

Physics
(Theory)

Time : 3 hour

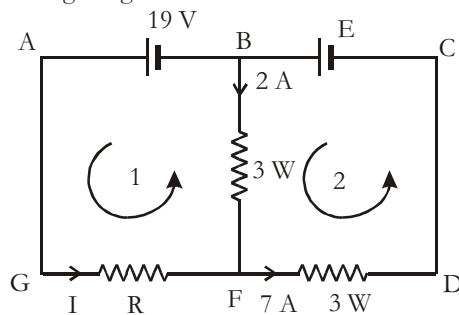
Maximum Marks : 70

General Instructions

- I. All questions are compulsory.
 - II. There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and one question of five marks. You have to attempt only one of the choices in such questions.
 - III. Questions 1 to 5 are very short answer questions carrying 1 mark each.
 - IV. Question 6 to 12 are short answer question, carrying 2 marks each.
 - V. Question 13 to 24 are short answer questions, carrying 3 marks each.
 - VI. Question 25 to 27 are long answer questions, carrying 5 marks each.
 - VII. Use of calculators is not permitted. However, you may use log tables if necessary.
 - VIII. You may use the following values of physical constants wherever necessary:
 $c = 3 \times 10^8 \text{ ms}^{-1}$
 $h = 6.6 \times 10^{-34} \text{ Js}$
 $e = 1.6 \times 10^{-19} \text{ C}$
 $\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$
Mass of neutron $m_n = 1.6 \times 10^{-27} \text{ kg}$
Boltzmann's constant $k = 1.38 \times 10^{-23} \text{ JK}^{-1}$
1. Can electric potential at any point in the space be zero while the intensity of electric field at that point is not zero?
 2. What is Curie temperature?
 3. What is magnetic Lorentz force? Express its vector form.
 4. Why is the core used in transformers or other electromagnetic devices laminated?
 5. What does AGC stand for? Give its use.

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6. How does the force change if the charge on each sphere as well as the distance between them is doubled?
7. Two charges $5 \times 10^{-5} \text{ C}$ and $-2 \times 10^{-5} \text{ C}$ are placed at 10 cm apart. Find at what distance between them the electric potential will be zero. (Electric potential at infinity is zero)
8. Define resistivity of a material. Does it depend on temperature?
9. Derive an expression for the energy stored in a self-inductance coil.
10. A convex lens of focal length 30 cm is placed in contact with a concave lens of focal length of 20 cm. Find the focal length and type of equivalent lens.
OR
A thin prism of 6° angle gives a deviation of 3° . What is the refractive index of the material of the prism?
11. Write any four properties of cathode rays.
12. Calculate de Broglie wavelength of an electron beam accelerated through a potential difference of 60 V.
13. A parallel plate capacitor is charged to a potential V by using a DC source. It is then disconnected and a dielectric material is introduced between the plates. How does the following change?
(i) Potential difference between the plates, (ii) capacitance and
(iii) energy stored in the capacitor.
14. Find the equivalent resistance if three resistances are connected in a series.
15. Using Kirchhoff's law, calculate the unknown current I, resistance R and emf E in the circuit diagram given below.



OR

- (i) What is meant by local action?
(ii) It is desired to deposit 0.254 kg of copper at the cathode of a copper voltmeter. How long will it take to deposit this mass with a steady current of 100 A. (Relative atomic mass of copper = 63.5, Faraday constant = 96,500 C)
16. (i) What is the angle of dip at a place where the horizontal and vertical components of the earth's magnetic fields are equal?
(ii) The ratio of horizontal component of earth's magnetic field to the resultant field at a place is $\frac{1}{\sqrt{2}}$.
Find the angle of dip at the place.
17. Derive an expression for the PE of a magnetic dipole placed in a magnetic field.
18. What is meant by intensity of electromagnetic wave? Write the expressions for the same in terms of (i) maximum electric field (ii) maximum magnetic field.
19. What is total internal reflection? What are the necessary conditions for total internal reflection to occur?
20. (a) Give two limitations of Thomson's model.
(b) Calculate the radius of the smallest orbit of hydrogen atom.
21. Define the term decay constant. How is it related to half-life period?
22. (a) What is meant by doping?
(b) A semiconductor has equal electron and hole concentrations of $2 \times 10^8 \text{ m}^{-3}$
On doping the electron concentration rises to $3.5 \times 10^8 \text{ m}^{-3}$.
(i) What type of impurity was added?
(ii) Find the new hole concentration.
(iii) How does the energy gap vary with doping?
23. What are the advantages of optical fibre communication?

