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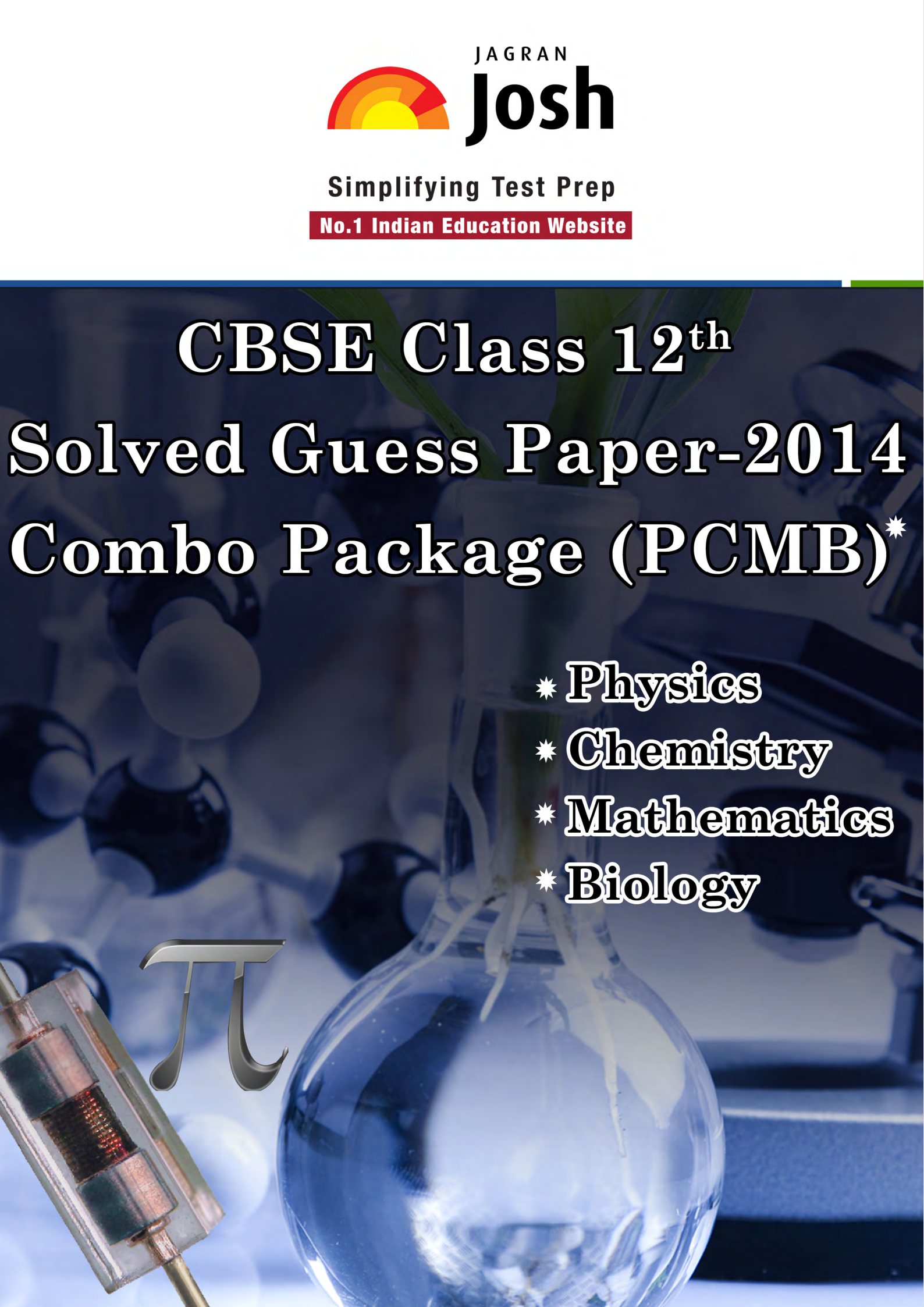
CBSE Class 12th Solved Guess Paper-2014 Combo Package (PCMB)*

- Physics
- Chemistry
- Mathematics
- Biology

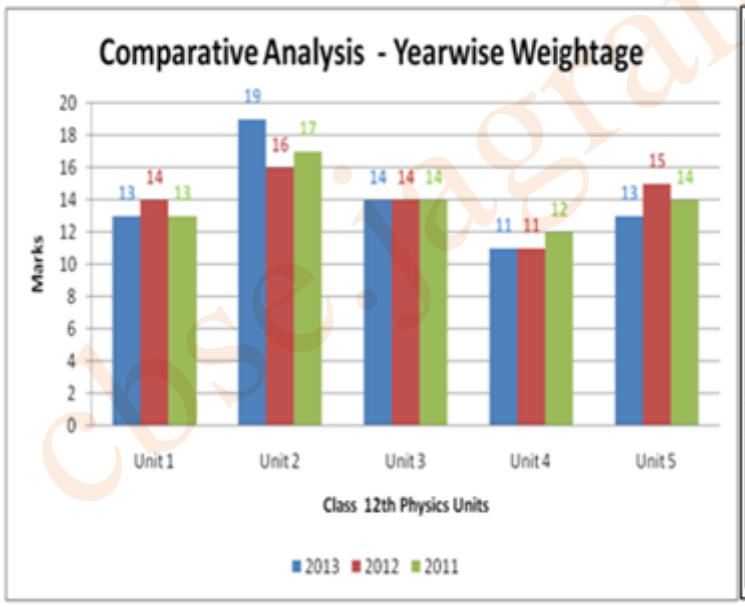


PREFACE

The Guess Papers are a product of CBSE Class 12th Board exam experts of **jagranjosh.com**, an on-line educational portal of Dainik Jagran.

An analysed report of the Questions from the previous three Years of CBSE Class 12th Physics, Chemistry, Mathematics & Biology Questions Papers, respectively can be found here. This factor of analysing the papers has led to the preparation of Questions as per the Board pattern & standards.

A graphical analysis for the 4 subjects is shown below for detailed understanding of the pattern of Questions followed by CBSE in Boards.



Unit 1	➢ Electrostatics & Current Electricity
Unit 2	➢ Magnetism, Electromagnetic Induction & Alternating Current
Unit 3	➢ Electromagnetic Waves & Optics (Ray & Wave Optics)
Unit 4	➢ Atoms & Nuclei
Unit 5	➢ Electronic, Semiconductors & Communication Systems

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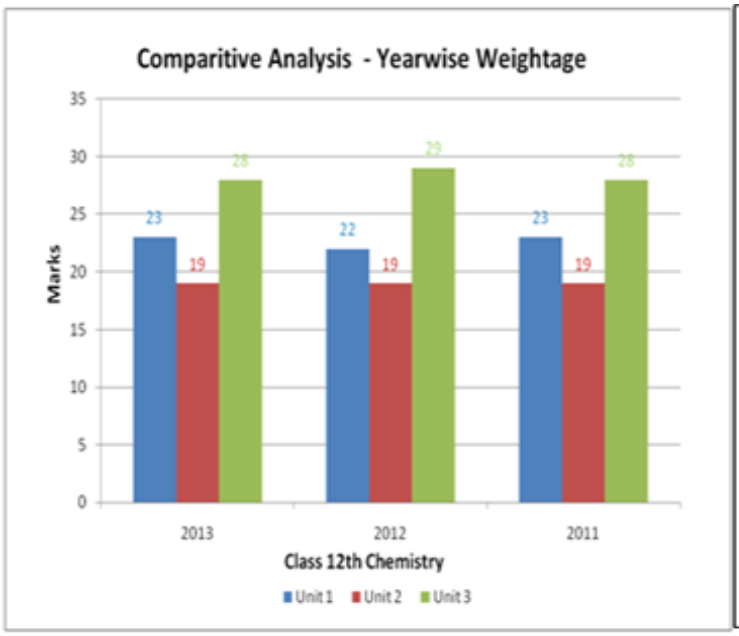
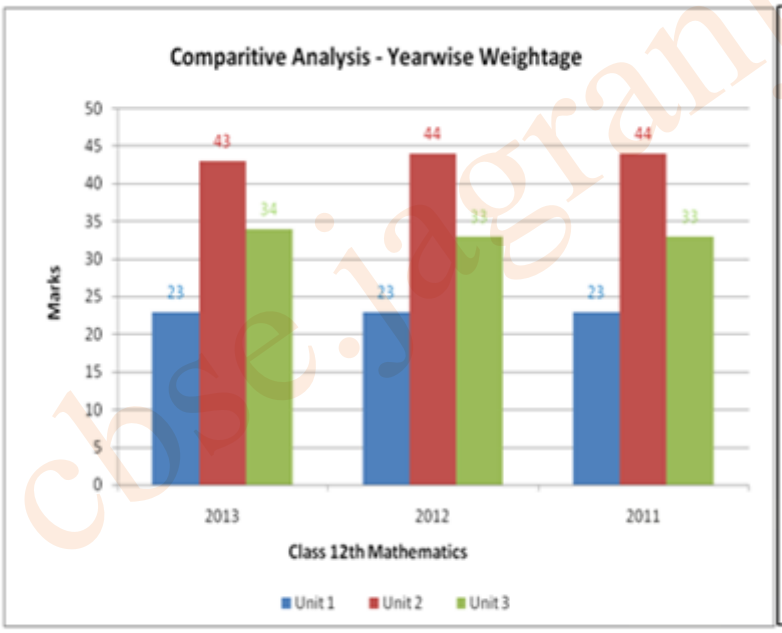


Unit 1	➢ The Solid State ➢ Solutions ➢ Electrochemistry ➢ Chemical Kinetics ➢ Surface Chemistry
Unit 2	➢ General Principles and Processes of Isolation of Elements ➢ The p – Block Elements ➢ The d – & f – Block Elements ➢ Coordination Compounds
Unit 3	➢ Haloalkanes & Haloarenes ➢ Alcohols, Phenols & Ether ➢ Aldehydes, Ketones & Carboxylic Acids ➢ Amines ➢ Biomolecules ➢ Polymers ➢ Chemistry In Everyday Life



Unit 1	➢ Relations & Functions ➢ Inverse trigonometric Functions ➢ Matrices ➢ Determinants
Unit 2	➢ Continuity & Differentiability ➢ Application of Derivatives ➢ Integrals ➢ Application of Integrals ➢ Differential Equations
Unit 3	➢ Vector Algebra ➢ Three Dimensional Geometry ➢ Linear Programming ➢ Probability

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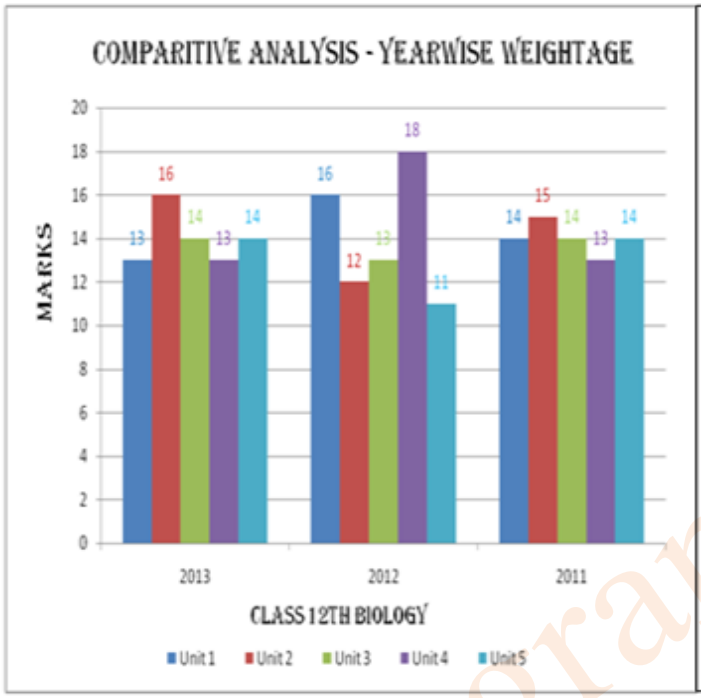

Unit 1	➢ Reproduction in Organisms ➢ Sexual Reproduction in Flowering Plants ➢ Human Reproduction ➢ Reproductive Health
Unit 2	➢ Principles of Inheritance & Variations ➢ Molecular Basis of Inheritance ➢ Evolution
Unit 3	➢ Human Health & Diseases ➢ Strategies for Enhancement in Food Production ➢ Microbes in Human Welfare
Unit 4	➢ Biotechnology: Principles & Processes ➢ Biotechnology & its Applications
Unit 5	➢ Organisms & Populations ➢ Ecosystems ➢ Biodiversity & its conservation ➢ Environmental Issues

These conceptual Guess Papers along with guided solutions is a product exclusively for CBSE Class 12th students. The pattern of the Guess Papers is as per the Previous Year's CBSE Board Question Papers of the respective subjects, thus the students will find it easy and understandable in all its aspects.

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Physics

Guess Paper: 2014
Class: XII

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

General Instructions:

(i) All questions are compulsory.
(ii) There are 29 Questions in all.
(iii) Question numbers 1 to 8 carry 1 mark each.
(iv) Question numbers 9 to 16 carry 2 marks each.
(v) Question numbers 17 to 26 carry 3 marks each.
(vi) Question numbers 27 to 29 carry 5 marks each.
(vii) Internal choices have been provided in some questions.
Use Log Tables, if necessary.

'SECTION – A'

Q.1. Define electric dipole moment. Why two electric field lines never cross each other. Explain.

Q.2. A current is passed through a loop of flexible wire. What shape will it take?

Q.3. How does the self inductance of the coil change when an iron rod is introduced in it?

Q.4. A convex lens is held in water. What would be the change in the focal length?

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Q.5. The threshold frequency of a material is 2 x 10^{14} Hz. What is its work function?

Q.6. The a.c. current gain of transistor is 120. What is change in the collector current in the transistor whose base current changes by 100 μA?

Q.7. What is the significance of negative energy of electron in the orbits?

Q.8. What percentage of the incident light is transmitted if the angle between polarizer and analyzer is 30^0?

'SECTION – B'

Q.9. An induced emf has no direction of its own. Comment.

Q.10. Show that during the charging of a parallel plate capacitor, the rate of change of charge on each plate equals ε_0 times the rate of change of electric flux (ϕ_E) linked with it.What is the name given to the term. $\varepsilon_0 \frac{d\varphi_E}{dt}$.

Q.11. A circular brass loop of radius 'a' and resistance R is placed with its plane perpendicular to a magnetic field which varies with time as $B = B_0 \sin \omega t$. Obtain the expression for the induced current in the loop.

Q.12. A bulb and a capacitor are connected in series to an a.c. source of variable frequency. How will the brightness of the bulb change on increasing the frequency of ac source?

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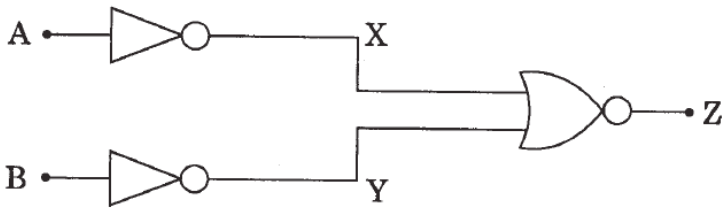
Q.13. Write down the truth table and the logic operation for the circuit given below:



OR

Explain why transistor is a temperature-sensitive device?

Q.14. Induced magnetic field due to changing electric fields are not so readily observed as induced electric field due to changing magnetic flux. Why?

Q.15. Why are microwaves used in RADAR technology?

Q.16. You are given a 2 μF parallel plate capacitor. How would you establish an instantaneous displacement current of 1 mA in the space between its plates?

'SECTION – C'

Q.17. Explain the property of brilliance of diamonds?

Q.18. The refractive index of the material of a concave lens is n. It is immersed in a medium of refractive index n_1. A parallel beam of light is incident on the lens. Trace the path of emergent rays when $n_1 > n$.

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OR

Is it necessary to use satellite for long distance T.V. transmission? Give reasons.

Q.19. A prism is made of glass of unknown refractive index. A parallel beam of light is incident on a face of the prism. By rotating the prism, the minimum angle of deviation is measured to be 40^0. What is the refractive index of the prism? If the prism is placed in water ($\mu = 1.33$), predict the new angle of minimum deviation of the parallel beam. The refracting angle of prism is 60^0.

Q.20. Prove that energy is conserved in interference?

Q.21. Why do you think the reflected and the reflected light both have the same frequency as the incident light, if the monochromatic light is incident on a surface separating two media?

Q.22. "In the wave picture of light, intensity of light is determined by the square of the amplitude of the wave". Do you agree with the above statement? Give reason.

Q.23. Distinguish between magnifying power and resolving power of a microscope.

Q.24. An equi-convex lens, with radii of curvature of magnitude 10 cm each, is put over a liquid layer poured on top of a plane mirror. A small needle, with its tip on the principal axis of the lens, is moved along the axis until its inverted real image coincides with the needle itself. The distance of the needle, from the lens, is measured to be 15 cm. On removing the liquid layer, and repeating the experiment, the distance is measured to be 10 cm.

Given that the two values of the distance measured represent the focal length values in the two cases, calculate the refractive index of the liquid.

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Q.25. (a) State Einstein's photoelectric equation and give the characteristics properties of photons on which this equation is based.

(b) On the basis of this equation explain three observable features.

Q.26. (a) With the help of a schematic diagram, explain the principle behind the working of Van de Graff generator.

(b) Is there any restriction on the upper limit of the high voltages set up in this machine? Explain.

'SECTION – D'

Q.27. (a) Derive the expression for the magnetic field in the vector form at a point on the axis of a circular current loop, using Biot - Savart Law?

(b) What does a toroid consist of? Find out the expression for the magnetic field inside a toroid for N turns of the coil having the average radius r and carrying a current I. Show that the magnetic field in the open space inside and exterior to the toroid is zero.

OR

(a) A rectangular coil of sides 8 cm and 6 cm having 2000 turns and carrying a current of 200 mA is placed in a uniform magnetic field of 0.2 T directed along the positive x-axis.

(i) What is the maximum torque the coil can experience? In which orientation does it experience the maximum Torque?

(ii) For which orientations of the coil is the torque zero? When is this equilibrium stable and unstable?

(b) (i) Write the expression for the magnetic moment (m) due to a planar square loop of side '*l*' carrying a steady current *I* in a vector form.

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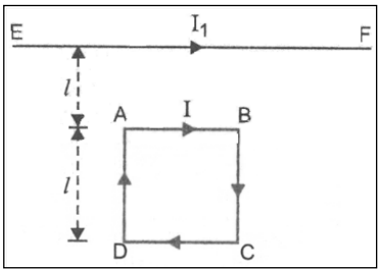
(ii) In the given figure, this loop is placed in a horizontal plane near a long straight conductor carrying a steady current I_1 at a distance l as shown. Give reasons to explain that the loop will experience a net force but no torque. Write the expression for this force acting on the loop.



Q.28. (a) State the basic postulates of Bohr's theory of hydrogen atom.

(b) Use these postulate to obtain an expression for total energy of an electron revolving in Bohr's orbit.

OR

(a) Using de Broglie's hypothesis, explain with the help of a suitable diagram, Bohr's second postulate of quantization of energy levels in a hydrogen atom.

(b) The ground state energy of hydrogen atom is - 13.6 eV. What are the kinetic and potential energies of the electron in this state?

(c) You are given two nuclei ${}_3X^7$ and ${}_3Y^4$. Explain giving reasons, as to which one of the two nuclei is more stable?

Q.29. (a) With the help of neat and labelled diagram, discuss the working of common emitter n-p-n transistor amplifier.

(b) Explain the phase relationship between input and output signal voltage and its voltage gain and current gain.

OR

(a) Draw the circuit arrangement for studying the input and the output characteristic of an *n-p-n* transistor in CE configuration. With the help of these characteristics define:

(i) Input resistance

(ii) Current Amplification factor

(b) Describe briefly with the help of a circuit diagram how an *n-p-n* transistor is used to produce self sustained oscillations?

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Solutions

'SECTION – A'

Answer 1: Electric dipole moment is defined as the product of either of the charge and the distance between those charges. It is a vector quantity.

Two electric field lines never cross each other because at the point of intersection two normals can be drawn. Thus there will be two directions of electric field at that point which is not possible.

Answer 2: The loop will acquire a circular shape because each small part of the loop will experience a repulsive force due to the magnetic field from the opposite part of the loop.

Answer 3: Soft iron has a large relative permeability (μ_r). Its presence increases the magnetic flux μ_r times. Hence, the self inductance also increases by same ratio.

Answer 4: There will be an increase in the focal length of the lens, according to the Lens Maker's formula.

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

This happens because the refractive index of glass in water becomes less than the refractive index in air.

Answer 5: Work function, $W = h\nu_0$

$$= 6.63 \times 10^{-34} \times 2 \times 10^{14}$$
$$= 1.326 \times 10^{-19} \text{ J}$$

Hence, the work function of the material is 1.326×10^{-19} J .

Answer 6: Using the formula for current gain,

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$$\beta = \frac{\Delta I_C}{\Delta I_B}$$
$$\text{or } \Delta I_C = \beta \times \Delta I_B$$
$$= 120 \times 100$$
$$= 12000\mu A \text{ or } 12mA$$

The change in collector current I transistor would be 12mA.

Answer 7: This signifies that the electron is bound to the nucleus. Due to electrostatic attraction between electron and nucleus, the P.E. is negative and is greater than K.E. of electron. Total energy of electron is negative hence it cannot escape from the atom.

Answer 8: From Malus Law,

$$I = I_0 \cos^2 30^0$$
$$= \frac{3I_0}{4}$$

Therefore, percentage transmitted is

$$\frac{I_0}{I} \times 100 = \frac{3}{4} \times 100$$
$$= 75\%$$

Hence, 75 % of the incident light is travelled.

'SECTION – B'

Answer 9: According to Lenz's law, the direction of induced emf in a circuit is always such as to oppose the cause of its production.

Thus, if the magnetic flux linked with a closed circuit increases the induced current flows in such a direction so as to create a magnetic flux in the opposite direction of the original magnetic flux. If the magnetic flux linked with the closed circuit decreases, the induced current flows in such a direction so as to create a magnetic flux in the direction

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of the original flux. So we can say that the induced emf has no direction of its own.

Answer 10: Suppose the parallel plat capacitor has plates of area A each. If Q is the charge given to the plates of the capacitor, then the electric field between the plates of the capacitor is given by

$$E = \frac{\sigma}{\varepsilon_0} = \frac{Q}{\varepsilon_0 A}$$

Therefore, electric flux through the plates of the capacitor is

$$\varphi = EA = \frac{Q}{\varepsilon_0}$$

Differentiating each side with respect to time, we have

$$\frac{d\varphi}{dt} = \frac{1}{\varepsilon_0}\frac{dQ}{dt}$$

$$\text{or } \frac{dQ}{dt} = \varepsilon_0 \times \frac{d\varphi}{dt}$$

The term $\varepsilon_0 \frac{d\varphi}{dt}$ is called displacement current. This term has been used to modify and generalize

Ampere's Circuital Law.

Answer 11: Flux linked with a loop is given by

$$\varphi = BA\cos\theta$$

In this case,

$$B = B_0 \sin \omega t \text{ and } \theta = 0^0$$

$$\text{Also, } \varepsilon = -\frac{d\varphi}{dt}, \text{ therefore, we have}$$

$$\varepsilon = -\frac{d}{dt}(AB_0 \sin \omega t)$$

$$= B_0 A\omega \cos \omega t$$

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But $A = \pi a^2$

Hence induced current in the brass loop is

$$I = \frac{\varepsilon}{R} = \frac{B_0 \pi a^2 \omega \cos \omega t}{R}$$

Answer 12: The bulb acts as a resistor. When it is connected to an a.c. source through the capacitor, the circuit is RC circuit, whose impedance,

$$Z = \sqrt{R^2 + X_C^2}$$
$$= \sqrt{R^2 + \frac{1}{\omega^2 C^2}}$$

As frequency $\nu = \frac{\omega}{2\pi}$ of a.c. source is increased, Z decreases.

The current through the bulb increases. Therefore, brightness of the bulb (which corresponds to) increases.

Answer 13: The gate so obtained is an OR Gate.

Output is 0 when both A & B is 0.

Output is 1 when either A & B or either of them is 1.

Thus the truth table for the given circuit is:

A	B	Y
1	0	0
1	1	1
0	0	1
0	1	1

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OR

In a transistor, free electrons and holes are charge carriers. When a transistor is properly biased *i.e.* emitter is forward biased and collector is reverse biased, these charge carriers are responsible for the current through the transistor as well as in external circuit. If the temperature of the transistor increases, some of the covalent bonds may be broken, giving rise to additional number of free electrons and holes. As a result of it, the current in a transistor will be very strong, which may cause large heat and finally may result complete breakdown of semi-conducting device.

Answer 14: The changing electric field produces displacement current, which is very small and hence the magnetic field set up by it is also small, the same cannot be observed easily. In an a.c. circuit displacement current can be increased by increasing the angular frequency of current. This would increase the induced electric field due. In the other hand, the induced electric field due to changing magnetic flux can be increased by taking more number of turns of the coil. The induced emf in different terms of the same coil are added up, resulting in electric field which is easily observed.

Answer 15: As microwaves (1 GHz to 300 GHz) are smaller in wavelengths, hence they can be transmitted as a beam signals in particular direction much better than radio waves because microwaves do not bend around the corners of any obstacle coming in their path.

Answer 16: Here,

$$I_D = 1\text{mA} = 10^{-3}\text{A}$$
$$C = 2\mu\text{F} = 2\times10^{-6}\text{F}$$

$$I_D = I \ (\text{say})$$
$$= \frac{d}{dt}(CV)$$
$$= C\frac{dV}{dt}$$

Therefore,

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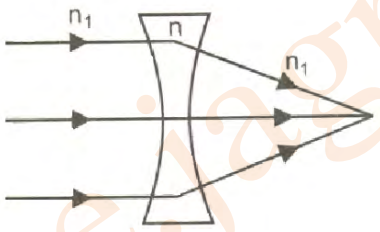
$$\frac{dV}{dt} = \frac{I_D}{C}$$
$$= \frac{10^{-3}}{2\times10^{-6}}$$
$$= 500 \text{ V/s}$$

Therefore, applying a varying potential difference of 500 *V/s* would produce a displacement current of desired value.

'SECTION – C'

Answer 17: The brilliance of diamond is due to total internal reflection of light. μ for diamond is 2.42, so critical angle for diamond air interface is C = 24.4^0 (from sin C = l/μ). The diamond is cut suitably so that light entering the diamond from any face suffers multiple total internal reflections at various faces, and remains within the diamond. Hence the diamond sparkles.

Answer 18:



As $n_1 > n$, light goes from denser to rarer medium. Therefore, in passing through a concave lens, it

converges instead of diverging.

OR

The T'V, transmission involves the television signal waves having the frequency range 80 MHz to 200 MHz. These waves neither follow the curvature of earth nor they get reflected by ionosphere. Therefore, their communication through sky wave is not possible. The reception of television signals is possible either:

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(i) By using communication geostationary satellite which reflects the television signals back to earth. Or

(ii) By using tall receiver antenna which may directly intercept the signals.

