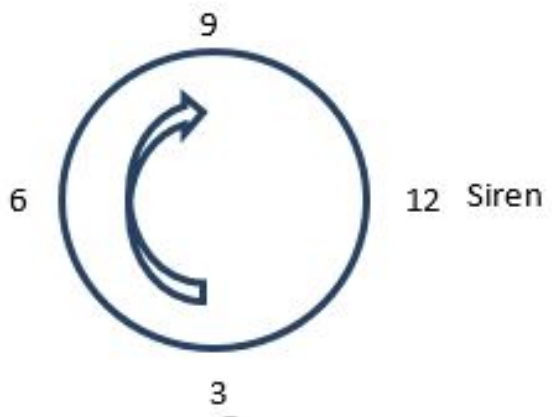## MCQ (30 Points)

Q.1.

A stationery siren goes on at a constant frequency in front of (outside) a merry-go-round. If the merry-go-round is rotating in the clockwise direction with the siren as shown in the figure. Following are some conditions at which higher frequency, lower frequency, and the original frequency are observed by a person sitting on the merry-go-round.

Select the correct statements from the following four options.

1. Original pitch is heard at 12 O'clock and 6 O'clock positions.
2. Original pitch is heard at 9 O'clock and 3 O'clock positions.
3. Higher pitch is heard at 3 O'clock and lower pitch at 9 O'clock positions.
4. Higher pitch is heard at 9 O'clock and lower pitch at 3 O'clock positions.

A.1 (1.0pt)
   a. 1 and 4
   b. 2 and 3
   c. 1 and 3
   d. 2 and 4

Q.2.

A light beam is travelling from vertically infinite region 1 to vertically infinite region 4 (refer to figure). The refractive indexes in regions 1, 2, 3, 4 are 1.62, 1.60, 1.55, and 1.50, respectively. The sin of angle of incidence θ for which the beam just misses entering region 4 is
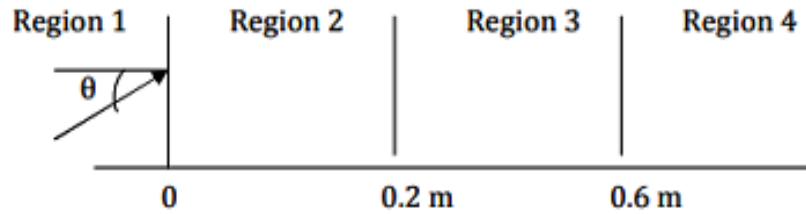
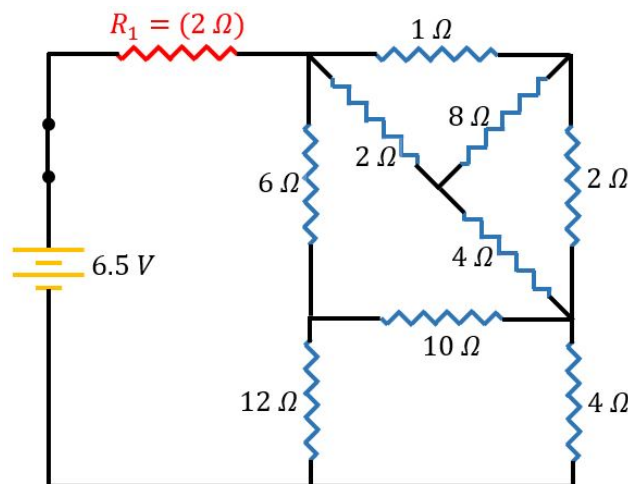(a) Region 1 (b) Region 2 (c) Region 3 (d) Region 4

A.2   (1.0pt)

   a. $\frac{1.50}{1.55}$

   b. $\frac{1.50}{1.62}$

   c. $\frac{1.60}{1.62}$

   d. $\frac{1.55}{1.60}$

Q.3.

In the following circuit, the current through the resistor R_1 (=2 Ω) is

---

A.3   (1.0pt)

   a. 0.5 A
   b. 1.0 A
   c. 1.8 A
   d. 2.0 A

MCQ

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Q1-3

English (Official)

Q.4.

Heater of an electric kettle is made of a wire of length L and diameter d. It takes 4 minutes to raise the temperature of 0.5 kg of water by 40 K when connected to a line voltage source. This heater is replaced by a new heater having two wires of the same material as that of the first one, each of length L and diameter 2d. Which of the following options is correct regarding the time taken for heating the same amount of water through the same temperature difference? (The entire system is thermally insulated)

A.4 (1.0pt)

a. 4 minutes if wires are in series.
b. 2 minutes if wires are in parallel.
c. 1 minute if wires are in series.
d. 0.5 minute if wires are in parallel.

Q.5.

Consider a cannon ball of mass 200 kg is projected from cannon placed in front of Burj Khalifa at angle of 60 degree with the horizontal with a velocity 100 km/hr during holy month of Ramadan. The initial kinetic energy at the time of projection of the cannon ball is K. Then, its kinetic energy at maximum height during its projection will be.

A.5 (1.0pt)

a. K
b. K/2
c. K/4
d. K/3

Q.6.

A given ray of light suffers deviation close to minimum deviation in an equilateral glass prism P. Additional glass prisms Q and R are identical to P are now added close to each other as shown in the figure. If the emerged ray from P enters Q and continues to R, then this ray will emerge from R with

A.6 (1.0pt)

a. Greater deviation.
b. Same deviation as if P is kept alone.
c. Total internal reflection.
d. No deviation.

MCQ

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Q1-4
English (Official)

Q.7.

When two mechanical waves meet in a small region of space, superposition of the two waves takes place. This is known as interference of waves. Which of the following statements is false?

