

Q1

Let the six numbers  $a_1, a_2, a_3, a_4, a_5, a_6$  be in A.P and  $a_1 + a_3 = 10$ . If the mean of these six numbers is  $\frac{19}{2}$  and their variance is  $\sigma^2$ , then  $8\sigma^2$  is equal to

- (1) 105 (2) 200 (3) 210 (4) 220

Q2

Let  $\vec{p}$  and  $\vec{q}$  be two vectors. The vector  $\vec{p}$  is given by  $\vec{p} = \hat{i} + m\hat{j} + n\hat{k}$ , where  $m, n$  are real numbers. The angle between  $\vec{p}$  and  $\vec{q}$  is  $\frac{\pi}{3}$ . If the magnitude squared of  $\vec{q}$  is 16, and their scalar product  $\vec{p} \cdot \vec{q}$  equals 4, what is the value of  $(m^2 + n^2)|\vec{p} \times \vec{q}|^2$ ?

- (1) 121 (2) 169 (3) 196 (4) 144

Q3

Consider a function  $f(x) = x^3 + Ax^2 + B \ln|x| + 5$ , where  $A$  and  $B$  are constants. It is given that  $x = -2$  and  $x = 1$  are its critical points. Determine the absolute minimum ( $m$ ) and absolute maximum ( $M$ ) values of  $f$  on the interval  $[-3, -1]$ . Then, calculate the value of  $|M + m|$ . (Take  $\ln 2 = 0.7$  and  $\ln 3 = 1.1$ )

- (1) 13.8 (2) 14.2 (3) 12.9 (4) 15.1

Q4

For the binomial expansion of  $\left(\sqrt[3]{4} + \frac{1}{\sqrt[3]{2}}\right)^n$ , where  $n$  is a positive integer, if the ratio of the 16<sup>th</sup> term from the initial position to the 16<sup>th</sup> term from the final position is  $\frac{1}{16}$ , calculate the value of  ${}^n C_3$ .

- (1) 2600 (2) 2925 (3) 2300 (4) 2024

Q5

Let  $I_1$  be the line  $4x + 3y = 3$  and  $I_2$  be the line  $y = 8x$ .  $L_1$  is the line formed by reflecting  $I_1$  across the line  $y = x$  and  $L_2$  is the line formed by reflecting  $I_2$  across the  $x$ -axis. If  $\theta$  is the acute angle between  $L_1$  and  $L_2$  such that  $\tan \theta = \frac{a}{b}$ , where  $a$  and  $b$  are coprime then find  $(a + b)$

- (1) 71 (2) 63 (3) 57 (4) 27

Q6

Let  $A = \begin{bmatrix} a & x & p \\ y & q & b \\ r & c & z \end{bmatrix}$  and  $B = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$  where  $a, b, c, x, y, z, p, q, r$  are natural numbers. If

$\text{tr.}(AB + AB^3 + AB^5 + \dots + AB^{19}) = 210$ , then find number of ordered triplets  $(p, q, r)$ . [Note:  $\text{tr.}(P)$  denotes the trace of matrix  $P$ ].

- (1) 180 (2) 210 (3) 200 (4) 190

**Q7** Consider two vectors  $\vec{u} = \hat{i} - 2\hat{j} + \hat{k}$  and  $\vec{v} = 3\hat{i} + \hat{j} - 2\hat{k}$ . Let  $\vec{w}$  be a vector such that  $\vec{u} \times \vec{w} = \vec{w} \times \vec{v}$  and  $(\vec{u} + \vec{w}) \cdot (\vec{v} + \vec{w}) = 35$ . What is the maximum value of  $|\vec{w}|^2$ ?

(1) 18 (2) 36 (3) 72 (4) 54

**Q8** Consider a real valued continuous function  $f$  such that  $f(x) = \sin x + \int_{-\pi/2}^{\pi/2} (\sin x + tf(t))dt$ . If  $M$  and  $m$  are maximum and minimum value of the function  $f$ , then

(1)  $\frac{M}{m} = 4$  (2)  $M - m = 2\pi + 1$   
 (3)  $M + m = 4(\pi + 1)$  (4)  $Mm = 2(\pi^2 + 1)$

**Q9** The lines  $\frac{x-4}{15} = \frac{y-17}{9} = \frac{z-11}{8}$  and  $\frac{x-15}{4} = \frac{y-9}{17} = \frac{z-8}{11}$  intersect at the point  $P$ , then square of the distance of  $P$  from the origin is  $1400 - \alpha$ ,  $\alpha =$

(1) 0 (2) 4 (3) 2 (4) 8

**Q10** 2 parabolas have the focus  $(5, -2)$ . Their directrices are  $x$ -axis and  $y$ -axis respectively. If the slope of their common chord is  $m$  then value of  $16m^2$  is

(1) 4 (2) 8 (3) 12 (4) 16

**Q11** A person has to catch a train. To catch train, from his home he can take a taxi or take rickshaw or walk by foot with respective probabilities  $\frac{1}{2}, \frac{1}{3}, \frac{1}{6}$ . Probability of him catching train when he takes rickshaw from his home is half that of when he takes the taxi and probability of catching the train when he walked by foot is  $\frac{1}{4}$  th that of when he takes rickshaw. He finally reached the train, the probability he walked by his foot to catch the train, is

(1)  $\frac{1}{33}$  (2)  $\frac{2}{33}$  (3)  $\frac{7}{33}$  (4)  $\frac{13}{33}$

**Q12** Consider a geometric progression (G.P.) with positive and increasing terms. If the product of the first and fifth terms is 9, and the sum of the second and fourth terms is  $4\sqrt{3}$ , determine the value of the sixth term.

