

## General Instructions

1. The test is of 3 hours duration and the maximum marks is 300.
2. The question paper consists of 3 Parts (Part I: Physics, Part II: Chemistry, Part III: Mathematics). Each Part has two sections (Section 1 & Section 2).
3. Section 1 contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.
4. Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 questions have to be attempted.

The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. In the OMR, do not bubble the sign for positive values. However, for negative values,  $\ominus$  sign should be bubbled. (Example: 6, 81, 1.50,  $\ominus$  3.25, 0.08)

5. No candidate is allowed to carry any textual material, printed, or written, bits of papers, pager, mobile phone, any electronic device, etc. inside the examination room/hall.
6. Rough work is to be done on the space provided for this purpose in the Test Booklet only.
7. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. However, the candidates are allowed to take away this Test Booklet with them.
8. Do not fold or make any stray mark on the Answer Sheet (OMR).

### Marking Scheme

1. Section – 1: +4 for correct answer, –1 (negative marking) for incorrect answer, 0 for all other cases.
2. Section – 2: +4 for correct answer, 0 for all other cases. There is no negative marking.

Name of the Candidate (In CAPITALS): .....

Roll Number: .....

OMR Bar Code Number: .....

Candidate's Signature: ..... Invigilator's Signature .....

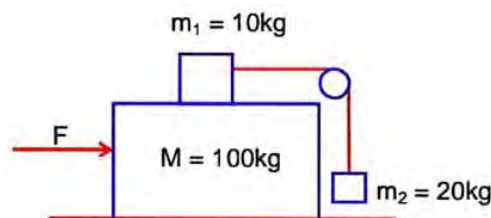
## Part – A (PHYSICS)

### SECTION – A

(One Option Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. Three masses  $M = 100\text{kg}$ ,  $m_1 = 10\text{kg}$  and  $M_2 = 20\text{kg}$  are arranged in a system as shown in figure. All the surface are frictionless and strings are inextensible and weightless. The pulleys are also weightless and frictionless. A force  $F$  is applied on the system so that the mass  $m_2$  moves upward with an acceleration of  $2\text{ms}^{-2}$ . The value of  $F$  is:



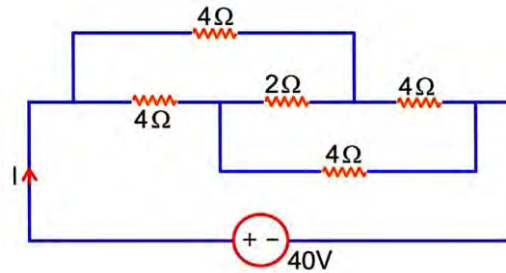
- (Take  $g = 10\text{ms}^{-2}$ )
- (a) 3360 N                                      (b) 3380                                      (c) 3120 N                                      (d) 3240 N
2. A radio can tune to any station in 6 MHz to 10 MHz band. The value of corresponding of wavelength bandwidth will be:
- (a) 4m                                      (b) 20m                                      (c) 30m                                      (d) 50m
3. The disintegration rate of a certain radioactive sample at any instant is 4250 disintegrations per minutes later, the rate becomes 2250 disintegrations per minute. The approximate decay constant is:
- (Take  $\log_{10} 1.88 = 0.274$ )
- (a)  $0.02 \text{ min}^{-1}$                                       (b)  $2.7 \text{ min}^{-1}$                                       (c)  $0.063 \text{ min}^{-1}$                                       (d)  $6.3 \text{ min}^{-1}$
4. A parallel beam of light of wavelength 900nm and intensity  $100\text{Wm}^{-2}$  is incident on a surface perpendicular to the beam. The number of photons crossing  $1\text{cm}^2$  area perpendicular to the beam in one second is:
- (a)  $3 \times 10^{18}$                                       (b)  $4.5 \times 10^{16}$                                       (c)  $4.5 \times 10^{17}$                                       (d)  $4.5 \times 10^{20}$
5. In Young's double slit experiment, the fringe width is 12mm. If the entire arrangement is placed in water refractive index  $\frac{4}{3}$ , then the fringe width becomes (in mm):
- (a) 16                                      (b) 9                                      (c) 48                                      (d) 12
6. The magnetic field of a plane electromagnetic wave is given by:
- $$\vec{B} = 2 \times 10^{-8} \sin(0.5 \times 10^3 x + 1.5 \times 10^{11} t) \hat{j} \text{ T.}$$
- The amplitude of the electric field would be:
- (a)  $6 \text{ Vm}^{-1}$  along x-axis                                      (b)  $3 \text{ Vm}^{-1}$  along z-axis  
(c)  $6 \text{ Vm}^{-1}$  along z-axis                                      (d)  $2 \times 10^{-8} \text{ Vm}^{-1}$  along z-axis
7. In a series LR circuit  $X_L = R$  and power factor of the circuit is  $P_1$ . When capacitor with capacitance  $C$  such that  $X_L = X_C$  is put in series, the power factor becomes  $P_2$ . The ratio  $\frac{P_1}{P_2}$  is:
- (a)  $\frac{1}{2}$                                       (b)  $\frac{1}{\sqrt{2}}$                                       (c)  $\frac{\sqrt{3}}{\sqrt{2}}$                                       (d) 2 : 1
8. A charge particle is moving in uniform magnetic field  $(2\hat{i} + 3\hat{j}) \text{ T}$ . If it has an acceleration of  $(\alpha\hat{i} - 4\hat{j})\text{m/s}^2$ , then the value of  $\alpha$  will be:

