* 1. Let *S*  (0,1)  (1, 2)  (3, 4) and *T*  {0,1, 2, 3} . Then which of the following statements is(are) true?
     1. There are infinitely many functions from *S* to *T*
     2. There are infinitely many strictly increasing functions from *S* to *T*
     3. The number of continuous functions from *S* to *T* is at most 120
     4. Every continuous function from *S* to *T* is differentiable

*x*2 *y*2

Let *T*1 and *T*2 be two distinct common tangents to the ellipse *E* : 6  3

 1 and the parabola

*P* : *y*2  12*x* . Suppose that the tangent *T* touches *P* and *E* at the points

1

*A*1 and

*A*2 ,

respectively and the tangent *T*2 touches *P* and *E* at the points which of the following statements is(are) true*?*

*A*4 and

*A*3 , respectively. Then

* + 1. The area of the quadrilateral
    2. The area of the quadrilateral

*A*1 *A*2 *A*3 *A*4 is 35 square units

*A*1 *A*2 *A*3 *A*4 is 36 square units

* + 1. The tangents *T*1 and *T*2 meet the *x* -axis at the point (3, 0)
    2. The tangents *T*1 and *T*2 meet the *x* -axis at the point (6, 0)

*x*3 2 5 17

Let *f* :[0,1]  [0,1] be the function defined by *f* (*x*)   *x*  *x*  . Consider the square

3 9 36

region *S*  [0,1][0,1] . Let *G*  {(*x*, *y*)  *S* : *y*  *f* (*x*)} be called the green region and

*R*  {(*x*, *y*)  *S* : *y*  *f* (*x*)} be called the red region. Let *Lh*  {(*x*, *h*)  *S* : *x* [0,1]} be the horizontal line drawn at a height *h* [0,1]. Then which of the following statements is(are) true?

* + 1. There exists an *h*   1 , 2  such that the area of the green region above the line *L* equals the

 4 3  *h*

area of the green region below the line *Lh*

* + 1. There exists an *h*   1 , 2  such that the area of the red region above the line *L* equals the

 4 3  *h*

area of the red region below the line *Lh*

* + 1. There exists an *h*   1 , 2  such that the area of the green region above the line *L* equals the

 4 3  *h*

area of the red region below the line *Lh*

* + 1. There exists an *h*   1 , 2  such that the area of the red region above the line *L* equals the

 4 3  *h*

area of the green region below the line *Lh*

Let

*f* : (0,1)  ℝ be the function defined as *f* (*x*)  if *x*   1 , 1  where *n*   . Let

 *n* 1 



*n*

*n*



*x*

1 *t*

*t*



*x*

*g* : (0,1)  ℝ be a function such that 

*x*2

lim *f* (*x*)*g*(*x*)

*x*0

* + 1. does **NOT** exist
    2. is equal to 1
    3. is equal to 2
    4. is equal to 3

*dt*  *g*(*x*)  2

for all *x* (0,1) . Then

* 1. Let *Q* be the cube with the set of vertices (*x* , *x* , *x* )  ℝ3 : *x* , *x* , *x* { 0, 1} . Let *F* be the set

1 2 3 1 2 3

of all twelve lines containing the diagonals of the six faces of the cube *Q* . Let *S* be the set of all four lines containing the main diagonals of the cube *Q* ; for instance, the line passing through the vertices (0, 0, 0) and (1,1,1) is in *S* . For lines 𝑙1 and 𝑙2 , let *d* (𝑙1, 𝑙2 ) denote the shortest distance between them. Then the maximum value of *d* (𝑙1, 𝑙2 ) , as 𝑙1 varies over *F* and 𝑙2 varies over *S* , is



1

6



1

8



1

3



1

12

(A)

(B)

(C)

(D)

Let

*X*  (*x*, *y*)  : *x*

8



2

*y*2

1 and *y*

 2

20

 5*x* . Three distinct points *P, Q* and *R* are

 



randomly chosen from *X* . Then the probability that *P, Q* and *R* form a triangle whose area is a positive integer, is

## 71 220

1. 220

## 220

1. 220
   1. Let *P* be a point on the parabola *y*2  4*ax* , where *a*  0 . The normal to the parabola at *P*

meets the *x* -axis at a point *Q* . The area of the triangle *PFQ* , where *F* is the focus of the parabola, is 120. If the slope *m* of the normal and *a* are both positive integers, then the pair (*a*, *m*) is

