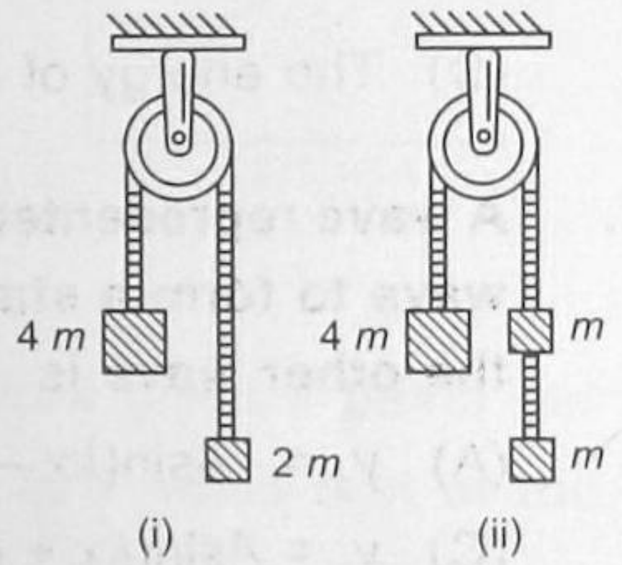
SECTION-1
PHYSICS

1. **A balloon starts rising from the ground with an acceleration of 1.25 m s^{-2}. After 8 s, a stone is released from the balloon. The stone will**

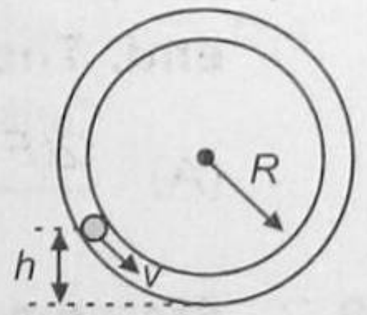
(A) Cover a distance of 40 m
(B) Have a displacement of 50 m
(C) Reach the ground in 4 s
(D) Begin to move down after being released

2. **In the arrangement shown in figure, pulley is smooth and massless and all the strings are light. Let F_1 be the force exerted on the pulley in case (i) and F_2 the force in case (ii). Then**



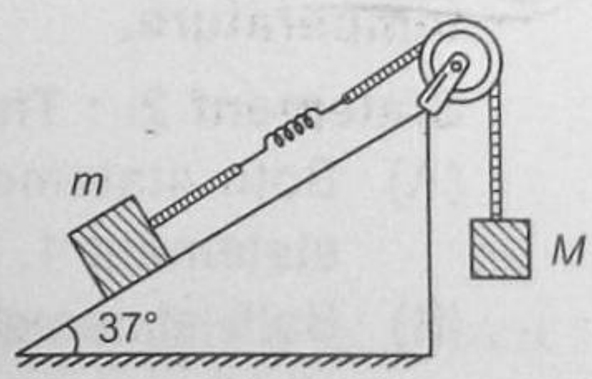
(A) $F_1 > F_2$
(B) $F_1 < F_2$
(C) $F_1 = F_2$
(D) $F_1 = 2F_2$

3. **With what minimum speed *v* must a small ball should be pushed inside a smooth vertical tube from a height *h* so that it may reach the top of the tube ? Radius of the tube *R* is**



(A) $\sqrt{2g(h+2R)}$
(B) $\frac{5}{2}R$
(C) $\sqrt{g(5R-2h)}$
(D) $\sqrt{2g(2R-h)}$

4. **A block of mass *m* is attached with a massless spring of force constant *k*. The block is placed over a rough inclined surface for which the coefficient of friction is $\mu = 3/4$. The minimum value of *M* required to move the block up the plane is (Neglect mass of string and pulley and friction in pulley)**



(A) $\frac{3}{5}m$
(B) $\frac{4}{5}m$
(C) $2\,m$
(D) $\frac{3}{2}m$

5. A uniform ring of mass M and radius R is placed directly above a uniform sphere of mass $8M$ and of same radius R. The centre of the ring is at a distance of $d = \sqrt{3}R$ from the centre of the sphere. The gravitational attraction between the sphere and the ring is

(A) $\frac{8GM^2}{R^2}$ (B) $\frac{2GM^2}{\sqrt{3}R^2}$ (C) $\frac{3GM^2}{2R^2}$ (D) $\frac{\sqrt{3}GM^2}{R^2}$

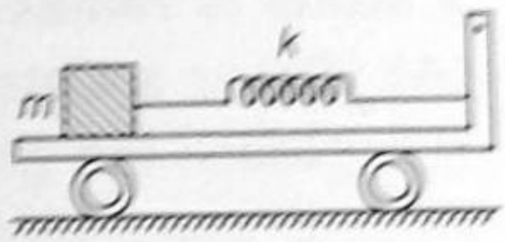
6. A block of mass m is attached to a massless spring of force constant k, the other end of which is fixed from the wall of a truck as shown in figure. The block is placed over a smooth surface and initially the spring is unstretched. Suddenly the truck starts moving towards right with a constant acceleration a_0. As seen from the truck

(A) The particle will execute SHM with a time period of $2\pi\sqrt{\frac{2m}{k}}$

(B) The time period of oscillations will be $2\pi\sqrt{\frac{m}{2k}}$

(C) The amplitude of oscillations will be $\frac{ma_0}{k}$

(D) The energy of oscillations will be $\frac{m^2a_0^2}{k}$



7. A wave represented by the equation $y_1 = A\cos(kx - \omega t)$ is superimposed with another wave to form a stationary wave such that the point $x = 0$ is a node. The equation of the other wave is

(A) $y_2 = -A\sin(kx - \omega t)$ (B) $y_2 = -A\cos(kx + \omega t)$

(C) $y_2 = A\sin(kx + \omega t)$ (D) $y_2 = A\cos(kx + \omega t)$

8. A thin uniform rod of mass m moves translationally with acceleration a due to two antiparallel force of lever arm l. One force is of magnitude F and acts at one extreme end. The length of the rod is

(A) $\frac{2(F+ma)l}{ma}$ (B) $l\left(1+\frac{F}{ma}\right)$ (C) $\frac{(F+ma)l}{2ma}$ (D) $\frac{mal}{ma+F}$

9. Statement 1 : In thermal conduction, energy is transferred due to chaotic motion of conduction electrons and atomic vibrations from region of high temperature to low temperature.

Statement 2 : There is overall transference of particles of conducting body.

(A) Both statements 1 and 2 are true and statement 2 is the correct explanation of statement 1.

(B) Both statements 1 and 2 are true but statement 2 is not the correct explanation of statement 1.

(C) Statement 1 is true but statement 2 is false

(D) Statement 1 is false and statement 2 is true.

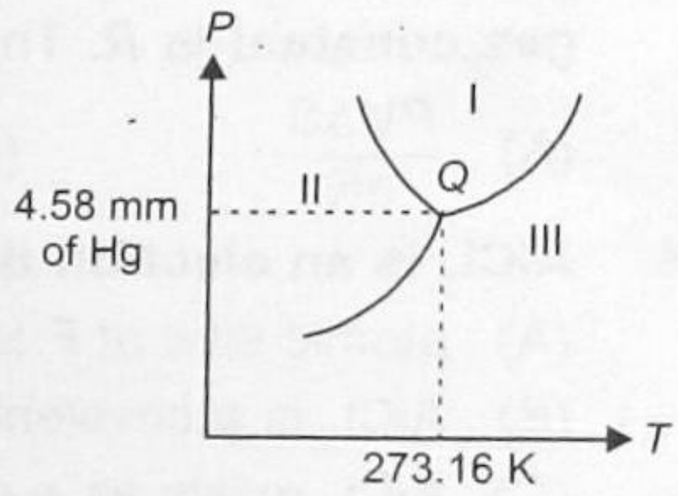
10. **The potential energy of a particle of mass 1 kg in motion along the x-axis is given by $U = 4(1 - \cos 2x)$ J. Here x is in meter. The period of small oscillations (in sec) is _____.**

(A) 2π (B) π (C) $\pi/2$ (D) $\sqrt{2}\pi$

11. **A solid sphere and a hollow sphere of equal mass and radius are placed over a rough horizontal surface after rotating it about its mass centre with same angular velocity ω_0. Once the pure rolling starts let v_1 and v_2 be the linear speeds of their centre of mass. Then**

