SAMPLE QUESTION PAPER

PHYSICS

Subject Code – 042

CLASS – XII

Academic Session 2024 – 25

Maximum Marks: 70 **Time Allowed: 3 hours**

General Instructions

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) **Section A** contains **sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each**, **Section B** contains **five questions of two marks each**, **Section C** contains seven questions of three marks each, **Section D** contains **two case study-based questions of four marks each** and **Section E** contains **three long answer questions of five marks each**.

(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary

i. $c = 3 \times 10^8$ m/s

ii. $m_e = 9.1 \times 10^{-31}$ kg

iii. $m_p = 1.7 \times 10^{-27}$ kg

iv. $e = 1.6 \times 10^{-19}$ C

v. $\mu_0 = 4\pi \times 10^{-7}$ T m $\boldsymbol{A^{-1}}$

vi. $h = 6.63 \times 10^{-34}$ J s

vii. $\varepsilon_0 = 8.854 \times 10^{-12}$ $\boldsymbol{C^2 N^{-1} m^{-2}}$

viii. Avogadro's number = 6.023 X $\mathbf{10^{23}}$ per gram mole

[SECTION – A] **(16x1=16 marks)**

Q1. A uniform electric field pointing in positive X-direction exists in a region. Let A be the origin, B be the point on the X-axis at x = +1 cm and C be the point on the Y-axis at y = +1 cm. Then the potential at points A, B and C satisfy.

(A) $V_A < V_B$ (B) $V_A > V_B$. (C) $V_A < V_C$ (D) $V_A > V_C$

Q2. A conducting wire connects two charged conducting spheres of radii r_1 and r_2 such that they attain equilibrium with respect to each other. The distance of separation between the two spheres is very large as compared to either of their radii.

The ratio of the magnitudes of the electric fields at the surfaces of the spheres of radii r_1 and r_2 is

(A) $\frac{r_1}{r_2}$ (B) $\frac{r_2}{r_1}$ (C) $\frac{{r_2}^2}{{r_1}^2}$ (D) $\frac{{r_1}^2}{{r_2}^2}$

Q3. A long straight wire of circular cross section of radius 'a' carries a steady current I. The current is uniformly distributed across its cross section. The ratio of magnitudes of the magnetic field at a point a/2 above the surface of wire to that of a point a/2 below its surface is

(A) 4:1 (B) 1:1 (C) 4: 3 (D) 3 :4

Q4. The diffraction effect can be observed in

(A) sound waves only
(B) light waves only
(C) ultrasonic waves only
(D) sound waves as well as light waves

Q5. A capacitor consists of two parallel plates, with an area of cross-section of 0.001 m^2, separated by a distance of 0.0001 m. If the voltage across the plates varies at the rate of 10^8 V/s, then the value of displacement current through the capacitor is

(A) $8.85 \times 10^{-3} A$ (B) $8.85 \times 10^{-4} A$ (C) $7.85 \times 10^{-3} A$ (D) $9.85 \times 10^{-3} A$

Q6. In a series LCR circuit, the voltage across the resistance, capacitance and inductance is 10 V each. If the capacitance is short circuited the voltage across the inductance will be

(A) 10 V (B) $10\sqrt{2}$ V (C) $10/\sqrt{2}$ V (D) 20 V

Q7. Correct match of column I with column II is

C-l (waves)	C-ll (Production)
(1) Infra-red	P . Rapid vibration of electrons in aerials
(2) Radio	Q . Electrons in atoms emit light when they move from higher to lower energy level.
(3) Light	R . Klystron valve
(4) Microwave	S . Vibration of atoms and molecules

(A) 1-P, 2-R, 3-S, 4-Q (B) 1-S, 2-P, 3-O, 4-R

(C) 1-Q, 2-P, 3-S, 4-R (D) 1-S. 2-R, 3-P, 4-Q

Q8. The distance of closest approach of an alpha particle is *d* when it moves with a speed V towards a nucleus.

Another alpha particle is projected with higher energy such that the new distance of the closest approach is *d*/2. What is the speed of projection of the alpha particle in this case?

(A) V /2 (B) $\sqrt{2}$ V (C) 2 V (D) 4 V

Q9. A point object is placed at the centre of a glass sphere of radius 6 cm and refractive index 1.5. The distance of virtual image from the surface of the sphere is

(A) 2 cm (B) 4 cm (C) 6 cm (D) 12 cm

Q10. Colours observed on a CD (Compact Disk) is due to

(A) Reflection (B) Diffraction (C) Dispersion (D) Absorption

Q11. The number of electrons made available for conduction by dopant atoms depends strongly upon

(A) doping level (B) increase in ambient temperature

(C) energy gap (D) options (A) and (B) both

Q12. If copper wire is stretched to make its radius decrease by 0.1%, then the percentage change in its resistance is approximately

(A)–0.4% (B) +0.8% (C) +0.4% (D) +0.2%

For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
C. If Assertion is true but Reason is false.
D. If both Assertion and Reason are false.

Q13. Assertion (A): On increasing the current sensitivity of a galvanometer by increasing the number of turns may not necessarily increase its voltage sensitivity.
Reason(R) : The resistance of the coil of the galvanometer increases on increasing the number of turns.

Q14. Assertion (A): In a hydrogen atom there is only one electron but its emission spectrum shows many lines.
Reason (R): In a given sample of hydrogen there are many atoms each containing one electron; hence many electrons in different atoms may be in different orbits so many transitions from higher to lower orbits are possible.

Q15. Assertion (A): Nuclei having mass number about 60 are least stable**..**
Reason (R): When two or more light nuclei are combined into a heavier nucleus then the binding energy per nucleon will decrease.

Q16. Assertion (A): de Broglie's wavelength of a freely falling body keeps decreasing with time.
Reason (R): The momentum of the freely falling body increases with time.

[SECTION – B] (05x2=10 marks)

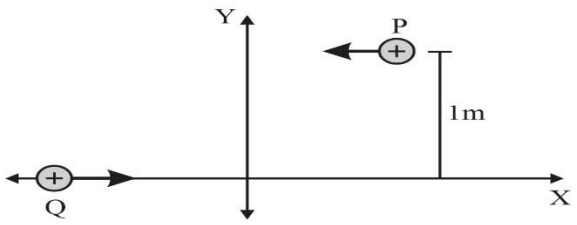
Q17. A platinum surface having work function 5.63 eV is illuminated by a monochromatic source of 1.6 x 10^{15} Hz. What will be the minimum wavelength associated with the ejected electron.

Q18. (I) A beam of light consisting of two wavelengths, 4000 Å and 6000 Å, is used to obtain interference fringes in a Young's double-slit experiment. What is the least distance from the central maximum where the dark fringe is obtained?

OR

(II) In Young's double-slit experiment using monochromatic light of wavelength λ, the intensities of two sources are I. What is the intensity of light at a point where path difference between wavefronts is λ/4?

Q19. P and Q are two identical charged particles each of mass 4×10^{-26} kg and charge 4.8×10^{-19} C, each moving with the same speed of 2.4×10^{5} m/s as shown in the figure. The two particles are equidistant (0.5 m) from the vertical Y -axis. At some instant, a magnetic field B is switched on so that the two particles undergo head-on collision.



Find –

(I) the direction of the magnetic field and

(II) the magnitude of the magnetic field applied in the region.

(for VI candidates)

A proton is moving with speed of 2×10^{5} m s^{-1} enters a uniform magnetic field B = 1.5 T. At the entry velocity vector makes an angle of 30° to the direction of the magnetic field. Calculate

(a) the pitch of helical path described by the charge

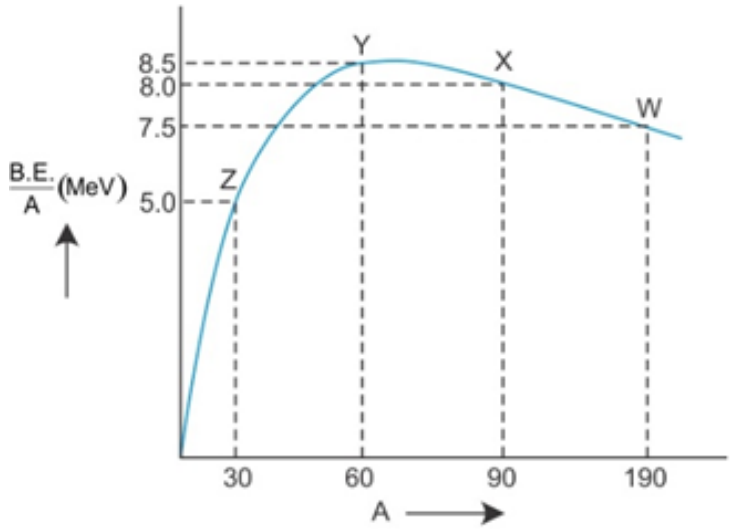
(b) Kinetic energy after completing half of the circle.

Q.20. Binding energy per nucleon vs mass number curve for nuclei is shown in the figure. W, X, Y and Z are four nuclei indicated on the curve. Identify which of the following nuclei is most likely to undergo

(i) Nuclear Fission

(ii) Nuclear Fusion.

Justify your answer.



(for V.I. Candidates)

Binding energy per nucleon and mass number of the following nuclei are given in the below table

Nuclei	Binding energy per nucleon (MeV)	Mass number
W	7.5	190
X	8.0	90
Y	8.5	60
Z	5.0	30

Identify which of the following nuclei is most likely to undergo

(i) Nuclear Fission

(ii) Nuclear Fusion.

Justify your answer.

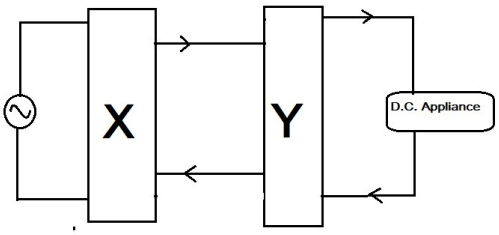
Q21. A cylindrical conductor of length l and cross-section area A is connected to a DC source. Under the influence of electric field set up due to source, the free electrons begin to drift in the opposite direction of the electric field.

(I) Draw the curve showing the dependency of drift velocity on relaxation time.

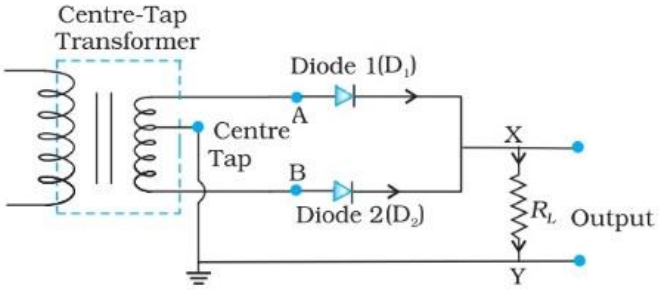
(II) If the DC source is replaced by a source whose current changes its magnitude with time such that $I = I_o \sin 2\pi\nu t$, where ν is the frequency of variation of current, then determine the average drift velocity of the free electrons over one complete cycle.

[SECTION – C] **(07x3=21 marks)**

Q22. (I) Identify the circuit elements X and Y as shown in the given block diagram and draw the output waveforms of X and Y.



(II) If the centre tapping is shifted towards Diode D1 as shown in the diagram, draw the output waveform of the given circuit.



(for V.I. candidates)

Which device is used to convert AC into DC. State it's underlying principle and explain its working. If the frequency of input AC to this device is 60 Hz, then what will be frequency of the output of this device.

Q23. Find the expression for the capacitance of a parallel plate capacitor of plate area A and plate separation d when (I) a dielectric slab of thickness t and (II) a metallic slab of thickness t, where (t < d) are introduced one by one between the plates of the capacitor. In which case would the capacitance be more and why?

Q24. (I) Draw a ray diagram for the formation of image by a Cassegrain telescope.

(II)Why these types of telescopes are preferred over refracting type telescopes. (Write 2 points)

(for V.I. Candidates)

A Cassegrain telescope is built with an arrangement of two mirrors placing them 20 mm apart. If the radius of curvature of the large mirror is 200mm and the small mirror is 150mm, where will the final image of an object at infinity be?

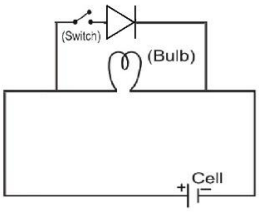
Q25. (I) Draw the energy band diagram for P-type semiconductor at (i) T=0K and (ii) room temperature.

(II)In the given diagram considering an ideal diode, in which condition will the bulb glow

(a) when the switch is open

(b) when the switch is closed

Justify your answer.



(for V.I. Candidates)

Explain briefly how

(i) barrier potential is formed in p-n junction diode.

(ii) Width of depletion region of the diode is affected when it is (a) forward biased, (b) reverse biased.

Q26. A boy is holding a smooth, hollow and non-conducting pipe vertically with charged spherical ball of mass 10 g carrying a charge of +10 mC inside it which is free to move along the axis of the pipe. The boy is moving the pipe from East to West direction in the presence of magnetic field of 2T. With what minimum velocity, should the boy move the pipe such that the ball does not move along the axis. Also determine the direction of the magnetic field.

Q27. A light ray entering a right-angled prism undergoes refraction at the face AC as shown in Fig. 1.

(I) What is the refractive index of the material of the prism in Fig. 1?

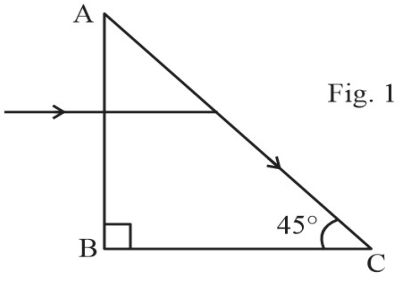


Fig. 1

(II) (a) If the side AC of the above prism is now surrounded by a liquid of refractive index $\frac{2}{\sqrt{3}}$, as shown in Fig. 2, determine if the light ray continues to graze along the interface AC or undergoes total internal reflection or undergoes refraction into the liquid.

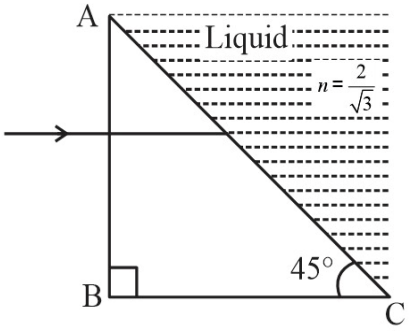


Fig. 2

(b) Draw the ray diagram to represent the path followed by the incident ray with the corresponding angle values.

(Given, $sin^{-1}(\frac{\sqrt{2}}{\sqrt{3}}) = 54.6^{\circ}$)

(for V.I. candidates)

A ray of light is incident on an equilateral prism at an angle 3/4 th of the angle of the prism. If the ray passes symmetrically through the prism, find the (a) angle of minimum deviation, and (b) refractive index of the material of the prism.

Q28. (I) State Gauss's theorem in electrostatics. Using this theorem, derive an expression for the electric field due to an infinitely long straight wire of linear charge density λ.