(A) (2, 3) (B) (1, 3) (C) (2, 4) (D) (3, 4)

* 1. Let tan1(*x*)    ,  , for *x*  ℝ . Then the number of real solutions of the equation

 2 2 

 

 tan1(tan *x*) in the set   3 ,       ,     , 3 

1 cos(2*x*)



2

 2 2  

2 2   2 2 

is equal to

* 1. Let *n*  2 be a natural number and

     

*f* :[0,1]  ℝ be the function defined by

*n*(1 2*nx*) if 0  *x*  1



 2*n*

2*n*(2*nx* 1) if

*f* (*x*)  

1  *x*  3

2*n* 4*n*



4*n*(1 *nx*) if



3  *x*  1

4*n n*

 *n* 1

 *n* 1 *nx* 1



if  *x*  1

*n*

If *n* is such that the area of the region bounded by the curves *x*  0 , *x*  1 ,

*y*  *f* (*x*) is 4 , then the maximum value of the function *f* is

*y*  0 and

⏞*r*

Let 7557 denote the (*r*  2) digit number where the first and the last digits are 7 and

⏞98

the remaining *r* digits are 5. Consider the sum *S*  77  757  7557  7557. If

⏞99

*S*  7557  *m* , where *m* and *n* are natural numbers less than 3000, then the value of

*n*

*m*  *n* is

Let

*A*  1967 1686 *i* sin

:   ℝ. If *A* contains exactly one positive integer *n* , then the

 7  3*i* cos 

 

value of *n* is

* 1. Let *P* be the plane 3*x*  2 *y*  3*z*  16 and let

*S*  *i*ˆ   ˆ*j*   *k*ˆ :  2   2   2  1 and the distance of ( ,  , ) from the plane *P* is 7 



.



2

→ → → → → → → 

Let *u*, *v* and *w* be three distinct vectors in *S* such that | *u*  *v* | = | *v*  *w* | = | *w*  *u* | . Let *V* be the

## →

volume of the parallelepiped determined by vectors *u*, *v* and *w* . Then the value of



3

80 *V* is

* 1. Let *a* and *b* be two nonzero real numbers. If the coefficient of *x*5 in the expansion of

 *ax*2 



70 4



is equal to the coefficient of *x*5 in the expansion of  *ax* 

1 7



, then

 27*bx*   *bx*2 



the value of 2*b* is

* 1. Let  ,  and  be real numbers. Consider the following system of linear equations

*x*  2 *y*  *z*  7

*x*  *z*  11

2*x*  3*y*   *z*  

Match each entry in **List-I** to the correct entries in **List-II.**

**List-I List-II**

* 1. If   1 (7  3) and   28 , then the

## 2

1. a unique solution

system has

* 1. If   1 (7  3) and   28 , then the

## 2

1. no solution

system has

* 1. If   1 (7  3) where   1 and

## 2

  28 , then the system has

1. infinitely many solutions
   1. If   1 (7  3) where   1 and

## 2

  28 , then the system has

(4) *x*  11 ,

*y*  2 and *z*  0 as a solution

|  |  |  |
| --- | --- | --- |
| The correct option is: |  | (5) *x*  15 , *y*  4 and *z*  0 as a solution |
| (A) (*P*)  (3) (*Q*)  (2) | (*R*)  (1) | (*S*)  (4) |
| (B) (*P*)  (3) (*Q*)  (2) | (*R*)  (5) | (*S*)  (4) |
| (C) (*P*)  (2) (*Q*)  (1) | (*R*)  (4) | (*S*)  (5) |
| (D) (*P*)  (2) (*Q*)  (1) | (*R*)  (1) | (*S*)  (3) |

* 1. Consider the given data with frequency distribution

## *xi* 3 8 11 10 5 4

*fi* 5 2 3 2 4 4

Match each entry in **List-I** to the correct entries in **List-II.**

**List-I List-II**

1. The mean of the above data is (1) 2.5
2. The median of the above data is (2) 5
3. The mean deviation about the mean of the above data is
4. The mean deviation about the median of the above data is

