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, Θ sign should be bubbled. (Example: 6, 81, 1.50,$\oplus$ 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 - I : PHYSICS

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

1. If the wavelength of α -line of Lyman series in hydrogen atom is λ, find the wavelength of ß -line of Paschen series.

(a) $\frac{3^2 \times 5^6}{2^3} \times \lambda$ (b) $\frac{3^6 \times 5^3}{2^2} \times \lambda$ (c) $\frac{3^3 \times 5^2}{2^6} \times \lambda$ (d) $\frac{3^2 \times 5^3}{2^6} \times \lambda$

2. If temperature of a liquid is increased, choose the correct option regarding change in its surface tension and viscosity.
   (a) Surface tension decreases while viscosity increases
   (b) Surface tension increases while viscosity decreases
   (c) Both increases
   (d) Both decreases

3. A proton of mass m and charge q enters a region of uniform magnetic field of a magnitude B with a velocity v directed perpendicular to the magnetic field. It moves in a circular path and leaves the magnetic field after completing a quarter of a circle. The time spent by the proton inside the magnetic field is proportional to:

(a) $v^{-1/2}$ (b) $v^{1/2}$ (c) v^0 (d) v

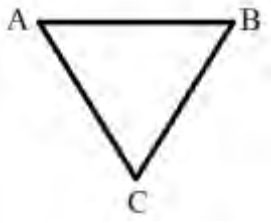
4. Abhishek and Deepak have two samples of magnetic materials X and Y. Experimentally they determine the following properties of the samples.

	Retentivity	**Coercivity**
X	1.5 T	20 Am^{-1}
Y	1.0 T	100 Am^{-1}

Considering this, choose best choice
(a) X and Y both for electromagnets
(b) X for electromagnetic and Y for permanent magnets
(c) X and Y both for permanent magnets
(d) X for permanent magnets and Y for electromagnets

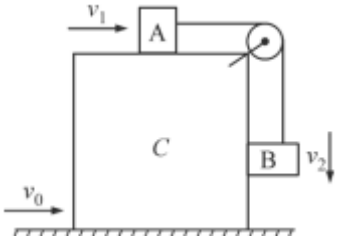
5. Three thin rods of mass m and length a each are joined to form a triangle ABC in vertical plane. The triangle is pivoted at the vertex A such that it can rotate in the vertical plane. It is

released from rest when the side AB is horizontal as shown. As the triangle rotates, the maximum velocity of the vertex B, v_{MAX} , is given by:



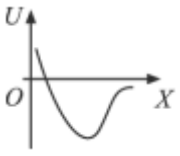
(a) $v^2{}_{MAX} = \frac{4ga}{\sqrt{3}}$ (b) $v^2{}_{MAX} = \sqrt{3}ga$ (c) $v^2{}_{MAX} = \frac{2ga}{\sqrt{3}}$ (d) $v^2{}_{MAX} = \frac{ga}{\sqrt{3}}$

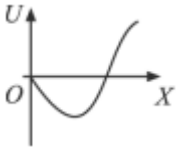
6. To a ground observer the block C is moving with v_0 and the block A with v_1. B is moving with v_2 relative to C as shown in the figure. Identify the correct statement.

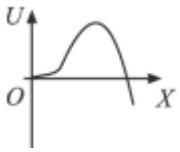


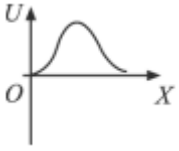
(a) $v_1 - v_2 = v_0$ (b) $v_1 = v_2$ (c) $v_1 + v_0 = v_2$ (d) None of these

7. A particle free to move along x - axis is acted upon by a force $F = -ax + bx^2$ where a and b are positive constants. For $x \geq 0$, the correct variation of potential energy function U(x) is best represented by (take U(0) = 0).

(a) 

(b) 

(c) 

(d) 

8. In system of particles, internal forces can change:
   (a) The linear momentum but not the kinetic energy
   (b) The kinetic energy but not the linear momentum
   (c) Linear momentum as well as kinetic energy
   (d) Neither the linear momentum nor the kinetic energy

9. From a point on smooth floor of a room, a ball is shot to hit a wall. The ball then returns back to the point of projection. If the time taken by the ball in returning is twice the time taken in reaching the wall, find the coefficient of restitution.