OR

(II) (a) Define electric flux and write its SI unit.

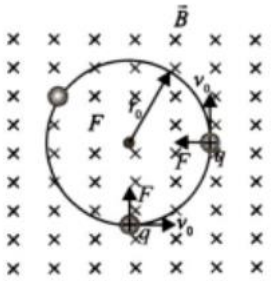
(b) Use Gauss's law to obtain the expression for the electric field due to a uniformly charged infinite plane sheet of charge.

[SECTION D] **(02x4=08 marks)**

Q29. **Case Study Based Question**: **<u>Motion of Charge in Magnetic Field</u>**

An electron with speed $v_o << c$ moves in a circle of radius r_o in a uniform magnetic field. This electron is able to traverse a circular path as the magnetic force acting on the electron is

perpendicular to both v_o and B ,as shown in the figure. This force continuously deflects the particle sideways without changing its speed and the particle will move along a circle perpendicular to the field. The time required for one revolution of the electron is T_o



(i) If the speed of the electron is now doubled to $2v_o$. The radius of the circle will change to

(A) $4r_o$ (B) $2\ r_o$ (C) r_o (D) $r_o/2$

(ii) If $v = 2v_o$, then the time required for one revolution of the electron (T_o) will change to

(A) $4\ T_o$ (B) $2\ T_o$ (C) T_o (D) $T_o/2$

(iii) A charged particle is projected in a magnetic field $\mathbf{B} = (2\ \mathbf{i} + 4\ \mathbf{j}) \times 10^2$ T . The acceleration of the particle is found to be $\mathbf{a} = (\ x\ \mathbf{i} + 2\ \mathbf{j}\ )$ m/s^2 . Find the value of x.

(A) 4 ms^{-2} (B) -4 ms^{-2} (C) -2 ms^{-2} (D) 2 ms^{-2}

(iv) If the given electron has a velocity not perpendicular to B, then trajectory of the electron is

(A) straight line (B) circular (C) helical (D) zig-zag

OR

If this electron of charge (e) is moving parallel to uniform magnetic field with constant velocity v, the force acting on the electron is

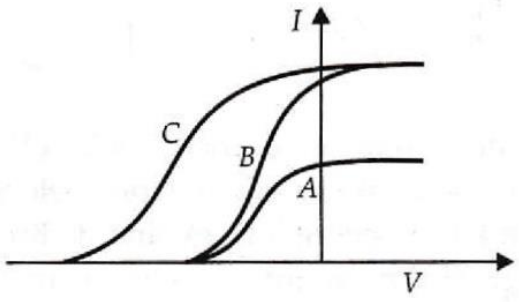
(A) Bev (B) Be/v (C) B/ev (D) Zero

Q30. Case Study Based Question: Photoelectric effect

It is the phenomenon of emission of electrons from a metallic surface when light of a suitable frequency is incident on it. The emitted electrons are called photoelectrons.

Nearly all metals exhibit this effect with ultraviolet light but alkali metals like lithium, sodium, potassium, cesium etc. show this effect even with visible light. It is an instantaneous process i.e. photoelectrons are emitted as soon as the light is incident on the metal surface. The number of photoelectrons emitted per second is directly proportional to the intensity of the incident radiation. The maximum kinetic energy of the photoelectrons emitted from a given metal surface is independent of the intensity of the incident light and depends only on the frequency of the incident light. For a given metal surface there is a certain minimum value of the frequency of the incident light below which emission of photoelectrons does not occur.

(I) In a photoelectric experiment plate current is plotted against anode potential.



(A) A and B will have same intensities while B and C will have different frequencies
(B) B and C will have different intensities while A and B will have different frequencies
(C) A and B will have different intensities while B and C will have equal frequencies
(D) B and C will have equal intensities while A and B will have same frequencies.

(II) Photoelectrons are emitted when a zinc plate is

(A) Heated
(B) hammered
(C) Irradiated by ultraviolet light
(D) subjected to a high pressure

(III) The threshold frequency for photoelectric effect on sodium corresponds to a wavelength of 500 nm. Its work function is about

(A) $4x10^{-19}$ J (B) 1 J (C) $2x10^{-19}$ J (D) $3x10^{-19}$ J

(IV) The maximum kinetic energy of photoelectrons emitted from a surface when photons of energy 6 eV fall on it is 4 eV. The stopping potential is

(A) 2 V (B) 4 V (C) 6 V (D) 10 V

OR

The minimum energy required to remove an electron from a substance is called its

(A) work function (B) kinetic energy (C) stopping potential (D) potential energy

[SECTION E] **(03X5=15)**

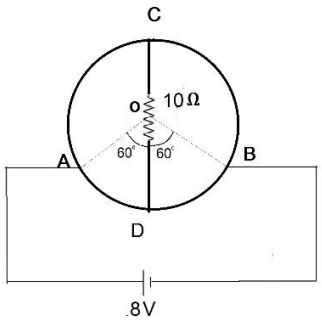
Q31. (I) a) Write two limitations of ohm's law. Plot their I-V characteristics.

b) A heating element connected across a battery of 100 V having an internal resistance of 1 Ω draws an initial current of 10 A at room temperature 20.0 °C which settles after a few seconds to a steady value. What is the power consumed by battery itself after the steady temperature of 320.0 °C is attained? Temperature coefficient of resistance averaged over the temperature range involved is 3.70×10^{-4} °C^{-1}.

OR

(II) a) Using Kirchhoff's laws obtain the equation of the balanced state in Wheatstone bridge.

b) A wire of uniform cross-section and resistance of 12 ohm is bent in the shape of circle as shown in the figure. A resistance of 10 ohms is connected to diametrically opposite ends C and D. A battery of emf 8V is connected between A and B. Determine the current flowing through arm AD.



(for V.I. Candidates)

(II) a) Using Kirchhoff's laws obtain the equation of the balanced state in Wheatstone bridge.

b) What do you understand by 'sensitivity of Wheatstone bridge' ? How the sensitivity of wheatstone bridge can be increased?

Q32. (I) Explain briefly, with the help of a labelled diagram, the basic principle of the working of an a.c. generator. In an a.c. generator, coil of N turns and area A is rotated at an angular velocity ω in a uniform magnetic field B. Derive an expression for the instantaneous value of the emf induced in coil. What is the source of energy generation in this device?

OR

(II) a) With the help of a diagram, explain the principle of a device which changes a low ac voltage into a high voltage . Deduce the expression for the ratio of secondary voltage to the primary voltage in terms of the ratio of the number of turns of primary and secondary winding. For an ideal transformer, obtain the ratio of primary and secondary currents in terms of the ratio of the voltages in the secondary and primary coils.

b) Write any two sources of the energy losses which occur in actual transformers.

c) A step-up transformer converts a low input voltage into a high output voltage. Does it violate law of conservation of energy? Explain.

Q33. (I) a) A giant refracting telescope at an observatory has an objective lens of focal length 15 m. If an eyepiece of focal length 1.0 cm is used, what is angular magnification of the telescope in normal adjustment?

b) If this telescope is used to view the moon, what is the diameter of the image of the moon formed by the objective lens? The diameter of the moon is 3.48×10^6 m, and the radius of lunar orbit is 3.8×10^8 m.

OR

(II) A compound microscope consists of an objective lens of focal length 2.0 cm and an eyepiece of focal length 6.25 cm separated by a distance of 15 cm. How far from the objective should an object be placed in order to obtain the final image at

a) the least distance of distinct vision (25 cm) and

b) infinity? What is the magnifying power of the microscope in each case?

SAMPLE PAPER (2024 -25)

CHEMISTRY THEORY (043)

Max. Marks:70 **Time: 3 hours**

GENERAL INSTRUCTIONS:

Read the following instructions carefully.

(a) There are **33** questions in this question paper with internal choice.
(b) SECTION A consists of 16 multiple-choice questions carrying 1 mark each.
(c) SECTION B consists of 5 short answer questions carrying 2 marks each.
(d) SECTION C consists of 7 short answer questions carrying 3 marks each.
(e) SECTION D consists of 2 case-based questions carrying 4 marks each.
(f) SECTION E consists of 3 long answer questions carrying 5 marks each.
(g) All questions are compulsory.
(h) Use of log tables and calculators is not allowed.

SECTION A

The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

1 Ammonolysis of ethyl chloride followed by reaction of the amine so formed with 1 mole of methyl chloride gives an amine that 1

a. reacts with Hinsberg reagent to form a product soluble in an alkali.
b. on reaction with Nitrous acid, produced nitrogen gas.
c. reacts with Benzenesulphonyl chloride to form a product that is insoluble in alkali.
d. does not react with Hinsberg reagent.

2 Which one of the following has the highest dipole moment? 1

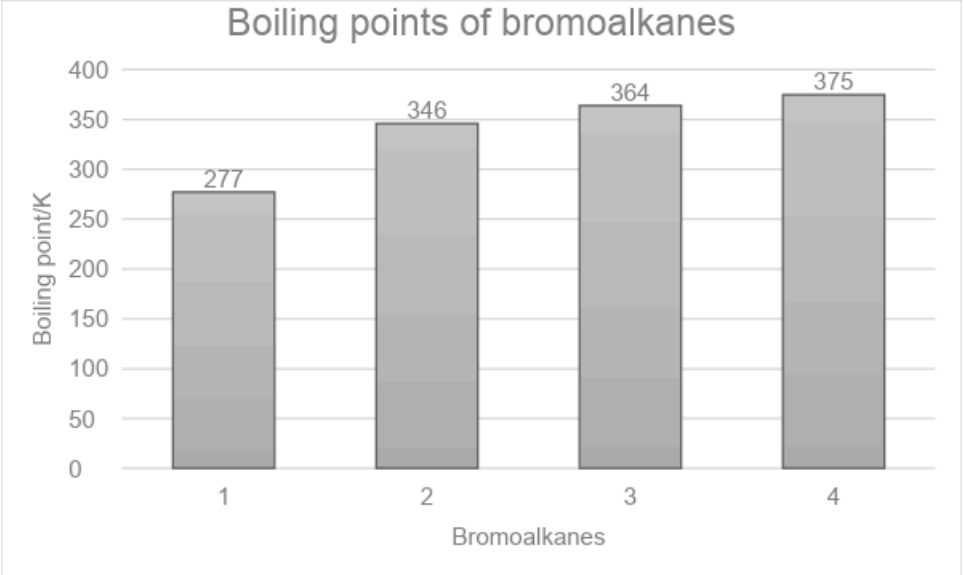
a. CH_3F
b. CH_3Cl
c. CH_3I
d. CH_3Br

3 Match the properties given in column I with the metals in column II 1

Column I	Column II
(i) Actinoid having configuration [Rn] $5f^7 6d^1 7s^2$	(A) Ce
(ii) Lanthanoid which has $4f^{14}$ electronic configuration in +3 oxidation state.	(B) Lu
(iii) Lanthanoid which show +4 Oxidation state	(C) Cm

a. (i)-(C), (ii)-(B), (iii)-(A)
b. (i)-(C), (ii)-(A), (iii)-(B)
c. (i)-(A), (ii)-(B), (iii)-(C)
d. (i)-(B), (ii)-(A), (iii)-(C)

4 Study the graph showing the boiling points of bromoalkanes and identify the compounds. 1



a. 1 = Bromomethane, 2= 2-Bromobutane, 3= 1-Bromobutane, 4= 2-Bromo-2-methylpropane

b. 1 =1-Bromobutane, 2= 2-Bromo-2-methylpropane, 3= 2-Bromobutane, 4= Bromomethane

c. 1 = Bromomethane, 2=1-Bromobutane, 3= 2-Bromo-2-methylpropane, 4= 2-Bromobutane,

d. 1 =Bromomethane, 2= 2-Bromo-2-methylpropane, 3=2- Bromobutane, 4= 1-Bromobutane

(for visually challenged learners)
Which of the following haloalkanes has the highest boiling point?

a. 2-Bromo-2-methylpropane
b. 2-Bromobutane
c. Bromomethane
d. 1-Bromobutane

5 The initial concentration of R in the reaction R□P is 4.62 x 10^{-2} mol/L. What is the half life for the reaction if k = 2.31x 10^{-2} $molL^{-1}s^{-1}$ 1

a. 30 s
b. 3 s
c. 1 s
d. 10 s

6 When $C_6H_5COOCOCH_3$ is treated with H_2O , the product obtained is : 1

a. Benzoic acid and ethanol
b. Benzoic acid and ethanoic acid
c. Acetic Acid and phenol
d. Benzoic anhydride and methanol

7 1

Formulation of Cobalt(III) Chloride-Ammonia Complexes

Colour	Formula	Solution conductivity corresponds to
Yellow	$[Co(NH_3)_6]^{3+}3Cl^-$	Y
Purple	$[CoCl(NH_3)_5]^{2+}2Cl^-$	1:2 electrolyte
Green	X	1:1 electrolyte

'X' and 'Y' in the above table are:

a. X=$[Co(NH_3)_6]^{2+}3Cl^-$, Y= 1:3
b. X= $[Co(NH_3)_4Cl_2]^+Cl^-$, Y= 1:3
c. X=$[Co(NH_3)_4Cl_2]^+Cl^-$, Y= 1:1
d. X=$[Co(NH_3)_4Cl_2]^{3+}3Cl^-$, Y= 1:1

8 Which of the following contains only β-D- glucose as its monosaccharide unit: 1

a. Sucrose
b. Cellulose
c. Starch
d. Maltose

9 Which one of the following sets correctly represents the increase in the paramagnetic property of the ions? 1

a. $Ti^{3+}< Fe^{2+} < Cr^{3+} < Mn^{2+}$
b. $Ti^{3+}< Mn^{2+}< Fe^{2+} < Cr^{3+}$
c. $Mn^{2+}< Fe^{2+}< Cr^{3+}<Ti^{3+}$
d. $Ti^{3+}< Cr^{3+}< Fe^{2+} < Mn^{2+}$

10 A first-order reaction is found to have a rate constant, $k = 5.5 \times 10^{-1}4\ s^{-1}$. The time taken for completion of the reaction is: 1

a. 1.26×10^{13} s
b. 2.52×10^{13} s
c. 0.63×10^{13} s
d. It never goes to completion

11 A student was preparing aniline in the lab. She took a compound "X" and reduced it in the presence of Ni as a catalyst. What could be the compound "X" 1

a. Nitrobenzene
b. 1-Nitrohexane
c. Benzonitrile
d. 1-Hexanenitrile

12 Which of the following compound gives an oxime with hydroxylamine: 1

a. CH_3COCH_3
b. CH_3COOH
c. $(CH_3CO)_2O$
d. CH_3COCl

13 **Assertion (A):** $[Mn(CN)_6]^{3-}$ has a magnetic moment of two unpaired electrons while $[MnCl_6]^{3-}$ has a paramagnetic moment of four unpaired electrons. 1
Reason (R): $[Mn(CN)_6]^{3-}$ is inner orbital complexes involving d^2sp^3 hybridisation,on the other hand, $[MnCl_6]^{3-}$ is outer orbital complexes involving sp^3d^2 hybridisation.

