CBSE 2025 Science — Set 2 — Answer Key

English Medium

Time Allowed: 3 Hours | Maximum Marks: 80

General Instructions:

1. This question paper contains 39 questions. All questions are compulsory.
2. Section A has 20 MCQs carrying 1 mark each.
3. Section B has 6 questions carrying 2 marks each.
4. Section C has 7 questions carrying 3 marks each.
5. Section D has 3 questions carrying 5 marks each.
6. Section E has 3 case-study based questions carrying 4 marks each.
7. Draw neat diagrams wherever required.

Section A

Multiple Choice Questions (1 mark each)

Q.1 [1 mark]

The correct balanced chemical equation showing exothermic reaction in which natural gas burns in air is:

(a) $CH_4 + O_2 \rightarrow CO_2 + 2H_2O$

(b) $CH_4 + 2O_2 \rightarrow 2CO_2 + 2H_2O$ + Energy

(c) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

(d) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + Energy <<

Explanation:

The balanced equation for combustion of methane (natural gas) is $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + Energy.

This is an exothermic reaction as heat and light energy are released.

Option (D) has the correct balancing with $2O_2$ on the reactant side.

Q.2 [1 mark]

The warning sign shown in the given figure must invariably be displayed/painted on the containers which contain hydroxide of:

(a) Aluminium

(b) Calcium

(c) Sodium <<

(d) Magnesium

Explanation:

The corrosive warning sign is displayed on containers containing sodium hydroxide (NaOH), which is a strong base/alkali and highly corrosive.

It can cause severe chemical burns.

Sodium hydroxide is commonly stored in containers with the corrosive hazard symbol.

Q.3 [1 mark]

The body of human beings works within the pH range of:

(a) 6.1 to 6.8
(b) 6.5 to 7.3
(c) 7.0 to 7.8 <<
(d) 7.5 to 8.1

Explanation:
The human body works within a narrow pH range of 7.0 to 7.8.
Our body functions optimally in this slightly alkaline range.
Any significant change in pH can disrupt bodily functions.

Q.4 [1 mark]

Aluminium powder is used in thermit welding because:

(a) Its reaction with iron is highly exothermic.
(b) When it is heated with iron (III) oxide, molten iron is obtained. <<
(c) When it is heated with iron (III) oxide, molten aluminium oxide is obtained to join railway tracks.
(d) Its melting point is low as compared to iron and a molten alloy of iron and aluminium is formed on heating which is used to join railway tracks.

Explanation:
In thermit welding, aluminium powder is used because when heated with iron (III) oxide (Fe_2O_3), a highly exothermic reaction occurs producing molten iron.
The molten iron produced is used to join railway tracks or cracked machine parts.
The reaction is: $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe + Heat$.
Note: this answer could not be confirmed against an official CBSE marking scheme.

Q.5 [1 mark]

Two metals zinc and tin are dissolved separately in definite proportions in molten copper (the primary metal) to obtain two different alloys respectively known as:

(a) Bronze and Brass
(b) Brass and Solder
(c) Brass and Bronze <<

(d) Solder and Bronze

Explanation:

When zinc is dissolved in molten copper, the alloy formed is Brass (Cu + Zn).

When tin is dissolved in molten copper, the alloy formed is Bronze (Cu + Sn).

So the correct answer is Brass and Bronze.

Q.6 [1 mark]

The opening and closing of stomata is regulated by:

(a) CO_2 concentration in stomata

(b) Temperature in guard cells

(c) O_2 concentration in stomata

(d) Amount of water in guard cells <<

Explanation:

The opening and closing of stomata is regulated by the amount of water (turgidity) in the guard cells.

When guard cells absorb water, they swell and become turgid, causing the stomatal pore to open.

When they lose water, they become flaccid and the pore closes.

Q.7 [1 mark]

One-cell thick blood vessels are known as:

(a) Alveoli

(b) Capillaries <<

(c) Arteries

(d) Veins

Explanation:

Capillaries are one-cell thick blood vessels.

Their walls are only one cell (endothelial cell) thick, which allows for the exchange of materials (oxygen, carbon dioxide, nutrients, waste) between blood and surrounding tissues.

Q.8 [1 mark]

Observe the given figures A and B. When chhui-mui (sensitive) plant is touched, its leaves fold. This is due to:

(a) Hormonal effect
(b) Thermal effect
(c) Change in amount of water in cells <<
(d) Electromagnetic effect

Explanation:

When the chhui-mui (Mimosa pudica / Touch-me-not) plant is touched, its leaves fold due to a change in the amount of water in the cells.

The stimulus causes water to move out of the cells at the base of the leaves (pulvinus), making them lose turgor pressure and fold.

This is a nastic movement.

Q.9 [1 mark]

Bryophyllum produces new plant through:

(a) Apical buds formed on the tip of the plant
(b) Vegetative buds produced in the notches of the leaf <<
(c) Flowers produced in the notches of the branches
(d) Fruits formed on the branches of the plant

Explanation:

Bryophyllum reproduces vegetatively through buds that develop in the notches (margins) of its leaves.