(A) $v_1 = v_2$ (B) $v_1 > v_2$ (C) $v_1 < v_2$ (D) None of these

12. **In the phase diagram shown, the point Q corresponds to the triple point of water. The regions I, II and III respectively correspond to phases**



(A) Liquid, solid, vapour

(B) Solid, liquid, vapour

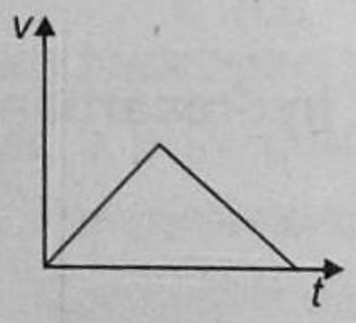
(C) Liquid, vapour, solid

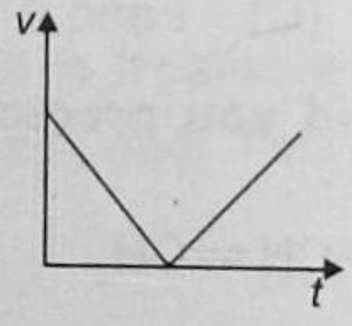
(D) Solid, vapour, liquid.

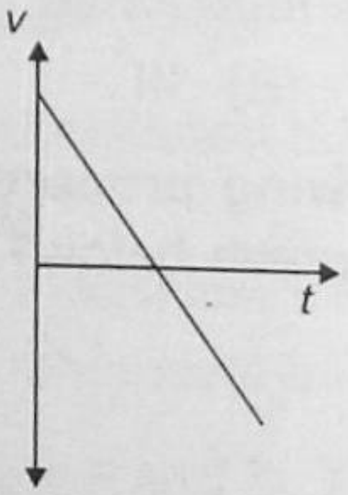
13. **A set of 56 tuning forks are so arranged in series that each fork gives 4 beats per second with the previous one. The frequency of the last fork is 3 times that of the first. The frequency of the first fork is**

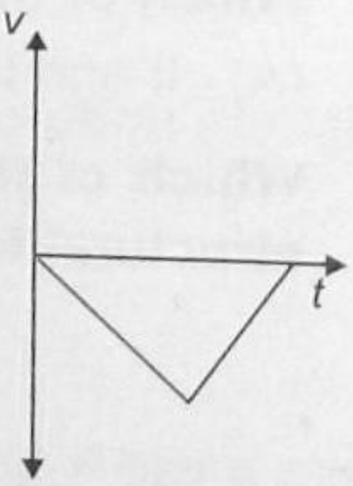
(A) 110 (B) 60 (C) 56 (D) 52.

14. **A ball is projected vertically upwards with a high velocity v. It comes back to the ground in time t. Which of the following graph shows the motion correctly?**

(A) 

(B) 

(C) 

(D) 

15. **The position x of a particle at time t is given by $x = \frac{v_0}{a}(1 - e^{-at})$ where v_0 is a constant and $a > 0$. The dimensional formula of v_0 and a are**

(A) $[M^0L^1T^{-1}]$ and $[M^0L^0T^{-1}]$ (B) $[M^0L^1T^0]$ and $[M^0L^0T^{-1}]$

(C) $[M^0LT^{-1}]$ and $[M^0L^1T^{-2}]$ (D) $[M^0L^1T^{-1}]$ and $[M^0L^0T^1]$.

16. $P \xleftarrow[\text{Heat}]{120^\circ C} \underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O} \xrightarrow{200^\circ C} Q \xrightarrow[\text{heated}]{\text{Strongly}} R$

P, Q and R are respectively

(A) Plaster of Paris, dead burnt plaster, calcium sulphide

(B) Dead burnt plaster, plaster of Paris, lime

(C) Plaster of Paris, dead burnt plaster, lime

(D) Anhydrous calcium sulphate, plaster of Paris, calcium sulphite.

17. **A sample of an ideal gas with initial pressure P and volume V is taken through an isothermal process during which entropy change is found to be ΔS. The universal gas constant is R. Then, the work done by the gas is given by**

(A) $\frac{PV\Delta S}{nR}$ (B) $nR\Delta S$ (C) PV (D) $\frac{P\Delta S}{nRT}$

18. **$AlCl_3$ is an electron deficient compound but AlF_3 is not. This is because**

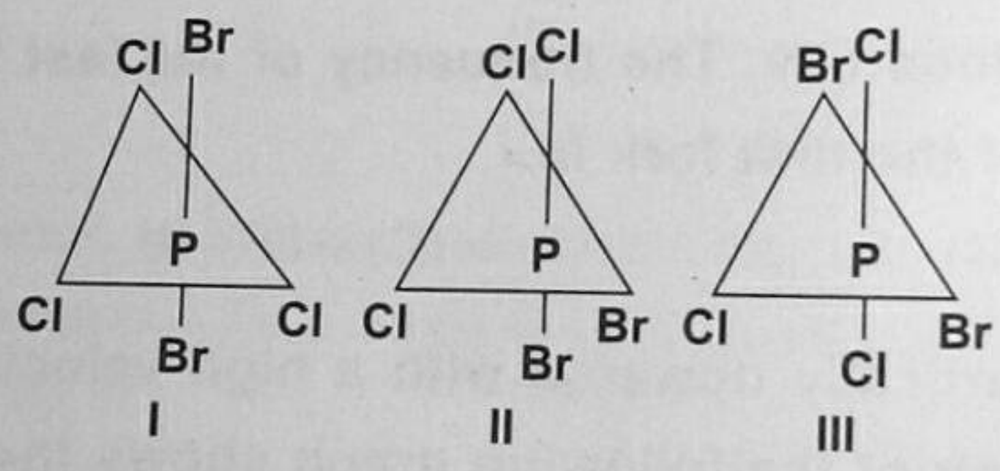
(A) atomic size of F is smaller than Cl which makes AlF_3 more covalent

(B) $AlCl_3$ is a covalent compound while AlF_3 is an ionic compound

(C) $AlCl_3$ exists as a dimer but AlF_3 does not

(D) Al in $AlCl_3$ is in sp^3 hybrid state but Al in AlF_3 is in sp^2 state.

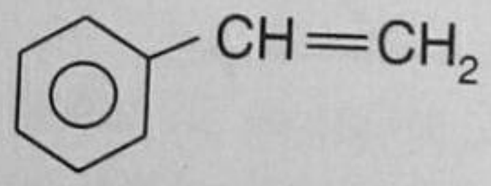
19. **PBr_2Cl_3 can exhibit geometrical isomerism. Geometrical isomers are as follows :**



Which of the above mentioned geometrical isomer(s) has/have no dipole(s)?

(A) II and III (B) III (C) I and II (D) I

20. **Which of the following properties would you predict for a hydrocarbon with the structural formula given below?**



i. **Liquid at room temperature.**

ii. **Decolourises aqueous bromine.**

iii. **Undergoes addition polymerisation.**

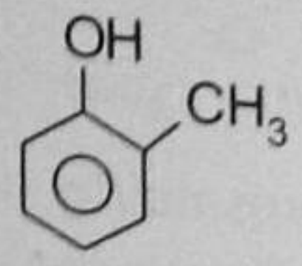
(A) (ii) and (iii)

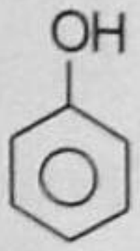
(B) (i) and (iii)

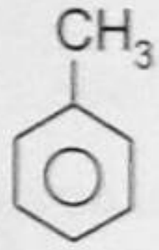
(C) (i), (ii) and (iii)

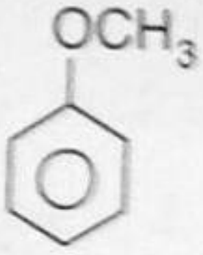
(D) (iv)

21. **The structure of an organic compound which on oxidation gives an acid that gives a mono-substituted product on nitration with HNO_3 and H_2SO_4, is**

(A) 

(B) 

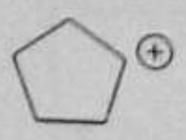
(C) 

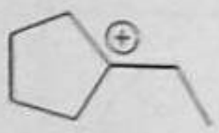
(D) 

