1. Answer: (c) Nitrogen
   Explanation:

- Greenhouse gases (GHGs) are gases that trap heat in the atmosphere by absorbing infrared radiation.

The main greenhouse gases are:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Water vapour (H_2O)
- Nitrous oxide (N_2O)
- Ozone (O_3)

Nitrogen (N_2), while making up ~78% of Earth's atmosphere, is not a greenhouse gas, because:

- It is diatomic and symmetrical → does not absorb infrared radiation efficiently.
- It's radiatively inactive in the infrared spectrum.

Therefore, (c) Nitrogen is NOT a greenhouse gas.

2. **Answer: (c) 1 and 3 only**

Detailed Solution:

- **Statement 1 – Correct:** PM2.5 means particulate matter with diameter ≤2.5 µm.
- **Statement 2 – Incorrect:** They are **not visible** to the naked eye (microscopic in size).
- **Statement 3 – Correct:** PM2.5 can penetrate deep into the lungs (alveoli) and **enter the bloodstream**, leading to respiratory and **cardiovascular diseases**.
- As per **NCERT**, fine particulates like PM2.5 and PM1 are most harmful.
- The **CPCB** and **WHO 2021 reports** associate PM2.5 exposure with premature mortality and chronic bronchitis.

3. **Answer: (c) 1 and 3 only**

Detailed Solution:

- **Statement 1 – Correct:** AQI was **launched under Swachh Bharat Mission**. It was introduced under the **'Swachh Bharat Abhiyan' in 2014 by MoEFCC**, but technically part of **National Air Quality Monitoring Programme (NAMP)** and **National Clean Air Programme (NCAP)**, 2019.
- **Statement 2 – Incorrect:** AQI categorises air quality into **six bands** — *Good, Satisfactory, Moderately Polluted, Poor, Very Poor, and Severe* — based on **8 pollutants** (PM10, PM2.5, NO_2, SO_2, CO, O_3, NH_3, Pb).
- **Statement 3 – Correct:** The **Central Pollution Control Board (CPCB)** operates and maintains the AQI network.

4. **Answer: (b) Earth's rotation axis is tilted with respect to its orbital plane.**

Explanation:

- The **tilt of Earth's axis (about 23.5°)** is the real reason why we experience **seasons** and **changing lengths of day and night**.
- **NCERT Class 6 and Class 9 Geography** highlight that if Earth's axis were not tilted, there would be **no solstices, no seasons**, and day length would be constant everywhere.
- According to **ISRO and IMD**, the tilt remains fixed relative to the stars, so as Earth revolves around the Sun, different hemispheres lean towards or away from the Sun, creating **summer and winter** alternately.

5. **Answer:** (b) 1 and 2 only

Detailed Solution:

- **Statement 1 – Correct:** Conduction occurs in solids due to particle vibration and collision (e.g., metals).
- **Statement 2 – Correct:** Convection occurs in fluids — heated particles move from one place to another carrying energy (e.g., boiling water).
- **Statement 3 – Incorrect:** Neither conduction nor convection can occur in a **vacuum** because no matter (particles) is present.
- **NCERT References:**
  - *Class 7 Science, Chapter 4: Heat* → Demonstrates conduction, convection, radiation with experiments.
  - *Class 11 Physics, Chapter 11: Thermal Properties of Matter* → Differentiates all three mechanisms.
- **Scientific Source:**
  - *Ministry of Earth Sciences – Basics of Meteorology Module* and *NCERT* jointly emphasize particle dependence for conduction and convection.

6. **Answer:** (b) Convection

Detailed Solution:

- **Convection currents** in air cause **sea and land breezes**.
  - During the day, land heats faster than water → hot air over land rises → cool air from sea flows in (sea breeze).
  - At night, the reverse occurs (land breeze).
- **NCERT References:**
  - Convection currents in air leading to formation of breezes.
  - Sea breeze formation through convection.
- **Government Source:**
  - *India Meteorological Department (IMD)* explains that local winds like sea breezes are due to convective circulation driven by temperature differences.

7. Answer: (b) Burning of fossil fuels

Explanation:

- Burning of fossil fuels (coal, oil, natural gas) releases large amounts of CO_2, the primary human-generated greenhouse gas.
- Also contributes to methane and nitrous oxide emissions indirectly through industries and agriculture.

🛢️ **Activities include:**

- Electricity production from coal
- Transport using petrol/diesel
- Industrial manufacturing (cement, steel)
- Oil refining and gas flaring

On the other hand:

- Planting trees → absorbs CO_2
- Solar panels → reduce emissions
- Construction of houses does not directly emit GHGs unless energy-intensive

8. **Answer: (b) Microwaves**

Explanation:

- **Microwaves:** Wavelength range of ~1 mm to 1 m.
  ➤ Used in radars, microwave ovens, satellite communications.
- Photon energy is inversely proportional to wavelength.
- So **longer wavelength = lower energy**.

Radiation	Approx. Wavelength	Energy per photon
Gamma rays	~10^{-12} m	Highest
Ultraviolet	~10^{-7} m	Moderate (high)
Infrared	~10^{-6} – 10^{-4} m	Lower
Microwave	~10^{-3} – 10^{-1} m	**Lowest**

9. Answer: (c) X-rays

Explanation:

- The **energy of a photon** is given by Planck's equation:
  $E=hv$
  where:
  - E is the energy of a photon,
  - h is Planck's constant (6.626×10^{-34} Js
  - v is the frequency of the wave.
- **X-rays** have **very high frequency** and **short wavelength** (about 10^{-10} m).

In comparison:

- **Infrared** → longer wavelength than visible light → lower frequency → lower energy

- **Microwaves** → even longer wavelength
- **Radio waves** → longest wavelength → lowest frequency → least energy per photon

Hence, **X-rays** have **highest frequency**, so **maximum energy per photon**.

10. Answer: (d) 1, 2 and 3

Explanation:

EM Wave	Wavelength	Application (as per NCERT)
Infrared	~700 nm – 1 mm	Used in night vision, thermal imaging
X-rays	~0.01 – 10 nm	Used in medical and airport security scanners
Radio	~1 mm – 100 km	Used in radio, TV, and satellite communication

11. Answer: (a) 2 - 3 - 1 - 4

Explanation:

Refer to the **electromagnetic spectrum** in NCERT. Based on increasing frequency (and thus energy per photon):

1. **Infrared (IR)** → longer wavelength (~700 nm to 1 mm) → lowest energy
2. **Visible light** → intermediate wavelength (~400–700 nm)
3. **Ultraviolet (UV)** → shorter wavelength (~10 nm to 400 nm) → higher energy
4. **X-rays** → much shorter wavelength (~0.01 nm to 10 nm) → highest energy

Therefore, the correct ascending order of energy per photon is:

Infrared < Visible < UV < X-rays

→ That's **2 - 3 - 1 - 4**

12. **Answer:** (a) The time when the Sun is directly overhead at the Equator

Explanation:

- Unlike a solstice, an **equinox** happens when the **Sun's rays fall directly on the Equator**, making **day and night of equal length** all over the world.
- This occurs **twice a year** — around **March 21 (Spring Equinox)** and **September 23 (Autumn Equinox)**.
- **NCERT Class 6 Geography** and **ISRO's Earth-Sun system modules** explain that equinoxes represent the midpoint of the Sun's apparent movement between the Tropics.
- Solstices, on the other hand, mark the **extremes** of this movement.

13. **Answer:** (c) The summer solstice occurs in the northern hemisphere on June 21 and on December 21 in the southern hemisphere

Explanation:

- A **solstice** happens twice a year — when the **Sun appears at its highest or lowest point in the sky at noon**.
- On **June 21 (approx.)**, the **Sun's rays are vertical over the Tropic of Cancer (23.5° N)** — it's **summer solstice** in the **Northern Hemisphere** and **winter solstice** in the **Southern Hemisphere**.
- On **December 21 (approx.)**, the **Sun's rays are vertical over the Tropic of Capricorn (23.5° S)** — **summer** in the **Southern Hemisphere** and **winter** in the **Northern Hemisphere**.
- As per **NCERT Class 6 Geography – The Earth: Our Habitat (Chapter 3, "Motions of the Earth")**, solstices mark the extremes of daylight duration and solar declination.
- The **IMD and ISRO** confirm that solstices result from Earth's **axial tilt (23.5°)** and **revolution around the Sun**.

14. **Answer:** (c) These are extremely fine particles of diameter less than 1 micron

Detailed Solution:

- **PM1** refers to **particulate matter with an aerodynamic diameter less than 1 micrometre (µm)**.
- As per **CPCB and WHO air quality definitions**, particles are classified as:
  - PM10 → ≤10 µm
  - PM2.5 → ≤2.5 µm
  - PM1 → ≤1 µm (ultrafine particles)
- These particles can bypass the body's upper respiratory filters (nose hairs, mucus membranes) and **penetrate deep into alveoli**, where gas exchange occurs.
- According to **NCERT**, finer particulate matter is **more hazardous** as it reaches the lungs easily.
- PM1 can even **enter the bloodstream**, affecting cardiovascular and neurological health.

15. Answer: (b) *E* = *hv*

Explanation (NCERT Class 12, Chapter 11 – Dual Nature of Radiation and Matter):

- Planck proposed that **light is made up of discrete packets of energy**, called **photons**.
- Each photon has energy:
  E*=*hv
  where:
  - *v* is the frequency,
  - *h*=6.626×10^{-34} Js (Planck's constant).

Other options are incorrect in this context:

- (a) $E = mc^2$ → Einstein's mass-energy equivalence (used for rest mass energy).
- (c) $E = \frac{1}{2}mv^2$ → Classical kinetic energy formula (not for photons).

- (d) $E = \frac{q}{V}$ → Doesn't describe photon energy (and dimensionally incorrect).

16. Answer: (c) Glass allows visible radiation to enter but blocks longwave infrared radiation from escaping
Explanation:
A greenhouse works as follows:

- Sunlight (shortwave radiation) enters the glasshouse easily.
- This light warms the surfaces inside (plants, soil, air).
- These surfaces emit infrared radiation (longwave heat radiation).
- Glass is transparent to shortwave radiation but opaque to longwave radiation.
    - This means heat cannot escape easily from the glasshouse.

Result: Heat is trapped inside — leading to a rise in temperature.
This physical model is analogous to how greenhouse gases trap heat in Earth's atmosphere.

17. Answer: (c) They absorb outgoing longwave radiation and re-emit it back
Detailed Explanation:
Supported by **IPCC reports**:

- The **Sun emits shortwave radiation** — mainly **visible light** and **ultraviolet (UV) rays**.
- This radiation **passes through the atmosphere** and **heats the Earth's surface**.
- The **Earth absorbs** this energy and **re-emits** it as **longwave infrared (IR) radiation** (heat)

Now comes the key part:

- **Greenhouse gases** — such as **carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), and water vapour (H_2O) — absorb this outgoing infrared radiation**.
- They then **re-emit** this energy **in all directions**, including **back toward Earth's surface**, causing additional warming.