These vegetative buds fall on the soil and grow into new plants.

This is a form of asexual reproduction called vegetative propagation.

Q.10 [1 mark]

The number of chromosomes in a cell division is halved. This kind of cell division is observed in:

(a) Only testis
(b) Only ovary

(c) Ovary and testis both <<

(d) All cells of the body

Explanation:

Meiosis is the type of cell division where the number of chromosomes is halved (from diploid to haploid).

This occurs in both the ovary (to form eggs) and testis (to form sperm).

These are the reproductive organs where gamete formation takes place.

Q.11 [1 mark]

If the absolute refractive indices of two media X and Y are 6/5 and 4/3 respectively, then the refractive index of Y with respect to X will be:

(a) 10/9 <<

(b) 9/10

(c) 9/8

(d) 8/9

Explanation:

The refractive index of Y with respect to X = n_Y / n_X = (4/3) / (6/5) = (4/3) × (5/6) = 20/18 = 10/9.

So the answer is 10/9.

Q.12 [1 mark]

An object is placed at a distance of 30 cm from the pole of a concave mirror. If its real and inverted image is formed at 60 cm in front of the mirror, the focal length of the mirror is:

(a) -15 cm

(b) -20 cm <<

(c) +20 cm

(d) +15 cm

Explanation:

Using mirror formula: 1/f = 1/v + 1/u.

Here u = -30 cm, v = -60 cm (real image in front of concave mirror).

1/f = 1/(-60) + 1/(-30) = -1/60 - 1/30 = -1/60 - 2/60 = -3/60 = -1/20.
Therefore f = -20 cm.

Q.13 [1 mark]

In the given figure showing refraction through a prism, the angle of incidence and the angle of deviation respectively are:

(a) 1 and 5
(b) 7 and 6
(c) 7 and 4
(d) 1 and 6 <<

Explanation:

In the prism diagram, angle 1 is the angle of incidence (angle between the incident ray and the normal at the first surface), and angle 6 is the angle of deviation (angle between the incident ray produced and the emergent ray).
So the correct answer is 1 and 6.

Q.14 [1 mark]

An electric bulb is connected to a power supply of 220 V. If the current drawn by the bulb from the supply is 500 mA, the power of the bulb is:

(a) 11 W
(b) 110 W <<
(c) 220 W
(d) 1100 W

Explanation:

Power = Voltage × Current = V × I = 220 V × 500 mA = 220 × 0.5 A = 110 W.

Q.15 [1 mark]

Four identical resistors of 12 Ω each are connected in series to form a square ABCD as shown in the figure. The resistance of the network between the points 1 and 2 is:

(a) 48 Ω

(b) 36 Ω

(c) 9 Ω <<

(d) 6 Ω

Explanation:

The four 12 Ω resistors form a square ABCD in series.

Points 1 and 2 divide the square into two parallel paths.

One path has one resistor (12 Ω) and the other path has three resistors in series (12 + 12 + 12 = 36 Ω).

The equivalent resistance = (12 × 36)/(12 + 36) = 432/48 = 9 Ω.

Q.16 [1 mark]

Identify from the following a group containing all non-biodegradable substances:

(a) Leather, Glass, Plastic

(b) Cotton, Wood, Nylon

(c) DDT, Polyester, Glass <<

(d) Leather, Silk, Wool

Explanation:

DDT, Polyester, and Glass are all non-biodegradable substances.

They cannot be broken down by biological processes.

Leather, cotton, wool, and silk are all biodegradable (natural materials).

Nylon and plastic are non-biodegradable but they are mixed with biodegradable items in options A and B.

Q.17 [1 mark]

Assertion (A): The metals high up in the reactivity series cannot be obtained from their compounds by heating with carbon.

Reason (R): Displacement reactions can also be used to obtain metal.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the

correct explanation of Assertion (A). <<

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

Explanation:

Assertion is true: Highly reactive metals (like Na, K, Ca, Al) cannot be obtained by reduction with carbon because they have higher affinity for oxygen than carbon.

Reason is also true: Displacement reactions can be used to obtain metals (e.g., thermit reaction).

However, the Reason does not explain the Assertion.

Hence both are true but R is not the correct explanation of A.

Q.18 [1 mark]

Assertion (A): A mango seed will germinate to form a mango tree.

Reason (R): Heredity determines the process by which traits and characteristics are reliably inherited from parents to offspring.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A). <<

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

Explanation:

Assertion is true: A mango seed will always germinate to form a mango tree (not any other plant).

Reason is also true: Heredity is the process by which traits are reliably inherited from parents to offspring.

The Reason correctly explains the Assertion because it is heredity (DNA passed from parent to offspring) that ensures a mango seed produces only a mango tree.

Q.19 [1 mark]

Assertion (A): Nichrome is an alloy which is commonly used in electrical heating devices such as electric irons, toasters, etc.