(a) $e = \frac{1}{2}$ (b) $e = \frac{1}{3}$ (c) $e = \frac{1}{4}$ (d) $e = 0.2$

10. A ball is projected horizontal with a velocity of $5ms^{-1}$ from the top of a building 20m. Displacement of ball when it hits the ground is : ($g = 10m/s^2$)

(a) 10 m (b) 20 m (c) $10\sqrt{3}m$ (d) $10\sqrt{5}m$

11. A planet is revolving around the sun in an elliptical orbit. The mass of planet is m, angular momentum of planet about sun is L, and length of semi major axis is a and eccentricity are e. Time period of revolution of planet is given by

(a) $T = \frac{2\pi ma^2\sqrt{1+e^2}}{L}$ (b) $T = \frac{\pi ma^2\sqrt{1-e^2}}{L}$

(c) $T = \frac{2\pi ma^2\sqrt{1-e^2}}{L}$ (d) $T = \frac{\pi ma^2\sqrt{1-e^2}}{3L}$

12. An ideal gas undergoes a thermodynamic process in which internal energy (U) of the gas depends on pressure (P) of the gas as $= aP^4$, where a is a positive constant. Assuming gas to be monoatomic, the molar heat capacity of the gas for given process will be

(a) $\frac{3R}{4}$ (b) $\frac{2R}{3}$

(c) $\frac{9R}{4}$ (d) $\frac{4R}{9}$

13. A vertical cylindrical vessel contains a half litre of water having column height of $60\ cm$. If the density and bulk modulus of water are $10^3\ kg\ m^{-3}$ and $2 \times 10^9\ N\ m^{-2}$ respectively, then the elastic deformation potential energy (approximately) of water, is

(a) $1.8\ \mu J$ (b) $1.5\ \mu J$

(c) $2.1\ \mu J$ (d) $2.4\ \mu J$

14. For an SHM oscillator, the amplitude is 5 cm and its time period is 4 seconds. The minimum time taken by the particle to pass between points which are at distances 4 cm and 3 cm from the centre of oscillation on the same side of it will be

(a) $0.13\ second$ (b) $0.18\ second$

(c) $0.26\ second$ (d) $0.35\ second$

15. A simple LR circuit is connected to a battery at $t = 0$. The time instant at which rate of energy storage in inductor is half of power delivered by battery

(a) $\frac{2L}{R} In\ 2$ (b) $\frac{L}{R} In\ \left(\frac{3}{2}\right)$

(c) $\frac{L}{R} In\ 2$ (d) $\frac{L}{R} In\ 3$

16. A uniform rod, of mass m, length l and r radius of cross section, is rotated about an axis passing through one of its ends and perpendicular to its length with constant angular velocity ω in horizontal plane. If Y is the Young's modulus of the material of rod, the increase in its length due to rotation of rod is

(a) $\frac{m\omega^2 L^2}{\pi r^2 Y}$ (b) $\frac{m\omega^2 L^2}{2\pi r^2 Y}$

(c) $\frac{m\omega^2 L^2}{3\pi r^2 Y}$ (d) $\frac{2m\omega^2 L^2}{\pi r^2 Y}$

17. A free particle having one electronic charge with initial kinetic energy 9 eV and de Broglie wavelength $1\ mm$ enters a region of V_0 potential difference such that new de Broglie wavelength is now $1.5\ mm$. Then eV_0 is

(a) $5\ eV$ (b) $6\ eV$

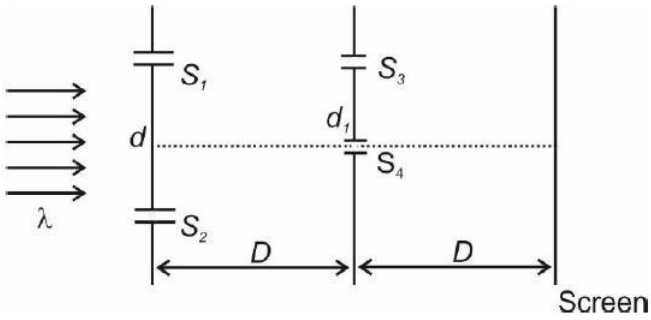
(c) $13.5\ eV$ (d) $15\ eV$

18. A radioactive β −emission. A detector records $n\ \beta$ −particles in $2s$ and by next $2s$ (accumulatively) it records $1.1\ n\ \beta$ −particle. Number of β −particles recorded by detector after a long time, is

