of the plane.
- $\text{H}_3\text{C}$ - and  $-\text{COOH}$  group are going into the plane.
- All are correct.

**Q28**

What will be binding energy per nucleon of  $^{16}_8\text{O}$  if mass defect is 0.210 amu ?

- 195.61 MeV
- 12.2 MeV
- 14.0 MeV
- 16.0 MeV

**Q29**

Sn reacts with conc.  $\text{HNO}_3$  to give

- $\text{Sn}(\text{NO}_3)_2$
- $\text{H}_2\text{SnO}_3$
- $\text{SnO}$
- None of these

Which of the following are isotonic with one another ?

1. 0.15 M urea
  2. 0.15 M  $\text{CaCl}_2$
  3. 0.15 M  $\text{MgSO}_4$
  4. 0.15 M glucose
- a. (i) and (ii)
  - b. (i), (ii), (iii), (iv)
  - c. (i) and (iv)
  - d. (ii) and (iii)

Q31

One gram of  $^{226}_{88}\text{Ra}$  has an activity nearly one Ci(Curie). The  $t_{1/2}$  of  $^{226}_{88}\text{Ra}$  is

- a. 1600 years
- b. 12.5 years
- c. 3200 years
- c. 1700 years

**Section-II**

**Assertion-Reason Type**

Q32

**Statement-1:**

Methanoic acid changes mercuric chloride to mercurous chloride (white ppt.) on heating but acetic acid does not. because

**Statement-2:**

Methanoic acid is stronger reducing agent than ethanoic acid.

- a. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- b. Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- c. Statement-1 is True, Statement-2 is False
- d. Statement-1 is False, Statement-2 is True

**Statement-1:**

The vapour pressure of water at  $27^{\circ}\text{C}$  in a one litre closed flask is greater than the vapour pressure of same amount of water in 3 L flask at  $27^{\circ}\text{C}$ . because

**Statement-2:**

The pressure of gas at a particular temperature is inversely proportional to volume of the gas.

- Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- Statement-1 is True, Statement-2 is False
- Statement-1 is False, Statement-2 is True

**Q34****Statement-1:**

The conversion of  $\text{NH}_4\text{CNO}$  into urea is an isomerization reaction. because

**Statement-2:**

Urea is the first organic compound prepared in the lab.

- Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- Statement-1 is True, Statement-2 is False
- Statement-1 is False, Statement-2 is True

**Q35****Statement-1:**

C-H bond in  $\text{CH}\equiv\text{CH}$  is stronger than C-H bond in  $\text{CH}_2=\text{CH}_2$ . because

**Statement-2:**

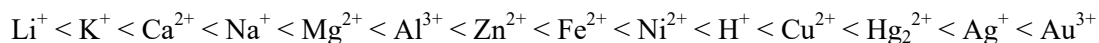
Sp-s overlapping is more effective than  $\text{sp}^2$ -s overlapping due to increase in size of  $\text{sp}^2$  hybridised orbital.

- Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- Statement-1 is True, Statement-2 is False
- Statement-1 is False, Statement-2 is True

**Linked Comprehension Type**

For a particular ion to be deposited at cathode, it requires minimum voltage which must be applied across the electrodes. The minimum voltage required is called discharge potential.

Increasing order of deposition of some metals:



For anions  $\text{SO}_4^{2-} < \text{NO}_3^- < \text{OH}^- < \text{Br}^- < \text{I}^-$

Lower the value of discharge potential, greater will be ease of deposition.

**Q36**

The products formed at anode and cathode, when dil.  $\text{H}_2\text{SO}_4$  is electrolyzed are

- a.  $\text{O}_2, \text{H}_2$
- b.  $\text{SO}_2, \text{H}_2$
- c.  $\text{H}_2\text{S}_2\text{O}_8, \text{H}_2$
- d.  $\text{SO}_3, \text{H}_2$

**Q37**

The amount of energy expended when current of 1 amp is passed for 100 seconds under a potential difference of 115 V is equal to

- a. 11.5 J
- b. 11.5 kJ
- c. 11.5 kW
- d. 11.5 kcal

**Q38**

When  $\text{H}_2\text{O}$  is electrolyzed using 1 Faraday of charge, volume of  $\text{O}_2$  liberated at anode at STP is equal to

- a. 22.4 L
- b. 11.2 L
- c. 5.6 L
- d. 2.8 L

A compound (W)  $C_{15}H_{17}N$  is treated with benzene sulphonyl chloride and aqueous KOH no apparent change occurs. Acidification of the mixture gives a clear solution. When W is reacted with  $CH_3I$ , an optically active compound (Y) is formed. Y gives yellow precipitate with  $AgNO_3$  solution. When Y is heated with  $Ag_2O$  then an amine of molecular formula  $C_{13}H_{18}N$  and ethylene are formed.