22. **0.34 gram of a hydrocarbon when treated with methyl magnesium iodide gives 112 mL of CH_4 at STP. Possible structure of the hydrocarbon is**

(A) $(CH_3)_2CH - C \equiv C - H$
(B) $CH_3 - (CH_2)_3 - C \equiv CH$
(C) $(CH_3)_3C - C \equiv C - H$
(D) Both (B) and (C)

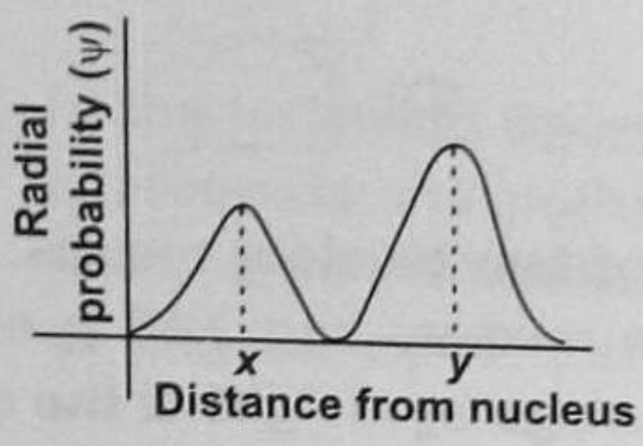
23. **Select the most stable carbocation from amongst the following.**

(A) 

(B) 

(C) 

(D) 

24. 

If the above radial probability curve indicates 2*s* orbital, the distance between the peak points *x* and *y* is

(A) 2.07 Å
(B) 1.59 Å
(C) 0.53 Å
(D) 2.12 Å

25. **An organic compound '*K*' having molecular formula C_2H_3N on reduction gave another compound '*L*'. Upon treatment with nitrous acid, '*L*' gave ethyl alcohol and on warming with chloroform and alcoholic KOH, it formed an offensive smelling compound '*M*'. The compound '*M*' is**

(A) $CH_3C \equiv N$
(B) $CH_3CH_2N \rightleftharpoons C$
(C) $CH_3CH_2NH_2$
(D) CH_3CH_2OH

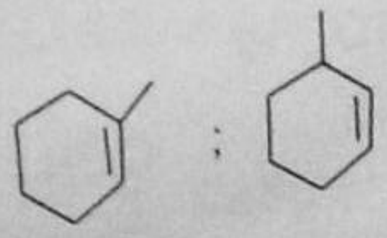
26. **When hydrogen peroxide is treated with a cold acidified $K_2Cr_2O_7$ solution containing ether, a blue colour is obtained. This is due to**

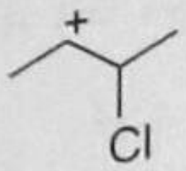
(A) Perchromic acid
(B) Potassium chromate
(C) Chromium sulphate
(D) Chromium trioxide.

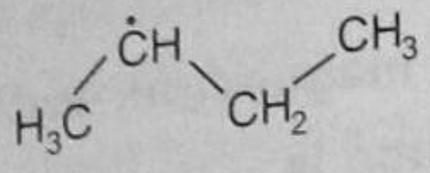
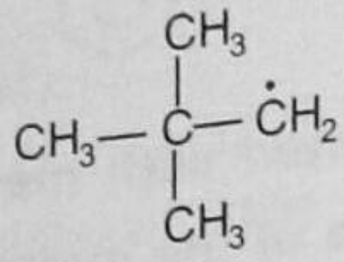
27. **A certain gas diffuses from two different vessels *P* and *Q*. The vessel *P* has a circular orifice while vessel *Q* has a square orifice of length equal to the radius of the orifice of vessel *P*. The ratio of the rates of diffusion of the gas from vessel *P* to vessel *Q*, assuming same temperature and pressure is**

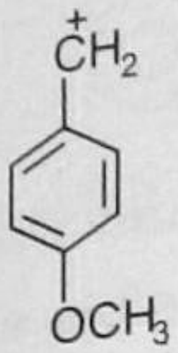
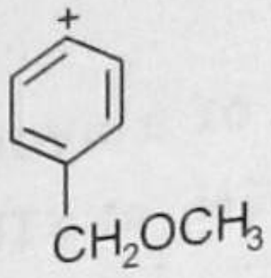
(A) π
(B) $1/\pi$
(C) 1 : 1
(D) 2 : 1

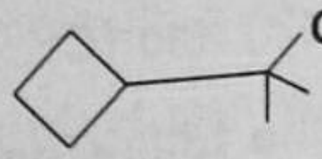
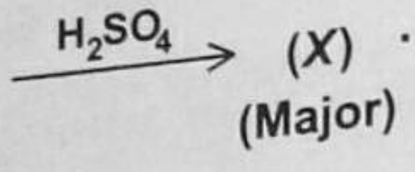
28. In which of the following pairs, the second member is more stable than first?

(A)  ;

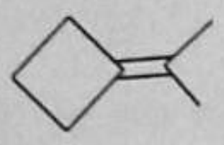
(B)  ; 

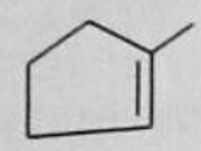
(C)  ; 

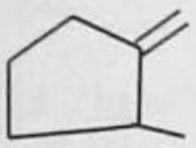
(D)  ; 

29. In the reaction,   . (X) (Major)

The product (X) is

(A) 

(B) 

(C) 

(D) 

30. A mixture contains equimolar quantities of carbonates of two bivalent metals. One metal is present to the extent of 13.5% by weight in the mixture and 2.58 g of the mixture on heating leaves a residue of 1.35 g. What percentage by weight of the other metal is there?

(A) 31.6 (B) 21.3 (C) 19.2 (D) 17.8

SECTION-2
MATHEMATICS

31. Which of the following is a singleton set?

(A) $\{x : |x| < 1, x \in I\}$ (B) $\{x : |x| = 5, x \in I\}$

(C) $\{x : x^2 = 1, x \in I\}$ (D) $\{x : x^2 + x + 1 = 0, x \in R\}$

32. $\arg\left[\dfrac{1+\cos\frac{\pi}{8}+i\sin\frac{\pi}{8}}{1-\cos\frac{\pi}{8}+i\sin\frac{\pi}{8}}\right]$ is equal to

(A) $\frac{3\pi}{4}$ (B) $-\frac{3\pi}{8}$ (C) $-\frac{3\pi}{4}$ (D) none of these

33. The value of x in the given equation $4^x - 3^{x-1/2} = 3^{x+1/2} - 2^{2x-1}$ is

(A) 4/3 (B) 3/2 (C) 2/1 (D) 5/3

34. If the sum of two extreme numbers of an *AP* with four terms is 8 and product of remaining two middle terms is 15, then greatest number of the AP will be

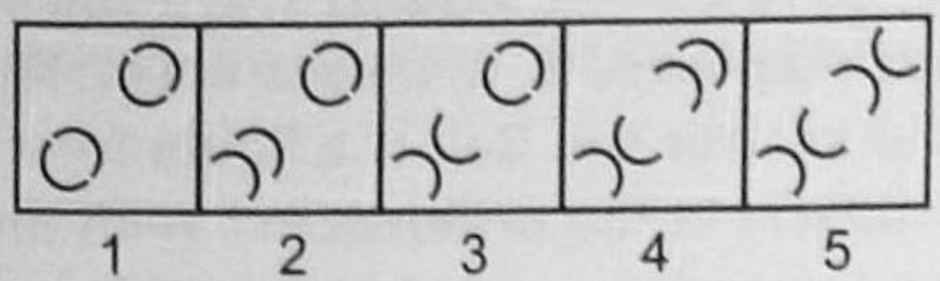
(A) 5 (B) 7 (C) 9 (D) 11

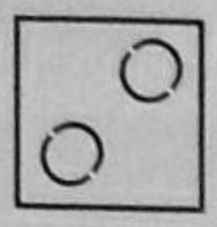
35. **The value of** $\frac{d}{dx}\left[\left(\frac{\tan^2 2x - \tan^2 x}{1-\tan^2 2x \tan^2 x}\right)\cos 3x\right]$ **is**