(a) $\frac{11n}{10}$ (b) $\frac{12n}{10}$

(c) $2n$ (d) $\frac{10n}{9}$

19. Consider the given arrangement. The two slits S_1 and S_2 are illuminated by monochromatic light of wavelength λ. Slits S_3 and S_4 are at separation $d_1 = \frac{\lambda D}{3d}$, then ratio of maximum and minimum intensity on the screen will be



(a) 9 : 1 (b) 8 : 1

(c) 4 : 1 (d) 2 : 1

20. A sine wave is travelling in a medium. The minimum distance between the two particles, always having same speed, is

(a) $\frac{\lambda}{4}$ (b) $\frac{\lambda}{3}$

(c) $\frac{\lambda}{2}$ (d) λ

SECTION – II

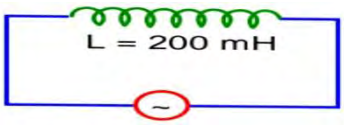
Numerical Value Type Questions: This section contains 10 questions. The answer to each questions is a NUMERICAL VALUE For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, -00.33, -00.30, 30.27, -27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. You have to attempt any five.

1. 0.056 kg of Nitrogen is enclose in a vessel at a temperature of 127°C. The amount of heat required to double the speed of its molecules is _____ k cal.

2. Two identical thin biconvex lenses of focal length 15 cm and refractive index 1.5 are in contact with each other. The space between the lenses is filled with a liquid of refractive index 1.25. The focal length of the combination is _____ cm.

3. A transistor is used in common-emitter mode in an amplifier circuit. When a signal of 10 mV is added to the base-emitter voltage, the base current changes by 10μA and the collector current changes by 1.5 mA. The load resistance is 5 kΩ. The voltage gain of the transistor will be _____.

4. As shown in the figure an inductor of inductance 200 mH is connected to an AC source of emf 220 V and frequency 50 Hz. The instantaneous voltage of the source is 0 V when the peak value of current is $\frac{\sqrt{a}}{\pi}$A. The value of a is _____.



5. Sodium light of wavelength 650nm and 655 nm is used to study diffraction at a single slit of aperture 0.5 mm. The distance between the slit and the screen is 2.0 m. The separation between the positions of the first maximum of diffraction pattern obtained in the two cases is _____$\times 10^{-5}$ m.

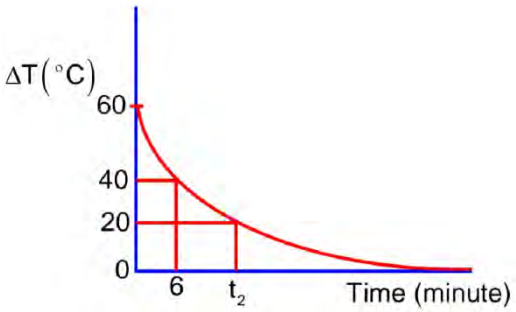
6. A sample contains 10^{-2}kg each of two substances A and B with half lives 4s and 8s respectively. The ration of their atomic weights is 1 : 2. The ratio of the amounts of A and B after16s is $\frac{x}{100}$. The value of x is _____.

7. A ray of light is incident at an angle of incidence $60°$ on the glass slab of refractive index $\sqrt{3}$. After refraction, the light ray emerges out from other parallel faces and lateral shift between incident ray and emergent ray is $4\sqrt{3}$ cm. The thickness of the glass slab is _____cm.

8. A circular coil of 1000 turns each with area $1m^2$ is rotated about its vertical diameter at the rate of one revolution per second in a uniform horizontal magnetic field of 0.07 T. The maximum voltage generation will be _____V.

9. A monoatomic gas performs a work of $\frac{Q}{4}$ where Q is the heat supplied to it. The molar heat capacity of the gas will be _____ R during this transformation. Where R is the gas constant.