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24. A TV tower has a height of 80 m. If the population density is 800 per sq.km, how much population is covered? Also find how much the height of the tower be increased to double its coverage value.
25. (i) Explain with the help of a labelled diagram, the principle of a transformer.
(ii) The primary of a transformer has 200 turns and the secondary has 100 turns. If the power output from the secondary at 1,000 V is 9 kW, calculate
(a) the primary voltage,
(b) the rate of heat loss in the primary coil if the resistance of primary is 0.2Ω and the efficiency of the transformer is 90%.

OR

- What is meant by instantaneous value of the emf? Write the expression for the emf induced between the ends of a metal conductor moving perpendicular to a uniform magnetic field. An rms current of 1.5 mA and angular frequency $\omega = 100 \text{ rad s}^{-1}$ flows through a $10 \text{ k}\Omega$ resistor and $0.50 \mu\text{F}$ capacitor in series. Calculate the value of rms voltage across the capacitor and the impedance of the circuit.
26. (i) What is interference? Does it violate law of conservation of energy?
(ii) Find the diameter of the third bright fringe from the centre when the screen distance, in a Young's experiment with monochromatic light of wavelength 500 nm , is 1.6 m from two identical slits at 2 mm apart.
27. Give the symbol of AND gate. Explain with the help of a circuit diagram, how this gate is realized in practice.

Chemistry
(Theory)

Time : 3 hour

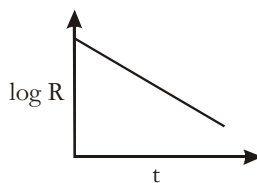
Maximum Marks : 70

General Instructions

- I. All questions are compulsory.
- II. Marks for each question are indicated against it.
- III. Questions 1 to 5 are very short-answer question, each of one mark. Answer these in one word or about one sentence each.

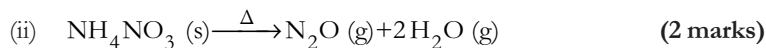
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- IV. Questions 6 to 12 are short answer questions of two marks each. Answer these in about 30 words each.
- V. Questions 13 to 24 are short answer questions of 3 marks each. Answer these in about 40 words each.
- VI. Questions 25 to 27 are long answer questions of 5 marks each. Answer these in about 70 words each.
- VII. Use log tables if necessary. Calculators are not permitted.
1. How many unit cell(s) share a constituent particle present on the edge of a unit cell? **(1 mark)**
2. Following graph is a plot of the logarithm of concentration of reactant (R) vs time (t).

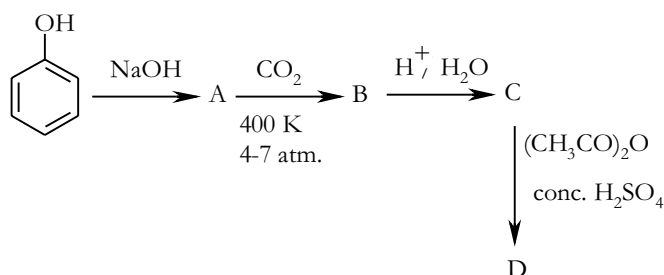


- Predict:
- i. the order of the reaction in this case.
- ii. what is the slope of the graph? **(1 mark)**
3. Give the IUPAC name of $(\text{CH}_2\text{CN})_2$. **(1 mark)**
4. How is benzaldehyde obtained from toluene? **(1 mark)**
5. Why do doctors advice gargles with salt water in case of sore throat? **(1 mark)**
6. Identify the type of intermolecular forces that exist between the following pairs:
- (i) Ar and Ar
- (ii) Ag^+ ion and I^- ion
- (iii) Na^+ ion and H_2O molecules
- (iv) HF and H_2O **(2 marks)**
7. Predict the sign of entropy change (ΔS) for the following and also give the suitable reasons.
- (i) Sublimation of ammonium chloride

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8. Explain why AlCl_3 exists as a dimer while BCl_3 exists as a monomer. (2 marks)
9. Draw a molecular model of *meso* form of 2,3-dihydroxybutanoic acid and mark the asymmetric carbon in it. (2 marks)
10. Identify A, B, C and D in the following reaction. (2 marks)