(A) tan2x tan$x$ (B) tan3x tan x (C) sec^2x (D) sec$x$ tan$x$

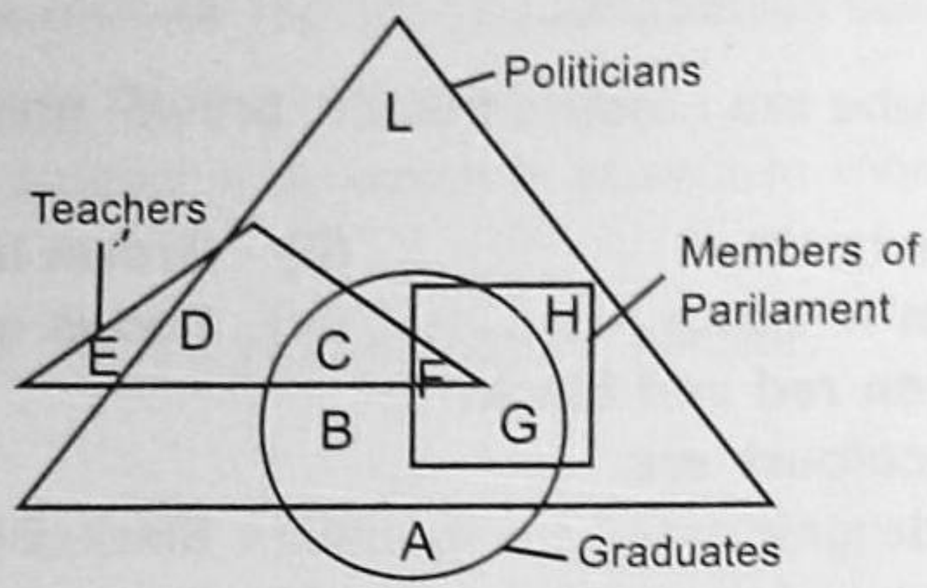
36. **The given question contains problem figures containing five figures 1, 2, 3, 4 and 5. Select one figure from the options which will continue the same series as given in the problem figures.**

Problem Figures



(A)  (B)  (C)  (D) 

37. **In the following figure, the smaller triangle represents the teachers, the big triangle represents the politicians, the circle represents the graduates, and the square represents the Members of Parliament. Different regions are being denoted by letters of English alphabets.**



Who among the following are graduates or teachers but not politicians?

(A) B, G (B) G, H (C) A, E (D) E, F

38. **In a certain code 'Ding Dong Dang' means 'Attacking the enemy', 'Ping Pond Dong' means 'Enemy is retreating', 'Ding Ping Mong' means 'Attacking and retreating'. Which of the following codes stands for Enemy?**

(A) Ding (B) Dong (C) Dang (D) None of these

39. **In the expansion of** $\left(\frac{a}{x}+bx\right)^{12}$ **, the coefficient of** x^{-10} **will be**

(A) $12a^{11}$ (B) $12b^{11}a$ (C) $12a^{11}b$ (D) $12a^{11}b^{11}$

40. **The remainder when** 5^{99} **is divided by 13, is**

(A) 6 (B) 8 (C) 9 (D) 10

41. A lady gives a dinner party for six guests. The number of ways in which they may be selected from among ten friends, if two of the friends will not attend the party together, is

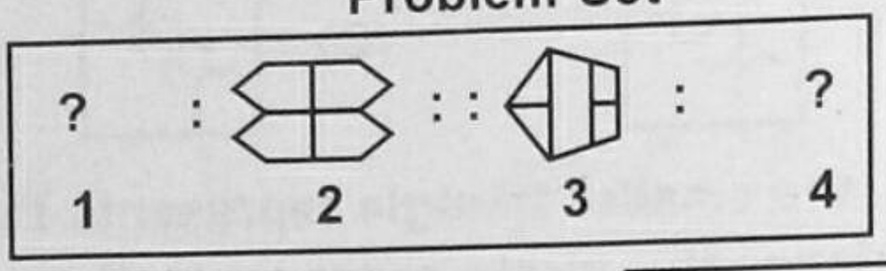
(A) 112 (B) 140 (C) 164 (D) None of these

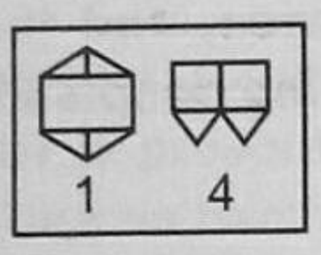
42. A bag contains 5 brown and 4 white socks. A man pulls out two socks. The probability that these are of the same colour, is

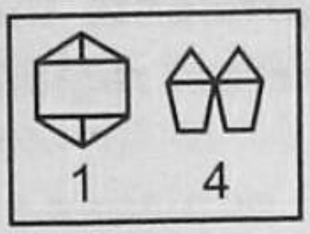
(A) 5/108 (B) 18/108 (C) 30/108 (D) 48/108

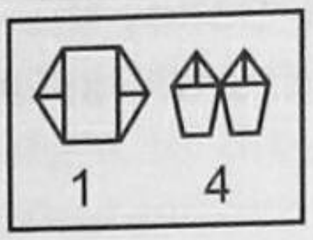
43. In the given question, there are four figures 1, 2, 3 and 4 which constitute the problem set and answer figures marked A, B, C, D each consisting of two figures marked 1 and 4 which constitute the answer set. Select a figure from the answer sets the contents of which best substitute(?) in the problem set such that figure 3 is related to figure 4 in the same way as figure 1 is related to figure 2.

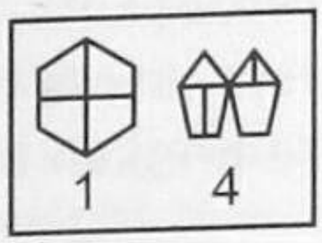
Problem Set



(A) 

(B) 

(C) 

(D) 

44. The six faces of a cube are coloured black, brown, green, red, white and blue in the following ways :

(i) Red is opposite to black
(ii) Brown is adjacent to blue
(iii) Blue is adjacent to white
(iv) Red is at the bottom surface
(v) Green is between red and black

The three adjacent colours are

(A) Black, Blue, Red (B) Black, Blue, Brown
(C) Black, Brown, White (D) Black, Brown, Red

45. If $\frac{x}{\cos\theta} = \frac{y}{\cos\left(\theta - \frac{2\pi}{3}\right)} = \frac{z}{\cos\left(\theta + \frac{2\pi}{3}\right)}$, then $x + y + z$ is equal to

(A) 1 (B) 0 (C) –1 (D) None of these

46. A man on the top of a cliff 100 m high observes the angles of depression of two points on the opposite sides of the cliff as 30° and 60° respectively. Then, the distance between the two points is

(A) 400 m (B) $\frac{400}{\sqrt{3}} m$ (C) $400\sqrt{3}\, m$ (D) None of these

47. The equation of circle whose centre and radius are (1, –1) and 4 respectively, is

(A) $x^2 + y^2 - 2x - 2y - 14 = 0$ (B) $x^2 + y^2 - 2x + 2y - 14 = 0$
(C) $x^2 + y^2 - 2x + 2y + 14 = 0$ (D) None of these

48. **Product of the perpendicular from the foci upon any tangent to the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1(a<b)$ is equal to**

(A) $2a$ (B) a^2 (C) b^2 (D) ab^2

49. **The value of $\lim_{x\to 0}(\cos x)^{\cot^2 x}$ is**

(A) e^{-1} (B) $e^{-1/2}$ (C) 1 (D) Not existing

50. **Select the correct options which shows the correct water image of the given combination.**

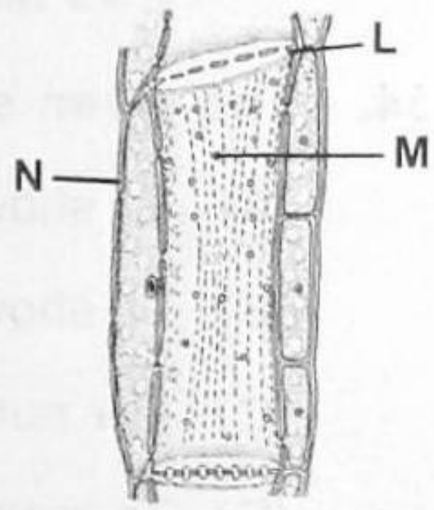
GR98AP76ES

(A) GR98AP76ES (B) GR98AP76ES (C) GR98AP76ES (D) GR98AP76ES

OR

BIOLOGY

31. **Identify the given figure and select the correct option for the parts labelled as L, M and N.**