This is what creates the **natural greenhouse effect**, making Earth warm enough to support life.

18. Answer: (c) Nitrogen oxides and volatile organic compounds
Detailed Solution:

- Photochemical smog is a type of air pollution formed when sunlight reacts with nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the atmosphere.
- The reaction produces ground-level ozone (O_3), peroxyacetyl nitrates (PANs), and aldehydes.
- NCERT explicitly mentions that NO_2 and hydrocarbons in the presence of sunlight produce photochemical smog, particularly in warm, dry climates.
- Sulphur dioxide leads to industrial smog (reducing smog), not photochemical smog.

19. Answer: (a) Basel Convention
Detailed Solution:

- The **Basel Convention (1989)** was adopted to **control the transboundary movement of hazardous wastes and their disposal**.
- It aims to **prevent developed countries from dumping hazardous wastes** (including particulate and toxic industrial wastes) into developing nations.
- **Stockholm Convention (2001)** → Persistent Organic Pollutants (POPs).
- **Rotterdam Convention (1998)** → Prior informed consent for certain hazardous chemicals and pesticides.
- **Vienna Convention (1985)** → Protection of the ozone layer.

20. Answer: (c) Shortwave visible and ultraviolet radiation
Explanation:
The **Sun emits radiation** in various forms:

- **Majority of solar radiation** that reaches Earth's surface is in the **shortwave spectrum**, especially:
  - **Visible light (400–700 nm)**
  - **Ultraviolet (UV) rays**
  - A small portion of **infrared (IR)**
- Solar radiation is **shortwave** because the **Sun is very hot** (~6000°C).
- The **Earth, being cooler**, emits **longwave radiation** (infrared).

So:

- The **incoming radiation** (from the Sun) = **shortwave**
- The **outgoing radiation** (from Earth) = **longwave**

21. **Answer:** (c) 1 and 3 only
Detailed Solution:

- **Statement 1 – Correct:** AQI was **launched under Swachh Bharat Mission**. It was introduced under the **'Swachh Bharat Abhiyan' in 2014 by MoEFCC**, but technically part of **National Air Quality Monitoring Programme (NAMP)** and **National Clean Air Programme (NCAP)**, 2019.
- **Statement 2 – Incorrect:** AQI categorises air quality into **six bands** — *Good, Satisfactory, Moderately Polluted, Poor, Very Poor, and Severe* — based on **8 pollutants** (PM10, PM2.5, NO_2, SO_2, CO, O_3, NH_3, Pb).
- **Statement 3 – Correct:** The **Central Pollution Control Board (CPCB)** operates and maintains the AQI network.

22. **Answer:** (c) They occur when the Sun is directly overhead at one of the Tropics
Explanation:

- Solstices happen when the **Sun's vertical rays strike one of the Tropics** —

    - **Tropic of Cancer (23.5° N)** during **June solstice** in Northern hemisphere.
    - **Tropic of Capricorn (23.5° S)** during **December solstice** in Northern hemisphere.
- As explained in **NCERT Class 8 Geography (Chapter 2: Solar Radiation, Heat Balance and Temperature)**, this marks the Sun's **apparent movement north or south**.
- These are **not equinoxes** — during solstices, day and night lengths are **unequal**, especially at higher latitudes.
- The **IMD's astronomical calendar** also highlights these as points of **maximum solar declination**.

23. Answer: (c) Radiation
Detailed Solution:

- **Conduction** and **convection** both require a **material medium** to transfer heat.
    - *Conduction:* Heat flows through molecular vibration (e.g., from a hot pan to its handle).
    - *Convection:* Heat transfer occurs through the bulk movement of fluids (liquids/gases).
- **Radiation**, on the other hand, does **not require any medium** — it can occur through a vacuum.
    - Example: **Solar energy** reaches Earth via **radiation through space**, which is a vacuum.
- **NCERT References:**
    - "Radiation can take place without any medium."
    - *Thermal Properties of Matter* → Radiation is energy transfer by electromagnetic waves.
- **Additional Source:**
    - Ministry of Earth Sciences (MoES): *Basics of Heat and Energy Transfer Module* confirms radiation as medium-free energy transfer.

24. **Answer:** (c) The North Pole is tilted towards the Sun
Explanation:

- During the **summer solstice**, the **Northern Hemisphere is inclined towards the Sun**, receiving **more direct sunlight** and longer daylight hours.
- As mentioned in **NCERT Class 6 Geography (Motions of the Earth)**, this is why countries like India experience their longest day and shortest night around **June 21**.
- At the same time, the **Southern Hemisphere** has shorter days and longer nights — it's winter there.
- **ISRO**'s educational material on Earth's motion describes this tilt as the main reason for seasonal variation.

25. **Answer:** (b) Conduction of heat through metal

Detailed Solution:

- In **solids**, particularly **metals**, heat is transferred mainly by **conduction**.
    - Free electrons in metal move rapidly, transferring kinetic energy.
- **NCERT References:**
    - Metals are good conductors of heat.
- **Scientific Source:**
    - *National Institute of Open Schooling (NIOS) Physics Module, Unit 3:* "Conduction occurs when energy is passed from particle to particle within a solid."

26. **Answer:** (c) Heat is transferred only through radiation.

Detailed Solution:

- In **outer space**, there is **no medium (air or matter)** to conduct or convect heat.
- Therefore, **radiation** is the **only mechanism** by which heat transfer occurs — e.g., Sun's energy reaching Earth
- **NCERT References:**
    - *Class 8 Science, Chapter 14: Chemical Effects of Electric Current* and *Class 7 Science, Chapter 4: Heat* both explain that radiation requires no medium.
    - *Class 11 Physics, Chapter 11* explains electromagnetic radiation as energy propagation through space.
- **Government Source:**
    - *ISRO & MoES educational notes* on solar radiation confirm that radiant energy travels through the vacuum of space.

27. Answer: (c) Electromagnetic induction**

Detailed Explanation:

An electric generator converts mechanical energy into electrical energy. This conversion is achieved through the phenomenon of ****electromagnetic induction**,** discovered by **Michael Faraday.** It states that a changing magnetic field within a closed loop of conductor induces an electric current in the conductor.

NCERT Source:

Class 10 - Science, Chapter 13: Magnetic Effects of Electric Current:** This chapter explicitly explains the principle of the electric generator. It states, "The phenomenon of electromagnetic induction is the production of induced current in a coil placed in a region where the magnetic field changes with time." It further elaborates how generators use this principle by rotating a coil in a magnetic field to produce electricity.

28. Answer: (b) High surface tension

- **Analysis:**

- Surface tension is the property of a liquid that allows it to resist an external force, due to the cohesive nature of its molecules.
- At the water-air interface, water molecules are pulled inward by strong hydrogen bonding with the molecules below them, creating a "skin" or stretched membrane-like effect.
- This high surface tension is strong enough to support the weight of small insects like water striders, allowing them to walk on the surface without sinking.

- **NCERT & Scientific Reference:**
  - While surface tension is a more advanced topic, its effects are observable and can be inferred from the properties of matter taught in Class 9 - Science, Chapter 1: Matter in Our Surroundings. The cohesive forces between particles are the fundamental reason for this phenomenon.

29. Answer: (c) One Carbon-Carbon triple bond

- **Analysis:**
  - Ethyne, commonly known as acetylene, is an alkyne with the molecular formula C_2H_2.
  - Carbon has 4 valence electrons. To form a triple bond between two carbon atoms, they share three pairs of electrons (6 electrons in total).
  - This uses up 3 of carbon's 4 valence electrons for the carbon-carbon bond. The remaining one valence electron on each carbon is used to form a single bond with one hydrogen atom, resulting in the structure H-C≡C-H.
- **NCERT Reference:**
  - Class 10 - Science, Chapter 4: Carbon and its Compounds: This chapter clearly differentiates between alkanes (single bonds), alkenes (double bonds), and alkynes (triple bonds). It explicitly states, "Ethyne (C_2H_2) has a triple bond between the two carbon atoms."

30. Answer: (c) Hydrogenation

- **Analysis:**
  - Unsaturated hydrocarbons (like those in vegetable oils) contain carbon-carbon double bonds.
  - Hydrogenation is an **addition reaction** where hydrogen molecules (H_2) are added to these double bonds in the presence of a catalyst like nickel or palladium.
  - This process converts the unsaturated liquid oil into a saturated fat, which is semi-solid at room temperature and is commercially known as vanaspati ghee.
  - **Esterification** is a chemical reaction in which a carboxylic acid reacts with an alcohol in the presence of a small amount of a strong acid (like concentrated H_2SO_4) as a catalyst to form a sweet-smelling compound called an **ester and water.**

- **Saponification** is the alkaline hydrolysis of esters (fats and oils). It is the process in which a fat or oil (a triglyceride ester) is heated with a strong alkali, such as Sodium Hydroxide (NaOH) or Potassium Hydroxide (KOH), to produce **soap** (a sodium or potassium salt of fatty acids) and **glycerol.**
- **oxidation** refers to a reaction in which an organic compound **gains oxygen** or **loses hydrogen.**

- **NCERT Reference:**
  - Class 10 - Science, Chapter 4: Carbon and its Compounds: The chapter explains this process under the section "Chemical Properties of Carbon Compounds." It states, "Unsaturated hydrocarbons add hydrogen in the presence of catalysts such as palladium or nickel to give saturated hydrocarbons. This reaction is commonly used in the hydrogenation of vegetable oils using a nickel catalyst."

31. Answer: (c) Uranium

- **Analysis:**
  - Nuclear power generation relies on a process called nuclear fission, where the nucleus of a heavy atom splits into smaller nuclei, releasing a tremendous amount of energy.
  - Uranium-235 (U-235) is a key isotope used as nuclear fuel because it is fissile, meaning its nucleus can be easily split by absorbing a neutron, initiating a sustained chain reaction.
- **NCERT & Government Source Reference:**
  - Class 10 - Science, Chapter 14: Sources of Energy: This chapter introduces nuclear energy. It states, "In a nuclear reactor, a controlled chain reaction of fission of uranium-235 is carried out. The energy released is used to generate electricity."
  - Nuclear Power Corporation of India Limited (NPCIL): As the government agency responsible for nuclear power, NPCIL's documentation confirms that natural uranium, enriched in the U-235 isotope, is the primary fuel for its pressurized heavy water reactors (PHWRs).

32. Answer: (c) It occurs only at the boiling point.

- This statement is **incorrect**. Evaporation is a cooling process that can occur at **any temperature** below the boiling point. It is the phenomenon where particles of a liquid gain enough kinetic energy from the surroundings to escape from the surface and turn into vapour. Boiling, on the other hand, is a bulk phenomenon that occurs at a fixed temperature (the boiling point) when the vapour pressure of the liquid equals the atmospheric pressure.