(1)  $27\sqrt{3}$  (2)  $9\sqrt{3}$  (3)  $3\sqrt{3}$  (4)  $81\sqrt{3}$

**Q13** The value of the integral  $\int_{\frac{\pi-2}{4}}^{\frac{\pi-1}{2}} [\sin^{-1}(\sin(2x + 1))] dx$  (where  $[.]$  denotes greatest integer function) is equal to

(1)  $\pi - 2$  (2) 2 (3)  $\frac{\pi}{2} - 1$  (4) 1

Q14

If  $f(x) = \begin{cases} (p^2 - 1)(\{x\} + 2[x]) - 2, & -2 < x \leq -1 \\ q\left(\frac{e^x + e^{-x}}{2}\right) + |p|(x - 1), & -1 < x < 2 \end{cases}$ ,  $p, q \in R$  is continuous in  $(-2, 2)$  then  $f(f(f(\frac{-1}{2})))$  is

- [Note:  $[k]$  denotes greatest integer function less than or equal to  $k$  and  $\{k\}$  denotes fractional part function of  $k$ .]  
 (1) -2 (2) -1 (3) 0 (4) not defined

Q15

Let  $F(x) = \log_e\left(\frac{x-1/4}{x^2-4}\right) + \cos^{-1}\left(\frac{11x-13}{5(x+1)}\right)$ . If the domain of  $F(x)$  is expressed as  $(\alpha, \beta]$ , calculate the numerical value of  $5\beta - 4\alpha$ .

- (1) 6 (2) 7 (3) 8 (4) 9

Q16

$A(1, 0)$  and  $B(0, 1)$  and two fixed points on the circle  $x^2 + y^2 = 1$ .  $C$  is a variable point on this circle. As  $C$  moves, the locus of the orthocentre of the triangle  $ABC$  is

- (1)  $x^2 + y^2 - 2x - 2y + 1 = 0$  (2)  $x^2 + y^2 - x - y = 0$   
 (3)  $x^2 + y^2 = 4$  (4)  $x^2 + y^2 + 2x - 2y + 1 = 0$

Q17

If the complex numbers  $z_1$  and  $z_2$  are the solutions of the equation  $z^2 - z + 1 = 0$ , then the value of the expression  $E = (z_1^4 - z_1^3 + 2z_1^2 - 2z_1 + 1)^{2013} + (z_2^4 - z_2^3 + 2z_2^2 - 2z_2 + 1)^{2013}$ , is

- (1) 1 (2) 2 (3) -200 (4) -2

Q18

Consider a function  $f : [0, 4] \rightarrow P$  defined by  $f(x) = x^3 - 6x^2 + 9x + 5$ . Also, let  $g : [0, \infty) \rightarrow Q$  be a function given by  $g(x) = \frac{x^2}{x^2 + 4}$ . If both  $f$  and  $g$  are surjective (onto) functions, and  $K = \{k \in \mathbf{Z} : k \in P \text{ or } k \in Q\}$ , then determine the number of elements in the set  $K$ .

- (1) 5 (2) 6 (3) 7 (4) 8

Q19

$\cos^4 \frac{\pi}{8} + \cos^4 \frac{2\pi}{8} + \cos^4 \frac{3\pi}{8} + \cos^4 \frac{4\pi}{8} + \cos^4 \frac{5\pi}{8} + \cos^4 \frac{6\pi}{8} + \cos^4 \frac{7\pi}{8} + \cos^4 \frac{8\pi}{8}$  is equal to

- (1) 3 (2) -1 (3) 1 (4) 4

Q20

Let  $A$  be a vertex of the ellipse  $S \equiv \frac{x^2}{4} + \frac{y^2}{9} - 1 = 0$  and  $F$  be a focus of the ellipse  $S' \equiv \frac{x^2}{9} + \frac{y^2}{4} - 1 = 0$ . Let  $P$  be a point on the major axis of the ellipse  $S' = 0$ , which divides  $OF$  in the ratio  $2 : 1$  ( $O$  is the origin). If the length of the chord of the ellipse  $S = 0$  through  $A$  and  $P$  is  $\frac{3\sqrt{101}}{k}$ , then  $k =$

- (1) 7 (2) 6 (3) 12 (4) 14

**Q21**

The remainder when  $\left(\sum_{k=1}^5 {}^{20}C_{2k-1}\right)^6$  is divided by 11, is :

**Q22**

Determine the count of integers between 200 and 800 (inclusive) that are perfectly divisible by 2 and 7, yet are not divisible by 3 and 14 simultaneously.

**Q23**

Consider the distinct letters available in the word 'EQUATION'. Determine the total count of 6-letter strings that can be formed, where each letter used in a string must occur at least twice.

**Q24**

Let  $\alpha$  and  $\beta$  be the roots of the equation  $x^2 + 4x + 13 = 0$ . Define  $S_n = \alpha^n + \beta^n$ . If  $4S_{10} = aS_9 - b$ , find the value of  $a + b$  given that:  $S_{12} + 2S_{11} - 3S_{10} = 156$ .

**Q25**

Let  $f(x)$  and  $g(x)$  are differentiable function of  $x$  such that

$$x^2(gf(x)) \cdot (f'g(x)) \cdot (g'(x)) = (1 - 2x^2)(g'f(x)) \cdot (f'(x))f(g(x)) \forall x \in R.$$

Moreover  $g(x)$  is positive and  $f(x)$  is non negative and  $\int_0^k f(g(x))dx = 1 - e^{-k^2}$ , then the value of  $\ln\left(\frac{gf(3)}{gf(2)}\right)$  is P, find 4P.

**Q26**

A small block is released from rest at a height of 1.3 m on a smooth inclined plane. It slides down to a point where its height is 0.5 m above the ground. Assuming no energy loss due to friction, what is the speed of the block at this lower point? (Take  $g = 10 \text{ m/s}^2$ ).