(3) 6 (4) 2.7 (5) 2.4

|  |  |  |  |
| --- | --- | --- | --- |
| The correct option is: |  | | |
| (A) (*P*)  (3) (*Q*)  (2)  (B) (*P*)  (3) (*Q*)  (2) | (*R*)  (4)  (*R*)  (1) | (*S*)  (5)  (*S*)  (5) |  |
| (C) (*P*)  (2) (*Q*)  (3)  (D) (*P*)  (3) (*Q*)  (3) | (*R*)  (4)  (*R*)  (5) | (*S*)  (1)  (*S*)  (5) |  |

* 1. Let 𝑙 and 𝑙 be the lines →  (*i*ˆ  ˆ*j*  *k*ˆ) and →  ( ˆ*j*  *k*ˆ)  (*i*ˆ  *k*ˆ) , respectively. Let *X* be

1 2 *r*1 *r*2

the set of all the planes *H* that contain the line 𝑙1 . For a plane *H* , let *d* (*H* ) denote the smallest possible distance between the points of 𝑙2 and *H* . Let *H*0 be a plane in *X* for which *d* (*H*0 ) is the maximum value of *d* (*H* ) as *H* varies over all planes in *X* .

Match each entry in **List-I** to the correct entries in **List-II.**

**List-I List-II**

1. The value of *d* (*H*0 ) is (1)



3

1. The distance of the point (0,1, 2) from *H*0 is (2) 1

3

1. The distance of origin from *H*0 is (3) 0
2. The distance of origin from the point of intersection of planes *y*  *z* , *x*  1 and *H*0 is

(5) 1



2

|  |  |  |
| --- | --- | --- |
|  | | 2 |
| The correct option is: |  |  |
| (A) (*P*)  (2) (*Q*)  (4) | (*R*)  (5) | (*S*)  (1) |
| (B) (*P*)  (5) (*Q*)  (4) | (*R*)  (3) | (*S*)  (1) |
| (C) (*P*)  (2) (*Q*)  (1) | (*R*)  (3) | (*S*)  (2) |
| (D) (*P*)  (5) (*Q*)  (1) | (*R*)  (4) | (*S*)  (2) |

* 1. Let *z* be a complex number satisfying | *z* |3 2*z*2  4*z*  8  0 , where *z* denotes the complex conjugate of *z* . Let the imaginary part of *z* be nonzero.

Match each entry in **List-I** to the correct entries in **List-II.**

**List-I List-II**

1. | *z* |2 is equal to (1) 12
2. | *z*  *z* |2 is equal to (2) 4
3. | *z* |2  | *z*  *z* |2 is equal to (3) 8
4. | *z* 1|2 is equal to (4) 10

|  |  |  |
| --- | --- | --- |
| The correct option is: |  | (5) 7 |
| (A) (*P*)  (1) (*Q*)  (3) | (*R*)  (5) | (*S*)  (4) |
| (B) (*P*)  (2) (*Q*)  (1) | (*R*)  (3) | (*S*)  (5) |
| (C) (*P*)  (2) (*Q*)  (4) | (*R*)  (5) | (*S*)  (1) |
| (D) (*P*)  (2) (*Q*)  (3) | (*R*)  (5) | (*S*)  (4) |

|  |  |
| --- | --- |
| Q.1 | A slide with a frictionless curved surface, which becomes horizontal at its lower end, is fixed on the terrace of a building of height 3ℎ from the ground, as shown in the figure. A spherical ball of mass  𝑚 is released on the slide from rest at a height ℎ from the top of the terrace. The ball leaves the slide with a velocity 𝑢⃗→0 = 𝑢0𝑥̂ and falls on the ground at a distance 𝑑 from the building making an angle 𝜃 with the horizontal. It bounces off with a velocity v⃗→ and reaches a maximum height ℎ1. The acceleration due to gravity is 𝑔 and the coefficient of restitution of the ground is 1⁄√3. Which of the following statement(s) is(are) correct? |
|  | (A) u⃗→0 = √2𝑔ℎ𝑥̂ |
|  | (B) v⃗→ = √2𝑔ℎ(𝑥̂ − 𝑧̂) |
|  | (C) 𝜃 = 60° |
|  | (D) 𝑑/ℎ1 = 2√3 |

|  |  |
| --- | --- |
| Q.2 | A plane polarized blue light ray is incident on a prism such that there is no reflection from the surface of the prism. The angle of deviation of the emergent ray is 𝛿 = 60° (see Figure-1). The angle of minimum deviation for red light from the same prism is 𝛿min = 30° (see Figure-2). The refractive index of the prism material for blue light is √3. Which of the following statement(s) is(are) correct? |
|  | (A) The blue light is polarized in the plane of incidence. |
|  | (B) The angle of the prism is 45°. |
|  | (C) The refractive index of the material of the prism for red light is √2. |
|  | (D) The angle of refraction for blue light in air at the exit plane of the prism is 60°. |