NCERT Reference:

- **Class 9 - Science, Chapter 1: Matter in Our Surroundings:** The chapter explicitly distinguishes between evaporation and boiling. It states, "Particles of matter are always in constant motion... a small fraction of particles at the surface, having higher kinetic energy, is able to break away from the forces of attraction of other particles and gets converted into vapour. This phenomenon of change of a liquid into vapours at any temperature below its boiling point is called evaporation."

33. Answer: (c) A step-down transformer
Detailed Explanation:
A transformer consists of two separate coils of wire (primary and secondary) wound around an iron core. An alternating current (AC) in the primary coil creates a continuously changing magnetic field. This changing field, linked to the secondary coil, induces an alternating voltage/current in it. This is a direct application of electromagnetic induction between two conductors.
NCERT Source:
Class 10 - Science, Chapter 13: Magnetic Effects of Electric Current:** The chapter explains the working of a transformer, stating, "A transformer is based on the principle of electromagnetic induction. It changes (transforms) an alternating voltage from one to another."

34. Answer: (b) Carbon-14

- **Analysis:**
  - All living organisms absorb carbon from the atmosphere, including a small amount of the radioactive isotope Carbon-14 (C-14).
  - Once an organism dies, it stops absorbing C-14. The existing C-14 in its body begins to decay at a fixed and known rate (its half-life is about 5,730 years).
  - By measuring the remaining amount of C-14 in an ancient organic sample (like wood, bone, or cloth), scientists can calculate how long it has been since the organism died.
- **NCERT & Government Source Reference:**
  - Class 9 - Science, Chapter 4: Structure of the Atom: Introduces the concept of isotopes.
  - The application is a cornerstone of archaeology. Institutions like the Archaeological Survey of India (ASI) collaborate with labs that use Radiocarbon Dating. The principle is widely documented in science curricula and resources provided by the National Council of Science Museums (NCSM).

35. **Correct Answer: (c) Glowing of an incandescent bulb****
Detailed Explanation:

The **glowing of an incandescent bulb** (c) is based on the **heating effect of electric current**. When current passes through the thin tungsten filament, it gets extremely hot and emits light.

All other options are applications of electromagnetic induction: **(a)** Hydro generators use moving water to spin a turbine, which rotates a coil in a magnetic field. **(b)** Wireless chargers use a changing magnetic field in a transmitter coil to induce a current in a receiver coil inside the phone. **(d)** Dynamic microphones have a diaphragm attached to a coil that moves in a magnetic field, inducing a current.

NCERT Source:

Class 10 - Science, Chapter 12: Electricity: The heating effect of current is explained by Joule's law of heating ($H = I^2Rt$). The chapter uses the example of an electric bulb's filament getting heated to a high temperature and emitting light.

36. **Correct Answer: (d) Solidification, or freezing, occurs at a temperature higher than the melting point.**

* This statement is **incorrect**. Solidification (or freezing) and melting are reverse processes that occur at the **exact same temperature**, known as the melting point or freezing point. For example, pure water freezes at 0°C and ice melts at 0°C. It is impossible for solidification to occur at a temperature higher than the melting point.

NCERT Reference:

* **Class 9 - Science, Chapter 1: Matter in Our Surroundings:** The chapter explains the concept of a fixed temperature for change of state. It states, "The temperature at which a solid melts to become a liquid at the atmospheric pressure is called its melting point." It also refers to the freezing point, implying they are the same for a pure substance. The latent heat of fusion graph in the chapter shows that melting and freezing occur at a constant temperature.

37. Explanation:

- **Correct Answer: (b) Phosphorus-32**
- **Analysis:**
  - Phosphorus is a key element used by the body in the formation of DNA, RNA, and bone marrow, where blood cells are produced.
  - Phosphorus-32 is a radioactive isotope that emits beta particles.
  - When introduced into the body, it is preferentially absorbed by bone marrow and cells that are rapidly dividing, such as the excess red blood cells in Polycythemia Vera.
  - The radiation from P-32 helps to suppress the overproduction of these cells, thereby controlling the disorder.
- **NCERT & Government Source Reference:**
  - Class 10 - Science, Chapter 4: Carbon and its Compounds: Provides the base knowledge of elements and their properties.

- The medical application is specified in resources from the Department of Atomic Energy (DAE) and publications by the Indian Society of Hematology & Transfusion Medicine. It is a established therapeutic procedure in nuclear medicine for treating certain blood cancers and disorders.

38. Answer: (b) Catenation

- **Analysis:**
  - Carbon has the unique ability to form bonds with other atoms of carbon, giving rise to large molecules. This property of forming long chains by linking identical atoms with itself is called catenation.
  - Due to its small size and the strength of the carbon-carbon bond, carbon shows the highest degree of catenation in the periodic table. This is the fundamental reason for the existence of a vast number of organic compounds.
- **NCERT Reference:**
  - Class 10 - Science, Chapter 4: Carbon and its Compounds: The chapter introduces this key concept: "The property of carbon element by virtue of which its atoms can join one another to form long carbon chains is called **catenation**." It is highlighted as the main reason for carbon's versatility.

39. **Answer: (b) C_2H_4 with a double bond**

- **Analysis**:
  - Ethene, also known as ethylene, is the simplest alkene.
  - Its molecular formula is C_2H_4. The two carbon atoms share two pairs of electrons, forming a strong carbon-carbon double bond.
  - This double bond is the defining feature of the alkene series. In contrast, Ethane (C_2H_6) has a single bond, and Ethyne (C_2H_2) has a triple bond.
- **NCERT Reference:**
  - Class 10 - Science, Chapter 4: Carbon and its Compounds: The chapter provides a clear comparison. It lists the first three homologues of the alkene series, starting with "Ethene - C_2H_4" and explains that these compounds are "characterized by the presence of a double bond between two carbon atoms."

40. **Explanation:**

- **Correct Answer: (b) Aquatic life surviving in frozen lakes.**
- **Analysis:**
  - Most substances contract and become denser as they cool. Water, however, exhibits anomalous expansion; it contracts until 4°C, but below 4°C, it starts expanding and becomes less dense until it freezes at 0°C.
  - This is why ice is less dense than liquid water and floats on its surface.

- When a lake freezes, this layer of ice acts as an insulator, preventing the water below from freezing solid. This allows aquatic life to survive in the liquid water beneath the icy surface.

- **NCERT & Scientific Reference:**
  - Class 9 - Science, Chapter 1: Matter in Our Surroundings: This chapter explicitly mentions this unique property: "Water... expands on cooling between 4°C and 0°C. This is called the anomalous expansion of water." It also explains the ecological significance of this phenomenon.

41. Answer: (c) Ethanol

- **Analysis:**
  - A functional group is an atom or a group of atoms that determines the chemical properties of an organic compound.
  - The -OH group is known as the alcohol functional group.
  - Ethanol (C_2H_5OH) is a two-carbon compound where one hydrogen is replaced by an -OH group, making it an alcohol.
  - Ethanal (CH_3CHO) has an aldehyde (-CHO) group, Ethanoic Acid (CH_3COOH) has a carboxylic acid (-COOH) group, and Acetone (CH_3COCH_3) has a ketone (-CO-) group.
- **NCERT Reference:**
  - Class 10 - Science, Chapter 4: Carbon and its Compounds: This chapter has a dedicated section on functional groups. It provides a table listing important functional groups, clearly identifying the -OH group as belonging to the alcohol family and giving Ethanol as a common example.

42. Answer: (a) Capillary action

- **Analysis:**
  - Capillary action (or capillarity) is the ability of a liquid to flow in narrow spaces without the assistance of, or even in opposition to, external forces like gravity.
  - It occurs due to the interplay of two forces: cohesion (attraction between water molecules) and adhesion (attraction between water molecules and the walls of the xylem vessels in plants).
  - The adhesive forces cause water to be drawn up the thin tubular xylem vessels, and the cohesive forces pull along the water molecules behind them, resulting in a continuous column of water rising from the roots to the leaves.
- **NCERT & Scientific Reference**:
  - Class 10 - Science, Chapter 6: Life Processes: This chapter explains the transport of water and minerals in plants. It states, "Water and minerals are transported... through the xylem vessels. The movement of water... is mainly due to [transpirational] pull. However, capillary action also contributes to some

extent." This identifies capillarity as a key physical process supporting this biological function.

43. Answer: (c) It has a high dipole moment.

- **Analysis:**
  - A solvent's ability to dissolve a solute depends on its ability to overcome the attractive forces within the solute. Ionic compounds are held together by strong electrostatic forces.
  - Water (H_2O) has a bent molecular shape and a significant difference in electronegativity between oxygen and hydrogen atoms. This creates a high dipole moment, meaning one end of the molecule (oxygen) is partially negative (δ^-) and the hydrogen ends are partially positive (δ^+).
  - When an ionic compound like NaCl is added to water, the positive ends (H) of water molecules surround and attract the chloride (Cl^-) ions, while the negative ends (O) surround and attract the sodium (Na^+) ions. This process, called hydration, pulls the ions away from the crystal lattice and into solution.
- **NCERT & Scientific Reference:**
  - Class 11 - Chemistry: NCERT (A higher-level concept, but the foundation is in Class 9-10) - The concept of polarity and dipole moment is formally introduced. However, the dissolving power is explained in lower classes.
  - Class 9 - Science, Chapter 2: Is Matter Around Us Pure? - This chapter introduces the concept of a solution, solute, and solvent, and uses the example of salt dissolving in water, laying the groundwork for understanding solvent action.

44. Answer: (d) The kinetic energy of particles is independent of temperature.

* This statement is **incorrect**. The kinetic energy of the particles of matter is **directly proportional to the temperature**. As the temperature increases, the particles gain energy and move more rapidly, meaning their kinetic energy increases. This is a fundamental characteristic of the particle nature of matter.

NCERT Reference:

* **Class 9 - Science, Chapter 1: Matter in Our Surroundings:** The chapter establishes this relationship clearly. It states, "With increase in temperature, the kinetic energy of the particles also increases." This principle is used to explain why diffusion becomes faster at higher temperatures and how evaporation is influenced by temperature.

45. Answer: (a) The presence of hydrogen bonding between water molecules.

- **Analysis:**
  - Specific heat capacity is the amount of heat energy required to raise the temperature of a unit mass of a substance by 1°C.

    - Water has an unusually high specific heat capacity. This is because a significant amount of the supplied heat energy is used to break the numerous hydrogen bonds between water molecules rather than increasing their kinetic energy (which would raise the temperature).
    - This property makes water a great temperature buffer, which is crucial for stabilizing environmental and biological temperatures.
- **NCERT & Scientific Reference:**
    - Class 11 - Chemistry: NCERT - Discusses hydrogen bonding and its effect on physical properties like specific heat.
    - The principle is a direct consequence of intermolecular forces, a topic built upon the foundation of Class 9 - Science, Chapter 1: Matter in Our Surroundings, which discusses the states of matter and the effect of heat.