Reason (R): The resistivity of nichrome is high and its resistance decreases with increase in temperature.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false. <<
(d) Assertion (A) is false, but Reason (R) is true.

Explanation:

Assertion is true: Nichrome is indeed used in electrical heating devices.
Reason is partially false: While nichrome does have high resistivity, its resistance does not decrease with increase in temperature.
Nichrome has a very low temperature coefficient of resistance, meaning its resistance remains nearly constant (or increases slightly) with temperature.
So A is true but R is false.

Q.20 [1 mark]

Assertion (A): Animals will not get energy if they eat (consume) coal as food.
Reason (R): Specific enzymes are needed for the breakdown of a particular food.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A). <<
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

Explanation:

Assertion is true: Animals cannot get energy from eating coal because their bodies lack the enzymes to break down coal.
Reason is also true: Specific enzymes are needed for the breakdown of particular foods.

The Reason correctly explains the Assertion — since animals lack enzymes to digest coal, they cannot derive energy from it.

Section B

Very Short Answer Questions (2 marks each)

Q.21 [2 marks]

(a) In common practice silver is recovered from silver nitrate solution by the use of copper metal. Name the type of reaction that takes place in this process and give the chemical equation of the reaction involved.

(b) Name the method used for refining silver.

Answer: (a) This is a displacement reaction. $Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$. Copper displaces silver from silver nitrate solution as copper is more reactive than silver.

(b) Electrolytic refining is used for refining silver.

Explanation:

(a) Since copper is more reactive than silver (higher in the reactivity series), it displaces silver from silver nitrate solution.

This is a displacement reaction: $Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$.

(b) Silver is refined by electrolytic refining, where impure silver is made the anode, pure silver is the cathode, and silver nitrate solution is used as the electrolyte.

Q.22 [2 marks]

(a) Select from the following members of same homologous series:

(1) H-C-C-C=O (with appropriate H atoms)

(2) H-C-C-C-H with an O attached to the middle carbon (C=O on the middle carbon, propanone)

(3) H-C-C-C-OH (with appropriate H atoms)

(4) H-C-C-C-C=O (with appropriate H atoms)

(b) What happens to (i) the melting point, and (ii) the solubility of compounds as the molecular mass of the compounds in a homologous series increases?

Answer: (a) Structures 1 and 4 belong to the same homologous series (aldehydes). Structure 1 is propanal (C_2H_5CHO) and structure 4 is butanal (C_3H_7CHO). They differ by a $-CH_2-$ unit.

(b) (i) The melting point increases as the molecular mass increases in a homologous series. (ii) The solubility in water decreases as the molecular mass increases.

Explanation:

Members of a homologous series have the same functional group and differ by $-CH_2-$ units.

Structures 1 and 4 are both aldehydes (containing -CHO group) and form a homologous series.

As molecular mass increases in a homologous series: (i) melting and boiling points increase due to stronger intermolecular forces, and (ii) solubility in water decreases as the hydrocarbon chain becomes longer and more hydrophobic.

Q.23 [2 marks]

Name the parts of hind-brain of the human brain. Which part of the hind-brain controls involuntary actions such as blood pressure and salivation?

Answer: The hind-brain has three parts: (i) Cerebellum, (ii) Pons, and (iii) Medulla oblongata. The Medulla oblongata controls involuntary actions such as blood pressure, salivation, and vomiting.

Explanation:

The hind-brain consists of three parts: Cerebellum (controls posture, balance, and precise voluntary movements), Pons (relays signals between cerebellum and cerebrum), and Medulla oblongata (controls involuntary actions like blood pressure, salivation, heart rate, breathing, vomiting, etc.).

Q.24 [2 marks]

(a) Write one function of each of the following, in a seed:

(i) Seed coat, (ii) Cotyledon, (iii) Radicle, (iv) Plumule

(b) Write the main steps to culture yeast in the laboratory.

Answer: (a) (i) Seed coat: Protects the seed from mechanical damage, desiccation, and pathogens. (ii) Cotyledon: Stores food/nutrients for the developing embryo. (iii) Radicle: Develops into the root of the new plant. (iv) Plumule: Develops into the shoot of the new plant.

(b) Steps to culture yeast: Take some yeast powder and mix it in warm water with sugar. Keep the mixture in a warm place for a few hours. Observe under microscope to see yeast cells multiplying by budding.

Explanation:

In a seed: the seed coat provides protection;
cotyledons store food;
radicle grows into the root system;
plumule grows into the shoot system.
Yeast can be cultured by dissolving yeast powder in warm sugar solution and keeping it warm for a few hours, allowing the yeast to reproduce by budding.

Q.25 [2 marks]

Out of the two lenses, one concave and the other convex, state which one will diverge a parallel beam of light falling on it. Draw a ray diagram to show the principal focus of the lens.

OR

(a) A ray of light after refraction from a convex lens emerges parallel to its principal axis.

(i) Draw a labelled ray diagram to show it.