|  |  |
| --- | --- |
| Q.3 | In a circuit shown in the figure, the capacitor 𝐶 is initially uncharged and the key 𝐾 is open. In this condition, a current of 1 A flows through the 1 Ω resistor. The key is closed at time 𝑡 = 𝑡0. Which of the following statement(s) is(are) correct?  [Given: 𝑒−1 = 0.36] |
|  | (A) The value of the resistance 𝑅 is 3 Ω. |
|  | (B) For 𝑡 < 𝑡0, the value of current 𝐼1 is 2 A. |
|  | (C) At 𝑡 = 𝑡0 + 7.2 𝜇s, the current in the capacitor is 0.6 A. |
|  | (D) For 𝑡 → ∞, the charge on the capacitor is 12 𝜇C. |

|  |  |  |
| --- | --- | --- |
| Q.4 | A bar of mass 𝑀 = 1.00 kg and length 𝐿 = 0.20 m is lying on a horizontal frictionless surface. One end of the bar is pivoted at a point about which it is free to rotate. A small mass 𝑚 = 0.10 kg is moving on the same horizontal surface with 5.00 m s−1 speed on a path perpendicular to the bar. It hits the bar at a distance 𝐿/2 from the pivoted end and returns back on the same path with speed v. After this elastic collision, the bar rotates with an angular velocity 𝜔. Which of the following statement is correct? | |
|  | (A) 𝜔 = 6.98 rad s−1 and v = 4.30 m s−1 | (B) 𝜔 = 3.75 rad s−1 and v = 4.30 m s−1 |
|  | (C) 𝜔 = 3.75 rad s−1 and v = 10.0 m s−1 | (D) 𝜔 = 6.80 rad s−1 and v = 4.10 m s−1 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Q.5 | A container has a base of 50 cm × 5 cm and height 50 cm, as shown in the figure. It has two parallel electrically conducting walls each of area 50 cm × 50 cm. The remaining walls of the container are thin and non-conducting. The container is being filled with a liquid of dielectric constant 3 at a uniform rate of 250 cm3 s−1. What is the value of the capacitance of the container after 10 seconds?  [Given: Permittivity of free space 𝜖0 = 9 × 10−12 C2N−1m−2, the effects of the non-conducting walls on the capacitance are negligible] | | | |
|  | (A) 27 pF | (B) 63 pF | (C) 81 pF | (D) 135 pF |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Q.6 | One mole of an ideal gas expands adiabatically from an initial state (𝑇A, 𝑉0) to final state (𝑇f, 5𝑉0). Another mole of the same gas expands isothermally from a different initial state (𝑇B, 𝑉0) to the same final state (𝑇f, 5𝑉0). The ratio of the specific heats at constant pressure and constant volume of this ideal gas is 𝛾. What is the ratio 𝑇A/𝑇B? | | | |
|  | (A) 5𝛾−1 | (B) 51−𝛾 | (C) 5𝛾 | (D) 51+𝛾 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Q.7 | Two satellites P and Q are moving in different circular orbits around the Earth (radius 𝑅). The heights of P and Q from the Earth surface are ℎP and ℎQ, respectively, where ℎP = 𝑅/3. The accelerations of P and Q due to Earth’s gravity are 𝑔P and 𝑔Q, respectively. If 𝑔P/𝑔Q = 36/25, what is the value of ℎQ? | | | |
|  | (A) 3𝑅/5 | (B) 𝑅/6 | (C) 6𝑅/5 | (D) 5𝑅/6 |

|  |  |
| --- | --- |
| Q.8 | A Hydrogen-like atom has atomic number 𝑍. Photons emitted in the electronic transitions from level 𝑛 = 4 to level 𝑛 = 3 in these atoms are used to perform photoelectric effect experiment on a target metal. The maximum kinetic energy of the photoelectrons generated is 1. 95 eV. If the photoelectric threshold wavelength for the target metal is 310 nm, the value of 𝑍 is .  [Given: ℎ𝑐 = 1240 eV-nm and 𝑅ℎ𝑐 = 13.6 eV, where 𝑅 is the Rydberg constant, ℎ is the Planck’s constant and 𝑐 is the speed of light in vacuum] |
| Q.9 | An optical arrangement consists of two concave mirrors M1 and M2, and a convex lens L with a common principal axis, as shown in the figure. The focal length of L is 10 cm. The radii of curvature of M1 and M2 are 20 cm and 24 cm, respectively. The distance between L and M2 is 20 cm. A point object S is placed at the mid-point between L and M2 on the axis. When the distance between L and M1 is 𝑛/7 cm, one of the images coincides with S. The value of 𝑛 is . |