- (a) 6 (b) 7 (c) 8 (d) 9

9.  $B_x$  and  $B_y$  are the magnetic fields at the centre of two coils X and Y respectively each carrying equal current. If coil X has 200 turns and 20 cm radius and coil Y has 400 turns and 20 cm radius, the ratio of  $B_x$  and  $B_y$  is:

- (a) 1 : 1 (b) 1 : 2 (c) 2 : 1 (d) 4 : 1

10. The current  $I$  in the above given circuit will be:



- (a) 10 A (b) 20 A (c) 4 A (d) 40 A

11. The total charge on the system of capacitors  $C_1 = 1\mu\text{F}$ ,  $C_2 = 2\mu\text{F}$ ,  $C_3 = 4\mu\text{F}$  and  $C_4 = 3\mu\text{F}$  connected in parallel is:

(Assume a battery of 20V is connected to the combination)

- (a)  $200\mu\text{C}$  (b) 200C (c)  $10\mu\text{C}$  (d) 10 C

12. When a particle executes Simple Harmonic Motion, the nature of graph of velocity as a function of displacement will be:

- (a) Circular (b) Elliptical (c) Sinusoidal (d) Straight line

13. 7 mol of a certain monoatomic ideal gas undergoes a temperature increase of 40K at constant pressure. The increase in the internal energy of the gas in this process is:

(Given  $R = 8.3 \text{ JK}^{-1} \text{ mol}^{-1}$ )

- (a) 5810 J (b) 3486 J (c) 11620 J (d) 6972 J

14. A monoatomic gas at pressure  $P$  and volume  $V$  is suddenly compressed to one eighth of its original volume. The final pressure at constant entropy will be:

- (a)  $P$  (b)  $8P$  (c)  $32P$  (d)  $64P$

15. A water drop of radius 1cm is broken into 729 equal droplets. If surface tension of water is 75 dyne/cm, then the gain in surface energy upto first decimal place will be:

(Given  $\pi = 3.14$ )

- (a)  $8.5 \times 10^{-4} \text{ J}$  (b)  $8.2 \times 10^{-4} \text{ J}$  (c)  $7.5 \times 10^{-4} \text{ J}$  (d)  $5.3 \times 10^{-4} \text{ J}$

16. The percentage decrease in the weight of a rocket, when taken to a height of 32 km above the surface of earth will, be:

(Radius of earth will, be:

- (a) 1% (b) 3% (c) 4% (d) 0.5%

17. As per the given figure, two blocks each of mass 250g are connected to a spring of spring constant  $2\text{Nm}^{-1}$ . If both are given velocity  $v$  in opposite directions, then maximum elongation of the spring is:



- (a)  $\frac{v}{2\sqrt{2}}$  (b)  $\frac{v}{2}$  (c)  $\frac{v}{4}$  (d)  $\frac{v}{\sqrt{2}}$

18. A monkey of mass 50kg climbs on a rope which can withstand the tension (T) of 350 N. If monkey initially climbs down with an acceleration of  $4 \text{ m/s}^2$  and then climbs up with an acceleration of  $5 \text{ m/s}^2$ . Choose the correct option ( $g = 10 \text{ m/s}^2$ ).
- (a)  $T = 700 \text{ N}$  while climbing upward (b)  $T = 350 \text{ N}$  while going downward
- (c) Rope will break while climbing upward (d) Rope will break while going downward
19. Two projectiles thrown at  $30^\circ$  and  $45^\circ$  with the horizontal respectively, reach the maximum height in same time. The ratio of their initial velocities is:
- (a)  $1:\sqrt{2}$  (b)  $2:1$  (c)  $\sqrt{2}:1$  (d)  $1:2$
20. A screw gauge of pitch 0.5mm is used to measure the diameter of uniform wire of length 6.8cm, the main scale reading is 1.5mm and circular scale reading is 7. The calculated curved surface area wire to appropriate significant figures is:  
[Screw gauge has 50 divisions on its circular scale]
- (a)  $6.8 \text{ cm}^2$  (b)  $3.4 \text{ cm}^2$  (c)  $3.9 \text{ cm}^2$  (d)  $2.4 \text{ cm}^2$