(1) 2 m/s

(2) 4 m/s

(3) 6 m/s

(4) 8 m/s



Q31

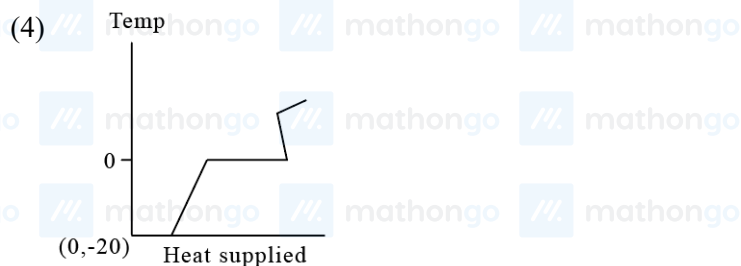
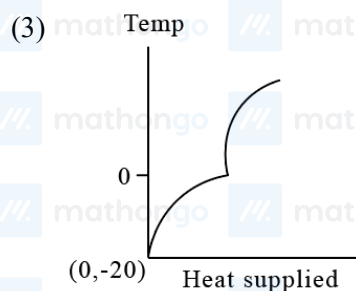
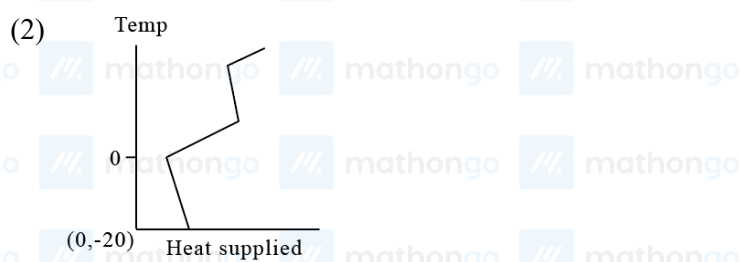
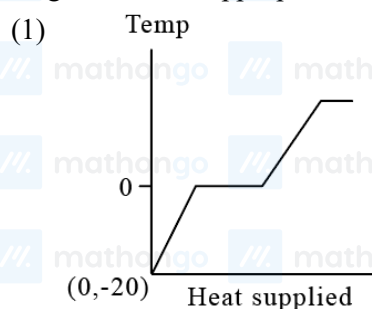
There are 3 concentric shells  $A, B$  and  $C$  of radius  $a, 2a$  and  $3a$ , respectively. Shells  $A$  and  $C$  are given charges  $+q$  and  $-q$  respectively centered at origin, shell  $B$  is earthed. Then, potential at point  $4a$  from origin is (here,

$$k = \frac{1}{4\pi\epsilon_0})$$

- (1)  $\frac{-kq}{12a}$  (2)  $\frac{kq}{3a}$  (3)  $\frac{kq}{4a}$  (4)  $-\frac{kq}{6a}$

Q32

A block of ice at temperature  $-20^\circ\text{C}$  is slowly heated and converted to steam at  $100^\circ\text{C}$ . Which of the following diagram is most appropriate?



Q33

An astronaut measures the escape velocity from Earth's surface to be  $8 \text{ km/s}$ . If they travel to a newly discovered exoplanet, 'Xylos', which has a mass nine times that of Earth and a radius four times that of Earth, what would be the escape velocity from Xylos?

- (1)  $12 \text{ km/s}$  (2)  $6 \text{ km/s}$  (3)  $18 \text{ km/s}$  (4)  $9 \text{ km/s}$

Q34

In the following a statement of Assertion is followed by a statement of Reason.

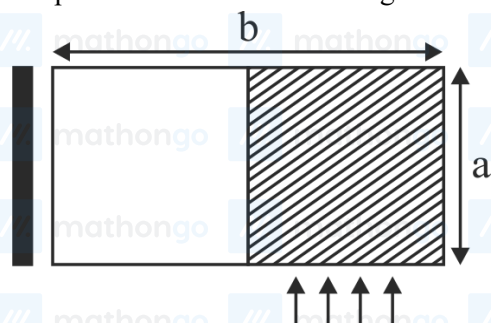
Assertion: The mass defect involved in a chemical reaction is almost a million times smaller than that in a nuclear reaction.

Reason: The mass energy interconversion does not take place in a chemical reaction.

- (1) Both Assertion & Reason are true and the Reason is the correct explanation of the Assertion.  
 (2) Both Assertion & Reason are true but the Reason is not the correct explanation of the Assertion.  
 (3) Assertion is true statement but Reason is false.  
 (4) Both Assertion and Reason are false statements.

Q35

There is a rectangular plate of mass  $M$  kg of dimensions  $(a \times b)$ . The plate is held in horizontal position by striking  $n$  small balls uniformly each of mass  $m$  per unit area per unit time. These are striking in the shaded half region of the plate. The balls are colliding elastically with velocity  $v$ . What is  $v$ ?



It is given  $n = 100$ ,  $M = 3$ , kg,  $m = 0.01$  kg;  $b = 2$  m;  $a = 1$  m,  $g = 10$

- (1) 10 m/s                      (2) 15 m/s                      (3) 20 m/s                      (4) 25 m/s

Q36

The electric potential between a proton and an electron is given by  $V = V_0 \ln \left( \frac{r}{r_0} \right)$  where  $V_0$  and  $r_0$  are constants and  $r$  is the radius of the electron orbit around the proton. Assuming Bohr's model to be applicable, it is found that  $r$  is proportional to  $n^x$ , where  $n$  is the principal quantum number. Find the value of  $x$ .

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

Q37

The electric field of an electromagnetic wave in free space is given by

$\vec{E} = 10 \cos (10^7 t + kx) \hat{j} \text{ V/m}$ , where  $t$  and  $x$  are in seconds and metres respectively. It can be inferred that

- (1) The wavelength  $\lambda$  is 188.4 m.  
 (2) The wave number  $k$  is 0.33rad/m.  
 (3) The wave amplitude is 10 V/m.  
 (4) The wave is propagating along positive  $x$  direction

Which one of the following pairs of statements is correct?

- (1) (3) and (4)                      (2) (1) and (2)                      (3) (2) and (3)                      (4) (1) and (3)

Q38

A certain amount of an ideal gas undergoes two distinct thermodynamic processes, Process X and Process Y.