46. Answer: (c) Cobalt-60

- **Analysis:**
    - Cobalt-60 is a radioactive isotope that emits powerful gamma rays.
    - When food is exposed to controlled doses of this gamma radiation, the high-energy rays kill bacteria, viruses, and insects without making the food itself radioactive.
    - This process, called food irradiation, significantly extends the shelf life of food products and reduces food-borne illnesses.
- **NCERT & Government Source Reference:**
    - Class 10 - Science (Biology): Discusses food preservation methods like pasteurization and chemical preservation. Food irradiation is a modern extension of these principles.
    - Bhabha Atomic Research Centre (BARC) & Department of Atomic Energy (DAE): The Indian government, through BARC, has pioneered food irradiation technology. They have developed and licensed several food irradiation plants in India that use Cobalt-60 to preserve grains, spices, and fruits.

47. Correct Answer: (c) Electric Motor

Detailed Explanation:

An **Electric Motor** works on the **magnetic effect of electric current**. When a current-carrying coil is placed in a magnetic field, it experiences a force that causes it to rotate.

In contrast, an **Electric Generator** (a) and a **Transformer** (b) work on **electromagnetic induction** (producing current from a changing magnetic field). An **Induction Cooktop** (d) also uses electromagnetic induction to generate heat directly in the cookware.

NCERT Source:

Class 10 - Science, Chapter 13: Magnetic Effects of Electric Current:** This chapter clearly distinguishes between the motor and the generator. It explains the principle of the electric motor under the section "Force on a Current-Carrying Conductor in a Magnetic Field" and the generator under "Electromagnetic Induction."

48. Correct Answer: (d) The melting point of a substance decreases with an increase in pressure.

* This statement is **not universally correct**. The effect of pressure on the melting point depends on whether the substance expands or contracts upon melting.
* For most substances (like wax, sulphur, and most solids that expand on melting), an **increase in pressure increases** the melting point.
* However, for a few substances like ice, which **contract upon melting**, an increase in pressure **lowers** the melting point. Since the statement makes a general claim that is not true for the majority of substances, it is considered incorrect in this context.

NCERT Reference:

* While **NCERT Class 9, Chapter 1** discusses the effect of pressure on boiling points and the liquefaction of gases, the nuanced effect on melting point is a higher-level concept.

However, the principle of how a substance behaves during a phase change is key.

49. Answer: (c) Iodine-131

- **Analysis:**
  - The thyroid gland in the human body requires iodine to produce hormones. Iodine-131 is a radioactive isotope that emits beta radiation.
  - When a patient is administered Iodine-131, the thyroid gland actively absorbs it, just like stable iodine.
  - Once concentrated in the thyroid, the radiation from I-131 destroys the overactive thyroid cells or cancerous cells, making it effective for treating goitre and thyroid cancer.
- **NCERT & Government Source Reference**:
  - Class 10 - Science, Chapter 4: Carbon and its Compounds: While this chapter introduces the concept of isotopes, the specific application is covered in higher secondary curriculum.
  - Atomic Energy Education Society (AEES) / Department of Atomic Energy (DAE), India: These official bodies detail the use of Iodine-131 in Radioiodine Therapy. The Bhabha Atomic Research Centre (BARC) produces and supplies I-131 for medical use across India, confirming its application in nuclear medicine.

50. Correct Answer: (b) Galvanometer

Detailed Explanation:
A **Galvanometer** is a device used to detect the direction and presence of a small electric current in a circuit. Its working principle is the **magnetic effect of current**. A current-carrying coil placed in a magnetic field experiences a torque, which causes it to deflect. The direction and magnitude of deflection indicate the direction and strength of the current. It does not rely on a *changing* magnetic field to *induce* a current (which is electromagnetic induction); rather, it uses the magnetic field produced by the current itself to cause motion**.**
NCERT Source:
Class 10 - Science, Chapter 13: Magnetic Effects of Electric Current: The chapter describes the principle of a galvanometer, linking it to the fact that a current-carrying coil behaves as a magnet and experiences a force when placed in a magnetic field. This is fundamentally different from the principle of electromagnetic induction used in devices like generators.

51. Answer: (b) The force of attraction between particles in a gas is very strong.

- This statement is **incorrect**. The defining characteristic of gases is that the intermolecular forces of attraction between their particles are **negligibly weak**. This is why gas particles are free to move in all directions and fill the entire volume of their container.

NCERT Reference:

- **Class 9 - Science, Chapter 1: Matter in Our Surroundings**: The chapter clearly differentiates between the states of matter. It states that in solids, the intermolecular forces are "strong," in liquids they are "less strong," and in gases, the forces are "negligible" or "very weak." This is the fundamental reason for the different properties of solids, liquids, and gases.

52. Answer: (a) Silica, Sodium Carbonate, Calcium Carbonate, and Cullets

- **Analysis:**
  Ordinary glass, known as soda-lime glass, is the most common type used for windows, bottles, and jars. Its composition is a specific mixture of raw materials that serve distinct purposes.
- **NCERT & Government Source Reference**:
  - Class 10 - Science, Chapter 3: Metals and Non-Metals: While not detailing glass, this chapter discusses the reactivity of metals and the concept of oxides, which is foundational.
  - The specific composition is covered in higher secondary NCERT Chemistry texts and resources from the Ministry of Micro, Small & Medium Enterprises (MSME), which detail process technologies for small-scale industries.

Role of Raw Materials in Soda-Lime Glass:

Raw Material	Chemical Formula	Primary Function
Silica Sand	SiO_2	Glass Former: The main network-forming oxide, providing the basic structure.
Sodium Carbonate (Soda Ash)	Na_2CO_3	Flux: Lowers the melting point of silica from ~1700°C to about 800°C, saving energy.
Calcium Carbonate (Limestone)	$CaCO_3$	Stabilizer: Prevents the glass from being soluble in water and improves chemical durability.
Cullets	Broken Glass	Melting Aid: Recycled glass that melts at a lower temperature, helping to fuse the raw batch.

53. **Explanation:**
- **Correct Answer: (b) Protons**
- **Analysis**:
  Isotopes are variants of the same element. An element is defined by its atomic number (number of protons). Isotopes have the same number of protons but different numbers of neutrons, hence they have different mass numbers.
- NCERT & Scientific Reference:
  - Class 9 - Science, Chapter 4: Structure of the Atom: The chapter explains, "Atoms of the same element, having the same atomic number but different mass numbers, are known as isotopes." It gives the example of Hydrogen-1 (Protium), Hydrogen-2 (Deuterium), and Hydrogen-3 (Tritium), all with 1 proton but 0, 1, and 2 neutrons respectively.

54. **Explanation:**
- **Correct Answer: (c) Photosynthesis**
- Analysis:
  Endothermic processes are those that absorb energy from their surroundings. Photosynthesis requires solar energy (sunlight) to convert carbon dioxide and water into glucose and oxygen. This absorption of external energy makes it a classic endothermic process.
- **NCERT Reference:**
  - Class 10 - Science, Chapter 1: Chemical Reactions and Equations: This chapter classifies reactions based on energy change. While it explicitly defines exothermic reactions, the concept of endothermic is implied. Photosynthesis is mentioned as a reaction that requires energy input.
  - Class 7 - Science, Chapter 1: Nutrition in Plants: This chapter details the process: "Plants use solar energy to synthesise food from carbon dioxide and

water. This process is called photosynthesis." The dependency on an external energy source is its key characteristic.

Comparison Table:

Process	**Energy Change**	**Type**
Photosynthesis	Absorbs solar energy	Endothermic
Combustion of Carbon	Releases heat and light	Exothermic
Mixing Acid & Alkali	Releases heat (Neutralization)	Exothermic
Respiration	Releases energy	Exothermic

55. Answer: (c)

Explanation:

- **Titanium dioxide (TiO_2)** is the **most common synthetic white pigment**, known for its high opacity and inertness.
- **White lead** ($2PbCO_3 \cdot Pb(OH)_2$) was formerly used but is **toxic**.
- **Zinc white (ZnO)** is less opaque, used as an alternative.
- **$CaCO_3$ (chalk)** is used as filler, not as primary pigment.

Pigment	Chemical Formula	Nature	Remarks
White lead	$2PbCO_3 \cdot Pb(OH)_2$	Reactive	Toxic
Zinc white	ZnO	Synthetic	Moderate opacity
Titanium dioxide	TiO_2	Synthetic / Inert	High opacity, non-toxic
Chalk	$CaCO_3$	Natural	Inert filler

Source: NCERT Class 10, “Metals and Non-Metals”; BIS Handbook on Paint Materials (IS 12858).

56. **Explanation:**

- **Correct Answer: (a) Valency 2, Cation X^{2+}**
- Analysis:
  An element with atomic number 12 is Magnesium (Mg). Its electronic configuration is 2, 8, 2. It has 2 electrons in its outermost shell. To achieve a stable, fully-filled shell, it is easier for magnesium to lose these 2 valence electrons. The loss of electrons

results in the formation of a positively charged ion called a cation (Mg^{2+}). The number of electrons lost determines the valency, which is 2.

- NCERT Reference:
  - Class 9 - Science, Chapter 4: Structure of the Atom: The chapter explains the formation of ions. It states that atoms which lose electrons become positively charged cations. Magnesium is a classic example of a metal that loses electrons to form a cation.
  - Class 10 - Science, Chapter 3: Metals and Non-Metals: This chapter reinforces that metals tend to form cations by losing electrons.

Summary for Element X (Atomic No. 12):

Property	Details
Element	Magnesium (Mg)
Electronic Configuration	2, 8, 2
Tendency	Lose 2 electrons
Valency	2
Ion Formed	Cation (Mg^{2+})

57. **Explanation:**

- **Correct Answer: (a) Chlorine (Cl)**
- Analysis:
  The electronic configuration 2, 8, 7 indicates a total of 17 electrons, which is the atomic number of Chlorine. An atom with 7 electrons in its outermost shell is one electron short of the stable octet (8 electrons). Such atoms have a strong tendency to gain one electron to achieve a stable configuration, thereby forming a negatively charged ion (anion), in this case, F^-.
- NCERT Reference:
  - Class 9 - Science, Chapter 4: Structure of the Atom: The chapter explains how elements tend to react to achieve a fully filled outermost shell. It states that atoms with 1, 2, or 3 valence electrons tend to lose them (forming cations), while atoms with 5, 6, or 7 valence electrons tend to gain electrons (forming anions).

Ion Formation Diagram:

Chlorine Atom (Cl) Chlorine Ion (Cl^-)
17 protons (+) 17 protons (+)
17 electrons (-) → 18 electrons (-)
Electronic Config: Electronic Config:

2,8, 7 (Unstable)	2,8, 8 (Stable, like Argon)
Neutral Atom	Negatively Charged Anion

58. **Answer:** (a)

Explanation (with classification table):

Type of Pigment	Characteristics	Examples	Reactivity
Natural pigment	Obtained from minerals	Chalk ($CaCO_3$), Ochre	Low
Synthetic pigment	Chemically prepared	TiO_2, ZnO	Stable
Reactive pigment	Reacts with binder/medium	White lead ($PbCO_3 \cdot Pb(OH)_2$), Red lead	High
Inert pigment	Adds opacity/texture only	Barytes ($BaSO_4$), Silica	Non-reactive

Source: NCERT Class 8 “Materials: Metals and Non-Metals”; BIS Handbook of Paints; DAE Chemistry Notes.

