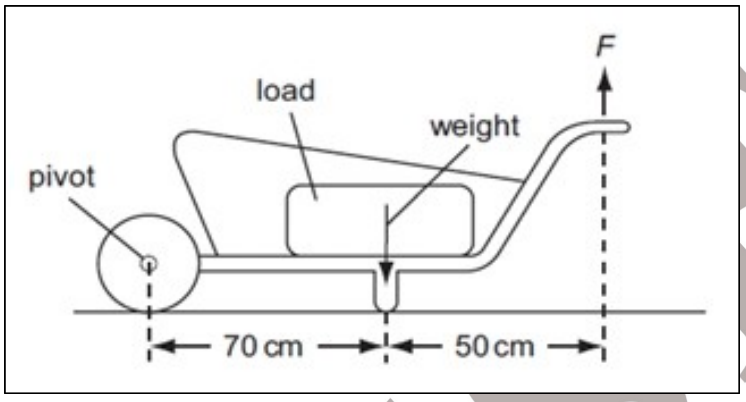
Questions (INJSO 2012)

Section A: Questions 1 to 60 are multiple choice with every correct answer carrying 1 mark and every wrong answer carrying -0.25 mark.

SECTION A

1. A load is to be moved using a wheelbarrow. The total mass of the load and wheelbarrow is 60 kg. The magnitude of gravitational acceleration is 10 ms^{-2}.



What is the work done if the handle is raised by 50 cm?

a) 35.0 J
b) 17.5 J
c) 175 J
d) 350 J

2. The electrons, identified by quantum numbers n and l can be placed in order of increasing energy, from the lowest to highest as

i. n = 4 & l = 1
ii. n = 4 & l = 0
iii. n = 3 & l = 2
iv. n = 3 & l = 1

a) iv < ii < iii < i
b) ii < iv < i < iii
c) i < iii < ii < iv
d) iii < i < iv < ii

3. Which of the following is an example of secondary succession?

a) Vegetation developing on a bare rock.
b) Vegetation developing following forest fire.
c) Fungus growing on a banana peel.
d) Conversion of pond into a crop field by humans.

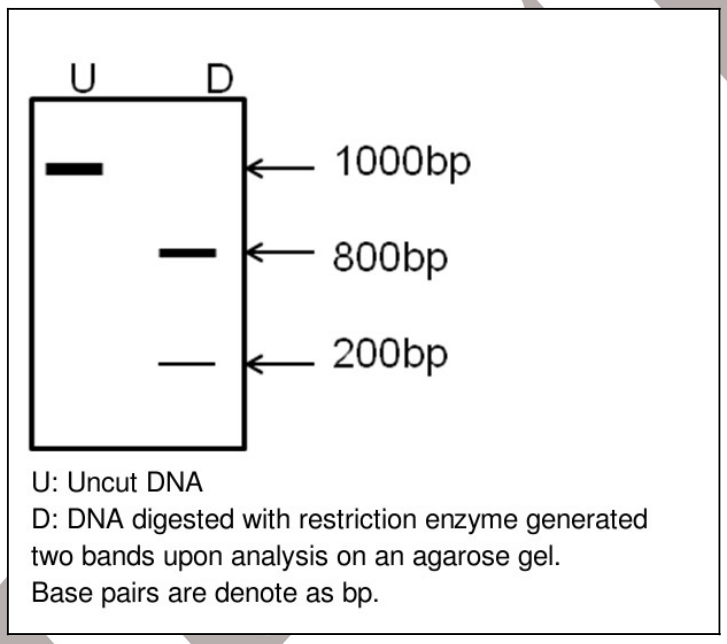
4. In the process of electrostatic induction...

a) a conductor is rubbed with an insulator.
b) a charge is produced by friction.
c) negative and positive charges are separated.
d) electrons are 'sprayed' on the object.

5. A white salt is readily soluble in water and gives colorless solution with pH of about 9. The salt would be...

a) NH_4NO_3 b) CH_3COONa c) CH_3COONH_4 d) $CaCO_3$

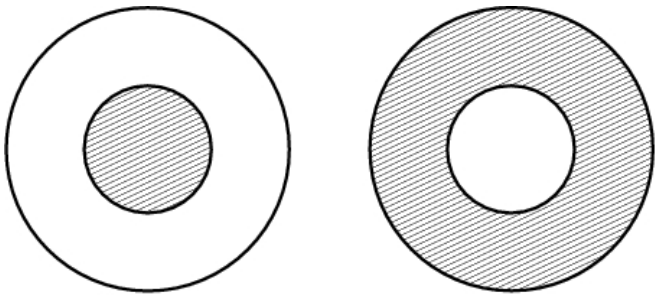
6. Twenty five micrograms (25 µg) of DNA amounting five micromole (5 µmole) was cut using a specific restriction enzyme into two pieces. Subsequently, when it was analyzed on an agarose gel it showed two bands of 200 bp and 800 bp. If the length of the original DNA was 1000 bp, Which of the following options best quantifies each band?



U: Uncut DNA
D: DNA digested with restriction enzyme generated two bands upon analysis on an agarose gel.
Base pairs are denote as bp.

	200 bp band		***800 bp band***	
	µmole	***µg***	***µmole***	***µg***
a)	5	5	5	20
b)	1	5	4	20
c)	5	25	5	25
d)	1	25	1	25

7. A spherical convex lens of diameter 0.1m and power 3 dioptre is used to produce the image of a candle flame kept at 0.4 m from the lens in two different methods as shown in the fig. (front view)



Method A Method B

Method A: 5 cm diameter of the lens is covered at the centre with dark paper and the periphery of the lens is clear.
Method B: 5 cm at the centre of the lens is clear and the periphery is covered with dark paper.
While the distance of the flame (object) is kept same, what difference you see in the image formation?

a) Method A produces *no* image and B produces an image
b) Method A produces an image and B produces *no* image
c) The image distance in both the methods is the same
d) Image due to A appears at a slightly different distance than due to B.

8. When pressure is applied to equilibrium system,

$$\text{Ice (s)} \Leftrightarrow H_2O\ (l)$$

which of the following will happen?
a) More ice will be formed
b) Water will evaporate
c) More water will be formed
d) There will be no change.