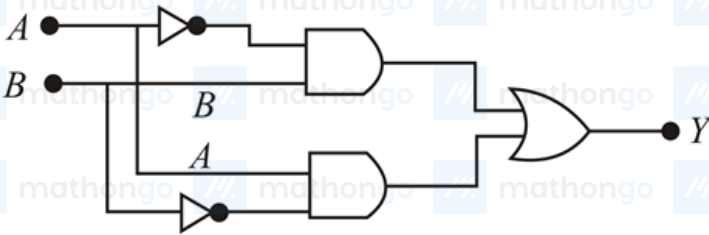
Process X is described by the relation  $PV^{1/2} = \text{constant}$ , and Process Y is described by  $PV^{-2} = \text{constant}$ . Let

$C_X$  and  $C_Y$  be the molar heat capacities for these processes, respectively.  $C_P$  and  $C_V$  denote the molar heat capacities at constant pressure and constant volume. Which of the following statements correctly compares these heat capacities?

- (1)  $C_X > C_P > C_Y > C_V$                       (2)  $C_Y > C_X > C_P > C_V$   
 (3)  $C_P > C_X > C_Y > C_V$                       (4)  $C_X > C_Y > C_P > C_V$

Q39

The truth table for the following logic circuit is



(1) 

| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

(2) 

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

(3) 

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

(4) 

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

Q40

A small ball moves in a horizontal circle of radius  $R_0$  with a constant speed, completing one full rotation in time  $T_0$ . If this ball is then launched from the ground with the same speed at an angle  $\phi$  above the horizontal, it reaches a maximum vertical height equal to  $2R_0$ . Determine the angle of projection  $\phi$ .

(1)  $\sin^{-1} \left( \sqrt{\frac{gT_0^2}{\pi^2 R_0}} \right)$

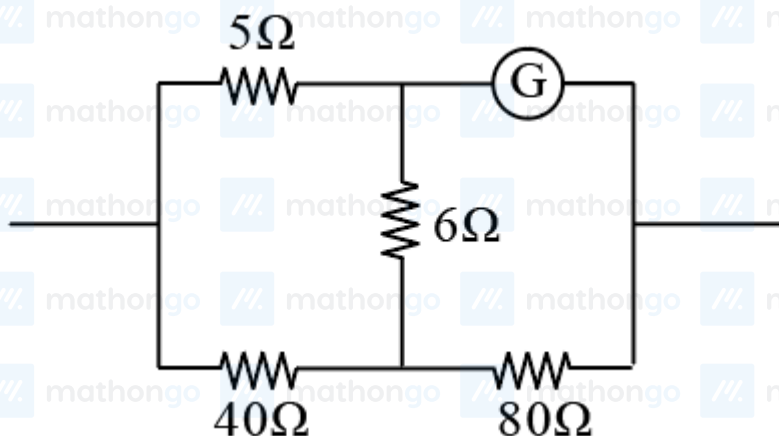
(2)  $\sin^{-1} \left( \sqrt{\frac{2gT_0^2}{\pi^2 R_0}} \right)$

(3)  $\cos^{-1} \left( \sqrt{\frac{gT_0^2}{\pi^2 R_0}} \right)$

(4)  $\sin^{-1} \left( \sqrt{\frac{\pi^2 R_0}{gT_0^2}} \right)$

Q41

A galvanometer of  $i_g = 1 \text{ mA}$  & resistance =  $10\Omega$  is connected in a circuit as shown. This combination (circuit) can be used as an ammeter or a voltmeter also. The range of ammeter ( $R_A$ ) and voltmeter ( $R_v$ ) are :-



(1)  $\frac{9}{8} \text{ mA}, 15\text{mV}$

(2)  $1 \text{ mA}, 12\text{mV}$

(3)  $\frac{8}{3} \text{ mA}, 20\text{mV}$

(4)  $\frac{4}{3} \text{ mA}, 10\text{mV}$

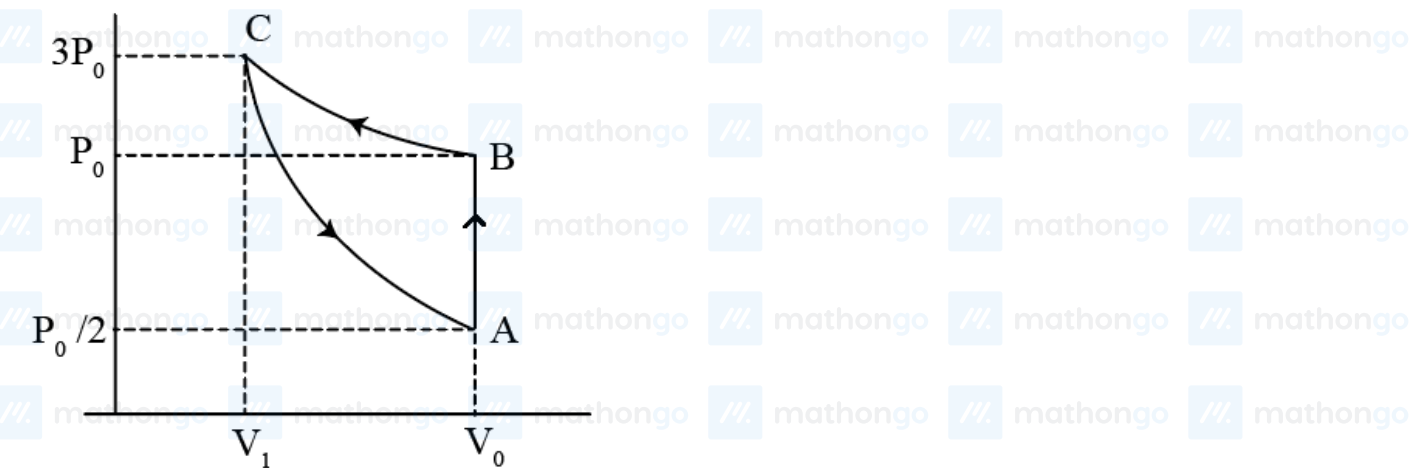
Q42

A stationary pulley carries a rope one end of which supports a ladder with a man of mass  $m$  and the other end a counter weight of mass  $M$ . A man of mass  $m$  climbs up a distance  $l$  w.r.t the ladder and then stops. The displacement of the centre of mass of this system is