|  |  |
| --- | --- |
| Q.10 | In an experiment for determination of the focal length of a thin convex lens, the distance of the  object from the lens is 10 ± 0.1 cm and the distance of its real image from the lens is 20 ± 0.2 cm. The error in the determination of focal length of the lens is 𝑛 %. The value of 𝑛 is . |

|  |  |
| --- | --- |
| Q.11 | A closed container contains a homogeneous mixture of two moles of an ideal monatomic gas (𝛾 = 5/3) and one mole of an ideal diatomic gas (𝛾 = 7/5). Here, 𝛾 is the ratio of the specific heats at constant pressure and constant volume of an ideal gas. The gas mixture does a work of 66 Joule when heated at constant pressure. The change in its internal energy is Joule. |
| Q.12 | A person of height 1.6 m is walking away from a lamp post of height 4 m along a straight path on the flat ground. The lamp post and the person are always perpendicular to the ground. If the speed of the person is 60 cm s−1, the speed of the tip of the person’s shadow on the ground with respect to the person is cm s−1. |
| Q.13 | Two point-like objects of masses 20 gm and 30 gm are fixed at the two ends of a rigid massless rod of length 10 cm. This system is suspended vertically from a rigid ceiling using a thin wire attached to its center of mass, as shown in the figure. The resulting torsional pendulum undergoes small oscillations. The torsional constant of the wire is 1.2 × 10−8 N m rad−1. The angular frequency of the oscillations in 𝑛 × 10−3 rad s−1. The value of 𝑛 is . |

* 1. List-I shows different radioactive decay processes and List-II provides possible emitted particles. Match each entry in List-I with an appropriate entry from List-II, and choose the correct option.

|  |  |
| --- | --- |
| **List-I** | **List-II** |

|  |  |
| --- | --- |
| (P) 238𝑈 → 234𝑃𝑎 92 91 | (1) one 𝛼 particle and one 𝛽+ particle |
| (Q) 214𝑃𝑏 → 210𝑃𝑏 82 82 | (2) three 𝛽− particles and one 𝛼 particle |
| (R) 210𝑇𝑙 → 206𝑃𝑏 81 82 | (3) two 𝛽− particles and one 𝛼 particle |
| (S) 228𝑃𝑎 → 224𝑅𝑎 91 88 | (4) one 𝛼 particle and one 𝛽− particle |
|  | (5) one 𝛼 particle and two 𝛽+ particles |

(A) 𝑃 → 4, 𝑄 → 3, 𝑅 → 2, 𝑆 → 1 (B) 𝑃 → 4, 𝑄 → 1, 𝑅 → 2, 𝑆 → 5

(C) 𝑃 → 5, 𝑄 → 3, 𝑅 → 1, 𝑆 → 4 (D) 𝑃 → 5, 𝑄 → 1, 𝑅 → 3, 𝑆 → 2

* 1. Match the temperature of a black body given in List-I with an appropriate statement in List-II, and choose the correct option.

[Given: Wien’s constant as 2.9 × 10−3 m-K and ℎ𝑐 = 1.24 × 10−6 V-m]

𝑒

|  |  |  |
| --- | --- | --- |
| **List-I** | **List-II** | |
| (P) 2000 K | (1) | The radiation at peak wavelength can lead to emission  of photoelectrons from a metal of work function 4 eV. |
| (Q) 3000 K | (2) | The radiation at peak wavelength is visible to human  eye. |
| (R) 5000 K | (3) | The radiation at peak emission wavelength will result  in the widest central maximum of a single slit diffraction. |
| (S) 10000 K | (4) | The power emitted per unit area is 1/16 of that emitted by a blackbody at temperature 6000 K. |
|  | (5) | The radiation at peak emission wavelength can be  used to image human bones. |