10. In an experiment to verigy Newton's law of cooling, a graph is plotted between, the temperature difference (ΔT) of the water and surrounding and time as shown in figure. The initial temperature of water is taken as $80°C$. The value of t_2 as mentioned in the graph will be _____.



Part – B (CHEMISTRY)

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. 120g of an organic compound that contains only carbon and hydrogen gives 330g of CO_2 and 270g of water on complete combustion. The percentage of carbon and hydrogen, respectively are

(a) 25 and 75 (b) 40 and 60 (c) 60 and 40 (d) 75 and 25

2. The energy of one mole of photons of radiation of wavelength 300nm is (Given: h = 6.63 × 10^{34} Js,N_A = 6.02 × 10^{23} mol^{-1} c = 3 × 10^8 ms^{-1})

(a) 235 kJ mol^{-1} (b) 325 kJ mol^{-1} (c) 399 kJ mol^{-1} (d) 435 kJ mol^{-1}

3. The correct order of bond orders of C_2^{2-}, N_2^{2-} and O_2^{2-} is, respectively

(a) $C_2^{2-} < N_2^{2-} < O_2^{2-}$ (b) $O_2^{2-} < N_2^{2-} - < C_2^{2-}$ (c) $C_2^{2-} < O_2^{2-} < N_2^{2-}$ (d) $N_2^{2-} < C_2^{2-} < O_2^{2-}$

4. At $25°C$ and 1 atm pressure, the enthalpies of combustion are as given below:

Substance	H_2	C(graphite	$C_2H_6(g)$
$\frac{\Delta_0 H^\ominus}{kjmol^{-1}}$	−286.0	−394.0	−1560.0

The enthalpy of formation of ethane is

(a) +54.0 kJ mol^{-1} (b) −68.0 kJ mol^{-1} (c) −86.0 kJ mol^{-1} (d) +97.0 kJ mol^{-1}

5. For a first order reaction, the time required for completion of 90% reaction is 'x' times the half life of the reaction. The value of 'x' is

(Given : In 10 = 2.303 and log 2 = 0.3010)

(a) 1.12 (b) 2.43 (c) 3.32 (d) 33.31

6. Given below are the oxides :

Na_2O, As_2O_3, N_2O, NO and Cl_2O_7

Number of amphoteric oxides is :

(a) 0 (b) 1 (c) 2 (d) 3

7. Match List – I with List – II:

List – I	List – II
(A) Sphalerite	(I) $FeCO_3$
(B) Calamine	(II) PbS
(C) Galena	(III) $ZnCO_3$
(D) Siderite	(IV) ZnS

Choose the **most appropriate** answer from the options given below :

(a) (A) – (IV), (B) – (III), (C) – (II), (D) – (I) (b) (A) – (IV), (B) – (I), (C) – (II), (D) –(III)

(c) (A) – (II), (B) – (III), (C) – (I), (D) – (IV) (d) (A) – (III), (B) – (IV), (D) – (II), (D) –(I)

8. The highest industrial consumption of molecular hydrogen is to produce compounds of element :

(a) Carbon (b) Nitrogen (c)Oxygen (d)Chlorine

9. Which of the following statements are **correct?**

(A) Both LiCl and $MgCl_2$ are soluble in ethanol

(B) The oxides Li_2O and MgO combine with excess of oxygen to give superoxide.

(C) LiF is less soluble in water than other alkali metal fluorides.

(D) Li_2O is more soluble in water than other alkali metal oxides.

Choose the **most appropriate** answer from the options given below :

(a) (A) and (C) only (b) (A), (C) and (D) only

(c) (B) and (C) only (d) (A) and (D) only

10. Identify the correct statement from B_2H_6 from those given below :

(A) In B_2H_6, all B-H bonds are equivalent

(B) In B_2H_6, there are four 3-centre 2- electron bonds

(C) B_2H_6 is a Lewis acid

(D) B_2H_6 can be synthesized from both BF_3 and $NaBH_4$.

(E) B_2H_6 is planar molecule.