Select the most appropriate answer from the options given below:
a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

14 **Assertion (A)**: For strong electrolytes, there is a slow increase in molar conductivity with dilution and can be represented by the equation 1

$$\Lambda_m^\circ = \Lambda_m - A\ c^{½}$$

Reason (R): The value of the constant '*A*' for NaCl, $CaCl_2$, and $MgSO_4$ in a given solvent and at a given temperature is different.

Select the most appropriate answer from the options given below:
a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

15 **Assertion (A)** Glucose does not form the hydrogensulphite addition product with $NaHSO_3$. 1
Reason (R): Glucose exists in a six-membered cyclic structure called pyranose structure.

Select the most appropriate answer from the options given below:
a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

16 **Assertion (A):** The half- life for a zero order reaction is independent of the initial concentration of the reactant. 1
Reason (R): For a zero order reaction, Rate = k

Select the most appropriate answer from the options given below:
a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

SECTION B

This section contains 5 questions with internal choice in one question. The following questions are very short answer type and carry 2 marks each.

17 a. Nitrogen gas is soluble in water. At temperature 293 K, the value of K_H is 76.48 kbar . How would the solubility of nitrogen vary (increase, decrease or remain the same) at a temperature above 293 K , if the value of K_H rises to 88.8 kbar. 1

b. Chloroform (b.p. 61.2°C) and acetone (b.p. 56°C) are mixed to form an azeotrope. The mole fraction of acetone in this mixture is 0.339. Predict whether the boiling point of the azeotrope formed will be (i) 60°C (ii)64.5 °C or (iii)54 °C. Defend your answer with reason. 1

OR

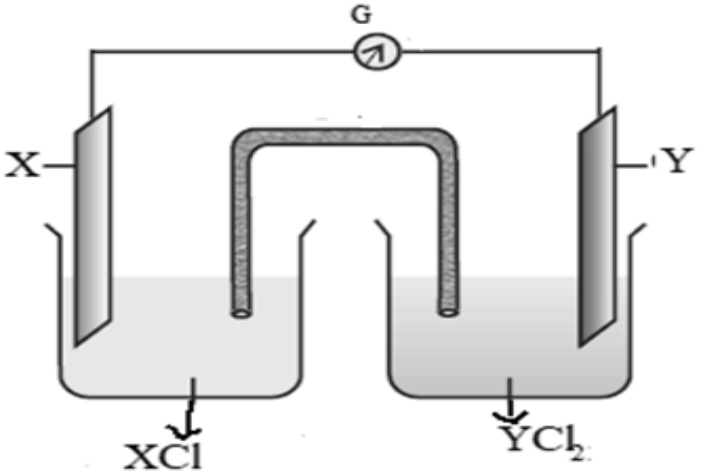
a. A soda bottle will go flat (loose its fizz) faster in Srinagar than in Delhi. Is this statement correct? Why or why not? 1

b. How does sugar help in increasing the shelf life of the product? 1

18 a. Write the IUPAC name of the following complex: $K[Cr(H_2O)_2(C_2O_4)_2]H_2O$ 1

b. Name the metal present in the complex compound of
(i) Haemoglobin (ii) Vitamin B-12 ½+½

19 Observe the following cell and answer the questions that follow:



a. Represent the cell shown in the figure. 1
b. Name the carriers of the current in the salt bridge ½
c. Write the reaction taking place at the anode. ½

(for visually challenged learners)
For the cell represented as:

$Mg(s)/Mg^{2+}(aq)//Ag^{+}(aq)/Ag(s)$
a. Identify the cathode and the anode 1
b. Write the overall reaction 1

20 Complete the following reactions by writing the major and minor product in each case (any 2)

a. $CH_3CH_2Br + KCN \rightarrow$ 1

b. $CH_3CH_2CH = CH_2 + HBr$ □ 1

c. $(CH_3)_2CHCHClCH_3$ + alc KOH → 1

21 The presence of Carbonyl group in glucose is confirmed by its reaction with hydroxylamine. Identify the type of carbonyl group present and its position. Give a chemical reaction in support of your answer. 1 1

SECTION C

This section contains 7 questions with internal choice in one question. The following questions are short answer type and carry 3 marks each.

22 a. Write down the reaction occurring on two inert electrodes when electrolysis of copper chloride is done. What will happen if a concentrated solution of copper sulphate is replaced with copper chloride? 2

b. Write an expression for the molar conductivity of aluminium sulphate at infinite dilution according to Kohlrausch law. 1

23 Account for the following:

a. The lowest oxide of transition metal is basic, and the highest is acidic. 1
b. Chromium is a hard metal while mercury is a liquid metal 1
c. The ionisation energy of elements of the 3d series does not vary much with increasing atomic number. 1

24 a. Give the chemical reaction involved when p-nitrotoluene undergoes Etard reaction. 1
b. Why does Benzoic acid exist as a dimer in an aprotic solvent? 1
c. Benzene on reaction with methylchloride in the presence of anhydrous $AlCl_3$ forms toluene. What is the expected outcome if benzene is replaced by benzoic acid? Give a reason for your answer. 1

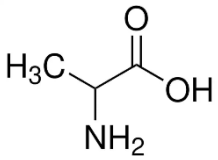
OR

An organic compound 'X', does not undergo aldol condensation. However 'X' with compound 'Y' in the presence of a strong base react to give the compound 1,3-diphenylprop-2-en-1-one.

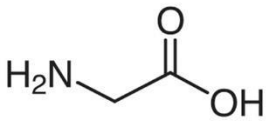
a. Identify 'X' and 'Y' 1
b. Write the chemical reaction involved. 1
c.Give one chemical test to distinguish between X and Y. 1

25 a. Give the structure of all the possible dipeptides formed when the following two amino acids form a peptide bond. 2

Alanine



Glycine



b. Keratin, insulin, and myosin are a few examples of proteins present in the human body. Identify which type of protein is keratin and insulin and differentiate between them based on their physical properties. 1

26 Neeta was experimenting in the lab to study the chemical reactivity of alcohols. She carried out a dehydration reaction of propanol at 140°C to 180°C. Different products were obtained at these two temperatures.

a. Identify the major product formed at 140°C and the mechanism followed in this case. 1+½ 1+½

b. Identify the major product formed at 180°C

27 Various isomeric haloalkanes with the general formula C_4H_9Cl undergo hydrolysis reaction. Among them, compound "A" is the most reactive through S_N1 mechanism. Identify "A" citing the reason for your choice. Write the mechanism for the reaction. 3

28 The equilibrium constant of cell reaction :

$Sn^{4+}(.aq) + Al(s) \rightarrow Al^{3+} + Sn^{2+}(aq)$ is 4.617×10^{184}, at 25 °C

a. Calculate the standard emf of the cell. 2
(Given: log 4.617×10^{184} = 184.6644)

b. What will be the E^o of the half cell Al^{3+}/Al , if E^o of half cell Sn^{4+}/Sn^{2+} is 0.15 V. 1

SECTION D

The following questions are case-based questions. Each question has an internal choice and carries 4 (2+1+1) marks each. Read the passage carefully and answer the questions that follow.

29 Dependence of the rate of reaction on the concentration of reactants, temperature, and other factors is the most general method for weeding out unsuitable reaction mechanisms. The term mechanism means all the individual collisional or elementary processes involving molecules (atoms, radicals, and ions included) that take place simultaneously or consecutively to produce the observed overall reaction. For example, when hydrogen gas reacts with bromine, the rate of the reaction was found to be proportional to the concentration of H_2 and to the square root of the concentration of Br_2. Furthermore, the rate was inhibited by increasing the concentration of HBr as the reaction proceeded. These observations are not consistent with a mechanism involving bimolecular collisions of a single molecule of each kind. The currently accepted mechanism is considerably more complicated, involving the dissociation of bromine molecules into atoms followed by reactions between atoms and molecules:

It is clear from this example that the mechanism cannot be predicted from the

overall stoichiometry.

(source: Moore, J. W., & Pearson, R. G. (1981). *Kinetics and mechanism*. John Wiley & Sons.)

a. Predict the expression for the rate of reaction and order for the following:

$H_2 + Br_2 \square 2\ HBr$ 1

What are the units of rate constant for the above reaction? 1

b. How will the rate of reaction be affected if the concentration of Br_2 is tripled? 1

OR

What change in the concentration of H_2 will triple the rate of reaction?

c. Suppose a reaction between A and B, was experimentally found to be first order with respect to both A and B. So the rate equation is: 1

Rate = k[A][B]

Which of these two mechanisms is consistent with this experimental finding? Why?

Mechanism 1

A → C + D (slow)

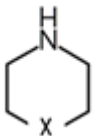
B + C → E (fast)

Mechanism 2

A + B → C + D (slow)

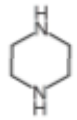
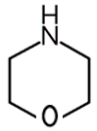
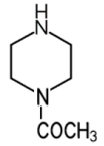
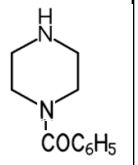
C → E (fast)

30 Amines are basic in nature. The pK_b value is a measure of the basic strength of an amine. Lower the value of pK_b, more basic is the amine. The effect of substituent on the basic strength of amines in aqueous solution was determined using titrations. The substituent "X" replaced "-CH_2" group in piperidine (compound 1) and propylamine $CH_3CH_2CH_2NH_2$, (compound 2).

Compound 1: 

Compound 2: $HXCH_2CH_2NH_2$

The experimental data is tabulated below:

Substituent "X"	**Electro-negativity of X**	**substituted piperidine compound**	**pK_a**	**Substituted propylamine compound**	**pK_a**
CH_2	2.55		11.13	$CH_3CH_2CH_2NH_2$	10.67
NH	3.12		9.81	$NH_2CH_2CH_2NH_2$	10.08
O	3.44		8.36	$HOCH_2CH_2NH_2$	9.45
CH_3CON	3.6		7.94	$CH_3CONHCH_2CH_2NH_2$	9.28
C_6H_5CON	3.7		7.78	$C_6H_5CONHCH_2CH_2NH_2$	___

(source: Hall Jr, H. K. (1956). Field and inductive effects on the base strengths of amines. *Journal of the American Chemical Society*, *78*(11), 2570-2572.)

Study the above data and answer the following questions:

a. Plot a graph between the electronegativity of the substituent vs pK_b value of the corresponding substituted propyl amine (given that $pK_a + pK_b = 14$). Is there any relation between the electronegativity of the substituent and its basic strength? 2

b. The electronegativity of the substituent "C_6H_5CON" is 3.7, what is the expected pKa value of compound $C_6H_5CONHCH_2CH_2NH_2$? 1

10

(i) 9.9 (ii) 9.5 (iii) 9.3 (iv) 9.1

c. The pKa value of the substituted piperidine formed with substituent "X" is found to be 8.28. What is the expected electronegativity of "X" 1

(i)3.5 (ii)3.4 (iii)3.8 (iv) 3.1

OR

What is the most suitable pKa value of the substituted propylamine formed with substituent "X" with electronegativity 3.0

(i)10.67 (ii)10.08 (iii)10.15 (iv)11.10

(for visually challenged learners)

a.How does the electronegativity of the substituent affect the pK_b value and the basic strength of the substituted propyl amine (given that $pK_a + pK_b = 14$).? Give a reason to support your answer. 2

b. The electronegativity of the substituent "C_6H_5CON" is 3.7, what is the expected pKa value of compound $C_6H_5CONHCH_2CH_2NH_2$? 1

(i) 9.9 (ii) 9.5 (iii) 9.3 (iv) 9.1

c. The pKa value of the substituted piperidine (compound 1) formed with substituent "X" is found to be 8.28. What is the expected electronegativity of "X" 1

(i)3.5 (ii)3.4 (iii)3.8 (iv) 3.1

OR

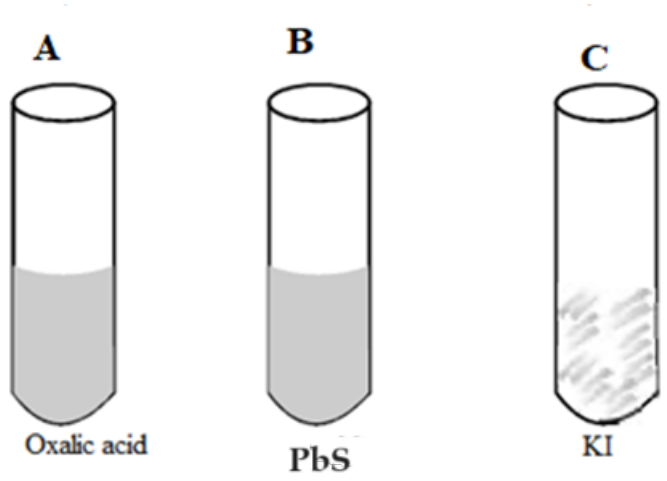
What is the most suitable pKa value of the substituted propylamine formed with substituent "X" with electronegativity 3.0

(i)10.67 (ii)10.08 (iii)10.15 (iv)11.10

SECTION E

The following questions are long answer types and carry 5 marks each. All questions have an internal choice.

31 a. A purple colour compound A, which is a strong oxidising agent and used for bleaching of wool, cotton, silk and other textile fibres was added to each of the three test tubes along with H_2SO_4. It was followed by strong heating.