(A) 𝑃 → 3, 𝑄 → 5, 𝑅 → 2, 𝑆 → 3 (B) 𝑃 → 3, 𝑄 → 2, 𝑅 → 4, 𝑆 → 1

(C) 𝑃 → 3, 𝑄 → 4, 𝑅 → 2, 𝑆 → 1 (D) 𝑃 → 1, 𝑄 → 2, 𝑅 → 5, 𝑆 → 3

* 1. A series LCR circuit is connected to a 45 sin(𝜔𝑡) Volt source. The resonant angular frequency of the circuit is 105 rad s−1 and current amplitude at resonance is 𝐼0. When the angular frequency of

the source is 𝜔 = 8 × 104 rad s−1, the current amplitude in the circuit is 0.05 𝐼0. If 𝐿 = 50 mH, match each entry in List-I with an appropriate value from List-II and choose the correct option.

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| **List-I** | **List-II** |
| (P) 𝐼0 in mA | (1) 44.4 |
| (Q) The quality factor of the circuit | (2) 18 |
| (R) The bandwidth of the circuit in rad s−1 | (3) 400 |
| (S) The peak power dissipated at resonance in Watt | (4) 2250 |
|  | (5) 500 |

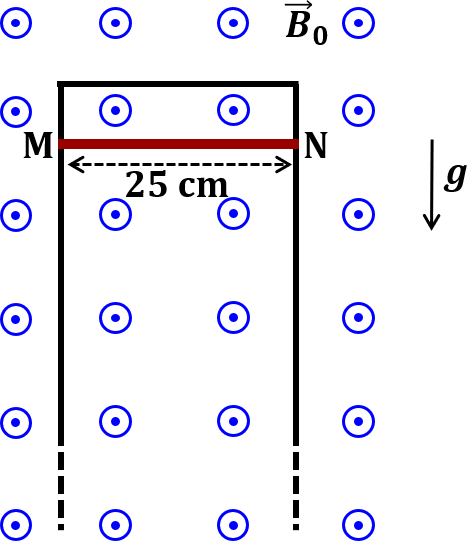
(A) 𝑃 → 2, 𝑄 → 3, 𝑅 → 5, 𝑆 → 1 (B) 𝑃 → 3, 𝑄 → 1, 𝑅 → 4, 𝑆 → 2

(C) 𝑃 → 4, 𝑄 → 5, 𝑅 → 3, 𝑆 → 1 (D) 𝑃 → 4, 𝑄 → 2, 𝑅 → 1, 𝑆 → 5

* 1. A thin conducting rod MN of mass 20 gm, length 25 cm and resistance 10 Ω is held on frictionless, long, perfectly conducting vertical rails as shown in the figure. There is a uniform magnetic field

𝐵0 = 4 T directed perpendicular to the plane of the rod-rail arrangement. The rod is released from rest at time 𝑡 = 0 and it moves down along the rails. Assume air drag is negligible. Match each quantity in List-I with an appropriate value from List-II, and choose the correct option.

[Given: The acceleration due to gravity 𝑔 = 10 m s−2 and 𝑒−1 = 0.4]



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| **List-I** | **List-II** |
| (P) At 𝑡 = 0.2 s, the magnitude of the induced emf in Volt | (1) 0.07 |
| (Q) At 𝑡 = 0.2 s, the magnitude of the magnetic force in Newton | (2) 0.14 |
| (R) At 𝑡 = 0.2 s, the power dissipated as heat in Watt | (3) 1.20 |
| (S) The magnitude of terminal velocity of the rod in m s−1 | (4) 0.12 |
|  | (5) 2.00 |

(A) 𝑃 → 5, 𝑄 → 2, 𝑅 → 3, 𝑆 → 1 (B) 𝑃 → 3, 𝑄 → 1, 𝑅 → 4, 𝑆 → 5

(C) 𝑃 → 4, 𝑄 → 3, 𝑅 → 1, 𝑆 → 2 (D) 𝑃 → 3, 𝑄 → 4, 𝑅 → 2, 𝑆 → 5

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| Q.1 | The correct statement(s) related to processes involved in the extraction of metals is(are) |
|  | (A) Roasting of Malachite produces Cuprite. |
|  | (B) Calcination of Calamine produces Zincite. |
|  | (C) Copper pyrites is heated with silica in a reverberatory furnace to remove iron. |
|  | (D) Impure silver is treated with aqueous KCN in the presence of oxygen followed by reduction with  zinc metal. |