Choose the **most appropriate** answer from the options given below :

(a) (A) and (E) only (b) (B), (C) and (E) only

(c) (C) and (D) only (d) (C) and (E) only

11. SO_2Cl_2 on reaction with excess of water results into acidic mixture

$SO_2Cl_2 + H_2O \rightarrow H_2SO_4 + 2HCl$

16 moles of NaOH is required for the complete neutralization of the resultant acidic mixture. The number of moles of SO_2Cl_2 used is:

(a) 16 (b) 8 (c) 4 (d) 2

12. Which of the following sets of quantum numbers is not allowed?

(a) $n=3,\ \ell=2,\ m_1=0,\ s=+\frac{1}{2}$ (b) $n=3,\ \ell=2,\ m_1=-2,\ s=+\frac{1}{2}$

(c) $n=3,\ \ell=3\ m_1=-3,\ s=-\frac{1}{2}$ (d) $n=3,\ \ell=0,\ m_1=0,\ s=-\frac{1}{2}$

13. The depression in freezing point observed for a formic acid solution of concentration 0.5 mL L^{-1} is $0.0405°C.$ Density of formic acid is 1.05 g mL^{-1}. The Van't Hoff factor of the formic acid solution is nearly: (Given for water $K_f = 1.86\ k\ kg\ mol^{-1}$)

(a) 0.8 (b) 1.1 (c) 1.9 (d) 2.4

14. 20 mL of 0.1 M NH_4Oh is mixed with 40 mL of 0.05 M HCl. The pH of the mixture is nearest to: (Given K_b (NH_4OH) = 1×10^{-5}, log2 = 0.30, log3 = 0.48, log5 = 0.69, log7 = 0.84, log11 = 1.04

(a) 3.2 (b) 4.2 (c) 5.2 (d) 6.2

15. Match the **List-I** with **List-II**

List-I **List-II**

(A) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ (I) Cu

(B) $CO(g) + 3H_2(g) \rightarrow CH_4(g) + H_2O(g)$ (II) $Cu/ZnO - Cr_2O_3$

(C) $CO(g) + H_2(g) \rightarrow HCOH(g)$ (III) $Fe_xO_y + K_2O + Al_2O_3$

(D) $CO(g) + 2H_2(g) \rightarrow CH_3OH(g)$ (IV) Ni

Choose the **correct** answer from the options given below:

(a) (A) – (II), (B) – (IV), (C) – (I), (D) – (III)

(b) (A) – (II), (B) – (I), (C) – (IV), (D) – (III)

(c) (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

(d) (A) – (III), (B) – (I), (C) – (IV), (D) – (II)

16. The IUPAC nomenclature of an element with electronic configuration [Rn] $5f^{14}6d^{1}7s^{2}$ is:

(a) Unnibium (b) Unnilunium (c) Unnilquandium (d) Unniltrium

17. The compound(s) that is (are) removed as slag during the extraction of copper is:

(A) CaO

(B) FeO

(C) Al_2O_3

(D) ZnO

(E) NiO

Choose the **correct** answer from the options given below.

(a) (C), (D) only (b) (A), (B), (E) only (c) (A), (B) only (d) (B) only

18. The reaction of H_2O_2 with potassium permanganate in acidic medium leads to the formation of mainly.

(a) Mn^{2+} (b) Mn^{4+} (c) Mn^{3+} (d) Mn^{6+}

19. Choose the **correct** order of density of the alkali meals:

(a) Li < K < Na < Rb < Cs (b) Li < Na < K < Rb < Cs

(c) Cs < Rb < K < Na < Li (d) Li < Na < K < Cs < Rb

20. The geometry around boron in the product 'B' formed from the following reaction is

$$BF_3 + NaH \xrightarrow{450K} A + NaF$$

$$A + NMe_3 \longrightarrow B$$

(a) Trigonal planar (b) Tetrahedral (c) Pyramidal (d) Square planar

SECTION – B

(Numerical Answer Type)

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

1. In the given reaction,

$X + Y + 3Z \longrightarrow XYZ_3$

If one mole of each of X and Y with 0.05 mol of Z gives compound XYZ_3. (Given: Atomic masses of X, Y and Z are 10, 20 and 30 amu, respectively.) The yield of XYZ_3 is_____g.