9. Students of botany class expressed that their class is very boring. Next day Smita madam brought a few botanical samples. She asked the class to group the plants according to some criteria. They classified the plants and tabulated their observations as in the table below. Looking at this information, she asked them to find out the correct set belonging to Pteridophyta & Algae respectively.

Criteria	**I**	**II**	**III**	**IV**	**V**
Seed production	Not seen	Not seen	Seen	Seen	Not seen
Vascular tissues	Absent	Present	Present	Present	Absent
Flowers	Absent	Absent	Absent	Present	Absent
Cones	Absent	Present	Present	Absent	Absent
Tissue differentiation	Absent	Present	Present	Present	Absent
Habit	Amphibious	Terrestrial	Terrestrial	Terrestrial	Aquatic

a) II & V b) II & I c) III & V d) II & III

10. A direct current (dc) motor is connected to a battery by means of two leads. The motor moves for slightly less than half the cycle and comes to halt. Which of the following components is missing?

a) one of the brushes
b) commutator
c) slip ring
d) one of the two magnets

11. Sumit evacuated a cylinder and filled in 4g of gas *A* at temperature 25˚C. Pressure was found to be 1 atm. His friend Vineet, filled another 8g of gas *B* in the cylinder at the same temperature. The final pressure was found to be 1.5 atm. The ratio of molecular masses of *A* and *B* (assuming ideal gas behaviour) is

a) 1 : 1 b) 1 : 2 c) 1 : 3 d) 1 : 4

12. Chromosomes in metaphase get arranged at the equatorial plate (see Fig. 1). When these cells are treated with colchicine, cell division is arrested and the cells never enter anaphase. If we were to compare a colchicine treated cell at metaphase and an untreated cell in the same phase, we notice that chromosomes are more dispersed and do not arrange themselves on the equatorial plate in the treated cells (see Fig 2.).

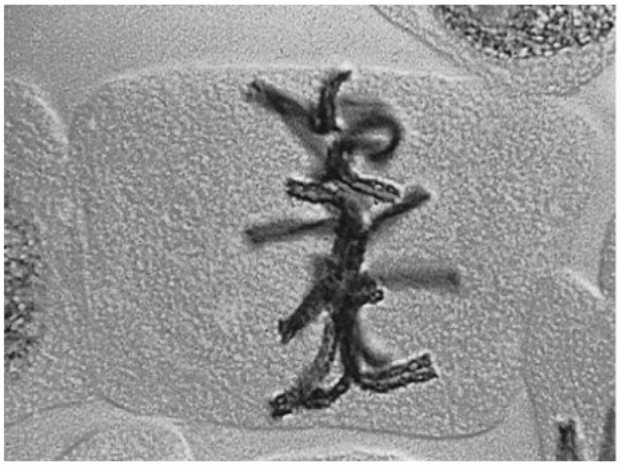


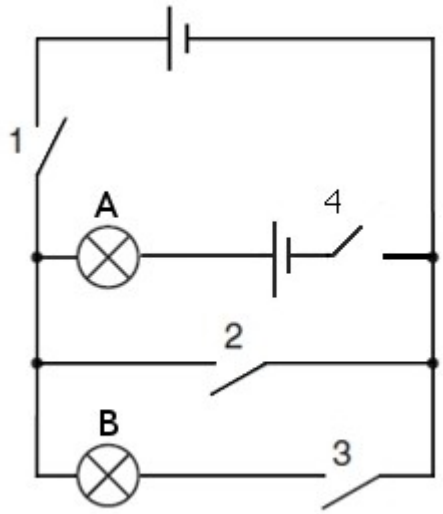
Fig.1: Metaphase

Fig.2: Colchicine treated Metaphase

Using this information, which of the following will be affected by colchicine?

a) Centromere
b) Spindle fiber
c) Centriole
d) Arms of chromosomes

13. A student connects two lamps in the circuit shown. The emf of the two batteries is different.



Which of the following statements are correct?

i. When keys 1, 2, 3 and 4 are closed, bulbs A and B will both glow
ii. When key 2 and 4 are closed bulb A will glow
iii. When 1 and 4 are closed, bulb A will glow
iv. When 2, 3 and 4 are closed, both A and B will glow

a) only ii
b) only iv
c) i, ii and iv
d) ii and iii

14. A person is stuck in Antarctica in a ship wreck. He doesn't have any drinking water available. He finds an ethylene (CH_2=CH_2) cylinder containing 4.2 g of ethylene. He decides to burn this ethylene to melt 1kg of ice at -10ºC. When a mole of ethylene is combusted it releases 340 kcal of energy. Assuming, no heat is lost to the environment, the amount of water available for drinking is...

a) 1 litre
b) 575 ml
c) 900 ml
d) It is not sufficient to melt the ice

15. A girl has undergone a surgery for removal of gall bladder. While being discharged from the hospital, which of the following advise would you give her, being a doctor? She should...

a) take food less in fats
b) have a diet with less proteins
c) take less sugary fruits
d) take less quantity of liquids

16. *A* is a tank filled to its 75% with water, *B* is a weighing balance and *C* is a stone hung from a stand. If fig. 1 is correct, what do you expect to be the position of needle in fig. 2?