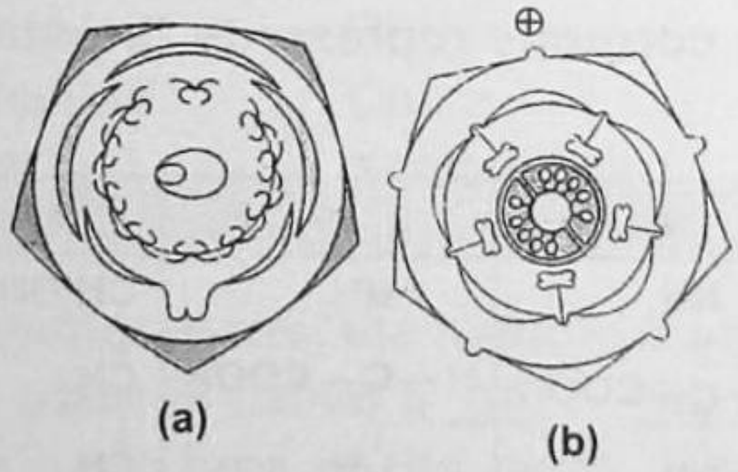
(A) N represents the cells which are replaced by albuminous cells in non-flowering plants such as gymnosperms.

(B) L represents phloem parenchyma, which is absent in most monocots.

(C) M represents the cells which become dead on maturity.

(D) All of these.

32. **Which of the following is correct for the given floral diagrams?**



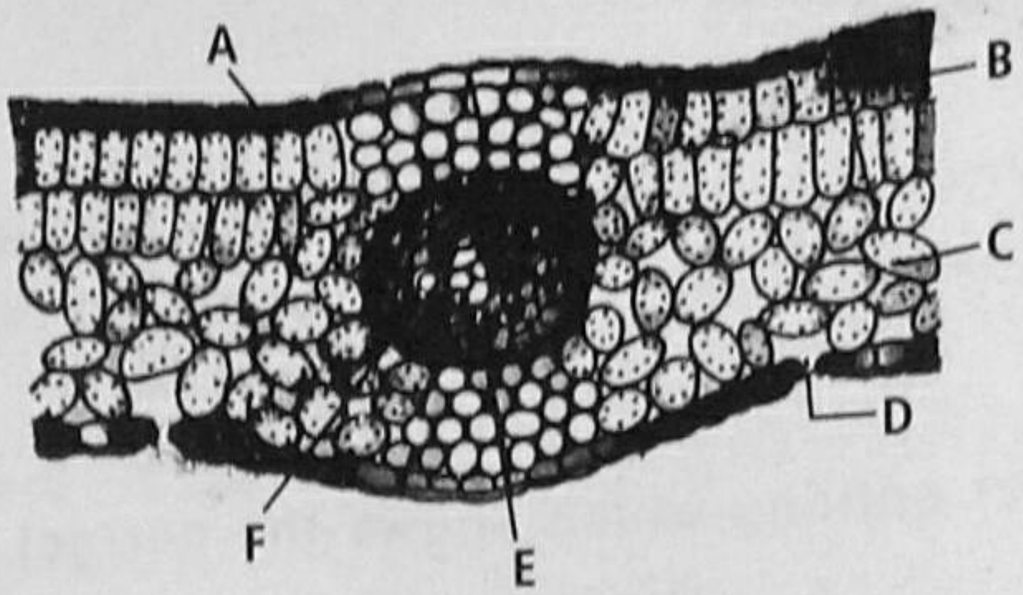
(A) 'a' shows the floral diagram of family Solanaceae, while 'b' shows the floral diagram of family Fabaceae.

(B) The floral formula of 'a' is $\%\,\male\, K_{(5)}C_{1+2+(2)}A_{(9)+1}\underline{G}_1$, while that of 'b' is $\oplus\,\male\, K_{(5)}\overset{\frown}{C_{(5)}\,A_5}\underline{G}_2$.

(C) The fruits of both 'a' and 'b' are berry or capsule.

(D) *Asparagus* and belladonna belong to 'b', while *Sesbania* and *Trifolium* belong to 'a'.

33. **The given figure shows T.S. of *Helianthus* leaf with various parts labelled as A, B, C, D, E and F. Identify the parts and select the correct option.**



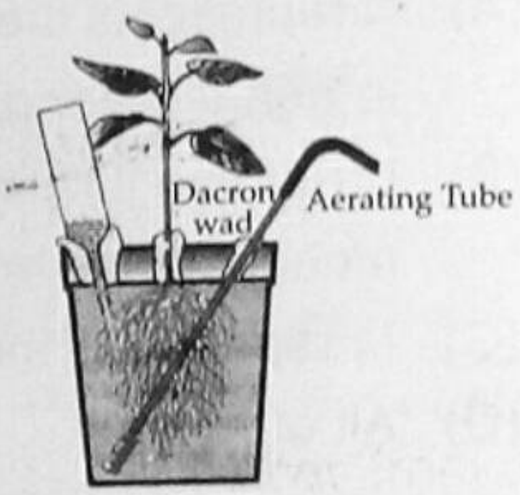
(A) A - Epidermis, B - Spongy parenchyma, C - Palisade parenchyma, D - Stomata, E - Phloem, F - Xylem

(B) A - Epidermis, B - Palisade parenchyma, C - Spongy parenchyma, D - Stomata, E - Xylem, F - Phloem

(C) A - Epidermis, B - Palisade parenchyma, C - Spongy parenchyma, D - Stomata, E - Endodermis, F - Xylem

(D) A - Epidermis, B - Palisade parenchyma, C - Spongy parenchyma, D - Stomata, E - Phloem, F - Xylem

34. **The given experimental set-up is used**



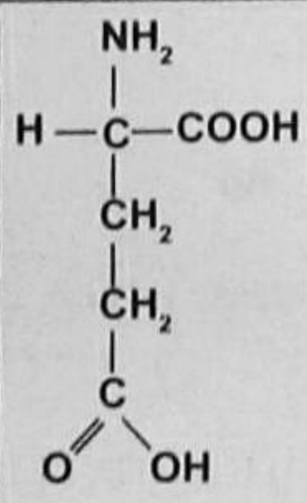
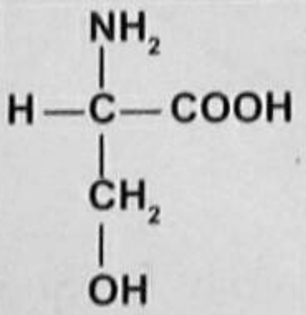
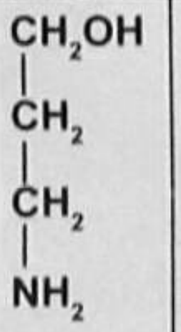
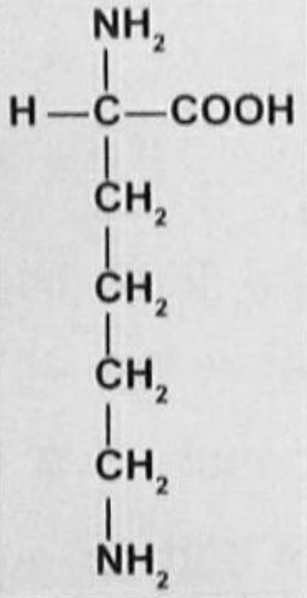
(A) To show that CO_2 is required during photosynthesis

(B) To show that O_2 is evolved during photosynthesis

(C) For nutrient solution culture

(D) To measure growth of a plant.