(ii) In this case, the incident ray before refraction from the lens passes through a point on its principal axis. Name the point.

Answer: A concave lens diverges a parallel beam of light falling on it. The ray diagram shows parallel rays hitting a concave lens and diverging, with the principal focus (F) being the point from which the diverged rays appear to come.

OR

(i) Ray diagram showing a ray passing through the focus (F) of a convex lens and

emerging parallel to the principal axis after refraction.

(ii) The point is called the Focus (F) or Principal Focus of the convex lens.

Explanation:

A concave lens is a diverging lens that spreads out parallel light rays.

Its principal focus is virtual (on the same side as the incident light).

For the OR part: When a ray passes through the focus of a convex lens, it emerges parallel to the principal axis after refraction.

This is one of the standard rules for ray diagrams of convex lenses.

OR

Q.25 [2 marks]

(OR for Q25) (a) A ray of light after refraction from a convex lens emerges parallel to its principal axis.

(i) Draw a labelled ray diagram to show it.

(ii) In this case, the incident ray before refraction from the lens passes through a point on its principal axis. Name the point.

Answer: (i) Ray diagram showing a ray passing through the focus (F) of a convex lens and emerging parallel to the principal axis after refraction.

(ii) The point is called the Focus (F) or Principal Focus of the convex lens.

Explanation:

When a ray of light passes through the principal focus of a convex lens, after refraction it emerges parallel to the principal axis.

This is one of the three standard rules used for constructing ray diagrams for convex lenses.

Q.26 [2 marks]

An electric kettle is rated 750 W; 220 V. Can this kettle be used in a circuit which has a fuse of current rating 3 A ? Give reason for your answer.

Answer: No. Current drawn = P/V = 750/220 ≈ 3.41 A, which is more than the fuse rating of 3 A, so the fuse would melt and break the circuit. (A fuse of higher rating, e.g. 5 A, is needed.)

Explanation:

I = P/V = 750 W / 220 V ≈ 3.41 A.

Since 3.41 A > 3 A, the 3 A fuse would blow as soon as the kettle is switched on.

So the kettle cannot be used in this circuit.

Section C

Short Answer Questions (3 marks each)

Q.27 [3 marks]

(a) (i) Define the term decomposition reaction. Write one chemical equation each for decomposition reactions where energy is supplied in the form of heat, light or electricity.

(ii) Decomposition of vegetable matter into compost is considered an exothermic reaction. Why?

OR

(b) Why are decomposition reactions called the opposite of combination reactions? Write one chemical equation each for these two types of reactions mentioning the name of the reactant(s) and the product(s) involved in the reactions.

Answer: (a)(i) Decomposition reaction: A reaction in which a single compound breaks down into two or more simpler substances. Heat: $2Pb(NO_3)_2 \xrightarrow{\text{heat}} 2PbO + 4NO_2 + O_2$ (thermal decomposition). Light: $2AgCl \xrightarrow{\text{sunlight}} 2Ag + Cl_2$ (photolytic decomposition). Electricity: $2H_2O \xrightarrow{\text{electricity}} 2H_2 + O_2$ (electrolytic decomposition).

(ii) Decomposition of vegetable matter into compost is exothermic because bacteria and microorganisms break down the organic matter, releasing heat energy in the process.

OR

(b) Decomposition reactions are opposite of combination reactions because in decomposition a single compound breaks into simpler substances, while in combination two or more substances combine to form a single product.

Decomposition: $CaCO_3 \rightarrow$(heat) $CaO + CO_2$ (Calcium carbonate decomposes into calcium oxide and carbon dioxide). Combination: $CaO + H_2O \rightarrow Ca(OH)_2$ (Calcium oxide and water combine to form calcium hydroxide).

Explanation:

Decomposition reactions involve breaking down of a single substance into two or more products.

They require energy input (heat/light/electricity).

The decomposition of vegetable matter is exothermic because microbial activity releases heat.

Combination reactions are the reverse — two or more substances combine to form one product.

Q.28 [3 marks]

Write the electron-dot structures of (i) sodium, and (ii) oxygen. Using these structures, show the formation of sodium oxide. Mark the anion and cation present in this compound. (At. No. – Sodium = 11 and Oxygen = 8)

Answer: (a) Electron-dot structures: sodium (Na, 2,8,1) has 1 valence electron, shown as one dot: Na•. Oxygen (O, 2,6) has 6 valence electrons: ·Ö: (six dots). Two Na atoms each transfer 1 electron to one O atom: $2Na\bullet + O \rightarrow [Na]^+ [:\ddot{O}:]^{2-} [Na]^+$, giving Na_2O ($2Na^+ + O^{2-}$). Cation: Na^+; anion: O^{2-}.

(Atomic number: Na = 11 [2,8,1], O = 8 [2,6])

Explanation:

Na (2,8,1) loses 1 electron to become Na^+; O (2,6) gains 2 electrons to become O^{2-}.