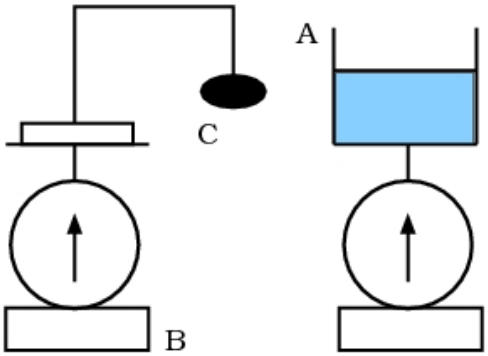


Fig. 1

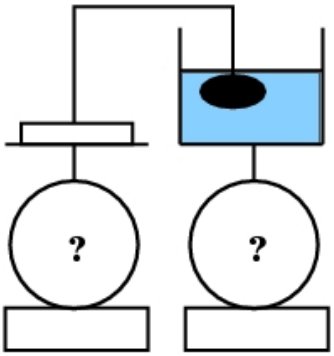
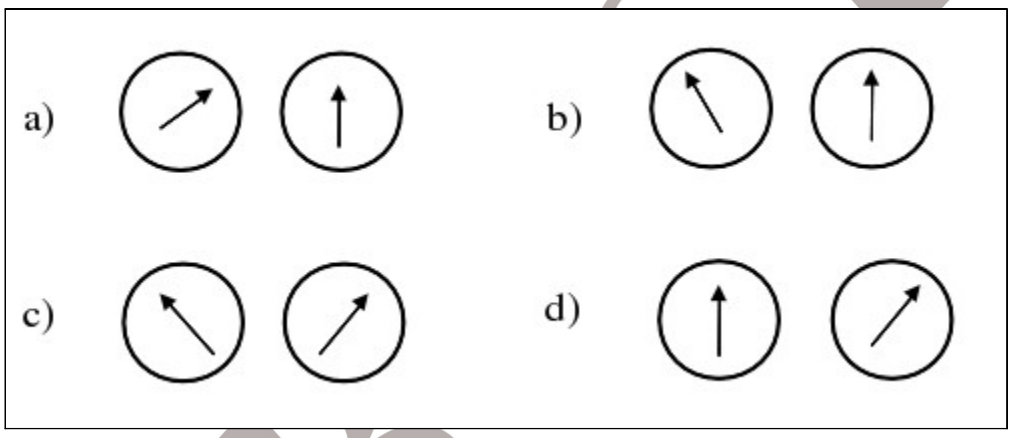


Fig. 2



17. Haemophilia and colourblindness are the disorders caused by X chromosome linked recessive gene. A woman has one X chromosome having gene for haemophilia and colourblindness. The other X chromosome has wild allele for both the characters. She marries a man having phenotype normal for both the traits. Which of the following statement is most likely for the progeny?

a) All daughters haemophilic and colourblind.
b) 50% haemophilic sons and 50% colourblind sons.
c) 50% haemophilic colourblind sons and 50% normal sons.
d) 25% haemophilic daughters and 75% colourblind sons

18. Liquid state of He is due to

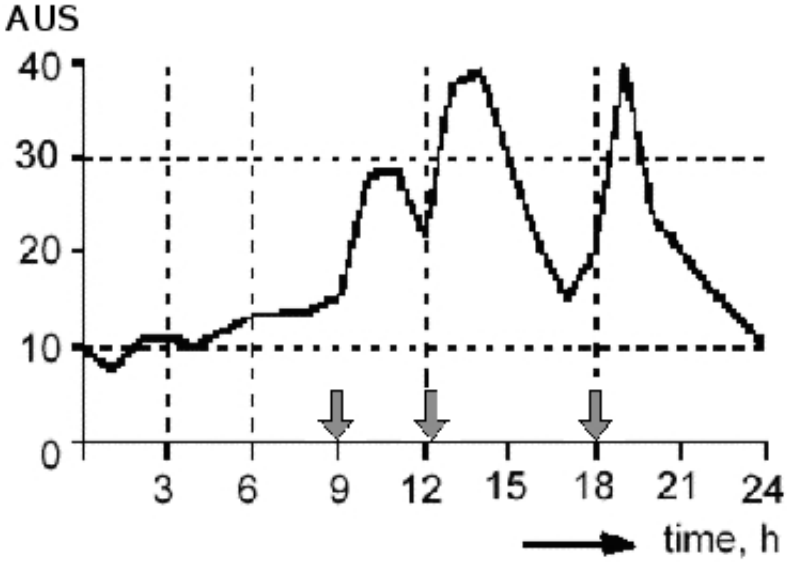
a) dipole-dipole interaction
b) ion-dipole interaction
c) dipole-induce dipole interaction
d) dispersion forces

19. A transistor based radio receiver set (effective resistance of the order of 18 ohms) operates on a 9V (dc) battery. If this battery is replaced by a dc power supply with rating 9V, 500A then

a) receiver will work normally
b) receiver will give distorted output
c) receiver will get burnt
d) power supply will get over heated

20. Daily changes in the concentration of which hormone are represented by the graph.

 = arrow indicating the time of food consumption

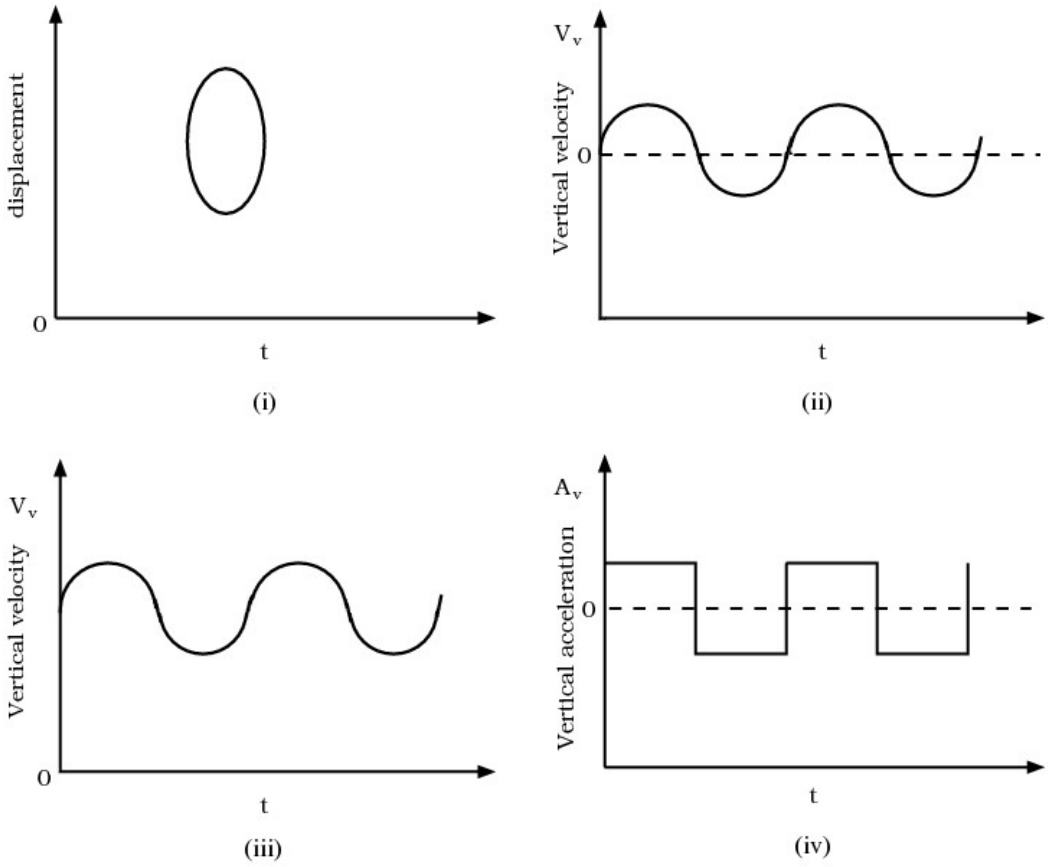


a) Thyroxine
b) Glucagon
c) Insulin
d) Cortisol

21. Sulphur exhibits two allotropic forms which are interconvertible. These two allotropes of sulphur are rhombic and monoclinic sulphur. When both of them are heated in excess of oxygen, rhombic sulphur releases 297.681 kJ whereas monoclinic sulphur releases 300.193 kJ of heat. Which of the following statements is true ?

