



General Instructions:

- (i) There are a total 26 questions in five sections in the question paper. All questions are compulsory.
- (ii) Section A contains questions number 1 to 5, Very Short Answer type questions for one mark each.
- (iii) Section B contains questions number 6 to 10, Short Answer type 1 questions of two marks each.
- (iv) Section C contains questions number 11 to 22, Short Answer type 2 questions for the three marks each.
- (v) Section D contains question number 23, Value Based Question of four marks.
- (vi) Section E contains questions number 24 to 26, Long Answer type questions of five marks each.
- (vii) There is no overall choice in the question paper, however, an internal choice is provided in one question of two marks, one question of three marks and all three questions of five marks. An examinee is to attempt any one question out of two given in the question paper with the same question number.

You may use the following values of physical constants wherever necessary:

$$g = 9.8 \text{ m/s}^2$$

$$R = 8.3 \text{ J/mol K}$$

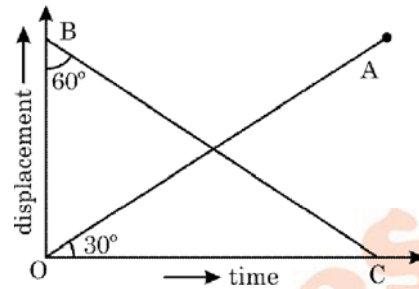
Section A

1. Obtain the dimensional formula for molar gas constant R.
2. A gardener moves a lawn roller through a distance of 50 m with a force of 100 N. If the force is acting at an angle of 60° to the direction of motion, find the work done.
3. Two bodies of masses m and $4m$ are moving with equal kinetic energies. What is the ratio of their linear momenta?
4. Obtain the dimensional formula for coefficient of viscosity.
5. Write the rms speed of molecules of a gas in terms of its pressure.

Section B

6. Angular diameter of Sun as observed by a scientist from the surface of Earth, is $32'$. What is the diameter of Sun? Given that mean distance of Earth from the Sun is $1.5 \times 10^{11} \text{ m}$.
7. The velocity of a body of mass 1 kg as a function of time t is given by $\vec{v}(t) = 2t \hat{i} + t^2 \hat{j}$. Find the momentum and the force acting on it at time $t = 2\text{s}$.

8. The displacement-time graph of two bodies P and Q are represented by OA and BC, respectively. What is the ratio of speeds of P and Q?
 $\angle OBC = 60^\circ$ and $\angle AOC = 30^\circ$



or

It is observed that in a vector operation $|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$. How is it possible?

9. Obtain an expression for the angle which a cyclist will have to make with the vertical while taking a circular turn (for successful negotiation).
10. How will you 'weigh the Sun', that is estimate its mass? The mean orbital radius of the Earth around the Sun is $1.5 \times 10^8 \text{ km}$.

Section C

11. A 100 m sprinter uniformly increases his speed from rest at the rate of 1 m/s^2 up to $\frac{3}{4}$ th of the total run and then covers the balance $\frac{1}{4}$ th run with uniform speed. How much time does he take to complete the race?
12. To a person moving eastwards with a velocity of 4.8 m/s, the rain appears to fall vertically downwards with a speed of 6.4 m/s. What is the actual velocity of the rain?
13. Two masses m_1 and m_2 (where $m_1 > m_2$) are connected together by a light, inextensible string passing over a smooth, light pulley. Find the magnitude of acceleration of the system. Also find the tension in the string.
14. Four particles of mass 1 kg, 2 kg, 3 kg and 4 kg are placed at the four vertices A, B, C and D of a square of side 1 m. Find the position of centre of mass of the particle.
15. A grind stone has a moment of inertia of 6 kgm^2 . A constant torque is applied and the grind stone is found to have a speed of 150 rpm, 10 seconds after starting from rest. Calculate the torque.

or

A tangential force F acts at the top of a thin spherical shell of mass m and radius R . Find the acceleration of the shell if it rolls without slipping.

16. Define gravitational potential energy of a body. Derive an expression for the gravitational potential energy of body of mass 'm' located at a distance 'r' from the centre of the Earth.
17. A copper wire of 2.2 m length and a steel wire of length 1.6 m, both of diameter 3.0 mm are connected end to end. When stretched by load, the net elongation is found to be 0.7 mm. Obtain the load applied. ($Y_{\text{copper}} = 1.1 \times 10^{11} \text{ N/m}^2$ and $Y_{\text{steel}} = 2.0 \times 10^{11} \text{ N/m}^2$).
18. What is an isothermal process? Derive an expression for work done during an isothermal expansion of a gas.
19. One mole of an ideal monatomic gas occupies a volume of 0.01 m^3 at a pressure of $2.0 \times 10^5 \text{ N/m}^2$.
(a) What is the temperature of the gas?
(b) The gas undergoes a quasi-static adiabatic compression until its volume is decreased to 0.005 m^3 . What is the new gas temperature?
(c) How much work is done on the gas during the compression?
Take $\gamma = 5/3$
20. A cylinder of fixed capacity 44.8 litre contains helium gas at standard temperature and pressure. What is the amount of heat needed to raise the temperature of the gas in the cylinder by 15.0°C ?
21. From the equation $y = A \sin \frac{2\pi}{\lambda} (vt - x)$, establish the relation between particle velocity and wave velocity.
22. If the earth was a homogenous sphere of radius 6400 km and a straight hole was bored in it through its centre, calculate the period of oscillation of a body dropped in the hole.

Section D

23. Sudha's grandmother had read in 'Mahabharat' that during the famous war of Kurukshetra, Bheem used to throw away elephants in sky so that they never returned back on the Earth. However, she could not understand how is it possible. She narrated the story to Sudha.

Sudha remarked that it is possible. Then she explained in detail to her grandmother that if any object is thrown from the surface of Earth with a speed equal or greater than escape speed, it will keep on moving to cross the gravitational field of Earth and will never return on the Earth. Spacecrafts launched by scientists and aimed to land to moon or other planets are based on this very principle. Sudha's grandmother thanked her for the explanation given by her.

- (a) What is escape speed? Give a formula for it. What is its value on surface of Earth?
- (b) Planet Mars has a radius of 3400 km and value of acceleration due to gravity 'g' at the surface of Mars is 4.5 m/s^2 . What is the value of escape speed at Mars?
- (c) What values were displayed by Sudha?

Section E

24. (a) Discuss elastic collision in one dimension. Obtain expressions for velocities of the two bodies after such collision.
(b) A railway carriage of mass 9000 kg moving with a speed of 36 km/h collides with a stationary carriage of the same mass. After the collision, the two get coupled and move together. What is the common speed and what type of collision is this?

or

State parallelogram law of vector addition and find magnitude and direction of resultant of two vector \vec{A} and \vec{B} in terms of their magnitude and angle between them.

25. A particle is moving in a vertical circle. What should be the minimum velocity given to it at the lowest point so that it completes the circle? Also derive expression for the tension at the lowest point when it is just able to loop the loop.

or

Find an expression for acceleration of a cylinder rolling down a rough inclined plane. What is the condition so that no slipping takes place?

26. State and prove Bernoulli's theorem for steady flow of an ideal fluid.

or

- (a) Explain the terms 'specific heat' and 'heat capacity'.
(b) State Newton's law of cooling. Define mathematical expression for it.



General Instructions:

- (i) There are a total 26 questions in five sections in the question paper. All questions are compulsory.
- (ii) Section A contains questions number 1 to 5. Very Short Answer type questions for one mark each.
- (iii) Section B contains questions number 6 to 10, Short Answer type 1 questions of two marks each.
- (iv) Section C contains questions number 11 to 22, Short Answer type 2 questions for the three marks each.
- (v) Section D contains question number 23, Value Based Question of four marks.
- (vi) Section E contains questions number 24 to 26, Long Answer type questions of five marks each.
- (vii) There is no overall choice in the question paper, however, an internal choice is provided in one question of two marks, one question of three marks and all three questions of five marks. An examinee is to attempt any one question out of two given in the question paper with the same question number.

You may use the following values of physical constants wherever necessary:

$$g = 9.8 \text{ m/s}^2$$

$$R = 8.3 \text{ J/mol K}$$

$$\text{Speed of sound} = 344 \text{ m/s}$$

Section A

1. Define a radian.
2. State work-energy theorem.
3. A particle of mass m has momentum p . What is its kinetic energy?
4. Is viscous force a conservative force?
5. If three molecules have speeds v_1 , v_2 and v_3 , respectively, then what will be their average speed and the root mean square speed?

Section B

6. A drop of olive oil of radius 1 mm spreads into a circular film of diameter 40 cm on water surface. Estimate the size of an oil molecule.
7. A elevator weighs 3000 kg. What is its acceleration when the tension in supporting cable is 33000 N in upward direction?
8. If the distance covered by a moving object varies directly as the square of time, what conclusions would you draw about the motion?

or

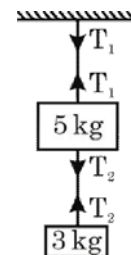
A boy is travelling in a car moving with a speed of 40 km/h along a straight level road. He throws a ball with a speed of 30 km/h from the window horizontally but perpendicular to the direction of

motion of car. What is the speed and direction of motion of the ball w.r.t. ground?

9. A wooden box is placed on a 30° slope. If the coefficient of kinetic friction is 0.1, what is the acceleration of the box?
10. A rocket is fired from the Earth towards the Sun. At what distance from the Earth's centre is the gravitational force on the rocket zero? Given $M_s = 2 \times 10^{30} \text{ kg}$, $M_E = 6 \times 10^{24} \text{ kg}$ and orbital radius of Earth = $1.5 \times 10^{11} \text{ m}$.

Section C

11. Draw position-time graphs for (i) uniform motion, (ii) positively accelerated motion, and (iii) negatively accelerated motion. How do you identify the graphs?
12. Show that for a projectile fired at an angle of elevation θ , there are two times for which the projectile travels the same vertical distance. Also prove that the sum of these two times is equal to the total time of flight.
13. Two masses of 5 kg and 3 kg are suspended with the help of massless inextensible strings as shown in figure. Calculate T_1 and T_2 when whole system is going upwards with acceleration = 2 m/s^2 .



14. Define centre of mass of a n -particle system. State the coordinates of centre of mass of a n -particle system.
15. A flywheel in the shape of a uniform disc has a mass of 40 kg and is of radius 0.5 m. It is revolving around its own axis at the rate of 360 rpm. What torque is needed to bring it to rest in 10 s? If the torque is on account of a force applied tangentially on the rim of flywheel, what is the magnitude of force?

or

A 3 m long ladder weighing 20 kg leans on a frictionless wall. Its feet rest on the floor 1 m from the wall. Find the reaction forces of the wall and the floor.

16. A satellite is revolving in a circular path close to a planet of density ρ . Find expression for its period of revolution.

17. Explain the following:
- Concrete beams used in large buildings have greater depth than breadth.
 - Load bearing bars are generally made in I-section.
 - Pillar with distributed ends is preferred over a pillar with rounded ends.
18. Show that slope of indicator diagram in an adiabatic process is steeper than isothermal process.
19. Calculate the amount of heat required to raise the temperature of two moles of an ideal gas from 0 °C to 100 °C under constant pressure conditions. Given that the molar specific heat of the above gas at constant volume is 2.5 R.
20. One mole of a monatomic gas is mixed with three moles of a diatomic gas. What is the molar specific heat of the mixture at constant volume?
21. A wave travelling along a string is described by equation $y(x, t) = 0.05 \sin (40x - 5t)$ in which the numerical constants are in SI. Calculate the (a) amplitude (b) wavelength (c) the period and (d) frequency of wave. Also calculate the displacement at distance 35 cm and time 10 s.
22. A particle is vibrating in SHM, when the displacement of the particle from its equilibrium position are x_1 and x_2 , it has velocities v_1 and v_2 respectively. Show that its time period is given by

$$T = 2\pi \sqrt{\frac{x_1^2 - x_2^2}{v_2^2 - v_1^2}}$$

Section D

23. Anand and his classmates went to a hilly forest area for a plants collection tour. As students were moving in different directions collecting various plants, Mukul got separated from other students. He searched the other students but some how passed in dense forest. He shouted loudly naming his classmates. He observed that somebody was copying him and shouting the same words. He got more perplexed and thought that some ghost is present there. He started crying. Somehow, Anand heard the sound of Mukul, guessed that Mukul is having some problem. He then asked his classmates to search Mukul. With some efforts they could locate Mukul. Mukul was highly depressed and terrified. Anand comforted him. When Mukul said that some ghost is present in the forest, Anand told him that it is nothing. He listened the same sound again due to formation of echo. To demonstrate this, Anand whistled sharply.