A.7 (1.0pt)

a. The resultant displacement of the two waves can be obtained by adding their individual displacements.
b. The waves leaving the region carry less energy than the waves had before interference.
c. The frequency of each wave does not change after interference.
d. After leaving the region, the characteristics of the waves remain same as before interference.

Q.8.

While doing an experiment in physics laboratory, Mustafa connected two coils (say coil B and coil A) in series with a galvanometer and dropped a magnet through the coils, as shown in the figure. He noticed that there was no deflection in the galvanometer when the magnet passed through coil A and observed a large deflection when it passed through coil B. He noticed that both coils are identical in shape, size and material. Both had same number of turns and the speed with which the magnet passed through each coil was nearly the same. He concluded that
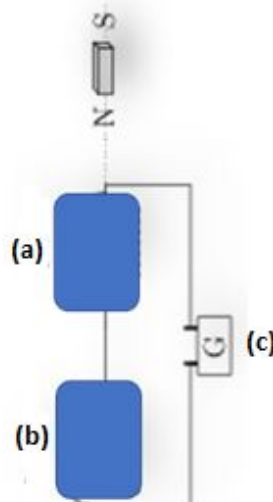
(a) Coil A (b) Coil B (c) Galvanometer

(A) The net magnetic flux through coil A must be zero.

(B) When passing through coil A, induced emf across coils B and A must be in the opposite directions.

(C) The galvanometer would show deflection for coil A if the poles of the bar magnet were reversed.

(D) Coil A must have different pattern of windings than that of coil B.

Which of the above statements is correct?

A.8		(1.0pt)
	a. A	
	b. B	
	c. C	
	d. D	

Q.9.

A typical ping pong ball is dropped from a height of 1 m above a marble floor. The ball bounces several times before it comes to rest. For every successive bounce, it loses 20% of its maximum height. Fatima plotted two quantities that she observed in this phenomenon and the graphs are shown below. Identify the two quantities plotted on the vertical axis.

(Air resistance is neglected)
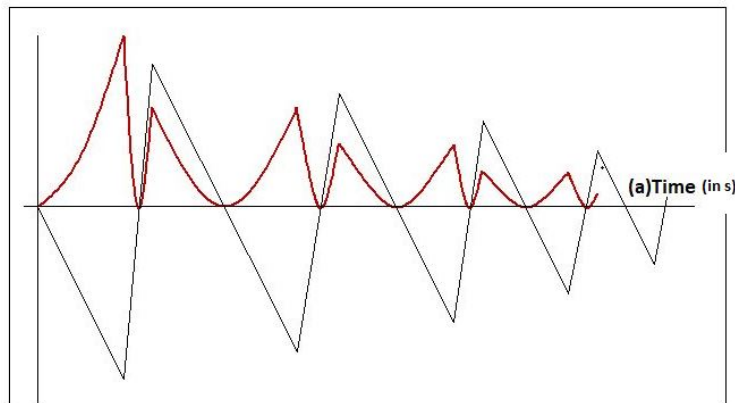
(a) Time (in seconds)

A.9		(1.0pt)
	a. Height and velocity	
	b. Velocity and kinetic energy	
	c. Potential energy and kinetic energy	
	d. Velocity and potential energy	

Q.10.

Mercury is the fastest planet in the solar system moving with an average orbital speed of 47 km/s. The earth moves slower with an average orbital speed of 30 km/s. What is the radius of mercury's orbit around the Sun in astronomical units.(Considering the orbits are circular)

(Hint: Astronomical unit nearly equals the orbital radius of the earth)

A.10
(1.0pt)
a. 0.25
b. 0.40
c. 0.50
d. 0.70

Q.11.

In a titration of an acid mixture with base, the teacher prepared an acid mixture by mixing 4.0 mL of 4.0 M HCl, 4.0 mL of $18.0M\ H_2SO_4$ and a certain volume of $4.0M\ HNO_3$, and then made up 3.0 L of solution using distilled water. She used an aqueous solution of Sodium Carbonate $(Na_2CO_3.10H_2O)$ as base for the titration, that was prepared by dissolving 2.0g of $(Na_2CO_3.10H_2O)$ in water and diluting to 100 mL with distilled water. After performing the titration, she observed that 15.0 mL of the initial acid mixture required 7.5 mL of Sodium Carbonate solution for complete neutralisation. The mass of nitrate ions in grams in the acid mixture is:

A.11 (1.0pt)
   a. $0.12g$
   b. $3.1g$
   c. $0.31g$
   d. $1.2g$

Q.12.

UAE has vast reserves of limestone particularly in the eastern and northern parts of the Emirates. Jabel Hafeet Mountain is the part of Hajar mountains and made of predominantly tertiary sedimentary rock –Limestone. It is primarily composed of Calcite which is chemically Calcium carbonate. Calcite is used on a large scale as a building material.

A mason was designing a pattern of transparent calcite tiles that were to be fixed in the laboratory. He spread the tiles on the table to arrange different patterns. Accidentally two tiles from the pattern came loose and fell in a container having 100g of hydrochloric acid solution. Each pure calcite tile weighs exactly 20g, and the concentration of hydrochloric acid solution in the container is 10% by mass(w/w).The calcite is converted to calcium chloride, carbon dioxide and water. Assuming that both tiles dissolve equally, what is the mass of each tile that remains undissolved?

A.12 (1.0pt)

a. $26.31g$
b. $13.15g$
c. $6.31g$
d. $13.69g$

Q.13.

The solid fuel in the booster stage of the space shuttle is a mixture of ammonium perchlorate (NH_4ClO_4) and aluminium powder. On the ignition of this mixture the products obtained are solid aluminium oxide, gaseous hydrogen chloride, water, and nitrogen gas. Using the following data find out the standard enthalpy change per mole of Aluminium at 298K for the reaction.