(Nearest integer)

2. An element M crystallises in a body centred cubic unit cell with a cell edge of 300 pm. The density of the element is 6.0g cm^{-3}. The number of atoms in 180g of the element is_____$\times 10^{23}$ (Nearest integer)

3. The number of paramagnetic species among the following is

B_2, Li_2, C_2, C_2^-, O_2^{-2}, O_2^+ and He_2^+.

4. 150g of acetic acid was contaminated with 10.2g ascorbic acid $(C_6H_8O_6)$ to lower down its freezing point by $(x \times 10^{-1})$°C. The value of x is _____. (Nearest integer)

(Given $K_f = 3.9$ K kg mol^{-1}; molar mass of ascorbic acid = 176 g mol^{-1}]

5. Ka for butyric acid (C_3H_7COOH) is 2×10^{-5}. The pH of 0.2 M solution of butyric acid is _____$\times 10^{-1}$ (Nearest integer)

[Given log2 = 0.30]

6. For the given first order reaction

$A \rightarrow B$

The half life of the reaction is 0.3010 min. The ration of the initial concentration of reactant to the concentration of reactant at time 2.0 min will be equal to_____. (Nearest integer)

7. The number of interhalogens from the following having square pyramidal structure is:

ClF_3, IF_7, BrF_5, BrF_3, I_2Cl_6, IF_5, ClF, ClF_5

8. The disproportionation of MnO_4^{2-} in acidic medium resultant in the formation of two manganese compounds A and B. If the oxidation state of Mn is B is smaller than that of A, then the spin-only magnetic moment (μ) value of B in BM is_____.

(Nearest integer)

9. Total number of relatively more stable isomer(s) possible for octahedral complex $\left[Cu(en)_2(SCN)_2\right]$ will be_____.

10. On complete combustion of 0.492g of an organic compound containing C, H and O, 0.7938 g of CO_2 and 0.4428 g of H_2O was produced. The % composition of oxygen in the compounds is_____.

Part – C (MATHEMATICS)

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.

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1. Let f : R $\to$ R be a continuous function such that f(3x) – f(x) =. If f(8) = 7, then f(14) is equal to:

(a) 4 (b) 10 (c) 11 (d) 16

2. Let O be the origin and A be the point $z_1 = 1 + 2i$. If B is the point z_2, $Re(z_2) < 0$, such that OAB is a right angled isosceles triangle with OB as hypotenuses, then which of the following is NOT true?

(a) arg z_2 $\pi - \tan^{-3} 3$ (b) $\arg(z_1 - 2z_2) = -\tan^{-1}\frac{4}{3}$

(c) $|z_2| = \sqrt{10}$ (d) $|2z_1 - z_2| = 5$

3. If the system of linear equations.

$8x + y + 4z = -=-2$

$x + y + z = 0$

$\lambda x - 3y = \mu$

has infinitely many solutions, then the distance of the point $\left(\lambda, \mu - \frac{1}{2}\right)$ from the plane 8x + y + 4z + 2 = 0 is:

(a) $3\sqrt{5}$ (b) 4 (c) $\frac{26}{9}$ (d) $\frac{10}{3}$

4. Let A be a 2 × 2 matrix with det(A) = -1 and det $\left((A+I)\left(\text{Adj}(A)+I\right)\right) = 4$. Then the sum of the diagonal elements of A can be:

(a) -1 (b) 2 (c) 1 (d) $-\sqrt{2}$

5. The odd natural number a, such that the area of the region bounded by y = 1, y = 3, x = 0, $x = y^a$ is $\frac{364}{3}$, is equal to:

(a) -1 (b) 5 (c) 1 (d) $-\sqrt{2}$

6. Consider two G.P.'s. 2, 2^2, 2^3, …… and 4, 4^2, 4^3, …… of 60 and n terms respectively. If the geometric mean of all the 60 + n terms is $(2)^{\frac{225}{8}}$, then $\sum_{k=1}^{n} k(n-k)$ is equal to:

(a) 560 (b) 1540 (c) 1330 (d) 2600

7. If the function $f(x) = \begin{cases} \dfrac{\log_e\left(1-x+x^2\right)+\log_e\left(1+x+x^2\right)}{\sec x-\cos x} \\ k \end{cases}$, $x \in \left(\dfrac{-\pi}{2}, \dfrac{\pi}{2}\right) - \{0\}$ is continuous at x = 0, then k is equal to:

(a) 1 (b) -1 (c) e (d) 0

8. If $f(x) = \begin{cases} x+a\ , x \le 0 \\ |x-4|, x > 0 \end{cases}$ and $g(x) = \begin{cases} x+1 \quad\quad ,x < 0 \\ (x-4)^2+b, x \ge 0 \end{cases}$ are continuous on R, then (gof)(2) + (fog)(-2) is equal to:

(a) -10 (b) 10 (c) 8 (d) -8

9. Let $f(x) = \begin{cases} x^3-x^2+10x-7\ ,x \le 1 \\ -2x+\log_2\left(b^2-4\right), x > 1 \end{cases}$. Then the set of all values of b, for which f(x) has maximum value at x = 1, is:

(a) (-6, -2) (b) (2, 6)

(d) $[-6,-2) \cup (2, 6]$ (d) $\left[-\sqrt{6},-2\right) \cup \left(2, \sqrt{6}\right]$

10. If $a = \lim\limits_{n\to\infty} \sum\limits_{k=1}^{n} \dfrac{2n}{n^2+k^2}$ and $f(x) = \sqrt{\dfrac{1-\cos x}{1+\cos x}}$, $x \in (0, 1)$, then:

(a) $2\sqrt{2}f\left(\dfrac{a}{2}\right) = f'\left(\dfrac{a}{2}\right)$ (b) $f\left(\dfrac{a}{2}\right)f'\left(\dfrac{a}{2}\right) = \sqrt{2}$

(c) $\sqrt{2}f\left(\dfrac{a}{2}\right) = f'\left(\dfrac{a}{2}\right)$ (d) $f\left(\dfrac{a}{2}\right) = \sqrt{2}f'\left(\dfrac{a}{2}\right)$

11. If $\dfrac{dy}{dx} + 2y \tan x = \sin x$, $0 < x < \dfrac{\pi}{2}$ and $y\left(\dfrac{\pi}{3}\right) = 0$, then the maximum value of y(x) is:

(a) $\dfrac{1}{8}$ (b) $\dfrac{3}{4}$ (c) $\dfrac{1}{4}$ (d) $\dfrac{3}{8}$

12. A point P moves so that the sum of squares of its distances from the points (1, 2) and (-2, 1) is 14. Let f(x, y) = 0 be the locus of P, which intersects the x-axis at the points A , B and the y-axis at the points C, D. Then the area of the quadrilateral ACBD is equal to:

(a) $\dfrac{9}{2}$ (b) $\dfrac{3\sqrt{17}}{2}$ (c) $\dfrac{3\sqrt{17}}{4}$ (d) 9

13. Let the tangent drawn to the parabola $y^2 = 24x$ at the point (α, β) is perpendicular to the line $2x + 2y = 5$. Then the normal to the hyperbola $\dfrac{x^2}{\alpha^2} - \dfrac{y^2}{\beta^2} = 1$ at the point $(\alpha + 4, \beta + 4)$ does NOT pass through the point:

(a) (25, 10) (b) (20, 12) (c) (30, 8) (d) (15, 13)

14. The length of the perpendicular from the point (1, -2, 5) on the line passing through (1, 2, 4) and parallel to the line $x + y - z = 0 = x - 2y + 3z - 5$ is:

(a) $\sqrt{\dfrac{21}{2}}$ (b) $\sqrt{\dfrac{9}{2}}$ (c) $\sqrt{\dfrac{73}{2}}$ (d) 1

15. Let $\vec{a}=\alpha\hat{i}+\hat{j}-\hat{k}$ and $\vec{b}=2\hat{i}+\hat{j}-\alpha\hat{k}$, $\alpha>0$. If the projection of $\vec{a}\times\vec{b}$ on the vector $-\hat{i}+2\hat{j}-2\hat{k}$ is 30, then α equal to:

(a) $\frac{15}{2}$ (b) 8 (c) $\frac{13}{2}$ (d) 7

16. The mean and variance of a binomial distribution are α and $\frac{\alpha}{3}$ respectively. If P(X = 1) = $\frac{4}{243}$ then P(X = 4 or 5) is equal to:

(a) $\frac{5}{9}$ (b) $\frac{64}{81}$ (c) $\frac{16}{27}$ (d) $\frac{145}{243}$

17. Let E_1, E_2, E_3 be three mutually exclusive events such that $P(E_1) = \frac{2+3p}{6}$, $P(E_2) = \frac{2-p}{8}$ and $P(E_3) = \frac{1-p}{2}$. If the maximum and minimum values of p are p_1 and p_2, then $(p_1 + p_2)$ is equal to:

(a) $\frac{2}{3}$ (b) $\frac{5}{3}$ (c) $\frac{5}{4}$ (d) 1

18. Let $S = \left\{\theta\in[0, 2\pi]: 8^{2\sin^2\theta}+8^{2\cos^2\theta}=16\right\}$. Then $n(S)+\sum_{\theta\in S}\left(\sec\left(\frac{\pi}{4}+2\theta\right)\operatorname{cosec}\left(\frac{\pi}{4}+2\theta\right)\right)$ is equal to:

(a) 0 (b) -2 (c) -4 (d) 12

19. $\tan\left(2\tan^{-1}\frac{1}{5}+\sec^{-1}\frac{\sqrt{5}}{2}+2\tan^{-1}\frac{1}{8}\right)$ is equal to:

(a) 1 (b) 2 (c) $\frac{1}{4}$ (d) $\frac{5}{4}$

20. The statement $(\sim(p\Leftrightarrow\sim q))\wedge q$ is:

(a) a tautology (b) a contradiction

(c) equivalent to $(p\Rightarrow q)\wedge q$ (d) equivalent to $(p\Rightarrow q)\wedge p$

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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1. If for some q, q, r $\in$ R, not at all have same sign, one of the roots of the equation $(p^2+q^2)x^2-2q(p+r)x+q^2+r^2=0$ is also a root of the equation $x^2 + 2x - 8 = 0$, then $\frac{q^2+r^2}{p^2}$ is equal to……

2. The number of 5-digit natural numbers, such that the product of their digits is 36, is……

3. The series of positive multiples of 3 is divided into sets : $\{3\},\{6, 9, 12\},\{15, 18, 21, 24, 27\},\ldots\ldots$ Then the sum of the elements in the 11^{th} set is equal to……..

4. The number of distinct real roots of the equation $x^5\left(x^3-x^2-x+1\right)+$ $x\left(3x^3-4x^2-2x+4\right)-1=0$ is …….

5. If the coefficients of x and x^2 in the expansion of $(1+x)^p(1-x)^q$, p, q $\leq$ 15, are -3 and -5 respectively, then the coefficient of x^3 is equal to……

6. If $n(2n+1)\int_0^1\left(1-x^n\right)^{2n}dx=1177\int_0^1\left(1-x^n\right)^{2n+1}dx$, then n $\in$ N is equal to…….

7. Let a cure y = y(x) pass through the point (3, 3) and the area of the origin under this curve, above the x-axis and between the abscissae 3 and x (>3) be $\left(\frac{y}{x}\right)^3$. If the curve also passes through the point $\left(\alpha, 6\sqrt{10}\right)$ in the first quadrant, then α is equal to…….

8. The equations of the sides AB, BC and CA of a triangle ABC are 2x + y = 0, x + py = 15a and x – y = 3 respectively. If its orthocenter is (2, a), $-\frac{1}{2}<a<2,$ then p is equal to……

9. Let the function $f(x) = 2x^2 - \log_e x$, $x > 0$, be decreasing in (0, a) and increasing in (a, 4). A tangent to the parabola $y^2 = 4ax$ at a point P on it passes through the point (8a, 8a – 1) but does not pass through the point $\left(-\frac{1}{a}, 0\right)$. If the equation of the normal at P is $\frac{x}{\alpha}+\frac{\gamma}{\beta}=1,$ then $\alpha + \beta$ is equal to…….

10. Let Q and R be two points on the line $\frac{x+1}{2}=\frac{y+2}{3}=\frac{z-1}{2}$ at a distance $\sqrt{26}$ from the point P(4, 2, 7). Then the surface of the area of the triangle PQR is……