After a few seconds all students heard the same sound due to reflection from the nearby hills. Now Mukul was satisfied and became normal.

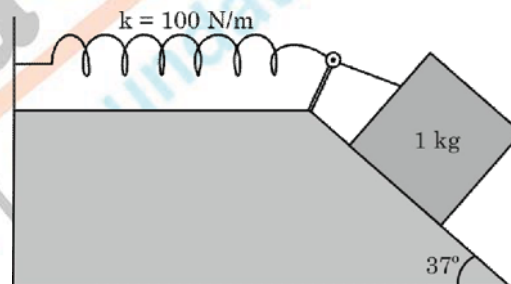
- What value/qualities were shown by Anand?
- What is echo? How is it formed?
- If a reflector is situated at a distance of 860 m from a sound source, what is the time of echo?

Section E

24. A projectile is fired at an angle θ upward with the horizontal with velocity u .
- Show that its trajectory is parabolic.
 - Obtain expression for:
 - Maximum height attained
 - Time of flight
 - Horizontal range.
 - At what value of θ the range is maximum?

or

A 1 kg block situated on a rough incline is connected to a spring of spring constant 100 N m⁻¹ as shown below. The block is released from rest with the spring in the un-stretched position. The block moves 10 cm down the incline before coming to rest. Find the coefficient of friction between the block and the incline. Assume that the spring has a negligible mass and the pulley is frictionless.



25. What is a two dimensional elastic collision? Discuss collision of two bodies in two dimensions.

or

Discuss rolling motion without slipping of a solid cylinder down a rough inclined plane and find an expression for acceleration of cylinder.

26. What is capillarity? Establish an expression for rise of a liquid in a capillary tube.

or

Define coefficient of thermal conductivity and derive its SI unit. Calculate the rate of loss of heat through a glass window of area 1000 cm² and thickness 0.4 cm when temperature inside is 37 °C and outside is - 5 °C. Coefficient of thermal conductivity of glass is 2.2 × 10⁻³ cal s⁻¹ cm⁻¹ °C⁻¹.



General Instructions:

- (i) There are a total 26 questions in five sections in the question paper. All questions are compulsory.
- (ii) Section A contains questions number 1 to 5, Very Short Answer type questions for one mark each.
- (iii) Section B contains questions number 6 to 10, Short Answer type 1 questions of two marks each.
- (iv) Section C contains questions number 11 to 22, Short Answer type 2 questions for the three marks each.
- (v) Section D contains question number 23, Value Based Question of four marks.
- (vi) Section E contains questions number 24 to 26, Long Answer type questions of five marks each.
- (vii) There is no overall choice in the question paper, however, an internal choice is provided in one question of two marks, one question of three marks and all three questions of five marks. An examinee is to attempt any one question out of two given in the question paper with the same question number.

Section A

1. Express the density 2.1 g/cm^3 in kg/m^3 .
2. The potential energy of an object at a height h is mgh . What will be its kinetic energy when it freely falls to ground?
3. Does the amount of work done depend upon the fact that how fast is a load raised or moved in the direction of force?
4. State formula for viscous drag due to Stoke's law.
5. What is the mean translational kinetic energy of a mole of helium gas at 400 K ?

Section B

6. Give an example of
 - (a) A physical quantity which has a unit but no dimensions.
 - (b) A physical quantity which has neither unit nor dimensions.
 - (c) A constant which has a unit.
 - (d) A constant which has no unit.
7. A cricket ball of mass 0.15 kg moving with a speed of 20 m/s is brought to rest by a player in 0.1 s . What is the average force applied by the player?
8. An object is covering distance in direct proportion to t^3 , where t is the time. Find acceleration?

or

Find the angle between $\vec{A} = \hat{i} + \hat{j} - 2\hat{k}$ and $\vec{B} = \hat{i} + \hat{j} + \hat{k}$.

9. A block is gently placed at the top of an inclined plane 6.4 m long. Find the time taken by the block to slide down if the plane makes an angle 30° with the horizontal. Given $\mu = 0.2$ and $g = 10 \text{ m/s}^2$.
10. The escape speed of a projectile on the Earth's surface is 11.2 km s^{-1} . A body is projected out with thrice this speed. What is the speed of the body far away from the Earth?

Section C

11. Derive position-time relation of a body moving with constant acceleration and discuss it graphically.

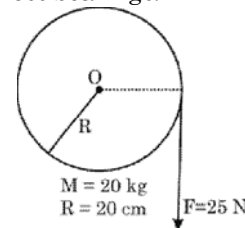
or

Derive the equation of motion $s = ut + \frac{1}{2} at^2$ using calculus method where symbols have their usual meanings.

12. A projectile has the same range when the maximum height attained by it is either H_1 or H_2 . Find the relation between R , H_1 and H_2 .
13. A body of mass m is suspended by two strings making angles α and β with the horizontal. Calculate the tensions in the two strings.
14. (a) State theorem of parallel axes.
(b) Determine the moment of inertia of a thin ring about a tangent to the circle in the plane of the ring.
15. A comet revolves around the Sun in an elliptical orbit having a minimum distance of $7 \times 10^{10} \text{ m}$ and a maximum distance of $1.4 \times 10^{13} \text{ m}$. If its perihelion speed is 60 km/s , find its aphelion speed.

or

A cord of negligible mass is wound round the rim of a flywheel of mass 20 kg and radius 20 cm . A steady pull of 25 N is applied on the cord as shown in fig. The flywheel is mounted on a horizontal axle with frictionless bearings.



- (a) Compute the angular acceleration of the wheel.
- (b) Find the work done by the pull after unwinding 2 m of the cord.
- (c) Find also the kinetic energy of the wheel at this point assuming that the wheel starts from rest.
- (d) Compare answers in parts (b) and (c).
16. Obtain an expression for height of a satellite in terms of its time period.

17. Draw stress-strain graph for a metallic solid and show (i) elastic limit, (ii) region of plasticity (iii) point of ultimate tensile strength and (iv) fracture point on the graph.
18. A system containing μ mole of an ideal gas is expanded adiabatically. If the temperature falls from T_1 to T_2 , find the work done by the gas.
19. In a refrigerator heat from inside of a refrigerator at 270 K is transferred to a room at 300 K.
(i) What is its coefficient of performance?
(ii) How much heat will be delivered to the room for each joule of electric energy consumed? Assume the refrigerator to be ideal one.
20. A closed container of volume 0.02 m^3 contains a mixture of neon and argon gases at a temperature of 27°C and pressure of $1 \times 10^5 \text{ Pa}$. The total mass of the mixture is 28 g. If the molar masses of neon and argon are 20 g and 40 g respectively, find the masses of the individual gases in the container. Take $R = 8.314 \text{ J/mol K}$.
21. Define standing wave. Displacement of a string, in which standing wave is formed, is given as:

$$y = 20 \sin 157x \cos 314t$$

Find (a) amplitude of individual waves, (b) velocity of wave.

22. A 2.5 kg mass block attached to a spring of force constant 1000 N/m slides on a frictionless horizontal surface. The block is displaced from its equilibrium position by 5.0 cm and released. Calculate (a) the oscillation period, (b) acceleration amplitude, and (c) velocity amplitude.

Section D

23. Samir read in his science book that work is being done when is applied to a body and under its effect the body moves through a certain distance in the direction of force applied. Samir could not understand this because he thought that he was doing work while reading or doing school home work etc. He became impatient and immediately went to his elder brother Vijay. On listening the story of Samir, Vijay explained to him the difference between mechanical work and mental work. While reading or doing our school home work etc., we may be doing mental work but for mechanical work presence of a force acting on a body and its displacement is essential. Moreover, mechanical work can be positive as well as negative. Now Samir was satisfied.
- (a) When is the work done positive or negative? Give examples.
(b) Can work be zero in spite of applying force?
(c) What values were displayed by Vijay and What by Samir?

Section E

24. Derive an expression for velocity of a car on a banked circular road having coefficient of friction μ and $v > v_0$. Write the expression for optimum velocity of the car. (v : speed of car, v_0 : optimum speed)

or

A body is projected at an angle θ upward with the horizontal:

- (a) Obtain the condition for maximum horizontal range.
(b) Prove that horizontal range of projectile is same when fired at complimentary angles.
(c) Obtain an expression for velocity of projectile at any instant t .
25. Derive an expression for the potential energy stored in a stretched spring.

A force $F = -\frac{k}{x^2}$ ($x \neq 0$) acts on a particle in x -direction. Find the work done by the force in displacing the particle from $x = -a$ to $x = 2a$.

or

Prove that the velocity v of translation of a rolling body of radius R (like a ring, disc, cylinder or sphere) at the bottom of an inclined plane of height h is given by:

$$v^2 = \frac{2gh}{(1 + K^2 / R^2)}$$

Where K is the radius of gyration and body starts from rest.

26. Briefly explain the reasons of the following:
(i) Two row boats moving parallel to each other and nearby are pulled towards each other.
(ii) When air is blown in between two pith balls suspended freely and close to each other, they are attracted towards each other.
(iii) A water stream coming out of a water tap thins out as it falls vertically downward.

or

What is a black body? Draw the curves showing the energy distribution among black body radiations at different temperatures. Hence define Wien's displacement law. Give one application of Wien's displacement law.



General Instructions:

- (i) There are a total 26 questions in five sections in the question paper. All questions are compulsory.
- (ii) Section A contains questions number 1 to 5, Very Short Answer type questions for one mark each.
- (iii) Section B contains questions number 6 to 10, Short Answer type 1 questions of two marks each.
- (iv) Section C contains questions number 11 to 22, Short Answer type 2 questions for the three marks each.
- (v) Section D contains question number 23, Value Based Question of four marks.
- (vi) Section E contains questions number 24 to 26, Long Answer type questions of five marks each.
- (vii) There is no overall choice in the question paper, however, an internal choice is provided in one question of two marks, one question of three marks and all three questions of five marks. An examinee is to attempt any one question out of two given in the question paper with the same question number.

Section A

1. Write the dimensional formula for power.
2. Ram is doing work at a faster rate but works only for one hour. Shyam does work at a somewhat slower rate but continues to work for eight hours. Who has greater power? Who has greater energy?
3. Calculate the power of an electric engine which can lift 20 tonne of coal per hour from a 180 m deep mine.
4. How is surface energy related to surface tension?
5. What is the number of degrees of freedom of a mosquito flying in a room?

Section B

6. If displacement of a body $s = (200 \pm 0.5)$ m and time taken by it is $t = (20 \pm 0.2)$ s, then find the percentage error in the calculation of velocity.
7. Find an expression for recoil velocity of a gun.
8. A car covers one-half of its journey with a speed of 40 km/h and the other half with a speed of 60 km/h. What is the average speed?

or

Can three vectors not in one plane give a zero resultant? Can four vectors do?

9. Derive a relation for the optimum velocity of negotiating a curve by a vehicle in a banked curve.
10. A Saturn year is 29.5 times the Earth year. How far is the Saturn from the Sun if the Earth is 1.50×10^8 km away from the Sun?

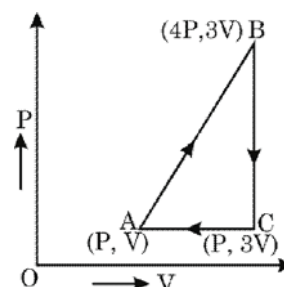
Section C

11. A boy runs at a constant speed of 2 m/s to catch a bus standing at the bus stop. When boy was 4.2 m behind the bus, it suddenly started with an acceleration of 0.4 m/s^2 .
 - (a) How much time will boy take to catch the bus?
 - (b) If the boy does not catch the bus but continues to run at the same rate, at what time will the bus overtake the boy?
 - (c) If the boy was 8 m behind the bus when it started with an acceleration of 0.4 m/s^2 , could the boy had been successful in catching the bus?
12. The position of a particle is given by $\vec{r} = 9t\hat{i} + 6t^2\hat{j} + 8t\hat{k}$. (i) Find velocity $\vec{v}(t)$ and $\vec{a}(t)$ of the particle. (ii) Find velocity at $t = 2$ s.
13. Define angle of repose. Show that coefficient of limiting friction is equal to the tangent of angle of repose?
14. State perpendicular axes theorem using appropriate diagram. Also calculate moment of inertia about a diameter if that about an axis perpendicular to plane of a disc and passing through its centre is given by $\frac{1}{2}MR^2$.
15. If the radius of the Earth contracts to half of its present value without change in its mass, what will be the duration of the day?