Summary Table — Key Pigments in Paints

Pigment Name	Type	Colour	Chemical Formula	Remarks
Chalk	Natural	White	$CaCO_3$	Filler, inert
White Lead	Reactive	White	$2PbCO_3 \cdot Pb(OH)_2$	Toxic, obsolete
Red Lead	Reactive	Red	Pb_3O_4	Used in anti-rust primer
Titanium Dioxide	Synthetic / Inert	White	TiO_2	Common non-toxic white
Zinc Oxide	Synthetic	White	ZnO	Mild antiseptic, paint base

59. **Explanation:**

- **Correct Answer: (b) Covalent Bond**
- Analysis:
  A covalent bond is specifically formed when two atoms share one or more pairs of electrons. This type of bond is typically found between non-metal atoms. The shared electrons are counted in the outermost shell of both bonded atoms, helping them achieve stability.
- NCERT Reference:
  - Class 10 - Science, Chapter 4: Carbon and its Compounds: This chapter is dedicated to covalent bonding. It defines it clearly: "The bond formed by the sharing of electrons between two atoms is known as a covalent bond." It uses the examples of H_2, O_2, N_2, and CH_4.

60. **Explanation:**

- **Correct Answer: (a) A-2, B-4, C-3, D-1**
- Analysis:
  To solve this, we need to write the electronic configuration of each element and count the unpaired electrons in their outermost shell (valence shell).
- **NCERT Reference:**
  - Class 9 - Science, Chapter 4: Structure of the Atom: This chapter provides the rules for writing electronic configurations (2, 8, 8...). The concept of paired and unpaired electrons is foundational for understanding chemical bonding, which is covered in Class 10, Chapter 4.

Electronic Configuration and Unpaired Electrons Table:

Element	Atomic No.	Electronic Configuration (K, L, M)	Unpaired e^-
A. Boron (B)	5	2, 3	1
B. Nitrogen (N)	7	2, 5	3
C. Oxygen (O)	8	2, 6	2
D. Neon (Ne)	9	2, 8	0

61. Explanation:

- **Correct Answer: (d) Crystallization**
- **Analysis:**
  The sugar industry relies on a physical process to extract pure sucrose from the impure juice. After purification and concentration, the syrup is seeded with tiny sugar crystals, prompting the dissolved sugar to come out of the solution and form crystals. This process is known as crystallization.
- **NCERT & Government Source Reference:**
  - Class 7 - Science, Chapter 5: Physical and Chemical Changes: This chapter introduces the concept of crystallization as a physical change, using the example of forming crystals from a supersaturated solution.
  - Class 9 - Science, Chapter 2: Is Matter Around Us Pure?: This chapter elaborates on crystallization as a separation technique to obtain pure substances in their crystalline form.

62. Explanation:

- **Correct Answer: (c) Limestone**
- **Analysis:**
  Portland cement is the most common type of cement used worldwide. Its production involves heating a mixture of materials in a kiln. Limestone ($CaCO_3$) is the

indispensable raw material as it provides the necessary lime (CaO) which is the primary binding component in cement clinker.

- **NCERT & Government Source Reference:**
  - Class 10 - Geography, Chapter 6: Manufacturing Industries: This chapter explicitly lists the raw materials for cement as **"limestone, silica, alumina, and gypsum."**
  - Class 10 - Science, Chapter 1: Chemical Reactions and Equations: The chapter discusses the decomposition reaction, using the heating of limestone ($CaCO_3 \rightarrow CaO + CO_2$) as a classic example. This exact reaction is the first chemical step inside a cement kiln.

63. Explanation:

- **Correct Answer: (b) Number of protons = Number of electrons**
- Analysis:
  An atom is electrically neutral because the positive charge of the protons in the nucleus is exactly balanced by the negative charge of the electrons surrounding it. Therefore, for a neutral atom, the atomic number (Z) gives both the number of protons and the number of electrons.
- NCERT & Scientific Reference:
  - Class 9 - Science, Chapter 4: Structure of the Atom: The concept is foundational. The chapter implies this balance when describing the structure, stating that electrons are present outside the nucleus, and the atom as a whole is neutral. This leads to the direct conclusion that in a neutral atom, number of protons = number of electrons.

Charge Balance in a Neutral Atom:

Particle	Charge	Quantity in Neutral Atom
Proton	+1	Z
Electron	-1	Z
Neutron	0	N
Total Charge	0	

64. Explanation:

- **Correct Answer: (b) Endothermic and absorbs heat**
- **Analysis:**
  When the ionic solid Ammonium Chloride dissolves in water, energy is required to break the strong ionic bonds holding the crystal lattice together. This energy is

absorbed from the surrounding water, causing the temperature of the solution to drop significantly. This principle is harnessed in instant cold packs for first-aid.

- **NCERT & Government Source Reference:**
  - Class 7 - Science, Chapter 6: Physical and Chemical Changes: Introduces the concept of physical changes involving heat.
  - The specific example is a standard demonstration in school science. Resources from the National Council of Science Museums (NCSM) and Vigyan Prasar often feature this experiment to explain endothermic dissolution.

65. **Explanation:**

- **Correct Answer: (b) Endothermic decomposition reaction**
- **Analysis**:
  Let's break down the given equation:
  - Reactant: One single compound - Calcium Carbonate ($CaCO_3$).
  - Products: Two simpler substances - Calcium Oxide (CaO) and Carbon Dioxide (CO_2).
  - Energy: The "+ Heat" on the left (reactant) side indicates that heat energy is required or absorbed for this reaction to proceed.
- A reaction where a single compound breaks down into simpler substances upon absorbing energy is an endothermic decomposition reaction.
- **NCERT Reference:**
  - Class 10 - Science, Chapter 1: Chemical Reactions and Equations: This chapter is the definitive source. It defines decomposition reactions and classifies them based on energy. It explicitly uses the decomposition of calcium carbonate (limestone) in a kiln as a prime example of a reaction that "requires heat", making it endothermic.

Reaction Analysis:

Calcium Carbonate + Heat → Calcium Oxide + Carbon Dioxide
(1 Reactant) (Absorbed) (2 Products)
| | |
Decomposition Endothermic Simple Products

66. **Answer:** (b)

Explanation:

All four examples are correctly matched:

Pigment	Type	Chemical Nature / Source
Ochre	Natural	Iron oxide mineral ($Fe_2O_3 \cdot H_2O$)
Zinc oxide	Synthetic	Prepared industrially by oxidation of Zn

Titanium dioxide (TiO_2)	Inert	Chemically stable white pigment
Red lead (Pb_3O_4)	Reactive	Oxidation product of lead, reacts with binders

Source: NCERT Class 8–10 Chemistry notes; BARC Science Communication Portal.

67. **Explanation:**

- **Correct Answer: (d) 3 unpaired electrons in the outermost shell.**
- Analysis:
  Valency is determined by the number of unpaired electrons available for bonding. Nitrogen has 5 valence electrons. According to **Hund's rule**, these are arranged in the 2p subshell as three unpaired electrons and one paired electron. These three unpaired electrons can participate in covalent bond formation, giving nitrogen a valency of 3 (as seen in Ammonia, NH_3).
- NCERT Reference:
  - Class 10 - Science, Chapter 4: Carbon and its Compounds: While explaining covalent bonds, the chapter uses the example of Nitrogen forming NH_3, implying its valency of 3. The underlying reason is the number of unpaired electrons.

68. **Answer:** ©

Explanation:

- **Lead compounds** are poisonous; prolonged exposure damages the nervous system and kidneys.
- **UNEP and BIS** recommend phasing out lead pigments, replacing with safer options like TiO_2 or ZnO.
- NCERT (Class 10, Metals and Non-Metals) notes that heavy metals such as lead and mercury cause pollution.

Reference:

- Ministry of Environment, Forest and Climate Change (MoEFCC), India: *Lead Paint Regulation (2016)*.
- NCERT Class 10 Science – *Environmental Concerns in Industrial Use*.

69. **Explanation:**

- **Correct Answer: (c) Decomposition of vegetable matter : Exothermic**
- **Analysis:**
  This question tests the application of the concept to natural and chemical processes.
- **NCERT Reference:**
  - Class 10 - Science, Chapter 1: Chemical Reactions and Equations: This chapter is the primary source for classifying these common reactions.

Process Classification Table:

Process	Description	Energy Type	Reason
Respiration	Breaking down glucose to release energy.	Exothermic	Releases energy for cellular activities.
Photosynthesis	Building glucose using solar energy.	Endothermic	Requires absorption of sunlight.
Decomposition of matter	Breakdown by microbes releases heat.	Exothermic	A slow combustion process.
Dissolution of NaOH	Releases a large amount of heat.	Exothermic	Energy is released as heat.

70. **Explanation:**

- **Correct Answer: (b) Aluminium**
- Analysis:
  Ruby and Sapphire are gemstone varieties of the mineral Corundum. The chemical formula of corundum is Aluminium Oxide (Al_2O_3). Its exceptional hardness (9 on the Mohs scale) also makes it very useful as an abrasive, used in sandpaper and grinding wheels.
- **NCERT & Government Source Reference:**
  - Class 10 - Science, Chapter 3: Metals and Non-Metals: This chapter mentions that "aluminium is a very reactive metal" but forms a protective layer of "aluminium oxide (Al_2O_3)" which prevents further corrosion.
  - The Geological Survey of India (GSI) provides information on mineral resources, classifying Corundum as an industrial mineral, with its gem varieties being Ruby and Sapphire.

Diagram: From Ore to Gemstone/Abrasive

Bauxite Ore ($AlO_x(OH)_{3-2x}$)
|
| (Refining & Processing)
↓
Aluminium Oxide (Al_2O_3) - "Alumina"
|
|--- If pure → Used as an **Abrasive**
|
|--- With Chromium impurity → **Ruby** (Red)
|
|--- With Iron/Titanium impurity → **Sapphire** (Blue)

71. **Explanation:**

- **Correct Answer: (b) Iron with Molybdenum Promoter**
- **Analysis:**
  The Haber process combines nitrogen and hydrogen gases at high pressure and temperature to form ammonia ($N_2 + 3H_2 \rightleftharpoons 2NH_3$). A catalyst is essential to achieve a commercially viable reaction rate. Finely divided Iron (Fe) is used as the primary catalyst, and it is often promoted by Molybdenum (Mo) or potassium and aluminium oxides to increase its efficiency and lifespan.
- **NCERT & Government Source Reference:**
  - Class 12 - Chemistry (NCERT): Details the Haber process and its catalyst. For the CAPF level, knowing the primary catalyst is sufficient.
  - The Department of Fertilizers, Government of India, oversees the urea industry, which relies on ammonia produced via the Haber process, confirming the use of iron-based catalysts.