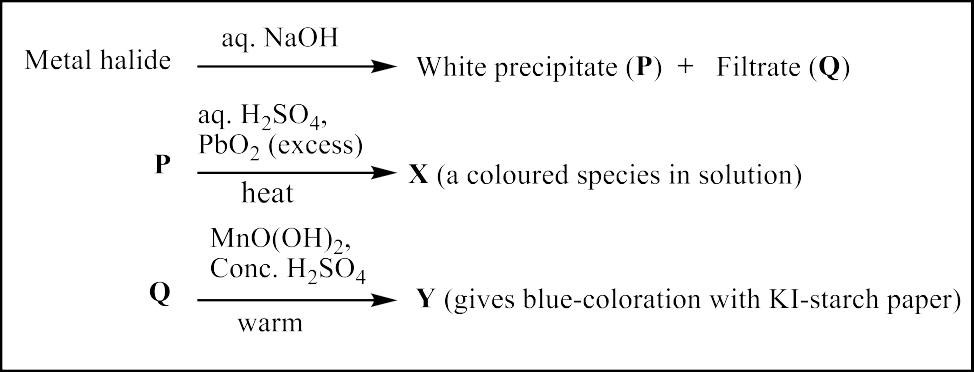
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| Q.2 | In the following reactions, **P**, **Q**, **R**, and **S** are the major products.          The correct statement(s) about **P**, **Q**, **R**, and **S** is(are) |
|  | (A) Both **P** and **Q** have asymmetric carbon(s). |
|  | (B) Both **Q** and **R** have asymmetric carbon(s). |
|  | (C) Both **P** and **R** have asymmetric carbon(s). |
|  | (D) **P** has asymmetric carbon(s), **S** does **not** have any asymmetric carbon. |





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| Q.3 | Consider the following reaction scheme and choose the correct option(s) for the major products **Q**, **R** and **S**. |
|  | (A) |
|  | (B) |
|  | (C) |
|  | (D) |

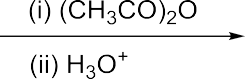




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| Q.4 | In the scheme given below, **X** and **Y**, respectively, are |
|  | 2  (A) CrO4 and Br2 |
|  | 2  (B) MnO4 and Cl2 |
|  |   (C) MnO4 and Cl2 |
|  | (D) MnSO4 and HOCl |

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| Q.5 | Plotting 1/Λm against cΛm for aqueous solutions of a monobasic weak acid (HX) resulted in a straight line with y-axis intercept of P and slope of S. The ratio P⁄S is  [Λm = molar conductivity   = limiting molar conductivity  m  c = molar concentration  Ka = dissociation constant of HX] |
|  | (A) Ka   m |
|  | (B) Ka  /2  m |
|  | (C) 2 Ka   m |
|  | (D) 1 / (Ka  )  m |

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| Q.6 | On decreasing the 𝑝H from 7 to 2, the solubility of a sparingly soluble salt (MX) of a weak acid (HX) increased from 10−4 mol L−1 to 10−3 mol L−1. The 𝑝Ka of HX is |
|  | (A) 3 |
|  | (B) 4 |
|  | (C) 5 |
|  | (D) 2 |



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| Q.7 | In the given reaction scheme, **P** is a phenyl alkyl ether, **Q** is an aromatic compound; **R** and **S** are the major products.        The correct statement about **S** is |
|  | (A) It primarily inhibits noradrenaline degrading enzymes. |
|  | (B) It inhibits the synthesis of prostaglandin. |
|  | (C) It is a narcotic drug. |
|  | (D) It is *ortho*-acetylbenzoic acid. |

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| Q.8 | The stoichiometric reaction of 516 g of dimethyldichlorosilane with water results in a tetrameric cyclic product **X** in 75% yield. The weight (in g) of **X** obtained is .  [Use, molar mass (g mol−1): H = 1, C = 12, O = 16, Si = 28, Cl = 35.5] |

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| Q.9 | A gas has a compressibility factor of 0.5 and a molar volume of 0.4 dm3 mol−1 at a temperature of 800 K and pressure **x** atm. If it shows ideal gas behaviour at the same temperature and pressure, the molar volume will be **y** dm3 mol−1. The value of 𝐱/𝐲 is .  [Use: Gas constant, R = 8 × 10−2 L atm K−1 mol−1] |