Two Na atoms give one electron each to one O atom, forming the ionic compound Na_2O.

Cation = Na^+, anion = O^{2-}.

Q.29 [3 marks]

(a) Define hormone.

(b) 'Hormones should be secreted in precise quantities. We have a feedback mechanism through which this is done.' With the help of an example justify

the statement.

Answer: (a) Hormones are chemical substances (chemical messengers) secreted by endocrine glands directly into the blood in small quantities. They regulate and coordinate various physiological processes in the body.

(b) Example: When blood sugar rises, the pancreas secretes insulin which lowers blood sugar levels. When blood sugar falls to normal, the secretion of insulin is reduced. This is a feedback mechanism. If blood sugar drops too low, the pancreas secretes glucagon to raise it. This feedback ensures hormones are secreted in precise quantities as needed.

Explanation:

Hormones are chemical messengers produced by endocrine glands that travel through blood to target organs.

The feedback mechanism ensures precise regulation — for example, insulin-glucagon regulation of blood sugar by the pancreas is a classic example of negative feedback that maintains homeostasis.

Q.30 [3 marks]

(a) The lowest part of the ear called earlobe, is closely attached to the side of the head in some of us (Figure 'X'), and not in others, called free earlobe (Figure 'Y'). Attached and free earlobes are two variants found in human populations. The gene for free earlobe is dominant over attached earlobes.

(a) A man with attached earlobes marries a woman having free earlobes. 50% of their children have free earlobes and 50% have attached earlobes. Explain the inheritance of this trait and write the trait combinations of the progeny.

(b) Write the gene combinations of the father and the mother in the above case.

Answer: (a) Let 'F' represent the dominant gene for free earlobes and 'f' represent the recessive gene for attached earlobes. Father has attached earlobes so his genotype is 'ff'. Since 50% of children have attached earlobes, the mother must be

heterozygous 'Ff'. Cross: Ff x ff. Offspring: Ff (free earlobe) and ff (attached earlobe) in 1:1 ratio i.e., 50% free and 50% attached.

(b) Father's gene combination: ff (homozygous recessive). Mother's gene combination: Ff (heterozygous).

Explanation:

Since free earlobe (F) is dominant over attached (f), the father with attached earlobes must be ff.

For the offspring to be 50% free and 50% attached, the mother must be heterozygous (Ff).

Cross: Ff × ff gives Ff (free) and ff (attached) in 1:1 ratio.

Q.31 [3 marks]

A convex lens forms an 80 cm long image of a 20 cm long object which is kept at a distance of 60 cm from the optical centre of the lens. If the object and the image are on the same side of the lens, find (i) the nature of the image, (ii) the position of the image, and (iii) the focal length of the lens.

Answer: Magnification m = h'/h = 80/20 = 4. The object and image are on the same side of a convex lens, so the image is virtual and erect, and m = +4.

(i) Nature: virtual, erect and magnified.

(ii) u = −60 cm; m = v/u = 4, so v = 4 × (−60) = −240 cm. The image is 240 cm from the lens, on the same side as the object.

(iii) 1/f = 1/v − 1/u = 1/(−240) − 1/(−60) = −1/240 + 4/240 = 3/240 = 1/80, so f = +80 cm.

Explanation:

m = 80/20 = +4 (virtual, same side).

v = m·u = 4(−60) = −240 cm.

1/f = 1/v − 1/u = 3/240, so f = +80 cm.

Q.32 [3 marks]

Three resistors of 2 Ω, 3 Ω and 6 Ω are connected in (i) series, and (ii) parallel. Draw the arrangements of the resistors and find the equivalent

resistance of each arrangement.

Answer: (i) Series: $R_{eq} = R_1 + R_2 + R_3 = 2 + 3 + 6 = 11\ \Omega$.

(ii) Parallel: $1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3 = 1/2 + 1/3 + 1/6 = 3/6 + 2/6 + 1/6 = 6/6 = 1$. $R_{eq} = 1\ \Omega$.

Explanation:

In series connection, resistances add up directly: $R = 2 + 3 + 6 = 11\ \Omega$.

In parallel connection, reciprocals add up: $1/R = 1/2 + 1/3 + 1/6 = (3+2+1)/6 = 6/6 = 1$, so $R = 1\ \Omega$.

The diagram should show resistors connected end-to-end for series and all between the same two nodes for parallel.

Q.33 [3 marks]

Write the essential function performed by ozone at the higher levels of the atmosphere. How is it formed in the upper atmosphere? Write the name of the group of chemicals mainly responsible for the depletion of ozone layer.

Answer: Essential function: Ozone (O_3) at higher levels of the atmosphere (stratosphere) acts as a shield that absorbs harmful ultraviolet (UV) radiation from the sun, protecting living organisms on Earth from its damaging effects.

Formation: UV radiation splits O_2 molecules into free oxygen atoms: $O_2 \xrightarrow{UV} O + O$. These free oxygen atoms combine with O_2 to form ozone: $O + O_2 \rightarrow O_3$.