### SECTION – B

#### (Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

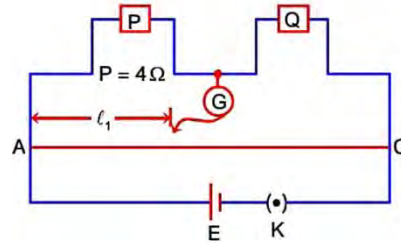
1. If the initial velocity in horizontal direction of a projectile is unit vector  $\hat{i}$  and the equation of trajectory is  $y = 5x(1 - x)$ . The y component vector of the initial velocity is \_\_\_\_\_  $\hat{j}$ .
2. A disc of mass 1kg and radius R is free to rotate about a horizontal axis passing through its centre and perpendicular to the plane of disc. A body of same mass as that of disc is fixed at the highest point of the disc. Now the system is released, when the body comes to the lowest position, its angular speed will be  $\sqrt{\frac{x}{3R}} \text{ rad s}^{-1}$  where  $x =$  \_\_\_\_\_.
3. In an experiment to determine the Young's modulus of wire of a length exactly 1m, the extension in the length of the wire is measured as 0.4mm with an uncertainty of  $\pm 0.02\text{mm}$  when a load of 1kg is applied. The diameter of the wire is measured as 0.4mm with an uncertainty of  $\pm 0.02\text{mm}$ . The error in the measurement of Young's modulus ( $\Delta Y$ ) is found to be  $x \times 10^{10} \text{ Nm}^{-2}$ . The value of x is \_\_\_\_\_.  
(take  $g = 10 \text{ ms}^{-2}$ )

4. When a car is approaching the observer, the frequency of horn is 100Hz. After passing the observer, it is 50 Hz. If the observer moves with the car, the frequency will be  $\frac{x}{3}$  Hz where x = \_\_\_\_\_.

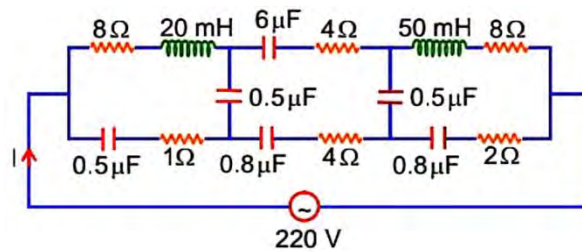
5. A composite parallel plate capacitor is made up to two different dielectric materials with different thickness ( $t_1$  and  $t_2$ ) as shown in figure. The two different dielectric materials are separated by a conducting foil F. The voltage of the conducting foil is \_\_\_\_\_ V.



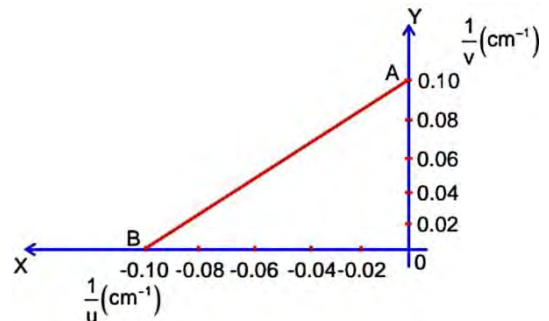
6. Resistances are connected in a meter bridge circuit as shown in the figure. The balancing length  $\ell_2$  is 40cm. Now an unknown resistance x is connected in series with P and new balancing length is found to be 80cm measured from the same end. Then the value of x will be \_\_\_\_\_  $\Omega$ .