35. **Which of the following correctly represents the structural formula of a basic amino acid?**

a	b	c	d
			

(A) c (B) d (C) a (D) b

36. ***Selaginella* and *Salvinia* are considered to represent a significant step toward evolution of seed habit because**

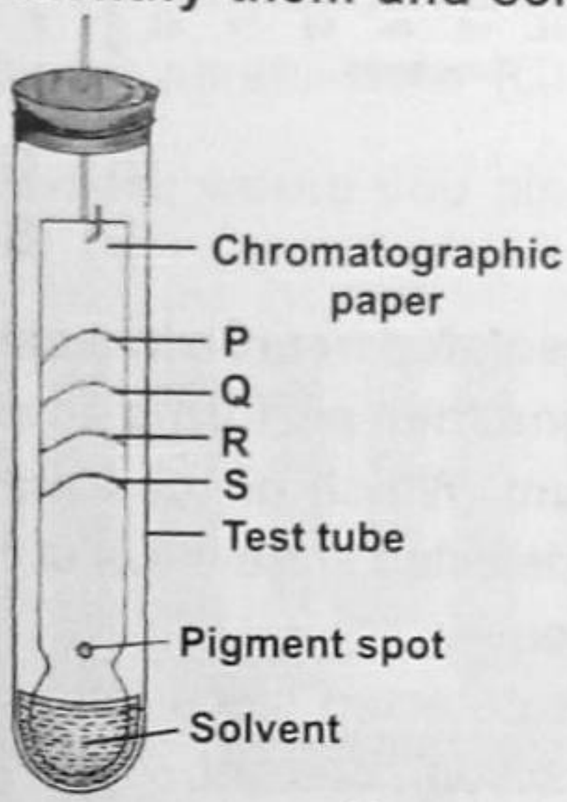
(A) Female gametophyte is free and gets dispersed like seeds.
(B) Female gametophyte lacks archegonia.
(C) Megaspores possess endosperm and embryo surrounded by seed coat.
(D) Embryo develops in female gametophyte which is retained on parent sporophyte.

37. **Consider the following statements and select the correct option.**

(i) GERL includes Golgi body and lysosomes only.
(ii) Peroxisomes help to metabolise xenobiotics.
(iii) Polysomes are aggregates of ribosomes.
(iv) Mitochondria help in oxidative phosphorylation and generation of ATP.

(A) (ii), (iii) and (iv) are correct
(B) (i) alone is correct
(C) (ii) alone is correct
(D) (iii) alone is correct

38. **When the separation of photosynthetic pigments is carried out using a strip of chromatographic paper, then the dried strip shows four distinct bands P, Q, R and S as shown in the given figure. Identify them and select the correct option.**



	P	Q	R	S
(A)	Chl. *a*	Chl. *b*	Carotene	Xanthophyll
(B)	Xanthophyll	Carotene	Chl. *b*	Chl. *a*
(C)	Carotene	Xanthophyll	Chl. *a*	Chl. *b*
(D)	Chl. *b*	Chl. *a*	Xanthophyll	Carotene

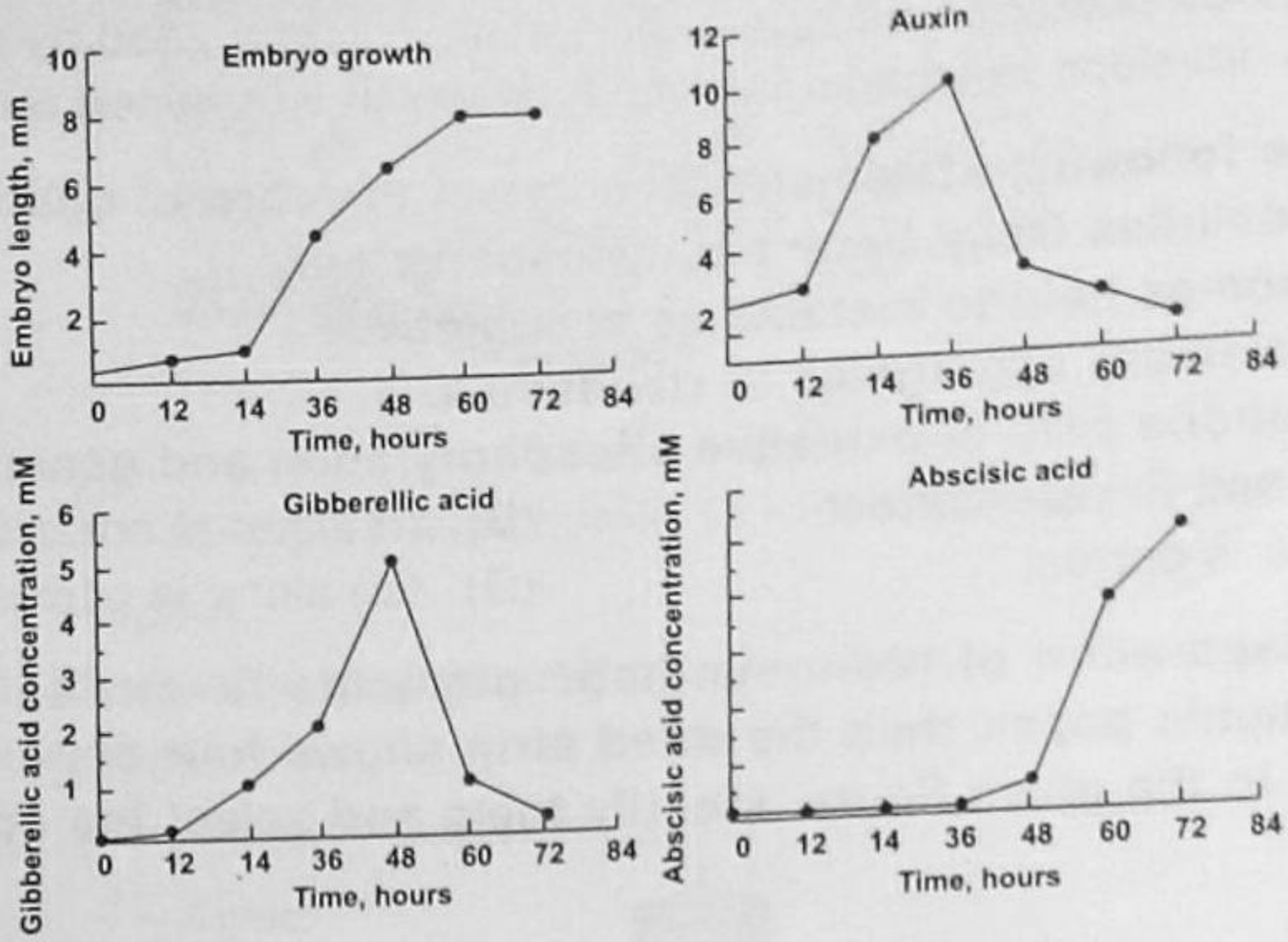
39. **Read the given paragraph.**

Where there is alternation of generations, the haploid multicellular plant is called a (i) and the diploid multicellular plant is called a (ii) . (iii) generation is the dominant phase in algae showing haplontic type of life cycle. Bryophytes and pteridophytes usually possess (iv) types of life cycle.

Select the correct sequence of terms to complete the above paragraph.

	(i)	(ii)	(iii)	(iv)
(A)	Sporophyte	Gametophyte	Gametophyte	Diplontic
(B)	Gametophyte	Sporophyte	Sporophyte	Haplontic
(C)	Sporophyte	Gametophyte	Sporophyte	Haplodiplontic
(D)	Gametophyte	Sporophyte	Gametophyte	Haplodiplontic

40. **Plant hormones play a role in regulating the development of plant seeds. The graphs below plot embryo growth and the changes in hormone concentration over time. Based on these results, which hormone most likely regulates embryo growth?**

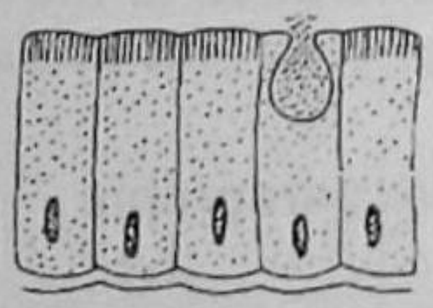
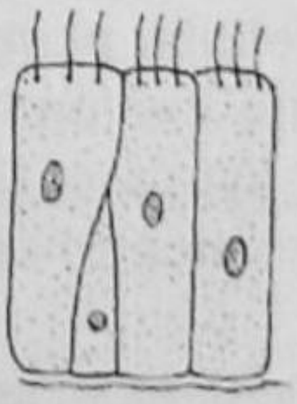
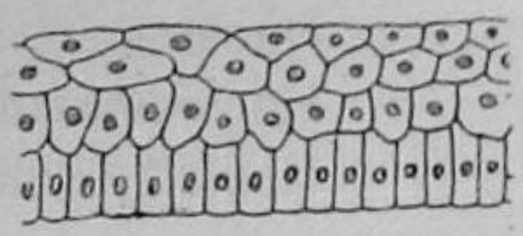


(A) Auxin
(B) Gibberellic acid
(C) Abscisic acid
(D) Both (A) and (B)

41. **An investigator places an isolated neuron in a calcium-free medium, gives the neuron a suprathreshold stimulus and then performs an assay to test whether neurotransmitter is released into the medium. Which of the following outcomes would you predict?**

(A) No neurotransmitter is detected since influx of calcium into the synaptic knob is required for neurotransmitter release.
(B) No neurotransmitter is detected since influx of calcium is required in order for the neuron to conduct an action potential.
(C) Neurotransmitter is detected since calcium is not required for action potential conduction and the initial stimulus was suprathreshold.
(D) We cannot predict the outcome without knowing whether the neuron was myelinated or non-myelinated.