Chemicals responsible for depletion: Chlorofluorocarbons (CFCs) are mainly responsible for the depletion of the ozone layer.

Explanation:

Ozone in the stratosphere shields Earth from harmful UV radiation.

It is formed when UV rays split oxygen molecules into atoms, which then react with other oxygen molecules to form ozone.

CFCs (used in refrigerants, aerosols) are the primary chemicals that deplete the ozone layer by releasing chlorine atoms that catalytically destroy ozone molecules.

Section D

Long Answer Questions (5 marks each)

Q.34 [5 marks]

(a) (i) A compound 'X' having two carbon atoms in its molecule turns blue litmus red and 'X' in 5-8% solution in water is widely used as a preservative. Identify the compound 'X' and write its structure.

(ii) Compare its pH nature with a mineral acid.

(iii) 'X' on reacting with alcohols produces sweet smelling compounds, used in making perfumes. Name the reaction and write its chemical equation.

(iv) When sodium carbonate is added to 'X', a colourless gas is produced which turns lime water milky. Write the chemical equation for the reaction giving the name of the salt produced.

OR

(b) (i) Giving one example each, differentiate between saturated and unsaturated hydrocarbons with a structural formula.

(ii) Write the method of converting an unsaturated hydrocarbon into a saturated hydrocarbon. Name the industry where this reaction is commonly used.

(iii) Write the name and structure of a hydrocarbon having double bond and four carbon atoms in its one molecule.

Answer: (a) X is Ethanoic acid (Acetic acid, CH_3COOH).

(i) Structure: CH_3COOH. 5-8% solution is vinegar.

(ii) Ethanoic acid is a weak organic acid with pH around 3-4, while mineral acids like HCl, H_2SO_4 have much lower pH (stronger acids, pH around 1). Ethanoic acid partially ionizes while mineral acids fully ionize.

(iii) Esterification reaction: $CH_3COOH + C_2H_5OH \rightarrow$(acid catalyst) $CH_3COOC_2H_5 + H_2O$ (Ethyl ethanoate/ethyl acetate - sweet smelling ester).

(iv) $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2\uparrow$. Salt: Sodium ethanoate (sodium acetate).

OR

(b) (i) Saturated: Only single bonds, e.g., Ethane C_2H_6 (H_3C-CH_3). Unsaturated:

Contains double/triple bonds, e.g., Ethene C_2H_4 ($H_2C=CH_2$).

(ii) Hydrogenation: Adding H_2 in presence of Ni/Pd catalyst. Used in vanaspati ghee industry (hydrogenation of vegetable oils).

(iii) Butene (C_4H_8): $CH_2=CH-CH_2-CH_3$ (But-1-ene).

Explanation:

Compound X is ethanoic acid (acetic acid) - a 2-carbon organic acid.

Its 5-8% solution is vinegar.

It is weaker than mineral acids.

Esterification with alcohol produces esters (sweet smelling).

Reaction with Na_2CO_3 produces CO_2 and sodium ethanoate.

For the OR part: saturated hydrocarbons have single bonds only (ethane), unsaturated have double/triple bonds (ethene).

Hydrogenation converts unsaturated to saturated, used in food industry.

Q.35 [5 marks]

(a) (i) 'The length of the small intestine in various animals depends on the food they eat.' Justify the statement.

(ii) Discuss the role of the pancreas and bile juice in the digestion of food in human beings.

(iii) How is the small intestine designed to absorb digested food?

OR

(b) (i) State the role of rings of cartilage present in the throat.

(ii) Discuss the role of the ribs and diaphragm when air is taken in during the breathing cycle.

(iii) Why do we get muscle cramps during heavy exercise? Explain.

Answer: (a)(i) Herbivores have longer small intestines because cellulose in plant food takes longer to digest. Carnivores have shorter intestines because meat is easier to digest. The length is adapted to the type of food and time needed for digestion.

(ii) Pancreas secretes pancreatic juice containing trypsin (digests proteins), lipase (digests fats), and amylase (digests starch). Bile juice is secreted by the liver and

stored in the gall bladder. Bile salts emulsify fats (break large fat globules into smaller ones) making it easier for lipase to act.

(iii) The small intestine has villi (finger-like projections) on its inner lining which increase the surface area for absorption. Villi have a rich blood supply and thin walls for efficient absorption of digested food.

OR

(b)(i) Rings of cartilage in the throat (trachea) ensure that the air passage does not collapse when there is no air in it.

(ii) During inhalation: ribs move upward and outward, diaphragm contracts and flattens. This increases the volume of the chest cavity, decreasing air pressure inside the lungs, causing air to rush in.

(iii) During heavy exercise, muscles respire anaerobically due to insufficient oxygen supply. This produces lactic acid in the muscles, which accumulates and causes muscle cramps.

Explanation:

The length of the small intestine varies with diet - herbivores need longer intestines for cellulose digestion.

Pancreas provides digestive enzymes, bile emulsifies fats.