7. The effective current I in the given circuit at very high frequencies will be \_\_\_\_\_ A.

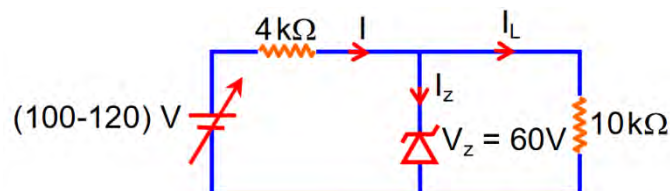


8. The graph between  $\frac{1}{u}$  and  $\frac{1}{v}$  for a thin convex lens in order to determine its focal length is plotted as shown in the figure. The refractive index of lens is 1.5 and its both the surfaces have same radius of curvature R. The value of R will be \_\_\_\_\_ cm. (where u = object distance, v = image distance)



9. In the hydrogen spectrum,  $\lambda$  be the wavelength of first transition line of Lyman series. The wavelength difference will be "a $\lambda$ " between the wavelength of 3<sup>rd</sup> transition line of Paschen series and that 2<sup>nd</sup> transition line B Balmer series where a = \_\_\_\_\_.

10. In the circuit shown below, maximum zener diode current will be \_\_\_\_\_ mA.



## Part – B (CHEMISTRY)

### SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

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1. The number of radial and angular nodes in 4d orbital are, respectively  
(a) 1 and 2                      (b) 3 and 2                      (c) 1 and 0                      (d) 2 and 1

2. Match List I with List II

List I Enzyme	List II Conversion of
A. Invertase	I. Starch into maltose
B. Zymase	II. Maltose into glucose
C. Diastase	III. Glucose into ethanol
D. Maltase	IV. Cane sugar into glucose

Choose the most appropriate answer from the options given below:

- (a) A-III, B-IV, C-II, D-I      (b) A-III, B-II, C-I, D-IV      (c) A-IV, B-III, C-I, D-II      (d) A-IV, B-II, C-III, D-I
3. Which of the following elements is considered as a metalloid?  
(a) Sc                      (b) Pb                      (c) Bi                      (d) Te
4. The role of depressants in 'Froth Flotation method' is to  
(a) Selectively prevent one component of the ore from coming to the froth.  
(b) reduce the consumption of oil for froth formation  
(c) stabilize the froth  
(d) enhance non-wettability of the mineral particles.
5. Boiling of hard water is helpful in removing the temporary hardness by converting calcium hydrogen carbonate and magnesium hydrogen carbonate to  
(a)  $\text{CaCO}_3$  and  $\text{Mg(OH)}_2$       (b)  $\text{CaCO}_3$  and  $\text{MgCO}_3$       (c)  $\text{Ca(OH)}_2$  and  $\text{MgCO}_3$       (d)  $\text{Ca(OH)}_2$  and  $\text{Mg(OH)}_2$
6. s-block element which cannot be qualitatively confirmed by the flame test is  
(a) Li                      (b) Na                      (c) Rb                      (d) Be
7. The oxide which contains an odd electron at the nitrogen atom is  
(a)  $\text{H}_2\text{O}$                       (b)  $\text{NO}_2$                       (c)  $\text{N}_2\text{O}_3$                       (d)  $\text{N}_2\text{O}_5$
8. Which one of the following is an example of disproportionation reaction?  
(a)  $3\text{MnO}_4^{2-} + 4\text{H}^+ \rightarrow 2\text{MnO}_4^- + \text{MnO}_2 + 2\text{H}_2\text{O}$   
(b)  $\text{MnO}_4^- + 4\text{H}^+ + 4\text{e}^- \rightarrow \text{MnO}_2 + 2\text{H}_2\text{O}$   
(c)  $10\text{I}^- + 2\text{MnO}_4^- + 16\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 8\text{H}_2\text{O} + 5\text{I}_2$   
(d)  $8\text{MnO}_4^- + 3\text{S}_2\text{O}_3^{2-} + \text{H}_2\text{O} \rightarrow 8\text{MnO}_2 + 6\text{SO}_4^{2-} + 2\text{OH}^-$
9. The most common oxidation state of Lanthanoid elements is +3. Which of the following is likely to deviate easily from +3 oxidation state?  
(a) Ce (At. No. 58)      (b) La (At. No. 57)      (c) Lu (At. No. 71)      (d) Gd (At. No. 64)
10. The measured BOD values for four different water sample (A-D) are as follows

A = 3 ppm;                      B = 18 ppm;                      C = 21 ppm;                      D = 4 ppm.