$\Delta_f^0 H \; of \; NH_4ClO_4(s) \; = \; -295.3 \; kJ \; mol^{-1}$

$\Delta_f^0 H \; of \; Al_2O_3(s) \; = \; -1675.7 \; kJ \; mol^{-1}$

$\Delta_f^0 H \; of \; HCl(g) \; = \; -92.3 \; kJ \; mol^{-1}$

$\Delta_f^0 H \; of \; H_2O(l) \; = \; -285.8 \; kJ \; mol^{-1}$

Note: The above values are standard enthalpies

A.13 (1.0pt)

a. $-976.9 \; kJ$
b. $-973.3 \; kJ$
c. $-862.5 \; kJ$
d. $-813.2 \; kJ$

Q.14.

When a certain mass of solid Potassium permanganate [Potassium Manganate (VII)] was treated with an excess of hydrogen peroxide, Manganese dioxide (MnO_2) was one of the products and the volume of oxygen formed was 168 L at STP. What is the mass in kg of potassium permanganate used? Molar volume of the gas at STP was 22.4 L/mol

A.14 (1.0pt)

a. 3.16 kg
b. 0.158 kg
c. 0.790 kg
d. 7.90 kg

Q.15.

X ray diffraction studies show that an alkaline earth metal has a face centered cubic (FCC) structure with a unit cell width 0.197 nm. If the density of the metal is $1.55 \; g \; cm^{-3}$, the number of atoms present in 40 g of the metal are: (Hint: The FCC has 4 atoms per unit cell)

A.15 (1.0pt)

a. 3.37×10^{24}
b. 6.74×10^{24}
c. 1.35×10^{25}
d. 2.70×10^{25}
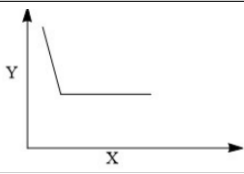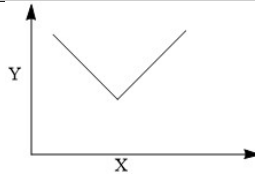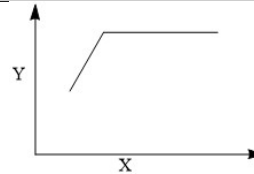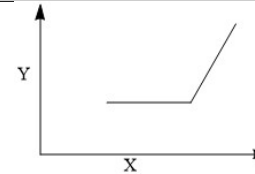
Q.16.

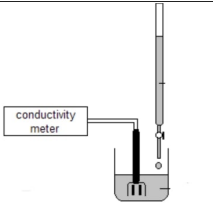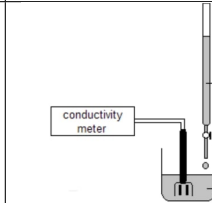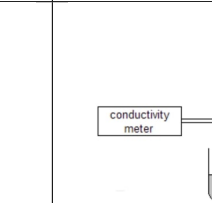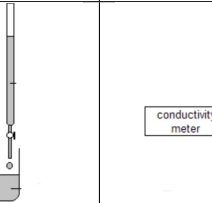The graphs in the table below represent conductometric titrations. Choose the appropriate entry/entries from graphs to match each of the entries in titrations. All entries in titrations refer to aqueous solutions. (Hint: Conductance depends on number of free ions as well as nature of the ions. Neglect the dilution effect)

Graph and diagram Specifications:

X = Volume of solution added from the burette; Y = Conductance

(i). Acetic acid vs. Ammonia (in burette),

(ii) Silver nitrate vs. Potassium chloride (in burette)

(iii) Nitric acid vs. Ammonia (in burette)

(iv) Magnesium Sulphate vs. Barium Hydroxide (in burette)

	P	Q	R	S
Graph				
Titrations				
	(i)	(ii)	(iii)	(iv)

A.16

a. $(i) \longrightarrow (R)$, $(ii) \longrightarrow (S)$, $(iii) \longrightarrow (Q)$, $(iv) \longrightarrow (P)$
b. $(i) \longrightarrow (R)$, $(ii) \longrightarrow (S)$, $(iii) \longrightarrow (P)$, $(iv) \longrightarrow (Q)$
c. $(i) \longrightarrow (P)$, $(ii) \longrightarrow (S)$, $(iii) \longrightarrow (R)$, $(iv) \longrightarrow (Q)$
d. $(i) \longrightarrow (S)$, $(ii) \longrightarrow (Q)$, $(iii) \longrightarrow (R)$, $(iv) \longrightarrow (P)$

(1.0pt)

Q.17.

When a 1 g piece of metal (Atomic Weight 89) was dropped into dilute sulfuric acid, a large volume of gas was evolved. All the gas was collected and dried to remove moisture and was found to occupy a volume of $378\ cm^3$ at STP(273 K, 1 atm). The resulting solution was electrolysed between platinum electrodes using a current of 1A for a period of 15 minutes. [Molar volume of the gas at STP was 22.4 L/mol] The following statements can be made about the above entire process

(1) The metal sulfate produced is MSO_4

(2) Oxygen is liberated at anode.

(3) The gas collected is hydrogen.

(4) Sulfur dioxide is produced at the anode.

(5) The metal sulfate produced is $M_2(SO_4)_3$

(6) The percentage of metal recovered by electrolysis is about 26-28%.

Choose the right options:

A.17
     a. Only options 1, 3, 4 are correct
     b. Only options 2, 3, 5, 6 are correct
     c. Only options 3, 4, 5 are correct
     d. Only options 1, 2, 3, 6 are correct
	(1.0pt)

Q.18.