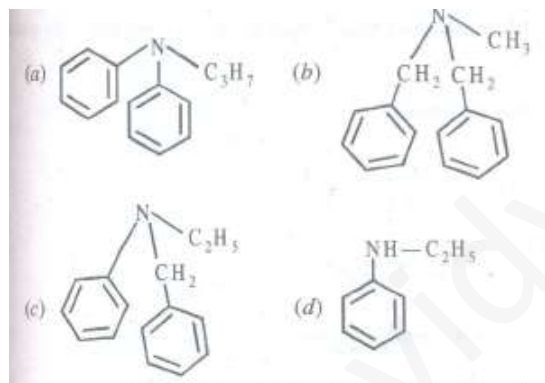
**Q39**

The degree of unsaturation in  $C_{15}H_{17}N$  is....and the number of phenyl group could be...

- a. 8, 8
- b. 2, 8
- c. 2, 2
- d. 8, 2

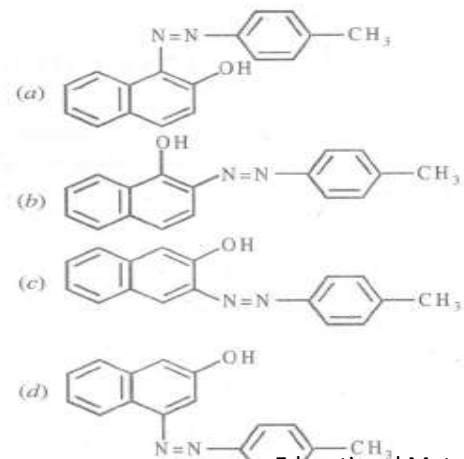
**Q40**

The compound W is therefore



**Q41**

When p-toluidine is diazotized and reacted with  $\beta$ -naphthol in basic medium then the compound formed is



**Matrix-Match Type**

	P	Q	R	S
A	P	Q	R	S
B	P	Q	R	S
C	P	Q	R	S
D	P	Q	R	S

**Q42**

**Column I**

- Dilution
- Increase in temperature
- Atmospheric pressure
- Nature of electrode

**Column II**

- discharging of ions
- reduction potential
- Equilibrium constant
- Vapour pressure

**Q43**

**Column I**

- $\alpha > 0 \rightarrow \alpha$ -Hydroxy carboxylic acid  
 $R-COOH \rightarrow R-CH_2COOH$   
 $R-CH=CH-CHO \rightarrow R-CH=CH-CH_2OH$
- Regioselective conversion of alkenes to alcohols.

**Column II**

- Arndt Eistert synthesis
- $Hg(OAc)_2/AcOH$
- (i) HCN (ii)  $H^+/H_2O$
- $NaBH_4$ .

**Q44**

**Column I**

- 2<sup>nd</sup> most abundant element in the earth crust.
- Most abundant transition element
- Most abundant element in the earth crust.
- Most abundant element in the universe.

**Column II**

- Fe
- $H_2$
- Si
- $O_2$

**Section-I****Straight Objective Type****Q45**

The value of  $\left(\frac{\sqrt{3}}{2} + i.\frac{1}{2}\right)^{165}$  is

- a. -1
- b.  $\frac{\sqrt{3}}{2} + i.\frac{1}{2}$
- c.  $i$
- d.  $-i$

**Q46**

The area of the triangle whose vertices are  $(a, a), (a + 1, a + 1), (a + 2, a)$  is

- a.  $a^3$
- b.  $2a$
- c. 1
- d.  $\sqrt{2}$

**Q47**

If in a triangle,  $a = 2b$  and  $A = 3B$ , then the triangle

- a. is isosceles
- b. is right-angled but not isosceles
- c. is right-angled and isosceles
- d. None of these