Answer 19: Here,

$$\delta_m = 40^0$$
$$A = 60^0$$

$$\text{As} \quad \mu = \frac{\sin\left(A+\delta_m\right)/2}{\sin A/2}$$

$$\therefore \quad \mu = \frac{\sin\left(60^0+40^0\right)/2}{\sin 60^0/2}$$
$$= \frac{\sin 50^0}{\sin 30^0}$$
$$= \frac{0.7660}{0.5000}$$

When prism is immersed in water, we have to take refractive index of glass w.r.t. water;

$$^w\mu_g = \frac{^a\mu_g}{^a\mu_w}$$
$$= \frac{1.532}{1.33}$$
$$= 1.149$$

If $\delta_m^{'}$ is angle of minimum deviation in water, then

$$^w\mu_g = \frac{\sin\left(A+\delta_m^{'}\right)/2}{\sin A/2}$$
$$\sin\left(A+\delta_m^{'}\right)/2 = {}^w\mu_g \times \sin A/2$$
$$= 1.149 \times \sin 30^0$$
$$= \frac{1.149}{2}$$
$$= 0.5745$$

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$$\sin\left(A+\delta_m'\right)/2 = \sin^{-1}(0.5745)$$
$$= 35^0 4'$$
$$A+\delta_m' = 70^0 8'$$
$$\delta_m' = 70^0 8' - A$$
$$= 70^0 8' - 60^0$$
$$= 10^0 8'$$

The new angle of minimum deviation of the parallel beam is $10^0 8'$.

Answer 20: Consider two coherent sources of light with amplitudes a_1 and a_2.
If there is no interference between the light waves, then the intensity of light at any point on the screen will be

$$I = I_1 + I_2$$
$$= a_1^2 + a_2^2 \qquad \ldots (i)$$

We also know,

$$I(\text{max.}) = (a_1 + a_2)^2$$
$$I(\text{min.}) = (a_1 - a_2)^2$$
$$I(\text{avg.}) = I(\text{max.}) + I(\text{min.})/2$$
$$= (a_1 + a_2)^2 + (a_1 - a_2)^2/2$$
$$= a_1^2 + a_2^2 \qquad \ldots (ii)$$

From equations (i) and (ii), it follows that when light energy disappears from the regions of destructive interference, it appears at the regions of constructive interference. Thus, making the average intensity same before and after. In other words, energy is neither created at the region of constructive interference nor is energy destroyed at the regions of destructive interference, and hence the energy remains conserved.

Answer 21: When monochromatic light is incident on a surface separating two media, both reflection and refraction occur due to interaction of light with the atoms at the surface

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of separation. These atoms may be regarded as oscillators. Light incident on such atoms forces them to vibrate with the frequency of light. As the light emitted by these charged oscillators is equal to their own frequency of oscillation, so both the reflected and refracted lights have the same frequency as the frequency of incident light.

Answer 22: The above statement is not correct.

Consider a pulse made of harmonic waves with a large range of wavelengths. Since, the speed of propagation in a medium depends on wavelength, so different wavelength components of the pulse travel with different speeds.

Hence, according to Huygens' theory of wave propagation, the pulse will not retain its shape as it travels through the medium.

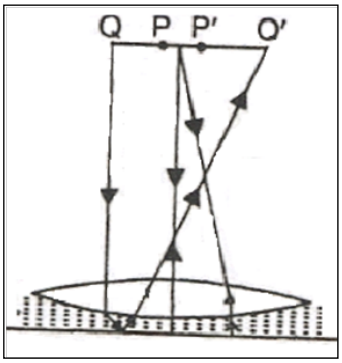
Answer 23: The magnifying power of a microscope is defined as the ratio of the angle subtended by the image at the eye to the angle subtended by the object as seen directly, when both lie at the least distance of distinct vision. The magnifying power of a compound microscope is given by

$$M = \frac{L}{f_0}\left(1+\frac{D}{f_e}\right)$$

The resolving power of a microscope is defined as the reciprocal of the minimum distance *(d)* between two point objects RP, which can just be seen through the microscope as distinct.

Mathematically, we have $\frac{2\mu\sin\theta}{\lambda}$ where μ is the refractive index of the medium between object and objective lens and Θ is half the angle of cone of light from the point object.

Answer 24: From the first measurement, we get the value of focal length F of the combination of equi-convex lens and a plano-concave liquid lens *i.e.,*



F = 15 cm

Focal length of the equi-convex lens f_1 = 10 cm
Focal length of the liquid lens $f_2 = f_L$

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By the formula,

$$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}$$

We have,

$$\frac{1}{15}=\frac{1}{10}+\frac{1}{f_L}$$

$$\text{or } \frac{1}{f_L}=\frac{1}{15}-\frac{1}{10}$$

$$\text{or } f_L=\frac{15\times 10}{10-15}=-30$$

Using Len's maker's formula' for the equi-convex lens, we have

$$\frac{1}{f_e}=(\mu_e-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\text{or } \frac{1}{10}=(\mu_e-1)\left(\frac{2}{10}\right)$$

$$\text{or } \mu_e-1=\left(\frac{5}{10}\right)$$

$$\text{or } \mu_e=1.5$$

Using Len's maker's formula for the plano-convex lens, we have

$$\frac{1}{f_L}=(\mu_L-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\text{or } \frac{10-15}{15\times 10}=(\mu_L-1)\left(\frac{1}{-10}-\frac{1}{\infty}\right)$$

$$\text{or } \mu_L-1=\frac{(15-10)10}{15\times 10}$$

$$\text{or } \mu_L=1.33$$

Hence, the refractive index of the liquid is 1.33.

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Answer 25: Einstein's photoelectric equation is:

$$K_{max.} = h\nu - \varphi_o$$

where; Work function, $\varphi_o = h\nu_o$

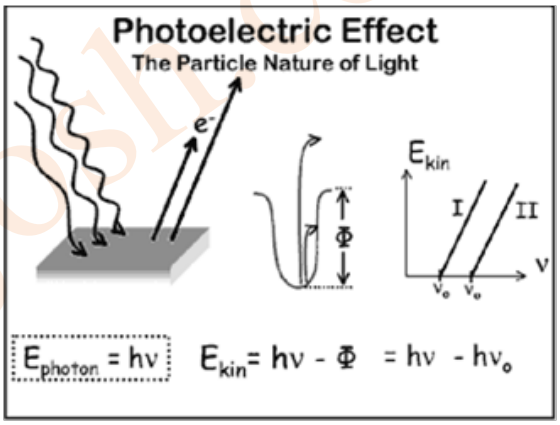
$$K_{max.} = h\nu - h\nu_o$$

$$= h(\nu - \nu_o)$$

$$= h\left(\frac{1}{\lambda} - \frac{1}{\lambda_o}\right)$$

Two properties:

(i) The photoelectric emission is an instantaneous process without any apparent time lag.



(ii) Below threshold frequency no emission of photoelectron takes place.

(iii) Above the threshold frequency, the photoelectric current is directly proportional to the intensity of incident light.

(iv) For a given frequency of the incident radiation the stopping potential is independent of its intensity.

Three observed features are:

Solar Cells: Also called photo-voltaic cells. It converts solar radiations to electrical EMF.

Television Telecast: The dark and bright light parts of images are interpreted as high and low electrical charges as given by photoelectric emission principle. These are further processed and transmitted.

Burglar alarm: The moment the ultraviolet radiation is cut, it stops the supply of photons and thus works as 'off' mode and the ring bells automatically.

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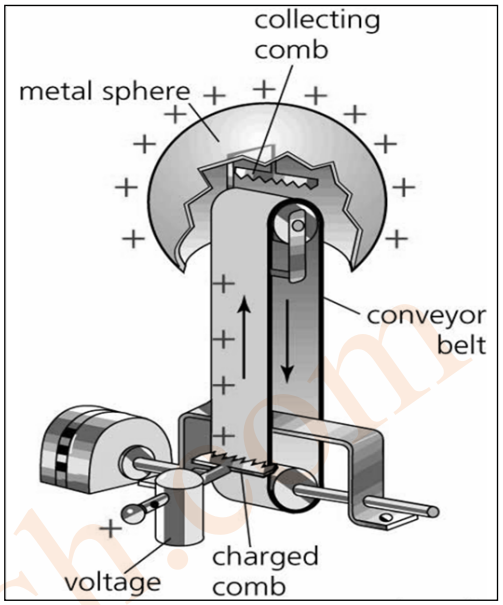
Answer 26: Van de Graff generator can build up high voltages of the order of a few million volts.



Principle: When charge is given to a spherical conducting shell, it spreads uniformly all over the sphere.

Working: There are two pulleys connected by belt driven by motor. A metallic brush is used to give positive charge to belt at lower pulley, which is then transferred to upper pulley. The charge accumulates there where it is received by another metallic brush, connected to the outer spherical shell. Thus a voltage can be generated of few million volts.

It can generate the voltage level, unless it is high enough to breakdown the surrounding air, which is 13.6 kV/cm. It depends on radius of spherical shell of generator.

'SECTION – D'

Answer 27: Magnetic field on the axis of a circular current loop

$I \rightarrow$ Current in the loop

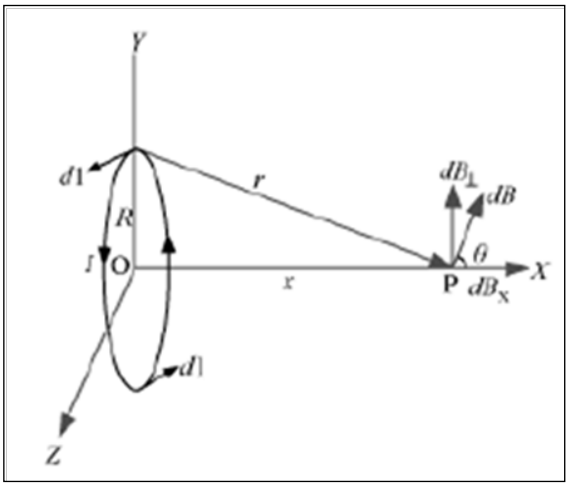
$R \rightarrow$ Radii of the loop

X-*axis* $\rightarrow$ Axis of the loop

$x \rightarrow$ Distance of OP

$dl \rightarrow$ Conducting element of the loop

According to Biot-Savart Law, the magnetic field at P is



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$$dB = \frac{\mu_0 I |dl \times r|}{4\pi r^3}$$

$$r^2 = x^2 + R^2$$

$$|dl \times r| = r\,dl \quad (\because \text{they are perpendicular})$$

$$\therefore dB = \frac{\mu_o}{4\pi} \frac{Idl}{(x^2 + R^2)}$$

dB has two components → dB_x and dB_y.

dB_y is cancelled out and only the x-component remains.

$$dB_x = dB\cos\theta$$

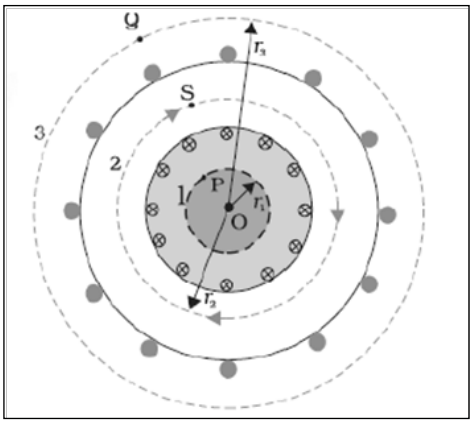
$$\cos\theta = \frac{R}{(x^2 + R^2)^{1/2}}$$

$$dB_x = \frac{\mu_o Idl}{4\pi} \frac{R}{(x^2 + R^2)^{3/2}}$$

Summation of dl over the loop is given by $2\pi R$.

$$\boxed{B = B_x \hat{\mathbf{i}} = \frac{\mu_o I R^2}{2(x^2 + R^2)^{3/2}} \hat{\mathbf{i}}}$$

(b) Toroid is a hollow circular ring on which a large number of turns of a wire are closely wound. Figure shows a sectional view of the toroid. The direction of the magnetic field inside is clockwise as per the right-hand thumb rule for circular loops. Three circular Amperian loops 1, 2 and 3 are shown by dashed lines.



By symmetry, the magnetic field should be tangential to each of them and constant in magnitude for a given loop.

Let the magnetic field inside the toroid be B. We shall now consider the magnetic

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field at S. Once again we employ Ampere's law in the form of,

$$\oint \vec{B}.\vec{dl} = \mu_o I$$
$$\text{or } BL = \mu_o NI$$

Where, L is the length of the loop for which B is tangential, I be the current enclosed by the loop and N be the number of turns.

We find, $L = 2\pi r$.

The current enclosed I is (for N turns of toroidal coil) NI.

$$B(2\pi r) = \mu_o NI$$
$$\text{Therefore, } B = \frac{\mu_o NI}{2\pi r}$$

Open space inside the toroid encloses no current thus, $I = 0$.

Hence, $B = 0$

Open space exterior to the toroid:

Each turn of current carrying wire is cut twice by the loop 3. Thus, the current coming out of the plane of the paper is cancelled exactly by the current going into it.

Hence, $\boldsymbol{I = 0}$ and $\boldsymbol{B = 0}$

This shows that the magnetic field in the open space inside and exterior to the toroid is zero.

OR

(a) A current loop having n turns, each of area A, carrying current I, when placed in a magnetic field $\vec{B}$, experience a torque whose magnitude is given by

$$\tau = nIAB\sin\alpha$$

where α is the angle which the normal on the plane of the current loop makes with the direction of magnetic field, *i.e.* angle between $\vec{A}$ and $\vec{B}$.

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Here,

$n = 2000$

$I = 200 \text{ mA} = 200 \times 10^{-3} \text{A}$

$A = 8 \times 6 \text{ sq.cm} = 48 \times 10^{-4} \text{m}^2$

$B = 0.2 \text{ T}$

(i) Torque acting on the coil will be maximum when sin α = 1 or, α = 90°

Therefore, Maximum Torque,

$$\tau_{max.} = nIAB$$
$$= 2000 \times (200 \times 10^{-3}) \times (48 \times 10^{-4}) \times 0{\cdot}2$$
$$= 0.384 \text{ N-m}$$

In this situation, the plane of the coil is parallel to the direction of magnetic field *i.e.* the plane of the coil is in the direction of X-axis.

(ii) Torque on the coil will be zero, if sin α = 0 or α = 0° or 180°.

It will be so if plane of the coil is perpendicular to the direction of magnetic field *i.e.,* the plane of the coil is along *Y* or Z axis.

The coil will be in stable equilibrium when $\vec{A}$ is parallel to $\vec{B}$ and is unstable equilibrium when $\vec{A}$ is anti parallel to $\vec{B}$.

(b) (i) The magnetic moment *(m)* due to a planar square loop of side *l* carrying current *I* is

$\vec{m} = I\vec{A}$, where $A = l^2$

(ii) The currents in *AB* and *EF* are in the same direction. So *AB* will be attracted towards *EF* with a force F_1, given by

$$F_1 = \frac{\mu_o}{4\pi}\frac{2II_1}{l} \times (\text{length } AB)$$
$$= \frac{\mu_o}{4\pi}\frac{2II_1}{l} l$$
$$= \frac{\mu_o}{4\pi} 2II_1$$

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The currents in *CD* and *EF* are in the opposite direction. So *CD* will experience repulsion away from *EF* with a force F_2, given by

$$F_2 = \frac{\mu_o}{4\pi}\frac{2II_1}{2l} \times (\text{length } CD)$$
$$= \frac{\mu_o}{4\pi}\frac{2II_1}{2l} l$$
$$= \frac{\mu_o}{4\pi} II_1$$

The forces on the portions *BC* and *DA* will cancel out each other's effect. Therefore, net force on loop is

$$\text{Net force} = F_1 - F_2$$
$$= \frac{\mu_o}{4\pi} 2II_1 - \frac{\mu_o}{4\pi} II_1$$
$$= \frac{\mu_o}{4\pi} II_1 \quad \text{towards } EF$$

As $F_1 \neq F_2$, hence no torque acts on loop.

Answer 28: There are three basic postulates for the Bohr's model of an atom:

(a) Every atom consists of a central core called the nucleus; in which entire positive charge and almost entire mass of the atom are concentrated. A suitable number of electrons revolve around the nucleus in circular orbits. The centripetal force required for revolution is provided by the electrostatic force of attraction between the electron and the nucleus..

The electrostatic force of attraction between the nucleus of charge (+Ze) and electron of charge (-e) is:

$$\frac{mv^2}{r} = \frac{KZe^2}{r^2}$$

(b) According to Bohr, electrons revolve only in certain discrete non-radiating orbits called the stationary orbits, for which total angular momentum of the revolving elec-

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tron is an integral multiple of h/2π, where h is Planck's constant.

Thus, angular momentum of the orbiting electron is quantized.

For any stationary orbit,

$$mvr = \frac{nh}{2\pi}$$

(c) The emission/absorption of energy occurs only when an electron jumps from one of its specified non-radiating orbit to another. The difference in the total energy of electron in the permitted orbits is absorbed when the electron jumps from an inner to an outer orbit, and emitted when electron jumps from outer to the inner orbit.

Frequency v is related to change in energy as follows:

$$h\nu = E_2 - E_1$$

The Total Energy of electron revolving in Bohr's stationary orbit

The energy of electron revolving in a stationary orbit is of two types:

Kinetic Energy → Due to Velocity

Potential Energy → Due to Position

From the first postulate of Bohr's atom model,

$$\frac{mv^2}{r} = \frac{KZe^2}{r^2}$$

$$\frac{1}{2}mv^2 = \frac{1}{2}\frac{KZe^2}{r}$$

That is, Kinetic energy of electron $= \frac{1}{2}mv^2 = \frac{KZe^2}{2r}$

Potential due to the nucleus, at any point in the orbit in which electron is revolving

$$\frac{KZe}{r}$$

$$\text{Therefore, Potential energy of electron} = \text{Potential} \times \text{Charge}$$

$$= \frac{KZe(-e)}{r}$$

$$= \frac{-KZe^2}{r}$$

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Total energy of electron in the orbit,

$$E = K.E. + P.E.$$
$$= \frac{1}{2}\frac{KZe^2}{r} - \frac{KZe^2}{r}$$
$$= -\frac{KZe^2}{2r}$$

From the expression for Radii of Bohr's stationary orbits,

$$r = \frac{n^2h^2}{4\pi^2 mKZe^2}$$
$$E = -\frac{2\pi^2 mK^2Z^2e^4}{n^2h^2}$$

Substituting the standard values, we get

$$E = -\frac{21.76Z^2}{n^2} \times 10^{-19} \text{ joule}$$
$$= -\frac{21.76 \times 10^{-19} Z^2}{n^2 \times 1.6 \times 10^{-19}} \text{ eV}$$
$$E = -\frac{13.6Z^2}{n^2} \text{ eV}$$

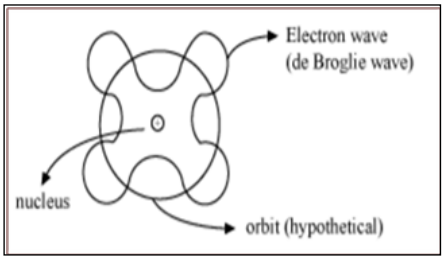
For hydrogen atom, $Z = 1$.

Therefore, $E = -\frac{13.6}{n^2}$ eV

The above equation shows total energy of electron in a stationary orbit is negative, which means the electron is bound to the nucleus and is not free to leave it.

OR

(a) Louis de Broglie introduced a bold hypothesis that like radiation, matter should also have a dual nature. According to him, all material particles in motion have wave nature also. The waves associated with moving particles of matter are called 'de Broglie waves' or 'matter waves'.



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(b) According to de Broglie hypothesis,

$\lambda = \frac{h}{p}$ same for the Bohr's model

It states,

$n\lambda = 2\pi r$

$n\frac{h}{p} = 2\pi r$

$rp = n\frac{h}{2\pi}$

$L = n\frac{h}{2\pi}$ Bohr's 2nd Postulate

Potential energy of electron in ground state of H-atom,

$V = -\frac{1}{4\pi \in_0}.\frac{qq}{r_a}$ (r_a = Bohr's Radius)

$= -27.2eV$ ($V = 2E_0$)

Kinetic energy of electron in this state,

$K = \frac{1}{2}m_e v^2$ (v = velocity of electron in ground state)

$= 13.6eV$ ($K = E_0$)

(c) In case of ${}_3X^7$

$$\frac{\text{neutron number}}{\text{proton number}} = \frac{7-3}{3} = 1.33$$

In case of ${}_3Y^4$

$$\frac{\text{neutron number}}{\text{proton number}} = \frac{4-3}{3} = 0.33$$

For stability, this ratio has to be close to one.

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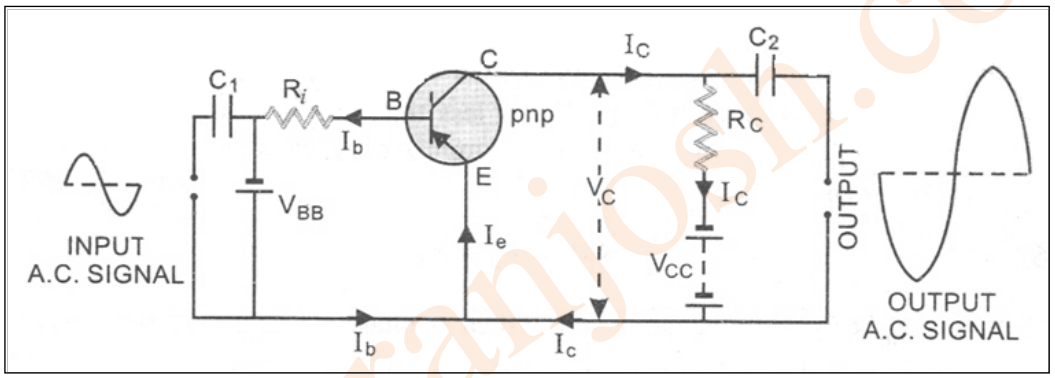
Obviously, nucleus $_3X^7$ is more stable than the nucleus $_3Y^4$.

Answer 29: Here emitter is common to both the input and the output circuits, The input (emitter base) circuit is forward biased with battery V_{BB} of voltage V_{EB}, and the output (collector-emitter) circuit is reversed biased with battery V_{CC} of voltage V_{CEo} Due to this, the resistance of input circuit is low and that of output circuit is high. *Re* is a load resistance connected in collector circuit. The low input a.c. voltage signal is applied across base-emitter circuit and the amplified a.c. voltage signal *(i.e.,* output) is obtained as the change in collector voltage. In circuit diagram arrows represent the direction of conventional current or hole current, which is opposite to the direction of electronic current.



When no a.c. signal voltage is applied to the input circuit but emitter base circuit is closed, let us consider, that I_e ,I_b and I_c be the emitter current, base current and collector current respectively. Then according to Kirchhoff's first law,

$$I_e = I_b + I_c$$

In this case, the output signal voltage obtained across collector is 180^0 out of phase with the input voltage signal.

Phase relationship between input and output voltages:

(a) When the positive half cycle of input a.c. signal voltage comes, it opposes the forward biasing of emitter base circuit. Due to it, the emitter current decreases and hence collector current decreases; consequently the collector voltage V_c increases. Since the collector is connected to the negative terminal of V_{CC} battery of voltage V_{CE}, therefore, the increase in collector voltage means, the collector will become more negative. This indicates that during positive half cycle of input a.c. signal voltage, the

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output signal voltage at the collector varies through negative half cycle, i.e., 180^0 out of phase.

(b) During negative half cycle of input *a.c.* signal voltage, it supports the forward biasing of emitter-base circuit, due to it the emitter current increases and hence collector current increases; consequently the collector voltage V_c decreases *i.e.,* the collector becomes less negative. Thus, the output signal voltage at the collector varies through the positive half cycle, *i.e.,* 180^0 out of phase.

Hence, in common emitter transistor amplifier circuit, the input signal voltage and the output collector voltage are 180^0 out of phase.

Current Gain: It is defined as ratio of change in collector current (ΔI_C) to the change in base current (ΔI_b) at constant collector voltage. It is denoted by $\beta_{a.c.}$

$$\text{Therefore,} \qquad \beta_{a.c.} = \frac{\Delta I_c}{\Delta I_b}$$

Voltage Gain: It is defined as the ratio of the change in output voltage (ΔV_C) to the change in input voltage (ΔV_i).

$$A_V = \frac{\Delta V_C}{\Delta V_i}$$

$$= \frac{\Delta I_C \times R_o}{\Delta I_b \times R_i}$$

$$= \beta_{a.c.} \times \frac{R_o}{R_i}$$

$$= \beta_{a.c.} \times \text{Resistance Gain}$$

Where R_o and R_i are the output and input resistances of the circuit.

Here $\beta_{a.c.} >> \alpha_{a.c.}$, but resistance gain (R_o/R_i) is less than that in case of common base transistor amplifier, hence the a.c. voltage gain in common emitter amplifier is greater as compared to that of common base transistor amplifier.

From the above equation:

$$A_V = \beta_{a.c.} \times \frac{R_o}{R_i}$$

$$= g_m \times R_o$$

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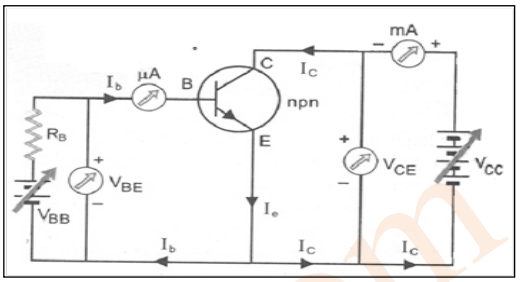
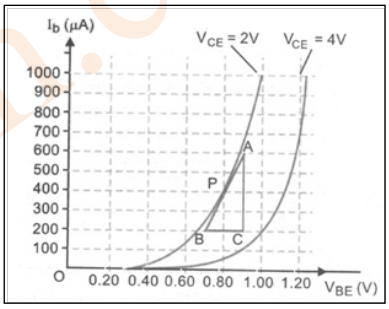
Actually, $A_V = -g_m \times R_o$, here the negative sign indicates phase reversal of output.

OR



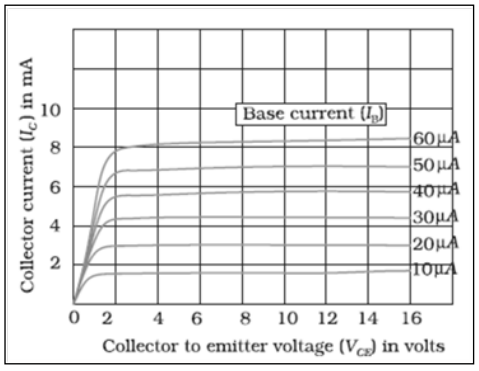
(a) The study of characteristics of a transistor when grounded emitter is kept as a common terminal is as shown in the figure. Base is the input terminal and collector is the output terminal as shown. The various currents are marked keeping in view the condition

$$I_e = I_b + I_c$$



Input Characteristic: The input characteristics of the transistor represent the variation of the base current I_b with base emitter voltage V_{BE}, keeping V_{CE} fixed. Their shape is shown in figure. The current is small as long as V_{BE} is less than the barrier voltage. When V_{BE} is greater than the barrier voltage, the curves look similar to that of a forward biased diode. More than 95% of emitter electrons (in *npn* transistor) and emitter holes (in *pnp* transistor) go to the collector to form the collector current. That is why I_b is much smaller (in micro- ampere).

As long as the collector- emitter junction is reverse biased, the input characteristics are not affected much by small changes in V_{CE}.