Ion exchange Resins are used to soften water. They contain sodium ions which get exchanged with 'hard' ions like Ca^{2+} and Mg^{2+} . Resins are not 100% efficient *i.e.* all sodium ions present in the resin do not get exchanged at once and may need repeated passage of a solution through the column to attain full efficiency.

The average empirical formula of a commercial ion –exchange resin is $C_8H_7SO_3Na$. (Average empirical mass= 206). A $100cm^3$ solution containing $0.3\,mol\,L^{-1}$ of Mg^{2+} is passed through a column of ion exchange resin weighing 20g only once. What are the molarities of Mg^{2+} and Na^+, respectively, in the solution obtained after passing through the column, if the exchange efficiency of the resin is only 25%.
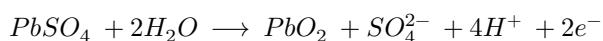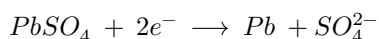

A.18
     a. 0.13M and 0.26M
     b. 0.26M and 0.17M
     c. 0.18M and 0.24M
     d. 0.21M and 0.14M
	(1.0pt)

Q.19.

The electrode reactions involved in the charging process of a lead storage battery are:

$$PbSO_4 + 2e^- \longrightarrow Pb + SO_4^{2-}$$

$$PbSO_4 + 2H_2O \longrightarrow PbO_2 + SO_4^{2-} + 4H^+ + 2e^-$$

In a certain lead storage battery containing 2 L of aqueous sulphuric acid, the density of the electrolyte solution was found to be 1.14 g/mL $(20\% \, H_2SO_4 \, by \, mass)$. This was charged using an average current of 1.67 A till the density rose to 1.28g/mL $(36.9\,\% \, H_2SO_4 \, by \, mass)$. What was the duration of the charging process?

Assume that the volume of acid solution remains constant during the charging process.

A.19
     a. 80 hours
     b. 100 hours
     c. 160 hours
     d. 188 hours
	(1.0pt)

Q.20.

Arrange the molecules H_2O, H_2S, BF_3 and NH_3 in order of their increasing dipole moment.

A.20	(1.0pt)
a. $BF_3 < NH_3 < H_2S < H_2O$	
b. $H_2S < NH_3 < BF_3 < H_2O$	
c. $BF_3 < H_2S < H_2O < NH_3$	
d. $BF_3 < H_2S < NH_3 < H_2O$	

Q.21.

An ecologist found a small water body on an isolated island and observed the various organisms present in it. He classified the organisms based on different trophic levels as shown in the table:

Trophic level	Name of Trophic level	Organisms found	Description
Trophic level 1	Producers	Phytoplankton	Phytoplankton are autotrophs which produce their own organic nutrients.
Trophic level 2	Primary consumers	Zooplankton	Zooplankton are herbivores. They feed on the phytoplankton for their energy source.
Trophic level 3	Secondary consumers	Small Planktivorous fish	These small fish are the primary carnivores. They feed on the zooplankton and derive their energy from it.

For studying the interactions between the organisms, the ecologist introduced a population of a carnivorous fish (which feed only on other small fish) in the waterbody.

Which of the following statements is correct regarding the long-term consequence of this introduction?

A.21 (1.0pt)

a. There will be an increase in the biomass of autotrophs.
b. There will be a decrease in the biomass of both autotrophs and herbivores.
c. There will be an increase in the biomass of herbivores.
d. There will be a decrease in the biomass of herbivores and an increase in the biomass of autotrophs.

Q.22.

Paramecium lives in pond water that is hypotonic to its cellular contents. However, paramecium does not burst due to excess water uptake because of its contractile vacuole.

The vacuole collects fluids from a system of canals present in the cytoplasm. When full the vacuole and canals contract, expelling fluid from the paramecium.
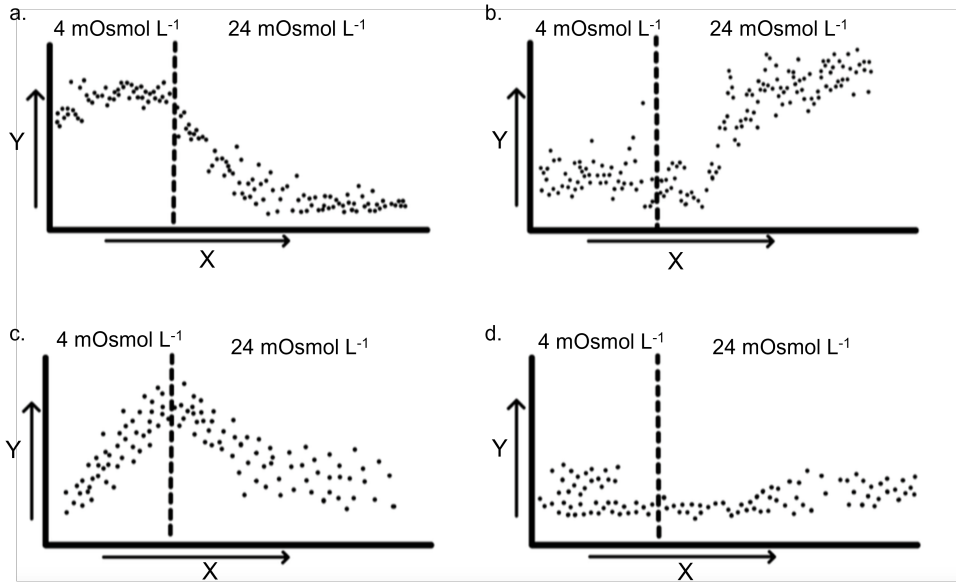
In an experiment, the activity of the contractile vacuole was monitored over time after placing paramecium in a growth medium with an osmotic concentration (osmolarity) of 4 mOsmol L^{-1} (similar to that of the pond water) for 30 minutes and then shifted to a growth medium having an osmolarity of 24 mOsmol L^{-1}.