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| Q.10 | The plot of log 𝑘𝑓 versus 1⁄𝑇 for a reversible reaction A (g) ⇌ P (g) is shown.    Pre-exponential factors for the forward and backward reactions are 1015 s−1 and 1011 s−1, respectively. If the value of log 𝐾 for the reaction at 500 K is 6, the value of | log 𝑘𝑏 | at 250 K is .  [*K* = equilibrium constant of the reaction  𝑘𝑓 = rate constant of forward reaction  𝑘𝑏 = rate constant of backward reaction] |

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| Q.11 | One mole of an ideal monoatomic gas undergoes two reversible processes (A  B and B  C) as shown in the given figure:    A  B is an adiabatic process. If the total heat absorbed in the entire process (A  B and B  C) is  R𝑇2 ln 10, the value of 2 log 𝑉3 is .  [Use, molar heat capacity of the gas at constant pressure, 𝐶 = 5 R]  p,m 2 |

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| Q.12 | In a one-litre flask, 6 moles of A undergoes the reaction A (g) ⇌ P (g). The progress of product formation at two temperatures (in Kelvin), T1 and T2, is shown in the figure:    If T1 = 2T2 and (∆GΘ − ∆GΘ) = RT2 ln x, then the value of x is .  2 1  [∆GΘ and ∆GΘ are standard Gibb’s free energy change for the reaction at temperatures T1 and T2,  1 2  respectively.] |



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| Q.13 | The total number of *sp*2 hybridised carbon atoms in the major product **P** (a non-heterocyclic  compound) of the following reaction is . |

* 1. Match the reactions (in the given stoichiometry of the reactants) in List-I with one of their products given in List-II and choose the correct option.

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| **List-I** | **List-II** |
| (P) P2O3 + 3H2O  | (1) P(O)(OCH3)Cl2 |
| (Q) P4 + 3NaOH + 3H2O  | (2) H3PO3 |
| (R) PCl5 + CH3COOH  | (3) PH3 |
| (S) H3PO2 + 2H2O + 4AgNO3  | (4) POCl3 |
|  | (5) H3PO4 |

(A) P  2; Q  3; R  1; S  5

(B) P  3; Q  5; R  4; S  2

(C) P  5; Q  2; R  1; S  3

(D) P  2; Q  3; R  4; S  5

* 1. Match the electronic configurations in List-I with appropriate metal complex ions in List-II and choose the correct option.

[Atomic Number: Fe = 26, Mn = 25, Co = 27]

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| **List-I** | **List-II** |
| (P) t6 e0  2g g | (1) [Fe(H2O)6]2+ |
| (Q) t3 e2  2g g | (2) [Mn(H2O)6]2+ |
| (R) e2 t3  2 | (3) [Co(NH3)6]3+ |
| (S) t4 e2  2g g | (4) [FeCl4] |
|  | (5) [CoCl4]2 |

(A) P  1; Q  4; R  2; S  3

(B) P  1; Q  2; R  4; S  5

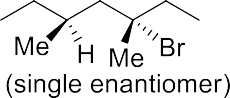
(C) P  3; Q  2; R  5; S  1

(D) P  3; Q  2; R  4; S  1

* 1. Match the reactions in List-I with the features of their products in List-II and choose the correct option.



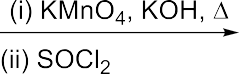
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| --- | --- |
| **List-I** | **List-II** |
| (P) | 1. Inversion of configuration 2. Retention of configuration 3. Mixture of enantiomers 4. Mixture of structural isomers 5. Mixture of diastereomers |
| (Q) |
| (R) |  |
| (S) |  |

(A) P  1; Q  2; R  5; S  3

(B) P  2; Q  1; R  3; S  5

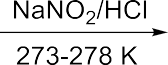
(C) P  1; Q  2; R  5; S  4

(D) P  2; Q  4; R  3; S  5

* 1. The major products obtained from the reactions in List-II are the reactants for the named reactions mentioned in List-I. Match List-I with List-II and choose the correct option.



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| **List-I** | **List-II** |
| (P) Etard reaction | (1) |
| (Q) Gattermann reaction | (2) |
| (R) Gattermann-Koch reaction | (3) |
| (S) Rosenmund reduction | (4) |
|  | (5) |

(A) P  2; Q  4; R  1; S  3



(B) P  1; Q  3; R  5; S  2

(C) P  3; Q  2; R  1; S  4

(D) P  3; Q  4; R  5; S  2