42. **Which of these epithelia is chiefly involved in function like diffusion and thereby is found in the wall of blood vessels and air sacs of the lungs?**

(A) 
(B) 
(C) 
(D) 

43.

Target Sites:	Liver	Adipose cell	Muscle
Metabolic actions Carbohydrate	↑ Glucokinase ↑ Glycogen synthetase ↓ Phosphorylase ↓ Gluconeogenesis	↑ Glucose transport ↑ Glycerol synthesis	↑ Glucose transport ↑ Glycolysis ↑ Glycogen synthesis
Fat	↑ Lipogenesis	↑ Triglycerides ↑ Fatty acid synthesis ↓ Lipolysis	
Protein	↓ Proteolysis		↑ Amino acid uptake ↑ Protein synthesis

Study the above given metabolic actions of a hormone on different targ select the correct option regarding it.

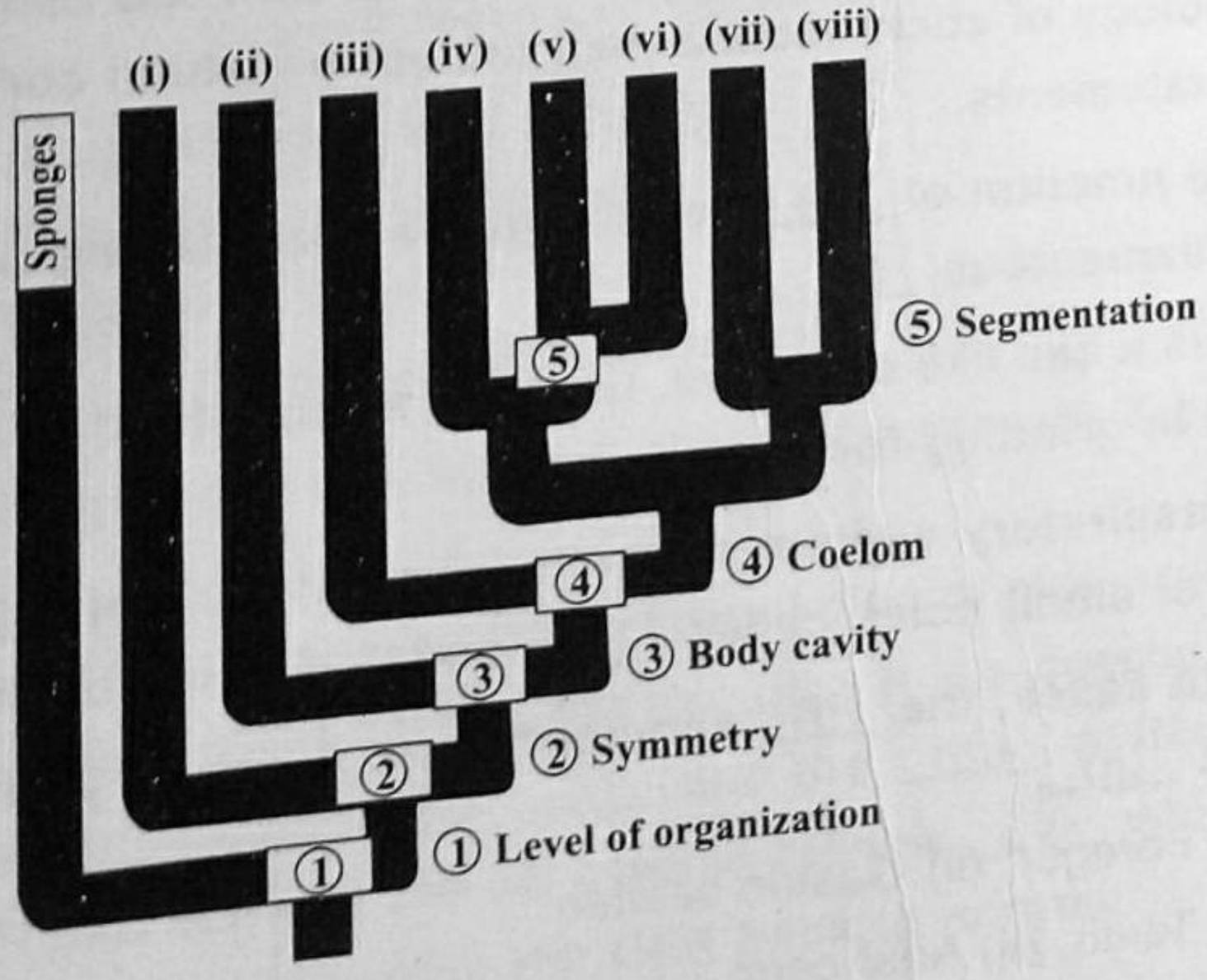
(A) It is the anabolic hormone secreted by the beta cells of heterocrine glan

(B) It is the hormone secreted by alpha cells of pancreas.

(C) It is the hormone secreted by the anterior pituitary gland.

(D) It is the hormone secreted by the parafollicular (C) cells.

44. In the given phylogenetic tree, where would you place the following?



(P) Echinodermata

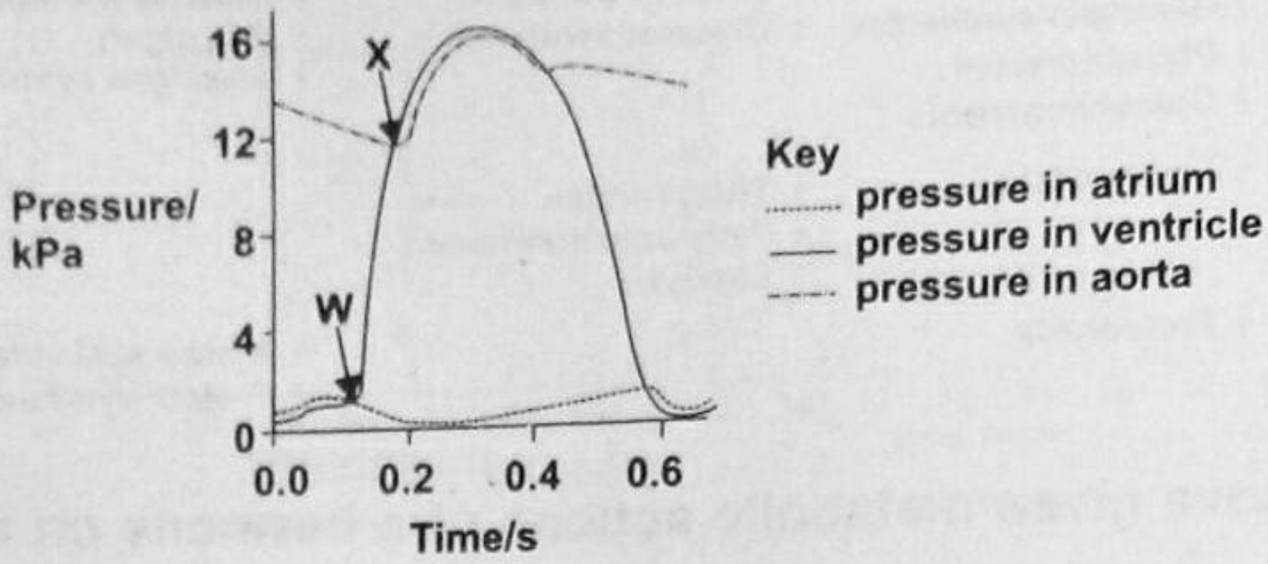
(Q) Cnidaria

(R) Annelida

(S) Platyhelminthes

	P	Q	R	S
(A)	(vii)	(ii)	(v)	(i)
(B)	(viii)	(ii)	(vi)	(i)
(C)	(vii)	(i)	(v)	(ii)
(D)	(viii)	(iii)	(vii)	(i)

45. The given graph shows pressure changes in the left side of the heart during a single heart beat. Between points W and X, which of the following valves are open or closed respectively?