The water samples which can be called as highly polluted with organic wastes, are

- (a) A and B                      (b) A and D                      (c) B and C                      (d) B and D

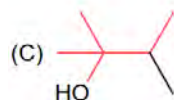
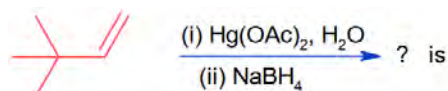
11. The correct order of nucleophilicity is

- (a)  $F^- > OH^-$                       (b)  $H_2O > OH^-$                       (c)  $R\ddot{O}H > RO^-$                       (d)  $NH_2^- > NH_3$

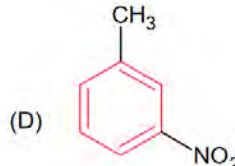
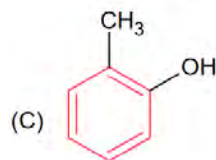
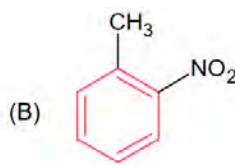
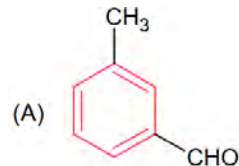
12. Oxidation of toluene to benzaldehyde can be easily carried out with which of the following

- (a)  $CrO_3 / \text{acetic acid}, H_3O^+$                       (b)  $CrO_3 / \text{acetic anhydride}, H_3O^+$   
 (c)  $KMnO_4 / HCl, H_3O^+$                       (d)  $CO / HCl, \text{anhydrous } AlCl_3$

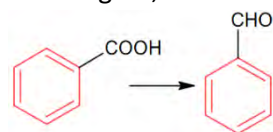
13. The major product in the following reaction



14. Halogenation of which one of the following will yield m-substituted product with respect to methyl group as a major product?



15. The reagent, from the following, which converts benzoic acid to benzaldehyde in one step is



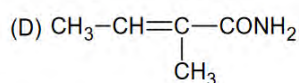
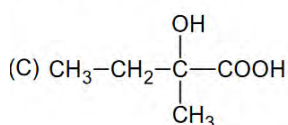
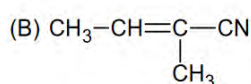
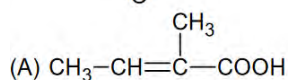
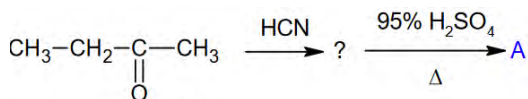
(a)  $LiAlH_4$

(b)  $KMnO_4$

(c)  $MnO$

(d)  $NaBH_4$

16. The final product 'A' in the following reaction sequence



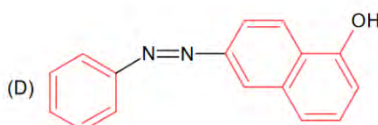
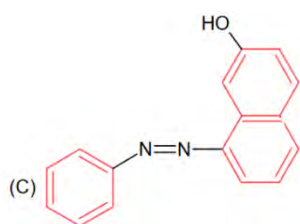
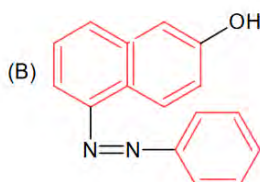
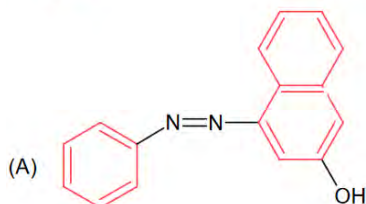
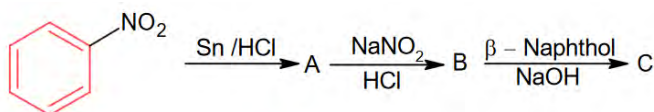
17. Which statement is NOT correct for p-toluenesulphonyl chloride?

(a) It is known as Hinsberg's reagent

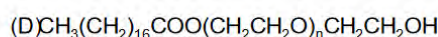
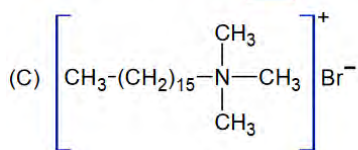
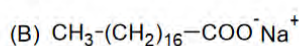
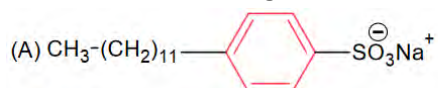
(b) It is used to distinguish primary and secondary amines.