Output characteristic: The output characteristic is obtained by observing the variation of I_c as V_{CE} is varied keeping I_b constant. It is obvious that if V_{BE} is increased by a small amount, both hole current from the emitter region and the electron current from the base region will increase. As a consequence both I_b and I_c will increase proportionately. This shows that when I_b increases I_c also increases. The plot of I_c versus V_{CE} for different fixed values of I_b gives one output characteristic. So there will be different output characteristics corresponding to different values of I_b as shown in Figure.

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(i) **Input resistance (r_i):** This is defined as the ratio of change in base-emitter voltage (ΔV_{BE}) to the resulting change in base current (ΔI_b) at constant collector-emitter voltage (V_{CE}). This is dynamic (ac resistance) and as can be seen from the input characteristic, its value varies with the operating current in the transistor:

$$r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)_{V_{CE}}$$

The value of r_i can be anything from a few hundreds to a few thousand ohms.

(ii) **Current amplification factor (β):** This is defined as the ratio of the change in collector current to the change in base current at a constant collector-emitter voltage (V_{CE}) when the transistor is in active state.

$$\beta_{ac} = \left(\frac{\Delta I_c}{\Delta I_b}\right)_{V_{CE}}$$

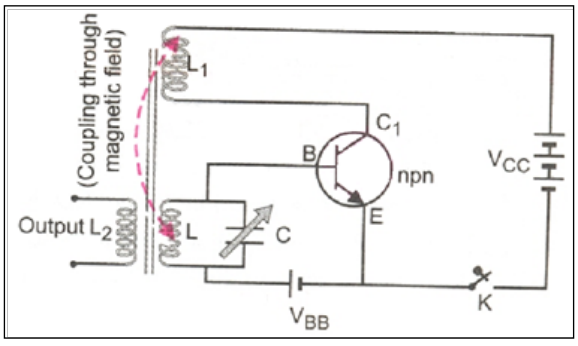
This is also known as small signal current gain and its value is very large.

Also the ratio of I_c and I_b gives dc β of the transistor. Hence,

$$\beta_{dc} = \frac{I_c}{I_b}$$

Since I_c increases with I_b almost linearly and $I_c = 0$ when $I_b = 0$, the values of both β_{dc} and β_{ac} are nearly equal. So, for most calculations β_{dc} can be used. Both β_{ac} and β_{dc} vary with V_{CE} and I_b (or I_c) slightly.

(b) For transistor as an oscillator, the *L-C* circuit is inserted in emitter base circuit of transistor which is forward biased with battery V_{BB}. The collector emitter circuit is reverse biased with battery V_{cc}. A coil L_1 is inserted in collector emitter circuit. It is coupled with L in such a way that if increasing magnetic flux is linked with L, it will support the forward bias of emitter base circuit and if decreasing magnetic flux is linked with L, it will oppose the forward bias of emitter base circuit. Hence, the oscillator will produce self sustained oscillations.



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Chemistry

Guess Paper: 2014
Class: XII

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

General Instructions:

1. All questions are compulsory.
2. There are 30 Questions in all.
3. "Section – A" from 1 to 8 carry 1 mark each.
4. "Section – B" from 9 to 18 carry 2 marks each.
5. "Section – C" from 19 to 27 carry 3 marks each.
6. "Section – D" from 28 to 30 carry 5 marks each.
7. Internal choices have been provided in some questions. Use Log Tables, if necessary.

"Section – A"

Q 1. Arrange the following compounds in order of increasing boiling points.

1–Chloropropane, Isopropyl chloride, 1–Chlorobutane

Q 2. For the reaction: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

If $\frac{\Delta[NH_3]}{\Delta t} = 4 \times 10^{-8}\, mol^{-1}s^{-1}$, what is the value of $-\frac{\Delta[H_2]}{\Delta t}$?

Q 3. 'Crystalline solids are anisotropic in nature.' What does this statement mean?

Q 4. What would happen if no salt bridge were used in an electrochemical cell (like Zn–Cu cell)?

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Q 5. $CuSO_4.5H_2O$ is blue in colour while $CuSO_4$ is colourless. Why?

Q 6. Draw the structure of XeO_3 molecule?

Q 7. Write the structural formula and IUPAC name of isobutyl alcohol?

Q 8. Arrange the following in order of decreasing ease of dehydration:

$(CH_3)_3COH$, CH_3CH_2OH, $(CH_3)_2CHOH$

"Section – B"

Q 9. The chemistry of corrosion of iron is essentially an electrochemical phenomenon. Explain the reactions occurring during the corrosion of iron in the atmosphere.

Q 10. State Raoult's law for a solution containing volatile liquids. Explain with suitable example the concept of maximum boiling azeotropes.

Q 11. An aqueous solution containing urea was found to have to have boiling point more than the normal boiling point of water (373.13 K). When the same solution was cooled it was found that its freezing point is less than the normal freezing point of water (273.13 K). Explain these observations.

Q 12. Propose mechanism of the reaction taking place when:

(a) (–) – 2 – Bromo – octane reacts with sodium hydroxide to form (+) – octane – 2 – ol.

(b) 2-Bromo pentane is heated with alcoholic KOH to form alkenes.

OR

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State reasons for each of the following:

(a) All the P-Cl bonds in PCI_5 molecule are not equivalent.

(b) Sulphur has greater tendency for catenation than oxygen.

Q 13. Assign reasons for the following:

(a) Transition metal fluorides are ionic in nature whereas bromides and chlorides are usually covalent in nature.

(b) Chemistry of all the lanthanoids is quite similar.

Q 14. Explain the following giving one example for each:

(a) Cannizzaro Reaction

(b) Reimer–Teimann Reaction

Q 15. Describe a chemical test in each case to distinguish between the following pairs of compounds:

(a) Aniline and N-ethylaniline.

(b) N-Methyl propan-2- amine and N-Ethyl- N -methylethanamine.

Q 16. What is essentially the difference between α-form of glucose and β-form of glucose Explain?

Q 17. Describe what you understand by primary structure & secondary structure of proteins.

Q 18. How do antiseptics differ from disinfectants? Give one example of each.

"Section – C"

Q 19. Silver crystallizes in face-centred cubic unit cell. Each side of this unit cell has a length of 400 pm. Calculate the radius of the silver atom. (Assume the atoms just touch each other on the diagonal across the face of the unit cell. That is each face atom is touching the four corner atoms.)

Q 20. Nitrogen pentoxide decomposes according to equation

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$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$

This first order reaction was allowed to proceed at 40 °C and the data below were collected:

$[N_2O_5]$ (M)	Time (min)
0.400	0.00
0.289	20.0
0.209	40.0
0.151	60.0
0.109	80.0

(a) Calculate the rate constant. Include units with your answer.
(b) What will he the concentration of N_2O_5 after 100 minutes?
(c) Calculate the initial rate of reaction.

Q 21. (a) On the basis of Hardy-Schulze rule explain why the coagulating power of phosphate is higher than chloride.

(b) Do the vital functions of the body such as digestion get affected during fever? Explain your answer.

OR

Give reasons:

(a) Gelatine is generally added to ice-creams.

(b) Effect of prolonged dialysis.

(c) Peptising agent is added to convert precipitate into colloidal solution.

Q 22. Describe the principle behind each of the following processes:
(i) Vapour phase refining of a metal.

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(ii) Electrolytic refining of a metal.
(iii) Recovery of silver after silver ore was leached with NaCN.

Q 23. Complete the following chemical equations:

(i) $CH_3CH_2NH_2 + CHCl_3 + Alc.KOH \rightarrow$

(ii) $KMnO_4 \xrightarrow{Heated}$

(iii) $Cr_2O_7^{2-} + H_2S + H^+ \rightarrow$

Q 24. Write the name, stereochemistry and magnetic behaviour of the following:
(Atomic numbers: Mn = 25, Co = 27, Ni = 28)

(i) $K_4[Mn(CN)_6]$

(ii) $[Co(NH_3)_5Cl]Cl_2$

(iii) $K_2[Ni(CN)_4]$

Q 25. Answer the following:

(a) Alcohols are more soluble in water than the hydrocarbons of comparable molecular masses.

(b) C — X bond length in halobenzene is smaller than C — X bond length in CH_3 — X.

(c) Of the two bromo derivatives, $C_6H_5CH(CH_3)Br$ and $C_6H_5CH(C_6H_5)Br$, which one is more reactive in S_N1 substitution reaction and why?

Q 26. (a) Explain why an alkyl-amine is more basic than ammonia.

(b) How would you convert
(i) Aniline to nitro-benzene
(ii) Aniline to iodo-benzene?

Q 27. Describe the following giving one example for each

(a) Tranquilizers
(b) Artificial sweetener
(c) Antihistamines

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"Section – D"

Q 28. The experimental data for decomposition of N_2O_5

$$2N_2O_5 \rightarrow 4NO_2 + O_2$$

In gas phase at 318K are given below:

t(s)	0	400	800	1200	1600	2000	2400	2800	3200
$10^2 \times [N_2O_5]\ mol/l$	1.63	1.36	1.14	0.93	0.78	0.64	0.53	0.43	0.35

(a) Plot $[N_2O_5]$ against t.

(b) Find the half-life period for the reaction.

(c) Draw a graph between log $[N_2O_5]$ and t.

(d) What is the rate law?

(e) Calculate the rate constant.

(f) Calculate the half-life period from k and compare it with (b).

OR

(a) In a reaction between A and B, the initial rate of reaction (r_0) was measured for different initial concentrations of A and B as given below:

A/ mol L^{-1}	0.20	0.20	0.40
B/ mol L^{-1}	0.30	0.10	0.05
r_0/ mol L^{-1} s^{-1}	5.07×10^{-5}	5.07×10^{-5}	1.43×10^{-4}

What is the order of the reaction with respect to A and B?

(b) The time required for 10% completion of a first order reaction at 298 K is equal to that required for its 25% completion at 308 K. The value of A is $4 \times 10^{10}\ s^{-1}$. Calculate k at 318 K and E_a.

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Q 29. (a) (i) Ammonia (NH3) has a higher boiling point than phosphine (PH3).

(ii) SO_2 is a gas while SeO_2 is a solid at room temperature.

(b) Complete the following reaction:

(i) $Cu + H_2SO_4 \rightarrow$

(ii) $SCl_2 + NaF \rightarrow$

(c) Why is $Ka_2 << Ka_1$ for H_2SO_4 in water?

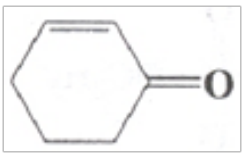
OR

(a) The HNH angle value is higher than HPH, HAsH and HSbH angles. Why?

(b) Differentiate between the basic oxide, acidic oxide and amphoteric oxide?

(c) How is ozone produced in the atmosphere? What are the possible advantages of the ozone layer present in the upper atmosphere? Why is ozone not present in the lower layer of atmosphere?

Q 30. (a) An alkyl halide 'X' on reaction with aq. NaOH gives a product capable of being resolved into optical isomer. Write the structure and IUPAC name of 'X'?

b) What is the expected product from the reactions of  with

(i) $LiAlH_4$

(ii) H_2/Pt

(c) Convert:

(i) Ethanal into 2 – hydroxyl – 3 – butenoic acid.

(ii) Methanal into n– butane

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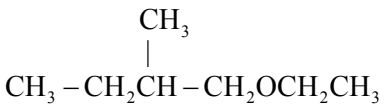
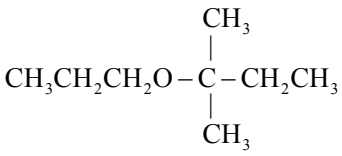
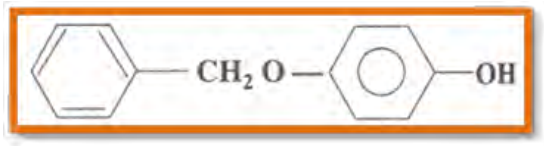
OR

(a) Give the products that are formed by heating each of the following compounds of ether with HI:

(i) 

(ii) 

(iii) 

(b) Organic compound **A** (C_3H_sO) gives a sweet smelling compound on reaction with CH_3COOH in the presence of an acid. On dehydrogenation, **A** gives another organic compound B (C_3H_6O), **B** gives a crystalline product with sodium hydrogen sulphite and oxidation of **B** with $K_2Cr_2O_7$ / H_2SO_4 gives propionic acid. Write the structure of compound **A** and **B** and explain the reactions involved.

(c) Give reasons:

(i) Lower ethers are soluble in water, alkanes are not.

(ii) $CH_2 = CH - O - CH_2CH_3$ is less soluble in water than $CH_3CH_2OCH_2CH_3$.

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Solutions

"Section – A"

Answer 1: The order of increasing boiling point is:

Isopropyl Chloride < 1–Chloropropane < 1–Chlorobutane

Answer 2: The rate of the reaction $= -\frac{1}{3}\frac{\Delta[H_2]}{\Delta t} = +\frac{1}{2}\frac{\Delta[NH_3]}{\Delta t}$

$$-\frac{1}{3}\frac{\Delta[H_2]}{\Delta t} = +\frac{1}{2}\frac{\Delta[NH_3]}{\Delta t}$$

$$-\frac{1}{3}\frac{\Delta[H_2]}{\Delta t} = \frac{1}{2}\times 4\times 10^{-8}\,mol^{-1}s^{-1}$$

$$-\frac{\Delta[H_2]}{\Delta t} = \frac{3}{2}\times 4\times 10^{-8}\,mol^{-1}s^{-1}$$

$$-\frac{\Delta[H_2]}{\Delta t} = 6\times 10^{-8}\,mol^{-1}s^{-1}$$

The value of $-\frac{\Delta[H_2]}{\Delta t}$ is $6\times 10^{-8}\,mol^{-1}s^{-1}$.

Answer 3: The anisotropic nature of crystalline solids is due to the fact that they show different values for the physical properties like refractive index, electrical conductivity; on passing through different directions (the three dimensions) in the same crystal.

Answer 4: If no salt bridge were used in electrochemical cell, the metal ions $\left(Zn^{2+}\right)$ formed by the loss of electrons will accumulate in one electrode and the negative ions $\left(SO_4^{2-}\right)$ will accumulate in the other. Thus, the solution will develop charges and the current stops flowing. Moreover, inner circuit is not completed.

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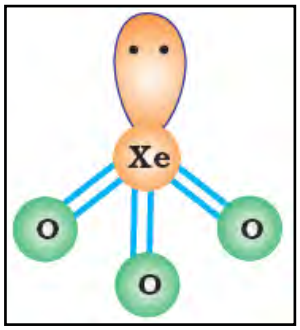
Answer 5: In $CuSO_4.5H_2O$, $4H_2O$ molecules are present as ligand. Crystal field splitting occurs and *d–d* transition occurs which gives it blue colour. In $CuSO_4$, there are no H_2O molecules present as ligand. No crystal field splitting occurs and hence it has no colour.

Answer 6: The structure of XeO_3 molecule is:



Answer 7: The structural formula for isobutyl alcohol is:

$$CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle |}{CH}}-CH_2OH$$

The IUPAC name is: 2–Methyl propane–1–ol

Answer 8: The relative ease of dehydration of alcohols is found high in tertiary alcohols and least in primary alcohols. So the order would be:

$$(CH_3)_3\,COH > (CH_3)_2\,CHOH > CH_3CH_2OH$$

"Section – B"

Answer 9: Corrosion is a redox reaction. In this reaction, simultaneous oxidation and reduction reactions takes place at cathode & anode. Because of presence of air and moisture, oxidation takes place anode. The point where oxidation takes place, it behaves as the anode.

Anode:

$$Fe_{(s)} \rightarrow Fe^{2+}_{(aq)} + 2e^-$$

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Electrons released at the anodic position move through the metallic object and go to another position of the object. Presence of H ions helps the electrons to reduce molecular oxygen. This point behaves as the cathode. These H^+ ions come either from H_2CO_3, which are formed due to the dissolution of carbon dioxide from air into water or from the dissolution of other acidic oxides from the atmosphere in water.

Cathode:

$$O_{2(g)} + 4H^+_{(aq)} + 4e^- \rightarrow 2H_2O_{(l)}$$

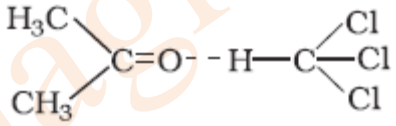
The overall reaction is:

$$2Fe_{(s)} + O_{2(g)} + 4H^+_{(aq)} \rightarrow 2Fe^{2+}_{(aq)} + 2H_2O_{(l)}$$

Ferrous ions are further oxidized by atmospheric oxygen to ferric ions. These ferric ions combine with moisture & forms hydrated ferric oxide i.e., rust.

Answer 10: Raoult's Law: For a solution of volatile liquids, the partial pressure of each component in a solution is directly proportional to its mole fraction.

Maximum boiling azeotropes are formed by the solution showing large negative deviation from Raoult's law form the maximum boiling azeotropes; for e.g., mixture of chloroform and acetone.



The hydrogen bond formation decreases the escaping tendency of molecules for each component and consequently the vapour pressure decreases resulting in negative deviation from Raoult's law and thus leads to high boiling point.

Answer 11: The vapour pressure of the aqueous solution containing urea is less than the vapour pressure of pure water because urea is a non-volatile solute. To boil this solution we have to heat it to the temperature higher than the normal boiling point of water.

To freeze the solution the temperature is lowered, the vapour pressure of solution also lowers. The vapour pressure of solution equalizes the vapour pressure of solid solvent at temperature lower than the normal freezing point of water.

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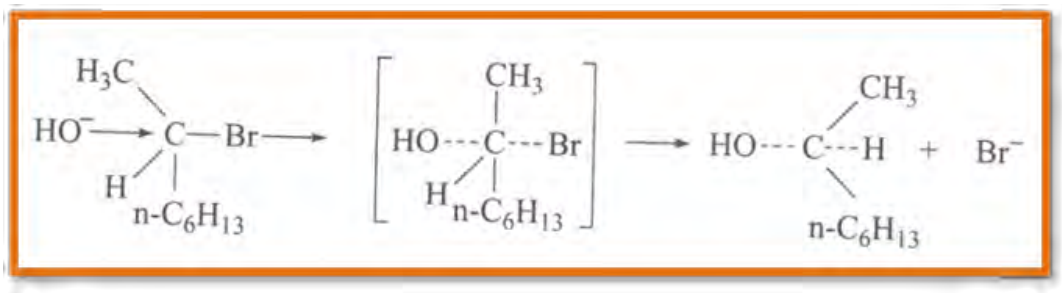
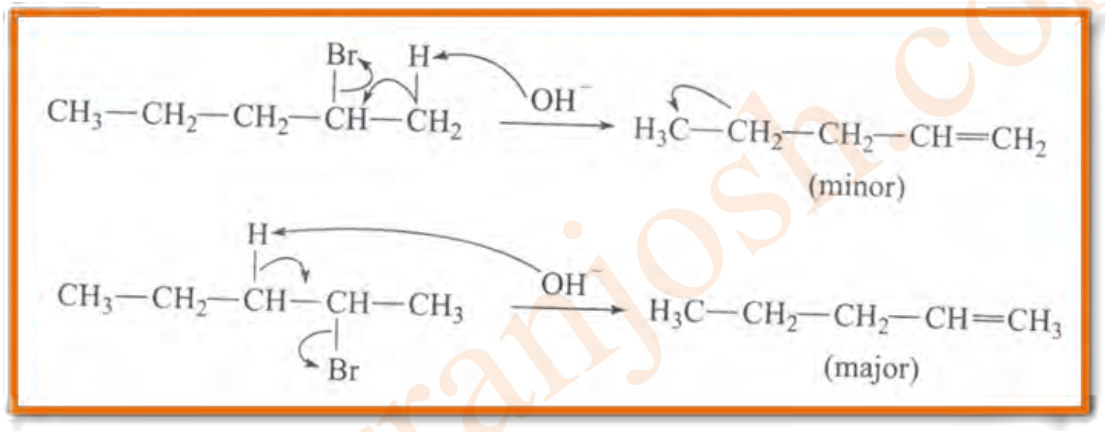
nswer 12: (a) The reaction mechanism is:



(b) The reaction mechanism for the formation of alkenes is:



OR

(a) In PCl_5, there is trigonal bipyramidal geometry. In this structure, the two axial P— Cl bonds are longer than the three equatorial P — Cl bonds. Thus, axial bonds are less stable. This is because of the greater bond pair - bond pair repulsion in the axial bonds. Hence, all the bonds in PCl_5 are not equivalent.

(b) S — S bonds are stronger as compared to O—O bonds. Thus, sulphur has a greater tendency for catenation than oxygen.

Answer 13: (a) As electro negativity of halogens decreases in the order F > Cl > Br, the ionic character of transition metal halides decreases in the order M – F > M – Cl > M – Br. Hence, fluorides are ionic whereas chlorides and bromides are covalent.

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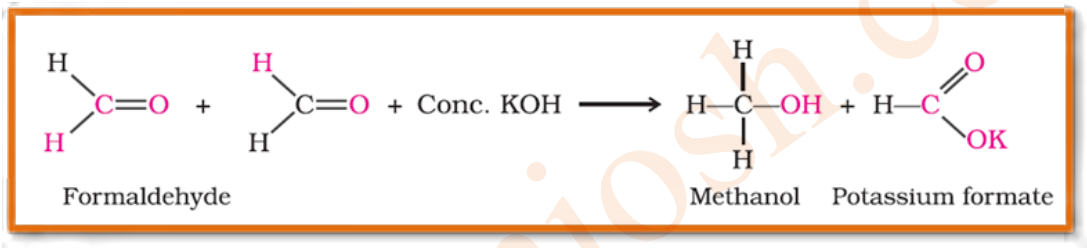
(b) The change in size of the lanthanoids due to lanthanoids contraction is very small as we proceed from La (Z = 57) to Lu (Z = 71). Hence, their chemical properties are similar. Moreover, their valence shell configuration remains the same because the electrons are added into the inner 4 *f*–subshell. Hence, they show similar characteristics.

Answer 14: (a) Cannizzaro Reaction: Aldehydes do not contain a α-hydrogen atom, when treated with concentrated alkali solution; undergo disproportionation, i.e., self oxidation – reduction. As a result one molecule of the aldehyde is reduced to the corresponding alcohol at the cost of the other which is oxidised to the corresponding carboxylic acid. This reaction is called Cannizzaro reaction. For example: the reaction of formaldehyde in the presence of conc. KOH leads to formation of methanol and potassium formate.



(b) Reimer–Teimann Reaction: Treatment of phenol with chloroform in the presence of aqueous sodium or potassium hydroxide (electrophilic substation reaction) at 340 K followed by hydrolysis of the resulting product gives salicylaldehyde. This reaction is called Reimer–Teimann reaction.sulting product gives salicylaldehyde. This reaction is called Reimer–Teimann reaction.

Answer 15: (a) Aniline is a primary amine. Therefore it gives carbyamine test, i.e., when heated with an alcoholic solution of KOH and $CHCl_3$, it gives offensive smell of phenyl isocyanide. But N-ethyl aniline is secondary amine and hence does not give carbylamine test.

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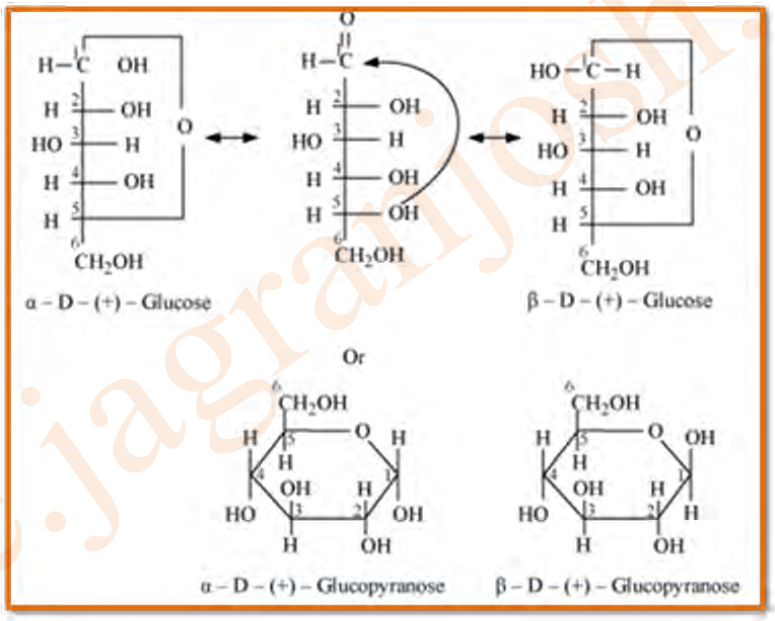
(b) N-methylpropan-2 amine is a secondary amine. On adding Hinsberg's reagent compound is formed which is soluble in aqueous NaOH. But N-ethyl-N-methylethamine does not react with Hinsberg's reagent.

Answer 16: α -form of glucose and β -form of glucose can be distinguished by the position of hydroxyl group on the first carbon atom.

In open chain β -glucose, the hydroxyl group on the first carbon atom is present towards the left side whereas in the closed ring β –glucose, the hydroxyl group on the first carbon atom is above the plane of the ring.

In open chain α –glucose, the hydroxyl group on the first carbon atom is towards the right whereas, in the closed ring α -glucose, the hydroxyl group on the first carbon atom is below the plane of the ring.



Answer 17: Primary structure of proteins: In this structure, each polypeptide chain of a protein has amino acids. These amino acids are linked with each other in a specific sequence.

Secondary structure of proteins: This structure refers to the shape in which a long polypeptide can exist.

There are two different secondary structures possible:

(a) Helical structure: In this, a polypeptide chain forms all possible hydrogen bonds by twisting

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into a helix with —NH group of each amino acid residue and hydrogen bonded to > C = O of an adjacent turn of helix.

(b) b–pleated structure: In this, all peptide chains are stretched out to their maximum extensions and then laid side by side which are held together by intermolecular hydrogen bonds.

Answer 18: Antiseptics: They are chemical substances which prevent the growth of micro-organisms and may even kill them but are not harmful to human or animal tissues. For example, dettol and savlon. They are generally applied on wounds, cuts, ulcers and diseased skin surfaces.

Disinfectants: They are chemical substances which kill micro-organisms but are not safe to be applied to the living tissue. These are generally used to kill micro-organisms present in the drains, toilets, floors, etc. Some common examples are phenol and chlorine.