In which of the above test tubes; A,B or C:

(i) Violet vapours will be formed 1

(ii) The bubbles of gas evolved will extinguish a burning matchstick. Write an equation for each of the above observations. 1

b. A metal ion M^{n+} of the first transition series having d^5 configuration combines with three didentate ligands. Assuming $\Delta_0 < P$:

(i) Draw the crystal field energy level diagram for the 3d orbital of this complex. 1

(ii) What is the hybridisation of M^{n+} in this complex and why? 1

(iii) Name the type of isomerism exhibited by this complex. 1

OR

a. Using, Valence Bond Theory identify A, B, C, D, E and F in the following table

S.No	Complex	central metal ion	configuration of metal ion	Hybridization of Metal ion	Geometry of the Complex	Number Of Unpaired Electron	Magnetic Behaviour
i	$[CoF_4]^{2-}$	**A**	$3d^7$	sp^3	tetrahedral	**B**	Paramagnetic
ii	$[Cr(H_2O)_2C_2O_4)_2]$	Cr^{3+}	$3d^3$	**C**	octahedral	3	**D**
iii	$[Ni(CO)_4]$	Ni	$3d^84s^2$	**E**	**F**	0	Diamagnetic

3

b. Write the ionic equations for the reaction of acidified $K_2Cr_2O_7$ with (i)H_2S and (ii)$FeSO_4$ 2

32 a. Give reasons for the following:

(i)The reaction of ethanol with acetyl chloride is carried out in the presence of pyridine . 1

(ii) Cresols are less acidic than phenol. 1

b. Williamson's process is used for the preparation of ethers from alkyl halide. Identify the alkyl bromide and sodium alkoxide used for the preparation of 2- Ethoxy-3-methylpentane 1

c. Convert:

(i) Toluene to 3-nitrobenzoic acid. 1

(ii) Benzene to m-nitroacetophenone. 1

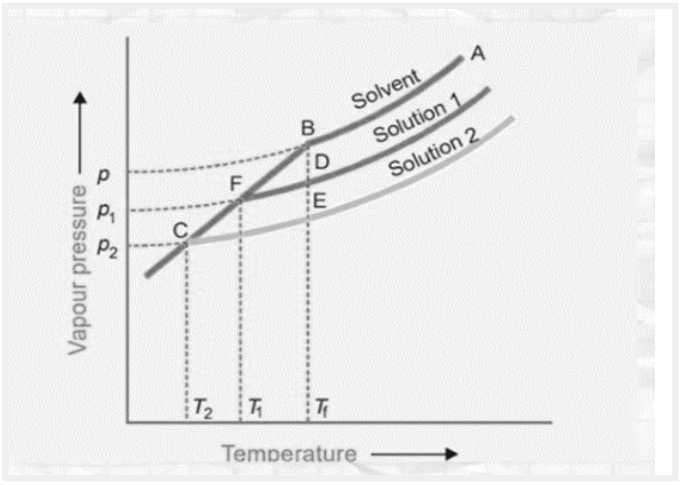
OR

a. Out of formic acid and acetic acid, which one will give the HVZ reaction? Give a suitable reason in support of your answer and write the chemical reaction involved. 2

b. Alcohols are acidic but they are weaker acids than water. Arrange various isomers of butanol in the increasing order of their acidic nature. Give a reason for the same. 1

c. An organic compound A which is a Grignard reagent is used to obtain 2-methylbutan-2-ol on reaction with a carbonyl compound 'B' . Identify A' and 'B'. Write the equation for the reaction between A and B. 2

33 a. An experiment was carried out in the laboratory, to study depression in freezing point. 1M aqueous solution of $Al(NO_3)_3$ and 1 M aqueous solution of glucose were taken. From the given figure identify solution 1 and solution 2. Give a plausible reason for your answer. 2



b. The osmotic pressure of a solution of cane sugar was found to be 2.46 atm at 300 K. If the solution was diluted five times, calculate the osmotic pressure at the same temperature. 3

How can the osmotic pressure of the given cane sugar solution be decreased without changing its volume? Give a reason for your answer.

OR

a. While giving intravenous injections to the patients, the doctors take utmost care of the concentration of the solution used. Why is it necessary to check the concentration of the solution? 2

b. A solution of phenol was obtained by dissolving 2X 10^{-2} kg of phenol in 1 kg of benzene. Experimentally it was found to be 73 % associated. Calculate the depression in the freezing point recorded. 3

(for visually challenged learners)

a. Which of the two solutions : 1M aqueous solution of $Al(NO_3)_3$ or 1M aqueous solution of glucose will show a greater depression in freezing point? Give a plausible reason for your answer. 2

b. The osmotic pressure of a solution of cane sugar was found to be 2.46 atm at 300 K. If the solution was diluted five times, calculate the osmotic pressure at the same temperature. 3

How can the osmotic pressure of the given cane sugar solution be decreased without changing its volume? Give a reason for your answer.

OR

a. While giving intravenous injections to the patients, the doctors take utmost care of the concentration of the solution used. Why is it necessary to check the concentration of the solution? 2

b. A solution of phenol was obtained by dissolving 2X 10^{-2} kg of phenol in 1 kg of benzene. Experimentally it was found to be 73 % associated. Calculate the depression in the freezing point recorded. 3

SAMPLE QUESTION PAPER (2024 - 25)

CLASS- XII

SUBJECT: Mathematics (041)

Time: 3 Hours **Maximum Marks: 80**

General Instructions:

Read the following instructions very carefully and strictly follow them:

(i) This Question paper contains **38** questions. **All** questions are **compulsory.**

(ii) This Question paper is divided into **five** Sections - **A, B, C, D** and **E.**

(iii) In **Section A**, Questions no. **1** to **18** are **multiple choice questions (MCQs)** and Questions no. **19** and **20** are **Assertion-Reason based** questions of **1 mark each**.

(iv) In **Section B,** Questions no. **21** to **25** are **Very Short Answer (VSA)-type** questions, carrying **2 marks each**.

(v) In **Section C,** Questions no. **26** to **31** are **Short Answer (SA)-type** questions, carrying **3 marks each**.

(vi) In **Section D,** Questions no. **32** to **35** are **Long Answer (LA)-type** questions, carrying **5 marks each**.

(vii) In **Section E,** Questions no. **36** to **38** are **Case study-based questions,** carrying **4 marks each.**

(viii) There is no overall choice. However, an internal choice has been provided in 2 questions in Section B, 3 questions in Section C, 2 questions in Section D and one subpart each in 2 questions of Section E.

(ix) Use of calculators is **not** allowed.

SECTION-A $[1\times 20 = 20]$

(*This section comprises of multiple choice questions (MCQs) of 1 mark each*)

Select the correct option (Question 1 - Question 18):

Q.1. If for a square matrix A, $A.(adjA) = \begin{bmatrix} 2025 & 0 & 0 \\ 0 & 2025 & 0 \\ 0 & 0 & 2025 \end{bmatrix}$, then the value of $|A| + |adj\ A|$ is equal to:

(A) 1 (B) $2025+1$ (C) $(2025)^2+45$ (D) $2025+(2025)^2$

Q.2. Assume X, Y, Z, W and P are matrices of order $2 \times n$, $3 \times k$, $2 \times p$, $n \times 3$ and $p \times k$, respectively. Then the restriction on n, k and p so that $PY + WY$ will be defined are:

(A) $k = 3, p = n$ (B) k **is arbitrary,** $p = 2$

(C) p **is arbitrary,** $k = 3$ (D) $k = 2, p = 3$

Q.3. The interval in which the function f defined by $f(x) = e^x$ is strictly increasing, is

(A) $[1, \infty)$ (B) $(-\infty, 0)$ (C) $(-\infty, \infty)$ (D) $(0, \infty)$

Q.4. If $\boldsymbol{A}$ **and** $\boldsymbol{B}$ are non-singular matrices of same order with $\boldsymbol{det(A) = 5}$, then $\boldsymbol{det\left(B^{-1}AB\right)^2}$ is equal to

(A) $\mathbf{5}$ (B) $\mathbf{5^2}$ (C) $\mathbf{5^4}$ (D) $\mathbf{5^5}$

Q.5. The value of $\boldsymbol{'n'}$, such that the differential equation $\boldsymbol{x^n \frac{dy}{dx} = y(logy - logx + 1)}$;

$\boldsymbol{(where\ x, y\ \in R^+)}$ is homogeneous, is

(A) $\mathbf{0}$ (B) $\mathbf{1}$ (C) $\mathbf{2}$ (D) $\mathbf{3}$

Q.6. If the points $\boldsymbol{(x_1, y_1)}$, $\boldsymbol{(x_2, y_2)}$ **and** $\boldsymbol{(x_1 + x_2, y_1 + y_2)}$ are collinear, then $\boldsymbol{x_1y_2}$ is equal to

(A) $\boldsymbol{x_2y_1}$ (B) $\boldsymbol{x_1y_1}$ (C) $\boldsymbol{x_2y_2}$ (D) $\boldsymbol{x_1x_2}$

Q.7. If $\boldsymbol{A = \begin{bmatrix} 0 & 1 & c \\ -1 & a & -b \\ 2 & 3 & 0 \end{bmatrix}}$ is a skew-symmetric matrix then the value of $\boldsymbol{a + b + c =}$

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

Q.8. For any two events $\boldsymbol{A}$ and $\boldsymbol{B}$, if $\boldsymbol{P\left(\overline{A}\right) = \frac{1}{2}}$, $\boldsymbol{P\left(\overline{B}\right) = \frac{2}{3}}$ and $\boldsymbol{P\left(A \cap B\right) = \frac{1}{4}}$, then $P\left(\bar{A}/\bar{B}\right)$ equals:

(A) $\frac{3}{8}$ (B) $\frac{8}{9}$ (C) $\frac{5}{8}$ (D) $\frac{1}{4}$

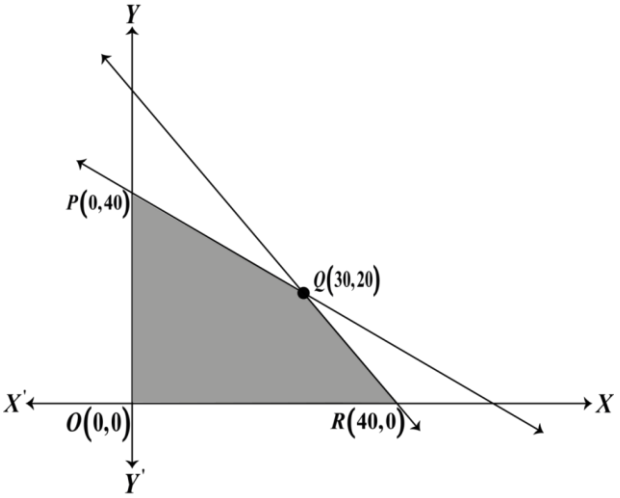
Q.9. The value of α if the angle between $\vec{p} = 2\alpha^2\hat{\imath} - 3\alpha\hat{\jmath} + \hat{k}$ and $\vec{q} = \hat{\imath} + \hat{\jmath} + \alpha\hat{k}$ is obtuse, is

(A) $R - [0, 1]$ (B) (0, 1) (C) [0, ∞) (D) [1, ∞)

Q.10. If $|\vec{a}| = 3, \left|\vec{b}\right| = 4$ and $\left|\vec{a} + \vec{b}\right|$ =5, then $\left|\vec{a} - \vec{b}\right| =$

(A) **3** (B) **4** (C) **5** (D) **8**

Q.11. For the linear programming problem (**LPP**), the objective function is $\boldsymbol{Z = 4x + 3y}$ and the feasible region determined by a set of constraints is shown in the graph:



(Note*: The figure is not to scale.)*

Which of the following statements is true?

(A) Maximum value of $\boldsymbol{Z}$ is at $\boldsymbol{R(40,0)}$.

(B) Maximum value of $\boldsymbol{Z}$ is at $\boldsymbol{Q(30,20)}$.

(C) Value of $\boldsymbol{Z}$ at $\boldsymbol{R(40,0)}$ is less than the value at $\boldsymbol{P(0,40)}$.

(D) The value of $\boldsymbol{Z}$ at $\boldsymbol{Q(30,20)}$ is less than the value at $\boldsymbol{R(40,0)}$.

Q.12. $\int \frac{dx}{x^3(1+x^4)^{\frac{1}{2}}}$ equals

(A) $-\frac{1}{2x^2}\sqrt{1+x^4}+c$ (B) $\frac{1}{2x}\sqrt{1+x^4}+c$

(C) $-\frac{1}{4x}\sqrt{1+x^4}+c$ (D) $\frac{1}{4x^2}\sqrt{1+x^4}+c$

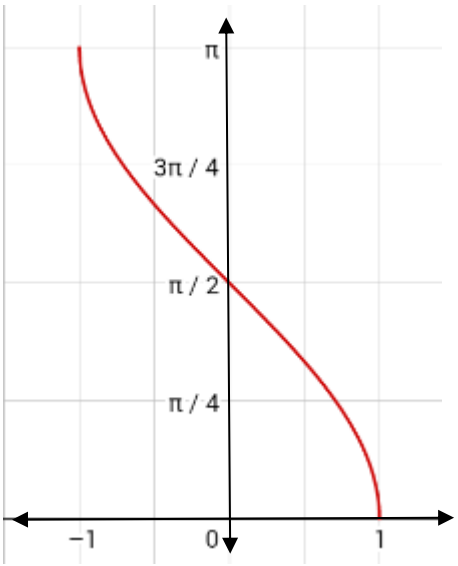
Q.13. $\int_0^{2\pi} cosec^7 x\, dx =$

(A) **0** (B) **1** (C) **4** (D) 2π

Q.14. What is the general solution of the differential equation $e^{y'} = x$?

(A) $y = xlogx + c$ (B) $y = xlogx - x + c$ (C) $y = xlogx + x + c$ (D) $y = x + c$

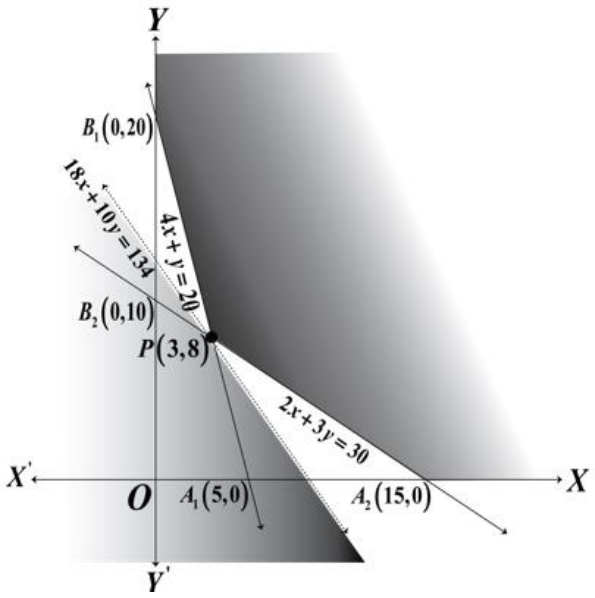
Q.15. The graph drawn below depicts



(A) y = $sin^{-1}x$ (B) y = $cos^{-1}x$ (C) y = $cos\ ec^{-1}x$ (D) y = $cot^{-1}x$

Q.16. A linear programming problem (**LPP**) along with the graph of its constraints is shown below.

The corresponding objective function is: $Z = 18x + 10y$, which has to be minimized. The smallest value of the objective function Z is 134 and is obtained at the corner point $(3,8)$,



(Note*: The figure is not to scale.)*

The optimal solution of the above linear programming problem _____.

(A) does not exist as the feasible region is unbounded.

(B) does not exist as the inequality $18x + 10y < 134$ does not have any point in common with the feasible region.

(C) exists as the inequality $18x + 10y > 134$ has infinitely many points in common with the feasible region.

(D) exists as the inequality $18x + 10y < 134$ does not have any point in common with the feasible region.

Q.17. The function $f: R \to Z$ defined by $f(x) = [x]$; where $[.]$ denotes the greatest integer function, is

(A) Continuous at $x = 2.5$ but not differentiable at $x = 2.5$

(B) Not Continuous at $x = 2.5$ but differentiable at $x = 2.5$

(C) Not Continuous at $x = 2.5$ and not differentiable at $x = 2.5$

(D) Continuous as well as differentiable at $x = 2.5$

Q.18. A student observes an open-air Honeybee nest on the branch of a tree, whose plane figure is parabolic shape given by $x^2 = 4y$. Then the area (in sq units) of the region bounded by parabola $x^2 = 4y$ and the line $y = 4$ is

(A) $\frac{32}{3}$ (B) $\frac{64}{3}$ (C) $\frac{128}{3}$ (D) $\frac{256}{3}$

ASSERTION-REASON BASED QUESTIONS

(Question numbers 19 and 20 are Assertion-Reason based questions carrying 1 mark each. Two statements are given, one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer from the options (A), (B), (C) and (D) as given below.)