- (c) On treatment with secondary amine, it leads to a product, that is soluble in alkali.  
 (d) It doesn't react with tertiary amines

18. The final product 'C' in the following series of reactions



19. Which of the following is NOT an example of synthetic detergent?



20. Which of the following is a water soluble vitamin, that is not excreted easily?

(a) Vitamin B<sub>2</sub>

(b) Vitamin B<sub>1</sub>

(c) Vitamin B<sub>6</sub>

(d) Vitamin B<sub>12</sub>

### SECTION – B

#### (Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

- CNG is an important transportation fuel. When 100g CNG is mixed with 208g oxygen in vehicles, it leads to the formation of CO<sub>2</sub> and H<sub>2</sub>O and produces large quantity of heat during this combustion, then the amount of carbon dioxide produced in grams is \_\_\_\_\_.  
 (nearest integer)  
 [Assume CNG to be methane]
- In a solid AB, A atoms are in ccp arrangement and B atoms occupy all octahedral sites. If two atoms from the opposite face are removed, then the resultant stoichiometry of the compound is A<sub>x</sub>B<sub>y</sub>. The value of x is \_\_\_\_\_ (nearest integer)



3. Amongst SF<sub>4</sub>, XeF<sub>4</sub>, CF<sub>4</sub> and H<sub>2</sub>O, the number of species with two lone pairs of electrons is \_\_\_\_\_.
4. A fish swimming in water body when taken out from the water body is covered with a film of water of weight 36g. When it is subjected to cooking at 100°C, then the internal energy for vaporization in kJ mol<sup>-1</sup> is \_\_\_\_\_. (nearest integer)  
[Assume steam to be an ideal gas. Given  $\Delta_{\text{vap}}H^\ominus$  for water at 373K and 1 bar is 41.1 kJ mol<sup>-1</sup>; R = 8.31 JK<sup>-1</sup>mol<sup>-1</sup>]
5. The osmotic pressure exerted by a solution prepared by dissolving 2.0g of protein of molar mass 60 kg mol<sup>-1</sup> in 200 mL of water at 27°C is \_\_\_\_\_ Pa. (nearest integer)  
(Use R = 0.083 L bar mol<sup>-1</sup> K<sup>-1</sup>)
6. 40% of HI undergoes decomposition to H<sub>2</sub> and I<sub>2</sub> at 300K.  $\Delta G^\ominus$  for this decomposition reaction at one atmosphere pressure is \_\_\_\_\_ J mol<sup>-1</sup> (nearest integer)  
(Use R = 8.31 JK<sup>-1</sup> mol<sup>-1</sup>; log 2 = 0.3010, ln 10 = 2.3, log 3 = 0.477)
7.  $\text{Cu(s)} + \text{Sn}^{2+}(0.001\text{M}) \rightarrow \text{Cu}^{2+}(0.01\text{M}) + \text{Sn(s)}$   
The Gibbs free energy change for the above reaction at 298 K is  $x \times 10^{-1}$  KJmol<sup>-1</sup>. The value of x is \_\_\_\_\_. (nearest integer)  
[Given :  $E_{\text{Cu}^{2+}/\text{Cu}}^\ominus$  0.34V;  $E_{\text{Sn}^{2+}/\text{Sn}}^\ominus = -0.14\text{V}$ ; F = 96500 Cmol<sup>-1</sup>]
8. Catalyst A reduces the activation energy for a reaction by 10 kJ mol<sup>-1</sup> at 300K. The ratio of rate constants,  $\frac{k_{\text{T,Catalysed}}}{k_{\text{T,Uncatalysed}}}$  is e<sup>x</sup>. The value of x is \_\_\_\_\_. (nearest integer)  
[Assume that the pre-exponential factor is same in both the cases. Given R = 8.31 JK<sup>-1</sup> mol<sup>-1</sup>]
9. Reaction of [Co(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> with excess ammonia and in the presence of oxygen results into a diamagnetic product. Number of electrons present in t<sub>2g</sub>-orbitals of the product is \_\_\_\_\_.
10. The moles of methane required to produce 81 g of water after complete combustion is \_\_\_\_\_  $\times 10^{-2}$  mol. (nearest integer)