"Section – C"

Answer 19: For a fcc structure,

$$r = \frac{a}{2\sqrt{2}}$$

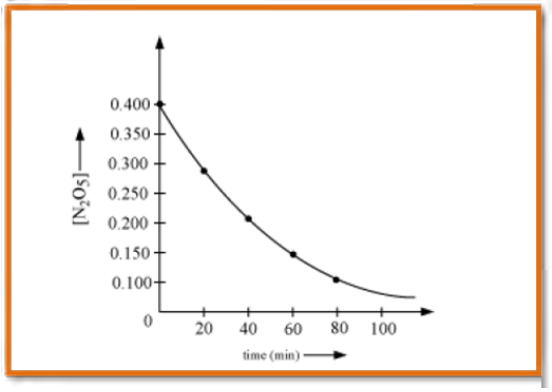
$$a = 400 \text{ pm} = 400 \times 10^{-10} \text{ cm}$$

$$r = \frac{400 \times 10^{-10}}{2 \times 1.414}$$

$$r = 141.4 \text{ pm}$$

Thus, the radius of the silver atom is 141.4 pm

Answer 20: (a)



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(b)

$[N_2O_5]$ (M)	Time (min)	$\log [N_2O_5]$
0.400	0.00	-0.3979
0.289	20.0	-0.5391
0.209	40.0	-0.6798
0.151	60.0	-0.8210
0.109	80.0	-0.9625

From this plot,

$$\text{Slope} = \frac{-0.70-(-0.60)}{40-20}$$

$$= \frac{-0.10}{20}$$

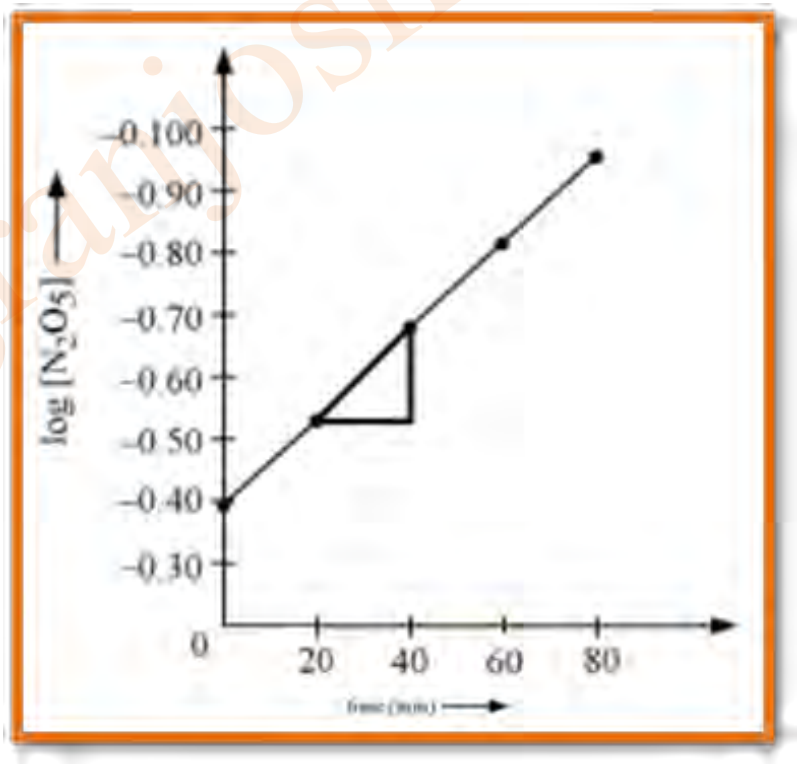
Also, Slope of the line $= \frac{-k}{2.303}$

Thus,

$$\frac{-k}{2.303} = \frac{-0.10}{20}$$

$$k = 0.0115$$

$$k = 1.15\times10^{-3}\ \text{min}^{-1}$$



(*b*)

$$k = \frac{2.303}{t}\log\frac{[N_2O_5]_0}{[N_2O_5]_t}$$

After 100 min,

$$k = \frac{2.303}{100}\log\frac{0.4}{0.098}$$

$$k = 0.1406\,\text{min}^{-1}$$

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(c)

$r = k[N_2O_5]$

$r = 1.15 \times 10^{-3} \times 0.4$

$r = 4.6 \times 10^{-4}\ s^{-1}$

Answer 21: (a) Coagulating power of an electrolyte depends upon the charge on the ion having charge opposite to that of colloidal particles. Greater the change on the oppositely charged ion, small is its amount required for coagulation and hence greater is its coagulating power. Hence, for a positively charged sol, PO_4^{3-} ion with three units of negative charge has greater coagulating power than Cl^- ion with one unit negative charge.

(b) Yes, vital functions of the body are affected during fever. This is because biological reactions taking place in our body are catalysed by enzymes. These enzymes show maximum activity in the temperature range 298 – 310 K. During fever, when temperature rises above 310 K, enzymatic activity becomes less.

OR

(a) Ice cream is an emulsion of milk and cream in water, i.e., oil–in–water type. Gelatine is added to act as an emulsifier, i.e., it helps to stabilise the emulsion.

(b) On prolonged dialysis, even the very small amount (trace amount) of the electrolyte which stabilises the sol is completely removed. Hence, the sol becomes unstable and its coagulation takes place.

(c) Ions (either positive or negative) of peptising agent (electrolyte) are adsorbed on the particles of the precipitate. They repel and hit each other breaking the particles of the precipitate into colloidal size.

Answer 22: (a) Vapour phase refining of a metal: It is the process of refining metal by converting it into its vol-

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atile compound and then, decomposing it to obtain a pure metal. To carry out this process, metal should form a volatile compound with an available reagent, and the volatile compound should be easily decomposable so that the metal can be easily recovered.

(b) Electrolytic refining: In this process, impure metals are refined through the use of electricity; by anode being made of impure metal and cathode being made of a strip of pure metal. A solution of a soluble salt of the same metal is taken as the electrolyte. When an electric current is passed, metal ions from the electrolyte are deposited at the cathode as pure metal and the impure metal from the anode dissolves into the electrolyte in the form of ions. The impurities present in the impure metal gets collected below the anode. This is known as anode mud.

Anode:

$M \rightarrow M^{n+} + ne^-$

Cathode:

$M^{n+} + ne^- \rightarrow M$

(c) Leaching: The powdered ore is digested with a dilute sodium cyanide while a current of air is continuously passed. As a result, silver pass into the solution forming sodium dicyanoargentate (I) while the impurities remain unaffected which are filtered off.

$$Ag_2S + 4NaCN \rightarrow \underset{\text{Sod. dicyanoargentate(I)}}{2Na\left[Ag(CN)_2\right]} + Na_2S$$

Answer 23: (*i*) $CH_3CH_2NH_2 + CHCl_3 + 3\text{KOH}_{(\text{alc.})} \rightarrow CH_3CH_2 - NC + 3KCl + 3H_2O$

(*ii*) $KMnO_4 \xrightarrow{Heated} K_2MnO_4 + MnO_2 + O_2$

(*iii*) $Cr_2O_7^{2-} + H_2S + H^+ \rightarrow 2Cr^{3+} + 7H_2O + 3S$

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Answer 24: (1) $K_4\left[Mn(CN)_6\right]$

Name: - Potassium hexacyanomanganate (II)
Stereochemistry - Does not show geometric or optical isomerism
Magnetic behaviour — Paramagnetic

(2) $\left[Co(NH_3)_5Cl\right]Cl_2$

Name -Pentaamminechloridocobalt (III) Chloride
Stereochemistry- Does not show geometric isomerism but is optically active
Magnetic behaviour- Paramagnetic

(3) $K_2\left[Ni(CN)_4\right]$

Name - Potassium tetracyanonickelate (II)
Stereochemistry - Does not show geometric or optical isomerism
Magnetic behaviour- Diamagnetic

Answer 25: (a) Alcohols form Hydrogen-bonding with water due to the presence of −OH group whereas hydrocarbons cannot form Hydrogen-bonding with water due to non-polar nature. As a result, alcohols are comparatively more soluble in water than hydrocarbons of comparable molecular masses.

(b) Because of resonance in halobenzene, C—X acquires partial double bond character. On the other hand, no resonance takes place in CH_3—X.

We know that, bond length of double bond is smaller than single bond. Thus, C—X bond length in halobenzene is smaller than C-X bond length in CH3-X.

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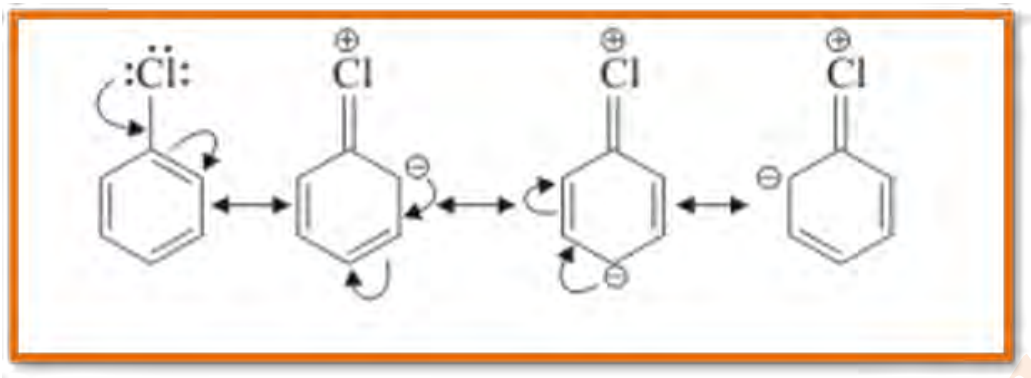
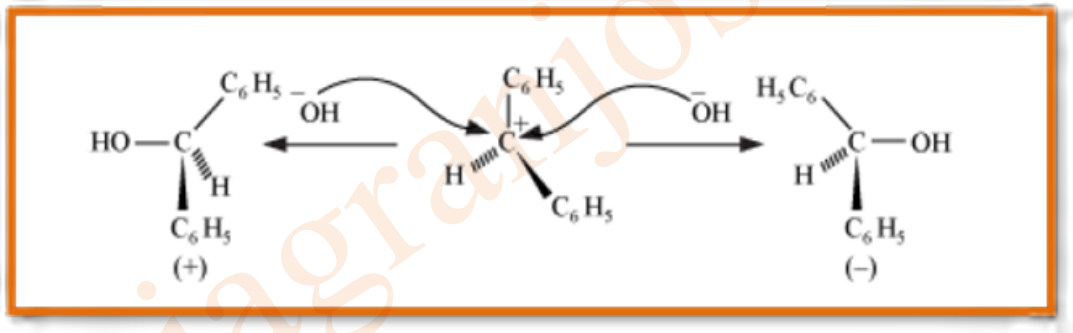


(c) C_6H_5CH (C_6H_5) Br will be more reactive towards S_N1 substitution reaction because S_N1 substitution reaction involves the formation of carbocation which is not affected by the presence of bulky groups



Answer 26: (a) The basicity of amines depends on the +I effect of the alkyl groups. In alkyl-amine, $-CH_3$ groups increase the electron density on the nitrogen atom and thus increases the basicity whereas in ammonia - CH_3 groups are absent. Thus, alkyl-amine is more basic than ammonia

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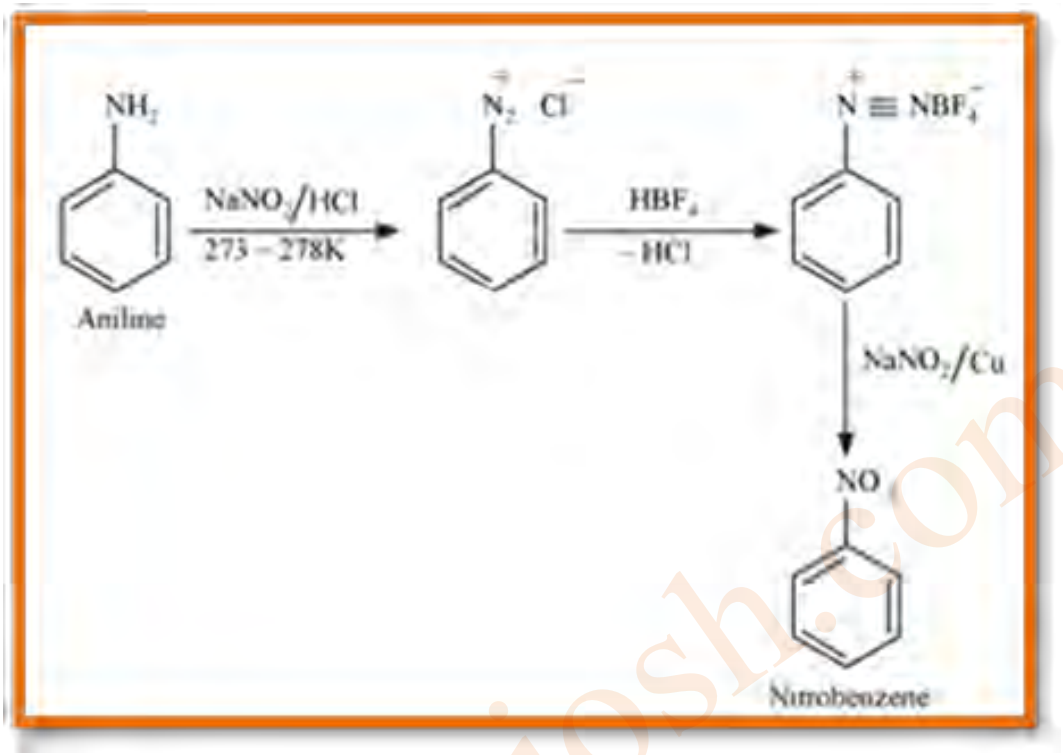
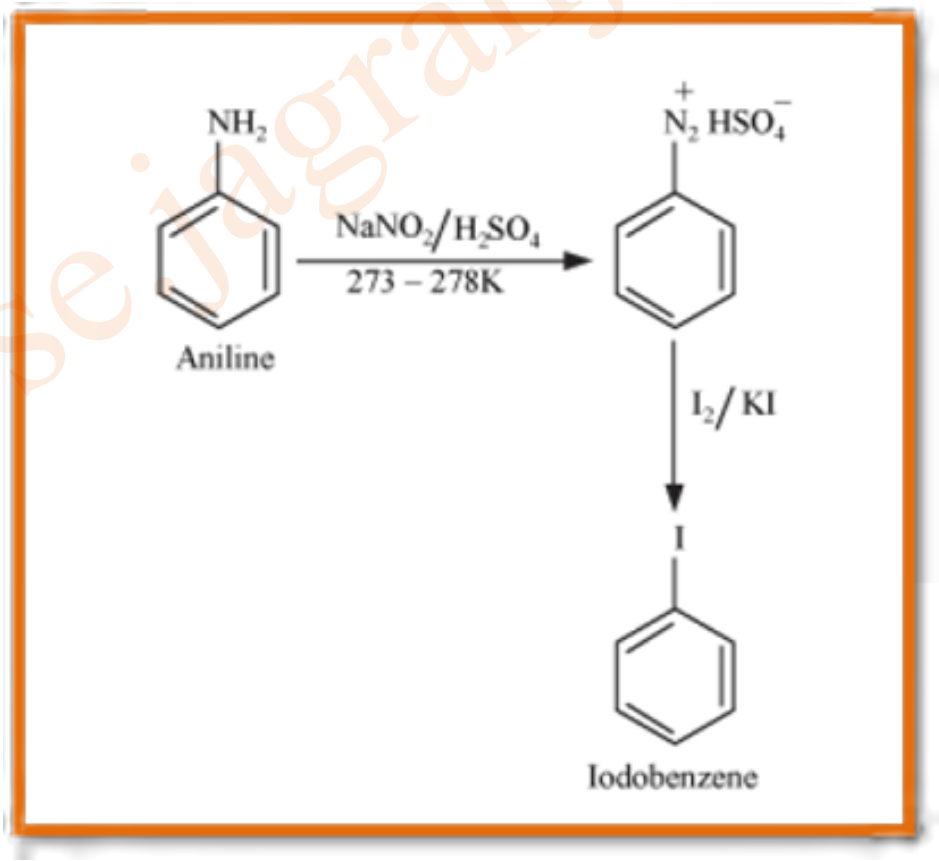
(b) (i)



(ii)



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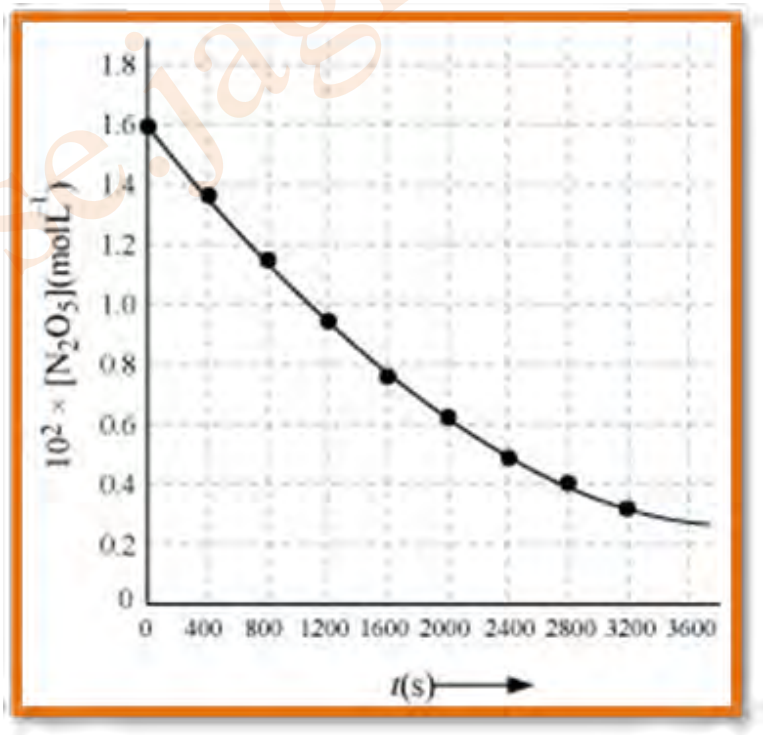
Answer 27: (a) Tranquilizers: These are chemical substances which reduces anxiety, stress by acting on-nerve centres. These drugs induce sleep and have a habit forming effect. They form an essential component of sleeping pills.

(b) Artificial sweetener: These are the compounds which are added to food to give sweet taste without increasing the calories. Examples: Sacchrin, aspartame.

(c) Antihistamines: These are anti-allergic drugs and are used to treat allergy, e.g., skin rashes, conjunctivitis, nasal discharge, etc. Allergy is caused due to the liberation of histamine in the body. Example: Chloropheiramine, promethazine.

"Section – D"

Answer 28: (a)



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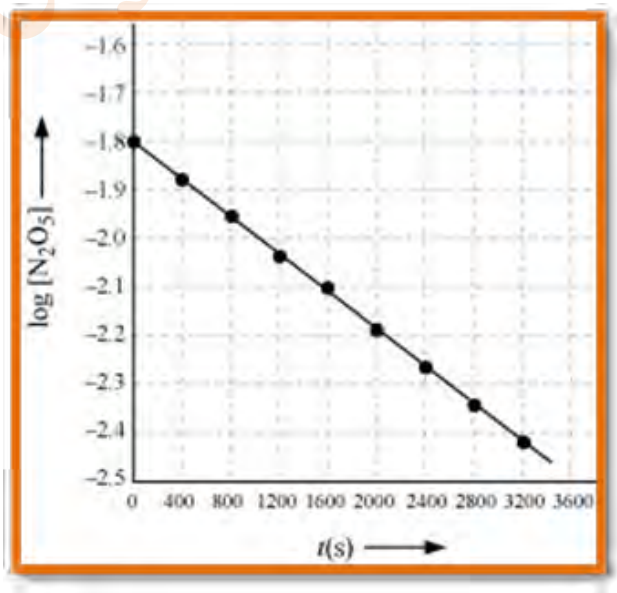
(b) The concentration = $\frac{1.63\times100}{2} = 81.5\ mol/l$ is corresponds to the half life.

From the graph, we can say that the half life = 1450 s.

(c)

t(s)	$10^2\times[N_2O_5]\ mol/l$	$\log[N_2O_5]$
0	1.63	− 1.79
400	1.36	− 1.87
800	1.14	− 1.94
1200	0.93	− 2.03
1600	0.78	− 2.11
2000	0.64	− 2.19
2400	0.53	− 2.28
2800	0.43	− 2.37
3200	0.35	− 2.46



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(d) The plot, $\log[N_2O_5]$ v/s t, is a straight line. Therefore, the given reaction is of the first order. The rate law of the reaction is

$$\text{Rate} = k[N_2O_5]$$

(e) From the plot, we have

$$\text{slope} = \frac{-2.46-(-1.79)}{3200-0}$$

$$= \frac{-0.67}{3200}$$

Slope of the line of the plot is $= -\frac{k}{2.303}$

Thus, $-\frac{k}{2.303} = -\frac{0.67}{3200}$

$$k = 4.82\times10^{-4}\ \text{sec}^{-1}$$

(f) Half-life of the given reaction is,

$$t_{1/2} = \frac{0.639}{k}$$

$$= \frac{0.693}{4.82\times10^{-4}}s$$

$$= 1.438\times10^{3}\,s$$

$$= 1438\ s$$

This value, 1438 s, is very close to the value that was obtained from the graph.

OR

(a) Let the order of the reaction with respect to A is x and with respect to B be y.

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Hence, rate of reaction will be

$$r_0 = k[A]^x [B]^y$$

$$5.07\times10^{-5} = k[0.20]^x [0.30]^y \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

$$5.07\times10^{-5} = k[0.20]^x [0.10]^y \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

$$1.43\times10^{-4} = k[0.40]^x [0.05]^y \quad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Dividing equation (1) by (3),

$$\frac{5.07\times10^{-5}}{5.07\times10^{-5}} = \frac{k[0.20]^x [0.30]^y}{k[0.20]^x [0.10]^y}$$

$$1 = \frac{[0.30]^y}{[0.10]^y}$$

$$[3]^y = 1$$

$$y = 0$$

Dividing equation (3) by (2),

$$\frac{1.43\times10^{-4}}{5.07\times10^{-5}} = \frac{k[0.40]^x [0.05]^y}{k[0.20]^x [0.30]^y}$$

$$y = 0$$

$$\frac{1.43\times10^{-4}}{5.07\times10^{-5}} = \frac{[0.40]^x}{[0.20]^x}$$

$$2.821 = [2]^x$$

Taking log both sides

$$x\log 2 = \log 2.821$$

$$x = 1.496$$

$$x \approx 1.5$$

Thus, the order of the reaction with respect to A is 1.5 and with respect to B is zero.

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(b) For a first order reaction,

$$t = \frac{2.303}{k}\log\frac{a}{a-x}$$

$$At\ 298\ \text{K}$$
$$t = \frac{2.303}{k}\log\frac{100}{90}$$
$$= \frac{0.1054}{k}$$

At 308 K,

$$t' = \frac{2.303}{k'}\log\frac{100}{75}$$
$$= \frac{0.2877}{k'}$$

Now, as per the question

$$t' = t$$
$$\frac{0.1054}{k} = \frac{0.2877}{k'}$$
$$\frac{k'}{k} = 2.7296$$

From Arrhenius equation,

$$\log\frac{k'}{k} = \frac{E_a}{2.303R}\left[\frac{T'-T}{TT'}\right]$$
$$\log 2.7296 = \frac{E_a}{2.303\times 8.314}\left[\frac{308-298}{298\times 308}\right]$$
$$E_a = \frac{2.303\times 8.314\times 298\times 308\times \log 2.7296}{10}$$
$$= 76.64\ kj/mol$$

Now we can calculate k at 318 K,

We have $A = 4\times 10^{10}\ \text{sec}^{-1}$

$$T = 318\ K$$

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Again, use Arrhenius equation,

$$\log k = \log A - \frac{E_a}{2.303RT}$$

$$= \log\left(4\times10^{10}\right) - \frac{76.64\times10^{3}}{2.303\times8.314\times318}$$

$$= 10.6021 - 12.5876$$

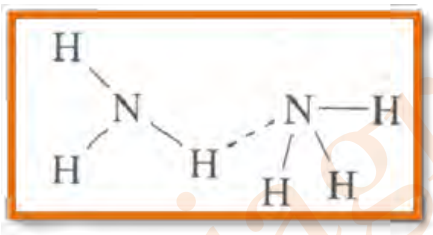
$$= -1.9855$$

Thus,

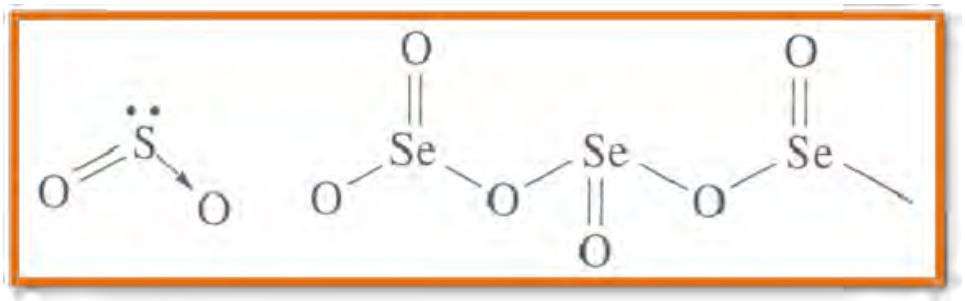
$$k = anti\log(-1.9855)$$

$$= 1.034\times10^{-2}\ \text{sec}^{-1}$$

Answer 29: a) (i) Nitrogen can form strong hydrogen bonds because of its high electronegativity and smaller size than phosphorus which forms only very weak hydrogen bonds. As a result, NH_3 molecules are more strongly associated than PH_3. Hence, NH_3 has a higher boiling point compared to PH_3.



(ii) Sulphur due to its small size, has more tendency to form $p\pi - p\pi$ bonds. So, SO_2 is a discrete molecule and intermolecular forces are weak van-der Waals forces. Hence, SO_2 is a gas. SeO_2 is a solid due to less tendency of selenium to participate in multiple bond formation. Therefore, SeO_2 polymerizes and is a solid.



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(b) The completed reactions are as follows:

$$Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + 2H_2O$$

$$3SCl_2 + 4NaF \rightarrow S_2Cl_2 + SF_4 + 4NaCl$$

(c) H_2SO_4 is a very strong acid and gives H^+ ion very readily in water. Therefore, the first ionization is very high.

$$H_2SO_4 + H_2O \rightleftharpoons HSO_4^- + H_3O^+$$

But HSO_4^- (the conjugate base of H_2SO_4) is more resonance stabilized and gives second H^+ ion with difficulty. Hence, $Ka_2 << Ka_1$.

OR

(a) In NH_3, N is *sp3* hybridized and one lone pair of electrons is present on N atom. Due to lone pair – bond pair repulsions, the H – atoms are pushed closer and the bond angles decreases from 109° to 107°. In HPH or HAsH or HSbH, the central atom uses only pure *p*- atomic orbital in the bond formation. As *p*- atomic orbitals are mutually perpendicular to each other, the bond angle is close to 90°.

(b) Basic oxides: They are the binary compounds of oxygen and electropositive metals. They are generally ionic compounds with high melting and boiling points. Example: MgO, Na_2O.
Acidic oxides: They are the compounds of oxygen and non-metals. These have low melting and boiling point. Aqueous solution of these oxides turns blue litmus red. Example: SO_3, CO_2.
Amphoteric oxides: They are the oxides which react with acids as well as base to form salts. Example: Al_2O_3, ZnO.

(c) Ozone is formed in the stratosphere by the reaction of O_2 with nascent oxygen [O] atoms which form in the stratosphere when O_2 absorbs short wavelength ultraviolet radiation (less than 2.00 nm).

$$O_2(g) + [O](g) \rightarrow O_3(g)$$

Ozone in the stratosphere is vitally important to us. Radiations from the Sun contain ultraviolet radiation of short wavelengths, which are harmful to biological organisms. Fortunately, these

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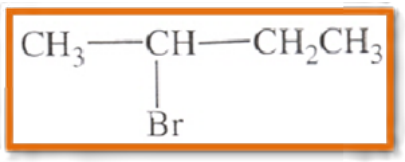
harmful wavelengths are absorbed before they reach the surface of the earth. The most energetic are absorbed by O_2 in the earth's upper atmosphere. Less energetic but still harmful radiation is absorbed by the ozone in the stratosphere. Ozone is an essential component of the stratosphere, a region of the atmosphere beginning at about 15 km above the earth's surface. The high temperature in the stratosphere is responsible for the presence of ozone in this layer of atmosphere and not in the other layers of atmosphere.