a) The heat of transformation of rhombic to monoclinic sulphur is - 2.512 kJ. Rhombic and monoclinic both form SO_2 and SO_3 on oxidation.
b) The heat of transformation of rhombic to monoclinic sulphur is + 2.512 kJ. Rhombic and monoclinic, both form SO_2 on oxidation.
c) The heat of transformation of rhombic to monoclinic sulphur is -597.875 kJ. Rhombic and monoclinic, both form SO_2 and SO_3 on oxidation.
d) The heat of transformation of rhombic to monoclinic sulphur is + 597.875 kJ. Rhombic and monoclinic, both form SO_2 on oxidation.

22. A vibrator is generating a wave on the surface of water. An object x is floating on the surface. Which of the following graphs, of the floating object is/are correct?



a) i, ii and iv
b) only ii
c) only iii
d) ii and iii

23. Which one is not an acid salt?

a) NaH_2PO_4 b) NaH_2PO_2 c) NaH_2PO_3 d) Na_3PO_3

24. When one glucose molecule undergoes one turn of aerobic respiration, 38 ATP molecules are produced. Cellular respiration takes partly in cytoplasm and partly in mitochondria. During the process, some ATP molecules are produced in the cytoplasm, some in the mitochondrial matrix and some in the oxysomes on cristae. Maximum number of these ATP molecules is produced in....

a) cytoplasm
b) mitochondrial matrix
c) cytoplasm and mitochondrial matrix together
d) oxysomes on cristae

25. A ripple is created in water. The amplitude at a distance of 5 cm from the point where the ripple was created is 4 cm. Ignoring damping, what will be the amplitude at the distance of 10 cm.

a) $\sqrt{(16)}\,cm$
b) $\sqrt{(8)}\,cm$
c) $\sqrt{(4)}\,cm$
d) $\sqrt{(2)}\,cm$

26. The equilibrium constant for the reaction

$$N_2(g) + O_2(g) \Leftrightarrow 2NO\ (g)$$

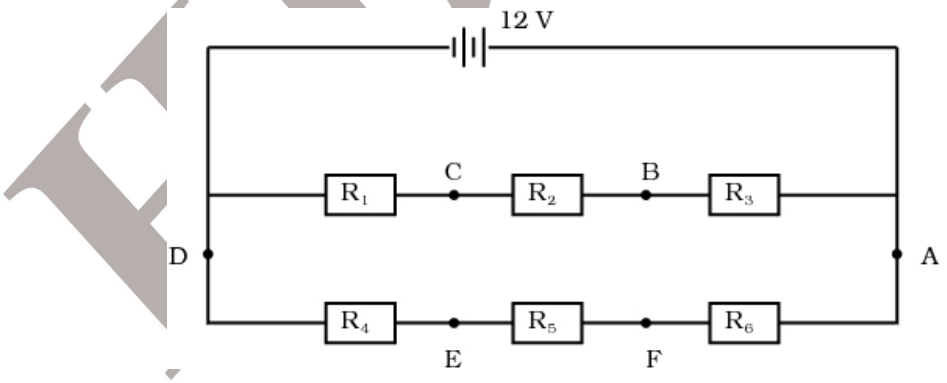
is 4.0 x 10^{-4} at 2000 K. In presence of a catalyst equilibrium is attained 10 times faster. Therefore equilibrium constant in presence of catalyst at 2000 K is

a) 40×10^{-4}
b) 4×10^{-4}
c) 4×10^{-2}
d) none of these

27. A snail crawling across a board will withdraw into its shell when you drop a marble on the board. Repetition of dropping marble will lead to a weaker withdraw action and in the end the snail will ignore the marble dropping. Which of the following terms best captures the phenomena?

a) adaptation and imprinting
b) conditioning and insight
c) learned behaviour and habituation
d) imprinting and habituation

28. In the following circuit, each resistor has a resistance of 15 Ω, and the battery has an e.m.f. of 12 V with negligible internal resistance.



When a resistor of resistance *R* is connected between D & F, no current flows through the galvanometer (not shown in the figure) connected between C & F. Calculate the value of *R*.

a) 10 Ω b) 15 Ω c) 5 Ω d) 30 Ω

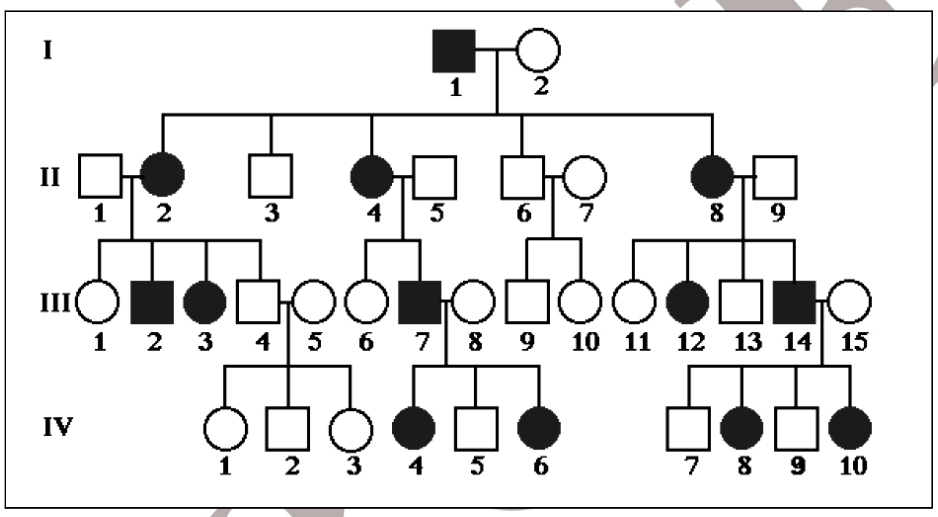
29. Real gases can be described by the Van der Waal's equation as:

$$(P+ n^2a/V^2)(V- nb) = nRT.$$

The compressibility factor for a gas is defined by Z = pV/RT. Which of the following statements is correct?

a) When Z > 1, real gases are difficult to compress than the ideal gases.
b) When Z > 1, real gases are easy to compress than the ideal gases.
c) When Z = 1, real gases are difficult to compress than the ideal gases.
d) When Z < 1, real gases are difficult to compress than the ideal gases.