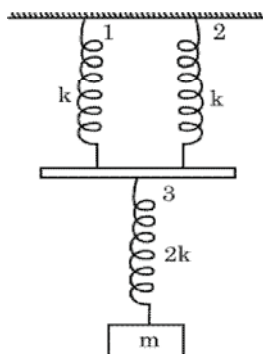
or

If angular momentum is conserved in a system whose moment of inertia is decreased, will its rotational kinetic energy be also conserved? Explain.

16. Jupiter has a mass 318 times that of Earth and its radius is 11.2 times the Earth's radius. Estimate the escape velocity of a body from Jupiter's surface if Earth's surface escape velocity is 11.2 km/s.
17. Define stress and strain and derive their units. What is Hook's law? Write its one limitation.
18. An ideal gas is taken through a series of changes represented by $A \rightarrow B$, $B \rightarrow C$ and $C \rightarrow A$ as represented in figure. Find the net work done by the gas in whole process.



19. If the coefficient of performance of a refrigerator is 5 and operates at the room temperature (27°C), find the temperature inside the refrigerator.
20. Calculate the mean free path of nitrogen gas at STP, if diameter of nitrogen molecule is 2 \AA .
21. Show that in an open pipe all harmonics are present.
22. Find the period of oscillation of the system shown in figure.



Section D

23. Ram is a renowned swimming coach. Mohan is fond of diving. During his diving exercise Mohan observed that after jumping from the diving board he could neither exhibit somersaults in mid air nor touch the water surface gently. He tried his best and could not succeed. He approached Ram. Ram carefully listened to him and then advised him to first curl his body by folding his arms and legs towards the centre of his body in mid air so that he may easily take a somersault. Then while entering the water in the swimming pool he should straighten his body by pulling apart his arms as well as legs. In this way he will touch the water surface gently. Mohan followed Ram's advice, practised a lot and became an expert diver. He thanked the diving coach Ram for his expert advice.
 - (a) What according to you are the values displayed by Ram and Mohan?
 - (b) Which principle is involved here? State the principle and explain it briefly.
 - (c) Give yet another application/illustration of the principle.

Section E

24. (a) Discuss the motion of a body in a vertical circle. Find the expressions for the minimum velocity at the lowest and highest points while looping a loop.
- (b) A bullet of mass 0.01 kg travelling at a speed of 500 m/s strikes a block of mass 2 kg which is suspended by a string of length 5 m . The centre of gravity of the block is found to rise a vertical distance of 0.1 m . What is the speed of the bullet after it emerges from the block? ($g = 9.8\text{ m s}^{-2}$)

or

Derive the following equations of motion for uniformly accelerated motion using calculus method (symbols have their usual meaning):

- (a) $v = u + at$
- (b) $s = ut + \frac{1}{2} at^2$
- (c) $v^2 - u^2 = 2as$

25. Define a rigid body. Name two kinds of motion which a rigid body can execute. What is meant by the term equilibrium? For the equilibrium of a body two conditions need to be satisfied. State them.

or

What is geostationary satellite? Derive an expression for its height above the surface of the Earth. Hence, find the actual value of height.

26. What is terminal velocity? Why does a body falling freely in a medium acquire this velocity? Derive expression for it.

or

State Newton's law of cooling. With relevant theory explain experimental verification of Newton's law of cooling.



General Instructions:

- (i) There are a total 26 questions in five sections in the question paper. All questions are compulsory.
- (ii) Section A contains questions number 1 to 5, Very Short Answer type questions for one mark each.
- (iii) Section B contains questions number 6 to 10, Short Answer type 1 questions of two marks each.
- (iv) Section C contains questions number 11 to 22, Short Answer type 2 questions for the three marks each.
- (v) Section D contains question number 23, Value Based Question of four marks.
- (vi) Section E contains questions number 24 to 26, Long Answer type questions of five marks each.
- (vii) There is no overall choice in the question paper, however, an internal choice is provided in one question of two marks, one question of three marks and all three questions of five marks. An examinee is to attempt any one question out of two given in the question paper with the same question number.

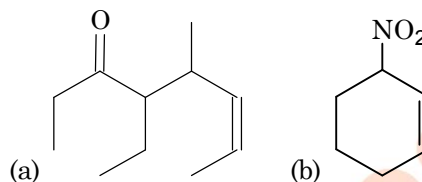
Section A

1. What is the SI unit of molarity?
2. Write the electronic configuration of scandium having atomic number 21.
3. Why are vegetables cooked with difficulty at hill stations?
4. What is the shape of NH_4^+ ?
5. What is the oxidation number of
(a) H in CaH_2
(b) O in H_2O_2 ?

Section B

6. Calculate the energy of one mole of photons of radiation whose frequency is 5×10^{14} Hz.
7. Express the change in internal energy of a system when
 - (a) No heat is absorbed by the system from the surroundings, but work (w) is done on the system. What type of wall does the system have?
 - (b) No work is done on the system, but q amount of heat is taken out from the system and given to the surroundings. What type of wall does the system have?
 - (c) 'w' amount of work is done by the system and q amount of heat is supplied to the system. What type of system would it be?

8. All compounds of alkali metals are easily soluble in water but lithium compounds are more soluble in organic solvents. Explain.
9. CCl_4 is immiscible in water, whereas SiCl_4 is easily hydrolysed. Explain.
10. Name the compounds whose line formulae are given below:



Section C

11. If 4g of NaOH dissolves in 36 g of H_2O , calculate the mole fraction of each component in the solution. Also determine the molarity of solution. (specific gravity of the solution is 1 g mL^{-1})
12. Give the reason for the following:
 - (a) Electron gain enthalpy of fluorine is less negative than that of chlorine.
 - (b) Anionic radius is always more than that of neutral atom.
 - (c) Ionization enthalpy of nitrogen is more than that of oxygen.
13. Which out of NH_3 and NF_3 has higher dipole moment and why?
14. Why is it that in the SF_4 molecule, the lone pair of electrons occupies equatorial position in the overall trigonal bi-pyramidal arrangement in preference to an axial position.
15. (a) Explain the significance of van der Waals parameters.
(b) In terms of Charles's law explain why -273°C is the lowest possible structure.
16. The difference between C_p and C_v can be derived using the empirical relation $H = U + pV$. Calculate the difference between C_p and C_v for 10 moles of an ideal gas.
17. Write the net ionic reaction showing the oxidant of Fe^{2+} ions to Fe^{3+} ions by dichromate ions $[\text{Cr}_2\text{O}_7]^{2-}$ in acidic medium, wherein $\text{Cr}_2\text{O}_7^{2-}$ ions are reduced to Cr^{3+} ions (by half reaction or ion electron method).

18. How would you prepare
- dihydrogen from water by a reducing agent?
 - dihydrogen from a substance other than water in the laboratory in pure form?
 - dihydrogen from hydrocarbons?
19. (a) List two properties showing similarity between lithium and magnesium.
 (b) State as to why a solution of Na_2CO_3 is alkaline in nature.
 (c) Arrange the following: CaH_2 , BeH_2 and TiH_2 in order of increasing electrical conductance.
20. Complete the following chemical equations:
- $\text{Z} + 3\text{LiAlH}_4 \rightarrow \text{X} + 3\text{LiF} + 3\text{AlF}_3$
 - $\text{X} + 6\text{H}_2\text{O} \rightarrow \text{Y} + 6\text{H}_2$
 - $3\text{X} + 3\text{O}_2 \xrightarrow{\Delta} \text{B}_2\text{O}_3 + 3\text{H}_2\text{O}$
21. Write the structure and names of products obtained in the reactions of sodium with a mixture of 1-iodo-2-methyl-2-propane and 2-iodopropane.
22. Complete the following reactions:
- $\text{CH}_3\text{CH}=\text{CHCH}_3 \xrightarrow[298-303\text{ K}]{\text{cold \& dil. KMnO}_4}$
 - $\text{CH}_2=\text{CH}_2 \xrightarrow[298-303\text{ K}]{\text{cold \& dil. KMnO}_4}$

Section D

23. A trainee pilot was flying his plane in stratosphere. His senior advised him not to fly the aeroplane in the stratosphere.
 Answer the following questions:
- In your opinion, why the senior pilot advised his trainee pilot not to fly his plane in the stratosphere?
 - Write the possible chemical reaction affecting the stratosphere.
 - Mention the values associated with your reply.

Section E

24. When electromagnetic radiation of wavelength 300 nm falls on the surface of sodium, electrons are emitted with a kinetic energy of $1.68 \times 10^5 \text{ J mol}^{-1}$. What is the minimum energy needed to remove an electron from sodium? What is the maximum wavelength that will cause a photoelectron to be emitted?

or

- The energy associated with the first orbit in the hydrogen atom is $-2.18 \times 10^{-18} \text{ J atom}^{-1}$. What is the energy associated with the fifth orbit?
 - Calculate the radius of Bohr's fifth orbit for hydrogen atom.
25. Write a relation between ΔG and Q and define the meaning of each term and answer the following:
- Why a reaction proceeds forward when $Q < K$ and no net reaction occurs when $Q = K$?
 - Explain the effect of increase in pressure in terms of reaction quotient Q for the reaction:
 $\text{CO(g)} + 3\text{H}_2\text{(g)} \rightleftharpoons \text{CH}_4\text{(g)} + \text{H}_2\text{O(g)}$

or

- At 298 K calculate the pH of (a) 0.200 M solution of methylamine, CH_3NH_2 (ionisation constant = 4.4×10^{-5}), (b) 0.23 M weak acid HX (ionization constant = 7.3×10^{-6}).
 - At 298 K the pH of a solution of lemon juice is 2.32. What are the $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$ in this solution?
26. An alkyl halide $\text{C}_5\text{H}_{11}\text{Br}$ reacts with ethanolic KOH to give an alkene B, which reacts with Br_2 to give a compound C, which on dehydrobromination gives an alkyne D. On treatment with sodium metal in liquid ammonia one mole of D gives one mole of sodium salt of D and half a mole of hydrogen gas. Complete hydrogenation of D yields a straight chain alkane. Identify A, B, C and D. Give the reactions involved.



General Instructions:

- There are a total 26 questions in five sections in the question paper. All questions are compulsory.
- Section A contains questions number 1 to 5, Very Short Answer type questions for one mark each.
- Section B contains questions number 6 to 10, Short Answer type 1 questions of two marks each.
- Section C contains questions number 11 to 22, Short Answer type 2 questions for the three marks each.
- Section D contains question number 23, Value Based Question of four marks.
- Section E contains questions number 24 to 26, Long Answer type questions of five marks each.
- There is no overall choice in the question paper, however, an internal choice is provided in one question of two marks, one question of three marks and all three questions of five marks. An examinee is to attempt any one question out of two given in the question paper with the same question number.

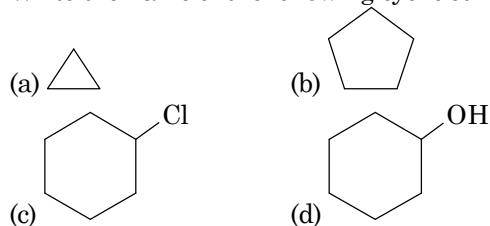
Section A

- How many significant figures are there in 0.00134g?
- Arrange the following elements in the increasing order of metallic character:
B, Al, Mg, K
- Out of NH_3 and N_2 , which will have (a) higher value of 'a' (b) higher value of 'b'?
- According to M.O. theory, explain why Be_2 molecule does not exist.
- Identify the oxidant and reductant in the following reaction:
 $2\text{K}_4[\text{Fe}(\text{CN})_6] (\text{aq}) + \text{H}_2\text{O} (\text{aq})$
 $\rightarrow 2\text{K}_3[\text{Fe}(\text{CN})_6] (\text{aq}) + 2\text{KOH} (\text{aq})$

Section B

- The threshold frequency ν_0 for a metal is $7.0 \times 10^{14} \text{ s}^{-1}$. Calculate the kinetic energy of an electron emitted when radiation of frequency $\nu = 1.0 \times 10^{15} \text{ s}^{-1}$ hits the metal.
- Two litres of an ideal gas at a pressure of 10 atm expands isothermally into a vacuum until its total volume is 10 litres. How much heat is absorbed and how much work is done in the expansion?
- What is the structure of BeCl_2 in gaseous and solid states?
- Explain the following.
(a) CO_2 is a gas whereas SiF_6^{2-} is a solid.
(b) Silicon forms SiF_6^{2-} ion whereas corresponding fluoro compound of carbon is not known.