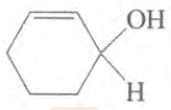
Answer 30: (a) The compound 'X' which gives a product capable of being resolved into optical isomer on reaction with aq. NaOH is:



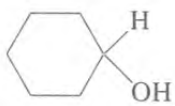
And its IUPAC name is: 2–bromobutane.

(b) The products in both the cases are:

(i)



(ii)



(c) The required products are:

(i)

$$CH_3CHO \xrightarrow[OH^-]{HCHO} CH_2=CH-CHO \xrightarrow[H^+]{HCN} CH_2=CH-\underset{\displaystyle OH}{\underset{|}{CH}}\,COOH$$

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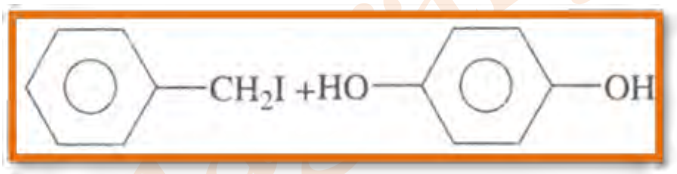
(ii) $HCHO \xrightarrow[H^+]{CH_3MgBr} CH_3CH_2OH \xrightarrow{PCl_5} CH_3CH_2Cl \xrightarrow[\text{dry ether}]{Na} CH_3CH_2CH_2CH_3$

OR

(a) The products that are formed by heating compounds of ether with HI are:

(i) $CH_3CH_2\underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_2OH + CH_3CH_2I$

(ii) $CH_3CH_2CH_2OH + CH_3CH_2 - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}} - I$

(iii) 

(b) The compound A is an alcohol as it gives ester with CH_3COOH.

Dehydrogenation of alcohol gives either an aldehyde or ketone. But compound B is an aldehyde as it is giving an acid with the same number of carbon on oxidation.

As B is an aldehyde, so 'A' is a 1^0 alcohol. The structures of compound A and B are

$A \rightarrow CH_3CH_2CH_2OH$

$B \rightarrow CH_3CH_2CHO$

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The reactions involved are:

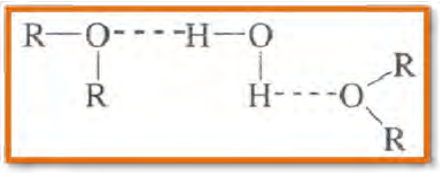
$$CH_3CH_2CH_2OH \xrightarrow[-H_2]{Cu} CH_3CH_2CHO$$

(A) → CH_3CO_2H, H^+ → $CH_3CO_2CH_2CH_2CH_3$

(B) → $K_2Cr_2O_7$, H_2SO_4 → CH_3CH_2COOH

$$CH_3CH_2CHO \xrightarrow{NaHSO_4} CH_3CH_2CH(OH)SO_3Na$$

(c) (i) Lower ether are soluble in water because of H–bonding between the O of ethers and the H of water. Alkanes do not participate in H–bonding.



(ii) The greater the electron density on the O, the stronger is the hydrogen–bond and the more soluble is the ether. In

$$CH_2=CH-\ddot{O}-CH_2CH_3$$

The lone pair of oxygen is involved into resonance with double bond.

$$CH_3=CH-\ddot{O}-CH_2\,CH_3 \longleftrightarrow \overset{\ominus}{C}H_2-CH=\overset{+}{\ddot{O}}-CH_2\,CH_3$$

As a result, electron density on O atom decreases the tendency to form H–bond with water decreases, ultimately solubility decreases.

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Mathematics

Guess Paper: 2014
Class: XII

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

General Instructions:

1. The question paper consists of 29 questions divided into three sections A, B and C.
2. Section A comprises of 10 questions of one mark each.
3. Section B comprises of 12 questions of four marks each
4. Section C comprises of 7 questions of six marks each.
5. All questions in Section A are to be answered in one word, one sentence or as per the exact requirement of the question.
6. Use of calculators is not permitted.
7. All questions are compulsory

"Section – A"

Q 1. Write the value of $\tan^{-1}\left[2\sin\left(2\cos^{-1}\frac{\sqrt{3}}{2}\right)\right]$.

Q 2. Write the intercept cut off by the plane 2x + y – z = 5 on x-axis.

Q 3. For what value of 'a' the vectors $2\hat{i}-3\hat{j}+4\hat{k}$ & $a\hat{i}+6\hat{j}-8\hat{k}$ are collinear?

Q 4. Write the differential equation representing the family of curves y = mx, where m is an arbitrary constant.

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Q 5. For what value of ë is the function defined by $f(x)=\begin{cases} ë(x^2-2x), & \text{if } x \le 0 \\ 4x+1, & \text{if } x > 0 \end{cases}$ continuous at x = 0? What about continuity at x = 1?

Q 6. If A_{ij} is the cofactor of the element a_{ij} of the determinant $\begin{vmatrix} 2 & -3 & 5 \\ 6 & 0 & 4 \\ 1 & 5 & -7 \end{vmatrix}$, then write the value of $a_{32}.A_{32}$

Q 7. State the reason for the relation R in the set {1, 2, 3} given by R = {(1, 2), (2, 1)) not to be transitive.

Q 8. P and Q are two points with position vectors $3\vec{a}-2\vec{b}$ and $\vec{a}+\vec{b}$ respectively. Write the position vector of a point R which divides the line segment PQ in the ratio 2:1 externally.

Q 9. The money to be spent for the welfare of the employees of a firm is proportional to the rate of change of its total revenue (marginal revenue). If the total revenue (in rupees) received from the sale of x units of a product is given by $R(x) = 3x^2 + 36x + 5$, find the marginal revenue, when x = 5, and write which value does the question indicate.

Q 10. Find $|\vec{x}|$, if for a unit vector $\vec{a}, (\vec{x}-\vec{a}).(\vec{x}+\vec{a})=15$.

"Section – B"

Q 11. Probabilities of solving a specific problem independently by A and B are ½ & 1/3 and respectively. If both try to solve the problem independently, find the probability that

(i) The problem is solved

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(ii) Exactly one of them solves the problem.

Q 12. Find the angle between the following pair of lines:

$$\frac{-x+2}{-2}=\frac{y-1}{7}=\frac{z+3}{-3} \;\&\; \frac{x+2}{-1}=\frac{2y-8}{4}=\frac{z-5}{4}$$

OR

Find the coordinates of the point where the line through the point $A=(3,4,1)$ & $B=(5,1,6)$ crosses the XY-plane.

Q 13. Find the inverse of the matrices by row transformation method, if it exists.

$$\begin{bmatrix} 2 & -3 & 3 \\ 2 & 2 & 3 \\ 3 & -2 & 2 \end{bmatrix}$$

Q 14. Solve the following equation:

$$\cos\left(\tan^{-1}x\right)=\sin\left(\cot^{-1}\frac{3}{4}\right)$$

Q 15. Differentiate $\tan^{-1}\left[\frac{\sqrt{1+x^2}-1}{x}\right]$ with respect to x.

Q 16. Solve the following differential equation: $\cos^2 x\frac{dy}{dx}+y=\tan x$

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OR

Solve the following differential equation: $\left(1+x^2\right)dy+2xydx=\cot xdx\ ;\ x\neq 0$

Q 17. Form the differential equation of the family of parabolas having vertex at the origin and axis along positive y-axis.

OR

Find the particular solution of the differential equation

$x\left(x^2-1\right).\frac{dy}{dx}=1;\ y=0$ when $x=2$.

Q 18. Maximise Z = − x + 2y, subject to the constraints:

x ≥ 3, x + y ≥ 5, x + 2y ≥ 6, y ≥ 0.

Q 19. Evaluate: $x\cos^{-1}x$

Q 20. Find the equation of the plane through the line of intersection of the planes x + y + z = 1 and 2x + 3y + 4z = 5 which is perpendicular to the plane x – y + z = 0.

Q 21. Evaluate:

$$\int\frac{5x+3}{\sqrt{x^2+4x+10}}dx$$

OR

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Evaluate:

$$\int \frac{(x^2+1)(x^2+2)}{(x^2+3)(x^2+4)}$$

Q 22. A cottage industry manufactures pedestal lamps and wooden shades, each requiring the use of a grinding/cutting machine and a sprayer. It takes 2 hours on grinding/cutting machine and 3 hours on the sprayer to manufacture a pedestal lamp. It takes 1 hour on the grinding/cutting machine and 2 hours on the sprayer to manufacture a shade. On any day, the sprayer is available for at the most 20 hours and the grinding/cutting machine for at the most 12 hours. The profit from the sale of a lamp is Rs 5 and that from a shade is Rs 3. Assuming that the manufacturer can sell all the lamps and shades that he produces, how should he schedule his daily production in order to maximize his profit?

"Section – C"

Q 23. Prove that the volume of the largest cone that can be inscribed in a sphere of radius R is $\frac{8}{27}$ of the volume of the sphere.

Q 24. If $A = \begin{bmatrix} 2 & -3 & 5 \\ 3 & 2 & -4 \\ 1 & 1 & -2 \end{bmatrix}$, find A^{-1}. Using A^{-1} solve the system of equations

$$2x-3y+5z=11$$
$$3x+2y-4z=-5$$
$$x+y-2z=-3$$

OR

The cost of 4 kg onion, 3 kg wheat and 2 kg rice is Rs 60. The cost of 2 kg onion, 4 kg wheat and 6 kg rice is Rs 90. The cost of 6 kg onion 2 kg wheat and 3 kg rice is Rs 70. Find cost of each item per kg by matrix method.

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Q 25. The area between $x = y^2$ and $x = 4$ is divided into two equal parts by the line $x = a$, find the value of a.

Q 26. Find the equation of the plane through the line of intersection of the planes $x + y + z = 1$ and $2x + 3y + 4z = 5$ which is perpendicular to the plane $x - y + z = 0$.

OR

Let the vectors

$\vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$

$\vec{b} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}$

$\vec{c} = c_1\hat{i} + c_2\hat{j} + c_3\hat{k}$

Then show that $\vec{a} \times (\vec{b} + \vec{c}) = (\vec{a} \times \vec{b}) + (\vec{a} \times \vec{c})$

Q 27. Find the limit of sums: $\int_1^4 (x^2 - x)\,dx$

Q 28. The management committee of a residential colony decided to award some of its members (say x) for honesty, some (say y) for helping others and some others (say z) for supervising the workers to keep the colony neat and clean. The sum of all the awardees is 12. Three times the sum of awardees for cooperation and supervision added to two times the number of awardees for honesty is 33. If the sum of the number of awardees for honesty and supervision is twice the number of awardees for helping others, using matrix method, find the number of awardees of each category. Apart from these values, namely, honesty, cooperation and supervision, suggest one more value which the management of the colony must include for awards.

Q 29. Let X denotes the sum of the numbers obtained when two fair dice are rolled. Find the variance and standard deviation of X.

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Solutions

"Section – A"

Answer 1:

$$\tan^{-1}\left[2\sin\left(2\cos^{-1}\frac{\sqrt{3}}{2}\right)\right]=\tan^{-1}\left[2\sin\left\{2\cos^{-1}\left(\cos\frac{\pi}{6}\right)\right\}\right]$$

$$=\tan^{-1}\left[2\sin\left\{2\left(\frac{\pi}{6}\right)\right\}\right]$$

$$=\tan^{-1}\left[2\sin\left\{\frac{\pi}{3}\right\}\right]$$

$$=\tan^{-1}\left[2\left(\frac{\sqrt{3}}{2}\right)\right]$$

$$=\tan^{-1}\left[\sqrt{3}\right]$$

$$=\tan^{-1}\left[\tan^{-1}\left(\frac{\pi}{3}\right)\right]$$

$$=\frac{\pi}{3}$$

Answer 2: $2x + y - z = 5$

Divide the equation by 5

$$\frac{2}{5}x+\frac{1}{5}y-\frac{1}{5}z=1$$

$$\frac{1}{\frac{5}{2}}x+\frac{1}{5}y-\frac{1}{5}z=1$$

Thus, the intercepts cut off by the plane are $=\left(\frac{5}{2},5,-5\right)$

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Answer 3: Let $\vec{P} = 2\hat{i} - 3\hat{j} + 4\hat{k}$

$\vec{Q} = a\hat{i} + 6\hat{j} - 8\hat{k}$

$\vec{Q} = -2\left(-\frac{a}{2}\hat{i} - 3\hat{j} + 4\hat{k}\right)$

Thus, $-\frac{a}{2} = 2$

$a = -4$

Answer 4: We have,

$y = mx$

On differentiation

$\frac{dy}{dx} = m$

$m = \frac{y}{x}$

The differential equation representing the family of curves y = mx, is

$xdy - ydx = 0$

Answer 5: $f(x) = \begin{cases} \lambda(x^2 - 2x), & \text{if } x \le 0 \\ 4x + 1, & \text{if } x > 0 \end{cases}$

If f is continuous at x = 0, then

$\lim_{x \to 0^-} f(x) = \lim_{x \to 0^+} f(x) = f(0)$

$\lim_{x \to 0^-} \lambda(x^2 - 2x) = \lim_{x \to 0^+} (4x + 1) = \lambda(0)$

$\lambda(0^2 - 0) = 0 + 1 = 0$

$0 = 1 = 0$

This is not possible.

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Therefore, there is no value of λ for which f is continuous at x = 0

At x = 1,

$$f(1) = 4x + 1$$
$$= 4 + 1 = 5$$

$$\lim_{x \to 1}(4x + 1) = 4 + 1 = 5$$

Thus,

$$\lim_{x \to 1} f(x) = f(1)$$

Therefore, for any values of λ, f is continuous at x = 1

Answer 6: Let $A = \begin{vmatrix} 2 & -3 & 5 \\ 6 & 0 & 4 \\ 1 & 5 & -7 \end{vmatrix}$

$$A_{32} = -\begin{vmatrix} 2 & 5 \\ 6 & 4 \end{vmatrix} = -(8 - 30) = 22$$

$$a_{32} = 5$$

Thus,

$$a_{32}.A_{32} = 22 \times 5 = 110$$

Answer 7: Let A = {1, 2, 3}.

R = {(1, 2), (2, 1)}.

We know that,

(1, 1), (2, 2), (3, 3) ∉ R

Hence, R is not reflexive.

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Now,

As (1, 2) ∈ R and (2, 1) ∈ R, then R is symmetric.

(1, 2) and (2, 1) ∈ R

Also,

(1, 1) ∉ R

Thus, R is not transitive.

Therefore, R is symmetric but neither reflexive nor transitive.

Answer 8:

$$\text{Position vector of point R} = \frac{2\left(\vec{a}+\vec{b}\right)-1\left(3\vec{a}-2\vec{b}\right)}{2-1}$$

$$= 2\vec{a}+2\vec{b}-3\vec{a}+2\vec{b}$$

$$= -\vec{a}+4\vec{b}$$

Answer 9: Total revenue, $R(x) = 3x^2 + 36x + 5$

Marginal revenue, $\frac{dR(x)}{dx} = 6x + 36$

At $x = 5$,

$$\frac{dR(x)}{dx} = 6(5) + 36 = 66$$

Thus,

Marginal revenue = 66

Answer 10: We have,

$$\left(\vec{x}-\vec{a}\right).\left(\vec{x}+\vec{a}\right) = 15$$

$$\left|\vec{x}\right|^2 - \left|\vec{a}\right|^2 - 15$$

$$\left|\vec{x}\right|^2 = \sqrt{15 + \left|\vec{a}\right|^2}$$

$$\left|\vec{x}\right| = \sqrt{15 + |1|^2} \qquad \left(\because \left|\vec{a}\right| = 1\right)$$

$$\left|\vec{x}\right| = 4$$

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"Section – B"

Answer 11: $P(A) = \frac{1}{2}$ and $P(B) = \frac{1}{3}$

(i) Problem is solved independently by A and B,

Thus, $P(A') = 1 - P(A)$

$= 1 - \frac{1}{2} = \frac{1}{2}$

$P(B') = 1 - P(B)$

$= 1 - \frac{1}{3} = \frac{2}{3}$

$P(AB) = P(A).P(B)$

$= \frac{1}{2}.\frac{1}{3} = \frac{1}{6}$

Probability (problem is solved) = P (A ∪ B)

ii) P (A ∪ B) = P (A) + P (B) − P (AB)

$= \frac{1}{2} + \frac{1}{3} - \frac{1}{6}$

$= \frac{2}{3}$

Probability (exactly one of them solves the problem)

$= P(A).P(B') + P(B).P(A')$

$= \frac{1}{2} \times \frac{2}{3} + \frac{1}{2} \times \frac{1}{3}$

$= \frac{1}{3} + \frac{1}{6}$

$= \frac{1}{2}$

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Answer 12: $\frac{-x+2}{-2}=\frac{y-1}{7}=\frac{z+3}{-3}$ & $\frac{x+2}{-1}=\frac{2y-8}{4}=\frac{z-5}{4}$

$\frac{x-2}{2}=\frac{y-1}{7}=\frac{z+3}{-3}$ and $\frac{x+2}{-1}=\frac{y-4}{2}=\frac{z-5}{4}$

$\vec{a_1}=2\hat{i}+7\hat{j}-3\hat{k}$

$\vec{a_2}=-\hat{i}+2\hat{j}+4\hat{k}$

Angle between the given pair of lines, $\cos\theta=\left|\frac{\vec{a_1}.\vec{a_2}}{\left|\vec{a_1}\right|\left|\vec{a_2}\right|}\right|$

$\vec{a_1}.\vec{a_2}=\left(2\hat{i}+7\hat{j}-3\hat{k}\right)\left(-\hat{i}+4\hat{j}+4\hat{k}\right)$

$=2\times-1+7\times4-3\times(4)$

$=-2+28-12$

$=28-14$

$=14$

$\left|\vec{a_1}\right|=\sqrt{2^2+7^2+(-3)^2}$

$=\sqrt{4+49+9}$

$=\sqrt{62}$

$\left|\vec{a_2}\right|=\sqrt{(-1)^2+2^2+4^2}$

$=\sqrt{1+4+16}$

$=\sqrt{21}$

$\cos\theta=\frac{14}{\sqrt{62}\times\sqrt{21}}$

$=\frac{\sqrt{14}}{\sqrt{93}}$

$\theta=\cos^{-1}\left(\sqrt{\frac{14}{93}}\right)$

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OR

$A = (3,4,1)$ & $B = (5,1,6)$

The equation of line passing throgh above points is

$$\frac{x-3}{5-3} = \frac{y-4}{1-4} = \frac{z-1}{6-1}$$

$$\frac{x-3}{2} = \frac{y-4}{-3} = \frac{z-1}{5}$$

XY plane means Z=0

$$\frac{x-3}{2} = \frac{y-4}{-3} = \frac{0-1}{5}$$

$$\therefore x = \frac{-2}{5} + 3 = \frac{13}{5}$$

$$\therefore y = \frac{3}{5} + 4 = \frac{23}{5}$$

So, Co-ordinates of the point where the line through the points A & B crosses the XY-plane is $\left(\frac{13}{5}, \frac{23}{5}, 0\right)$

Answer 13:

$$A = \begin{bmatrix} 2 & -3 & 3 \\ 2 & 2 & 3 \\ 3 & -2 & 2 \end{bmatrix}$$

$A = IA$

$$\begin{bmatrix} 2 & -3 & 3 \\ 2 & 2 & 3 \\ 3 & -2 & 2 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} A$$

$R_2 \to R_2 - R_1$

$$\begin{bmatrix} 2 & -3 & 3 \\ 0 & 5 & 0 \\ 3 & -2 & 2 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ -1 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} A$$

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$$R_2 \to \frac{1}{5}R_2$$

$$\begin{bmatrix} 2 & -3 & 3 \\ 0 & 1 & 0 \\ 3 & -2 & 2 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ -\frac{1}{5} & \frac{1}{5} & 0 \\ 0 & 0 & 1 \end{bmatrix} A$$

$$R_1 \to R_1 - R_3$$

$$\begin{bmatrix} -1 & -1 & 1 \\ 0 & 1 & 0 \\ 3 & 2 & 2 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 1 \\ -\frac{1}{5} & \frac{1}{5} & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$R_1 \to R_1 + R_2$$

$$R_3 \to R_3 + R_2$$

$$\begin{bmatrix} -1 & 0 & 1 \\ 0 & 1 & 0 \\ 3 & 0 & 2 \end{bmatrix} = \begin{bmatrix} \frac{4}{5} & \frac{1}{5} & -1 \\ -\frac{1}{5} & \frac{1}{5} & 0 \\ \frac{-2}{5} & \frac{2}{5} & 1 \end{bmatrix} A$$

$$R_3 \to R_3 + 3R_1$$

$$\begin{bmatrix} -1 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 0 & 5 \end{bmatrix} = \begin{bmatrix} \frac{4}{5} & \frac{1}{5} & -1 \\ -\frac{1}{5} & \frac{1}{5} & 0 \\ 2 & 1 & -2 \end{bmatrix} A$$

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$$R_3 \to \frac{1}{5}R_3$$

$$\begin{bmatrix} -1 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} \frac{4}{5} & \frac{1}{5} & -1 \\ -\frac{1}{5} & \frac{1}{5} & 0 \\ \frac{2}{5} & \frac{1}{5} & -\frac{2}{5} \end{bmatrix} A$$

$$R_1 \to R_1 - R_3$$

$$\begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} \frac{2}{5} & 0 & -\frac{3}{5} \\ -\frac{1}{5} & \frac{1}{5} & 0 \\ \frac{2}{5} & \frac{1}{5} & -\frac{2}{5} \end{bmatrix} A$$

$$R_1 \to -R_1$$

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} -\frac{2}{5} & 0 & \frac{3}{5} \\ -\frac{1}{5} & \frac{1}{5} & 0 \\ \frac{2}{5} & \frac{1}{5} & -\frac{2}{5} \end{bmatrix} A$$

$$A^{-1} = \begin{bmatrix} -\frac{2}{5} & 0 & \frac{3}{5} \\ -\frac{1}{5} & \frac{1}{5} & 0 \\ \frac{2}{5} & \frac{1}{5} & -\frac{2}{5} \end{bmatrix}$$

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Answer 14:

$$\cos\left(\tan^{-1}x\right)=\sin\left(\cot^{-1}\frac{3}{4}\right)$$

$$\cos\left(\tan^{-1}\frac{x}{1}\right)=\sin\left(\tan^{-1}\frac{4}{3}\right)$$

$$\cos\left(\tan^{-1}\frac{x}{1}\right)=\cos\left[\frac{\pi}{2}-\left(\tan^{-1}\frac{4}{3}\right)\right]$$

On comparing

$$\tan^{-1}\frac{x}{1}=\frac{\pi}{2}-\tan^{-1}\frac{4}{3}$$

$$\tan^{-1}\frac{x}{1}+\tan^{-1}\frac{4}{3}=\frac{\pi}{2}$$

$$\tan^{-1}\left(\frac{x+\frac{4}{3}}{1-\frac{4}{3}x}\right)=\frac{\pi}{2}$$

$$\tan^{-1}\left(\frac{\frac{3x+4}{3}}{\frac{3-4x}{3}}\right)=\frac{\pi}{2}$$

$$\frac{\frac{3x+4}{3}}{\frac{3-4x}{3}}=\tan\frac{\pi}{2}$$

$$\frac{3x+4}{3-4x}=\infty$$

$$3-4x=0$$

$$x=\frac{3}{4}$$

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Answer 15:

Let $y = \tan^{-1}\left[\frac{\sqrt{1+x^2}-1}{x}\right]$

Put $x = \tan A$ ---------- equation 1

$$y = \tan^{-1}\left[\frac{\sqrt{1+\tan^2 A}-1}{\tan A}\right]$$

$$y = \tan^{-1}\left[\frac{\sqrt{\sec^2 A}-1}{\tan A}\right]$$

$$y = \tan^{-1}\left[\frac{\sec A-1}{\tan A}\right]$$

$$y = \tan^{-1}\left[\frac{1-\cos A}{\sin A}\right]$$

$$y = \tan^{-1}\left[\frac{2\sin^2\left(\frac{A}{2}\right)}{2\sin\left(\frac{A}{2}\right)\cos\left(\frac{A}{2}\right)}\right] \qquad \left[\because\ 1-\cos 2x = 2\sin^2 x,\quad \sin 2x = 2\sin x\cos x\right]$$

$$y = \tan^{-1}\left[\tan\left(\frac{A}{2}\right)\right]$$

$$y = \frac{A}{2}$$

Put value of A from equation 1

$$y = \frac{\tan^{-1} x}{2}$$

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On differentiation

$$\frac{dy}{dx}=\frac{1}{2\left(1+x^2\right)}$$

Answer 16:

$$\cos^2 x\frac{dy}{dx}+y=\tan x$$

$$\frac{dy}{dx}+\sec^2 xy=\sec^2 x.\tan x$$

$$\frac{dy}{dx}+Py=Q$$

Where $P=\sec^2 x,\ Q=\sec^2 x\tan x$

$$I.F=e^{\int Pdx}=e^{\int \sec^2 xdx}=e^{\tan x}$$

Now, multiplying the equation by I.F

$$\left(\frac{dy}{dx}+\sec^2 xy\right)e^{\tan x}=e^{\tan x}\left(\sec^2 x.\tan x\right)$$

$$e^{\tan x}\frac{dy}{dx}+e^{\tan x}\sec^2 xy=e^{\tan x}\left(\sec^2 x.\tan x\right)$$

$$y.e^{\tan x}=\int e^{\tan x}\left(\sec^2 x.\tan x\right)dx$$

Let $\tan x=t$

$$\sec^2 xdx=dt$$

$$y.e^{\tan x}=\int t.e^t dt.....(1)$$

Let $I=\int t.e^t dt$

$$I=t\int e^t dt-\int\left[\left(\frac{d}{dt}t\right).\int e^t dt\right]dt$$

$$I=t.e^t-\int\left(e^t\right)dt$$

$$I=t.e^t-e^t+C$$

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Now, equation (1) becomes as

$y.e^{\tan x} = t.e^{t} - e^{t} + C$

$y.e^{\tan x} = \tan x.e^{\tan x} - e^{\tan x} + C$

$y = (\tan x - 1) + Ce^{-\tan x}$

OR

$(1+x^2)dy + 2xydx = \cot x dx$

$\frac{dy}{dx} + \left(\frac{2x}{1+x^2}\right)y = \frac{\cot x}{1+x^2}$

$\frac{dy}{dx} + Py = Q$

Where $P = \frac{2x}{1+x^2}, \quad Q = \frac{\cot x}{1+x^2}$

Now,

I.F=$e^{\int Pdx} = e^{\int \left(\frac{2x}{1+x^2}\right)dx}$ .....*Equation* 1

Let $1+x^2 = t$

$2xdx = dt$ .....*Equation* 2

Put value of equation 2 in equation 1

I.F=$e^{\int \frac{dt}{t}} = e^{\log t} = t = 1+x^2$

Multiplying both sides by I.F

$(1+x^2)\frac{dy}{dx} + 2xy = \cot x$

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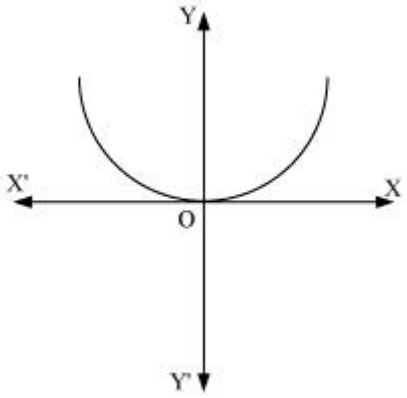
$$\frac{d}{dx}\left[y.\left(1+x^2\right)\right]=\cot x$$

On integrating both sides

$$y\left(1+x^2\right)=\int \cot x$$

$$y\left(1+x^2\right)=\log|\sin x|+C$$

Answer 17: Vertex = (0, 0)



The equation of the parabola

$$x^2=4ay.....(1)$$

On differentiation

$$2x=4ay'$$

$$x=2ay'$$

$$a=\frac{x}{2y'}$$

Put value of a in equation (1)

$$x^2=4\frac{x}{2y'}y$$

$$y'x^2=2xy$$

$$y'x=2y$$

$$xy'-2y=0$$

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This is the required differential equation.