The number of values of  $x$  satisfying the equation  $\sqrt{\sin x} - \frac{1}{\sqrt{\sin x}} = \cos x$  is

- a. 0
- b. 2
- c. 3
- d. more than 3

**Q49**

The least period of the function  $\sin x + \tan x/2 - \cos 3x$  must be

- a.  $\frac{\pi}{3}$
- b.  $2\frac{\pi}{3}$
- c.  $2\pi$
- d.  $4\pi$

**Q50**

The equation of  $y^5x + y - x\frac{dy}{dx} = 0$  is

- a.  $\frac{x^4}{4} + \frac{1}{5}\left(\frac{x}{y}\right)^5 = C$
- b.  $\frac{x^5}{5} + \frac{1}{4}\left(\frac{x}{y}\right)^4 = C$
- c.  $\left(\frac{x}{y}\right)^5 + \frac{x^4}{4} = C$
- d.  $(xy)^4 + \frac{x^5}{5} = C$

**Q51**

If  $w$  is a complex cube root of unity, then the matrix  $A = \begin{bmatrix} 1 & w^2 & w \\ w^2 & w & 1 \\ w & 1 & w^2 \end{bmatrix}$  is a

- a. singular matrix
- b. non-singular matrix
- c. skew symmetric matrix
- d. None of these

**Q52**

The number of real values of  $a$  for which the system of equations  $x + ay - z = 0$ ,  $2x - y + az = 0$ ,  $ax + y + 2z = 0$  has a non-trivial solution, is

- a. 3
- b. 1
- c. 0
- d. infinite

**Q53**

Let there be two points  $A, B$  on the curve  $y = x^2$  in plane  $OXY$  satisfying  $OA \cdot i = 1$  and  $OB \cdot i = -2$  then the length of the vector  $2OA - 3OB$  is

- a.  $\sqrt{14}$
- b.  $2\sqrt{15}$
- c.  $3\sqrt{41}$
- d. None of these

**Section-II****Assertion-Reason Type****Q54****Statement-1:**

$n$  letters are put in  $n$  corresponding envelopes at random. The probability that exactly  $r$  ( $r \leq n$ ), letters go to the correct envelop is  $1 - \frac{C_r}{n!}$ . because

**Statement-2:**

$n$  letters in  $n$  corresponding envelopes can be put in  $n!$  ways.

- Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- Statement-1 is True, Statement-2 is False
- Statement-1 is False, Statement-2 is True

**Q55****Statement-1:**

The minimum value of  $|2x - 1| + |3x - 2| + |4x - 3|$  is  $\frac{2}{3}$ . because

**Statement-2:**

If  $a < b < c$ , then minimum value of  $A|x - a| + B|x - b| + C|x - c|$  ( $A, B, C > 0$ ) is attained at  $x = b$ .

- Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- Statement-1 is True, Statement-2 is False
- Statement-1 is False, Statement-2 is True

**Q56****Statement-1:**

If  $l_n = \int_0^{\pi/2} \sin^n x \, dx$  where  $n$  is a positive integer then  $l_n$  is rational if  $n$  is odd. because

**Statement-2:**

$$l_n = \frac{n-1}{n} l_{n-2}$$

- Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- Statement-1 is True, Statement-2 is False
- Statement-1 is False, Statement-2 is True

**Statement-1:**

$\frac{\tan 3x}{\tan x} = \tan\left(\frac{\pi}{3} - x\right) \tan\left(\frac{\pi}{3} + x\right)$  is an identity if  $x \neq \frac{K\pi}{6}$ , where  $K$  is an integer. because

**Statement-2:**

$\tan x$  is defined if  $x \neq (2m + 1)\frac{\pi}{2}$ , where  $m$  is a positive integer.

- Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
- Statement-1 is True, Statement-2 is False
- Statement-1 is False, Statement-2 is True

### Section-III

#### Linked Comprehension Type

**M<sub>58-60</sub>: Paragraph for Question Nos. 58 to 60**

Consider the ellipses  $E_1: a^2x^2 + b^2y^2 = 1$ ,  $E_2: B^2x^2 + a^2y^2 = 1$  ( $0 < a < b$ ) and answer the following questions

**Q58**

The distance between any foci of  $E_1$  and any foci of  $E_2$  must be

a.  $\frac{\sqrt{2}\sqrt{b^2-a^2}}{ab}$

b.  $\frac{\sqrt{3}\sqrt{b^2-a^2}}{ab}$

c.  $\sqrt{a^2 + b^2}$

d. None of these

**Q59**

If area bounded by  $E_1$  and  $E_2$  is  $4 \int_0^\alpha \frac{\sqrt{1-a^2x^2}}{b} + \int_\alpha^\beta \frac{\sqrt{1-b^2x^2}}{a} dx$  then

a.  $\alpha = \frac{1}{\sqrt{ab}}$ ,  $\beta = \frac{1}{b}$

b.  $\alpha = \frac{1}{\sqrt{a^2+b^2}}$ ,  $\beta = \frac{1}{a}$

c.  $\alpha = \frac{1}{\sqrt{a^2+b^2}}$ ,  $\beta = \frac{1}{b}$

d. None of these

The value of the integral described in Q. 59 above is

a.  $\frac{4}{ab} \tan^{-1} \frac{a}{b}$

b.  $\frac{4}{\sqrt{ab}} \tan^{-1} \frac{a}{b}$

c.  $\frac{4}{\sqrt{ab}} \tan^{-1} \frac{a}{b}$

d. None of the above

**M<sub>61-63</sub>: Paragraph for Question Nos. 61 to 63**

Consider the number function  $f(n)$  defined by  $f(n) = 2^{2^n} + 1$  ( $n \in \mathbb{N}$ ).

**Q61**

$(f(n) - 1)^2$  is equal to

a.  $f(2n) - 1$

b.  $f(n + 1) - 1$

c.  $f(n + 1) - 1$

d. None of these

**Q62**

If  $m$  and  $n$  are distinct positive integers then

a. HCF of  $(m)$  and  $f(n)$  can be a non-unity number

b. HCF of  $f(m)$  and  $f(n)$  is essentially

c.  $\text{HCF} = \min(m, n)$

d. None of these

The correct answer in Q. 62 implies

- The number of prime numbers is finite
- The number of prime numbers is infinite
- The gaps between two successive primes can be as large as possible
- None of these

### Section-IV

	P	Q	R	S
A	P	O	R	S
B	P	Q	R	S
C	P	Q	R	S
D	P	Q	R	S

### Matrix-Match Type

#### Q64

Let  $I_m = \int_0^{\infty} e^{-x} (\sin x)^m dx$  where  $m$  is a positive integer greater than 2, then  $A I_5 = B I_3$  whence  $A, B$  are positive integers. Then match the following :

- |             |       |
|-------------|-------|
| a. A        | p. 24 |
| b. B        | q. 26 |
| c. $85 I_4$ | r. 20 |

#### Q65

If  $\int \frac{dx}{(2x-3)\sqrt{4x-x^2}} = C - \frac{1}{\sqrt{A}} \ln \left| \frac{x+B\sqrt{Dx-Ex^2}}{2x-3} \right|$ , ( $A, B, C, D$  are independent of  $x$ ), then match the following:

- |      |       |
|------|-------|
| a. A | p. 6  |
| b. B | q. 60 |
| c. C | r. 15 |
| d. D |       |
| e. E |       |

Match the limits of following expressions when  $\rightarrow \infty$  :

a.  $\frac{1}{n} + \frac{n^2}{(n+1)^3} + \frac{n^2}{(n+2)^3} + \dots + \frac{1}{8n}$

p.  $1/24$

b.  $\frac{1}{n} + \frac{1}{n+1} + \frac{1}{n+2} + \dots + \frac{1}{4n}$

q.  $\pi/2$

c.  $\sum_{r=1}^{3n} \frac{n^3}{(3n+r)^3}$

r.  $\log 4$

d.  $\frac{1}{\sqrt{2n-1^2}} + \frac{1}{\sqrt{4n-2^2}} + \frac{1}{\sqrt{6n-3^2}} + \dots + \frac{1}{n}$

s.  $3/8$