- (1)  $\frac{ml}{M+m}$  (2)  $\frac{ml}{2M}$  (3)  $\frac{ml}{M+2m}$  (4)  $\frac{ml}{2M+m}$

Q43

One mole of an ideal gas is carried through a thermodynamic cycle as shown in the figure. The cyclic process consists of an isochoric, an isothermal and an adiabatic process. Find adiabatic exponent of gas :



- (1)  $\frac{5}{3}$  (2)  $\frac{\ln 5}{\ln 3}$  (3)  $\frac{4}{3}$  (4)  $\frac{\ln 6}{\ln 3}$

Q44

A trolley is moving away from a stop with an acceleration  $a = 0.2 \text{ m/s}^2$ . After reaching the velocity  $u = 36 \text{ km/hr}$  it moves with a constant velocity for the time of 2 min. Then it uniformly slows down, and stops after further travelling a distance of 100 m. Find the average speed all the way between stops :-

- (1)  $\frac{56}{17} \text{ m/s}$  (2)  $\frac{208}{21} \text{ m/s}$  (3)  $\frac{85}{12} \text{ m/s}$  (4)  $\frac{155}{19} \text{ m/s}$

Q45

Consider a scenario where a light pulse completely transfers a total momentum of  $1.5 \times 10^{-3} \text{ kg m s}^{-1}$  to an object. Assuming the speed of light in vacuum is  $3 \times 10^8 \text{ m/s}$ , determine the total energy contained within this light pulse.

- (1)  $4.5 \times 10^5 \text{ J}$  (2)  $3.0 \times 10^5 \text{ J}$   
 (3)  $6.0 \times 10^5 \text{ J}$  (4)  $1.5 \times 10^5 \text{ J}$

Q46

A container filled with air under pressure  $P_0$  contains a soap bubble of radius  $R$ . When the air pressure is reduced to half isothermally, the bubble radius becomes  $(5R/4)$ . If the surface tension of the soap water solution is  $S$ , then find

$\left(\frac{RP_0}{12S}\right)$ .

**Q47**

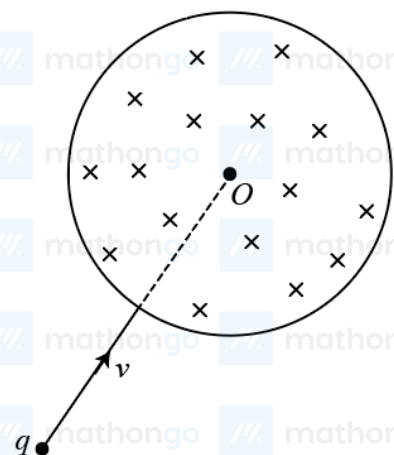
A disc of mass 4 kg and radius 0.4 m is rotating with angular velocity  $30\text{rad s}^{-1}$ . When two point-masses, each 0.25 kg are attached on the periphery of the disc, at diametrically opposite points, its angular velocity becomes (in rad/s)

**Q48**

A closed pipe is suddenly opened and changed to an open pipe of same length. The fundamental frequency of the resulting open pipe is less than that of 3rd harmonic of the earlier closed pipe by 55 Hz. Then, the value of fundamental frequency of the closed pipe is

**Q49**

Figure shows a circular region of radius  $R = \sqrt{3}m$  which has a uniform magnetic field  $B = 0.2T$  directed into the plane of the figure. A particle having mass  $m = 2g$ , speed  $v = 0.3m/s$  and charge  $q = 1mC$  is projected along the radius of the circular region as shown in figure. Calculate the angular deviation produced in the path of the particle as it comes out of the magnetic field. Neglect any other force apart from the magnetic force. (answer in degree)



**Q50**

Optic axis of a thin equiconvex lens is the  $x$ -axis. The co-ordinates of a point object and its image are  $(-40\text{ cm}, 1\text{ cm})$  and  $(50\text{ cm}, -2\text{ cm})$  respectively. Lens is located at  $(x, y)$  coordinates. The magnitude of  $x$  in cm is?

**Q51**

Consider 2-bromopropane, a secondary alkyl halide.

Scenario 1: 2-bromopropane is reacted with a concentrated solution of sodium ethoxide ( $CH_3CH_2ONa$ ) in dimethyl sulfoxide (DMSO) at room temperature.

Scenario 2: 2-bromopropane is heated in a large excess of ethanol ( $CH_3CH_2OH$ ) as both solvent and nucleophile.

Which of the following statements correctly describes the predominant reaction mechanism in each scenario?

- (1) Scenario 1 favors  $S_N1$ , and Scenario 2 favors  $S_N2$ .
- (2) Scenario 1 favors  $S_N2$ , and Scenario 2 favors  $S_N1$ .
- (3) Both Scenario 1 and Scenario 2 favor  $S_N1$ .
- (4) Both Scenario 1 and Scenario 2 favor  $S_N2$ .

**Q52**

Identify correct statements about NO molecule:

- (i) When NO is ionized to  $NO^+$ , the electron is removed from the  $\pi^* 2p$  orbital.
- (ii) Bond order of NO is 2.5 and bond order of  $NO^+$  is 3.
- (iii) Bond length of  $NO^+$  is greater than that of NO.
- (iv) It is similar to  $N_2^-$  in all respect.

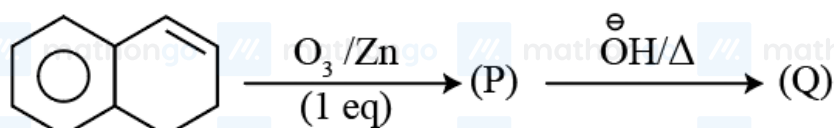
- (1) (i) and (ii)
- (2) (i) and (iii)
- (3) (i) and (iv)
- (4) All are correct

**Q53**

$x$  grams of water is mixed in 69 g of ethanol. Mole fraction of ethanol in the resultant solution is 0.6. What is the value of  $x$  in grams?