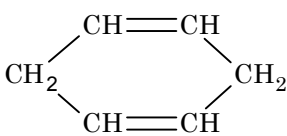
- Write the name of the following cyclic compounds:



Section C

- The reactant which is entirely consumed in reaction is known as limiting reagent. In the reaction $2\text{A} + 4\text{B} \rightarrow 3\text{C} + 4\text{D}$, when 5 moles of A react with 6 moles of B. Then
(a) which is the limiting reagent?
(b) calculate the amount of C formed.
- (a) Write the general outer electronic configuration of f-block elements.
(b) Predict the formula of the binary compound formed between silicon and oxygen.
(c) Why N has higher first ionization enthalpy than O?
- Write the resonance structures of NO_3^- and CO_3^{2-} .
- Calculate the lattice enthalpy of LiF given that the enthalpy of (a) sublimation of lithium is $155.2 \text{ kJ mol}^{-1}$ (b) dissociation of $\frac{1}{2}$ mole of F_2 is 75.3 kJ (c) ionization of lithium is 520 kJ mol^{-1} (d) electron gain of 1 mole of $\text{F}(\text{g})$ is -333 kJ (e) $\Delta_f H^\ominus$ overall is $-594.1 \text{ kJ mol}^{-1}$.
- (a) Why do gases deviate from ideal behaviour?
(b) What would be the SI unit for the quantity Pv^2T^2/n ?
- (a) Calculate the energy needed to raise the temperature of 10.0 g of iron from 25°C to 500°C if specific heat capacity of iron is $0.45 \text{ J } (\text{ }^\circ\text{C})^{-1}\text{g}^{-1}$.
(b) What mass of gold of specific heat capacity $0.13 \text{ J } (\text{ }^\circ\text{C})^{-1} \text{ g}^{-1}$ can be heated through the same temperature difference when supplied with the same amount of energy as in (a)?
- Identify the redox reactions out of the following reactions and identify the oxidising and reducing agents in them.
(a) $3\text{HCl}(\text{aq}) + \text{HNO}_3(\text{aq})$
 $\rightarrow \text{Cl}_2(\text{g}) + \text{NOCl}(\text{g}) + 2\text{H}_2\text{O}(\text{l})$
(b) $\text{HgCl}_2(\text{aq}) + 2\text{KI}(\text{aq}) \rightarrow \text{HgI}_2(\text{s}) + 2\text{KCl}(\text{aq})$
(c) $\text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}(\text{g}) \xrightarrow{\Delta} 2\text{Fe}(\text{s}) + 3\text{CO}_2(\text{g})$
(d) $\text{PCl}_3(\text{l}) + 3\text{H}_2\text{O}(\text{l}) \rightarrow 3\text{HCl}(\text{aq}) + \text{H}_3\text{PO}_3(\text{aq})$
(e) $4\text{NH}_3 + 3\text{O}_2(\text{g}) \rightarrow 2\text{N}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g})$
- Explain the correct context in which the following terms are used:
(a) diprotium (b) dihydrogen
(c) proton and (d) hydron

19. What happens when
 (a) sodium metal is dropped in water?
 (b) sodium metal is heated in free supply of air?
 (c) sodium peroxide dissolves in water?
20. BCl_3 exists as a monomer whereas AlCl_3 is dimerised through halogen bridging. Give reason. Explain the structure of the dimer of AlCl_3 also.
21. An alkane C_8H_{18} is obtained as the only product on subjecting a primary alkyl halide to Wurtz reaction. On mono bromination this alkane yields a single isomer of a tertiary bromide. Write the structure of alkane and the tertiary bromide.
22. Write the product obtained when the following compounds are ozonised:

(a)	$\text{CH}_3\text{CH}=\text{CHCH}_3$
(b)	

Section D

23. A factory was started near a village. Suddenly villagers started feeling the presence of irritating vapours in the village and cases of headache, chest pain, cough, dryness of throat and breathing problems increased. Anil a science student blamed the emissions from the chimney of the factory for such problems. After reading the above paragraph, answer the following questions:
 (a) Explain what could have happened?
 (b) Give chemical reactions for the support of your explanation.
 (c) Mention the values shown by the students in the above paragraph.

Section E

24. According to Bohr's theory, the electronic energy of hydrogen atom in the n th Bohr's orbit is given by

$$E_n = \frac{-2.18 \times 10^{-18} \text{ J}}{n^2}$$

Calculate the longest wavelength of light that will be needed to remove an electron from third Bohr's orbit of He^+ ion.

or

How much energy is required to ionise a H atom if the electron occupies $n = 5$ orbit? Compare your answer with the ionization enthalpy of H atom (energy required to remove the electron from $n = 1$ orbit).

25. The solubility product constant of Ag_2CrO_4 and AgBr are 1.1×10^{-12} and 5.0×10^{-13} respectively. Calculate the ratio of the molarities of their saturated solutions.

or

The solubility of $\text{Sr}(\text{OH})_2$ at 298 K is 19.23 g/L of solution. Calculate the concentrations of strontium and hydroxyl ions and the pH of the solution.

26. An unsaturated hydrocarbon A adds two molecules of H_2 and reductive ozonolysis gives butane-1,4-dial, ethanal and propanone. Give the structure of A, write the IUPAC name and explain the reaction involved.



General Instructions:

- (i) There are a total 26 questions in five sections in the question paper. All questions are compulsory.
- (ii) Section A contains questions number 1 to 5, Very Short Answer type questions for one mark each.
- (iii) Section B contains questions number 6 to 10, Short Answer type 1 questions of two marks each.
- (iv) Section C contains questions number 11 to 22, Short Answer type 2 questions for the three marks each.
- (v) Section D contains question number 23, Value Based Question of four marks.
- (vi) Section E contains questions number 24 to 26, Long Answer type questions of five marks each.
- (vii) There is no overall choice in the question paper, however, an internal choice is provided in one question of two marks, one question of three marks and all three questions of five marks. An examinee is to attempt any one question out of two given in the question paper with the same question number.

Section A

1. State the number of significant figures in each of the following number:
(a) 2.653×10^4
(b) 0.00368
2. Predict the position of the elements in the periodic table satisfying the electron configuration $(n-1)d^1 ns^2$ for $n = 4$
3. What is the SI unit of surface tension?
4. What type of bonding is likely in binary compound, when both the elements are:
(a) non-metal
(b) ion forming with opposite electric charges?
5. Identify the oxidant and reductant in the following reactions:
(a) $Zn(s) + \frac{1}{2} O_2(g) \rightarrow ZnO(s)$
(b) $Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$

Section B

6. What is the wavelength of light emitted when the electron in a hydrogen atom undergoes transition from an energy level with $n = 4$ to an energy level with $n = 2$?
7. In a process, 701 J of heat is absorbed by a system and 394 J of work is done by the system. What is the change in internal energy for the process?

8. Account for the following:
(a) Potassium carbonate cannot be prepared by Solvay process.
(b) CO_2 turns the lime water milky. On passing CO_2 in excess, the milkiness disappears.
9. Complete the following equations:
(a) $Al + NaOH + H_2O \xrightarrow{\Delta}$
(b) $H_3BO_3 \xrightarrow{\Delta} A \xrightarrow{\Delta} B$
10. Draw the two geometrical isomers of but-2-en-1,4-dioic acid.

Section C

11. Zinc and hydrochloric acid react according to the reaction:
 $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
If 0.30 mol of Zn are added to hydrochloric acid containing 0.52 mol of HCl, how many moles of H_2 are produced?
12. (a) Arrange the following ions in the order of increasing ionic radii: Na^+ , Mg^{2+} , F^- , O^{2-}
(b) Explain why Be has higher ionization enthalpy than B.
(c) Predict the formula of the compound which might be formed by silicon and bromine.
13. Compare the relative stability of the following species on the basis of M.O. theory and indicate their magnetic properties:
14. Discuss how the valence bond theory explains the shapes of BF_3 and $AlCl_3$ molecules.
15. A neon-dioxygen mixture contains 70.6g dioxygen and 167.5 g neon. If pressure of the mixture of gases in the cylinder is 25 bar, what is the partial pressure of dioxygen and neon in the mixture?
16. For the reaction $2A(g) + B(g) \rightarrow 2D(g)$
 $\Delta U^\circ = -10.5 \text{ kJ}$ and $\Delta S^\circ = -44 \text{ J K}^{-1}$ Calculate ΔG° for the reaction and predict whether the reaction may occur spontaneously. (Given $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$, $T = 298 \text{ K}$)
17. The compound AgF_2 is an unstable compound. However, if formed, the compound acts as a very strong oxidising agent. Why?
18. Distinguish clearly between:
(a) hard and soft water
(b) temporary hardness and permanent hardness

19. Explain what happens when
 (a) sodium hydrogen carbonate is heated?
 (b) sodium amalgam reacts with water?
 (c) fused sodium metal reacts with ammonia?
20. Given reasons:
 (a) Why CO is a poisonous gas?
 (b) Lead (IV) chloride is highly unstable towards heat.
 (c) Boric acid is not protic acid.
21. Write the addition reaction of HBr to symmetrical alkenes.
22. Why do conjugation dienes undergo 1, 4-additions? Explain.

Section D

23. Ramesh, a science student and his friends decide to start a campaign to motivate people to reduce global warming by minimising the use of automobiles, motivating them to use bicycle, public transport or go for carpool, which is also economical and should plant trees to increase the green cover, avoid burning of dry leaves, wood etc., and also motivated for the plantation.
 Answer the following questions:
 (a) Name the two greenhouse gases.
 (b) What is global greenhouse gases?
 (c) What values are associated with Ramesh's campaign?

Section E

24. The ionization energy of He^+ is $19.6 \times 10^{-18} \text{ J atom}^{-1}$. Calculate the energy of the first stationary state of Li^{2+} .

or

A photon of wavelength $4 \times 10^{-7} \text{ m}$ strikes on metal surface, the work function of the metal being 2.13 eV. Calculate (i) the energy of the photon (eV), (ii) the kinetic energy of the emission and (iii) the velocity of the photoelectric ($1 \text{ eV} = 1.6020 \times 10^{-19} \text{ J}$)

25. What is the pH of 0.001 M aniline solution? The ionisation constant of aniline is 4.27×10^{-10} . Calculate the degree of ionization of aniline in the solution. Also calculate the ionization constant of the conjugate acid aniline.

or

The concentration of sulphide ions in 0.1 M HCl solution saturated with hydrogen sulphide is $1.0 \times 10^{-19} \text{ M}$. If 10 mL of this is added to 5 mL of 0.04 M solution of the following: FeSO_4 , MnCl_2 , ZnCl_2 , CdCl_2 , in which of these solutions precipitation will take place?
 Given: K_{sp} , $\text{FeS} = 6.3 \times 10^{-8}$; K_{sp} , $\text{MnS} = 2.5 \times 10^{-13}$; K_{sp} , $\text{ZnS} = 1.6 \times 10^{-24}$; K_{sp} , $\text{CdS} = 8.0 \times 10^{-27}$.

26. In the presence of peroxide, addition of HBr to propene takes according to anti-Markovnikov's rule but peroxide effect is not seen in the case of HCl and HI. Explain.



General Instructions:

- There are a total 26 questions in five sections in the question paper. All questions are compulsory.
- Section A contains questions number 1 to 5, Very Short Answer type questions for one mark each.
- Section B contains questions number 6 to 10, Short Answer type 1 questions of two marks each.
- Section C contains questions number 11 to 22, Short Answer type 2 questions for the three marks each.
- Section D contains question number 23, Value Based Question of four marks.
- Section E contains questions number 24 to 26, Long Answer type questions of five marks each.
- There is no overall choice in the question paper, however, an internal choice is provided in one question of two marks, one question of three marks and all three questions of five marks. An examinee is to attempt any one question out of two given in the question paper with the same question number.

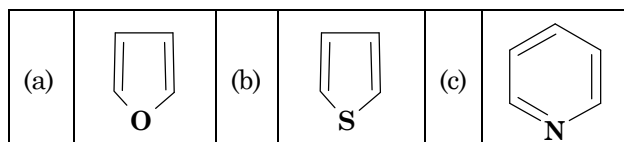
Section A

- Define the term Avogadro's number.
- Write the atomic number of the element present in the third period and seventeenth group of the periodic table.
- What are the conditions under which gases deviate from ideality?
- Write the correct decreasing order between lone pair-lone pair, lone pair-bond pair, bond pair-bond pair repulsion.
- Explain which one is oxidised and which one is reduced in the given equation?
 $3\text{MnO}_2 + 4\text{Al} \rightarrow 3\text{Mn} + 2\text{Al}_2\text{O}_3$

Section B

- Calculate the mass of the photon with wavelength 3.6\AA . ($h = 6.626 \times 10^{-34} \text{ J s}$)
- The equilibrium constant for a reaction is 10. What will be the value of ΔG^\ominus ? $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$, $T = 300 \text{ K}$.
- Why do beryllium and magnesium not impart colour to the flame in the flame test?
- What happens when
 - borax is heated strongly?
 - aluminium is treated with dilute NaOH?