Haber Process Diagram:

text

Nitrogen (from air) + Hydrogen (from natural gas)

↓

Mixer & Compressor (High Pressure ~200 atm)

↓

Catalyst Chamber (High Temperature ~450°C)

|_____[Iron Catalyst]_____|

↓

Cooler → Liquefies Ammonia (NH_3)

72. **Explanation:**

- **Correct Answer: (a) Cement Industry : Limestone and Gypsum**
- **Analysis:**
  This question tests knowledge of key industries and their foundational raw materials.
- **NCERT & Government Source Reference:**
  - Class 10 - Geography, Contemporary India-II: Chapters on 'Manufacturing Industries' provide an overview of the location and raw materials for key industries like cement and iron & steel.
  - Ministry of Steel, Government of India & Cement Manufacturers Association (CMA): These authentic sources provide detailed information on the input materials for these core industries.

Industry-Raw Material Matching Table:

Industry	Correct Raw Materials	Purpose of Key Material
Cement	Limestone, Clay, Gypsum	Limestone is the source of calcium; Gypsum controls the setting time.

Steel	Iron Ore, Coke, Limestone	Coke is a fuel & reducing agent; Limestone acts as a flux to remove impurities.
Paper	Wood Pulp, Bamboo, Rosin	Wood pulp provides cellulose fibers; Rosin is used for sizing.
Glass	Silica Sand, Soda Ash, Limestone	As explained in Question 1.

73. **Explanation:**

- **Correct Answer: (b) 12**
- Analysis:
  This question tests the direct application of the relationship between mass number (A), atomic number (Z), and the number of neutrons (N).
- NCERT Reference:
  - Class 9 - Science, Chapter 4: Structure of the Atom: The chapter establishes the formula: Mass Number = Number of Protons + Number of Neutrons.

Calculation:

- Mass Number (A) = 23
- Atomic Number (Z) = Number of Protons = 11
- Using the formula: A = Z + N
- Therefore, 23 = 11 + N
- Solving for N: N = 23 - 11 = 12

The number of neutrons in the atom is 12

74. **Explanation:**

- **Correct Answer: (a) Act as a flux and lower the melting point of the mixture.**
- **Analysis:**
  Cullets are pieces of recycled glass. Their primary function is not as a filler but as a crucial agent that facilitates the melting process. Because glass already has an amorphous structure, it melts at a lower temperature than the raw, crystalline batch materials (sand, soda ash, etc.). Adding cullets reduces the overall energy required to melt the entire mixture, acting synergistically with other fluxes.
- **NCERT & Government Source Reference:**
  - While the specific term 'cullet' may not be in school NCERTs, the concept of recycling and its benefits is a cross-cutting theme. The functional role is detailed in industrial technology notes from MSME, which emphasize that cullets "assist the fusion of the raw materials and reduce the fuel consumption."

75. **Explanation:**

- **Correct Answer: (b) Endothermic**
- **Analysis:**
  Energy is always conserved. In a chemical reaction, if energy is absorbed from the surroundings (the beaker, the air, etc.), that energy is used to break chemical bonds. This absorption of thermal energy causes the temperature of the immediate surroundings to decrease.
- **NCERT Reference:**
  - Class 10 - Science, Chapter 1: Chemical Reactions and Equations: The chapter provides a clear, practical definition: "Reactions in which heat is absorbed are known as endothermic reactions. In such reactions, the temperature of the reaction mixture falls."

Diagram: Energy Flow in Reactions

Endothermic Reaction:
Surroundings (Cooler) <--- Heat Energy --- Reaction Vessel
Exothermic Reaction:
Surroundings (Warmer) <--- Heat Energy --- Reaction Vessel

76. **Explanation**

- **Correct Answer: (d) Cerium oxide**
- **Analysis**:
  Certain metal oxides are added to glass to impart specific properties. Cerium(IV) oxide (CeO_2) has the ability to absorb ultraviolet (UV) light strongly while being transparent to visible light. This makes it an ideal additive for manufacturing glasses that provide protection from harmful UV radiation.
- **NCERT & Government Source Reference:**
  - While the specific use of Cerium oxide is a higher-level application, the principle of adding substances to glass to change its properties is introduced in Class 10 - Science, Chapter 3: Metals and Non-Metals, which discusses how glass can be coloured by adding metal oxides.
  - The Indian Bureau of Mines (IBM) in its publications on 'Minor Minerals' lists Cerium as one of the Rare Earth Elements (REEs) and highlights its use in glass polishing and as a UV absorber in glass.

Common Glass Additives and Their Functions:

Additive Compound	Element Imparted	Effect on Glass
Cerium Oxide	Cerium	Absorbs Ultraviolet (UV) rays
Cobalt Oxide	Cobalt	Blue Colour
Manganese Dioxide	Manganese	Purple Colour

Selenium	Selenium	Red Colour

77. **Explanation:**

- **Correct Answer: (c) Lead Dioxide**
- **Analysis:**
  A lead-acid battery involves a reversible chemical reaction between lead and its compounds. The positive plate is made of Lead Dioxide (PbO_2), and the negative plate is made of spongy lead (Pb). The electrolyte is a solution of Sulphuric Acid (H_2SO_4).
- **NCERT & Government Source Reference:**
  - Class 10 - Science, Chapter 12: Electricity: This chapter discusses different sources of electric current and mentions the storage battery. While it doesn't detail the chemistry, it forms the basis for understanding its application.

Key Components of a Lead-Acid Battery:

Component	Material	Chemical Formula	Role
Positive Electrode	Lead Dioxide	PbO_2	Active material for the positive terminal.
Negative Electrode	Spongy Lead	Pb	Active material for the negative terminal.
Electrolyte	Sulphuric Acid	H_2SO_4	Conducts ions and participates in the reaction.

78. Explanation:

- **Correct Answer: (b) Chromium and Nickel**
- **Analysis:**
  Stainless steel is an alloy of iron designed to resist corrosion. The key alloying element is Chromium (at least 10.5%), which forms a passive layer of chromium oxide on the surface that protects the underlying iron from rusting. Nickel is added to improve formability and toughness.
- NCERT & Government Source Reference:
  - Class 10 - Science, Chapter 3: Metals and Non-Metals: This chapter explicitly discusses the prevention of corrosion. It states, "Stainless steel is an alloy of iron which does not rust. This is because it is mixed with chromium and nickel."

Common Alloys and Their Compositions:

Alloy	Main Components	Key Properties
Stainless Steel	Iron, Chromium, Nickel	Corrosion Resistance

Brass	Copper, Zinc	Malleable, Decorative
Bronze	Copper, Tin	Hard, Used for statues
Solder	Lead, Tin	Low melting point

79. **Answer:** (b)
Explanation:

- **Natural pigments** are obtained from **minerals, clays, or biological materials** such as ochre ($Fe_2O_3 \cdot H_2O$) and chalk ($CaCO_3$).
- **Synthetic pigments** are **chemically prepared** compounds like titanium dioxide (TiO_2) or chrome yellow ($PbCrO_4$).
- **Reactive pigments** undergo **chemical change with the medium**, e.g. white lead ($2PbCO_3 \cdot Pb(OH)_2$).
- **Inert pigments** do not react with binder or environment (e.g., barytes, chalk).

Source: NCERT Class 8 Science ("Materials and Their Use"), BIS Handbook of Paints and Pigments.

80. **Explanation:**

- **Correct Answer: (c) The number of protons is the same as the atomic number.**
- Analysis:
  This is the fundamental definition of atomic number. It is the most important property of an element, defining its identity.
- NCERT & Scientific Reference:
  - Class 9 - Science, Chapter 4: Structure of the Atom: This chapter establishes the core concepts. It explicitly states, "The number of protons present in the nucleus of an atom is known as its atomic number. It is denoted by 'Z'."

Key Definitions Table:

Term	Symbol	Definition	Determines
Atomic Number	Z	Number of Protons in the nucleus.	The Identity of the Element.
Mass Number	A	Sum of Protons and Neutrons (A = Z + N).	The Mass of the specific atom.

81. Answer: (c)
Explanation:

- **Modern periodic law** → "Properties of elements are periodic functions of their *atomic number* (Z), not atomic mass."
- (c) therefore **incorrect** (that's Mendeleev's old law).

- Source: NCERT Class 10 Science Ch. 5 – *Periodic Classification of Elements*; Government of India (Vigyan Prasar) Science Portal.

Concept	Mendeleev Law	Modern Law
Basis of classification	Atomic Mass	Atomic Number

82. **Explanation:**

- **Correct Answer: (b) Red Biotechnology**
- Analysis:
  Biotechnology is often color-coded based on its field of application. Red Biotechnology is exclusively dedicated to medical processes.
- **NCERT & Government Source Reference**:
  - Class 12 - Biology, Chapter 12: Biotechnology and its Applications: This chapter provides the foundational knowledge. It details the production of genetically engineered insulin (humulin) and molecular diagnostics, which are core areas of Red Biotechnology.
  - Department of Biotechnology (DBT), Government of India: The DBT's mandate and programs explicitly include "Medical Biotechnology" which encompasses the development of vaccines, therapeutics, and diagnostics, aligning perfectly with the definition of Red Biotechnology.

Table: Branches of Biotechnology and Their Applications

Branch of Biotechnology	Primary Focus	Key Applications
Red Biotechnology	Medical Processes	Manufacturing of pharmaceuticals: Insulin, antibiotics, vaccines, gene therapy, molecular diagnostics.
Green Biotechnology	Agricultural Processes	Genetically Modified (GM) crops, biofertilizers, biopesticides (e.g., **Bt Cotton).**
White Biotechnology	Industrial Processes	Producing biofuels (e.g., ethanol), enzymes, chemicals using microorganisms.
Blue Biotechnology	Marine & Aquatic Processes	Utilizing aquatic organisms for aquaculture, cosmetics, and healthcare.

83. **Explanation:**

Correct Answer: (b) Hearing damage and stress

- According to the **Central Pollution Control Board (CPCB)** and **WHO**, **prolonged exposure** to noise levels **>85 dB** causes **permanent hearing loss**, **hypertension**, and **stress**.
- Common sources: traffic, loudspeakers, industrial machinery.

Noise Level	Source	Impact
30 dB	Whisper	Safe
60–70 dB	Conversation	Normal
85–100 dB	Heavy traffic, horns	**Hearing risk**
>120 dB	Jet engine	Pain threshold

Source:

- *NCERT Class 8 Science – Sound*
- *CPCB Guidelines on Ambient Noise Standards (2024)*

The Hindu (2024): "Noise pollution and hearing loss in urban India."