- (1) 54
- (2) 36
- (3) 180
- (4) 18

Q54



The final product Q is:

- (1) (2)
- (3) (4)

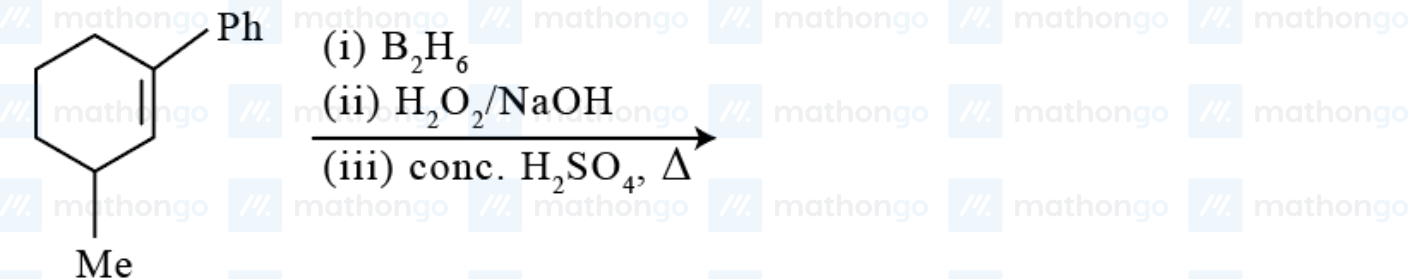
Q55

Choose the correct statements about the properties of group 15 hydrides:

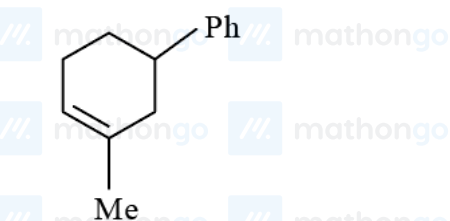
- (A) The bond angle in  $\text{NH}_3$  is greater than in  $\text{PH}_3$  due to stronger lone pair-lone pair repulsion.
- (B)  $\text{BiH}_3$  has the lowest basicity among the group 15 hydrides.
- (C) The bond dissociation energy increases in the order  $\text{NH}_3 < \text{PH}_3 < \text{AsH}_3 < \text{SbH}_3 < \text{BiH}_3$ .
- (D) The covalent radius of the central atom in the hydrides increases in the order  $\text{NH}_3 < \text{PH}_3 < \text{AsH}_3 < \text{SbH}_3 < \text{BiH}_3$ .
- (1) A and B only
- (2) A, C, and D only
- (3) B and D only
- (4) A, B, and D only

Q56

The major product of the following reaction sequence is



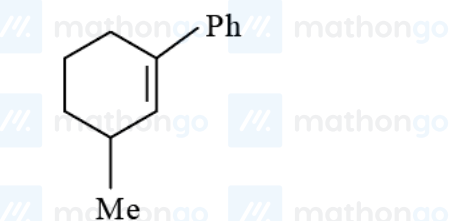
(1)



(2)



(3)

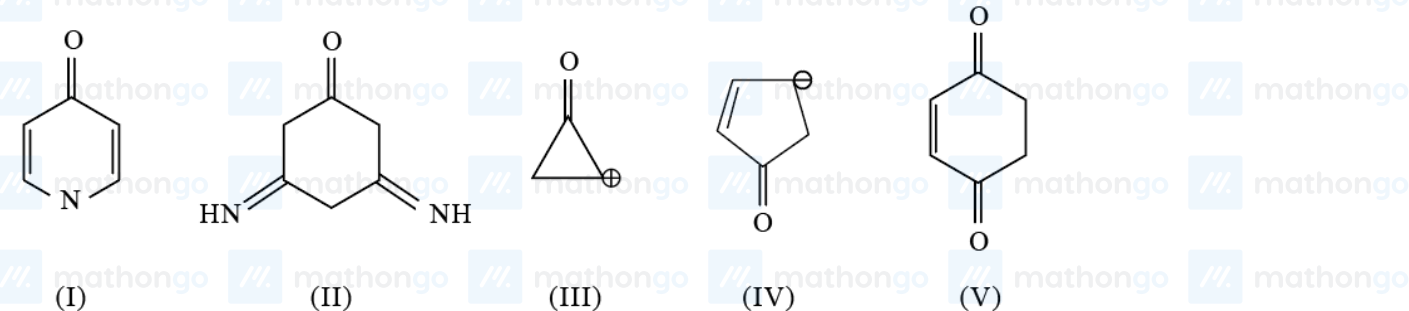


(4)



Q57

how many of the following enolic form is more stable than keto form



(1) 2

(2) 3

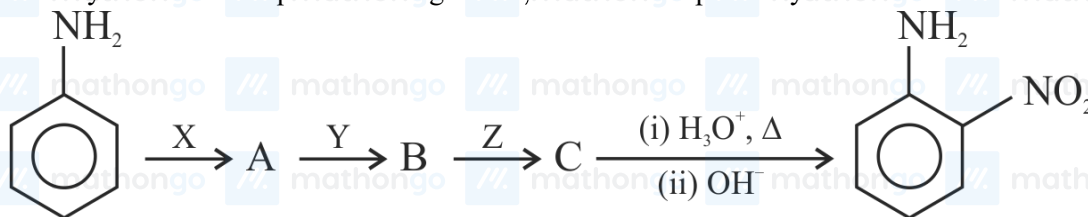
(3) 4

(4) 1

Q58

For the following reaction sequence

Identify the correct sequence of reagents X, Y and Z respectively.

(1) Conc.  $\text{HNO}_3$     $\text{CH}_3\text{COCl}$    Conc.  $\text{H}_2\text{SO}_4$ (2)  $\text{CH}_3\text{COCl}$    Conc.  $\text{HNO}_3$    Conc.  $\text{H}_2\text{SO}_4$ (3) Conc.  $\text{H}_2\text{SO}_4$     $\text{CH}_3\text{COCl}$    Conc.  $\text{HNO}_3$ (4)  $\text{CH}_3\text{COCl}$    Conc.  $\text{H}_2\text{SO}_4$    Conc.  $\text{HNO}_3$ 

Q59

Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).