- Write the IUPAC name of



Section C

- N_2 and H_2 react with each other to produce NH_3 according to the following chemical equation:
 $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$
 - Calculate the mass of ammonia produced if $2.0 \times 10^3 \text{ g}$ of N_2 reacts with $1.0 \times 10^3 \text{ g}$ of H_2
 - Will any of the two reactants remain unreacted?
 - If yes, which one and what will be its mass?
- How the shielding effects explain the ionisation enthalpy in a group in moving from top to bottom?
- Write formal charges of atoms in carbonate ion.
- What is the total number of sigma bonds and pi-bonds in the following molecules:
- Calculate the total pressure of a mixture of 8 g O_2 and 4 g H_2 confined in a vessel of volume 1 dm^3 at 27°C ($R = 0.083 \text{ bar dm}^3 \text{ K}^{-1} \text{ mol}^{-1}$)
- Calculate the value of $\Delta_f H^\ominus$ for the reaction
 $2\text{H}_2\text{S}(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + 2\text{SO}_2$
Given:
 $\text{H}_2(\text{g}) + \text{S}(\text{s}) \rightarrow \text{H}_2\text{S}(\text{g}), \Delta_f H^\ominus \text{H}_2\text{S} = 20.1 \text{ kJ mol}^{-1}$
 $\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l}),$
 $\Delta_f H^\ominus \text{H}_2\text{O} = -285.8 \text{ kJ mol}^{-1}$
 $\text{S}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{SO}_2(\text{g}),$
 $\Delta_f H^\ominus \text{SO}_2 = -296.9 \text{ kJ mol}^{-1}$
- The Mn^{3+} ion is unstable in solution and undergoes disproportionate to give Mn^{2+} , MnO_2 and H^+ ion. Write a balanced ionic equation for the reaction.
- Distinguish clearly between salt-like and covalent hydrides.
- State as to why
 - lithium on being heated in air mainly forms the monoxide and not the peroxide?
 - an aqueous solution of sodium carbonate gives alkaline tests?
 - sodium is prepared by electrolytic method and not by chemical method?

20. Write the equations for (a) laboratory method and (b) industrial method for the preparation of diborane.
21. Write the different products formed when propene reacts with diborane.
22. How would you convert the following compounds to benzene?
(a) Benzoic acid
(b) Benzene diazonium chloride

Section D

23. Rohit and Mohit were returning home after attending the coaching class. There was a traffic jam on the road. Their car A.C. was not working. So they had to lower the door glasses to let fresh air in. Forget the fresh air, there was not even pure air. Both the friends started coughing heavily. They also felt dizziness. This showed that the air that was entering their car was polluted.
(a) Which factors were responsible for causing atmospheric pollution?
(b) What remedial measures can be taken to check atmospheric pollution?

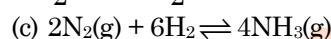
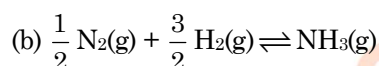
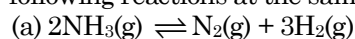
Section E

24. Calculate the wavelength and energy of radiation emitted for the electronic transition from infinity to stationary state of the hydrogen atom.

or

Electrons are emitted with zero velocity from a metal surface when it is exposed to radiation of wavelength 6800\AA . Calculate threshold frequency (ν_0) and work function (W_0) of the metal.

25. For the reaction $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$
At 400 K, $K_p = 41$. Find the value of K_p for each following reactions at the same temperature:



or

The solubility product constant of Ag_2Cr_4 and AgBr are 1.1×10^{-12} and 5.0×10^{-13} respectively. Calculate the ratio of the molarities of their saturated solution.

26. How will you convert benzene into
(a) p-nitrobromobenzene
(b) m-nitrochlorobenzene
(c) p-nitrotoluene
(d) acetophenone?



General Instructions

- All questions are compulsory.
- This question paper contains **29** questions divided into four sections A,B,C and D. **Section A** comprises of **4** questions of **One** mark each. **Section B** comprises of **8** questions of **Two** marks each. **Section C** comprises of **11** questions of **Four** marks each and **Section D** comprises of **6** questions of **Six** marks each.
- All questions in **Section A** are to be answered in one word, one sentence or as per the exact requirement of the question.
- There is no overall choice. However internal choice has been provided in 3 questions of four marks each and 3 questions of six marks each. You have to attempt only one of the alternatives in all such questions.
- Use of calculator is not permitted. You may ask for logarithm tables, if required.

Section A

- The minute hand of a watch is 1.5cm long. How far does its tip move in 40 minutes?
- Evaluate $\left(i^{18} + \frac{1}{i^{25}}\right)^3$.
- Find the co-ordinates of the point which divides the line segment joining the points (1, -2, 3) and (3, 4, -5) in the ratio 2:3 internally.
- Please mind your business. Is this sentence a statement?

Section B

- Find derivative of $\frac{\cos x}{1 + \sin x}$.
- Let $U = \{1, 2, 3, 4, 5, 6\}$, $A = \{2, 3\}$ and $B = \{3, 4, 5\}$. Verify $(A \cup B)' = A' \cap B'$.
- Show that $A \cup B = A \cap B \Rightarrow A = B$.
- Write the relation $R = \{(x, x^3) : x \text{ is a prime number less than } 10\}$ in roster form. Also find the domain and range of the relation.
- Find the 13th term of the expansion of $\left(9x - \frac{1}{3\sqrt{x}}\right)^{18}$, $x \neq 0$.
- In class XI of a school 40% of the students study Mathematics and 30% study Biology. 10% of the class study both Mathematics and Biology. If a student is selected at random from the class, find the probability that he will be studying Mathematics or Biology.

- Determine the truth value of the statement : If Mumbai is in Kerala then Delhi is in Punjab.
- If the origin is the centroid of the triangle PQR with vertices P(2a, 2, 6), Q(-4, 3b, -10) and R(8, 14, 2c) then find the values of a, b and c.

Section C

- In a survey of 60 people, it was found that 25 people read newspaper H, 26 read newspaper T, 26 read newspaper I, 9 read both H and I, 11 read both H and T, 8 read both T and I, 3 read all three newspapers. Find
 - the number of people who read atleast one of the newspaper.
 - the number of people who read exactly one newspaper
- Find n if the ratio of the 5th term from beginning to the 5th term from the end in the expansion of $(2^{1/4} + 3^{-1/4})^n$ is $6^{1/2} : 1$
- Prove that $\frac{\sec 8x - 1}{\sec 4x - 1} = \frac{\tan 8x}{\tan 2x}$.
or
Prove that $\sin 10^\circ \cdot \sin 50^\circ \cdot \sin 60^\circ \cdot \sin 70^\circ = \frac{\sqrt{3}}{16}$.
- Find the number of words with or without meaning which can be made using all the letters of the word AGAIN; If these words are written as in a dictionary, what will be the 50th word?
or
If 4-digit numbers greater than 5000 are randomly formed from the digits 0, 1, 3, 5 and 7, what is the probability of forming a number divisible by 5 when
 - the digits are repeated
 - the repetition is not allowed.
- Find the general solution of the trigonometric equation $\sin x + \sin 2x + \sin 3x = 0$.
- Convert the complex number $z = \frac{i - 1}{\cos 60^\circ + i \sin 60^\circ}$ in polar form.
- The sum of 1st three terms of a G.P is 13/12 and their product is -1. Find the common ratio and the terms.
- Find the equation of circle passing through the points (2, 3) and (-1, 1) and whose centre lies on the line $4x + y = 16$.

21. (a) Using 1st principle of derivative, find derivative

$$\text{of } f(x) = \frac{x-1}{x+1}.$$

(b) Evaluate $\lim_{x \rightarrow \frac{\pi}{4}} \frac{\sqrt{2} \cos x - 1}{\cot x - 1}$.

22. Let $f(x) = (x-1)/(x+1)$, then show that

(a) $f(1/x) = -f(x)$

(b) $f(-1/x) = -1/f(x)$.

or

(a) Find the domain of $f(x) = \sqrt{9-x^2}$.

(b) Find range of $f(x) = \frac{x-1}{x-2}, x \neq 2$.

23. If the letter of the word 'ATTRACTION' are written at random, find the probability that

(a) all the T's occur together

(b) no two T's occur together.

Section D

24. In triangle ABC, prove that

$$\frac{b^2 - c^2}{\cos B + \cos C} + \frac{c^2 - a^2}{\cos C + \cos A} + \frac{a^2 - b^2}{\cos A + \cos B} = 0.$$

25. Solve the system of inequalities graphically :

$$x + 2y \leq 10, x + y \geq 1, x - y \leq 0, x \geq 0, y \geq 0.$$

26. Using mathematical induction prove that $2 \cdot 7^n + 3 \cdot 5^n - 5$ is divisible by 24 for all $n \in \mathbb{N}$.

or

Using mathematical induction prove that $1 \cdot 3 + 3 \cdot 5 + 5 \cdot 7 + \dots + (2n-1)(2n+1)$

$$= \frac{n(4n^2 + 6n - 1)}{3}.$$

27. Prove that the product of the lengths of perpendicular drawn from the points $(\sqrt{a^2 - b^2}, 0)$ and $(-\sqrt{a^2 - b^2}, 0)$ to the line

$$\frac{x}{a} \cos \theta + \frac{y}{b} \sin \theta = 1 \text{ is } b^2.$$

or

A line is such that its segment between the lines $5x - y + 4 = 0$ and $3x + 4y - 4 = 0$ is bisected at the point $(1, 5)$. Obtain its equation.

28. If a and b are the roots of $x^2 - 3x + p = 0$ and c, d are the roots of $x^2 - 12x + q = 0$ where a, b, c and d form a G.P. Prove that $(q+p):(q-p) = 17 : 15$.

29. The mean and standard deviation of 100 observations were calculated as 40 and 5.1 respectively by a student who took by mistake 50 instead of 40 for one observation. What are the correct mean and standard deviation.

or

Calculate mean, Variance and Standard Deviation for the following distribution.

Classes	Frequency
30 - 40	3
40 - 50	7
50 - 60	12
60 - 70	15
70 - 80	8
80 - 90	3
90 - 100	2



General Instructions

- All questions are compulsory.
- This question paper contains **29** questions divided into four sections A,B,C and D. **Section A** comprises of 4 questions of **One** mark each. **Section B** comprises of **8** questions of **Two** marks each. **Section C** comprises of **11** questions of **Four** marks each and **Section D** comprises of **6** questions of **Six** marks each.
- All questions in **Section A** are to be answered in one word, one sentence or as per the exact requirement of the question.
- There is no overall choice. However internal choice has been provided in 3 questions of four marks each and 3 questions of six marks each. You have to attempt only one of the alternatives in all such questions.
- Use of calculator is not permitted. You may ask for logarithm tables, if required.

Section A

- Write the contrapositive of the following statement:
If a number n is even, then n^2 is even.
- Find the modulus of $\frac{1+i}{1-i}$.
- Find the value of $\tan(19\pi/3)$.
- What is the eccentricity of the curve $4x^2 + y^2 = 100$.

Section B

- Out of 500 car owners investigated, 400 owned car A and 200 owned car B, 50 owned both A and B cars. Is this data correct?
- Let $f = \{(1, 1), (2, 3), (0, -1), (-1, -3)\}$ be a function from Z to Z defined by $f(x) = ax + b$, for some integers a and b . Determine a , b .
- Find the value of $\tan \frac{\pi}{8}$.
- The longest side of a triangle is 3 times the shortest side and the third side is 2 cm shorter than the longest side. If the perimeter of the triangle is at least 61cm, find the minimum length of the shortest side.
- Find the ratio in which the line joining the points $(4, 8, 10)$ and $(6, 10, -8)$ is divided by the YZ -plane.
- Evaluate $\lim_{x \rightarrow \frac{\pi}{2}} \frac{\tan 2x}{x - \frac{\pi}{2}}$.

- If p and q are two statements given by :
 p : 25 is multiple of 5.
 q : 25 is multiple of 8.
Write the compound statement connecting these two statements with “And” and “Or”. In both cases check the validity of compound statement.
- Three letters are dictated to three persons and an envelope is addressed to each of them. The letters are inserted into the envelopes at random so that each envelope contains exactly one letter. Find the probability that at least one letter is in its proper envelope.