30. Nisha was found to be affected with a genetic disease. The genetic counselor Dr. Dasgupta asked her to gather information about her lineage. Dr. Dasgupta then made a pedigree chart for four generations based on the information provided by Nisha. From the following pedigree chart, what can you infer about the inheritance pattern in Nisha's family?



a) Autosomal dominant
b) Autosomal recessive
c) X-linked dominant
d) X-linked recessive

31. Consider a gas enclosed in a cylinder with frictionless piston. When the gas is compressed at constant temperature by the piston, the pressure of the gas increases. Consider the following statements:

i. The average speed of the molecules increases.
ii. The rate at which the molecules collide with the piston increases.
iii. The molecules collide with each other more often.

Which of the above statement(s) is/are correct?

a) i only
b) iii only
c) ii & iii only
d) all three are correct

32. Sumit went to a fun fair with his friends Amit and Rohit. Rohit and Amit were scared to sit on a merry go round and preferred to stroll around. Sumit was very excited when he came down the merry go round. How will this change the pH of his blood?

a) increases
b) decreases
c) no change in pH
d) pH level gets adjusted at 7

33. Which of the following statement/s is/are true for Maize *(Zea mays)*?

i. CO_2 is fixed only once in the process of photosynthesis
ii. CO_2 is fixed twice in the process of photosythesis
iii. It undergoes the process of photorespiration
iv. CO_2 can be fixed even in very low concentrations during photosynthesis.

a) i & iii b) ii only c) i & iv d) ii & iv

34. White light is incident on one of the refracting faces of a prism. Inside the prism,
i. at normal incidence, the blue light slows down more than red light
ii. at normal incidence, blue light refracts same as red light
iii. for oblique incidence, blue light bends more than red light
iv. for oblique incidence, blue light slows down more than the red light

Which of the above statements are correct?
a) i & iv
b) i, iii & iv
c) ii, iii & iv
d) i, ii, iii & iv

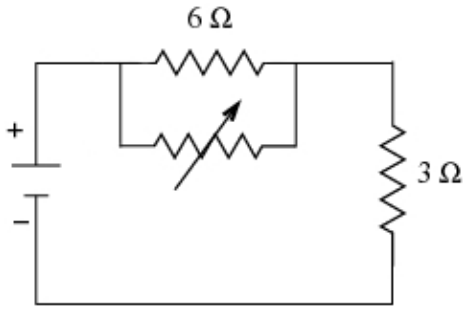
35. All chemical reactions with dissociation can be of following type/s :
i. reversible ii. irreversible iii. endothermic iv. exothermic

a) i, ii, iii b) ii, iii, iv c) i, iii, iv d) i,ii,iv

36. Polyomavirus (a DNA virus) causes tumors in "nude mice" (nude mice do not have a thymus, because of a genetic defect) but not in normal mice. The best interpretation is that...

a) macrophages are required to reject polyomavirus-induced tumors.
b) natural killer cells can reject polyomavirus-induced tumors without help from T lymphocytes.
c) T lymphocytes play an important role in the rejection of polyomavirus-induced tumors.
d) B lymphocytes play no role in rejection of polyomavirus-induced tumors.

37. The circuit given below is for the operation of an industrial fan. The resistance of the fan is 3 ohms. The regulator provided with the fan is a fixed resistor and a variable resistor in parallel.



Under what value of the variable resistances given below, power transferred to the fan will be maximum? The power source of the fan is a dc source with internal resistance of 6 ohms.

a) 3Ω b) 0 c) ∞ d) 6Ω

38. All mutations in genetic material may not lead to change in amino acid composition. Though there is a change in the codon, it is not expressed in the amino acids. Such mutations are called as ‘silent mutations'. Which of the following alternation of codons ATTGCC is NOT a 'silent mutation'?

a) ATCGCC
b) ATTGCA
c) ATTTGC
d) ATCGCG

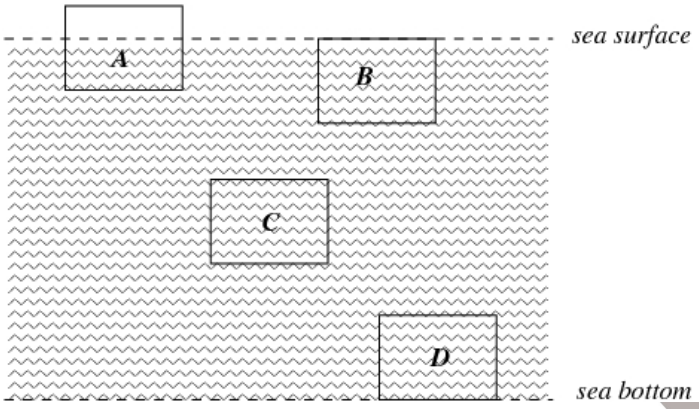
39. A diver releases bubbles of gas from the bottom of a lake. The bubbles increase to 10 times of their original volume when they reach the surface. Assuming that the pressure exerted by a column of water of 5m height is double the atmospheric pressure, the depth of the lake is...

a) 45m
b) 90m
c) 80m
d) 22.5m

40. ATP is known as energy currency of a cell. ATP is synthesized from ADP and Pi. The reaction is catalyzed by an enzyme called as ATP synthase. When the enzyme and substrate (ADP) are distant inside the cell, the reaction cannot take place spontaneously. Which of the following statements best explains the cause for the ATP synthase and ADP to interact?

a) Electronegativity of ADP attracts ATP synthase
b) ADP will be actively pumped to ATP synthase
c) Random movements will bring ADP to ATP synthase
d) ADP and ATP synthase always remain bound to oxysomes

41. A submarine is floating on water, half submerged (position A). It is then lowered to position B where it sits for a while. Later the submarine is taken to position C and submarine waits there before it is finally taken to the rest position at the bottom of the sea, which is position D. Assume that density of water and value of *g* is same everywhere.