OR

$$x\left(x^2-1\right).\frac{dy}{dx}=1,\ y=0,\ x=2$$

$$dy=\frac{dx}{x\left(x^2-1\right)}$$

$$\int dy=\int\frac{dx}{x\left(x^2-1\right)}$$

$$y=\int\frac{dx}{x\left(x^2-1\right)}$$

Now,

$$\frac{1}{x\left(x^2-1\right)}=\frac{1}{x(x-1)(x+1)}$$

$$\frac{1}{x(x-1)(x+1)}=\frac{A}{x}+\frac{B}{x-1}+\frac{C}{x+1}$$

$$\frac{1}{x(x-1)(x+1)}=\frac{A\left(x^2-1\right)+B.x.(x+1)+c.x.(x-1)}{x(x-1)(x+1)}$$

$$A\left(x^2-1\right)+B\left(x^2+x\right)+c\left(x^2-x\right)=1$$

By putting $x=0,1,-1$

We get

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$$A=-1,\ B=\frac{1}{2},\ C=\frac{1}{2}$$

$$\int\frac{dx}{x\left(x^2-1\right)}=A\int\frac{dx}{x}+B\int\frac{dx}{x-1}+C\int\frac{dx}{x+1}$$

$$y=-\int\frac{dx}{x}+\frac{1}{2}\int\frac{dx}{x-1}+\frac{1}{2}\int\frac{dx}{x+1}$$

$$y=-\log x+\frac{1}{2}\log\left(x-1\right)+\frac{1}{2}\log\left(x+1\right)$$

$$y=\log\left(\frac{1}{x}\right)+\frac{1}{2}\log\left(x^2-1\right)$$

$$y=\log\left(\frac{\sqrt{x^2-1}}{x}\right)+C$$

Now, we know that

$y=0,x=2$

$$0=\log\frac{\sqrt{3}}{2}+C$$

$$C=-\log\frac{\sqrt{3}}{2}$$

Now the equation becomes as;

$$y=\log\left(\frac{\sqrt{x^2-1}}{x}\right)+-\log\frac{\sqrt{3}}{2}$$

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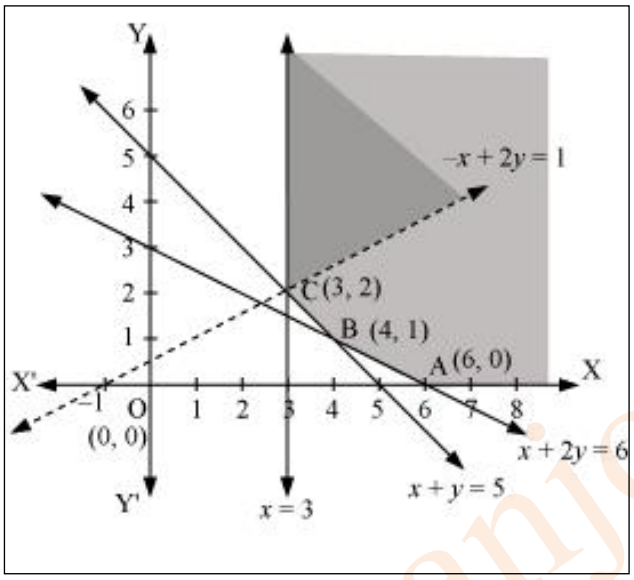
Answer 18: $x \geq 3$,

$x + y \geq 5$

$x + 2y \geq 6$

$y \geq 0$



Points of shaded region are:

A = (6, 0)

B = (4, 1)

C = (3, 2)

Point	$Z = -x + 2y$
A(6, 0)	Z = - 6 + 2.0 = - 6
B(4, 1)	Z = - 4 + 2.1 = - 2
C(3, 2)	Z = -3 + 2.2 = 1

It can be seen that the feasible region is unbounded.

Thus, Z = 1 is not the maximum value. Z has no maximum value.

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Answer 19:

Let $I = \int x\cos^{-1}x\,dx$

$$I = \cos^{-1}x\int x\,dx - \int\left\{\left(\frac{d}{dx}\left(\cos^{-1}x\right)\right)\int x\,dx\right\}dx$$

$$I = \cos^{-1}x\left(\frac{x^2}{2}\right) - \int\frac{-1}{\sqrt{1-x^2}}\left(\frac{x^2}{2}\right)dx$$

$$I = \cos^{-1}x\left(\frac{x^2}{2}\right) - \frac{1}{2}\int\frac{-x^2}{\sqrt{1-x^2}}dx$$

$$I = \cos^{-1}x\left(\frac{x^2}{2}\right) - \frac{1}{2}\int\left[\frac{1-x^2}{\sqrt{1-x^2}} - \frac{1}{\sqrt{1-x^2}}\right]dx$$

$$I = \cos^{-1}x\left(\frac{x^2}{2}\right) - \frac{1}{2}\int\left[\sqrt{1-x^2} - \frac{1}{\sqrt{1-x^2}}\right]dx$$

$$I = \frac{x^2\cos^{-1}x}{2} - \frac{1}{2}\int\left[\sqrt{1-x^2} - \frac{1}{\sqrt{1-x^2}}\right]dx$$

$$I = \frac{x^2\cos^{-1}x}{2} - \frac{1}{2}\int\sqrt{1-x^2}\,dx - \frac{1}{2}\int\frac{-1}{\sqrt{1-x^2}}dx$$

$$I = \frac{x^2\cos^{-1}x}{2} - \frac{1}{2}\int\sqrt{1-x^2}\,dx - \frac{1}{2}\cos^{-1}x$$

$$I = \frac{x^2\cos^{-1}x}{2} - \frac{1}{2}A - \frac{1}{2}\cos^{-1}x.....equation(1)$$

$$A = \int\sqrt{1-x^2}\,dx$$

$$A = \int\sqrt{1-x^2}.1\,dx$$

$$A = \sqrt{1-x^2}\int dx - \int\left\{\left(\frac{d}{dx}\left(\sqrt{1-x^2}\right)\right)\int dx\right\}dx$$

$$A = x\sqrt{1-x^2} - \int\left\{\left(\frac{-2x}{2\sqrt{1-x^2}}\right)x\right\}dx$$

$$A = x\sqrt{1-x^2} - \int\frac{-x^2}{\sqrt{1-x^2}}dx$$

$$A = x\sqrt{1-x^2} - \int\left[\frac{1-x^2}{\sqrt{1-x^2}} + \frac{-1}{\sqrt{1-x^2}}\right]dx$$

$$A = x\sqrt{1-x^2} - \int\left[\sqrt{1-x^2} - \frac{1}{\sqrt{1-x^2}}\right]dx$$

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$$A = x\sqrt{1-x^2} - \int \sqrt{1-x^2}dx - \int \frac{-1}{\sqrt{1-x^2}}dx$$

$$A = x\sqrt{1-x^2} - A - \int \frac{-1}{\sqrt{1-x^2}}dx$$

$$2A = x\sqrt{1-x^2} - \cos^{-1}x$$

$$A = \frac{x}{2}\sqrt{1-x^2} - \frac{1}{2}\cos^{-1}x$$

Put value of A in equation 1

$$I = \frac{x^2\cos^{-1}x}{2} - \frac{1}{2}A - \frac{1}{2}\cos^{-1}x$$

$$I = \frac{x^2\cos^{-1}x}{2} - \frac{1}{2}\left[\frac{x}{2}\sqrt{1-x^2} - \frac{1}{2}\cos^{-1}x\right] - \frac{1}{2}\cos^{-1}x$$

$$I = \frac{x^2\cos^{-1}x}{2} - \frac{x}{4}\sqrt{1-x^2} + \frac{1}{4}\cos^{-1}x - \frac{1}{2}\cos^{-1}x$$

$$I = \frac{x^2\cos^{-1}x}{2} - \frac{x}{4}\sqrt{1-x^2} - \frac{1}{4}\cos^{-1}x$$

$$I = \left(\frac{2x^2-1}{4}\right)\cos^{-1}x - \frac{x}{4}\sqrt{1-x^2} + C$$

Answer 20: Equations of planes are:

$x + y + z = 1$ and $2x + 3y + 4z = 5$

The equation of the plane passing through the intersection of the given planes is:

$$(x+y+z-1) + \lambda(2x+3y+4z-5) = 0$$

$$(2\lambda+1)x + (3\lambda+1)y + (4\lambda+1)z - (5\lambda+1) = 0$$

The direction ratios of this plane are:

$a_1 = (2\lambda + 1)$

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$b_1 = (3\lambda + 1)$

$c_1 = (4\lambda + 1)$

The given plane x – y + z = 0 is perpendicular to the equation of desired plane

Direction ratios of plane, x – y + z = 0 are:

$a_2 = 1$

$b_2 = -1$

$c_2 = 1$

Both planes are perpendicular. Thus,

$$a_1a_2 + b_1b_2 + c_1c_2 = 0$$
$$(2\lambda + 1) - (3\lambda + 1) + (4\lambda + 1) = 0$$
$$3\lambda + 1 = 0$$
$$\lambda = -\frac{1}{3}$$

Equation of desired plane becomes as:

$$\left(2\times\left(\frac{-1}{3}\right)+1\right)x+\left(3\times\left(\frac{-1}{3}\right)+1\right)y+\left(4\times\left(\frac{-1}{3}\right)+1\right)z-\left(5\times\left(\frac{-1}{3}\right)+1\right)=0$$
$$\frac{1}{3}x-\frac{1}{3}z+\frac{2}{3}=0$$
$$x-z+2=0$$

This is the required equation of the plane.

Answer 21: $\frac{5x+3}{\sqrt{x^2+4x+10}}$

$$\text{Let } x+3 = A\frac{d}{dx}\left(x^2+4x+10\right)+B$$
$$5x+3 = A(2x+4)+B$$
$$5x+3 = 2Ax+4A+B$$

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On equating coefficients

$5x = 2Ax$

$A = \frac{5}{2}$

$3 = 4A + B$

$3 = 4\left(\frac{5}{2}\right) + B$

$B = -7$

Now,

$$\int \frac{5x+3}{\sqrt{x^2+4x+10}}dx$$

$$= \int \frac{\frac{5}{2}(2x+4)-7}{\sqrt{x^2+4x+10}}dx$$

$$= \frac{5}{2}\int \frac{(2x+4)}{\sqrt{x^2+4x+10}}dx - 7\int \frac{1}{\sqrt{x^2+4x+10}}dx$$

$$= A - B.....Equation(1)$$

$$A = \frac{5}{2}\int \frac{(2x+4)}{\sqrt{x^2+4x+10}}dx$$

Let $x^2+4x+10 = t$

$(2x+4)dx = dt$

Now,

$$= \frac{5}{2}\int \frac{(2x+4)}{\sqrt{x^2+4x+10}}dx$$

$$= \frac{5}{2}\int \frac{1}{\sqrt{t}}dt$$

$$= \frac{5}{2}\left(2\sqrt{x^2+4x+10}\right)$$

$$= 5\sqrt{x^2+4x+10}$$

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$$B = 7\int \frac{1}{\sqrt{x^2+4x+10}}dx$$
$$= 7\int \frac{1}{\sqrt{(x^2+4x+4)+6}}dx$$
$$= 7\int \frac{1}{\sqrt{(x+2)^2+(\sqrt{6})^2}}dx$$
$$= 7\log\left|(x+2)+\sqrt{x^2+4x+10}\right|$$

Put value of A & B in equation 1

$$= A - B$$
$$= 5\sqrt{x^2+4x+10} - 7\log\left|(x+2)+\sqrt{x^2+4x+10}\right| + C$$

OR

$$\int \frac{(x^2+1)(x^2+2)}{(x^2+3)(x^2+4)}dx$$
$$= \int\left[1 - \frac{(4x^2+10)}{(x^2+3)(x^2+4)}\right]dx$$

Let $\frac{(4x^2+10)}{(x^2+3)(x^2+4)} = \frac{Ax+B}{(x^2+3)} + \frac{Cx+D}{(x^2+4)}$

$$4x^2+10 = (Ax+B)(x^2+4)+(Cx+D)(x^2+3)$$
$$4x^2+10 = Ax^3+4Ax+Bx^2+4B+Cx^3+3Cx+Dx^2+3D$$
$$4x^2+10 = (A+C)x^3+(B+D)x^2+(4A+3C)x+(4B+3D)$$

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Equating the coefficients of x^3, x^2, x, and constant term, we obtain

$A + C = 0$

$B + D = 4$

$4A + 3C = 0$

$4B + 3D = 10$

On solving these equations, we obtain

$A = 0$, $B = -2$, $C = 0$, and $D = 6$

Now,

$$\int\left[1-\frac{\left(4x^2+10\right)}{\left(x^2+3\right)\left(x^2+4\right)}\right]dx$$

$$=\int\left[1+\frac{2}{\left(x^2+3\right)}-\frac{6}{\left(x^2+4\right)}\right]dx$$

$$=\int\left[1+\frac{2}{\left(x^2+\left(\sqrt{3}\right)^2\right)}-\frac{6}{\left(x^2+2^2\right)}\right]dx$$

$$=x+\frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{x}{\sqrt{3}}\right)-\frac{6}{2}\tan^{-1}\left(\frac{x}{2}\right)+C$$

$$=x+\frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{x}{\sqrt{3}}\right)-3\tan^{-1}\left(\frac{x}{2}\right)+C$$

Answer 22: Let the cottage industry manufacture pedestal lamps = x

Wooden shades = y

As per the question,

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	Lamps	Shades	Availability
Grinding/Cutting Machine (h)	2	1	12
Sprayer (h)	3	2	20

The profit on a lamp = Rs 5

Profit on the shades = Rs 3

Total profit, Z = 5x + 3y

The equations are:

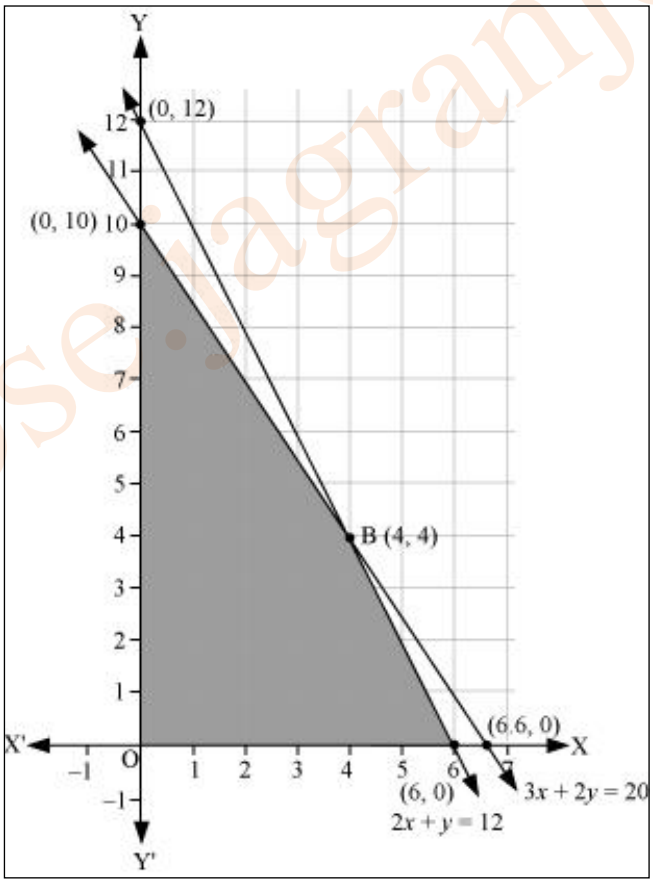
$2x + y \leq 12$

$3x + 2y \leq 20$

$x \geq 0$

$y \geq 0$

Now,



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The corner points are:

A = (6, 0)

B = (4, 4)

C = (0, 10)

The values of Z are:

Corner point	$Z = 5x + 3y$
A(6, 0)	30
B(4, 4)	32
C(0, 10)	30

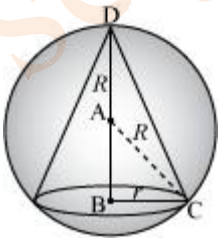
The maximum value of Z is 32 at (4, 4).

Thus, the manufacturer should produce 4 pedestal lamps and 4 wooden shades to maximize his profits.

"Section – C"

Answer 23: Let r = radius of the cone

h = height of the cone



Let V = the volume of the cone

$$V = \frac{1}{3}\pi r^2 h$$

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Height of the cone, h = R + AB

$$h = R + \sqrt{R^2 - r^2}$$

$$h = R + \sqrt{R^2 - r^2}$$

$$V = \frac{1}{3}\pi r^2\left(R + \sqrt{R^2 - r^2}\right)$$

$$V = \frac{1}{3}\pi r^2 R + \frac{1}{3}\pi r^2\sqrt{R^2 - r^2}$$

$$\frac{dV}{dr} = \frac{2}{3}\pi rR + \frac{2}{3}\pi r\sqrt{R^2 - r^2} + \frac{1}{3}\pi r^2.\frac{-2r}{2\sqrt{R^2 - r^2}}$$

$$\frac{dV}{dr} = \frac{2}{3}\pi rR + \frac{2}{3}\pi r\sqrt{R^2 - r^2} - \frac{\pi r^3}{3\sqrt{R^2 - r^2}}$$

$$\frac{dV}{dr} = \frac{2}{3}\pi rR + \frac{2\pi r\left(R^2 - r^2\right) - \pi r^3}{3\sqrt{R^2 - r^2}}$$

$$\frac{dV}{dr} = \frac{2}{3}\pi rR + \frac{2\pi rR^2 - 2\pi r^3 - \pi r^3}{3\sqrt{R^2 - r^2}}$$

$$\frac{dV}{dr} = \frac{2}{3}\pi rR + \frac{2\pi rR^2 - 3\pi r^3}{3\sqrt{R^2 - r^2}}$$

$$\frac{dV}{dr} = 0$$

$$\frac{2}{3}\pi rR + \frac{2\pi rR^2 - 3\pi r^3}{3\sqrt{R^2 - r^2}} = 0$$

$$\frac{2}{3}\pi rR = -\frac{2\pi rR^2 - 3\pi r^3}{3\sqrt{R^2 - r^2}}$$

$$2R = -\frac{2R^2 - 3r^2}{\sqrt{R^2 - r^2}}$$

$$r^2 = \left(\frac{8}{9}\right)R^2$$

$$\frac{d^2V}{dr^2} < 0$$

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Thus, by second derivative test, the volume of the cone is the maximum at

$$r^2 = \left(\frac{8}{9}\right)R^2$$

$$h = R + \sqrt{R^2 - r^2}$$

$$h = R + \sqrt{R^2 - \left(\frac{8}{9}\right)R^2}$$

$$h = R + R\sqrt{1 - \left(\frac{8}{9}\right)}$$

$$h = R + \frac{R}{3} = \frac{4R}{3}$$

$$V = \frac{1}{3}\pi r^2 h$$

$$V = \frac{1}{3}\pi\left(\frac{8}{9}\right)R^2\frac{4R}{3}$$

$$V = \frac{8}{27} \times \text{Vol of sphere}$$

Answer 24:

$$A = \begin{bmatrix} 2 & -3 & 5 \\ 3 & 2 & -4 \\ 1 & 1 & -2 \end{bmatrix}$$

$$|A| = 2(-4+4) + 3(-6+4) + 5(3-2)$$

$$|A| = -6 + 5$$

$$|A| = -1$$

$$|A| \neq 0$$

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$A_{11} = 0$
$A_{12} = 2$
$A_{13} = 1$
$A_{21} = -1$
$A_{22} = -9$
$A_{23} = -5$
$A_{31} = 2$
$A_{32} = 23$
$A_{33} = 13$

Now,

$$adjA = \begin{bmatrix} 0 & -1 & 2 \\ 2 & -9 & 23 \\ 1 & -5 & 13 \end{bmatrix}$$

$$A^{-1} = -\begin{bmatrix} 0 & -1 & 2 \\ 2 & -9 & 23 \\ 1 & -5 & 13 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 1 & -2 \\ -2 & 9 & -23 \\ -1 & 5 & -13 \end{bmatrix}$$

Now,

$2x - 3y + 5z = 11$
$3x + 2y - 4z = -5$
$x + y - 2z = -3$

$$\begin{bmatrix} 2 & -3 & 5 \\ 3 & 2 & -4 \\ 1 & 1 & -2 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 11 \\ -5 \\ -3 \end{bmatrix}$$

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$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 2 & -3 & 5 \\ 3 & 2 & -4 \\ 1 & 1 & -2 \end{bmatrix}^{-1} \begin{bmatrix} 11 \\ -5 \\ -3 \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 0 & 1 & -2 \\ -2 & 9 & -23 \\ -1 & 5 & -13 \end{bmatrix} \begin{bmatrix} 11 \\ -5 \\ -3 \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} -5+6 \\ -22-45+69 \\ -11-25+39 \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$$

$x = 1,\ y = 2,\ z = 3$

OR

Let the cost of onions per kg be = Rs. x

Cost of wheat per kg be = Rs. y

Cost of rice per kg be = Rs z

Given equations are:

$4x + 3y + 2z = 60$

$2x + 4y + 6z = 90$

$6x + 2y + 3z = 70$

$$\begin{bmatrix} 4 & 3 & 2 \\ 2 & 4 & 6 \\ 6 & 2 & 3 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 60 \\ 90 \\ 70 \end{bmatrix}$$

$AX = B$

$X = A^{-1}B$

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$$A=\begin{bmatrix}4 & 3 & 2\\ 2 & 4 & 6\\ 6 & 2 & 3\end{bmatrix}$$

$$|A| = 4(12-12)-3(6-36)+2(4-24)$$

$$= 90-40$$

$$= 50$$

$$A_{11}=0$$

$$A_{12}=30$$

$$A_{13}=-20$$

$$A_{21}=-5$$

$$A_{22}=0$$

$$A_{23}=10$$

$$A_{31}=10$$

$$A_{32}=-20$$

$$A_{33}=10$$

Thus,

$$adjA=\begin{bmatrix}0 & -5 & 10\\ 30 & 0 & -20\\ -20 & 10 & 10\end{bmatrix}$$

$$A^{-1}=\frac{1}{|A|}adjA$$

$$=\frac{1}{50}\begin{bmatrix}0 & -5 & 10\\ 30 & 0 & -20\\ -20 & 10 & 10\end{bmatrix}$$

Now,

$$X = A^{-1}B$$

$$X=\frac{1}{50}\begin{bmatrix}0 & -5 & 10\\ 30 & 0 & -20\\ -20 & 10 & 10\end{bmatrix}\begin{bmatrix}60\\ 90\\ 70\end{bmatrix}$$

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$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \frac{1}{50}\begin{bmatrix} -450+700 \\ 1800-1400 \\ -1200+900+700 \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \frac{1}{50}\begin{bmatrix} 250 \\ 400 \\ 400 \end{bmatrix}$$

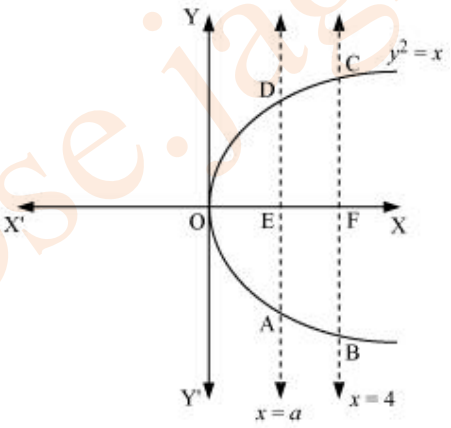
$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 5 \\ 8 \\ 8 \end{bmatrix}$$

$x = 5,\ y = 8,\ z = 8$

Thus,

The cost of onions is Rs 5 per kg, the cost of wheat is Rs 8 per kg, and the cost of rice is Rs 8 per kg.

Answer 25:



The line, x = a, divides the area bounded by the parabola and x = 4 into two equal parts.

∴ Area OAD = Area ABCD

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We can observe that the given area is symmetrical about x-axis.

Thus, Area OED = Area EFCD

Area of region OED is

$$= \int_0^a y dx$$

$$= \int_0^a \sqrt{x} dx$$

$$= \left[\frac{2x^{\frac{3}{2}}}{3} \right]_0^a$$

$$= \frac{2}{3}(a)^{\frac{3}{2}}$$

Area of region EFCD is

$$= \int_a^4 \sqrt{x} dx$$

$$= \left[\frac{2x^{\frac{3}{2}}}{3} \right]_a^4$$

$$= \frac{2}{3}\left(8 - a^{\frac{3}{2}}\right)$$

Now,

Area OED = Area EFCD

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$$\frac{2}{3}(a)^{\frac{3}{2}} = \frac{2}{3}\left(8 - a^{\frac{3}{2}}\right)$$

$$(a)^{\frac{3}{2}} = \left(8 - a^{\frac{3}{2}}\right)$$

$$2(a)^{\frac{3}{2}} = 8$$

$$(a)^{\frac{3}{2}} = 4$$

$$a = (4)^{\frac{2}{3}}$$

Answer 26: Equations of planes are:

$x + y + z = 1$ and $2x + 3y + 4z = 5$

The equation of the plane passing through the intersection of the given planes is:

$$(x + y + z - 1) + \lambda(2x + 3y + 4z - 5) = 0$$

$$(2\lambda + 1)x + (3\lambda + 1)y + (4\lambda + 1)z - (5\lambda + 1) = 0$$

The direction ratios of this plane are:

$a_1 = (2\lambda + 1)$

$b_1 = (3\lambda + 1)$

$c_1 = (4\lambda + 1)$

The given plane $x - y + z = 0$ is perpendicular to the equation of desired plane

Direction ratios of plane, $x - y + z = 0$ are:

$a_2 = 1$

$b_2 = -1$

$c_2 = 1$

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Both planes are perpendicular. Thus,

$a_1a_2 + b_1b_2 + c_1c_2 = 0$

$(2\lambda + 1) - (3\lambda + 1) + (4\lambda + 1) = 0$

$3\lambda + 1 = 0$

$\lambda = -\frac{1}{3}$

Equation of desired plane becomes as:

$$\left(2\times\left(\frac{-1}{3}\right)+1\right)x+\left(3\times\left(\frac{-1}{3}\right)+1\right)y+\left(4\times\left(\frac{-1}{3}\right)+1\right)z-\left(5\times\left(\frac{-1}{3}\right)+1\right)=0$$

$\frac{1}{3}x - \frac{1}{3}z + \frac{2}{3} = 0$

$x - z + 2 = 0$

This is the required equation of the plane.