	Atrio-ventricular valves	Semilunar valves
(A)	Closed	Closed
(B)	Closed	Open
(C)	Open	Closed
(D)	Open	Open

46. Given below are four statements (a – d) each with two blanks, regarding morphology and physiology of cockroach. Select the option which correctly fills up the blanks in any two statements.

(P) At the junction of __(i)__ and midgut is present ring of 100–150 yellow coloured thin filamentous __(ii)__.

(Q) __(i)__ is a sac like structure, used for storing food. It is followed by __(ii)__ which helps in grinding food.

(R) The respiratory system consists of a network of __(i)__, that open through 10 pairs of small holes called __(ii)__ on lateral side of the body.

(S) In both sexes, the __(i)__ segment bears a pair of jointed filamentous structures called __(ii)__.

(A) (P) (i) Foregut, (ii) Gastric caecae
(S) (i) Tenth, (ii) Anal cerci

(B) (P) (i) Hindgut, (ii) Malpighian tubules
(R) (i) Trachea, (ii) Spiracles

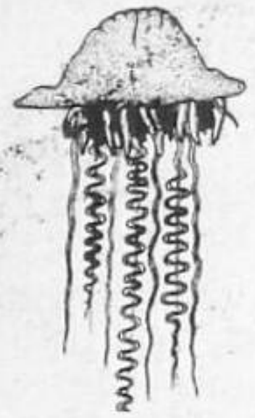
(C) (Q) (i) Gizzard, (ii) Crop
(S) (i) Sixth, (ii) Anal style

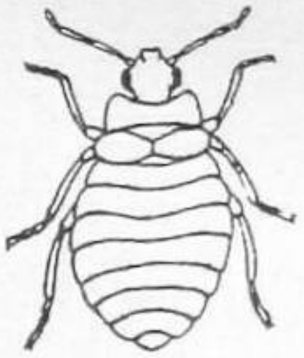
(D) (Q) (i) Crop, (ii) Gizzard
(R) (i) Spiracles, (ii) Tracheoles

47. **Which of the following shows polymorphism ?**

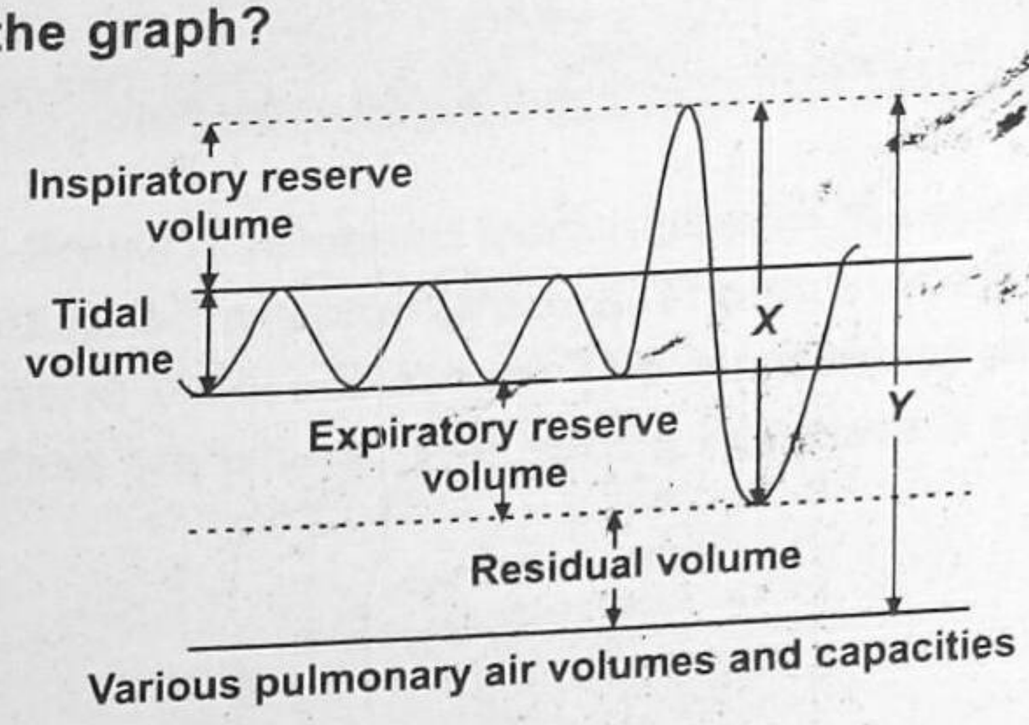
(A) 

(B) 

(C) 

(D) 

48. **The given graph shows various pulmonary air volumes and capacities. What is depicted by X and Y in the graph?**



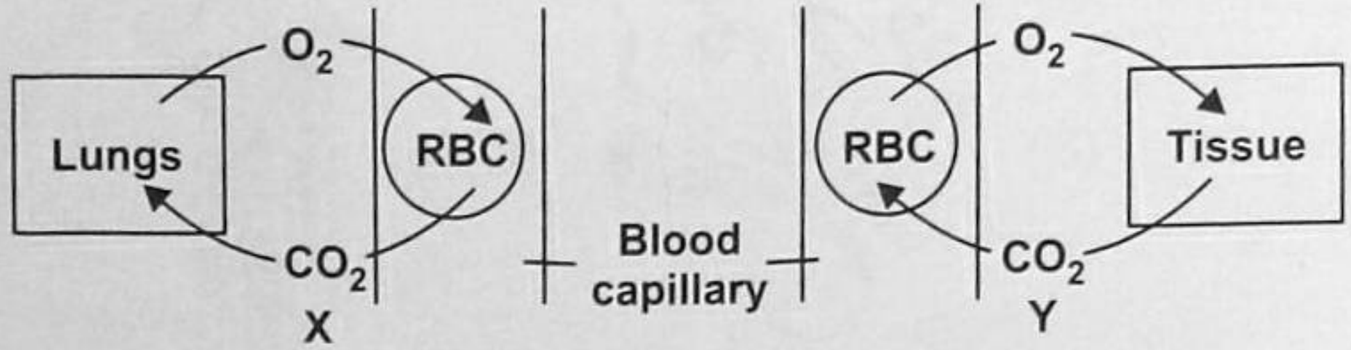
(A) Functional residual capacity and vital capacity
(B) Total lung capacity and inspiratory capacity
(C) Vital capacity and total lung capacity
(D) Inspiratory capacity and functional residual capacity

49. **Complete the following paragraph by selecting the option that correctly fills the blanks (i) - (iv).**

The kidneys have built-in mechanisms for the regulation of glomerular filtration rate. One such efficient mechanism is carried out by (i) . It is a special sensitive region formed by cellular modifications in the (ii) and the (iii) at the location of their contact. A fall in GFR can activate the JG cells to release (iv) which can stimulate the glomerular blood flow and thereby the GFR back to normal.

	(i)	(ii)	(iii)	(iv)
(A)	ANF	PCT	Efferent arteriole	Angiotensin
(B)	ANF	DCT	Afferent arteriole	Renin
(C)	JGA	PCT	Efferent arteriole	Angiotensinogen
(D)	JGA	DCT	Afferent arteriole	Renin

50. **The given figures show some processes occuring during gaseous- exchange in the human body. What are the phenomena X and Y called respectively ?**



(A) X- Hamburger's phenomenon, Y- Bohr's effect

(B) X- Bohr's effect, Y- Haldane effect

(C) X- Haldane effect, Y- Bohr's effect

(D) X- Haldane effect, Y- Hamburger's phenomenon