Section C

- How many litres of water will have to be added to 1125 litres of the 45% solution of acid so that the resulting mixture will contain more than 25% but less than 30% of acid content?
 - A college awarded 38 medals in football, 15 in basketball and 20 in cricket. If these medals went to a total of 58 men and only 3 men got medals in all the three sports, how many received medals in exactly two of the three sports.
 - (a) Let $f(x) = x^2$ and $g(x) = 2x + 1$ be two real functions. Find $f + g(x)$, $f - g(x)$, $(f \cdot g)(x)$ and $(f/g)(x)$.
(b) Given relation R on Z as $R = \{(a, b) \in Z \times Z; a^2 + b^2 \leq 4\}$. Write domain & range of relation R .
 - Find the value of $\sin 18^\circ$.
- or**
- Solve the equation $4 \sin x \sin 2x \sin 4x = \sin 3x$.
- Find the value of $\sin \frac{x}{2}$, $\cos \frac{x}{2}$ and $\tan \frac{x}{2}$, when $\tan x = \frac{-4}{3}$, x lies in second quadrant.
 - If α and β are different complex numbers with $|\beta| = 1$, then find $\left| \frac{\beta - \alpha}{1 - \overline{\alpha}\beta} \right|$.
 - How many words with or without meaning each of 3 vowels and 2 consonants can be formed from the letters of the word INVOLUTE.
 - If p, q, r are in G.P and the equations $px^2 + 2qx + r = 0$ and $dx^2 + 2ex + f = 0$ have a common root then show that $(d/p), (e/q), (f/r)$ are in A.P.
 - Find the equation of circle with centre $(2, 2)$ and passes through the point $(4, 5)$.
- or**
- An arch is in the form of a semi-ellipse. It is 8m wide and 2m high at the centre. Find the height of the arch at a point 1.5m from one end.

22. Using first principle, find the derivative of
 (a) $f(x) = (2x + 3)/(x - 2)$.
 (b) $f(x) = \sin \sqrt{x}$

or

Evaluate $\lim_{x \rightarrow 0} \frac{1 - \cos x \cos 2x \cos 3x}{\sin^2 2x}$.

23. Two students Anil and Ashima appeared in an examination. The probability that Anil will qualify the examination is 0.05 and that of Ashima will qualify the examination is 0.10. The probability that both will qualify the examination is 0.02. Find the probability that
 (a) both Anil and Ashima will not qualify the examination.
 (b) at least one of them will not qualify the examination.
 (c) only one of them will qualify the examination.

Section D

24. In a triangle ABC prove that :

$$\frac{b^2 - c^2}{a^2} \sin 2A + \frac{c^2 - a^2}{b^2} \sin 2B + \frac{a^2 - b^2}{c^2} \sin 2C = 0.$$

or

The angle of elevation of the top point P of the vertical tower PQ of height h from a point A is 45° and from a point B, the angle of elevation is 60° , where B is a point at a distance 'd' from the point A measured along the line AB which makes an angle 30° with AQ. Prove that $d = (\sqrt{3} - 1)h$.

25. If the coefficients of a^{r-1} , a^r , and a^{r+1} in the expansion of $(1 + a)^n$ are in A.P, prove that $n^2 - n(4r + 1) + 4r^2 - 2 = 0$

26. Using principle of mathematical induction, prove that

$$\frac{1}{1.2.3} + \frac{1}{2.3.4} + \dots + \frac{1}{n(n+1)(n+2)} = \frac{n(n+3)}{4(n+1)(n+2)}$$

or

Using principle of mathematical induction, prove that $10^{2n-1} + 1$ is divisible by 11.

27. Find the sum of the series up to n terms :

$$\frac{1^3}{1} + \frac{1^3 + 2^3}{1+3} + \frac{1^3 + 2^3 + 3^3}{1+3+5} \dots \dots \dots$$

28. If p and q are the length of perpendiculars from the origin to the lines $x \cos \theta - y \sin \theta = k \cos 2\theta$ and $x \sec \theta + y \operatorname{cosec} \theta = k$, respectively, prove that $p^2 + 4q^2 = k^2$.

29. The mean and variance of 8 observations are 9 and 9.25, respectively. If size of the observations is 6, 7, 10, 12, 12 and 13, find the remaining two observations.

or

Calculate the mean, variance and standard deviation for the following distribution.

Class	Frequency
30 - 40	3
40 - 50	7
50 - 60	12
60 - 70	15
70 - 80	8
80 - 90	3
90 - 100	2



General Instructions

- All questions are compulsory.
- This question paper contains 29 questions divided into four sections A,B,C and D. **Section A** comprises of 4 questions of **One** mark each. **Section B** comprises of 8 questions of **Two** marks each. **Section C** comprises of 11 questions of **Four** marks each and **Section D** comprises of 6 questions of **Six** marks each.
- All questions in **Section A** are to be answered in one word, one sentence or as per the exact requirement of the question.
- There is no overall choice. However internal choice has been provided in 3 questions of four marks each and 3 questions of six marks each. You have to attempt only one of the alternatives in all such questions.
- Use of calculator is not permitted. You may ask for logarithm tables, if required.

Section A

- If the lines $2x + y - 3 = 0$, $5x + ky - 3 = 0$ and $3x - y - 2 = 0$ are concurrent, find the value of k.
- Solve $\tan 2x = -\cot\left(x + \frac{\pi}{3}\right)$.
- Evaluate $\sum_{k=1}^{11} (2 + 3^k)$.
- Write the negation of the statement: "There exists a number which is equal to its square."

Section B

- A market research group conducted a survey of 1000 consumers and reported that 720 consumers like product A and 450 liked product B. What is the least number that must have liked both products.
- Let A,B,C be the sets such that $A \cup B = A \cup C$ and $A \cap B = A \cap C$. Show that $B = C$.
- Find the domain of $f(x) = \frac{x^2 + 3x + 5}{x^2 - 5x + 4}$.
- Using binomial theorem prove that $6^n - 5n$ always leaves remainder 1 when divided by 25.
- Find the co-ordinates of the point on y-axis which are at a distance of $5\sqrt{2}$ from the point $P(3, -2, 5)$.
- Evaluate $\lim_{x \rightarrow 0} \frac{\tan x - \sin x}{\sin^3 x}$.
- Show that the following statement is true by the method of contrapositive.
p: if x is an integer and x^2 is even, then x is also even.

- Three squares of Chess board are selected at random. Find the probability of getting 2 squares of one colour and other of a different colour.

Section C

- An equilateral triangle is inscribed in the parabola $y^2 = 4ax$, where one vertex is at the vertex of parabola. Find the length of the side of the triangle.
- In how many ways can the letters of the word "PERMUTATIONS" be arranged if
(a) Vowels are all together.
(b) there are always 4 letters between P and S.

- Find real θ such that $\frac{3 + 2i \sin \theta}{1 - 2i \sin \theta}$ is purely real.

or

If $(x + iy)^3 = u + iv$, then show that

$$\frac{u}{x} + \frac{v}{y} = 4(x^2 - y^2).$$

- (a) Suppose $f(x) = \begin{cases} a + bx, & x < 1 \\ 4, & x = 1 \\ b - ax, & x > 1 \end{cases}$ and if

$\lim_{x \rightarrow 1} f(x) = f(1)$. What are the possible values of a and b.

- (b) Find the derivative of $\frac{px^2 + qx + r}{ax + b}$ where a,b,p,q and r are constants.

or

- (a) Find the derivative of $\frac{a + b \sin x}{c + d \cos x}$ where a,b,c and d are constants.
- (b) Evaluate the following :

$$\lim_{x \rightarrow 0} \frac{8}{x^8} \left(1 - \cos \frac{x^2}{2} - \cos \frac{x^2}{4} + \cos \frac{x^2}{2} \cos \frac{x^2}{4} \right)$$

- Find the coefficient of x^5 in the product of $(1 + 2x)^6 (1 - x)^7$ using binomial theorem.
- In a survey It was found that 21 people liked product A, 26 liked product B and 29 liked product C. If 14 people liked products A and B, 12 people liked products C and A, 14 people liked products B and C and 8 people liked all the three products. Find
(a) how many liked product C only.
(b) how many liked at least two products only.
- (a) If $f(x) = x^2$, find $\frac{f(1.1) - f(1)}{1.1 - 1}$.
- (b) $f: \mathbb{R} \rightarrow \mathbb{R}$, defined by $f(x) = \frac{x^2}{1 + x^2}$. Find range of function.

20. Prove that $\tan 4x = \frac{4 \tan x(1 - \tan^2 x)}{1 - 6 \tan^2 x + \tan^4 x}$.

21. A committee of 7 has to be formed from 9 boys and 4 girls. In how many ways can this be done when the committee consists of:

- (a) exactly 3 girls.
(b) atleast 3 girls.

22. In triangle ABC, prove that

$$\frac{b^2 - c^2}{\cos B + \cos C} + \frac{c^2 - a^2}{\cos C + \cos A} + \frac{a^2 - b^2}{\cos A + \cos B} = 0.$$

or

A tree stands vertically on a hill side which makes an angle of 15° with the horizontal. From a point on the ground 35m down the hill from the base of the tree, the angle of elevation of the top of the tree is 60° . Find the height of the tree.

23. A fair coin is tossed 4 times, and a person win Rs 1 for each head and lose Rs1.50 for each tail that turns up. From the sample space, calculate how many different amounts of money he can have after four tosses and the probability of having each of these amounts.

Section D

24. Using mathematical induction prove that

$$\frac{1}{1.2} + \frac{1}{2.3} + \dots + \frac{1}{n(n+1)} = \frac{n}{n+1} \text{ for all } n \geq 1.$$

25. Solve the system of linear inequations graphically:

$$x + y \geq 1, 7x + 9y \leq 63, x \leq 6, y \leq 5, x \geq 0, y \geq 0.$$

26. If ' α ' and ' β ' are the solutions of the equation $a \cos x + b \sin x = c$, then show that

$$\cos(\alpha + \beta) = \frac{a^2 - b^2}{a^2 + b^2}.$$

or

$$\text{If } a \sin x = b \sin\left(x + \frac{2\pi}{3}\right) = c \sin\left(x + \frac{4\pi}{3}\right), \text{ prove}$$

$$\text{that } ab + bc + ca = 0.$$

27. The sum of two numbers is 6 times their geometric mean, show that numbers are in the ratio $(3 + 2\sqrt{2}) : (3 - 2\sqrt{2})$.

or

The sum of three numbers in G.P is 56. If we subtract 1,7,21 from the numbers in that order, we obtain an A.P. Find the numbers.

28. (a) The perpendicular from the origin to the line $y = mx + c$ meets it at the point $(-1, 2)$. Find the value of m and c .

(b) If p is the length of perpendicular from the origin to the line whose intercepts on the axes

$$\text{are 'a' and 'b', then show that } \frac{1}{p^2} = \frac{1}{a^2} + \frac{1}{b^2}.$$

29. The mean and standard deviation of 100 observations were calculated as 40 and 5.1 respectively by a student who took by mistake 50 instead of 40 for one observation. What are the correct mean and standard deviation.

or

Calculate the Standard deviation for the following data:

C.I	F
0 - 10	5
10 - 20	8
20 - 30	7
30 - 40	12
40 - 50	28
50 - 60	20
60 - 70	10
70 - 80	10



General Instructions

- All questions are compulsory.
- This question paper contains 29 questions divided into four sections A,B,C and D. **Section A** comprises of 4 questions of **One** mark each. **Section B** comprises of 8 questions of **Two** marks each. **Section C** comprises of 11 questions of **Four** marks each and **Section D** comprises of 6 questions of **Six** marks each.
- All questions in **Section A** are to be answered in one word, one sentence or as per the exact requirement of the question.
- There is no overall choice. However internal choice has been provided in 3 questions of four marks each and 3 questions of six marks each. You have to attempt only one of the alternatives in all such questions.
- Use of calculator is not permitted. You may ask for logarithm tables, if required.

Section A

- In a circle of diameter 40cm the length of a chord is 20cm. Find the length of minor arc corresponding to the chord.
- Find the non-zero integral solutions of $|1-i|^x = 2^x$.
- Find the equation of ellipse whose vertices $(\pm 5, 0)$ and Foci $(\pm 4, 0)$.
- Write the negation of the statement: $\sqrt{7}$ is rational.

Section B

- Suppose A_1, A_2, \dots, A_{30} are thirty sets each with five elements and B_1, B_2, \dots, B_n are n sets each with elements. Let $\bigcup_{i=1}^{30} A_i = \bigcup_{j=1}^n B_j = S$. Assume that each element of S belongs to exactly 10 of A_i 's and exactly 9 of B_j 's. Find n .
- Find the domain of $f(x) = \frac{1}{\sqrt{x-|x|}}$.
- Prove that $\tan 3x \tan 2x \tan x = \tan 3x - \tan 2x - \tan x$.
- A man wants to cut three lengths from a single piece of board of length 91cm. The second length is to be 3cm longer than the shortest and third length is to be twice as long as the shortest. What are the possible lengths for the shortest board if third piece is to be at least 5cm longer than the second?
- Using section formula, prove that the three points $A(-2, 3, 5)$, $B(1, 2, 3)$ and $C(7, 0, -1)$ are collinear.
- Evaluate $\lim_{x \rightarrow a} \frac{\sqrt{a+2x} - \sqrt{3x}}{\sqrt{3a+x} - 2\sqrt{x}}$.