**Assertion (A) :** Ionisation enthalpy increases along each series of the transition elements from left to right. However, small variations occur.**Reason (R) :** There is corresponding increase in effective nuclear charge which accompanies the filling of electrons in the inner d-orbitals.

In the light of the above statements, choose the most appropriate answer from the options given below.

(1) Both (A) and (R) are correct and (R) is the correct explanation of (A)

(2) Both (A) and (R) are correct but (R) is not the correct explanation of (A)

(3) (A) is correct but (R) is not correct

(4) (A) is not correct but (R) is correct

Q60

Among the following, in which type of chromatography, both stationary and mobile phases are in liquid state?

(1) Gas–liquid chromatography

(2) Ascending paper chromatography (Partition chromatography)

(3) High performance liquid chromatography (HPLC)

(4) Thin layer chromatography (TLC)

Q61

Identify, from the following, the diamagnetic, tetrahedral complex

(1)  $[\text{Ni}(\text{Cl})_4]^{2-}$ (2)  $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$ (3)  $[\text{Ni}(\text{CN})_4]^{2-}$ (4)  $[\text{Ni}(\text{CO})_4]$

Q62

From the following data. Calculate the magnitude of standard enthalpy of formation of propane (in KCal)

$$\Delta_f H^\ominus \text{CH}_4 = -17 \text{ kcal mol}^{-1}$$

$$\Delta_f H^\ominus \text{C}_2\text{H}_6 = -24 \text{ kcal mol}^{-1}; BE(C-H) = 99 \text{ kcal mol}^{-1}; BE(C-C) = 84 \text{ kcal mol}^{-1}$$

- (1) 42                      (2) 62                      (3) 31                      (4) 21

Q63

Given electrode potentials:

$$\text{Ag}^+/\text{Ag} = +0.80 \text{ V}, \text{Co}^{2+}/\text{Co} = -0.28 \text{ V}, \text{Cu}^{2+}/\text{Cu} = +0.34 \text{ V}, \text{Zn}^{2+}/\text{Zn} = -0.76 \text{ V}$$

Among these four metals, which can displace all other metals from their salts in a solution?

- (1) Ag                      (2) Cu                      (3) Co                      (4) Zn

Q64

Pyrolusite ( $\text{MnO}_2$ ) is used to prepare  $\text{KMnO}_4$ . Steps are,  $\text{MnO}_2 \xrightarrow{\text{I}} \text{MnO}_4^{2-} \xrightarrow{\text{II}} \text{MnO}_4^-$ . Steps I and II are respectively:

- (1) fuse with KOH/ air and electrolytic oxidation.  
 (2) fuse with KOH/ $\text{KNO}_3$  and electrolytic oxidation.  
 (3) fuse with conc.  $\text{HNO}_3$  / air and electrolytic reduction.  
 (4) Both A and B are correct

Q65

The initial rate of reaction

$\text{A} + 5\text{B} + 6\text{C} = 3\text{L} + 3\text{M}$  has been determined by measuring the rate of disappearance of A under the following

| Experiment No. | [A] <sub>0</sub> M | [B] <sub>0</sub> M | [C] <sub>0</sub> M | Initial rate M/min <sup>-1</sup> |
|----------------|--------------------|--------------------|--------------------|----------------------------------|
| 1.             | 0.02               | 0.02               | 0.02               | $2.08 \times 10^{-3}$            |
| 2.             | 0.01               | 0.02               | 0.02               | $1.04 \times 10^{-3}$            |
| 3.             | 0.02               | 0.04               | 0.02               | $4.16 \times 10^{-3}$            |
| 4.             | 0.02               | 0.02               | 0.04               | $8.32 \times 10^{-3}$            |

conditions : Determine the order of reaction ?

- (1) 4                      (2) 2                      (3) 3                      (4) 1

Q66

Reduction of hexose A (molecular formula  $\text{C}_6\text{H}_{12}\text{O}_6$ ) with sodium borohydride gives compound B and C. Both compounds B and C are optically active. Which of the following is compound A?

- (1) D-fructose                      (2) D-glucose                      (3) D-mannose                      (4) D-galactose

Q67

Match the following

| List - I<br>(Molecules) | List - II<br>(Dipole moment $\mu$ , D) |
|-------------------------|--|
| A. $\text{H}_2\text{O}$ | I. 0                                   |
| B. $\text{BF}_3$        | II. 0.23                               |
| C. $\text{NH}_3$        | III. 1.47                              |
| D. $\text{NF}_3$        | IV. 1.85                               |

The correct answer is

(1) A – IV, B – I, C – II, D – III

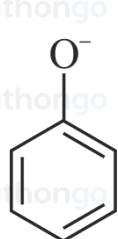
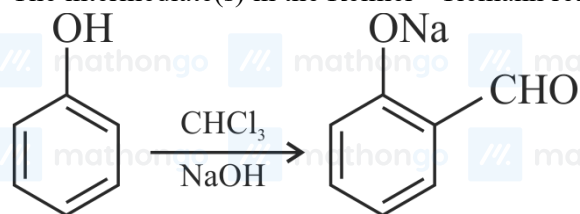
(2) A - IV, B - I, C - III, D - II

(3) A - IV, B - III, C - I, D - II

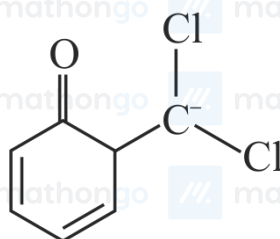
(4) A - III, B - IV, C - II, D - I

Q68

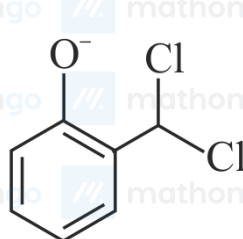
The intermediate(s) in the Reimer - Tiemann reaction of following reaction is/are....