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

(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).

(C) (A) is true but (R) is false.

(D) (A) is false but (R) is true.

Q.19. Assertion (A): Consider the function defined as $f(x) = |x| + |x-1|,\ x \in R$. Then $\boldsymbol{f(x)}$ is not differentiable **at $x = 0$ and $x = 1$**.

Reason (R): Suppose $\boldsymbol{f}$ be defined and continuous on $\boldsymbol{(a,b)}$ and $\boldsymbol{c \in (a,b)}$, then $\boldsymbol{f(x)}$ is not differentiable at $x = c$ if $\lim_{h\to 0^-} \frac{f(c+h)-f(c)}{h} \neq \lim_{h\to 0^+} \frac{f(c+h)-f(c)}{h}$.

Q.20. Assertion (A): The function $f: R - \left\{(2n+1)\frac{\pi}{2} : n \in Z\right\} \to (-\infty, -1] \cup [1, \infty)$ defined by $\boldsymbol{f(x) = \sec x}$ is not one-one function in its domain.

Reason (R): The line $\boldsymbol{y = 2}$ meets the graph of the function at more than one point.

SECTION B $\boldsymbol{[2\times 5 = 10]}$

(This section comprises of 5 very short answer (VSA) type questions of 2 marks each.)

Q.21. If $cot^{-1}(3x+5) > \frac{\pi}{4}$, then find the range of the values of $\boldsymbol{x}$.

Q.22. The cost (in rupees) of producing $\boldsymbol{x}$ items in factory, each day is given by

$$C(x) = 0.00013x^3 + 0.002\,x^2 + 5x + 2200$$

Find the marginal cost when 150 items are produced.

Q.23. (a) Find the derivative of $\boldsymbol{\tan^{-1} x}$ with respect to $\boldsymbol{\log x}$; (where $\boldsymbol{x \in (1,\infty)}$).

OR

Q.23. (b) Differentiate the following function with respect to x : $(cos\, x)^x$; $\left(\text{where} x \in \left(0, \frac{\pi}{2}\right)\right)$.

Q.24. (a) If vectors $\vec{a} = 2\hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{b} = -\hat{i} + 2\hat{j} + \hat{k}$ and $\vec{c} = 3\hat{i} + \hat{j}$ are such that $\vec{b} + \lambda\vec{c}$ is perpendicular to $\vec{a}$, then find the value of λ.

OR

Q.24. (b) A person standing at $\boldsymbol{O(0,0,0)}$ is watching an aeroplane which is at the coordinate point $\boldsymbol{A(4,0,3)}$. At the same time he saw a bird at the coordinate point $\boldsymbol{B(0,0,1)}$. Find the angles which $\overrightarrow{BA}$ makes with the x,y and z axes.

Q.25. The two co-initial adjacent sides of a parallelogram are $2\hat{i} - 4\hat{j} - 5\hat{k}$ and $2\hat{i} + 2\hat{j} + 3\hat{k}$. Find its diagonals and use them to find the area of the parallelogram.

SECTION C $[3\times6=18]$

(This section comprises of 6 short answer (SA) type questions of 3 marks each.)

Q.26. A kite is flying at a height of 3 metres and 5 metres of string is out. If the kite is moving away horizontally at the rate of 200 cm/s, find the rate at which the string is being released.

Q.27. According to a psychologist, the ability of a person to understand spatial concepts is given by

$A=\frac{1}{3}\sqrt{t}$, where t is the age in years, $t\in[5,18]$. Show that the rate of increase of the ability to understand spatial concepts decreases with age in between 5 and 18.

Q.28. (a) An ant is moving along the vector $\overrightarrow{l_1}=\hat{\imath}-2\hat{\jmath}+3\hat{k}$. Few sugar crystals are kept along the vector $\overrightarrow{l_2}=3\hat{\imath}-2\hat{\jmath}+\hat{k}$ which is inclined at an angle θ with the vector $\overrightarrow{l_1}$. Then find the angle θ. Also find the scalar projection of $\overrightarrow{l_1}$ *on* $\overrightarrow{l_2}$.

OR

Q.28. (b) Find the vector and the cartesian equation of the line that passes through $(-1,2,7)$ and is perpendicular to the lines $\vec{r}=2\hat{\imath}+\hat{\jmath}-3\hat{k}+\lambda(\hat{\imath}+2\hat{\jmath}+5\hat{k})$ and $\vec{r}=3\hat{\imath}+3\hat{\jmath}-7\hat{k}+\mu(3\hat{\imath}-2\hat{\jmath}+5\hat{k})$.

Q.29. (a) Evaluate: $\int\left\{\frac{1}{\log x}-\frac{1}{(\log x)^2}\right\}dx$; (**where** $x>1$).

OR

Q.29. (b) Evaluate : $\int_0^1 x(1-x)^n dx$; (**where** $n\in N$).

Q.30. Consider the following Linear Programming Problem:

Minimise $Z=x+2y$

Subject to $2x+y\geq3,\ x+2y\geq6,\ x,y\geq0.$

Show graphically that the minimum of Z occurs at more than two points

Q.31. (a) The probability that it rains today is **0.4**. If it rains today, the probability that it will rain tomorrow is **0.8**. If it does not rain today, the probability that it will rain tomorrow is **0.7**. If

P_1: denotes the probability that it does not rain today.

P_2: denotes the probability that it will not rain tomorrow, if it rains today.

P_3: denotes the probability that it will rain tomorrow, if it does not rain today.

P_4: denotes the probability that it will not rain tomorrow, if it does not rain today.

(i) Find the value of $P_1\times P_4-P_2\times P_3$. $[2\ Marks]$

(ii) Calculate the probability of raining tomorrow. $[1\ Mark]$

OR

Q.31. (b) A random variable X can take all non – negative integral values and the probability that X takes

the value r is proportional to 5^{-r}. Find $P(X < 3)$.

SECTION D

$[5 \times 4 = 20]$

(This section comprises of 4 long answer (LA) type questions of 5 marks each)

Q.32. Draw the rough sketch of the curve $y = 20\cos 2x; \left(\text{where} \frac{\pi}{6} \leq x \leq \frac{\pi}{3}\right)$.

U**sing integration,** find the area of the region bounded by the curve y = 20 cos2x from the ordinates $x = \frac{\pi}{6}$ to $x = \frac{\pi}{3}$ and the $x-$axis.

Q.33. The equation of the path traversed by the ball headed by the footballer is $y = ax^2 + bx + c; (where\ 0 \leq x \leq 14\ and\ a, b, c \in R\ and\ a \neq 0)$ with respect to a XY-coordinate system in the vertical plane. The ball passes through the points $(2,15)$, $(4,25)$ **and** $(14,15)$. Determine the values of a, b and c by solving the system of linear equations in a, b and c, using matrix method. Also find the equation of the path traversed by the ball.

Q.34. (a) If $f: R \to R$ is defined by $f(x) = |x|^3$, show that $f''(x)$ exists for all real x and find it.

OR

Q.34. (b) If $(x-a)^2 + (y-b)^2 = c^2$, for some $c > 0$, prove that $\frac{\left[1+\left(\frac{dy}{dx}\right)^2\right]^{\frac{3}{2}}}{\frac{d^2y}{dx^2}}$ is a constant independent of a and b.

Q.35. (a) Find the shortest distance between the lines l_1 and l_2 whose vector equations are

$$\vec{r} = \left(-\hat{\imath} - \hat{\jmath} - \hat{k}\right) + \lambda\left(7\hat{\imath} - 6\hat{\jmath} + \hat{k}\right) \text{ and } \vec{r} = \left(3\hat{\imath} + 5\hat{\jmath} + 7\hat{k}\right) + \mu\left(\hat{\imath} - 2\hat{\jmath} + \hat{k}\right)$$

where λ and μ are parameters.

OR

Q.35. (b) Find the image of the point $(1,2,1)$ with respect to the line $\frac{x-3}{1} = \frac{y+1}{2} = \frac{z-1}{3}$. Also find the equation of the line joining the given point and its image.

SECTION- E

$[4 \times 3 = 12]$

(*This section comprises of 3 case-study/passage-based questions of 4 marks each with subparts. The first two case study questions have three subparts (i), (ii), (iii) of marks 1, 1, 2 respectively. The third case study question has two subparts of 2 marks each)*

Case Study-1

Q.36. Ramesh, the owner of a sweet selling shop, purchased some rectangular card board sheets of dimension **25*cm* by 40 *cm*** to make container packets without top. Let $x\,cm$ be the length of the side of the square to be cut out from each corner to give that sheet the shape of the container by folding up the flaps.

Based on the above information answer the following questions.

(i) Express the volume (V) of each container as function of x only. **[1 Mark]**

(ii) Find $\frac{dV}{dx}$ **[1 Mark]**

(iii) (a) For what value of x, the volume of each container is maximum? **[2 Marks]**

OR

(iii) (b) Check whether V has a point of inflection at x = $\frac{65}{6}$ or not? **[2 Marks]**

Case Study-2

Q.37. An organization conducted bike race under 2 different categories-boys and girls. In all, there were **250** participants. Among all of them finally three from Category **1** and two from Category **2** were selected for the final race. Ravi forms two sets B and G with these participants for his college project.

Let $B = \{b_1, b_2, b_3\}, G = \{g_1, g_2\}$ where B represents the set of boys selected and G the set of girls who were selected for the final race.

Ravi decides to explore these sets for various types of relations and functions.

On the basis of the above information, answer the following questions:

(i) Ravi wishes to form all the relations possible from B to G. How many such relations are possible? **[1 Mark]**

(ii) Write the smallest equivalence relation on **G**. **[1 Mark]**

(iii) (a) Ravi defines a relation from **B to B** as $R_1 = \{(b_1, b_2), (b_2, b_1)\}$. Write the minimum ordered pairs to be added in R_1 so that it becomes (A) reflexive but not symmetric, (B) reflexive and symmetric but not transitive. **[2 Marks]**

OR

(iii) (b) If the track of the final race (for the biker b_1) follows the curve $x^2 = 4y; (\text{where} 0 \le x \le 20\sqrt{2} \& 0 \le y \le 200)$, then state whether the track represents a one-one and onto function or not. (Justify). **[2 Marks]**

Case Study- 3

Q.38. Arka bought two cages of birds: Cage-I contains 5 parrots and 1 owl and Cage –II contains 6 parrots. One day Arka forgot to lock both cages and two birds flew from Cage-I to Cage-II (simultaneously). Then two birds flew back from cage-II to cage-I(simultaneously).

Assume that all the birds have equal chances of flying.

On the basis of the above information, answer the following questions:-

(i) When two birds flew from Cage-I to Cage-II and two birds flew back from Cage-II to Cage-I then find the probability that the owl is still in Cage-I. **[2 *Marks*]**

(ii) When two birds flew from Cage-I to Cage-II and two birds flew back from Cage-II to Cage-I, the owl is still seen in Cage-I, what is the probability that one parrot and the owl flew from Cage-I to Cage-II? **[2 *Marks*]**

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SAMPLE QUESTION PAPER (2024 - 25)

CLASS- XII

SUBJECT: Applied Mathematics (241)

Time: 3 Hours. **Maximum Marks: 80**

General Instructions:

Read the following instructions very carefully and strictly follow them:

(i) This Question paper contains **38** questions. **All** questions are **compulsory.**

(ii) This Question paper is divided into **five** Sections - **A, B, C, D** and **E.**

(iii) In **Section A**, Questions no. **1** to **18** are **multiple choice questions (MCQs)** and Questions no. **19** and **20** are **Assertion-Reason based** questions of **1 mark each**.

(iv) In **Section B,** Questions no. **21** to **25** are **Very Short Answer (VSA)-type** questions, carrying **2 marks each**.

(v) In **Section C,** Questions no. **26** to **31** are **Short Answer (SA)-type** questions, carrying **3 marks each**.

(vi) In **Section D,** Questions no. **32** to **35** are **Long Answer (LA)-type** questions, carrying **5 marks each**.

(vii) In **Section E,** Questions no. **36** to **38** are **case study-based questions** carrying **4 marks each.**

(viii) There is no overall choice. However, an internal choice has been provided in 2 questions in Section B, 2 questions in Section C, 2 questions in Section D and one sub-part each in 2 questions of Section E.

(ix) Use of calculators is **not** allowed.

SECTION-A $[1\times 20 = 20]$

(*This section comprises of multiple-choice questions (MCQs) of 1 mark each*)

Select the correct option (Question 1 - Question 18):

Q.1. The area (in sq units) bounded by the curve $y = \sqrt{x}$, the $x-$axis, $x = 1$ and $x = 4$ is

(A) $\frac{11}{3}$ (B) $\frac{1}{4}$ (C) $\frac{14}{3}$ (D) $\frac{13}{3}$

Q.2. Sampling which provides for a known non-zero equal chance of selection is

(A) Systematic sampling (B) Convenience sampling

(C) Quota sampling (D) Purposive sampling

Q.3. Let the cost function for a manufacturer is given by $C(x) = \frac{x^3}{3} - x^2 + 2x$ (In rupees)

Which of the following statement is correct based on the above information?

(A) The marginal cost decreases from 0 to 1 and then increases onwards.

(B) The marginal cost increases from 0 to 1 and then decreases onwards.

(C) Marginal cost decreases as production level increases from zero.

(D) Marginal cost increases as production level increases from zero.