Osmole refers to the number of moles of solutes that contribute to the osmotic pressure of a solution. Osmolarity is osmole per liter.

Which of the following graphs is a correct representation of the activity of the contractile vacuole in these two media?

A.22 (1.0pt)

a.

4 mOsmol L^{-1} 24 mOsmol L^{-1}

Y

X

b.

4 mOsmol L^{-1} 24 mOsmol L^{-1}

Y

X

c.

4 mOsmol L^{-1} 24 mOsmol L^{-1}

Y

X

d.

4 mOsmol L^{-1} 24 mOsmol L^{-1}

Y
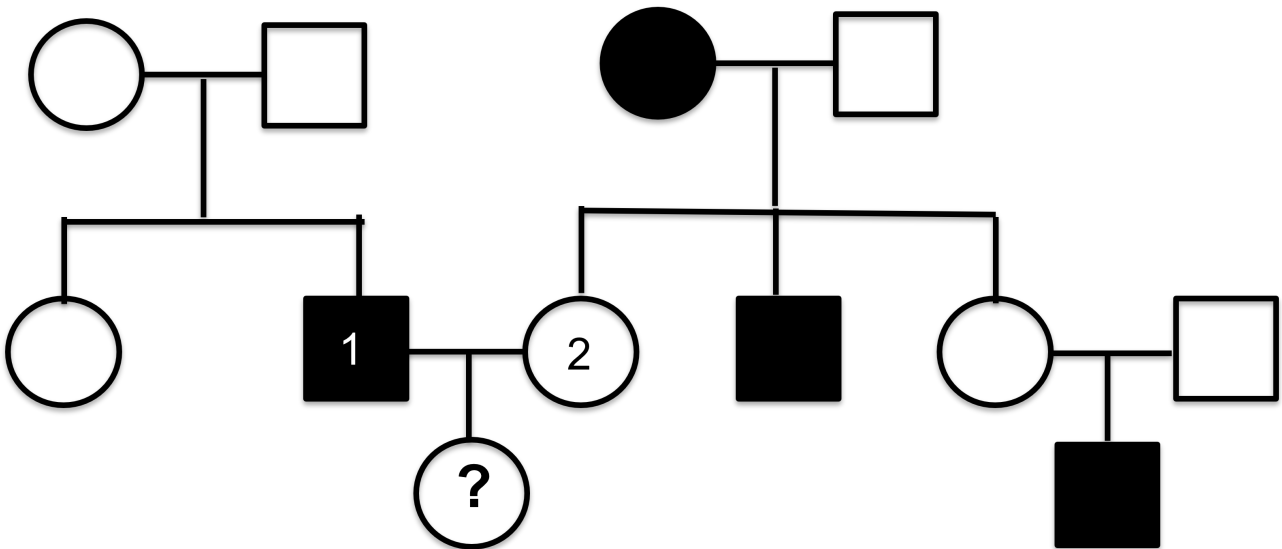
X
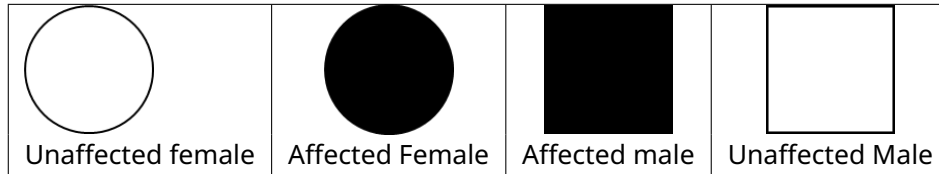
X = Time (min); Y = Activity (arbitrary units)

Q.23.

The pedigree below represents the inheritance of a genetic disorder.

| Unaffected female | Affected Female | Affected male | Unaffected Male |

If the individuals marked 1 and 2 had a daughter, what is the probability that the daughter would show the disorder?

A.23 (1.0pt)
- a. 1
- b. 1/2
- c. 2/3
- d. 1/4

Q.24.

Given below are schematic representations of chromosomes at Metaphase I of meiosis.