Villi increase surface area for absorption.

Cartilage rings prevent trachea collapse.

Ribs and diaphragm create pressure changes for breathing.

Anaerobic respiration during heavy exercise produces lactic acid causing cramps.

Q.36 [5 marks]

(a) The given figure shows the current passing through the straight conductor XY. A variable resistance, ammeter, battery, and key are shown in the circuit.

(i) Copy the diagram and draw the magnetic field lines when current flows from conductor X to Y.

(ii) Name and state the rule used in determining the direction of the magnetic field lines in the situation given above.

(iii) State Fleming's left hand rule. Using this rule, determine the direction of force applied on an electron entering a uniform magnetic field as shown in the figure.

OR

(b) (i) Define the term solenoid. Draw the pattern of the magnetic field lines in and around a current carrying straight solenoid. Mark on the pattern the (i) direction of current, (ii) direction of field lines near the ends of the solenoid, and (iii) region where the magnetic field is uniform.

(ii) How would you make an electromagnet using a current carrying solenoid?

Answer: (a)(i) The magnetic field lines around a straight current-carrying conductor are concentric circles centered on the wire. When current flows from X to Y, using the right-hand thumb rule, the field lines are concentric circles in the clockwise direction when viewed from above (from the X end), because in the figure the current flows downward from X to Y.

(ii) Right-hand thumb rule: If we hold the current-carrying conductor in the right hand such that the thumb points in the direction of the current, then the curled fingers indicate the direction of the magnetic field lines.

(iii) Fleming's Left Hand Rule: Stretch the thumb, forefinger, and middle finger of the left hand mutually perpendicular to each other. If the forefinger points in the direction of the magnetic field (B), the middle finger in the direction of the current (I), then the thumb gives the direction of the force (F) on the conductor. For the electron entering upward in the figure with the field towards the right: the conventional current is opposite to the electron's motion, i.e. downward. With the forefinger pointing right (field) and the middle finger pointing down (current), the thumb points out of the plane of the paper, towards the reader. So the force on the electron is directed out of the page.

OR

(b)(i) A solenoid is a coil of many circular turns of insulated copper wire wrapped closely in the shape of a cylinder. Inside the solenoid, field lines are parallel and

uniform. Outside, the pattern resembles a bar magnet. One end acts as N-pole and other as S-pole.

(ii) To make an electromagnet, insert a soft iron core inside the solenoid. When current flows through the solenoid, the iron core gets magnetized. The magnetism can be switched on/off by controlling the current.

Explanation:

For a straight conductor, magnetic field lines are concentric circles (right-hand thumb rule).

Fleming's left hand rule determines force direction on a current-carrying conductor in a magnetic field.

A solenoid produces a uniform magnetic field inside it similar to a bar magnet.

An electromagnet is made by placing a soft iron core inside a solenoid.

Q.37(a) [4 marks]

Case Study: Acid-base indicators can be used to distinguish between an acid and a base. Universal indicator, a mixture of several indicators, shows different colours at different concentrations of acids and bases, thereby indicating their pH on the pH scale of 0-14. The pH of a solution is measured by pH paper, which is a paper impregnated with a universal indicator.

Solution P is a strong acid while solution Q is a strong base. On the pH scale, where would you place the solutions P and Q?

Answer: Solution P (strong acid) would be placed near pH 0-1 on the pH scale. Solution Q (strong base) would be placed near pH 13-14 on the pH scale.

Explanation:

Strong acids have very low pH values (close to 0), while strong bases have very high pH values (close to 14) on the pH scale of 0-14.

Q.37(b) [4 marks]

Case Study (continued): A solution has a pH of 7. Name a compound you would use to (i) increase its pH, and (ii) decrease its pH.

Answer: (i) To increase the pH of a neutral solution, add a base such as sodium hydroxide (NaOH).

(ii) To decrease its pH, add an acid such as dilute hydrochloric acid (HCl).

Explanation:

A neutral solution (pH 7) becomes basic (pH > 7) when a base such as NaOH is added, and acidic (pH < 7) when an acid such as HCl is added.

Q.37(c) [4 marks]

Case Study (continued):

(i) When the pH of a solution is decreased from 4 to 2, what effect does it produce on its hydronium ion concentration? State the colour change shown by the pH paper.

OR

(ii) A person is feeling pain and irritation in the stomach due to indigestion. What could be the pH of the fluid in the stomach? Write the common name of the medicines people use for remedy. Give the chemical name of 'milk of magnesia' often used for this purpose.

Answer: (i) When pH decreases from 4 to 2, the hydronium ion (H_3O^+) concentration increases by 100 times (10^2 times). The pH paper colour changes from orange/yellow (pH 4) to red (pH 2) as the solution becomes more acidic.

OR

(ii) The pH of the fluid in the stomach during indigestion would be very low, around 1-2 (highly acidic due to excess HCl). The common name of the medicines is antacids. The chemical name of milk of magnesia is Magnesium hydroxide [$Mg(OH)_2$].