Q.4. The absolute minimum value of the function $f(x) = 4x - \frac{1}{2}x^2$ in the interval $\left[-2, \frac{9}{2}\right]$ is:

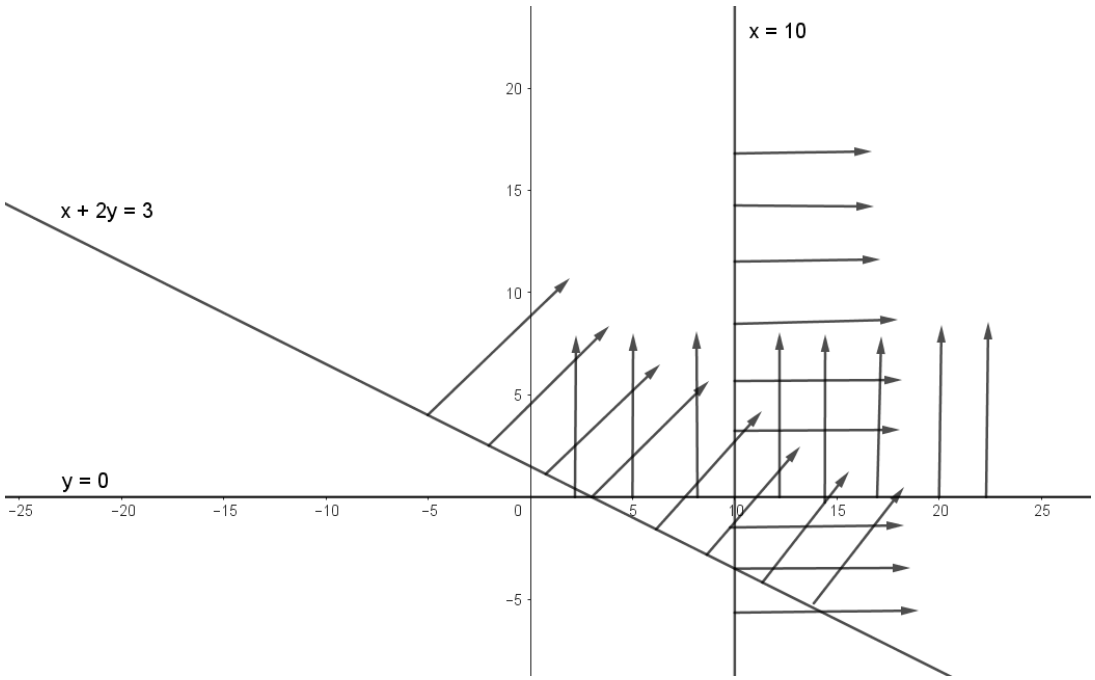
(A) -8 (B) -9 (C) -10 (D) -16

Q.5. For the purpose of $t-$ test of significance, a random sample of size $(n)_{2025}$ is drawn from a normal population, then the degree of freedom (υ) is

(A) 2025^{2025} (B) 2024^{2025} (C) 2025 (D) 2024

Q.6. The constraints of a linear programming problem along with their graphs is shown below:

$x + 2y \geq 3,\ x \geq 10,\ y \geq 0$



Which of the following inequality may be removed so that the feasible region remains the same in above graph?

(A) $x + 2y \geq 3$

(B) $x \geq 10$

(C) $y \geq 0$

(D) $x \geq 0$

Q.7. A player rolls one fair die. If the die shows an odd number, the player wins the value that appears on the die, else loses half the value that appears on it. The expected gain of the player is

(A) $-\frac{1}{2}$ (B) 0 (C) $\frac{1}{2}$ (D) 1

Q.8. The original cost of a machine is ₹ **1200000** and the scarp value of the machine after a useful life of **3 years is** ₹ **300000**, then the book value of the machine at the end **2 years** is

(A) ₹ **100000** (B) ₹ **250000** (C) ₹ **600000** (D) ₹ **800000**

Q.9. A fish jumps out of the water surface and follows the parabolic path $y = 6x - x^2 - 8;\ 2 \le x \le 4$. The fish reaches the highest height in its path at $(3,1)$. The slope of the path of the fish at $(3,1)$ is

(A) **0** (B) **1** (C) **2** (D) **3**

Q.10. In a large consignment of electric bulbs 5% of a batch of batteries are defective. A random sample of **80** is taken for inspection with replacement. Then the Variance of the number of defectives in the sample, is

(A) $\frac{18}{5}$ (B) $\frac{19}{5}$ (C) **4.555** (D) **8**

Q.11. If it is currently $6{:}\,00$ pm in 12 hours clock then what will be the time after 375 hours?

(A) 6 am (B) 6 pm (C) 9 am (D) 9 pm

Q.12. The values of $\frac{1}{x}$ for the given values of $x \in (-1,3) - \{0\}$ is

(A) $\left(-1,\frac{1}{3}\right) \cup (3,\infty)$ (B) $(-\infty,-1) \cup \left(\frac{1}{3},\infty\right)$ (C) $\left(-\frac{1}{3},1\right)$ (D) $\left(-\frac{1}{3},-1\right)$

Q.13. The component of a time series attached to long term variations is termed as

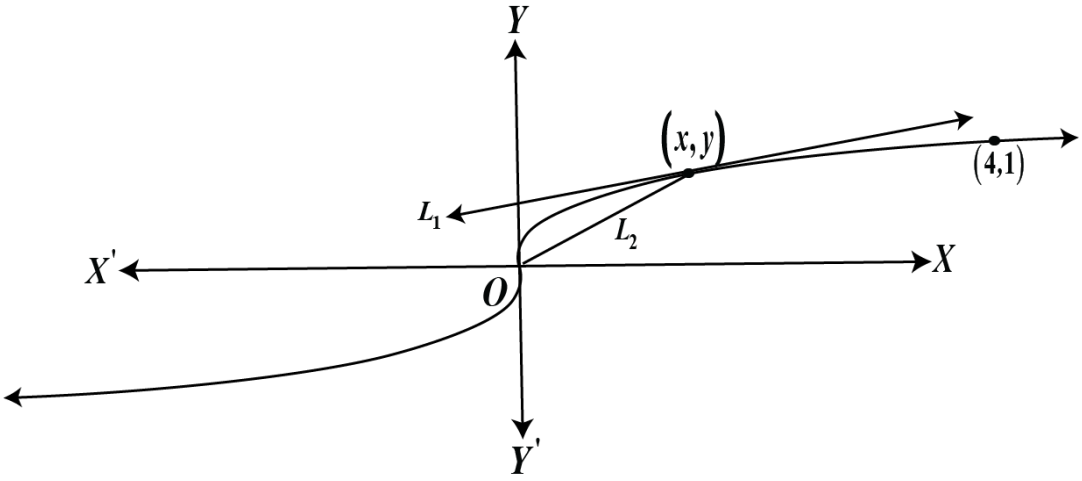
(A) Seasonal variations (B) Irregular variations

(C) Secular trend variations (D) Cyclic variations

Q.14. The present value of a sequence of payments of **₹ 800** made at the end of every **6 month** and continuing forever. If money is worth **4%** per annum compounded semi-annually, then the present value of the sequence is:

(A) ₹ 20000 (B) ₹ 40000 (C) ₹ 60000 (D) ₹ 80000

Q.15. Shown below is a curve.



L_1 is the tangent to any point (x, y) on the curve.

L_2 is the line that connects the point (x, y) to the origin.

The slope of L_1 is one third of the slope of L_2.

Then the differential equation, using the given conditions is:

(A) $\frac{dy}{dx} = \frac{y}{3x}$ (B) $\frac{dy}{dx} = \frac{y}{x}$ (C) $\frac{dy}{dx} = \frac{x}{3y}$ (D) $\frac{dy}{dx} = \frac{3y}{x}$

Q.16. For a 3×3 matrix if $\text{adj A} = 2\text{A}^{-1}$, find $|3\text{AA}^{\text{T}}|$

(A) 108 (B) 12 (C) 54 (D) 8

Q.17. For two matrices $P = \begin{bmatrix} 3 & 4 \\ -1 & 2 \\ 0 & 1 \end{bmatrix}$ & $Q^T = \begin{bmatrix} -1 & 2 & 1 \\ 1 & 2 & 3 \end{bmatrix}$; $\left(\text{where } Q^T \text{ is the transpose of the matrix } Q\right)$

, $P - Q$ is:

(A) $\begin{bmatrix} 2 & 3 \\ -3 & 0 \\ 0 & -3 \end{bmatrix}$ (B) $\begin{bmatrix} 4 & 3 \\ -3 & 0 \\ -1 & -2 \end{bmatrix}$ (C) $\begin{bmatrix} 4 & 3 \\ 0 & -3 \\ -1 & -2 \end{bmatrix}$ (D) $\begin{bmatrix} 2 & 3 \\ 0 & -3 \\ 0 & -3 \end{bmatrix}$

Q.18. The order and degree of a differential equation $\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^4 + x^{\frac{1}{5}} = 0$; respectively, are

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

ASSERTION-REASON BASED QUESTIONS

(Questions number 19 and 20 are Assertion and Reason based questions carrying 1 mark each. Two statements are given, one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer from the codes (A), (B), (C) and (D) as given below.)

$[1 \times 2 = 2]$

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

(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).

(C) (A) is true but (R) is false.

(D) (A) is false but (R) is true.

Q.19. Assertion (A): The effective rate of interest equivalent to a nominal rate of 6% when compounded continuously is equal to $e^{0.06} - 1 = 6.18\%$.

Reason (R): The relation between effective rate $\left(r_{eff}\right)$ of interest and nominal rate (r) of interest: $r_{eff} = e^{r} - 1;$ where $'e'$ - Euler's number (approximate value is 2.71828), when compounded continuously.

Q.20. Assertion(A): $A = [a_{ij}] = \begin{cases} m; i = j \\ 0; i \neq j \end{cases}$

where m is a scalar, is an identity matrix if $m = 1$

Reason (R): Every identity matrix is not a scalar matrix

SECTION B $[2 \times 5 = 10]$

(This section comprises of 5 very short answer (VSA) type questions of 2 marks each.)

Q.21. (a) In what ratio water must be added in milk costing ₹ 60 per litre, so that the resulting mixture would be of worth ₹ 50 per litre?

OR

Q.21. (b) A pump can fill a tank with water in 2 hours. Because of leakage, it took $\frac{7}{3}$ hrs to fill the tank. How much time will it take for the leakage to drain all the water in the full tank?

Q.22. In a 200 m race, A can give a start of 18 m to B and a start of 31 m to C. In a race of 350 m, how much start can B give to C?

Q.23. A boat takes thrice as long to go upstream to a point as to return downstream to the starting point. If the speed of the stream is $5km/h$, find the speed of the boat in still water.

Q.24. (a) The incidence of occupational disease in an industry is such that the workers have a **20%** chance of suffering from it. What is the probability that out of six workers **4 or more** will catch the disease?

OR

Q.24. (b) The lifetime of an item produced by a machine has a normal distribution with **mean 12 months** and **standard deviation** of 2 months. Find the probability of an item produced by this machine will last

(i) less than **7** months

(ii) between **7** and **14** months.

(Given $P\left(Z < \frac{5}{2}\right) = 0.9938$ and $P(Z < 1) = 0.8413$)

Q.25. If $A = \begin{bmatrix} \alpha & 0 \\ 1 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 0 \\ 5 & 1 \end{bmatrix}$, then find the value of α (if exists) for which $A^2 = B$.

SECTION C

$[3 \times 6 = 18]$

(This section comprises of 6 short answer (SA) type questions of 3 marks each.)

Q.26. Find the remainder when 5^{61} is divided by 7.

Q.27. (a) Two batches of the same product are tested for their mean life. Assuming that, the lives of the product follow a normal distribution with an unknown variance; test the hypothesis that the mean life is the same for both the branches, given the following information:

Batch	**Sample Size**	**Mean life** (in hours)	**Standard Deviation** (in hours)
Batch I	10	750	12
Batch II	8	820	14

$\left[\textbf{Given } \sqrt{4.4444} = 2.1081 \textbf{ and } t_{16}(0.05) = 2.120\right]$

OR

Q.27. (b) The manufacturer of electrical items makes bulbs and claims that these bulbs have a mean life of 25 months. The life in months of a random sample of 6 such bulbs are given to be 24, 26, 30, 20, 20 and 18. Test the validity of the manufacturer's claim at 1% level of significance. [Given $t_5(0.01) = 4.032$]

Q.28. A traffic engineer records the number of bicycle riders that use a particular cycle track. He records that an average of 3.2 bicycle riders use the cycle track every hour. Given that the number of bicycles that use the cycle track follow a Poisson distribution, what is the probability that 2 or less bicycle riders will use the cycle track within an hour? Also find the mean expectation and variance for the random variable. (Given $e^{-3.2} = 0.041$)

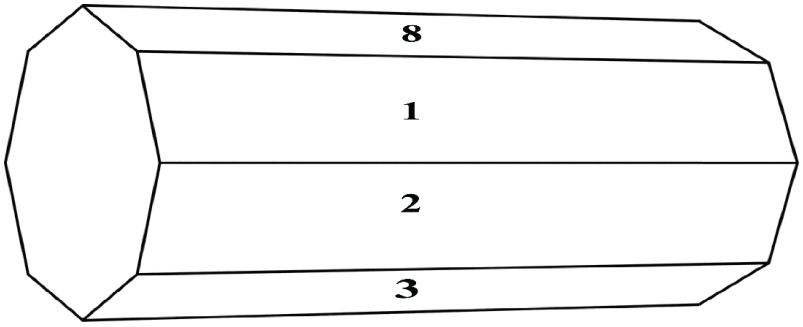
Q.29. Mr Rohit invested ₹ **5000** in a fund at the beginning of year **2021** and by the end of year **2021** his investment was worth ₹ **9000**. Next year market crashed and he lost ₹ **3000** and ending up with ₹ **6000** at the end of year **2022**. Next year i.e. **2023** he gained ₹ **4500** and ending up with ₹ **10500** at the end of the year. Find **CAGR** (Compounded Annual Growth Rate) of his investment. (Use $(2.1)^{1/3} = 1.2805$)

Q.30. A small firm manufactures necklaces and bracelets. The total number of necklaces and bracelets that it can handle per day is at most **25**. It takes one hour to make a bracelet and half

an hour to make a necklace. The maximum number of hours available per day is **14**. If the profit on a necklace is **₹ 100** and that on a bracelet is **₹ 300**, formulate an **L.P.P**. for finding how many of each should be produced daily to maximize the profit? It is being given that at least one of each must be produced.

(Note: No need to find the feasible region and optimal solution)

Q.31.(a) An octagonal prism is a three-dimensional polyhedron bounded by two octagonal bases and eight rectangular side faces. It has 24 edges and 16 vertices.



The prism is rolled along the rectangular faces and number on the bottom face (touching the ground) is noted. Let X denotes the number obtained on the bottom face and the following table gives the probability distribution of X .

X :	1	2	3	4	5	6	7	8
$P(X)$:	p	$2p$	$2p$	p	$2p$	p^2	$2p^2$	$7p^2 + p$

On the above context, answer the following questions.

(i) Find the value of p .

(ii) Find the mean, $E(X)$.

OR

Q.31.(b) If the probability of success in a single trial is 0.01 , how many minimum number of Bernoulli trials must be performed in order that the probability of at least one success is $\frac{1}{2}$ or more?

$\left(\text{Use } \log_{10} 2 = 0.3010 \text{ and } \log_{10} 99 = 1.9956\right)$

SECTION D $[5 \times 4 = 20]$

(This section comprises of 4 long answer (LA) type questions of 5 marks each)

Q.32. (a) Fit a straight-line trend by using the method of least squares for the following data and calculate the trend values.

Year	Production (in tonnes)
1962	2
1963	4
1964	3
1965	4
1966	4
1967	2
1968	4
1969	9
1970	7
1971	10
1972	8

OR

Q.32. (b) The quarterly profits of a small-scale industry (₹ in thousands) are as follows.

Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4
2020	39	47	20	56
2021	68	59	66	72
2022	88	60	60	67

Calculate **4-quarterly** moving averages.