Which of the following is correct for buoyancy force at the 4 places?

a) $F_A < F_B = F_C = F_D$
b) $F_A < F_B < F_C < F_D$
c) $F_A < F_B = F_C < F_D$
d) $F_A = F_B = F_C = F_D$

42. Glucose, a carbohydrate, is used by cells as a primary source of energy and metabolic intermediate. If 100 g of glucose is oxidized, it releases 1560 kJ of energy. Manish is given 100 g of glucose. Manish utilizes 50% of the gained energy in the event . Rest of the energy is used up in the process of sweating (evaporation). How much quantity of water Manish has to drink to compensate for this sweating. Consider enthalpy of evaporation of water to be 44 kJ/mole.

a) 319 ml
b) 345 ml
c) 2300 ml
d) 3300 ml

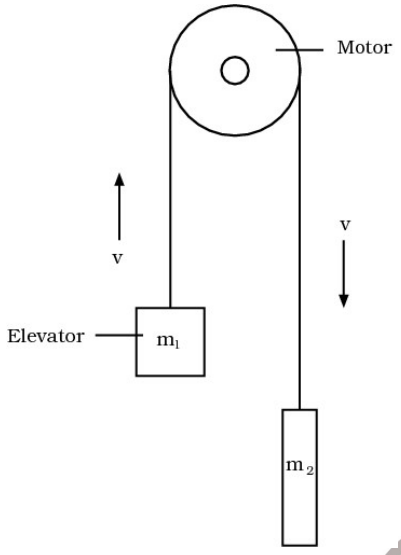
43. 10 g of ice at -10°C is added to 10 g of water at 85°C. What is the final temperature and amount of ice left in the system? (System is kept inside an ideal insulator).

a) 0°C, 0 g
b) 0°C, 2 g
c) 37.5°C, 0 g
d) 37.5°C, 5 g

44. Which of the following is NOT TRUE for the cleavage in human zygote?

a) The number of cells increase by mitotic division.
b) The embryo size goes on increasing with every cleavage.
c) The volume of cytoplasm of each cell decreases with every cleavage.
d) The cleavage starts when the egg is in the fallopian tube.

45. The diagram shows a lift system in which the elevator (mass m_1) is partly counterbalanced by a heavy weight (mass m_2).



At what rate does the motor provide energy to the system when the elevator is rising at a steady speed v ? (g = acceleration of free fall) (consider the pulley as frictionless at the pivot)

a) $(m_1 + m_2)gv$
b) ½ $(m_1 + m_2)gv$
c) (m_1m_2)gv $/(m_1 + m_2)$
d) $(m_1 - m_2)gv$

46. The following reaction is at equilibrium in a given cylinder of constant volume.

$$N_2(g) + 3\,H_2(g) \Leftrightarrow 2NH_3(g)$$

Addition of argon gas to the cylinder will...

a) reduce the formation of NH_3 with no change in temperature of the equilibrium system.
b) Increase the formation of NH_3 with increase in temperature.
c) reduce the formation of NH_3 with increase in temperature.
d) increase the formation of NH_3 with no change in temperature of the equilibrium system.

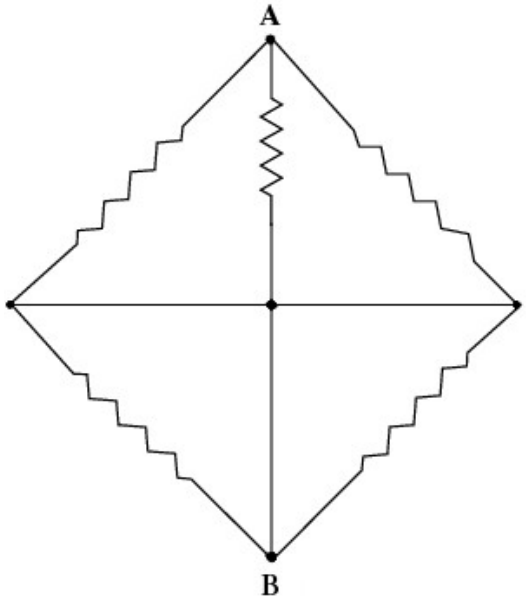
47. A heart is said to be *myogenic* when it has pacemaker...

a) originating in motor nerves present in the heart muscles.
b) originating in motor nerves present near the heart.
c) made up of specialized muscle tissues and located in the heart itself.
d) made up of specialized muscle tissues and located near the heart.

48. A balloon initially contains 7g of Nitrogen, and then 14g of Nitrogen is added to the balloon to expand its volume to 12 litre at the same temperature and pressure. Find the initial volume of the balloon.

a) 8 litre b)7 litre c) 5.6 litre d) 4 litre

49. When all the resistances in the circuit are 1Ω each, then the equivalent resistance across points A & B will be:



a) 5/6Ω b) 1/2Ω c) 2/3Ω d) 1/3Ω

50. Which of the following statements about food chains is FALSE?

a) A single organism can feed at different trophic levels.
b) The lower the trophic level at which the organism feeds, the more energy is available.
c) All organisms that are not producers are consumers.
d) Detritivores feed organisms of all trophic levels except those at the producer level.