Diagram (Simplified):

↑
120 dB → Pain Threshold
100 dB → Danger Zone
85 dB → Hearing Risk
60 dB → Conversation
30 dB → Whisper

84. **Explanation:**

Correct Answer: (C) Cloning

- **Cloning** is the process of producing **genetically identical copies** of cells or organisms.
- The most famous example is **Dolly the Sheep** (1996), cloned using **Somatic Cell Nuclear Transfer (SCNT)**.

Step	Description
1	Nucleus from donor somatic cell is extracted
2	Inserted into enucleated egg cell
3	Stimulated to divide and develop into embryo
4	Implanted into surrogate mother

Applications:

- Animal breeding
- Research on genetic diseases
- Production of transgenic animals

Sources:

- *NCERT Class 12 Biology, Chapter 9: Strategies for Enhancement in Food Production*
- *Indian Express, Feb 2024: "ICAR scientists clone elite buffalo breed for milk productivity"*

- *DBT India Annual Report 2023–24*

85. **Explanation:**
Answer: (b) A–3, B–2, C–1

Scientist	Contribution	Significance
Gregor Mendel	Proposed *Laws of Inheritance* (1865)	Foundation of genetics
Walter Sutton (1902)	*Chromosomal Theory of Inheritance*	Linked genes to chromosomes
Watson & Crick (1953)	Discovered *DNA double helix structure*	Explained molecular basis of heredity

Source:

- *NCERT Class 10 Science – Heredity and Evolution*
- *NCERT Class 12 Biology – Molecular Basis of Inheritance*
- *Indian Express, 2023: "From Mendel to Molecular Biology – 100 years of genetics"*

86. Explanation:

- **Correct Answer: (c) Regulate the opening and closing of stomata**
- Analysis:
  Guard cells are not just passive pores; they are dynamic and control the size of the stomatal opening. They do this by changing their shape in response to environmental factors like light, water availability, and carbon dioxide concentration.
- NCERT Reference:
  - Class 10 - Science, Chapter 6: Life Processes: The chapter explains the role of stomata: "The opening and closing of the pore is a function of the guard cells. The guard cells swell when water flows into them, causing the stomatal pore to open. Similarly, the pore closes if the guard cells shrink." This regulation is crucial for gas exchange and controlling water loss.

Mechanism of Stomatal Opening/Closing:
text
Conditions (e.g., Light, Water) → Guard Cells take in water → Become Turgid → Pore OPENS
Conditions (e.g., Dark, Drought) → Guard Cells lose water → Become Flaccid → Pore CLOSES

87. **Explanation:**
Correct Answer: (b) Bat

- **Bats** produce and detect **ultrasonic sound waves** for **echolocation** — to navigate and locate prey in the dark.
- Similarly, **dolphins** and **porpoises** also use ultrasound underwater.

Animal	Type of Sound	Purpose
Bat	**Ultrasonic (>20 kHz)**	Echolocation
Elephant	Infrasonic (<20 Hz)	Long-distance communication
Whale	Infrasonic	Deep-sea communication

Source: *NCERT Class 9 Science – Chapter 12: Sound*
Indian Express (2024) – "The science behind bat sonar navigation."
Diagram (Simplified):
Bat emits ultrasound → hits insect → echo returns → bat locates prey

88. **Explanation:**
Correct Answer: (b) Audible sound

- Sound with frequency **below 20 Hz = Infrasonic**
- Between **20–20,000 Hz = Audible**
- Above **20,000 Hz = Ultrasonic**

Type	Frequency Range	Example
Infrasonic	<20 Hz	Earthquakes, elephants rumbles
Audible	20–20,000 Hz	Human speech
Ultrasonic	>20,000 Hz	Bats, sonar

Hence, **50 Hz lies in the audible range**, but if the frequency is *below 20 Hz*, it's infrasonic.
Source: *NCERT Class 8 Science – Sound*
The Hindu (2023): "Sound frequencies and environmental applications."

89. **Explanation:**
Correct Answer: (c) Methanogens

- **Methanogens** (mainly *Methanobacterium*) convert **acetic acid and hydrogen** into **methane** under anaerobic conditions.
- They thrive in **sludge** of **biogas digesters**, and also occur in the **rumen (stomach) of cattle**.

Source: *NCERT Class 10 Science – Sources of Energy*
NCERT Class 9 Science – Improvement in Food Resources (Biofertilizers section)

Microorganism	Function
Rhizobium	Nitrogen fixation
Nitrosomonas	Nitrification
Methanogens	**Methane production**

Cyanobacteria	Photosynthetic bacteria

90. **Explanation:**

Correct Answer: (c) The Law of Segregation states that alleles separate during gamete formation and recombine during fertilization.

Mendel proposed **three fundamental laws of inheritance**:

Law	Description	Example
Law of Dominance	One allele dominates over the other	Tall (T) is dominant over Dwarf (t)
Law of Segregation	Two alleles of a gene separate during gamete formation	Each gamete carries only one allele (T or t)
Law of Independent Assortment	Genes for different traits assort independently	Seed shape and seed color inherited independently

Source:

- *NCERT Class 10 Science, Ch. 9 – Heredity and Evolution*
- *Class 12 Biology, Ch. 5*

The Hindu (2023) – "Mendel's Laws and the Rise of Genetic Science" explains modern-day validation through molecular genetics.

91. **Explanation:**

Correct Answer: It exhibits clear contrasting traits and can self- and cross-pollinate

Mendel's choice of *Pisum sativum* was crucial to the success of his experiments.

He selected **7 contrasting traits**, such as tall/dwarf and round/wrinkled seeds.

Reason for choosing Garden Pea	Explanation
Short life cycle	Allowed observation over multiple generations quickly
Distinct traits	Each character had two contrasting forms
Self-pollination & easy cross-pollination	Controlled breeding possible
Large number of offspring	Facilitated statistical analysis

Sources:

- *NCERT Class 12 Biology, Chapter 5 – Principles of Inheritance and Variation*
- *NCERT Class 10 Science, Chapter 9 – Heredity and Evolution*
- *The Hindu (Science Page, 2023): "How Mendel's pea experiments changed biology"*

92. Explanation:

- **Correct Answer: (b) Precise editing of an organism's DNA.**

- Analysis:
  CRISPR-Cas9 is a revolutionary gene-editing tool that acts like a pair of "molecular scissors." It allows scientists to cut DNA at a specific, targeted location in the genome and then add, remove, or alter the genetic material.
- **Current Affairs & Scientific Reference:**
  - The Hindu / Indian Express: These newspapers have frequently covered CRISPR technology in contexts ranging from its potential to cure genetic diseases like sickle cell anemia to its application in developing improved crop varieties. Articles often highlight its precision and the ethical debates surrounding its use.
  - Class 12 - Biology, Chapter 11: Biotechnology: Principles and Processes: While NCERT may not mention CRISPR specifically, it lays the groundwork by explaining **recombinant DNA technology**, restriction enzymes, and the fundamental principles of genetic engineering, of which CRISPR is a modern, advanced tool.

93. **Explanation:**
Correct Answer: (d) Leaf size
Mendel studied **7 contrasting traits** in pea plants:

Character	Dominant Trait	Recessive Trait
1. Plant height	Tall	Dwarf
2. Flower color	Violet	White
3. Flower position	Axial	Terminal
4. Pod shape	Inflated	Constricted
5. Pod color	Green	Yellow
6. Seed shape	Round	Wrinkled
7. Seed color	Yellow	Green

Note: *Leaf size* was **not** one of the traits studied by Mendel.
Source:

- *NCERT Class 10 Science, Ch. 9*
- *NCERT Class 12 Biology, Ch. 5 – Table of 7 Mendelian Traits*

94. **Explanation:**

- **Correct Answer: (c) Xylem**
- Analysis:
  Plants have a complex vascular system for transport. Xylem and Phloem are the two main tissues, each with a dedicated function.

- NCERT Reference:
    - Class 9 - Science, Chapter 6: Tissues: This chapter defines the roles: "Xylem consists of tracheids, vessels, xylem parenchyma and xylem fibres... It transports water and mineral nutrients from the soil to all parts of the plant." In contrast, "Phloem transports products of photosynthesis from the leaves to other parts of the plant."

Table: Comparison of Xylem and Phloem

Feature	**Xylem**	**Phloem**
Function	Transport of water & minerals (upward)	Transport of food & nutrients (bidirectional)
Direction of Flow	Roots → Leaves	Leaves → Other parts (and vice-versa)
Nature of Tissue	Mostly made of dead cells at maturity	Made of living cells

95. Explanation:
Correct Answer: (c) Overflow tank

- The **overflow tank** is used to **collect the digested slurry** after gas production.
- This slurry is **rich in nitrogen and phosphorus**, hence used as **bio-fertilizer**.

Part	**Function**
Inlet tank	Mixes dung and water
Digester	Anaerobic decomposition
Gas holder	Collects gas
Outlet tank	Expels used

Source: *NCERT Class 10 Science, Fig. 14.5 – Biogas Plant Structure*

The Hindu (2022): "Rural India embracing GOBAR-DHAN for waste-to-energy transformation."

96. **Explanation:**
Correct Answer: (c)Sound travels faster in air than in water.

- **Speed of sound** depends on the **medium**:
    - Fastest in **solids**, slower in **liquids**, slowest in **gases**.
- Thus, sound travels **faster in water (≈1500 m/s)** than in air (≈343 m/s).

Medium	**Speed of Sound (m/s, approx.)**

Air (20°C)	343
Water	1500
Iron	5000

Source: *NCERT Class 9 Science – Chapter 12: Sound*
Indian Express (2024): "Why sound travels differently underwater."

97. **Explanation:**
Correct Answer: (b) Anaerobic decomposition

- **Biogas formation** occurs in the **absence of oxygen**, when **anaerobic bacteria** (such as *Methanobacterium*) decompose **organic waste**.
- This process is called **anaerobic digestion**.

Process	**Oxygen Requirement**	**Example**	**Gas Produced**
Aerobic	Present	Composting	CO_2, heat
Anaerobic	**Absent**	**Biogas production**	**CH_4, CO_2**

Source: *NCERT Class 10 Science – Sources of Energy*
Indian Express (2024): "Anaerobic digesters: the backbone of rural clean energy."
Diagram (Simplified):
Cattle dung + Water → Fermentation (Anaerobic)
↓
Biogas (CH4 + CO2) + Slurry (Fertilizer)

98. **Explanation:**
Correct Answer: (c)Ultrasonic

- **Ultrasonic waves** (>20 kHz) are used in **medical imaging (ultrasound)** to visualize internal organs.
- They are safe, non-invasive, and provide real-time imaging of tissues.

Application	**Frequency Used**	**Purpose**
Medical ultrasound	1–15 MHz (million Hz)	Imaging body tissues
SONAR	20–200 kHz	Underwater mapping
Industrial cleaning	25–40 kHz	Cleaning delicate parts

Source: *NCERT Class 9 Science – Chapter 12: Sound*
The Hindu (2022): "How ultrasound transformed medical diagnostics."