- Check whether the following statement is true or false by proving its contrapositive.
“If x, y are integers such that xy is odd, then both x and y are odd integers”.
- In a lottery, a person chooses six different natural numbers match with the six numbers already fixed by the lottery committee, he wins the prize. What is the probability of winning the prize in the game?

Section C

- A survey shows 63% of the Indians like cheese where as 76% like apples. If $x\%$ of the Indians like both cheese and apples, find the value of x .
- Let R be a relation from Q to Q defined by $R = \{(a,b): a, b \in Q \text{ and } a - b \in Z\}$. Show that
(a) $(a,a) \in R$ for all $a \in Q$
(b) $(a,b) \in R$ implies that $(b,a) \in R$
(c) $(a,b) \in R$ and $(b,c) \in R$ implies that $(a,c) \in R$.
- Prove that $\cos \alpha + \cos \beta + \cos \gamma + \cos(\alpha + \beta + \gamma) = 4 \cos\left(\frac{\alpha + \beta}{2}\right) \cos\left(\frac{\beta + \gamma}{2}\right) \cos\left(\frac{\gamma + \alpha}{2}\right)$.
or
Prove that $\frac{\cos 6x + 6 \cos 4x + 15 \cos 2x + 10}{\cos 5x + 5 \cos 3x + 10 \cos x} = 2 \cos x$.
- If y_1, y_2, y_3 be the ordinates of a vertices of the triangle inscribed in a parabola $y^2 = 4ax$, then show that the area of the triangle is $\frac{1}{8a} |(y_1 - y_2)(y_2 - y_3)(y_3 - y_1)|$.
or
The foci of a hyperbola coincide with the foci of the ellipse $\frac{x^2}{25} + \frac{y^2}{9} = 1$. Find the equation of the hyperbola if its eccentricity is 2. Also find the equation of its directrices.
- Two ships leave a port at the same time. One goes 24km/h in the direction $N45^\circ E$ and the other travels 32km/h in the direction $S75^\circ E$. Find the distance between the ships at the end of 3 hours.
- Find the square root of complex number $3 + 4i$.
- Solve the system of linear inequations graphically:
 $2x + 3y \leq 35, y \geq 3, x \geq 2, x \geq 0, y \geq 0$.
- What is the number of ways of choosing 4 cards from a pack of 52 playing cards? In how many of these
(a) Four cards are of same suit.
(b) Four cards belong to four different suits.
(c) Two are red cards and two are black cards.

21. If S_1, S_2, S_3 are the sums of first n natural numbers, their squares, their cubes respectively, show that $9S_2^2 = S_3(1 + 8S_1)$.
22. (a) Evaluate $\lim_{y \rightarrow 0} \frac{(x+y)\sec(x+y) - x\sec x}{y}$.
 (b) Differentiate xe^x from first principle.
- or**
- (a) Let $f(x)$ be a function defined by $f(x) = \begin{cases} 4x - 5 & \text{if } x \leq 2 \\ x - \lambda & \text{if } x > 2 \end{cases}$. Find λ if $\lim_{x \rightarrow 2} f(x)$ exists.
23. Out of 100 students, two sections of 40 and 60 students are formed. If you and your friend are among the 100 students, what is the probability that
 (a) you both enter the same section.
 (b) you both enter the different sections.
26. Prove that $\sin 20^\circ \sin 40^\circ \sin 60^\circ \sin 80^\circ = \frac{3}{16}$.
- or**
- If $\frac{\tan(x+\alpha)}{a} = \frac{\tan(x+\beta)}{b} = \frac{\tan(x+\gamma)}{c}$, prove that $\frac{a+b}{a-b} \sin^2(\alpha-\beta) + \frac{b+c}{b-c} \sin^2(\beta-\gamma) + \frac{c+a}{c-a} \sin^2(\gamma-\alpha) = 0$.
27. Using principle of mathematical induction, prove that $1.3 + 2.3^2 + 3.3^3 + \dots + n.3^n = \frac{(2n-1)3^{n+1} + 3}{4}$, $\forall n \in \mathbb{N}$.
- or**
- Using principle of mathematical induction, prove that $n^3 + 3n^2 + 5n + 3$ is divisible by 3 $\forall n \in \mathbb{N}$.
28. The vertices of a triangle are $A(10, 4), B(-4, 9)$ and $C(-2, -1)$. Find the equation of its altitudes. Also find its orthocentre.
29. The mean and standard deviation of 20 observations are 10 and 12, respectively. On rechecking it was found that observation 8 was incorrect. Calculate the correct mean and standard deviation of the following cases
 (a) If wrong item is omitted
 (b) If it is replaced by 12.

Section D

24. (a) Show that the middle term in the expansion of $(1+x)^{2n}$ is $\frac{1.3.5 \dots (2n-1)}{n!} 2^n x^n$.
 (b) Find the term independent of x in the expansion of $\left(\frac{3}{2}x^2 - \frac{1}{3x}\right)^6$.
25. If the sum of m terms of an A.P is equal to the sum of either the next n terms or the next p terms, then prove that $\frac{\frac{1}{m} - \frac{1}{n}}{\frac{1}{1} - \frac{1}{p}} = \frac{m+n}{m+p}$.
- or**
- Find the mean deviation about the mean for the following data.

Marks Obtained	Number of Students
10 – 20	2
20 – 30	3
30 – 40	8
40 – 50	14
50 – 60	8
60 – 70	3
70 – 80	2



General Instructions:

- (i) There are a total 26 questions in five sections in the question paper. All questions are compulsory.
- (ii) Section A contains questions number 1 to 5, Very Short Answer type questions for one mark each.
- (iii) Section B contains questions number 6 to 10, Short Answer type 1 questions of two marks each.
- (iv) Section C contains questions number 11 to 22, Short Answer type 2 questions for the three marks each.
- (v) Section D contains question number 23, Value Based Question of four marks.
- (vi) Section E contains questions number 24 to 26, Long Answer type questions of five marks each.
- (vii) There is no overall choice in the question paper, however, an internal choice is provided in one question of two marks, one question of three marks and all three questions of five marks. An examinee is to attempt any one question out of two given in the question paper with the same question number.

Section A

1. What does ICZN stand for?
2. Name the different cells junctions found in tissues.
3. Mention a single membrane bound organelle which is rich in hydrolytic enzymes.
4. What is the basis for designating C₃ and C₄ pathways of photosynthesis?
5. What is the principle underlying the use of cyanobacteria in agricultural fields for crop improvement?

Section B

6. Tendrils are found in the following plants. Identify whether they are stem tendrils or leaf tendrils. (a) Cucumber (b) Peas (c) Pumpkins (d) Grapevine (e) Watermelons.
7. How does a gap junction facilitate intercellular communication?
8. List the organs of human alimentary canal and name the major digestive glands with their location.
9. Name the organs of respiration in the following organisms: (a) Flatworm; (b) Birds; (c) Frog; (d) Cockroach.

10. Neural system and computers share certain common features. Comment in five lines. (Hint: CPU, input-output devices)

or

What is the function ascribed to Eustachian tube?

Section C

11. Heterospory i.e., formation of two types of spores – microspores and megaspores is a characteristic feature in the life cycle of a few members of pteridophytes and all spermatophytes. Do you think heterospory has some evolutionary significance in plant kingdom?
12. Give an example for each of the following:
 - (a) A viviparous animal
 - (b) A fish possessing a poison sting
 - (c) A fish possessing an electric organ
 - (d) An organ, which regulates buoyancy
 - (e) Animal, which exhibits alternation of generations
 - (f) Oviparous animal with mammary gland
13. What are the characteristic differences found in the vascular tissue of gymnosperms and angiosperms?
14. Why are neurons called excitable cells? Mention special features of the membrane of the neuron?
15. Explain the association of carbohydrate to the plasma membrane and its significance.

or

What are histones? What are their functions?
16. What are Plasmids? Describe their role in bacteria?
17. State the role of centrioles other than spindle formation?
18. Oxygen is an essential requirement for aerobic respiration but it enters the respiratory process at the end? Discuss.
19. Succulents are known to keep their stomata closed during the day to check transpiration. How do they meet their photosynthetic CO₂ requirements?
20. Correct the following statements by deleting one of entries (given in bold italics). (a) Goblet cells are located in the intestinal mucosal epithelium and secrete **chymotrypsin / mucus**. (b) Fats are broken down into di- and monoglycerides with the help of **amylase / lipases**. (c) Gastric glands of stomach mucosa have **oxyntic cell / chief cells** which secrete HCl. (d) Saliva contains enzymes that digest **starch / protein**.

21. What is pancreas? Mention the major secretions of pancreas that are helpful in digestion.
22. Name the blood component which is viscous and straw coloured fluid.

Section D

23. Salim met an accident and he was immediately rushed to hospital. There was a lot of blood loss (B – Blood group) and the hospital failed to supply the B type of blood group. Ravi Shanker, a friend of Salim came to know about the accident and reached the hospital. He agreed to donate his O type of blood to Salim to save his life. However, Salim's mother refused to take the blood of Ravi on the pretext that he belongs to different community. Later on, doctor convinced her and she agreed for the same.
 - i. What value do you find in doctor and Ravi?
 - ii. Whether Salim's mother wrong or right in her objection of accepting the blood?
 - iii. Why O type of blood can be easily transferred to B-type of blood?
 - iv. What is the genetic basis of blood group inheritance?

Section E

24. A cell organelle is also considered as power house of the cell.
 - (a) Identify the cell organelle.
 - (b) Describe the structure of this cell organelle with the help of labelled diagram.

or

 - (a) Describe the happening under G₁ phase, S phase and G₂ phase of cell cycle.
 - (b) What is G₀ (quiescent phase) of cell cycle?
 - (c) Distinguish cytokinesis from karyokinesis.
25. What are the important events and end products of the light reaction?

or

Why is the RuBisCo enzyme more appropriately called RUBP Carboxylase-Oxygenase and what important role does it play in photosynthesis?
26. Illustrate the mechanism of electron transport system.

or

What is anaerobic respiration? Give its main characteristics.



General Instructions:

- (i) There are a total 26 questions in five sections in the question paper. All questions are compulsory.
- (ii) Section A contains questions number 1 to 5, Very Short Answer type questions for one mark each.
- (iii) Section B contains questions number 6 to 10, Short Answer type 1 questions of two marks each.
- (iv) Section C contains questions number 11 to 22, Short Answer type 2 questions for the three marks each.
- (v) Section D contains question number 23, Value Based Question of four marks.
- (vi) Section E contains questions number 24 to 26, Long Answer type questions of five marks each.
- (vii) There is no overall choice in the question paper, however, an internal choice is provided in one question of two marks, one question of three marks and all three questions of five marks. An examinee is to attempt any one question out of two given in the question paper with the same question number.

Section A

1. Amoeba multiplies by mitotic cells division. Is this phenomenon growth or reproduction?
2. Define metabolism.
3. What is the function of a polysome?
4. $F_0 - F_1$ particles participate in the synthesis of
5. Does moonlight support photosynthesis? Find out?

Section B

6. What is the epidermal cell modification in plant which prevents water loss?
7. Complete the following statement:
(a) In Cockroach grinding of food particle is performed by
- (b) Malpighian tubules help in removal of
- (c) Hind gut of Cockroach is differentiated into
8. Name the part of the alimentary canal where major absorption of digested food takes place. What are the absorbed forms of different kinds of food materials?
9. What is the significance of hepatic portal system in the circulatory system?

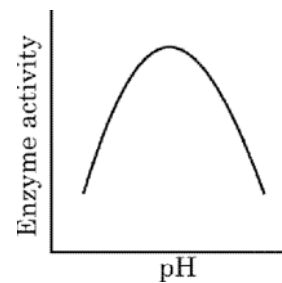
10. Thrombocytes are essential for coagulation of blood. Comment.

or

Answer the following : (a) Name the major site where RBCs are formed. (b) Which part of heart is responsible for initiating and maintaining its rhythmic activity? (c) What is specific in the heart of crocodiles among reptilians?