## Part – C (MATHEMATICS)

### SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

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- The area of the polygon, whose vertices are the non-real roots of the equation  $\bar{z} = iz^2$  is:  
(a)  $\frac{3\sqrt{3}}{4}$  (b)  $\frac{3\sqrt{3}}{2}$  (c)  $\frac{3}{2}$  (d)  $\frac{3}{4}$
- Let the system of linear equations  $x + 2y + z = 2$ ,  $\alpha x + 3y - z = \alpha$ ,  $-\alpha x + y + 2z = -\alpha$  be inconsistent. Then  $\alpha$  is equal to:  
(a)  $\frac{5}{2}$  (b)  $-\frac{5}{2}$  (c)  $\frac{7}{2}$  (d)  $-\frac{7}{2}$
- If  $x = \sum_{n=0}^{\infty} a^n$ ,  $y = \sum_{n=0}^{\infty} b^n$ ,  $z = \sum_{n=0}^{\infty} c^n$ , where  $a, b, c$  are in A.P. and  $|a| < 1, |b| < 1, |c| < 1, abc \neq 0$ , then:  
(a)  $x, y, z$  are in A.P. (b)  $x, y, z$  are in G.P.  
(c)  $\frac{1}{x}, \frac{1}{y}, \frac{1}{z}$  are in A.P. (d)  $\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = 1(a+b+c)$
- Let  $\frac{dy}{dx} = \frac{ax - by + a}{bx + cy + a}$ , where  $a, b, c$ , are constants, represent a circle passing through the point (2, 5). Then the shortest distance of the point (11, 6) from this circle is:  
(a) 10 (b) 8 (c) 7 (d) 5
- Let  $a$  be an integer such that  $\lim_{x \rightarrow 7} \frac{18 - [1-x]}{[x-3a]}$  exists, where  $[t]$  is greatest integer  $\leq t$ . Then  $a$  is equal to:  
(a) -6 (b) -2 (c) 2 (d) 6
- The number of distinct real roots of  $x^4 - 4x + 1 = 0$  is:  
(a) 4 (b) 2 (c) 1 (d) 0
- The lengths of the sides of a triangle are  $10 + x^2$ ,  $10 + x^2$  and  $20 - 2x^2$ . If for  $x = k$ , the area of the triangle is maximum, then  $3k^2$  is equal to:  
(a) 5 (b) 8 (c) 10 (d) 12
- If  $\cos^{-1}\left(\frac{y}{2}\right) = \log_e\left(\frac{x}{5}\right)^5, |y| < 2$ , then:  
(a)  $x^2y'' + xy' - 25y = 0$  (b)  $x^2y'' - xy' - 25y = 0$   
(c)  $x^2y'' - xy' + 25y = 0$  (d)  $x^2y'' + xy' + 25y = 0$
- If  $\int \frac{(x^2+1)e^x}{(x+1)^2} dx = f(x)e^x + C$ , where  $C$  is a constant, then  $\frac{d^3f}{dx^3}$  at  $x=1$  is equal to:  
(a)  $-\frac{3}{4}$  (b)  $\frac{3}{4}$  (c)  $-\frac{3}{2}$  (d)  $\frac{3}{2}$
- The value of the integral  $\int_{-2}^2 \frac{|x^3+x|}{(e^{|x|}+1)} dx$  is equal to:

- (a)  $5e^2$  (b)  $3e^{-2}$  (c) 4 (d) 6
11. If  $\frac{dy}{dx} + \frac{2^{x-y}(2^y-1)}{2^x-1} = 0, x, y > 0, y(1) = 1$ , then  $y(2)$  is equal to:  
 (a)  $2 + \log_2 3$  (b)  $2 + \log_3 2$  (c)  $2 - \log_3 2$  (d)  $2 - \log_2 3$
12. In an isosceles triangle ABC, the vertex A is (6, 1) and the equation of the base BC is  $2x + y = 4$ . Let the point B lie on the line  $x + 3y = 7$ . If  $(\alpha, \beta)$  is the centroid of  $\triangle ABC$ , then  $15(\alpha + \beta)$  is equal to:  
 (a) 39 (b) 41 (c) 51 (d) 63
13. Let the eccentricity of an ellipse  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, a > b$ , be  $\frac{1}{4}$ . If this ellipse passes through the point  $\left(-4\sqrt{\frac{2}{5}}, 3\right)$ , then  $a^2 + b^2$  is equal to:  
 (a) 29 (b) 31 (c) 32 (d) 34
14. If two straight lines whose direction cosines are given by the relations  $l + m - n = 0, 3l^2 + m^2 + cnl = 0$  are parallel, then the positive value of  $c$  is:  
 (a) 6 (b) 4 (c) 3 (d) 2
15. Let  $\vec{a} = \hat{i} + \hat{j} - \hat{k}$  and  $\vec{c} = 2\hat{i} - 3\hat{j} + 2\hat{k}$ . Then the number of vectors  $\vec{b}$  such that  $\vec{b} \times \vec{c} = \vec{a}$  and  $|\vec{b}| \in \{1, 2, \dots, 10\}$  is:  
 (a) 0 (b) 1 (c) 2 (d) 3
16. Five numbers  $x_1, x_2, x_3, x_4, x_5$  are randomly selected from the numbers 1, 2, 3, ..., 18 and are arranged in the increasing order ( $x_1 < x_2 < x_3 < x_4 < x_5$ ). The probability that  $x_2 = 7$  and  $x_4 = 11$  is:  
 (a)  $\frac{1}{136}$  (b)  $\frac{1}{72}$  (c)  $\frac{1}{68}$  (d)  $\frac{1}{34}$
17. Let  $X$  be a random variable having binomial distribution  $B(7, p)$ . If  $P(X = 3) = 5P(X = 4)$ , then the sum of the mean and the variance of  $X$  is:  
 (a)  $\frac{105}{16}$  (b)  $\frac{7}{16}$  (c)  $\frac{77}{36}$  (d)  $\frac{49}{16}$
18. The value of  $\cos\left(\frac{2\pi}{7}\right) + \cos\left(\frac{4\pi}{7}\right) + \cos\left(\frac{6\pi}{7}\right)$  is equal to:  
 (a) -1 (b)  $-\frac{1}{2}$  (c)  $-\frac{1}{3}$  (d)  $-\frac{1}{4}$
19.  $\sin^{-1}\left(\sin\frac{2\pi}{3}\right) + \cos^{-1}\left(\frac{7\pi}{6}\right) + \tan^{-1}\left(\tan\frac{3\pi}{4}\right)$  is equal to:  
 (a)  $\frac{11\pi}{12}$  (b)  $\frac{17\pi}{12}$  (c)  $\frac{31\pi}{12}$  (d)  $-\frac{3\pi}{4}$
20. The boolean expression  $(\neg p(p \wedge q)) \vee q$  is equivalent to:  
 (a)  $q \rightarrow (p \wedge q)$  (b)  $p \rightarrow q$  (c)  $p \rightarrow (p \rightarrow q)$  (d)  $p \rightarrow (p \vee q)$