51. A mixture of 0.3 moles of H_2 and 0.3 moles of I_2 are allowed to react in 10 litre evacuated flask at 500°C. The reaction is

$$H_2 + I_2 \Leftrightarrow 2HI$$

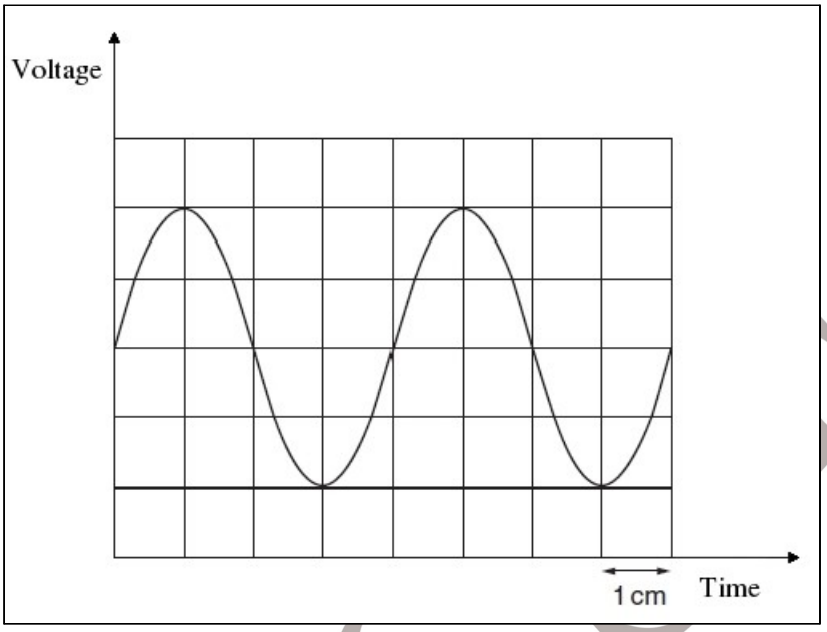
Value of k is found to be 64. The amount of I_2 present at equilibrium is

a) 0.15 mole b) 0.06 mole c) 0.03 mole d) 0.2 mole

52. In forensic science, DNA fingerprinting is a useful technique to trace genetic identity, relatedness and tissue matching. Which of the following material/tissue DOES NOT find any use in DNA fingerprinting?

a) Leucocytes
b) Erythrocytes
c) Sperms
d) Saliva

53. A cathode ray oscilloscope (CRO) is a device which converts electrical signals into an active graphical representation on a fluorescent screen. The x axis is always time axis, where the 1cm is equal to a preset time scale called time base. A sound wave is displayed on the screen of a cathode-ray oscilloscope.
The time base of the CRO is set at 2.5 ms / cm.



What is the frequency of the sound wave?

a) 50 Hz
b) 100 Hz
c) 200 Hz
d) 400 Hz

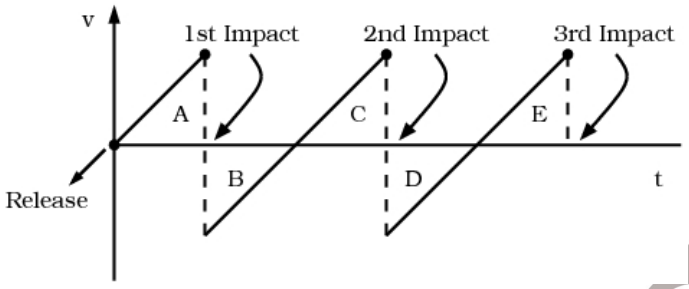
54. If at the top of a mountain the temperature is 0°C and the pressure is 0.934 atm and at the bottom of the mountain, the temperature is 30°C and the pressure is 1 atm. The ratio of density (considering the ideal gas situation) of air at the top, to that at the bottom of the mountain is:

a) 1 : 1
b) 1 : 1.4
c) 1.04 : 1
d) 1.5 : 1

55. The *Axolotl* larva of salamander is kept in water where iodine is absent then...

a) there will be no effect on its metamorphosis.
b) it will metamorphose but remain sexually immature.
c) it will fail to metamorphose but become sexually mature.
d) it will fail to metamorphose and will remain sexually immature also.

56. A ball is released from rest above a horizontal surface. The graph shows the variation with time of its velocity (not to scale). The scale on this graph is changed at every impact. A, B, C, D and E represent areas. Which of the following are correct?



a) A = B & B = C
b) A = C & C = E
c) B = C & D = E
d) all of the above

57. When a certain amount of ethylene (C_2H_4) was combusted, 6226 kJ heat was evolved. If heat of combustion of ethylene is 1411 kJ/mole, the volume of oxygen that entered into the reaction at STP is nearly...

a) 296 ml b) 296 litre c) 6226 x 22.4 litre d) 22.4 litre

58. A certain network consists of two ideal and identical voltage sources in series and a large number of ideal resistors. The power consumed in one of the resistors is 4W when either of the two sources is active and other is replaced by a short circuit. The power consumed by same resistor when both sources are simultaneously active would be:

a) 0 or 16W
b) 4W or 8W
c) 0 or 8W
d) 8W or 16W

59. The seven celled and eight nucleated female gametophyte of an angiospermic plant is produced as a result of _____ divisions of functional megaspore.

a) three mitotic
b) one meiotic and two mitotic
c) two mitotic
d) one meiotic and three mitotic

60. 50 ml ammonia undergoes oxidation with 60 ml of oxygen. If the reaction continues until one of the gases is completely consumed, the volume of water vapour produced will be:

a) 48 ml b) 60 ml c) 72 ml d) 84 ml

Section B: Questions 61 to 68 are of 5 marks each. Marks will also be indicated in the questions if there are more than one part to it.

SECTION B (Long questions)

61 (a). Sachin was suffering from problem of acidity, so he visited a physician who advised him to take 0.025 dm^3 of milk of magnesia for a fast relief. He exactly followed what the doctor told him to do. Out of curiosity he saw the label on milk of magnesia bottle and he found that there were different ingredients written on it and the concentration of milk of magnesia mentioned was 29 ppm. Assuming, the volume of milk of magnesia required for neutralization of acid is equal to intake of milk of magnesia, help Sachin to find out the following:

i. How many moles of acid was produced in Sachin's stomach? (0.5 mark)

ii. Write down the neutralization reaction of this process. (0.5 mark)

iii. Calculate the concentration of acid produced in mol/dm^3. (2 marks)

Total: 3 Marks

61 (b). Esha takes three flasks (*A*, *B*, *C*) with colorless contents. When Esha added content of flask '*A*' to that of flask '*B*', contents of flask '*B*' turned pink. Then she added contents of flask '*B*' to contents of flask '*C*' then contents of flask '*C*' turned colourless. Now she added contents of flask '*D*' to contents of flask '*E*' (which is common salt) and the colour of solution in flask '*E*' changed to green. According to you what is present in flask *A*, *B*, *C* and *D*.