OR

$\vec{b} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}$

$\vec{c} = c_1\hat{i} + c_2\hat{j} + c_3\hat{k}$

$(\vec{b} + \vec{c}) = (b_1 + c_1)\hat{i} + (b_2 + c_2)\hat{j} + (b_3 + c_3)\hat{k}$

$$\vec{a}\times(\vec{b}+\vec{c}) = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ a_1 & a_2 & a_3 \\ b_1+c_1 & b_2+c_2 & b_3+c_3 \end{vmatrix}$$

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$$\vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$$

$$= (a_2b_3 + a_2c_3 - a_3b_2 - a_3c_2)\hat{i} + (-a_1b_3 - a_1c_3 + a_3b_1 + a_3c_1)\hat{j} + (a_1b_2 + a_1c_2 - a_2b_1 - a_2c_1)\hat{k} \ldots\ldots\ldots(1)$$

$$\vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$$

$$= (a_2b_3 - a_3b_2)\hat{i} + (a_3b_1 - a_1b_3)\hat{j} + (a_1b_2 - a_2b_1)\hat{k} \ldots\ldots\ldots(2)$$

$$\vec{a} \times \vec{c} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ a_1 & a_2 & a_3 \\ c_1 & c_2 & c_3 \end{vmatrix}$$

$$= (a_2c_3 - a_3c_2)\hat{i} + (a_3c_1 - a_1c_3)\hat{j} + (a_1c_2 - a_2c_1)\hat{k} \ldots\ldots\ldots(3)$$

Now, add equation 2 & 3

$$(\vec{a} \times \vec{b}) + (\vec{a} \times \vec{c}) = (a_2b_3 + a_2c_3 - a_3b_2 - a_3c_2)\hat{i} + (-a_1b_3 - a_1c_3 + a_3b_1 + a_3c_1)\hat{j} + (a_1b_2 + a_1c_2 - a_2b_1 - a_2c_1)\hat{k}$$

Thus, *LHS = RHS*

$$\vec{a} \times (\vec{b} + \vec{c}) = (\vec{a} \times \vec{b}) + (\vec{a} \times \vec{c})$$

Answer 27: $\int_1^4 (x^2 - x)\,dx$

$$Let\ I = \int_1^4 (x^2 - x)\,dx$$

$$I = \int_1^4 (x^2)\,dx - \int_1^4 x\,dx$$

$$I = A - B$$

We know that

$$\int_a^b f(x)dx = \lim_{h \to 0} h\left[f(a) + f(a+h) + f(a+2h) + \ldots\ldots\ldots + f\{a + (n-1)h\} \right]$$

$$where\ h = \frac{b-a}{n}$$

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$$h=\frac{3}{n}$$

$$A=\int_1^4\left(x^2\right)dx$$

$$=\lim_{h\to 0}h\left[f(1)+f(1+\frac{3}{n})+.....+f\left\{1+(n-1)\frac{3}{n}\right\}\right]$$

$$=\lim_{n\to\infty}\frac{3}{n}\left[1^2+\left\{1^2+\left(\frac{3}{n}\right)^2+2.\frac{3}{n}\right\}+.....\left\{1^2+\left(\frac{3(n-1)}{n}\right)^2+2.3.\left(\frac{n-1}{n}\right)\right\}\right]$$

$$=3\lim_{n\to\infty}\left(\frac{1}{n}\right)\left[n+\left(\frac{3}{n}\right)^2\left\{1^2+2^2.....(n-1)^2\right\}+2.\frac{3}{n}(1+2+.....n-1)\right]$$

$$=3\lim_{n\to\infty}\left(\frac{1}{n}\right)\left[n+\frac{9}{n^2}\left\{\frac{n(n-1)(2n-1)}{6}\right\}+\frac{6}{n}\left(\frac{n(n-1)}{2}\right)\right]$$

$$=3\lim_{n\to\infty}\left(\frac{1}{n}\right)\left[n+\frac{3(n-1)(2n-1)}{2n}+\left(\frac{6(n-1)}{2}\right)\right]$$

$$=3\lim_{n\to\infty}\left(\frac{1}{n}\right)\left[n+\frac{6n^2-9n+3}{2n}+3n-3\right]$$

$$=3\lim_{n\to\infty}\left[1+\frac{6n^2-9n+3}{2n^2}+3-\frac{3}{n}\right]$$

$$=3\lim_{n\to\infty}\left[1+3-\frac{9}{2n}+\frac{3}{2n^2}+3-\frac{3}{n}\right]$$

$$=3[1+3+3]$$

$$=21$$

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Now,

$$B = \int_1^4 x dx$$

$$= \lim_{n\to\infty} h\left[1 + \left(1 + \frac{3}{n}\right) + ...\left\{1 + (n-1)\frac{3}{n}\right\}\right]$$

$$= \lim_{n\to\infty}\left(\frac{3}{n}\right)\left[1 + 1 + ...n \text{ times} + \frac{3}{n}(1 + 2 + 3 + ...n - 1)\right]$$

$$= 3\lim_{n\to\infty}\left(\frac{1}{n}\right)\left[n + \frac{3}{n}\left\{\frac{n(n-1)}{2}\right\}\right]$$

$$= 3\lim_{n\to\infty}\left(\frac{1}{n}\right)\left[n + \frac{3(n-1)}{2}\right]$$

$$= 3\lim_{n\to\infty}\left[1 + \frac{3(n-1)}{2n}\right]$$

$$= 3\lim_{n\to\infty}\left[1 + \frac{3}{2} - \frac{1}{2n}\right]$$

$$= 3\left[1 + \frac{3}{2}\right]$$

$$= \frac{15}{2}$$

Thus,

$$I = A + B$$

$$I = 21 - \frac{15}{2}$$

$$I = \frac{27}{2}$$

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Answer 28:

Let the awardees for honesty = x

Let the awardees for helping others = y

Let the awardees for keeping the colony neat & clean = z

As per the question,equations become as

$$x+y+z=12$$
$$2x+3y+3z=33$$
$$x-2y+z=0$$

$$\begin{bmatrix}1 & 1 & 1\\ 2 & 3 & 3\\ 1 & -2 & 1\end{bmatrix}\begin{bmatrix}x\\ y\\ z\end{bmatrix}=\begin{bmatrix}12\\ 33\\ 0\end{bmatrix}$$

$$AX=B$$

$$A=\begin{bmatrix}1 & 1 & 1\\ 2 & 3 & 3\\ 1 & -2 & 1\end{bmatrix}$$

$$|A|=1[3+6]-1[2-3]+1[-4-3]$$
$$|A|=9+1-7$$
$$|A|=3\neq 0$$

$$AdjA=\begin{bmatrix}9 & -3 & 0\\ 1 & 0 & -1\\ -7 & 3 & 1\end{bmatrix}$$

$$A^{-1}=\frac{1}{|A|}(adjA)$$

$$A^{-1}=\frac{1}{3}\begin{bmatrix}9 & -3 & 0\\ 1 & 0 & -1\\ -7 & 3 & 1\end{bmatrix}$$

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Now,

$AX = B$

$X = A^{-1}B$

$$X = \frac{1}{3}\begin{bmatrix} 9 & -3 & 0 \\ 1 & 0 & -1 \\ -7 & 3 & 1 \end{bmatrix}\begin{bmatrix} 12 \\ 33 \\ 0 \end{bmatrix}$$

$$X = \frac{1}{3}\begin{bmatrix} 108-99+0 \\ 12+0+0 \\ -84+99+0 \end{bmatrix}$$

$$X = \frac{1}{3}\begin{bmatrix} 9 \\ 12 \\ 15 \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 3 \\ 4 \\ 5 \end{bmatrix}$$

$x = 3,\ y = 4,\ z = 5$

The awardees for honesty = 3

The awardees for helping others = 4

The awardees for keeping the colony neat & clean = 5

The other category can be responsibility.

Answer 29:

$$P(X = 2) = P(1, 1) = \frac{}{36}$$

$$P(X = 3) = P(1, 2) + P(2, 1) = \frac{2}{36} = \frac{1}{18}$$

$$P(X = 4) = P(1, 3) + P(2, 2) + P(3, 1) = \frac{3}{36} = \frac{1}{12}$$

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$P(X = 5) = P(1, 4) + P(2, 3) + P(3, 2) + P(4, 1) = \frac{4}{36} = \frac{1}{9}$

$P(X = 6) = P(1, 5) + P(2, 4) + P(3, 3) + P(4, 2) + P(5, 1) = \frac{5}{36}$

$P(X = 7) = P(1, 6) + P(2, 5) + P(3, 4) + P(4, 3) + P(5, 2) + P(6, 1) = \frac{6}{36} = \frac{1}{6}$

$P(X = 8) = P(2, 6) + P(3, 5) + P(4, 4) + P(5, 3) + P(6, 2) = \frac{5}{36}$

$P(X = 9) = P(3, 6) + P(4, 5) + P(5, 4) + P(6, 3) = \frac{4}{36} = \frac{1}{9}$

$P(X = 10) = P(4, 6) + P(5, 5) + P(6, 4) = \frac{3}{36} = \frac{1}{12}$

$P(X = 11) = P(5, 6) + P(6, 5) = \frac{2}{36} = \frac{1}{18}$

$P(X = 12) = P(6, 6) = \frac{1}{36}$

Hence, required probability distribution is:

X	2	3	4	5	6	7	8	9	10	11	12
P (X)	$\frac{1}{36}$	$\frac{1}{18}$	$\frac{1}{12}$	$\frac{1}{9}$	$\frac{5}{36}$	$\frac{1}{6}$	$\frac{5}{36}$	$\frac{1}{9}$	$\frac{1}{12}$	$\frac{1}{18}$	$\frac{1}{36}$

$E(X) = \sum X_i P(X_i)$

$= 2 \times \frac{1}{36} + 3 \times \frac{1}{18} + 4 \times \frac{1}{12} + 5 \times \frac{1}{9} + 6 \times \frac{5}{36} + 7 \times \frac{1}{6} + 8 \times \frac{5}{36} + 9 \times \frac{1}{9} + 10 \times \frac{1}{12} + 11 \times \frac{1}{18} + 12 \times \frac{1}{36}$

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$$= \frac{1}{18} + \frac{1}{6} + \frac{1}{3} + \frac{5}{9} + \frac{5}{6} + \frac{7}{6} + \frac{10}{9} + 1 + \frac{5}{6} + \frac{11}{18} + \frac{1}{3}$$

$$= 7$$

$$\mathrm{E}(\mathrm{X}^2) = \sum X_i^2 P(X_i)$$

$$= 4 \times \frac{1}{36} + 9 \times \frac{1}{18} + 16 \times \frac{1}{12} + 25 \times \frac{1}{9} + 36 \times \frac{5}{36} + 49 \times \frac{1}{6} + 16 \times \frac{5}{36} + 81 \times \frac{1}{9} + 100 \times \frac{1}{12} + 121 \times \frac{1}{18} + 144 \times \frac{1}{36}$$

$$= \frac{1}{9} + \frac{1}{2} + \frac{4}{3} + \frac{25}{9} + 5 + \frac{49}{6} + \frac{80}{9} + 9 + \frac{25}{3} + \frac{121}{18} + 4$$

$$= \frac{329}{6} = 54.8$$

$$Var(X) = E(X^2) - [E(X)]^2$$
$$= 54.8 - 49$$
$$= 5.8$$

$$\text{Standard deviation} = \sqrt{Var(X)} = \sqrt{5.8} = 2.4$$

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Biology

Guess Paper: 2014
Class: XII

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

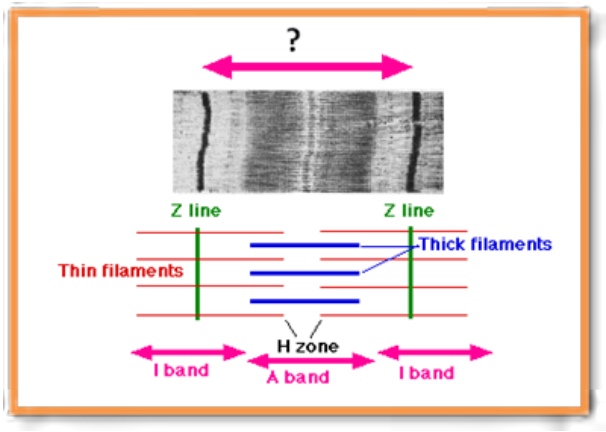
General Instructions:

1. All questions are compulsory.
2. The question paper consists of four sections A, B, C and D.
3. Section-A contains 8 questions of 1 mark each.
4. Section-B contains 10 questions of 2 marks each.
5. Section-C has 9 questions of 3 marks each.
6. Section-D contains 3 questions of 5 marks each.
7. Wherever necessary, the diagrams drawn should be neat and properly labeled

"Section - A"

Q.1 Mention the two events of pre-fertilization

Q.2 The actin filaments are attached to a protein named as Z lines or membrane of krouse. The dark region consists of heavy protein that is myosin. Can you label the region between two Z lines in the given diagram



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Q.3 In dogs black coat colour is dominant over white. What colour dog will you choose to breed a given black dog in order to find its genotype? What is this type of crossing known as?

Q.4 Various kinds of alleles that control the blood group in human beings?

Q.5 Given below is pairs of disease and causative organism. Which out of these is not a matching pair and why?

Ringworm: Worm

Candidiasis: Candida albicans.

Filariasis: Wuchereria

AIDS: Human Immunodeficiency Virus

Q.6 In the figure, what is the relationship between (1) and (2). What other name could you give to this relationship?

Q.7 Recall meiosis and indicate at what stage a recombinant DNA is made?

Q.8 What type of cut ends are formed when both the ends of DNA molecule is cleaved at exactly the same nucleotide position?

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"SECTION - B"

Q.9 How do kangaroo rats and camels adapt to arid conditions?

Q.10 Why both the strands of DNA are not copied during transcription?

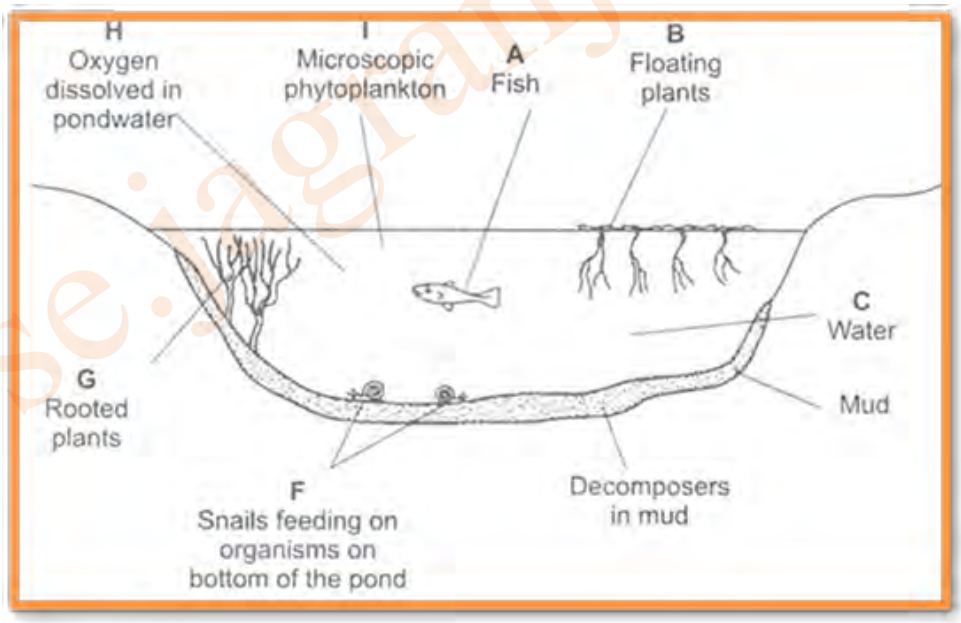
OR

A pea plant with purple flowers was crossed with a plant with white flowers producing 40 plants with only purple flowers. On selfing, these plants produced 470 plants with purple flowers and 162 with white flowers. What genetic mechanisms account for these results?

Q.11 The diagram shows some of the components of a pond ecosystem.

(i) What is an ecosystem?

(ii) List the letters that represent those components that are part of pond community.



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Q.12 How is the functioning of deoxyribonuclease different from that of ribonuclease?

Q.13 What is the lactational amenorrhea method (LAM) of family planning? How does LAM work?

Q.14 List few factors, which make the nutrient cycles unbalanced and the ecosystem unstable.

Q.15 Distinguish between upright pyramids and inverted pyramid.

Q.16 How is biodiversity distributed along major environmental gradients?

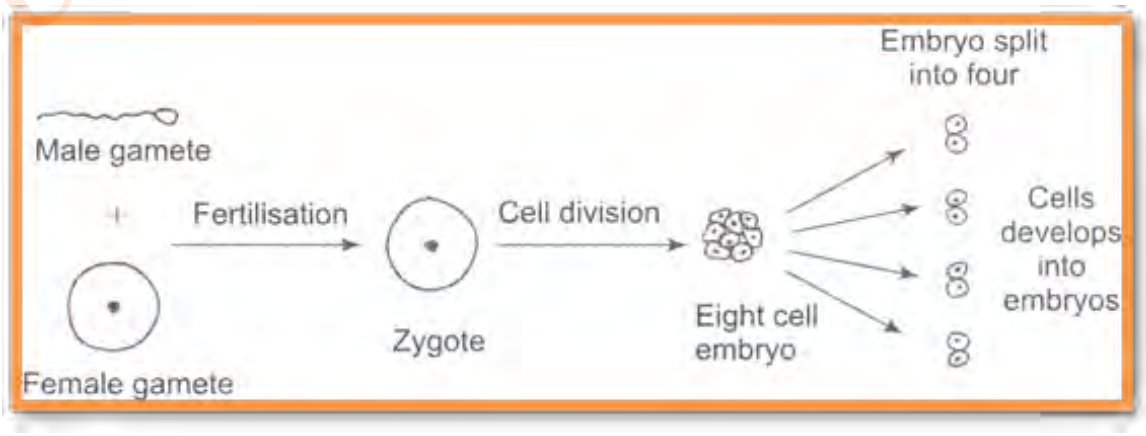
Q.17 What do you understand by fixed and mobile sources of air pollution?

Q.18 What is eutrophication? Explain its consequences on the life of plants and animals in such water bodies.

"SECTION-C"

Q.19 Define gross primary productivity (GPP) and net primary productivity (NPP). Give the range of net primary productivity in different ecosystems of the world?

Q.20 An egg cell from a cow was fertilized in a laboratory and allowed to develop into an eight-celled embryo. This was split into four parts, each of which developed into a new embryo. This is shown in the diagram. The new embryos were later transferred into different surrogate cows.



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(i) Explain why the new embryos produced are a clone.

(ii) If embryos with more than eight cells are split up, the separated cells fail to develop into new embryos. Suggest why.

Q.21 What are primary and secondary sexual organs of human female? Give an example of each.

Q.22 Few gaps have been left in the following table showing certain terms and their meanings. Fill up the gaps.

S. No.	Terms	Meanings
(i)		A haploid sex cell.
(ii)	Pure line	
(iii)		The hypothesis that genetic information flows only from DNA to RNA to protein.
(iv)		The set of genes required to metabolise lactose in bacteria.
(v)	Test cross	
(vi)	Inbreeding	

Q.23 What are radioactive wastes? Describe the harmful effects of nuclear radiations.

Q.24 What is competition? State the difference between interspecific and intraspecific competition

OR

Describe briefly the human role in carbon cycling.

Q.25 In a hospital laboratory, a sterile petri dish of nutrient agar was inoculated with bacteria from a patient with a throat infection. Four discs, each of which had been soaked in a different antibiotic, were placed on top of the bacteria. The dish was incubated at 37°C. Figure shows the appearance of the dish after incubation.

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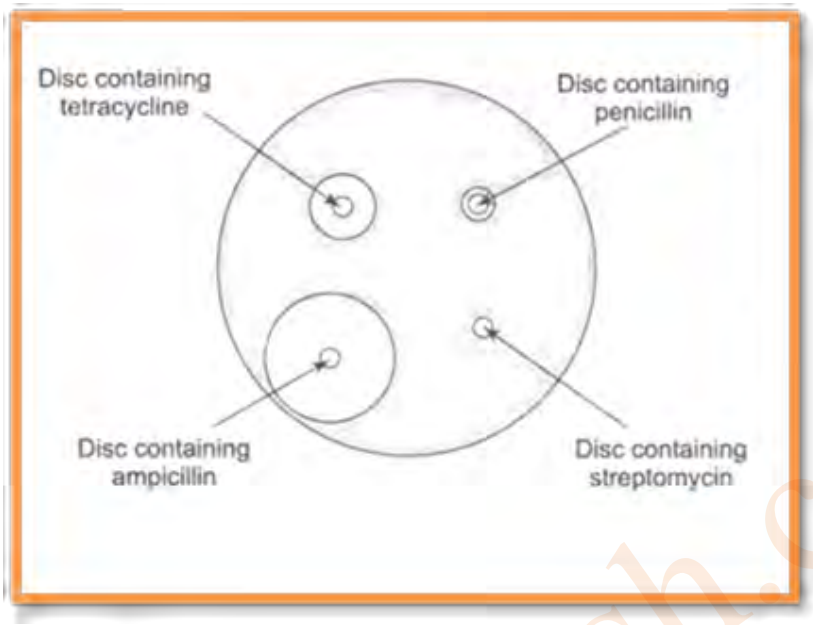

(a) Explain why there are clear zones around some of the discs containing antibiotic.

(b) It was suggested that ampicillin might be the best antibiotic to treat the patient's throat infection. Give the evidence from the laboratory test to support this suggestion.

Q.26 What is biochemical oxygen demand (BOD)? What does it indicates?

Q.27 What is a plasmid? Why do bacteria have them? What is it used for?

"SECTION-D"

Q.28 Describe the main steps involved in Recombinant DNA technology.

OR

What are some of the advantages of Genetically Modified Plants?

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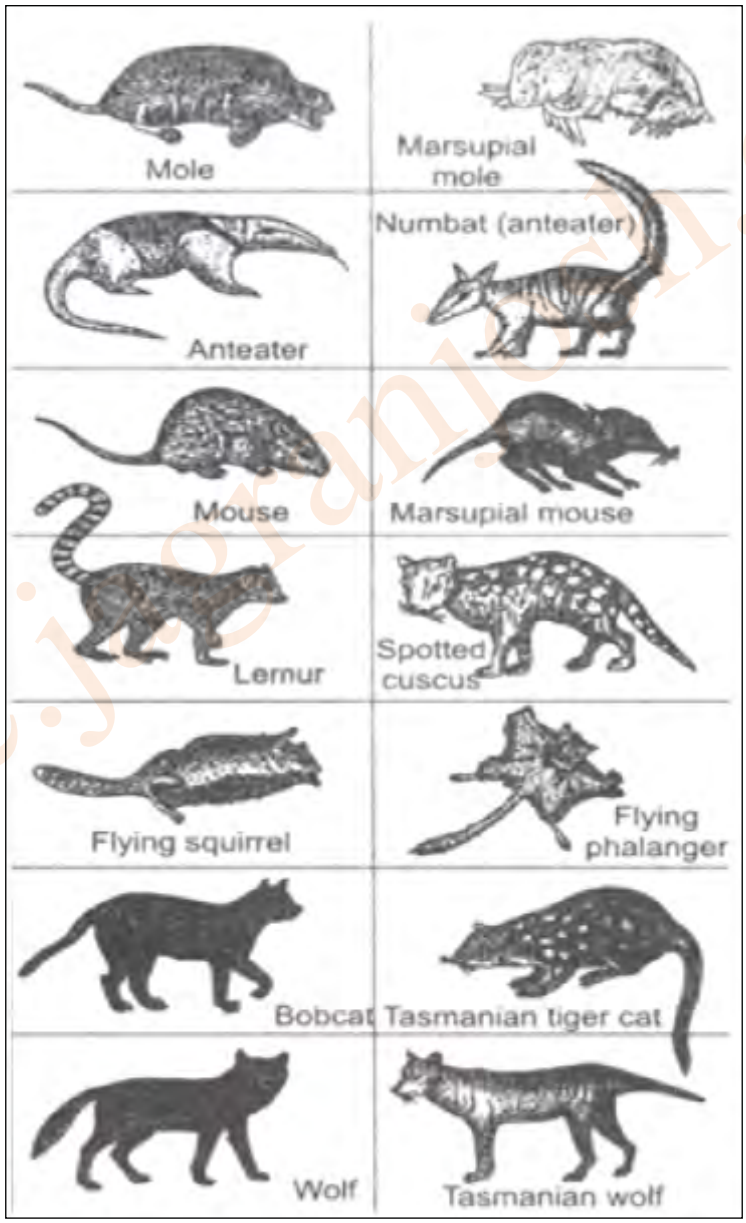
Q.29 What is soil pollution? Describe the ways by which soil gets polluted.

OR

What are two the basic strategies of biodiversity conservation? Explain briefly.

Q.30 (i) Images of Placental mammals and Australian Marsupials are given parallel in the given figure each other.



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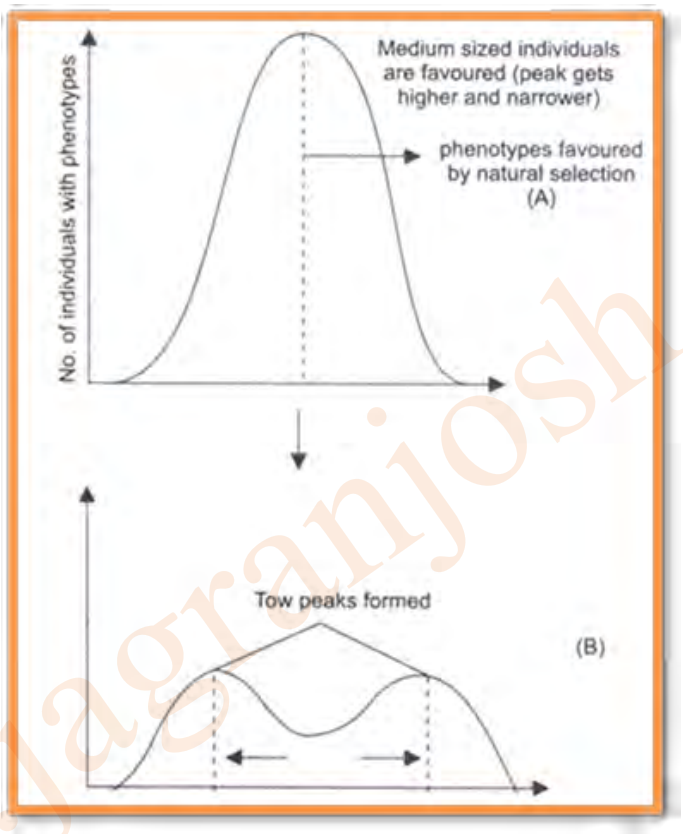
(a) Name and define the phenomenon which these groups of organisms exhibit?

(b) Mention the Habit / Adaptation of lemur and sportted Cuscus.

(ii) Graphical representation of the operation of natural selection on different traits is shown in the in the given diagram.



(a) Name the type of selection shown in Graph A & B respectively.

(b) What do you understand by Progressive selection? What would the graph look like in this case?

(iii) How does the study of fossils strengthen the theory of evolution?