OR

Explain how phenols may be prepared from benzene sulphonic acid and chlorobenzene. (2 marks)

11. What is the difference between monomer and polymer? Give monomer unit (units) of the following polymers:
i. Nylon 66
ii. Nylon-6 (2 marks)
12. What is a glycosidic carbon? What is the other name for such a carbon? (2 marks)
13. What is the order of bond dissociation energies of O_2^+ and O_2^- ? (2 marks)

OR

State Heisenberg's uncertainty principle. An electron has a speed of 50 ms^{-1} accurate upto 99%. What is the uncertainty in locating its position?
[Mass of electron = $9.1 \times 10^{-31} \text{ kg}$, Planck's constant = $6.6 \times 10^{-34} \text{ J s}$]

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14. Explain the following terms:
i. Anti-ferromagnetic substance.
ii. Ferroelectricity.
iii. Primitive unit cell (3 marks)
15. How many grams of urea should be dissolved in 100 g of water to prepare a solution which would have a difference of 105° C between its boiling point and freezing point?
 K_f of water = 1.86 K m⁻¹
 K_b of water = 0.53 K m⁻¹ (3 marks)

16. The following experimental data were obtained for the reaction
 $2A + B_2 \rightarrow 2AB$

Experiment	[A]/ M	[B ₂]/ M	Rate / M min ⁻¹
1	1.0	1.0	1.30×10^{-3}
2	2.0	1.0	5.20×10^{-3}
3	4.0	2.0	4.16×10^{-2}

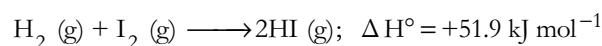
Determine the rate law. (3 marks)

17. i. Write the IUPAC name of $[\text{Co}(\text{en})_2\text{Cl}(\text{ONO})]^+$.
ii. Explain the octahedral shape of hexacyanoferrate(III) ion and account for its magnetic property. (3 marks)
18. Represent the following using a nuclear equation each:
(i) Production of C-14 in nature.
(ii) β -emission.
(iii) K-capture. (3 marks)
19. What happens when acetaldehyde reacts with following reagents:
i. Ethyl magnesium bromide followed by hydrolysis.
ii. Ethanol in the presence of dry HCl.
iii. Amalgamated zinc and concentrated hydrochloric acid.
Write the chemical equation. (3 marks)

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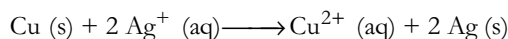
20. i. Which is more basic: Ammonia or Ethylamine and why?
ii. Discuss carbylamine reaction. **(3 marks)**
21. What is secondary structure of proteins? What are the two different secondary structures possible? **(3 marks)**
22. How is cream used in cosmetics? How are creams classified? Give use of each type of cream. **(3 marks)**

23. Calculate the standard free energy change for the reaction,



Given the standard entropies (S°) for H_2 , I_2 and HI are 130.6, 116.7 and 206.3 $\text{J K}^{-1} \text{mol}^{-1}$, respectively. Predict whether the reaction is feasible in the standard state at 298 K or not. **(3 marks)**

24. i. What is the order of Na^+ , Ba^{2+} and Al^{3+} for the coagulation of negatively charged As_2S_3 sol? Support your answer with reason.
ii. By dialyzing a colloid, frequent preparation of a colloid such as protein can be made more stable. How? **(3 marks)**
25. i. Write the symbolic representation of the electrochemical cell whose cell reaction is,



Indicate the oxidation and reduction electrode and also the direction of the movements of electrons. Write the electrode reactions. **(3 marks)**

- ii. For the above given cell reaction, what will be the concentration of Ag^+ (aq) when the emf of cell is zero and concentration of $\text{Cu}^{2+} = 0.1 \text{ M}$.