Explanation:

pH is a logarithmic scale, so a decrease of 2 units means H_3O^+ concentration increases 100 times.

Indigestion is caused by excess stomach acid (HCl).

Antacids like milk of magnesia ($Mg(OH)_2$) neutralize the excess acid, providing relief.

Q.38(a) [4 marks]

Case Study: When a girl is born, the ovaries already contain thousands of immature eggs. On reaching puberty, some of these start maturing. One matured egg is released every month by one of the ovaries. The two oviducts unite into an elastic bag-like structure known as uterus.

Write the site of fertilization in human female.

Answer: Fertilization in human female takes place in the oviduct (fallopian tube).

Explanation:

The oviduct (fallopian tube) is where the sperm meets the egg and fertilization occurs.

The fertilized egg then travels to the uterus for implantation.

Q.38(b) [4 marks]

Case Study (continued):

How does the uterus prepare itself to receive and nurture the growing embryo? Explain.

Answer: The uterus prepares itself by thickening its inner lining (endometrium). The lining becomes thick and spongy, richly supplied with blood vessels. This is necessary to nourish the growing embryo. If fertilization does not occur, this lining breaks down and is shed during menstruation.

Explanation:

The uterine wall (endometrium) thickens every month in preparation for receiving a fertilized egg.

It develops a rich blood supply to provide nutrients and oxygen to the developing embryo.

If no fertilization occurs, this lining sheds, resulting in menstruation.

Q.38(c) [4 marks]

Case Study (continued):

(i) What happens when the egg is not fertilised?

OR

(ii) How does the developing embryo get nutrition from the mother's blood? Explain.

Answer: (i) When the egg is not fertilised, the thick lining of the uterus (endometrium) slowly breaks down and comes out through the vagina as blood and mucus. This process is called menstruation. It occurs roughly every 28 days.

OR

(ii) The developing embryo gets nutrition from the mother's blood through the placenta. The placenta is a disc-like structure embedded in the uterine wall. It contains villi on the embryo's side, which are surrounded by blood spaces on the mother's side. This provides a large surface area for exchange of glucose, oxygen, and nutrients from the mother's blood to the embryo, and waste products from the embryo to the mother's blood.

Explanation:

If the egg is not fertilised, the uterine lining sheds during menstruation.

If fertilised, the embryo receives nutrition through the placenta, which acts as the interface between mother's and foetus's blood supply, allowing exchange of nutrients, oxygen, and waste products.

Q.39(a) [4 marks]

Case Study: A person allowed a narrow beam of white light from the sun to enter a dark room through a small aperture and placed a glass prism in its path in such a manner that the beam falls on the face AB of the prism as shown in the figure. A screen S is placed on the other side of the prism, facing AC. On turning the prism slowly, a beautiful band of colours is obtained on the screen. It is the spectrum of sunlight.

Name the phenomenon due to which a prism splits the incident white light into a band of colours.

Answer: The phenomenon is called Dispersion of light.

Explanation:

Dispersion is the splitting of white light into its component colours (VIBGYOR) when it passes through a prism.

This happens because different colours have different wavelengths and are refracted by different amounts.

Q.39(b) [4 marks]

Case Study (continued):

State the reason for getting a band of seven colours in the above case.

Answer: White light is composed of seven colours (VIBGYOR). When it passes through a glass prism, each colour is refracted by a different amount because each colour has a different wavelength. Violet light (shortest wavelength) is refracted the most and red light (longest wavelength) is refracted the least. This causes the white light to split into a band of seven colours.

Explanation:

The band of seven colours is obtained because white light is a mixture of seven colours, and the glass prism refracts each colour by a different angle (due to different wavelengths), separating them into a visible spectrum.

Q.39(c) [4 marks]

Case Study (continued):

(i) Explain with the help of a labelled ray diagram, an experimental arrangement to show the recombination of the spectrum of white light.

OR

(ii) Draw a labelled ray diagram to show the formation of a rainbow.

Answer: (i) Recombination of spectrum: Place a second identical glass prism in an inverted position in the path of the dispersed light (spectrum) coming from the first prism. The second prism recombines all seven colours back into white light. The ray diagram shows: white light entering prism 1, dispersing into VIBGYOR, then entering inverted prism 2, which recombines the colours into white light on a screen.

OR

(ii) Rainbow formation: Sunlight enters a water droplet suspended in the atmosphere. Inside the droplet, the light undergoes: (1) refraction (entering the droplet), (2) total internal reflection (at the back surface), and (3) refraction again (leaving the droplet). During refraction, dispersion occurs, splitting white light into seven colours. The ray diagram shows a water droplet with incoming white light, refraction at entry, internal reflection, and refraction at exit producing the spectrum.

Explanation:

Newton demonstrated recombination by using two prisms - the second inverted prism recombines the dispersed spectrum back to white light.

A rainbow is formed by dispersion, internal reflection, and refraction of sunlight by water droplets in the atmosphere.