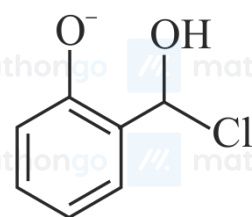
(I)



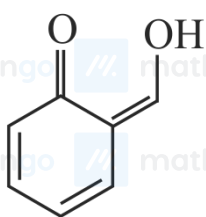
(II)



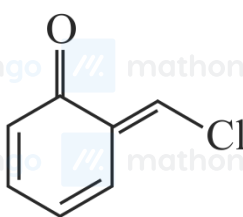
(III)



(IV)



(V)



(VI)

(1) I,II,III,IV,V,VI

(2) I,II,III,IV,V

(3) I,II,III, V, VI

(4) I,III,IV,V,VI

**Q69**

An animal cell has an internal fluid concentration equivalent to a 0.2 molal glucose solution. If this cell is immersed in an aqueous solution containing 1.8 g of glucose per 100 g of water, the cell will:

(Molar mass of glucose is 180 g/mol.)

- (1) Swell as water enters the cell.
- (2) Shrink as water leaves the cell.
- (3) Remain unchanged in volume.
- (4) Undergo plasmolysis.

**Q70**

Amongst  $\text{TiF}_6^{2-}$ ,  $\text{CoF}_6^{3-}$ ,  $\text{Cu}_2\text{Cl}_2$  and  $\text{NiCl}_4^{2-}$ , the colorless species are

(Atomic number of Ti = 22, Co = 27, Cu = 29, Ni = 28)

- (1)  $\text{CoF}_6^{3-}$  and  $\text{NiCl}_4^{2-}$ .
- (2)  $\text{TiF}_6^{2-}$  and  $\text{CoF}_6^{3-}$ .
- (3)  $\text{Cu}_2\text{Cl}_2$  and  $\text{NiCl}_4^{2-}$ .
- (4)  $\text{TiF}_6^{2-}$  and  $\text{Cu}_2\text{Cl}_2$ .

**Q71**

$K_a$  for HCN is  $5 \times 10^{-10}$  at  $25^\circ\text{C}$ . For maintaining a constant pH of 9, the volume in ml of 5M KCN solution required to be added to 10ml of 2M HCN solution is (Mark answer in ml)

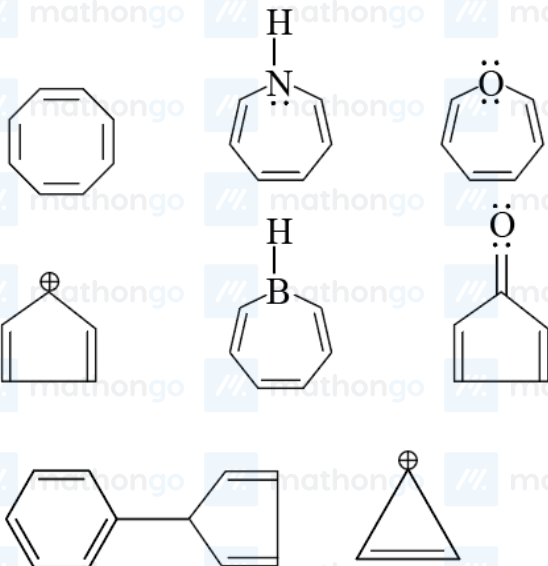
**Q72**

A 100 mL solution was made by adding 1.43 g of  $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$ . The normality of the solution is 0.1 N. The value of x is \_\_\_\_\_

(The atomic mass of Na is 23g/mol)

Q73

How many of the following compounds are antiaromatic.



Q74

Given:

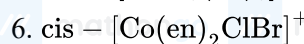
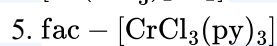
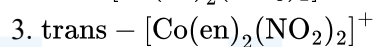
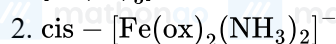
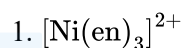
(a)  $n = 5, m_l = 0$

(b)  $n = 4, m_l = +2, m_s = -1/2$

The maximum number of electron(s) in an atom that can have the quantum numbers as given in (a) and (b) are respectively N and M. Find value of  $N + 2M$ :

Q75

Consider the following coordination compounds:



How many of these complexes are capable of exhibiting optical isomerism?

**ANSWERS AND SOLUTIONS**

|          |          |         |         |         |         |            |          |
|----------|----------|---------|---------|---------|---------|------------|----------|
| 1. (3)   | 2. (4)   | 3. (1)  | 4. (1)  | 5. (3)  | 6. (4)  | 7. (3)     | 8. (3)   |
| 9. (3)   | 10. (4)  | 11. (1) | 12. (2) | 13. (3) | 14. (4) | 15. (2)    | 16. (1)  |
| 17. (2)  | 18. (2)  | 19. (1) | 20. (1) | 21. 3.0 | 22. 8.0 | 23. 6448.0 | 24. 91.0 |
| 25. 10.0 | 26. (2)  | 27. (3) | 28. (3) | 29. (3) | 30. (3) | 31. (1)    | 32. (1)  |
| 33. (1)  | 34. (3)  | 35. (1) | 36. (3) | 37. (4) | 38. (1) | 39. (1)    | 40. (1)  |
| 41. (1)  | 42. (2)  | 43. (4) | 44. (4) | 45. (1) | 46. 8.0 | 47. 24.0   | 48. 55.0 |
| 49. 60.0 | 50. 10.0 | 51. (2) | 52. (1) | 53. (4) | 54. (1) | 55. (3)    | 56. (3)  |
| 57. (3)  | 58. (4)  | 59. (1) | 60. (2) | 61. (4) | 62. (3) | 63. (4)    | 64. (4)  |
| 65. (1)  | 66. (1)  | 67. (2) | 68. (1) | 69. (1) | 70. (4) | 71. 2.0    | 72. 10.0 |
| 73. 4.0  | 74. 14.0 | 75. 3.0 |         |         |         |            |          |