(Given: $E_{\text{Ag}^+/\text{Ag}}^0 = 0.80 \text{ V}$, $E_{\text{Cu}^{2+}/\text{Cu}}^0 = 0.34 \text{ V}$) **(2 marks)**

OR

- i. Describe the effect of dilution on molar conductivity of strong and weak electrolytes.
- ii. A conductivity cell has its electrodes 1 cm apart and each electrode has area of cross section 2 cm^2 . When filled with $\frac{N}{50}$ MX, the cell shows a resistance of 166.5 ohms. Calculate the equivalent conductivity of MX at the given concentration. **(5 marks)**

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26. (i) What are inner transition elements? Write their general electronic configuration.
- (ii) In what way are the observed oxidation states of the lanthanides related to their electronic configuration?
- (iii) What is the difference between the electronic configuration of transition and inner transition elements?
- (iv) Complete the following equations:
- (a) $\text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4 + \text{KI} \longrightarrow$
- (b) $\text{MnO}_4^- + \text{Fe}^{2+} + \text{H}^+ \longrightarrow$ **(5 marks)**
27. i. Which of these is regarded as the weakest acid and why? HF, HCl, HBr or HI.
- ii. How is bleaching powder prepared? Mention two uses of it?
- iii. Give four examples of compounds in which halogens display different positive oxidation states. **(5 marks)**

Mathematics

Time : 1 hour

Maximum marks : 100

General Instructions

- I. The question paper consists of three parts A, B and C. Part A is compulsory for all students. In addition to part A, every student has to attempt either Part B or Part C.
- II. **For part A**
Questions 1 to 8 are of 3 marks each.
Questions 9 to 15 are of 4 marks each.
Questions 16 to 18 are of 6 marks each.
- III. **For part B/part C**
Questions 19 to 22 are of 3 marks each.
Questions 23 to 25 are of 4 marks each.
Question 26 is of 6 marks.

- IV. All questions are compulsory.
- V. Internal choices have been provided in some questions. You have to attempt only one of the choices in such questions.
- VI. Use of calculator is not permitted. However, you may ask for logarithmic and statistical tables, if required.

Section – A

1. If $A = \begin{bmatrix} 1 & 0 \\ -1 & 6 \end{bmatrix}$ and $I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, then find λ so that $A^2 = 7A + \lambda I$.

OR

For the matrices A and B, verify $(AB)' = B'A'$, where $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ and

$$B = \begin{bmatrix} 4 & 5 \\ 1 & 2 \end{bmatrix}.$$

2. Using the properties of determinants, prove that

$$\begin{vmatrix} x & y & z \\ x^2 & y^2 & z^2 \\ x^3 & y^3 & z^3 \end{vmatrix} = xyz(x-y)(y-z)(z-x).$$

3. If A and B are two events such that $P(A) = 0.4$, $P(B) = 0.8$ and $P(B/A) = 0.6$, find $P(A/B)$ and $P(A \cup B)$.
4. A bag contains 7 red and 4 white balls. Three balls are drawn at random. Find the probability that one ball is red and two balls are white.

5. Evaluate: $\int \frac{1}{\sin(x-a)\cos(x-b)} dx$

6. Evaluate: $\int \frac{\cos x}{(1 + \sin x)(2 + \sin x)} dx$

7. Solve the following differential equation:
 $\cos x(1 + \cos y)dx - \sin y(1 + \sin x)dy = 0$.

8. Solve the following differential equation:

$$(x + 2y^2) \frac{dy}{dx} = y$$

9. Simplify the following Boolean expression:

$$a + a'(a + b) + bc$$

10. Find the value of k if the function $f(x)$ defined by

$$f(x) = \begin{cases} 2x - 1, & x < 2 \\ k, & x = 2 \\ x + 1, & x > 2 \end{cases} \text{ is continuous at } x = 2.$$

11. If $y = (\sin x)^{\tan x} + (\cos x)^{\sec x}$, find $\frac{dy}{dx}$.

12. If $y = \cos^{-1}(2x) + 2\cos^{-1}\sqrt{1 - 4x^2}$, then find $\frac{dy}{dx}$.

13. Show that $f(x) = \cos\left(2x + \frac{\pi}{4}\right)$ is increasing in $\left[\frac{3\pi}{8}, \frac{7\pi}{8}\right]$.

OR

Verify Rolle's theorem for the function $f(x) = x(x - 1)^2$ in the interval $[0, 1]$.