The figures below depict the arrangement of alleles on the chromosomes and the alignment of chromosomes at the equatorial plane. The dotted line indicates spindle fibres.
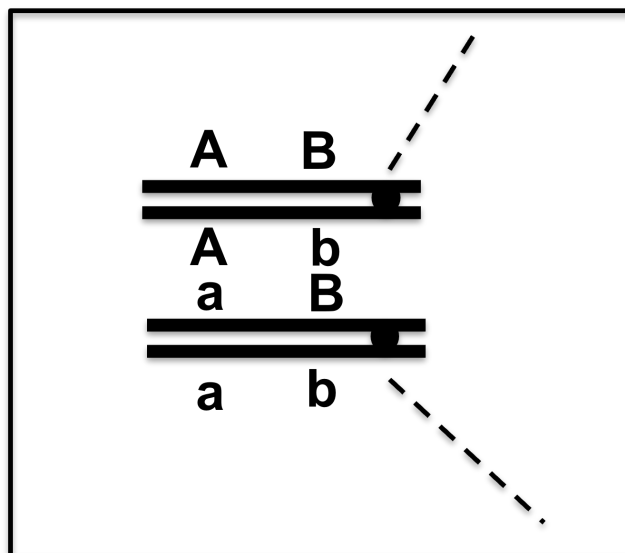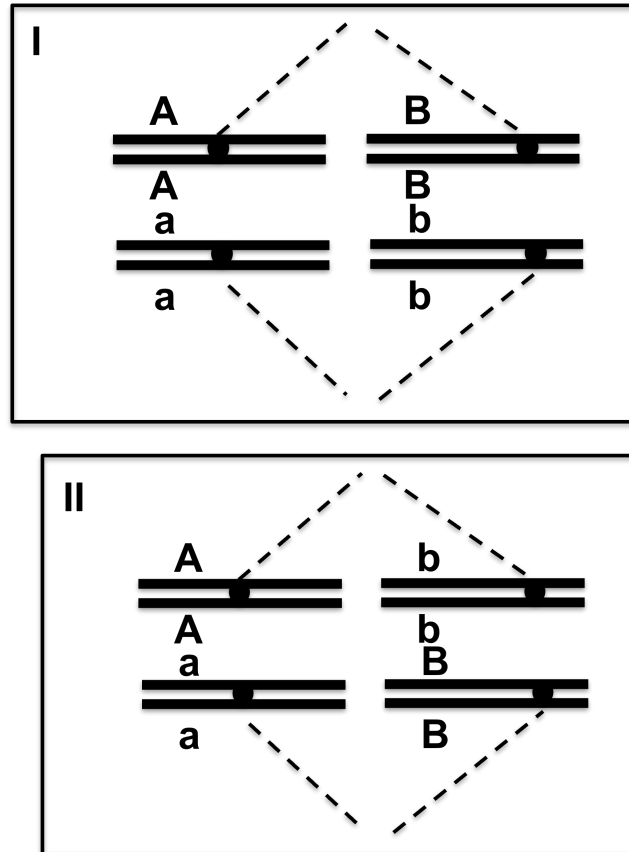

Figure 1

Figure 2
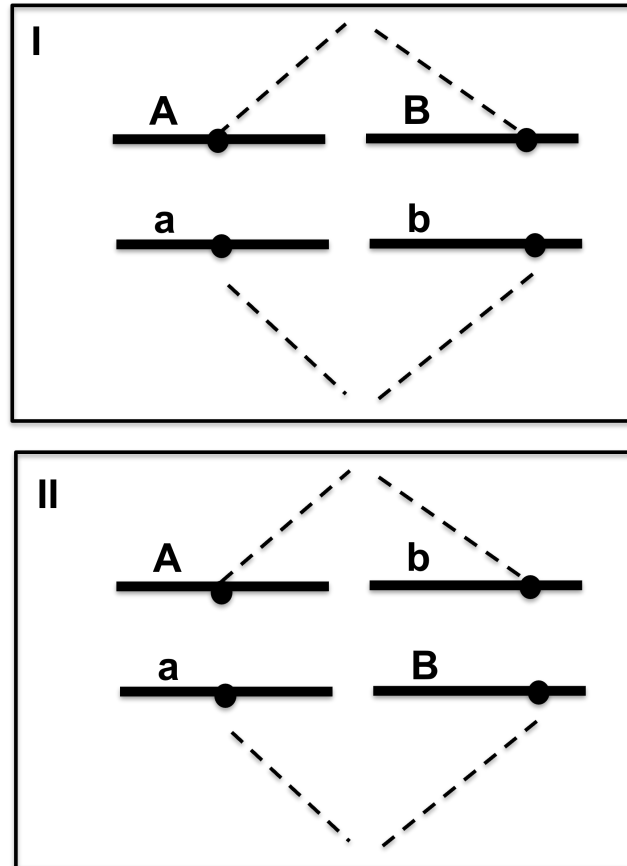
Figure 3

Which of the following will definitely ensure independent assortment of the genes 'A' and 'B' under normal meiotic division?

A.24

(1.0pt)

a. When chromosomes are arranged as shown in figure 1 and there is crossing over between genes A and B.

b. When 50% of the cells in meiosis have chromosomes in orientation I and 50% have chromosomes in orientation II as shown in figure 2.

c. When 50% of the cells in meiosis have chromosomes in orientation I and 50% have chromosomes in orientation II as shown in figure 3

d. When chromosomes are arranged as shown in figure 1 and there is no crossing over between genes A and B.

Q.25.