Q.33. (a) An owl was sitting at $(0,k);\ k>0$. Then it starts flying along the path whose equation is given by $y=ax^2+bx+c,$ where $a\in\mathbb{R}-\{0\}$, $b,c\in\mathbb{R}$. It passes through the points $(1,2),(2,1)$ and $(4,5)$. Using **Cramer's Rule**, find the values of a,b,c and hence k

OR

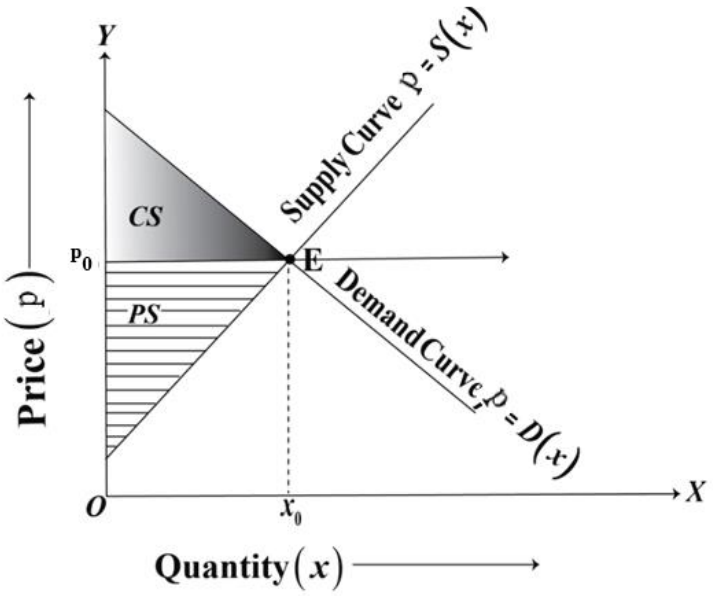
Q.33. (b) A toy rocket is fired, from a platform, vertically into the air, its height above the ground after t seconds is given by $s(t)=at^2+bt+c,$ where $a,b,c\in\mathbb{R};\ a\neq 0$ and $s(t)$ is measured in

metres. After **10** second, the rocket is **16 m** above the ground; after **20** seconds, **22 m**; after **30** seconds, **25 m**.

(i) Write down a system of three linear equations in terms of a, b and c.

(ii) Hence find the values of a, b and c, using matrix method.

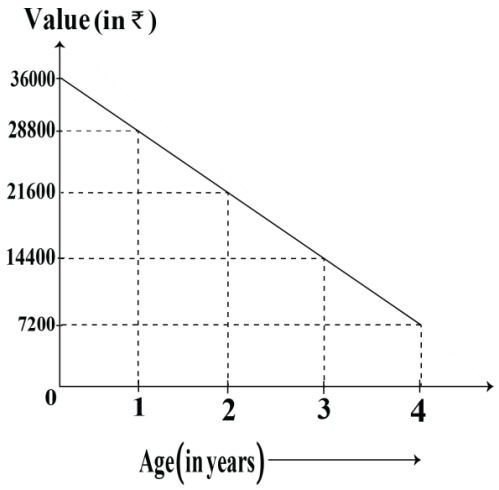
Q.34. Supply and demand curves of a tyre manufacturer company is given below:



The above graph showing the demand and supply curves of a tyre manufacturer company which are linear. 'ABC' tyre manufacturer sold **25** units every month when the price of a tyre was ₹ **20000** per units and 'ABC' tyre manufacturer sold **125** units every month when the price dropped to ₹ **15000** per unit. When the price was ₹ **25000** per unit, **180** tyres were available per month for sale and when the price was only ₹ **15000** per unit, **80** tyres remained. Find the demand function. Also find the consumer surplus if the supply function is given to be $S(x) = 100x + 7000$

Q.35. In **4** years, a mobile costing **₹ 36,000** will have a salvage value of ₹ **7200**.

The following graph shows the depreciation of a mobile's value over 4 years.



A new mobile at that time (i.e., after **4 years**) is expected to cost for ₹ **55,200**. In order to provide funds for the difference between the replacement cost and the salvage cost, a sinking

fund is set up into which equal payments are placed at the end of each year. If the fund earns interest at the rate 7% compounded annually, how much should each payment be? Also find the amount of Annual Depreciation of the mobile's value over **4** years and find the rate of depreciation (under straight line method). Use $(1.07)^4 = 1.3107$.

SECTION- E $[4 \times 3 = 12]$

(*This section comprises of 3 case-study/passage-based questions of 4 marks each with sub parts. The first two case study questions have three sub parts (i), (ii), (iii) of marks 1, 1, 2 respectively. The third case study question has two sub parts of 2 marks each)*

Case Study-1

Q.36. A student Shivam is running on a playground along the curve given by $y = x^2 + 7$. Another student Manita standing at point $(3, 7)$ on playground wants to hit Shivam by paper ball when Shivam is nearest to Manita.

Based on above information, answer the following questions:

(i) Let at any instant while running along the curve $y = x^2 + 7$, Shivam's position be (x, y). Find the expression for the distance (D) between Shivam and Manita in terms of 'x'. [1]

(ii) Find the critical point(s) of the distance function. [1]

(iii) (a) What is the distance between Shivam and Manita when they are at least distance from each other. [2]

OR

(iii) (b) Find the position of Shivam, when he is closest to Manita. [2]

Case Study-2

Q.37. EQUATED MONTHLY INSTALMENTS (EMI): -

Each instalment can be considered as consisting of two parts:

(i) Interest on the outstanding loan (ii) Repayment of part of the loan.

Methods of calculation of EMI or Instalment: -

EMI or Installment can be calculated by two methods:

1. Flat Rate Method
2. Reducing-balance method or Amortization of Loan

Rajesh purchased a house from a company for ₹ 2500000 and made a down payment of ₹ 500000 He repays the balance in 25 **years** by monthly instalments at the rate of 9% per annum compounded monthly. $\left(\text{Given}\left(1.0075\right)^{-300} = 0.1062\right)$

Based on the above information, answer the following questions:

(i) Find the number of payments and find the rate of interest per month. [1]

(ii) (a) What are the monthly payments of instalments using ***reducing balance method***? [2]

OR

(ii) (b) What are the monthly payments of instalments using ***flat rate method***? [2]

(iii) What is the total interest payment made in the process applied to calculate **EMI** in the above part $\left(37(ii)\right)$? [1]

Case Study- 3

Q.38. A company has two factories located at **P** and **Q** and has three depots situated at **A, B** and **C**. The weekly requirement of the depots at **A, B** and **C** is respectively **5, 5** and **4** units, while the production capacity of the factories **P** and. **Q** are respectively **8** and **6** units. The cost (in ₹) of transportation per unit is given below.

Cost (in ₹)			
To / From	A	B	C
P	160	100	150
Q	100	120	100

Based on the above information, answer the following questions:

(i) Formulate the objective function and the constraints of the above Linear programming problem. [2]

(ii) How many units should be transported from each factory to each depot in order that the transportation cost is minimum? [2]

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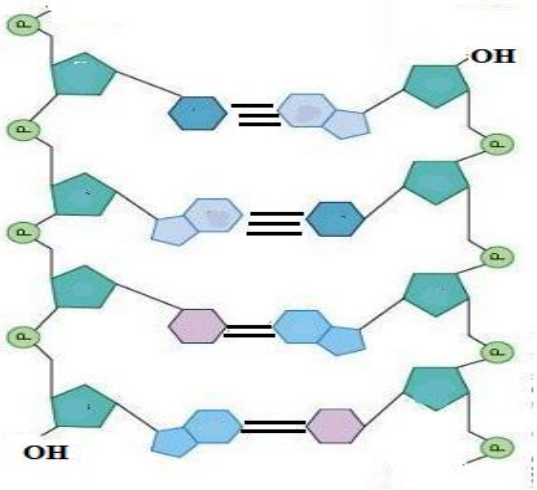
Sample Question Paper
Class XII
044 Biology (2024-25)

Maximum Marks: 70 **Time: 3 hours**

General Instructions:

(i) All questions are compulsory.
(ii) The question paper has five sections and 33 questions.
(iii) Section–A has 16 questions of 1 mark each; Section–B has 5 questions of 2 marks each; Section– C has 7 questions of 3 marks each; Section– D has 2 case-based questions of 4 marks each; and Section–E has 3 questions of 5 marks each.
(iv) There is no overall choice. However, internal choices have been provided in some questions. A student has to attempt only one of the alternatives in such questions.
(v) Wherever necessary, neat and properly labeled diagrams should be drawn.

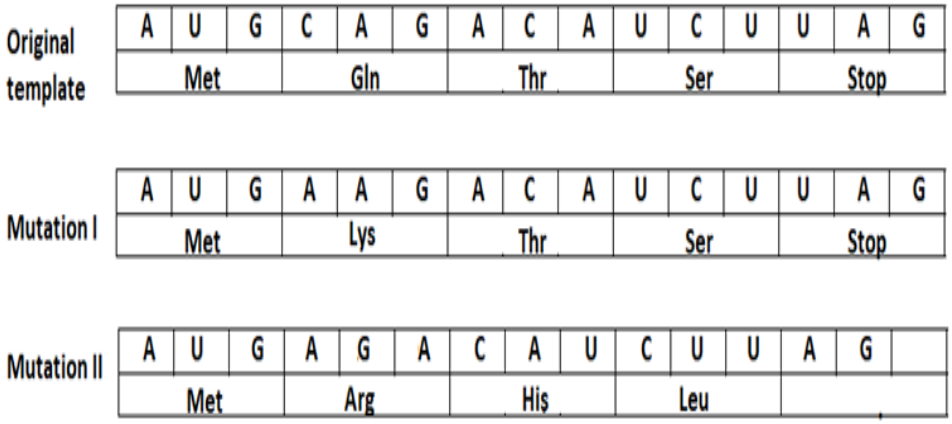
Section – A **Q. No. 1 to 12 are multiple choice questions. Only one of the choices is correct. Select and write the correct choice as well as the answer to these questions.**		
Q. No	**Question**	**Marks**
1	Signals for parturition in human female originate from A. Fully developed foetus only B. Both placenta as well as fully developed foetus C. Placenta only D. Oxytocin released from maternal pituitary	1
2	To produce 1600 seeds, the number of meiotic divisions required will be A. 2400 B. 2000 C. 1600 D. 1800	1
3	A sample of normal double-stranded DNA was found to have thymine content of 27%. What will be the expected proportion of guanine in this strand? A. 23% B. 32% C. 36% D. 73%	1

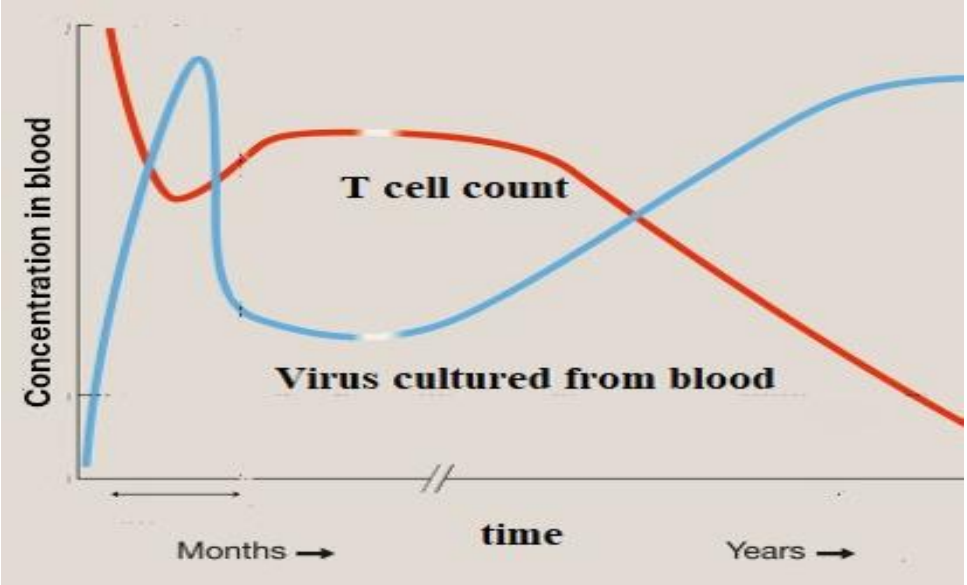
4	Observe the schematic diagram that depicts a small section of nucleic acid. The bases in two strands are paired through hydrogen bonds that are shown by the dark lines. Identify the correct sequence of nucleotide in the 5'-3' direction.  A. GCAT B. CGTA C. TAGC D. ATCG - - - - - - - - - - - - - - - - - - - *For Visual Impaired Students* *E. coli* has 4.6 X 10^{6} base pairs and completes the process of replication in 18 minutes, then the average rate of polymerization is approximately A. 2000 bp/s B. 4000 bp/s C. 3000 bp/s D. 1000 bp/s	1
5	Suresh and Rajesh have defective haemoglobin due to genetic disorders. In Suresh, the problem is qualitative as he is having incorrectly functioning globin molecules while in Rajesh the problem is quantitative as he is having very few globin molecules. Identify the disorder they are suffering from.	1

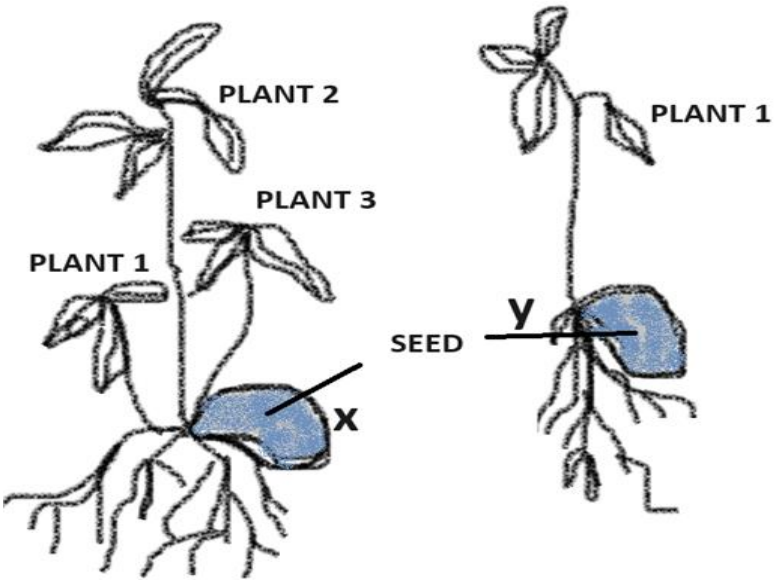
	Suresh	Rajesh
A	Thalassemia - Autosomal Dominant blood disorder	Sickle Cell Anaemia - Autosomal linked Recessive trait
B	Sickle Cell Anaemia - Autosomal linked Dominant trait	Thalassemia - Autosomal Recessive blood disorder
C	Sickle Cell Anaemia – Autosomal linked Recessive trait	Thalassemia – Autosomal Recessive blood disorder
D	Thalassemia - Autosomal Dominant blood disorder	Sickle Cell Anaemia - Autosomal linked Dominant trait