14. Evaluate: $\int \frac{3x + 1}{(x - 2)^2(x + 2)} dx$.

15. Evaluate: $\int_0^{\pi/4} \log(1 + \tan x) dx$.

16. Using matrices, solve the following system of linear equations:

$$x - 2y + z = 0$$

$$y - z = 2$$

$$2x - 3z = 10$$

OR

Use Cramer's rule to solve the system of equations

$$x + y + z = 1$$

$$ax + by + cz = p$$

$$a^2x + b^2y + c^2z = p^2$$

17. Show that the cone of greatest volume, which can be inscribed in a given sphere, is such that three times its altitude is twice the diameter of the sphere. Find the volume of the largest cone inscribed in a sphere of radius R.
18. Sketch the graph of the curve $y = |x + 3|$ and evaluate the area bounded by the curve and the X-axis between $x = -4$ and $x = 1$.

OR

Evaluate the following definite integral as limit of a sum:

$$\int_0^3 e^{x+2} dx$$

Section – B

19. Find the projection of the vector $\vec{a} = \hat{i} - 2\hat{j} + \hat{k}$ and $\vec{b} = 4\hat{i} - 4\hat{j} + 7\hat{k}$.
20. The position vectors of the points A, B, C and D are $3\hat{i} - 2\hat{j} - \hat{k}$, $2\hat{i} + 3\hat{j} - 4\hat{k}$, $\hat{i} - \hat{j} + 2\hat{k}$ and $5\hat{i} - 4\hat{j} + \lambda\hat{k}$ respectively. If the points A, B, C and D are coplanar, find the value of λ .
21. A man sitting in a train, traveling at 50 km/hr observes that a goods train, traveling in opposite direction, takes 18 seconds to pass him. If the goods train is 300 m long, find its speed.
22. A projectile is projected with a velocity of 90 m/s, at an angle of elevation of 60° . Find:

- i. The greatest height attained
 - ii. The time of flight and
 - iii. The horizontal range
- (Take $g = 10 \text{ m/sec}^2$)

OR

A man goes straight across a river. If he rows his boat with thrice the velocity of stream, then show that the inclination to the stream must be $\cos^{-1}\left(\frac{-1}{3}\right)$.

23. Find the centre and radius of the sphere
 $2(x - 5)(x + 1) + 2(y + 5)(y - 1) + 2(z - 2)(z + 2) - 7 = 0$
24. Find the magnitude and direction of the resultant of two forces of magnitude 12 N and 17 N, which are inclined to each other at an angle of 120° .
- OR**
- Find the magnitude and position of the resultant R of two unlike parallel forces P and Q acting at A and B when $P = 5 \text{ N}$, $Q = 12 \text{ N}$ and $AB = 12 \text{ m}$.
25. Three forces P, Q and R, acting at a point in east, north and southwest directions respectively, are in equilibrium. If the magnitude of P is 10 N, find the magnitude of Q and R.
26. Find the shortest distance and the vector equation of the line of shortest distance between the lines given by:

$$\vec{r} = \left(2\hat{j} - 3\hat{k} \right) + \lambda \left(2\hat{i} - \hat{j} \right)$$
$$\vec{r} = \left(4\hat{i} + 3\hat{k} \right) + \mu \left(3\hat{i} + \hat{j} + \hat{k} \right)$$

Section – C

19. A company has two plants to manufacture scooters. Plant-I manufactures 60% of the scooters and Plant-II manufactures 40%. At Plant-I, 70% of the scooters are rated of standard quality and at Plant-II, 80% of the scooters are rated of standard quality. A scooter is chosen at random and is found to be of standard quality. Find the probability that it has come from Plant-II.

20. Using binomial probability distribution, find the probability of obtaining 'less than 3 heads' when an unbiased coin is tossed 6 times.

OR

It is given that 4% of electric bulbs manufactured by a company are defective. Using Poisson distribution, find the probability that a sample of 100 bulbs will contain one defective bulb. [Take $e^{-4} = 0.0183$]

21. A toy company manufactures two types of toy; a basic version-toy P and a deluxe version-toy Q. Each toy of type Q takes twice as long to produce as one of type P, and the company would have time to make a maximum 200 per day if it produces only the basic version. The supply of plastic is sufficient to produce 150 toys per day (both P and Q combined). The deluxe version requires a fancy dress of which there are only 60 per day available. If the company make profit of Rs. 3.00 and Rs. 5.00 per toy respectively, on toy P and Q; how many of each should be produced per day in order to maximize profit? Formulate it as a linear programming problem mathematically.