The figure below represents two types of nephrons (labeled as A and B) observed in mammals.
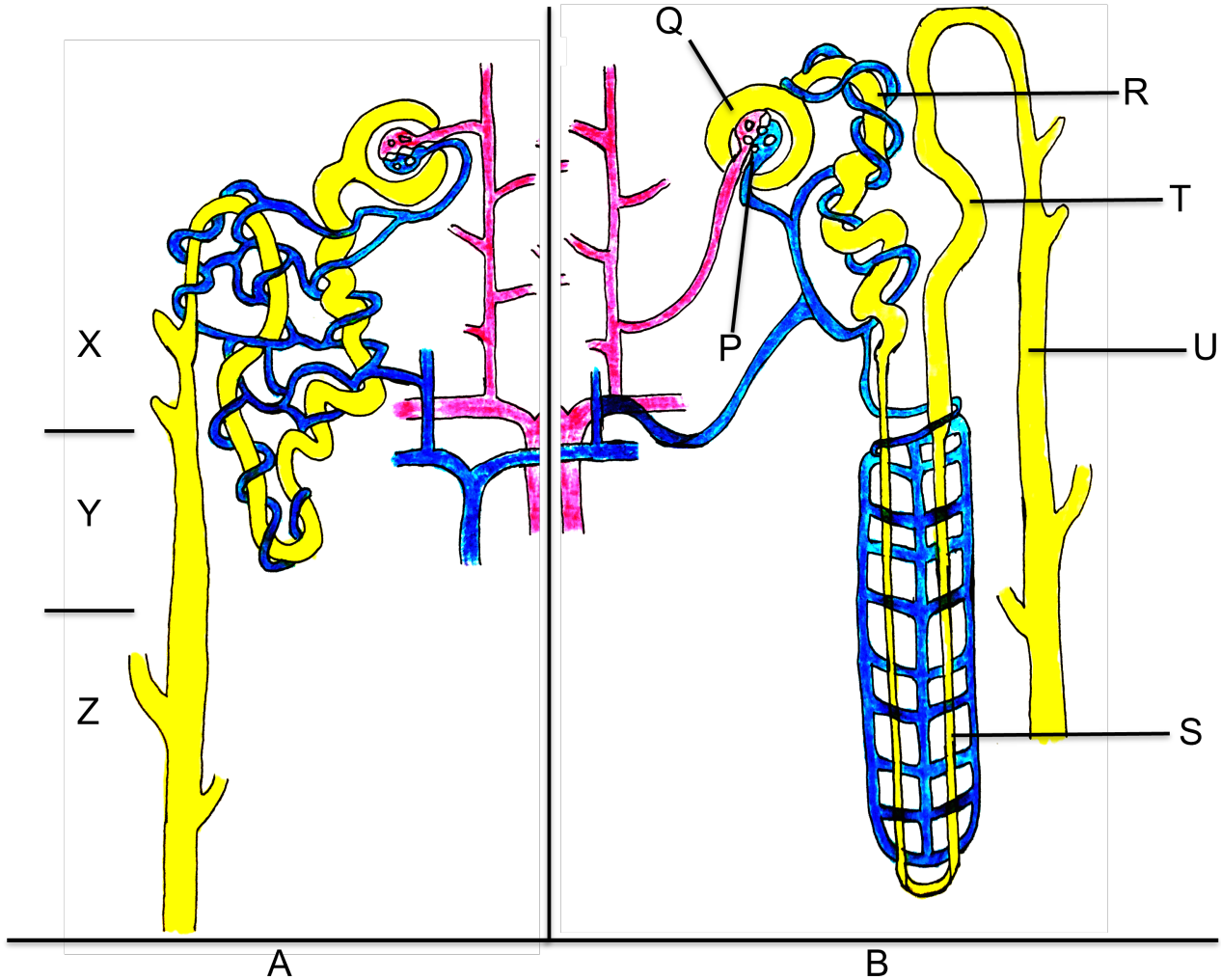
A- Type A nephron; B- Type B nephron; P- Glomerulus; Q- Bowman's capsule; R- Proximal convoluted tubule; S- Loop of Henle; T- Distal convoluted tubule; U- Collecting duct; X- Cortex; Y- Outer medulla; Z- Inner medulla

Which of the following statements regarding the nephrons is correct?

MCQ

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دبي، الإمارات العربية المتحدة Dubai, UAE

Q1-7

English (Official)

A.25 (1.0pt)

    a. In comparison to type A nephron, the urine produced by a type B nephron is likely to be more concentrated

    b. Type B nephron is likely to absorb more potassium ions as compared to type A nephron.

    c. In comparison to type B nephron, in type A nephron, reabsorption of NaCl leads to subsequent osmosis of water from loop of Henle into the blood.

    d. In comparison to type B nephron, type A nephron is likely to remove poisonous substances from the blood more efficiently.

Q.26.

A small population of monkeys from Africa (Old World) are thought to have drifted to South America (New World) on natural rafts about 40 million years ago

There were no monkeys in the New World. On reaching South America, these monkeys bred and over time looked very different from the monkeys in Africa. They formed new species.

1. Old world monkeys 2. New world monkeys

Arrange the evolutionary processes that would lead to the formation of the new species.

A.26 (1.0pt)

    a. Migration $\longrightarrow$ Adaptation $\longrightarrow$ Natural Selection

    b. Genetic drift $\longrightarrow$ Natural Selection $\longrightarrow$ Adaptation

    c. Natural Selection $\longrightarrow$ Adaptation $\longrightarrow$ Genetic drift

    d. Adaptation $\longrightarrow$ Genetic drift $\longrightarrow$ Natural Selection

---

Q.27.

In 1881, a scientist named Engelmann mounted a filamentous green alga, Spirogyra, on a slide and placed some motile bacteria in a nutrient medium around the algal filament.

He illuminated the algal filament with a light spectrum (400-700nm) obtained using a prism and viewed the slide under a microscope.
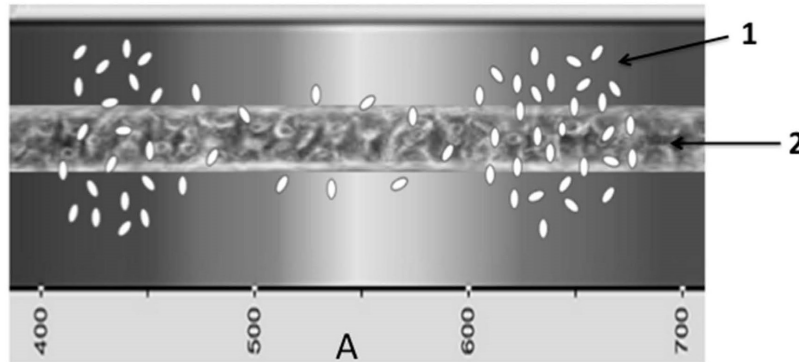
1 – Bacteria 2- Algal filament A- Wavelength (nm)

Based on the above information, which of the following statements is correct?

A.27   (1.0pt)

a. The experiment was carried out to study respiration in algae.
b. The bacteria used in this experiment are aerobic in nature.
c. The bacteria are naturally attracted to red and blue light and not dependent on the algal filament.
d. The distribution of bacteria is dependent on the specific structures present in the algal filament.