Section C

11. How are the male and female gametophytes of pteridophytes and gymnosperms different from each other?
12. There has been an increase in the number of chambers in heart during evolution of vertebrates. Give the names of the class of vertebrates having two, three or four-chambered heart.
13. On germination a seed first produces shoots with leaves. Flowers appear later.
(a) Why do you think this happens?
(b) How is this advantageous to the plant?
14. What is special about tissue present in the heart?
15. Enzymes are proteins. Proteins are long chains of amino acids linked to each other by peptide bonds. Amino acids have many functional groups in their structure. These functional groups are, many of them at least, ionisable. As they are weak acids and bases in chemical nature, this ionization is influenced by pH of the solution. For many enzymes, activity is influenced by surrounding pH. This is depicted in the curve below, explain briefly.



or

How does cytokinesis in plant cells differ from that in animal cells?

16. What is the significance of vacuole in plant cell?

17. Mitochondria and plastids have their own DNA (genetic material). What is known about their fate during nuclear division like mitosis?
18. In a slide showing different types of cells, can you identify which type of cell may be meristematic and the one which is incapable of dividing and how?
19. Classify the following plants into long day plants (LDP), short day plants (SDP) and day neutral plants (DNP):
20. Define the following terms? (a) Tidal volume; (b) Residual volume; (c) Asthma.
21. How is the intestinal mucosa protected from the acidic food entering from stomach?
22. The walls of ventricles are much thicker than atria. Explain.

Section D

23. A three month old Anu was crawling on the floor and suddenly he engulfed the small drooping of the sparrow. On seeing this Anu's mother was very much confused and she immediately consulted the doctor. The doctor ensured her that it is nothing to worry and it would not harm Anu.
 - i. On what basis, the doctor ensured Anu's mother for not being worried?
 - ii. The drooping of sparrow contains white and brownish crystals. What technical term is used for this type of excretion?
 - iii. In which form the excretion mainly occurs in man? Where does it produce in man's body and through which organ. It is excreted out?
 - iv. What values did Anu's mother show in consulting the doctor immediately?

Section E

24. Complete the statement by choosing appropriate match among the following:

(a) Resting potential	i. Chemicals involved in the transmission of impulses at synapses.
(b) Nerve impulse	ii. Gap between the pre synaptic and post synaptic neurons.
(c) Synaptic cleft	iii. Electrical potential difference across the resting neural membrane.
(d) Neurotransmitters	iv. An electrical wave like response of a neuron to a stimulation.

or

An old woman exhibits high level of LH in blood but low level of estrogen (E_2). Another woman exhibits high level of LH as well as E_2 in blood. Where is the defect in both these women.

25. Why is solute potential always negative? Explain $\psi_w = \psi_s + \psi_p$.

or

Differentiate between Apoplast and Symplast pathway of water movement. Which of these would need active transport?

26. (a) Why is Sino-atrial node (SAN) called as pacemaker of our heart? Where is SAN located?
- (b) What is electrocardiogram? What represents P-wave, QRS complex and T waves in a standard ECG.

or

- (a) What is lymph? Write its two functions.
- (b) Where are Bicuspid and tricuspid valve located in human heart?
- (c) Name the blood vessels that brings oxygenated blood from lungs to heart.



General Instructions:

- (i) There are a total 26 questions in five sections in the question paper. All questions are compulsory.
- (ii) Section A contains questions number 1 to 5, Very Short Answer type questions for one mark each.
- (iii) Section B contains questions number 6 to 10, Short Answer type 1 questions of two marks each.
- (iv) Section C contains questions number 11 to 22, Short Answer type 2 questions for the three marks each.
- (v) Section D contains question number 23, Value Based Question of four marks.
- (vi) Section E contains questions number 24 to 26, Long Answer type questions of five marks each.
- (vii) There is no overall choice in the question paper, however, an internal choice is provided in one question of two marks, one question of three marks and all three questions of five marks. An examinee is to attempt any one question out of two given in the question paper with the same question number.

Section A

1. Which is the largest botanical garden in the world? Name a few well known botanical gardens in India.
2. What is the function of phloem parenchyma?
3. At what stage of cell cycle does DNA synthesis take place?
4. Food is stored as Floridean starch in Rhodophyceae. Mannitol is the reserve food material of which group of algae?
5. The plant body in higher plants is well differentiated and well developed. Roots are the organs used for the purpose of absorption. What is the equivalent of roots in the less developed lower plants?

Section B

6. What are the cells that make the leaves curl in plants during water stress?
7. Mention special features of eye in Cockroach.
8. What is the role of gall bladder? What may happen if it stops functioning or is removed?
9. If someone receive a blow on the back of neck, what would be the effect on the person's CNS?

10. Sarcolemma, sarcoplasm and sarcoplasmic reticulum refer to a particular type of cell in our body. Which is this cell and to what parts of that cell do these names refer to?

or

Write a few lines about Gout.

Section C

11. Why are bryophytes called the amphibians of the plant kingdom?
12. Excretory organs of different animals are given below. Choose correctly and write in the space provided.

Animal	Excretory Organ/Unit
(a) Balanoglossus	i. Metanephridia
(b) Leech	ii. Nephridia
(c) Locust	iii. Flame cells
(d) Liver fluke	iv. Absent
(e) Sea urchin	v. Malpighian tubule
(f) Pila	vi. Proboscis gland

13. Give two examples of roots that develop from different parts of the angiospermic plant other than the radicle.
14. Stratified epithelial cells have limited role in secretion. Justify their role in our skin.
15. What is referred to as satellite chromosome?

or

Discuss briefly the role of nucleolus in the cells actively involved in protein synthesis.

16. Give the biochemical composition of plasma membrane. How are lipid molecules arranged in the membrane?
17. Comment on the statement—Meiosis enables the conservation of specific chromosome number of each species even though the process results in reduction of chromosome number.
18. A farmer add / supplies Na, Ca, Mg and Fe regularly to his field and yet he observes that the plants show deficiency of Ca, Mg and Fe. Give a valid reason and suggest a way to help the farmer improve the growth of plants.
19. Carnivorous plants exhibit nutritional adaptation. Citing an example explain this fact.

20. Complete the missing terms
 (a) Inspiratory Capacity (IC) =+ IRV
 (b) = TV + ERV
 (c) Functional Residual Capacity (FRC) = ERV + ...
21. With respect to rib cage, explain the following : (a) Bicephalic ribs. (b) True ribs. (c) Floating ribs
22. What is the role of second messenger in hormone action?

Section D

23. Mohan on entering an empty room suddenly finds a snake right in front on opening the door. He abruptly moves back without the intervention of will. He takes the sign of relief and thinks how I have immediately moved back.
- Which action has occurred in Mohan's body on seeing the snake?
 - Which nervous system gets activated in Mohan?
 - Name the hormone released during this action.
 - Is this action being operated by brain? If no, then write correct organ.
 - What value is reflected in Mohan's quick action?

Section E

24. Medicines are either man made (i.e., synthetic) or obtained from living organisms like plants, bacteria, animals etc. and hence the latter are called natural products. Sometimes natural products are chemically altered by man to reduce toxicity or side effects. Write and explain against each of the following whether they were initially obtained as a natural product or as a synthetic chemical.
- (a) Penicillin. (b) Sulfonamide.
 (c). Vitamin C. (d) Growth Hormone.

or

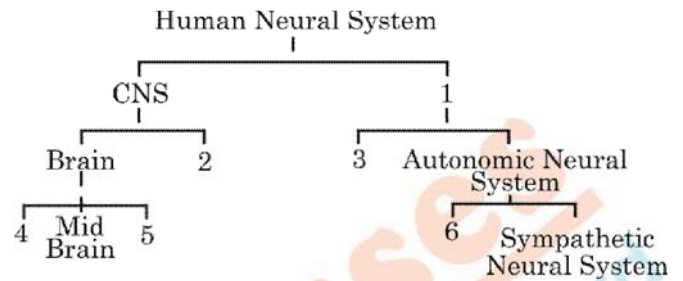
Starch, Cellulose, Glycogen, Chitin are polysaccharides found among the following. Choose the one appropriate and write against each. (a) Cotton fibre. (b) Exoskeleton of cockroach. (c) Liver (d) Peeled potato.

25. Explain noncyclic photo-phosphorylation in plants. Why is this process called so?

or

Where does Calvin cycle take place in Chloroplast? Describe the three phase of Calvin cycle.

26. The major parts of the human neural system are depicted below. Fill in the empty boxes with appropriate words and also explain Human neural system.



or

Arrange and explain the following terms based on their volumes in an ascending order (a) Tidal volume (TV). (b) Residual Volume (RV). (c) Inspiratory Reserve Volume (IRV). (d) Expiratory Capacity. (EC).



General Instructions:

- (i) There are a total 26 questions in five sections in the question paper. All questions are compulsory.
- (ii) Section A contains questions number 1 to 5, Very Short Answer type questions for one mark each.
- (iii) Section B contains questions number 6 to 10, Short Answer type 1 questions of two marks each.
- (iv) Section C contains questions number 11 to 22, Short Answer type 2 questions for the three marks each.
- (v) Section D contains question number 23, Value Based Question of four marks.
- (vi) Section E contains questions number 24 to 26, Long Answer type questions of five marks each.
- (vii) There is no overall choice in the question paper, however, an internal choice is provided in one question of two marks, one question of three marks and all three questions of five marks. An examinee is to attempt any one question out of two given in the question paper with the same question number.

Section A

1. Are Chemosynthetic bacteria autotrophic or heterotrophic?
2. Our fore arm is made of three different bones. Comment.
3. Write the name of any one amino acid, sugar, nucleotide and fatty acid.
4. What is meant by the statement “aerobic respiration is more efficient”?
5. In which plant will you look for mycorrhiza and coralloid roots? Also explain what these terms mean.

Section B

6. If one debarks a tree, what parts of the plant are being removed?
7. Give the location of hepatic caecae in a cockroach. What is their function?
8. What are the three major types of cells found in the gastric glands? Name their secretions.
9. Sort the following into actively or passively transported substances during reabsorption of GFR : Glucose, aminoacids, nitrogenous wastes, Na^+ , water

10. How have the terrestrial organisms adapted themselves for conservation of water?

or

Explain, why a haemodialysing unit called artificial kidney?

Section C

11. Diatoms are also called as “pearls of ocean”, why? What is diatomaceous earth?
12. How can you differentiate between free central and axile placentation?
13. What constitutes the cambial ring?
14. A muscle fibre tapers at both ends and does not show striations. Name the muscle fibre.
15. Comment on the cartwheel structure of centriole.

or

Briefly describe the cell theory.

16. Different between Rough Endoplasmic Reticulum (RER) and smooth Endoplasmic Reticulum (SER).
17. Name a cell that is found arrested in diplotene stage for months and years. Comment in 2-3 lines how it completes cell cycle?
18. From your knowledge of physiology can you think of some method of increasing the life of cut plants in a vase?
19. What conditions enable RuBisCo to function as an oxygenase? Explain the ensuing process.
20. For completion of respiration process, write the given steps in sequential manner: (a) Diffusion of gases (O_2 and CO_2) across alveolar membrane. (b) Transport of gases by blood. (c) Utilisation of O_2 by the cells for catabolic reactions and resultant release of CO_2 . (d) Pulmonary ventilation by which atmospheric air is drawn in and CO_2 rich alveolar air is released out. (e) Diffusion of O_2 and CO_2 between blood and tissues.
21. What is the difference between the matrix of bones and cartilage?
22. Which tissue is afflicted by myasthenia gravis? What is the underlying cause?

Section D

23. Reema had extreme pain in the joints of her fingers. The joints appeared to be swollen up and deformed. She was feeling difficulty in bending her finger or to hold up anything. She went to the doctor and asked for the treatment and probable cause for the same. Doctor explained her the possible cause and gave her the treatment.
- Name the disease by which Reema was suffering.
 - How it is diagnosed?
 - What happens in this disease?
 - What is the possible treatment for this disease?
 - What value did doctor exhibit in treating her?

Section E

24. (a) Is rubber a primary metabolite or a secondary metabolite? Write four sentences about rubber.
- (b) Nucleic acids exhibit secondary structure. Justify with example.
- or**
- (a) The energy yield in terms of ATP is higher in anaerobic respiration than during anaerobic respiration. Explain.
- (b) Write two energy yielding reactions of glycolysis.

25. Describe briefly the process of glycolysis.

or

How many ATP molecules are produced during aerobic respiration of one glucose molecule?

26. Draw a labelled diagram to show the structure of human eye in a vertical section. Describe its structure and functions of various parts in brief.

or

Rearrange the following hormones in Column I so as to match with their chemical nature in Column II. Also mention the secretory endocrine gland.

Column I

- Oxytocin
- Epinephrine
- Progesterone
- Growth hormone

Column II

- Amino acid derivation
- Steroid
- Protein
- Peptide