22. Solve graphically the following linear programming problem.

$$\text{Minimum } Z = 20x + 10y$$

Such that:

$$x + 2y \leq 40$$

$$3x + y \geq 30$$

$$4x + 3y \geq 60 \text{ and } x, y \geq 0.$$

23. X and Y are partners sharing profits and losses in the ratio 4 : 3. Z brings

Rs. 91,000 as premium and is admitted as a partner for $\left(\frac{1}{4}\right)$ share. Show how

this amount will be shared by X and Y, assuming that the share of Z is contributed by X and Y in the profit-sharing ratio. Find also the new profit-sharing ratio.

OR

X, Y and Z enter into a partnership with X investing Rs. 6,000 for the whole year. In the beginning, Y invests Rs. 3,000 and after six months he increases his capital to Rs. 4,000. In the beginning, Z invests Rs. 2,000 and after 4 months he increases his capital to Rs.5,000. In the annual profit of Rs. 4, 320, find the share of each.

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24. Find the present value of an annuity due Rs. 1,200 per annum payable at the beginning of each year for 2 years allowing interest at 6% per annum, compounded annually. [Take $(1.06)^{-1} = 0.943$]
25. The cost function of a firm is given by $C = 100x - 10x^2 + \frac{x^3}{3}$. Calculate the output of which the marginal cost is minimum.
26. A bill of Rs. 30,000 drawn on March 4, 2002 for 10 months was discounted at 5% on August 14, 2002. Find the banker's discount, banker's gain and the amount paid by the banker.

Biology
(Theory)

Time : 3 hours

Maximum Marks : 70

General Instructions

- I. This question paper consists of four Sections A, B, C and D. Section A contains 5 questions of 1 mark each. Section B is of 10 questions of 2 marks each. Section C is of 10 questions of 3 marks each and Section D is of 3 questions of 5 marks each.
- II. All questions are compulsory.
- III. There is no overall choice. However, an internal choice has been provided in one question of 2 marks, one question of 3 marks and one question of 5 marks weightage. Attempt only one of the choices in such questions.
- IV. Questions 1 to 5 are to be answered in one word or one sentence.
- V. Questions 6 to 15 are to be answered in approximately 20-30 words each.
- VI. Questions 16 to 25 are to be answered in approximately 30-50 words each.
- VII. Questions 26 to 28 are to be answered in approximately 80-120 words each.

Section – A

1. Abscisic acid is known as stress hormone. Why?
2. Which organs in insects are analogous to flame cells of tapeworms?
3. What happens when acrosome of the spermatozoon does not function properly?
4. What are the uses of biodiversity with respect to modern agriculture?
5. Which antibiotic is suitable to treat a person suffering from anthrax?

Section – B

6. Which two conditions are necessary for imbibition to take place?
7. What do you mean by ectotherms and endotherms?
8. Write a note on insectivorous plants.
9. A plant is showing symptoms of chlorosis and late flowering along with premature falling of leaves. Which minerals it is deficient of?
10. What are the functions of cerebrospinal fluid?
11. Discuss the stages of spermatogenesis.
12. List the characteristics of flowers, whose pollination is carried out by bats.
13. What is the basic difference between a habitat and a microhabitat?
14. Name the important vaccines given to babies and children to prevent diseases such as diphtheria, tetanus, pertussis, hepatitis, polio and tuberculosis.
15. What is sonography? What is its principle?

OR

What is the role of recombinant DNA technology in production of vaccines?

Section – C

16. How does temperature affect photosynthesis?
17. To sustain life on earth, photosynthesis is crucial. Why?
18. How are fats absorbed in the body?
19. Rate of heartbeat has to be detected. Which technique will help us to do this? What kind of wave display suggests that the nerve bundles are dispersed by inflammation or infection?
20. List the differences between an artery and vein.
21. Write a note on regeneration of animals.
22. Explain the artificial methods of vegetative propagation.
23. Define food chain. Explain ten percent law.

OR

Write a note on freshwater wetlands.

24. What does an electrocardiograph tells us?
25. What is allopolyploidy? Explain with example.

Section – D

26. Discuss the functions of gastrointestinal hormones.
 27. What are the causes and effects of deforestation?
- OR**
- What are the effects of air pollution on environment?
28. How can diseases in animals be controlled? Write a note on anthrax.