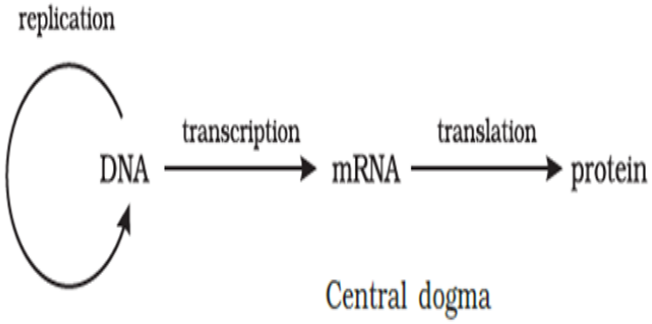
6	In *E.coli*, the lac operon gets switched on when lactose is A. present in the medium and it binds to the repressor. B. not present in the medium and the repressor binds to the operator. C. not present in the medium and RNA polymerase binds to the operator. D. Active lactose present in the medium binds to RNA polymerase.	1
7	Which of the following features shows the mechanism of sex determination in honey-bee? (i) An offspring formed from the union of a sperm and egg develops as a female. (ii) Males have half the number of chromosomes than that of female. (iii) The males are haploid having 32 chromosomes. (iv) All workers and males are diploid having 16 chromosomes A. (i) and (ii) B. (ii) and (iii) C. (i) and (iv) D. (ii) and (iv)	1
8	The following diagram shows a fragment of DNA which is going to be transcribed, the upper strand with polarity 3' to 5' is the template strand: 3´ ATTGCC 5´ 5´ TAACGG 3´ After transcription the mRNA can be represented by: A. 5´ AUUGCC 3´ B. 5´ AUUGCC 3' C. 5´ UAACGG 3´ D. 5´ GGCAAU 3´	1
9	Idli – dosa dough rises due to production of which of the following gas? A. CO B. CO_2 C. NO D. NO_2	1
10	Adaptive radiation leads to which of the following? A. Increased competition among species B. Decreased speciation rates C. Limited morphological diversity among species D. Rapid divergence of traits among populations inhabiting a given geographical area.	1

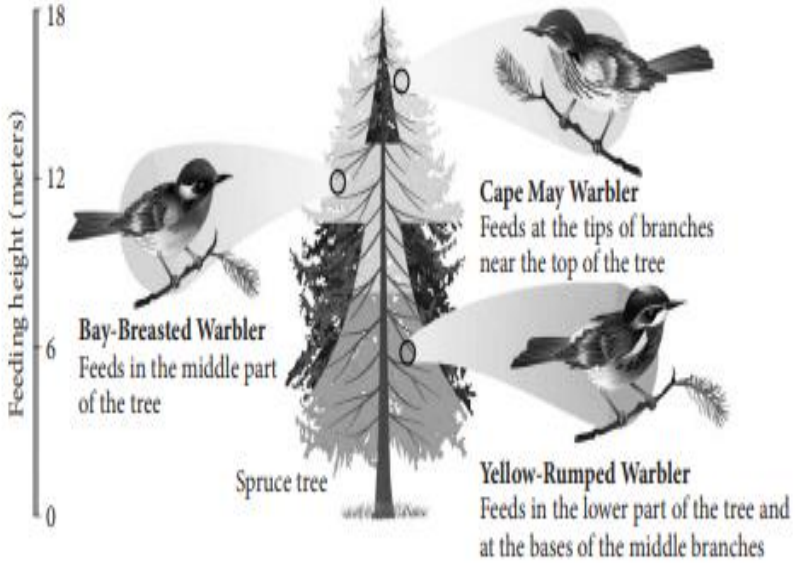
<table>
<tr><td>11</td><td>Eco R1 cuts the DNA between bases G and A only when the sequence of GAATTC is present. The number of nucleotides present in the resultant sticky ends that will be formed in each of the two strands of DNA after this enzyme cuts the DNA will be:
<table>
<tr><th></th><th>Vector DNA</th><th>Foreign DNA</th></tr>
<tr><td>A.</td><td>1 & 5</td><td>5 &1</td></tr>
<tr><td>B.</td><td>2 & 4</td><td>4 &2</td></tr>
<tr><td>C.</td><td>2 & 5</td><td>5 & 2</td></tr>
<tr><td>D.</td><td>3 & 4</td><td>4 & 3</td></tr>
</table></td><td>1</td></tr>
<tr><td>12</td><td>During the secondary treatment of sewage, which of the following change in the effluent occur due to flocs?
A. Reduction in BOD
B. Increase in BOD
C. Decrease in DO
D. No change in DO or BOD</td><td>1</td></tr>
<tr><td colspan="3">Question No. 13 to 16 consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:
A. Both A and R are true and R is the correct explanation of A.
B. Both A and R are true and R is not the correct explanation of A.
C. A is true but R is false.
D. A is False but R is true.</td></tr>
<tr><td>13</td><td>Assertion (A): Cells of tapetum have more than one nucleus.
Reason (R): They undergo meiosis without cytokinesis.</td><td>1</td></tr>
<tr><td>14</td><td>Assertion (A): Deoxyribonucleoside triphosphates serve dual purposes.
Reason (R): They act as proof readers and provide energy.</td><td>1</td></tr>
<tr><td>15</td><td>Assertion (A): A floating cover placed over the slurry in a biogas plant keeps on rising.
Reason (R): This cover keeps on rising due to the gas produced in the tank by the microbial activity.</td><td>1</td></tr>
<tr><td>16</td><td>Assertion (A): DNA fragments can be isolated by Gel electrophoresis on the basis of their size.
Reason (R): The larger the fragment size, the faster it moves.</td><td>1</td></tr>
<tr><td colspan="3">Section - B</td></tr>
<tr><td>17</td><td><u>Attempt either option A or B.</u>
A.
(i) A blood test reported negative for hCG.
What does negative hCG imply? Name the tissue which produces hCG?</td><td>2</td></tr>
</table>

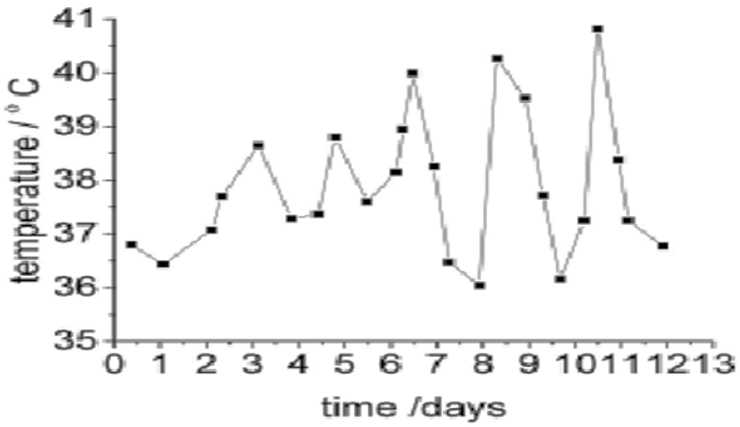
	(ii) If a blood test reported positive for hCG in a person, then which other hormones would also be secreted by the tissue secreting hCG? **OR** B. (i) The human male ejaculates about 200 to 300 million sperm during a coitus, however the ovum is fertilized by only one sperm. How does the ovum block the entry of additional sperms? (ii) All copulations will not lead to fertilization. Why?	
18	*Attempt either option A or B.* A. The schematic representation given below shows a DNA strand and two types of mutations in the DNA strand.  (i) Identify the type of mutation exhibited in I and II. (ii) Which of the above mutation is more harmful? Give reason. **OR** B. Given below is a schematic representation of a mRNA strand  (i) In the above sequence identify the translational unit in mRNA. (ii) Where are UTRs found and what is their significance?	2

19	Given below is the relationship between the HIV levels in the blood and helper T cell count in a person detected with AIDS. Study the relationship and answer the questions that follow.  A. What kind of relationship is observed in the virus levels and the immune response after some days of the initial infection? B. Does it completely clear the virus from the body permanently? Give reason for your answer. - - - - - - - - - - - - - - - - - - - *For visually impaired students.* Write the sequence of events that occur when a retrovirus enters a human being, causing reduction in helper T-cells.	2
20	A culture plate of *Lactobacillus* shows blue-coloured colonies and colourless colonies. Explain the principle involved in the formation of such variance in the colour of colonies.	2
21	*Attempt either option A or B.* A. (i) It was estimated that if an evergreen forest has a GPP of 400 J/m^2/day and 150 J/m^2/day worth of carbon dioxide flows out of that forest, what is the NPP in that forest? (ii) Explain why pyramids of energy must always be upright. **OR** B. (i) Assume that, GPP Forest A = GPP Forest B = GPP Forest C, If Forest A has NPP = 1254 J/m^2/day; Forest B, NPP =2157 J/m^2/day; and Forest C, NPP = 779 J/m^2/day, which one of these forests has maximum energy loss by respiration? Give reason. (ii) Draw an ecological pyramid of number of the following food chains a. Grass — Animal —Fleas on the host animal b. Tree — Insects — Woodpecker	2

Section - C		
22	The image below shows two germinated seeds X and Y which belong to the same species. Seed X is produced by apomixis whereas seed Y is a product of sexual reproduction.  A. Write the number of embryo(s), embryo sac(s) and ovules in the ovary of seed X. B. How multiples embryos are formed in citrus fruits? C. What advantage will plants developed from seed Y have over seed X? - - - - - - - - - - - - - - - - - - - *For visually impaired students* Each Mango fruit contains one seed. Two mango seeds, X and Y were sown in the soil. From Seed X, 3 plant saplings germinated but from seed Y only 1 plant sapling germinated. A. For seed X which is apomictic, calculate the number of: i) Embryo(s) ii) Embryo sac(s) iii) Ovules in this seed's ovary B. How multiples embryos are formed in citrus fruits? C. What advantage will plants developed from seed Y have over seed X?	3
23	Name the place in human ovary where the first meiotic division is completed during oogenesis. What are the products of this division? Give the chromosome number of each type of cells involved in the process.	3

24	The schematic representation given below shows the concept of Central Dogma.  Central dogma A. During the process of replication and transcription the pairing of nitrogenous bases is not similar. Explain. B. How is the above process modified in a retrovirus? Name the process. C. Justify why during the process of transcription only a segment of DNA is copied into RNA. - - - - - - - - - - - - - - - - - - - *For visually impaired students* Central Dogma explains the process of DNA transcription and translation. From DNA mRNA is transcribed and then mRNA is translated into a polypeptide. A. During the process of replication and transcription the pairing of nitrogen bases is not similar. Explain. B. How is the above process modified in viruses? Name the process. C. Justify why during the process of transcription only a segment of DNA is copied into RNA.	3
25	Describe the steps involved in Southern blot hybridization using radiolabeled VNTR as a probe.	3
26	Bio-fertilisers are organisms that enrich the nutrient quality in the soil. Explain the role of three main sources of bio-fertilisers.	3
27	Explain how PCR technique can be used for amplification of a small amount of DNA template.	3
28	A. Diagram given below depicts different species of Warbler birds feeding on different regions on a Spruce tree. Explain the mechanism which helps them to co-exist.	3

	 B. What does Gause's exclusion principle state? Does it apply in the case shown above? Explain. - - - - - - - - - - - - - - - - - - - *For visually impaired students* A. Name and explain the mechanism where two species competing for the same resource co-exist. B. What does Gause's exclusion principle state? Does it apply in the above situation? Explain.	
Section - D		
29	Assuming that within a population of beetles where Hardy Weinberg conditions are met, the colour black (B) is dominant over the colour red (b). 40% of all beetles are red (bb). Given this information, answer the questions below: A. What is the frequency of red beetles? (1) B. Calculate is the percentage of beetles in the population that are heterozygous. (2) *Attempt either subpart C or D.* C. What is the frequency of homozygous dominant individuals? (1) **OR** D. Assuming that Hardy Wienberg conditions are met in the beetle population consisting of 1500 beetles. How many beetles would you expect to be black and red in colour respectively? (1)	4
30	Given below is the pattern of temperature in a person suffering from a non-viral disease transmitted by mosquitoes. Study the graph and answer the questions that follow:	4



A. Explain the factor(s) responsible for this pattern of temperature. (1)
B. How does this pathogen multiply in the human body? (2)

Attempt either subpart C or D.

C. How is this infection transmitted to humans? (1)

OR

D. Which stages of the life cycle of this pathogen are completed in the mosquito's gut? (1)

- - - - - - - - - - - - - - - - - - -

For visually impaired students

A. A non-viral disease that is transmitted by mosquitoes causes recurring fever in an infected person. Explain giving reason(s). (1)
B. How does this pathogen multiply in the human body? (2)

Attempt either subpart C or D.

C. How is this infection transmitted to humans? (1)

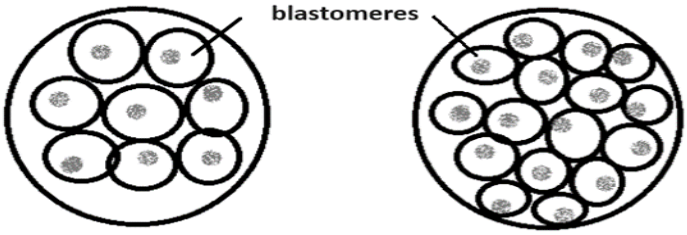
OR

D. Which stages of the life cycle of this pathogen are completed in the mosquito's gut? (1)

Section - E

31 *Attempt either option A or B.* 5

A. Cryptorchidism is a condition in which the testes fail to descend into the scrotum. It can also lead to compromised Sertoli cell function and has an impact on Leydig cell function.
   (i) Identify at least 3 parameters of male fertility which get affected due to cryptorchidism.
   (ii) Which process will be affected if mature spermatids are not released from Sertoli cells?
   (iii) Name and explain one assisted reproductive technology (ART process) in which the sperm/semen is used to assist fertilization.
   (iv) Name and explain the assisted reproductive technology that should be used to complete the development of embryos I and II shown in the figure given below.

	 Embryo I Embryo II - - - - - - - - - - - - - - - - - - - *For visually impaired students* (iv) An infertile couple decided to use ART to conceive. After IVF they decided for Embryo transfer of the following 2 embryos. Embryo 1 consisted of 8 blastomeres and Embryo 2 consisted of 16 blastomeres. Name and explain the techniques they should deploy to complete further development of the given embryos. **OR** B. (i) Explain the significance of each of the following features present in plants given below: a) In rose-bay plant the stamens ripen before the stigma. b) In certain species of primrose, the flowers have short stamen and long style. c) The bisexual flower of mustard exhibits rejection of self-pollen grain. (ii) Explain how autogamy is prevented in castor and papaya plant respectively.	
32	*Attempt either option A or B.* A. Explain how advent of biotechnology has helped in preventing infestation by nematodes and thereby increasing crop yield. **OR** B. In the future, genetic therapies may be used to prevent, treat, or cure certain inherited disorders in humans. Justify the statement with a suitable example.	5
33	*Attempt either option A or B.* A. (i) Why is there a need to conserve biodiversity? (Any two reasons) (ii) Name and explain any two causes that are responsible for the loss of biodiversity. **OR** B. (i) Name the two types of desirable approaches to conserve biodiversity? Explain with examples bringing out the difference between the two types. (ii) State the features of a stable biological community?	5

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