Q.28.

Filamentous cyanobacteria have special thick-walled structures called heterocysts, that help in nitrogen fixation.

Nitrogen from the atmosphere is fixed by the enzyme nitrogenase present in the heterocysts and converted to ammonia, using ATP as a source of energy.

Nitrogenase is very sensitive to inactivation by oxygen.

Which of the following modifications will allow heterocysts to effectively carry out nitrogen fixation?

A.28   (1.0pt)

a. High chlorophyll content
b. Reduced light-dependent activity
c. Enhanced CO_2 fixation
d. Low respiratory rate

Q.29.

A phylogenetic tree is a diagram that depicts the lines of evolutionary descent of different species from a common ancestor.

In the phylogenetic trees shown below, the evolutionary descent of three organisms –Humans (1), Whale (2) and Sharks (3) is depicted.

Which of the following phylogenetic trees correctly represents the relationship between these three organisms?
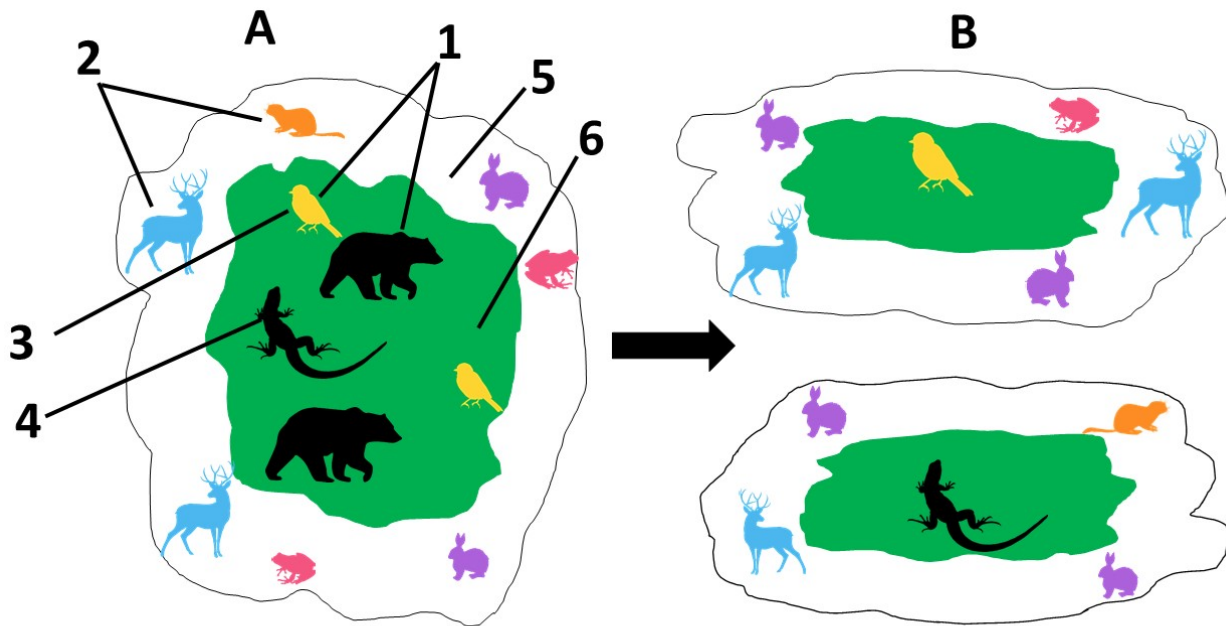
A.29 (1.0pt)

Q.30.

The figure illustrates a forest area depicting fauna living in deep forest (interior species) or the boundary zone (edge species).

1- Interior species; 2- Edge species; 3- Sp-Y (bird); 4- Sp-X (reptile) 5- boundary zone; 6- deep forest.

An ecological niche is defined as the sum of its use of the biotic and abiotic resources in its environment.

Compare A and B and analyse the inferences given below:

  i. A and B are examples of ecological succession.

  ii. A and B are examples of habitat fragmentation.

 iii. In B, the interior habitat has shrunk while the number of individuals of edge species has increased.

 iv. In B, there is an increase in both the inner habitat and the interior species.

  v. In A and B, sp-X and sp-Y occupy different niches.

Choose the option with correct combination of inferences cited above:

A.30   a. i and iii only
           b. ii and iv only
           c. ii, iii and v
           d. i, iv and v
	(1.0pt)

MCQ Answers (30 Points)

Number	Options			
Answer No 1	A	B	C	D
Answer No 2	A	B	C	D
Answer No 3	A	B	C	D
Answer No 4	A	B	C	D
Answer No 5	A	B	C	D
Answer No 6	A	B	C	D
Answer No 7	A	B	C	D
Answer No 8	A	B	C	D
Answer No 9	A	B	C	D
Answer No 10	A	B	C	D
Answer No 11	A	B	C	D
Answer No 12	A	B	C	D
Answer No 13	A	B	C	D
Answer No 14	A	B	C	D
Answer No 15	A	B	C	D
Answer No 16	A	B	C	D
Answer No 17	A	B	C	D
Answer No 18	A	B	C	D
Answer No 19	A	B	C	D
Answer No 20	A	B	C	D
Answer No 21	A	B	C	D
Answer No 22	A	B	C	D
Answer No 23	A	B	C	D
Answer No 24	A	B	C	D
Answer No 25	A	B	C	D
Answer No 26	A	B	C	D
Answer No 27	A	B	C	D
Answer No 28	A	B	C	D
Answer No 29	A	B	C	D
Answer No 30	A	B	C	D