**SECTION – B**

**(Numerical Answer Type)**

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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- Let  $f : \mathbb{R} \rightarrow \mathbb{R}$  be a function defined by  $f(x) = \frac{2e^{2x}}{e^{2x} + e}$ .  
Then  $f\left(\frac{1}{100}\right) + f\left(\frac{2}{100}\right) + f\left(\frac{3}{100}\right) + \dots + f\left(\frac{99}{100}\right)$  is equal to.....
- If the sum of all the roots of the equation  $e^{2x} - 11e^x - 45e^{-x} + \frac{81}{2} = 0$  is  $\log_e p$ , then  $p$  is equal to.....
- The positive value of the determination of the matrix  $A$ , whose 
$$\text{Adj}(\text{Adj}(A)) = \begin{pmatrix} 14 & 28 & -14 \\ -14 & 14 & 28 \\ 28 & -14 & 14 \end{pmatrix}$$
, is .....
- The number of ways, 16 identical cubes, of which 11 are blue and rest are red, can be placed in a row so that between any two red cubes there should be at least 2 blue cubes, is.....
- If the coefficient of  $x^{10}$  in the binomial expansion of  $\left(\frac{\sqrt{x}}{5^{\frac{1}{4}}} + \frac{\sqrt{5}}{x^{\frac{1}{3}}}\right)^{60}$  is  $5^k \cdot l$ , where  $l, k \in \mathbb{N}$  and  $l$  is co-prime to 5, then  $k$  is equal to.....
- Let  $A_1 = \{(x, y) : |x| \leq y^2, |x| + 2y \leq 8\}$  and  $A_2 = \{(x, y) : |x| + |y| \leq k\}$ : If  $27 (\text{Area } A_1) = 5 (\text{Area } A_2)$ , then  $k$  is equal to:
- If the sum of the first ten terms of the series  $\frac{1}{25} + \frac{2}{65} + \frac{3}{325} + \frac{4}{1025} + \frac{5}{2501} + \dots$  is  $\frac{m}{n}$ , where  $m$  and  $n$  co-prime numbers, then  $m + n$  is equal to.....
- A rectangle  $R$  with end points of one of its sides as  $(1, 2)$  and  $(3, 6)$  is inscribed in a circle. If the equation of a diameter of the circle is  $2x - y + 4 = 0$ , then the area of  $R$  is.....
- A circle of radius 2 unit passes through the vertex and the focus of the parabola  $y^2 = 2x$  and touches the parabola  $y = 2x$  and touches the parabola  $y = \left(x - \frac{1}{4}\right)^2 + \alpha$ , where  $\alpha > 0$ . Then  $(4\alpha - 8)^2$  is equal to.....
- Let the mirror image of the point  $(a, b, c)$ , with respect to the plane  $3x - 4y + 12z + 19 = 0$  be  $(a - 6, \beta, \gamma)$ . If  $a + b + c = 5$ , then  $7\beta - 9\gamma$  is equal to.....