Total: 2 Marks

62 (a). Ice exists at -20°C up to height h = 10 cm in a uniform cylindrical vessel (with no air gaps). Water at temperature x°C is filled in another identical vessel up to the same height h = 10 cm.
Now, water from second vessel is poured into first vessel and it is found that level of upper surface falls through h = 0.5 cm when thermal equilibrium is reached.
Neglecting the thermal capacity of vessels, change in density of water due to change in temperature and loss of heat due to radiation, calculate the initial temperature x°C of water.
Use density of ice as 0.8 g/cc.

Total: 2 Marks

62 (b). A ball of mass 10 kg, moving at 50 ms^{-1} in N-E direction is forced to move at 10 ms^{-1} in S-E direction in 10 sec by an application of a constant force. Find the force vector (magnitude and angle with respect to east).

Total: 3 Marks

63. $ABA \times C = BCC$. Find, with proof, all possible values of *A*, *B*, and *C* if distinct letters represent distinct digits in base 10 i.e the possible values of *A*, *B*, *C* belong to the set {0, 1, 2, 3, 4, 5, 6, 7, 8, 9}.

Total: 5 Marks

64. DNA is the genetic material in prokaryotic and eukaryotic organisms. The flow of genetic information is depicted as follows:

CENTRAL DOGMA

DNA forms daughter DNA molecules by replication. It also directs synthesis of proteins via RNA. The distance between two successive nucleotides in a DNA molecule is 3.4 nm. The average mass of one nucleotide is 330 Da and the average mass of one amino acid is 110 Da.

Now answer the following questions:

i. What will be mass of a double stranded DNA molecule of length 34 cm?
(1 mark)

ii. How many bases it will have?
(1 mark)

iii. What will be the length of mRNA transcribed from the piece of DNA?
(1 mark)

iv. What will be the mass of the protein synthesized from this piece of DNA?
(2 marks)

(Here assume that the entire DNA sequence is transcribed to RNA and then subsequently is translated to protein without loss of any sequence or nucleotide).

Total: 5 Marks

65. Sunita was checking chemical properties of some compounds. During her experiments, she observed that when she heated an orange solid '*A*', she obtained copious amounts of a green residue '*B*', a colourless gas '*C*' and some water vapour. She passed the dry gas '*C*' over heated Mg, and obtained a white solid '*D*'. When she tested the white solid '*D*', she found that it reacted with water to give a pungent smelling gas '*E*', which formed dense fumes with HCl. Can you identify the substances *A*, *B*, *C*, *D*, *E* ? Give chemical reactions in support of your answer.

Total: 5 Marks

66. A microscope is constructed from an objective of focal length 1cm and an eyepiece of focal length 5 cm. An object is placed 1.5 cm form the objective. If the final image is a virtual image 25 cm from the eyepiece,

i. Calculate the distance between the first image and the eyepiece.
ii. Calculate maximum possible angular magnification.
iii. Calculate the distance between the two lenses for this setting.
Least distance of distinct vision for unaided, normal human eye is 25 cm.

Total: 5 Marks

67. The process through which a new species emerges in a population is called speciation. This process is one of the main sources for biological diversity. Evolutionary theories try to explain how new species originate & develop through divergence of gene pools. Study of fossil records can reveal the cumulative effects of speciation over vast tracts of time.

Biologically, a species can be defined as a population or a group of populations whose members have the potential to inbreed in nature & produce fertile & viable offspring but are unable to do so with members of other population. Thus, members of a biological species are united by being *reproductively compatible* at least potentially.

Two basic patterns of evolutionary changes can be noted.
1. Anagenesis or phyletic evolution: It is the accumulation of changes that gradually transform a given species into a species with different characters.
2. Cladogenesis or branching evolution: It includes splitting of a gene pool into two or more separate pools which further can give rise to one or more new species.

As biological species are distinguished based on reproductive incompatibility, the concept hinges on reproductive isolation – existence of biological factors that impede members of two species from producing viable, fertile hybrids. Sometimes, only one barrier may not block all genetic exchange between species, but a combination of factors can effectively isolate a species' gene pool. These reproductive barriers can be classified into two main types, which are further classified into various sub types as given in the following table:

Isolating Mechanisms	***Description and Example/s***
Pre-mating Mechanisms	
Habitat isolation	A species in the same locale may occupy different habitats. e.g. *Pogostemon aquaticus* is found in stagnated water bodies as well as marshlands
Temporal isolation	Species reproduce at different seasons e.g. *Delonix* regia (Gulmohar) or different times of day.
Behavioral isolation	Reproduction in a species is governed by specific patterns of behaviour. In animals, courtship behaviour differs or they respond to different songs e.g. several bird species, calls, pheromones e.g. *ants* or other signals.
Mechanical isolation	Physical barriers in reproductive organs/mechanisms in a species to prevent reproduction. e.g. Genetalia unsuitable for one another, Different diameters of stylar tube in some plant species
Post-mating Mechanisms	
Gamete isolation	Sperm cannot reach or fertilize egg. e.g. Rat-mouse gametes in *In situ* environments
Zygote mortality	Fertilization occurs, but zygote does not survive e.g. In *Santalum spp* (Sandalwood) zygotes abort
Hybrid sterility	Hybrid survives but is sterile and cannot reproduce e.g. Male ligers (cross between Tiger and Lion)
F_2 fitness	Hybrid is fertile but F_2 hybrid has reduced fitness. e.g. In most of the hybrid varieties of garden flowers

Studying this concept, answer the following questions:

i. Which of the two basic patterns of evolutionary changes from those given above, do you think will promote biological diversity by increasing number of species?

ii. Which of the following statements is/are *incorrect*?

a) Anagenesis is the only process which can give rise to formation of new species
b) Splitting of gene pool takes place only in cladogenesis.
c) Cladogenesis is the only process which can give rise to formation of new species.
d) Anagenesis as well as cladogenesis can give rise to formation of new species.

iii. Write whether following statement is true or false.

"Five species of frog (*Rana spp.*) in a particular region show the period of most active mating different for each species. This is an example of temporal isolation."

iv. Identify the type of reproductive barriers listed in the following examples.

a) Male fireflies are recognized by females of their species by patterns of their flashings.
b) In tropical rain forests, many animal species are restricted to a particular level of the forest canopy.

Total: 5 Marks

68. Prove that there are infinitely many perfect squares ending in 444.

Total: 5 Marks

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Space for Rough Work

Space for Rough Work