OR

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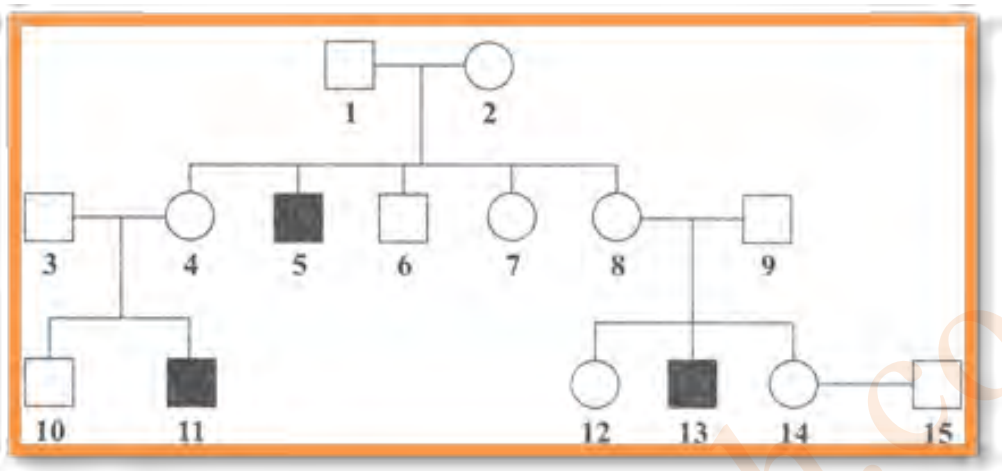
I. A blood test shows that person 14 is a carrier of muscular dystrophy. Person 15 has recently married person 14 but as yet they have had no children. What is the probability that their first child will be a male who develops muscular dystrophy?



II. (a) Identify the following fish. What is the scientific significance of this fish?

(b) What is the study of fish called?

III. You have sampled a population in which you know that the percentage of the homozygous recessive genotype (aa) is 36%. Using that 36%, calculate the following:

(a) The frequency of the "a" allele.

(b) The frequency of the "A" allele.

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Solutions

"SECTION-A"

Answer 1: Gametogenesis and gamete transfer.

Answer 2: Sarcomere

Answer 3: White colour dog will be chosen to determine its genotype and this type of crossing over is known as test cross.

Answer 4: Three different alleles (lA, IB and i) of a gene.

Answer 5: Ringworm.
It is the common name given to a group of fungal infections of the skin, hair and nails. It is caused by fungi.

Answer 6: The type of relationship is called protocooperation. It is also known as facultative mutualism.

Answer 7: A recombinant DNA is made in the first meiotic prophase by the process of crossing-over.

Answer 8: Blunt

"SECTION-B"

Answer 9: The kangaroo rat excretes solid urine and can live from birth to death without drinking water thereby conserving water.

The camels show unique adjustments to arid conditions, being very economical in water use, tolerant to wide fluctuations in body temperature, and are able to maintain blood stream moisture even during extreme heat stress.

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Answer 10: Because if both strands act as template, they would code for RNA molecule with different sequence, and if they code for proteins, the sequence of amino acids in protein would be different. For this reason one segment of the DNA would be coding for two different proteins, and this would make difficult the genetic information transfer machinery. Also, the two RNA molecules if produced concurrently would be complementary to each other, therefore would form a double stranded RNA. This would prevent RNA from being translated into protein, and the exercise of transcription would become a fruitless one.

OR

The ratio between plants with purple flowers to those with white flowers is approximately 3: 1.
This ratio (3: 1) is called Mendelian monohybrid ratio.
The genetic mechanisms that account for these results are principle of dominance and principle of segregation.

Answer 11: (i) Ecosystem is a functional unit of biosphere, composed of biotic and abiotic factors that interact among themselves.
(ii) A + B + E + F + G + I.

Answer 12: A deoxyribonuclease (DNAse, for short) is any enzyme that catalyses the hydrolytic cleavage of phosphodiester linkages in the DNA backbone. While, ribonuclease (RNAse) is an enzyme that catalyses the hydrolysis of phosphate ester linkages in ribonucleic acid.

Answer 13: Lactational amenorrhea method is a contraceptive method that is based on the natural post-partum infertility that occurs when a woman is amenorrheic and fully breast feeding. The infant's suckling suppresses the production of the hormones that are necessary for ovulation. Without ovulation, pregnancy cannot take place.

Answer 14: In an undisturbed ecosystem, (i.e. an ecosystem in which human activities are absent or nearly so) the input of nutrients may approximately equal the output of nutrients, rendering the nutrient cycles more or less balanced.

Severe disturbances in the ecosystem (e.g. tree felling, insect outbreak, fire, soil erosion, etc.) may make the nutrient cycles unbalanced and the ecosystem unstable. Harvesting of agricultural crops

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or transportation of logs from forests, represent nutrient loss from these ecosystems

Answer 15: When the number of producer organisms or their biomass is maximum in an ecosystem and these decreases progressively at each trophic level in a food chain, we get upright pyramids. For example, grassland ecosystem and cropland ecosystem.

In contrast, when number of individuals or their biomass at producer level is minimum and it increases progressively at each trophic level in a food chain, then we get inverted pyramid. For example, in a tree-ecosystem the number of primary producer (a tree) is less than that of herbivore birds feeding upon the tree fruits. The number of parasites like bugs and lice living and feeding upon the birds' body is still higher.

Answer 16: The latitudinal and altitudinal gradients are two master environmental gradients. Biodiversity varies with change in latitude or altitude.

Biodiversity increases from high to low latitude, e.g. from poles to equator. Likewise, a decrease in species diversity takes place from lower to higher altitudes on a mountain. A 1000 m increase in altitude results in a temperature drop of about 6.5°C. This drop in temperature and greater seasonal variability at higher altitudes are a major factor that reduces diversity. Further, it is expected that more complex and heterogeneous the physical environment, more complex and diverse will be the flora and fauna.

Answer 17: Anthropogenic (man-made) air pollutants enter the atmosphere from fixed and mobile sources. Fixed sources include large factories, electrical power plants, mineral smelters and different small-scale industries, whereas mobile sources include all sorts of transport vehicles moving by road, rail or air.

Answer 18: The process of nutrient enrichment of water and consequent loss of species diversity is called eutrophication.

Availability of excess nutrients causes profuse growth of algae (algal bloom), especially the blue-green algae. Such algal blooms may totally cover the water surface, often release toxins in water, and sometimes cause deficiency of oxygen in the water. Thus, in bloom-infested water body the growth of other algae may be inhibited due to toxins, and aquatic animals (e.g. fish) may die due to toxicity or lack of oxygen.

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"SECTION-C"

Answer 19: The rate of total capture of energy or the rate of total production of organic material (biomass), is known as gross primary productivity. However, while the energy capture process is operating in the green tissues, these as well as other tissues, are consuming energy in respiration. The balance energy or biomass remaining after meeting the cost of respiration of producers, is called net primary productivity, as shown below:

Net productivity = Gross productivity - Respiration rate

The net primary productivity results in the accumulation of plant biomass, which serves as the food of herbivores and decomposers.

Answer 20: (i) Because they are genetically and morphologically identical.

(ii) Cells have lost ability to control development and are no longer totipotent.

Answer 21: The primary sex organs are ovaries in females. Besides producing gametes, they also secrete sex hormones. Their growth, maintenance and functions are regulated by gonadotropins of the anterior pituitary.

The organs, which perform important functions in reproduction but neither produce gametes nor secrete sex hormones are called secondary sexual organs. These include the fallopian tubes, uterus, vagina and mammary glands in females.

Answer 22: (i) Gamete.

(ii) Pure line: A line that has been rendered homozygous for all genes under consideration in successive generations.

(iii) Central dogma

(iv) Lac operon

(v) A cross between an individual with the dominant phenotype and an allele with the recessive phenotype to see if the individual with the dominant phenotype is homozygous or heterozygous.

(vi) Inbreeding: Mating between genetically related individuals.

Answer 23: Radioactive wastes include materials that are radioactive and for which there is no further practical use. It includes a wide variety of material, such as, used equipment, contaminated clothing and

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reactor fuel components. Most radioactive waste is generated by the operation of nuclear power stations and by reprocessing their used or 'spent' nuclear fuel. Radiation, that is given off by nuclear waste is exceedingly damaging to biological organisms, because it causes mutations to occur at a very high rate. Increased risk of cancer, birth defects, and infertility are just a few of the harmful effects caused by nuclear waste. So, nuclear waste is an extremely potent pollutant and has to be dealt with maximum care. It has been recommended that storage of nuclear waste, after sufficient pre-treatment, should be done in properly shielded containers buried within the rocks, about 500 m deep below the Earth's surface.

Answer 24: Interaction between two species, where both suffer adverse effects, is known as competition. It occurs when resources, such as space, light and nutrients, etc. are in short supply. Competition is basically of two types:
(i) interspecific, and (ii) intraspecific.
Interspecific competition occurs between individuals of two different species occurring in a habitat.
On the other hand, intraspecific competition occurs between individuals of the same species. Generally, the intraspecific competition is more intense than interspecific competition. The requirements of individuals of the same species are very similar; hence, they compete more fiercely.

OR

Anthropogenic (human) activities, particularly fossil fuel burning and deforestation, are releasing carbon dioxide into the atmosphere. When we mine coal and extract oil from the Earth's crust, and then burn these fossil fuels for transportation, heating, cooking, electricity and manufacturing, we are effectively moving carbon more rapidly into the atmosphere than is being removed naturally through the sedimentation of carbon, ultimately causing atmospheric carbon dioxide concentrations to increase. In addition, by clearing forests to support agriculture, we are transferring carbon from living biomass into the atmosphere. The result is that humans are adding ever-increasing amounts of extra carbon dioxide into the atmosphere.

Answer 25: (a) Antibiotic has diffused into agar and killed or inhibited bacteria.
(b) Ampicillin might be the best antibiotic to treat the patient's throat infection. This is evident that largest clear area is due to this antibiotic.

Answer 26: BOD is a measure of oxygen required by aerobic decomposers for the biochemical degradation of organic materials (i.e. biodegradable materials) in water. Higher the BOD, lower would be the

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dissolved O_2 (DO). BOD indicates the degree of organic pollution in water. Usually, a high BOD in body of water or a waste stream means that high levels of nutrients are present, along with a high number of microorganisms feeding the nutrients.

Answer 27: Plasmid is an extrachromosomal, autonomous circular DNA molecule found in certain bacteria, capable of autonomous replication. It is not the main genetic material of the bacteria so it replicates itself independent of the bacteria's chromosomes, which are in the nucleus.

The purpose of the plasmid is such that different bacteria can exchange their genetic information in it to adapt to their environment. Thus, there are cases where bacteria suddenly grow resistant to medicine due to the exchange of drug-resistant genes among the bacteria.

Scientists make use of the ability for the plasmid to move in and out of the bacteria to "edit" the genetic material of the plasmid. After the plasmid has been altered, it is put back into the bacteria thus called DNA recombination.

"SECTION-D"

Answer 28: Recombinant DNA technology involves several steps in specific sequence such as:

a. Isolation of a specific genetic material (DNA). The removal of plasmid or genomic DNA from cells is termed isolation. Plasmid DNA may be removed only from certain bacteria or yeast cells, whereas genomic DNA may be isolated from many cells, both prokaryotic and eukaryotic. Isolation usually involves the breaking of the cell's membrane (and possibly nuclear membrane) and possibly also a cell wall (plant cells). DNA is obtained by treating the bacterial cells/plant or animal tissue with enzymes such as lysozyme (bacteria), cellulase (plant cells), chitinase (fungus). The RNA can be removed by treating with ribonuclease while proteins can be removed by treating with protease. Other molecules are removed by suitable treatments. The purified DNA ultimately precipitates out after the addition of chilled ethanol.

b. Cutting of DNA at specific locations. DNA purified from an organism can be prepared for cloning only after it has been cut into smaller molecules. Restriction endonucleases make possible the cleavage of DNA. Restriction enzyme digestions are achieved by incubating purified DNA molecules with the restriction enzyme, at the optimal conditions for that specific enzyme. Agarose gel electrophoresis is employed to check the progression of a restriction enzyme digestion. The process is repeated with the vector DNA also. After having cut the source DNA as well as the

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vector DNA with a specific restriction enzyme, the cut out 'gene of interest' from the source DNA and the cut vector with space are mixed and ligase is added. DNA ligase joins DNA to DNA. This results in the preparation of recombinant DNA.

c. Amplification of gene of interest using polymerase chain reaction (PCR). The polymerase chain reaction is a repetitive bi-directional synthesis of DNA. In this reaction, multiple copies of the gene (or DNA) of interest are synthesized in vitro using two sets of primers and the enzyme DNA polymerase. The enzyme extends the primers using the nucleotides provided in the reaction and the genomic DNA as template. As amplification proceeds, the DNA sequence between the primers doubles after each cycle. The process of replication of DNA is repeated many times. The segment of DNA can be amplified to approximately billion times. The amplified fragment can now be used to ligate with a vector for further cloning.

d. Insertion of recombinant DNA into the host cell/organism. The desired DNA sequence, once attached to a DNA vector, must be transferred to a suitable host. Transformation is defined as the introduction of foreign DNA into a recipient cell. Transformation of a cell with DNA from a virus is usually referred to as transfection. There are several methods of introducing the ligated DNA into recipient cells. Escherichia coli is usually the host, and transformation of E. coli is an essential step in these experiments. Several methods are available for the transfer of DNA into cells of higher eukaryotes.

e. Obtaining the foreign gene product. The ultimate aim of recombinant DNA technology is to produce a desirable protein. Therefore, there is a need for the recombinant DNA to be expressed. The foreign gene gets expressed under appropriate conditions. The cultures may be used for extracting the desired protein and then purifying it by using different separation techniques.

f. Downstream processing. After completion of the biosynthetic stage, the product is subjected through a series of processes. The processes include separation and purification, which are together referred to as downstream processing.

OR

Advantages of genetically modified plants:

a. Pest resistance. Crop losses from insect pests can be incredible, resulting in financial loss for farmers and starvation in developing countries. Farmers use many tons of chemical pesticides

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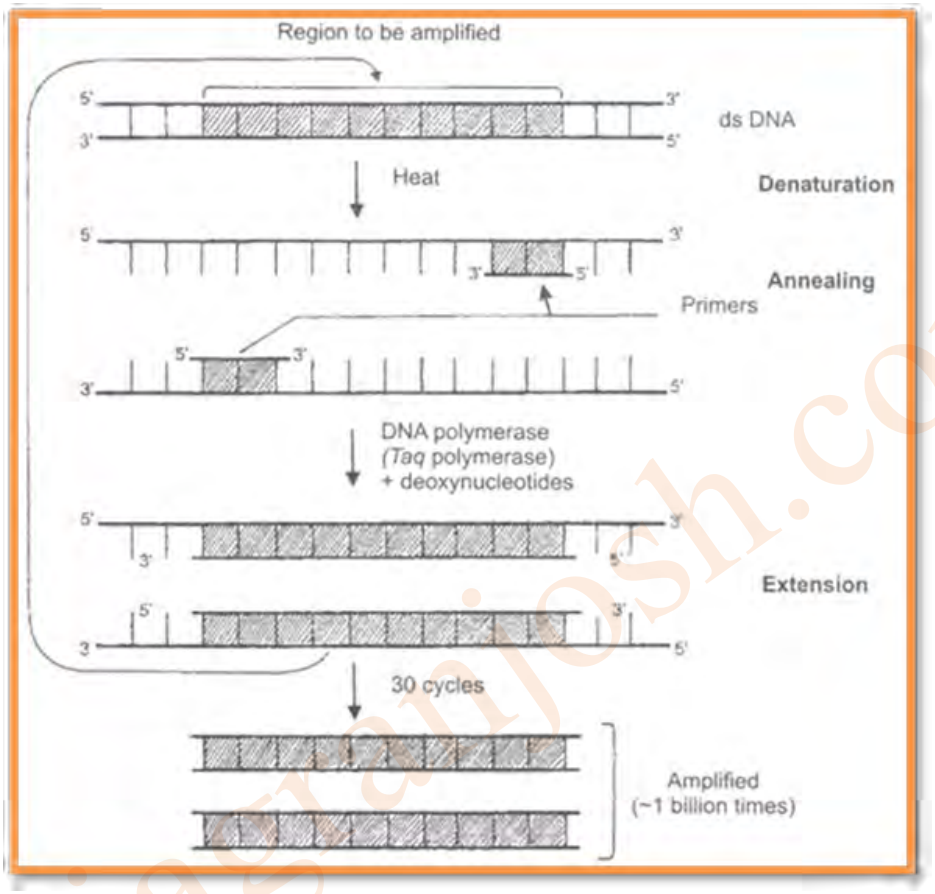
annually.



Consumers do not wish to eat food that has been treated with pesticides because of potential health hazards. Growing GM foods such as Bt corn, Bt cotton etc., can help eliminate the application of chemical pesticides and reduce the cost of bringing a crop to market.

b. Disease resistance. There are many viruses, fungi and bacteria that cause plant diseases. Plant biologists are working to create plants with genetically engineered resistance to these diseases.

c. Herbicide tolerance. For some crops, it is not cost-effective to remove weeds by physical means such as tilling, so farmers will often spray large quantities of different herbicides (weed-killer) to destroy weeds, a time-consuming and expensive process, that requires care so that the herbicide does not harm the crop plant or the environment. Crop plants genetically engineered to be resistant to one very powerful herbicide could help prevent environmental damage by reducing

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the amount of herbicides needed.

d. Cold tolerance. Unexpected frost can destroy sensitive seedlings. An antifreeze gene from cold-water fish has been introduced into plants such as tobacco and potato.

e. Nutrition. Malnutrition is common in third world countries where poor peoples rely on a single crop such as rice for the main staple of their diet. However, rice does not contain adequate amounts of all necessary nutrients to prevent malnutrition. If rice could be genetically engineered to contain additional vitamins and minerals, nutrient deficiencies could be alleviated. Plans are underway to develop golden rice that also has increased iron content.

f. Pharmaceuticals. Medicines and vaccines often are expensive to produce and sometimes require special storage conditions not readily available in third world countries. Researchers are working to develop edible vaccines in tomatoes and potatoes. These vaccines will be much easier to store and administer than traditional injectable vaccines.

Answer 29: Any unfavorable alteration in soil by addition or removal of substances and factors, which decreases soil fertility, is called soil pollution.

Soil pollution generally results from different human activities.

a. Industrial solid wastes and sludge are the main sources of soil pollution by toxic organic and inorganic chemical compounds and heavy metals. The fallout from industrial emissions, for example, the fly ash emitted by thermal power plants, can pollute surrounding land.

b. Radioactive wastes from nuclear testing laboratories and nuclear power plants and the radioactive fallout from nuclear explosions also contaminate the soil. Radioactive materials thrive in the soil for long periods because they usually have a long half-life

c. Municipal wastes largely include domestic and kitchen wastes, hospital wastes, livestock and poultry wastes, slaughter house wastes, waste metals, and glass and ceramic wastes, etc. Non-biodegradable materials like used polyethylene carry-bags, waste plastic sheets, pet-bottles etc., persist in soil for long periods.

d. Hospital wastes contain organic materials, chemicals, metal needles, plastic and glass bottles, vials

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etc. Dumping of domestic sewage and hospital organic wastes contaminate the environment with a variety of pathogens that can dangerously affect human health.

e. Pesticides and weedicides are being increasingly applied to control pests and weeds in agricultural systems. Excess inorganic fertilizers and biocide residues are contaminating the soil as well as surface and groundwater resources. Inorganic nutrients, like phosphate and nitrate are washed out to aquatic ecosystems and accelerate eutrophication there. Nitrate can also pollute drinking water. Inorganic fertilizers and pesticide residues change the chemical properties of soil and can adversely affect soil organisms.

f. Opencast mining (a process where the surface of the Earth is dug open to bring out the underground mineral deposits) completely devastates the topsoil and contaminates the area with toxic metals and chemicals.

OR

There are two basic strategies of biodiversity conservation, in situ (on site) and ex situ (off site).

a. In situ conservation strategies. In situ conservation of agricultural biodiversity has been defined as the maintenance of the diversity present in and among populations of many species used directly in agriculture, or used as sources of genes, in habitats where such diversity arose and continues to grow. The in situ strategies emphasise protection of total ecosystems. It is mostly done in the form of Protected areas, Biosphere reserves, and Sacred forests and Sacred lakes. In situ conservation of wild plants helps to protect species threatened with loss of extinction, supply material to restore degraded lands and provide material for genetic improvement of crop plants.

- Protected Areas: These are areas of land and/or sea, especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources. These are managed through legal or other effective means. Examples of protected areas are National Parks and Wildlife Sanctuaries. India has 581 protected areas (90 National Parks and 448 Wildlife Sanctuaries), covering 4.7 percent of the land surface, as against 10 percent internationally suggested norm.

- Biosphere Reserves: Biosphere Reserve is a part of an international network of preserved areas designated by the United Nations Educational Scientific and Cultural Organization (UNESCO). Biosphere Reserves are vital centres of biodiversity where research and monitoring activities are

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conducted, with the participation of local communities, to protect and preserve healthy natural systems threatened by development. These are representative examples of natural biomes and contain unique biological communities. There are 14 biosphere reserves in India. A Biosphere Reserve consists of core, buffer and transition zones.

- Sacred forests and sacred lakes: Sacred forests are the forest patches protected by tribal communities due to religious sanctity. They represent the most undisturbed forests without any human impact and are free from any human disturbance. In India, sacred forests are located in several parts, e.g. Karnataka, Maharashtra, Kerala, Meghalaya etc., and are serving as refuge for a number of rare, endangered and endemic taxa. Similarly, several water bodies (e.g. Khecheopalri lake in Sikkim) have been acknowledged sacred by the people, leading to protection of aquatic flora and fauna.

b. Ex situ conservation strategies. The ex situ conservation strategies include botanical gardens, zoos, conservation stands, and gene, pollen, seed, seedling, tissue culture and DNA banks. Seed gene banks are the easiest way to store germplasm of wild and cultivated plants at low temperature in cold rooms. Preservation of genetic resources is carried out in field gene banks under normal growing conditions.

Answer 30:

i. (a) Convergent Evolution or Adaptive Convergence.
Definition: Development of similar adaptive functional structures in unrelated groups of organisms is called Adaptive Convergence.

(b) Adaptation / Habit of lemur & spotted Cuscus – Arboreal

ii. (a) Graph A - Stabilising / Balancing Selection
Graph B - Disruptive / Diversifying Selection

(b) Progressive Selection - In this selection the population changes towards one particular direction which means this favors small or large sized individuals and more individuals of that type will be present in the next generation. The mean size of population changes.
For example evolution of DDT resistant mosquitoes.

iii. The study of fossils reveals ancient and extinct species having many similar structures to others of the present and of the past. Fossils still allow radioactive dating to estimate the periods during which the species lived and to establish a chronological relationship between them. These

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evidences strengthen the hypothesis of relationship and common origin among species and that their features have modified gradually until the formation of the current species.

OR

i. 25%

ii. (a) Coelacanth. This particular fish (Latimeria) is a living fossil which belongs to a specialized offshoot of fishes which were known to exist approximately 300 million years ago. The coelacanths were thought to have gone extinct at the end of the Cretaceous, 65 million years ago.

(b) Ichthyology.

iii. (a) The frequency of "aa" is 36%, which means that q2 = 0.36, by definition.
If q2 = 0.36, then q = 0.6, again by definition.
Since q equals the frequency of the "a" allele, then the frequency of "a" allele is 60%.

(b) Since q = 0.6, and p + q = 1, then p = 0.4; the frequency of "A" is by definition equal to p, so the answer is 40%.

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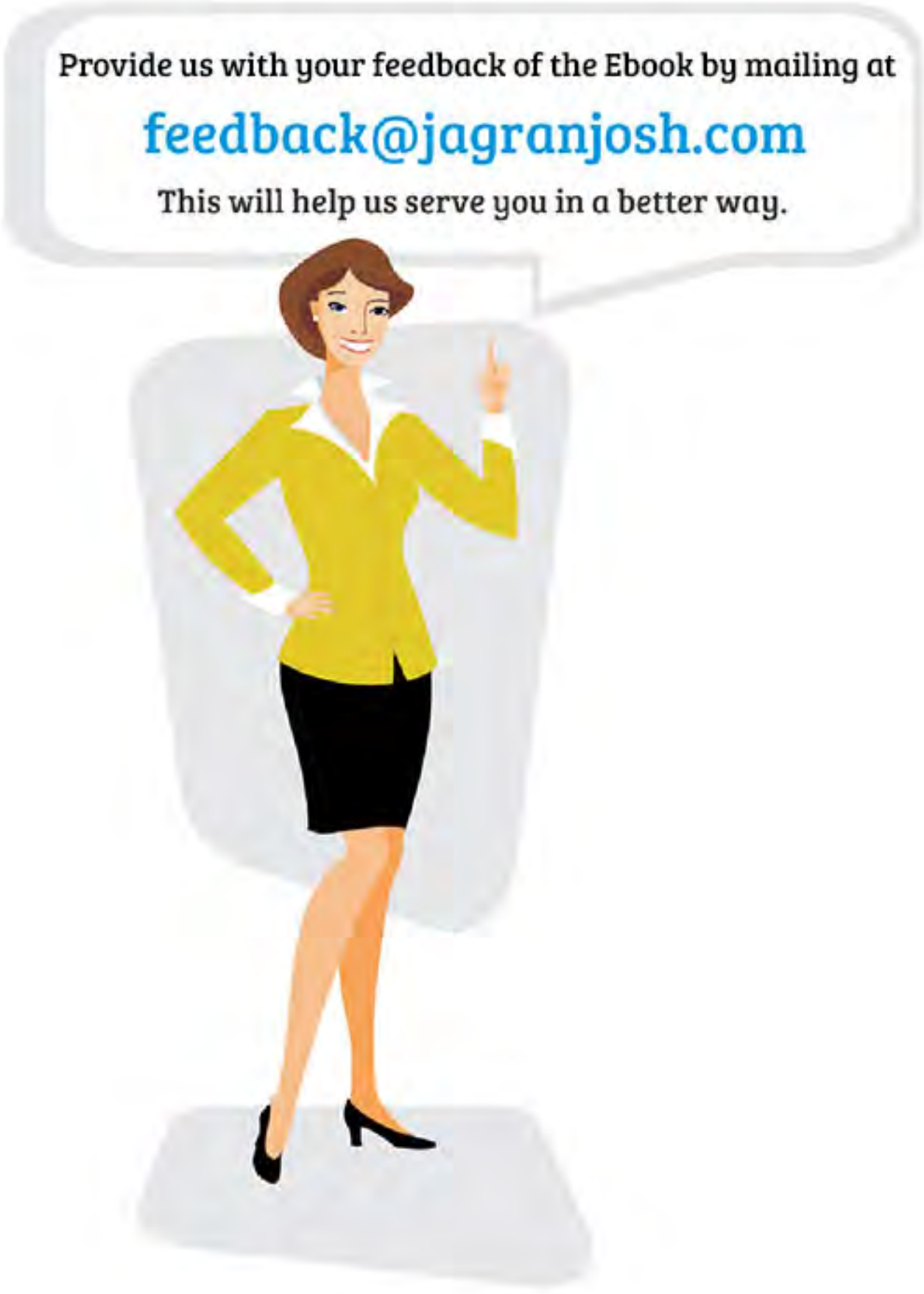

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