Govt. Source: *Ministry of Health & Family Welfare (2023): Medical Device Standards for Ultrasonic Equipment.*

99. **Explanation:**
Correct Answer: (b) Converting cattle dung and organic waste into biogas and compost

- **GOBAR-DHAN Scheme** was launched under the **Swachh Bharat Mission (Gramin)** by the **Ministry of Jal Shakti** in 2018.
- Aim: Promote **biogas production** from **cattle dung and solid waste** to ensure:
    - Clean villages
    - Energy security
    - Organic fertilizer availability

Parameter	Details
Scheme Name	GOBAR-DHAN
Ministry	Jal Shakti
Launch Year	2018
Key Objective	Waste-to-wealth through biogas
Output	Biogas + Organic compost

Source:

- *Ministry of Jal Shakti, GOBAR-DHAN Guidelines (2023)*
- *PIB Release: "Over 700 GOBAR-DHAN projects operational across India" (June 2024)*
  The Hindu (2024): "GOBAR-DHAN scheme gains traction in 2024 with biogas clusters."

100. **Explanation:Correct Answer: (c) Causes deforestation**
Advantages of Biogas (NCERT Class 10):

- Clean fuel (no smoke, low soot).
- Reduces dependence on firewood → prevents deforestation.
- Residue acts as excellent **manure**.
- Cost-effective for rural areas.

Advantage	Explanation
Renewable	Uses organic waste
Eco-friendly	Reduces CO_2 emissions
Fertilizer benefit	Slurry is nutrient-rich
Reduces deforestation	Less firewood used

Source: *NCERT Class 10 Science – Sources of Energy*
Indian Express (2023): "Biogas: rural India's weapon against deforestation."

101. Explanation:

- **Correct Answer: (c) Xylem : Transport of Water**
- Analysis:
  This question tests the precise understanding of the structure-function relationship in plant tissues.
- NCERT Reference:
  - Class 9 - Science, Chapter 6: Tissues: The functions of all the listed tissues are covered in this chapter.
    - Palisade Parenchyma: These are closely packed cells in the leaf that contain numerous chloroplasts. Their main function is photosynthesis, not transport.
    - Phloem: Its function is the transport of food.
    - Xylem: Its function is correctly the transport of water and minerals.
    - Guard Cells: Their primary function is to regulate stomata. While they may store some starch, it is not their defining function.

Summary of Tissue-Function Pairs:

Tissue	Correct Function
Palisade Parenchyma	Photosynthesis
Phloem	Transport of Food
Xylem	Transport of Water
Guard Cells	Regulate Stomata

102. **Explanation:**

- **Correct Answer: (c) Environmental Biotechnology**
- Analysis:
  This process, known as **Bioremediation**, uses naturally occurring microorganisms (like bacteria and fungi) to digest and break down environmental pollutants, converting them into less harmful substances.
- **NCERT & Government Source Reference:**
  - Class 12 - Biology, Chapter 10: Microbes in Human Welfare: This chapter explicitly discusses the role of microbes in "bioremediation" for cleaning up oil spills and other environmental contaminants. It provides a clear, curriculum-based link between microorganisms and this application.
  - CSIR-National Environmental Engineering Research Institute (NEERI): This premier institute under the Council of Scientific & Industrial Research actively

researches and develops bioremediation technologies for environmental cleanup, providing an authentic government-backed source for this application.

103. **Explanation:**

- **Correct Answer: (c) Genetic Engineering Appraisal Committee (GEAC)**
- Analysis:
  The GEAC is the **statutory body** under the **Ministry of Environment, Forest and Climate Change** responsible for the appraisal of activities involving large-scale use of hazardous microorganisms and recombinants in research and industrial production. It grants regulatory approval for the commercial release of GM crops.
- **Current Affairs & Government Source Reference:**
  - The Hindu: Articles discussing the approval or field trials of new GM crops (e.g., GM Mustard) consistently mention the GEAC as the apex regulatory body whose approval is mandatory.
  - Environment Protection Act, 1986: The GEAC is established under the "Rules for the Manufacture, Use/Import/Export and Storage of Hazardous Microorganisms/ Genetically Engineered Organisms or Cells, 1989" framed under this Act. Its composition and functions are detailed on the official website of the Ministry of Environment, Forest and Climate Change.

104. Explanation:

- **Correct Answer: (b) To determine the complete nucleotide sequence of the entire human** DNA.
- Analysis:
  The Human Genome Project (HGP) was an international, collaborative research program whose primary goal was the complete mapping and understanding of all the genes of human beings. This meant sequencing the entire ~3 billion base pairs of the human genome.
- Government & Current Affairs Reference:
  - Department of Biotechnology (DBT), Government of India: India was an active participant in the HGP. The DBT and the CSIR (Council of Scientific & Industrial Research) funded the Indian initiative, which sequenced the chromosome ends (telomeres). The DBT's official resources describe the HGP's goal as "decoding the entire human genome."
  - The Hindu / Indian Express: Articles commemorating the 20th anniversary of the HGP's completion in 2023 frequently highlighted its core achievement: "the first full sequence of the human genome." These articles also discuss its legacy in enabling personalized medicine and understanding genetic diseases.

105. **Explanation:**

Answer: (b) Transpiration

- Analysis:
  Transpiration is the loss of water in the form of vapour from the plant's surface. While it occurs through the cuticle and lenticels, the majority (90%) of transpiration happens through the stomata in the leaves. This process creates a "transpirational pull" that helps in the upward movement of water.
- NCERT Reference:
  - Class 10 - Science, Chapter 6: Life Processes: The process is clearly defined: "The loss of water in the form of vapour from the aerial parts of the plant is known as transpiration." It further explains its significance in the transport of water and minerals

106. Explanation:
Answer: (c) Epidermis

- Analysis:
  The epidermis is the outermost, protective layer of cells in a plant, covering the leaves, stems, and roots. Guard cells are specialized cells found within this epidermal layer.
- NCERT Reference:
  - Class 9 - Science, Chapter 6: Tissues: This chapter provides a clear description. It states, "The epidermis of the leaf is not continuous at some places because of the presence of small pores called stomata. Each stoma is bounded by a pair of specialised epidermal cells called guard cells."

The guard cells are embedded in the epidermis, surrounding the stomatal pore.

107. **Explanation:**
Correct Answer: (a) Liver – Emulsification of fats

- **Bile** is produced by the **liver** and stored in the **gall bladder**.
- It does **not contain enzymes** but helps in **emulsifying fats** — breaking large fat globules into smaller droplets, aiding lipase action.

Organ	Secretion	Function
Liver	Bile	Emulsifies fats
Pancreas	Pancreatic juice	Digest proteins, fats, carbs
Stomach	Gastric juice	Digest proteins
Salivary glands	Saliva	Breaks starch → maltose

Sources:

- *NCERT Class 10 Science – Life Processes*
- *MoHFW (Health Ministry), Digestive Health Guidelines*
- *The Hindu (2023): “How the liver aids digestion and metabolism”*

Diagram: Liver–Gall Bladder–Duodenum Connection

Liver → Bile → Gall Bladder → Duodenum → Fat Emulsification

108. **Explanation:**
Correct Answer: (a) Mouth → Oesophagus → Stomach → Small intestine → Large intestine → Anus

- The **alimentary canal** is a continuous passage for food digestion and absorption.

Step	Organ	Function
1	Mouth	Ingestion, starch digestion
2	Oesophagus	Food transport via peristalsis
3	Stomach	Protein digestion (pepsin)
4	Small Intestine	Digestion + absorption
5	Large Intestine	Water absorption
6	Anus	Egestion of undigested food

Sources:

- *NCERT Class 7 Science – Nutrition in Animals*
- *NCERT Class 10 Science – Life Processes*
- *Indian Express (2024): "How our digestive system works in harmony with gut bacteria"*

Diagram: Human Digestive System (Simplified)
Mouth → Oesophagus → Stomach → Small Intestine → Large Intestine → Anus

109. **Answer: (c)**
Explanation:

- **Watson & Crick (1953)** proposed the *Double Helix Model* of DNA using X-ray diffraction data by *Rosalind Franklin*.
- **Kary Mullis (1983)** developed *PCR technique*, not DNA fingerprinting.
- **Alec Jeffreys (1984)** developed *DNA fingerprinting*.
- **Ian Wilmut (1996)** cloned *Dolly the sheep*.

NCERT Link: Class 9 Science – Biotechnology section explains that DNA structure discovery led to the rise of genetic engineering.

110. **Answer: (b) Polymerase Chain Reaction (PCR)**
Explanation:

- Developed by **Kary Mullis (1983)**.
- Uses *Taq polymerase* enzyme from *Thermus aquaticus* bacteria.
- Used in diagnostics (COVID-19 RT-PCR), forensic science, and genetic studies.

Diagram (simplified)
DNA → Denaturation → Annealing → Extension → Repetition (x cycles)

NCERT Link: Class 9 Science – Biotechnology application in health;
Indian Express: "PCR at the heart of COVID-19 testing" (2020).

111. **Answer: (b) 100 J**
Explanation:

- Only **10% of energy** is transferred from one trophic level to the next.
- Calculation:
  - Plants (Producers) = 10,000 J
  - Herbivores = 10% of 10,000 = 1,000 J
  - Carnivores = 10% of 1,000 = 100 J
  - Tertiary consumers = 10% of 100 = 10 J (if counted further up)

Energy Pyramid Table:

Trophic Level	Energy (Joules)	% of Initial Energy
Producers	10,000	100%
Primary Consumers	1,000	10%
Secondary Consumers	100	1%
Tertiary Consumers	10	0.1%

NCERT Class 10: "Energy decreases at successive trophic levels due to loss as heat."
Indian Express: "Understanding Energy Flow in Ecosystems" (2022)

112. **Answer: (b) Simple tissues are uniform; complex tissues are composed of more than one type of cell**
Explanation:

- **Simple tissue:** Made of **similar cells** (Parenchyma, Collenchyma, Sclerenchyma)
- **Complex tissue:** Made of **more than one type of cell** to perform a collective function (Xylem: tracheids, vessels, xylem parenchyma, fibers; Phloem: sieve tubes, companion cells, phloem parenchyma, fibers)

NCERT Class 9 – Tissues in Plants
Diagram (Simplified):
Simple Tissue: Parenchyma → all similar cells
Complex Tissue: Xylem → vessel + tracheids + fibers + parenchyma

```
Plant Tissues
├── Meristematic Tissues
│    ├── Apical
│    ├── Lateral
│    └── Intercalary
└── Permanent Tissues
     ├── Simple Tissues
```

```
│   ├── Parenchyma
│   ├── Collenchyma
│   └── Sclerenchyma
└── Complex Tissues
    ├── Xylem
    └── Phloem
```

113. **Answer: (c) Sieve tube element**

Explanation:

- **Phloem:** Conducts food; composed of **sieve tube elements, companion cells, phloem fibers, phloem parenchyma**
- **Xylem:** Conducts water; sieve tubes are **absent**

Table: Xylem vs Phloem

Feature	Xylem	Phloem
Function	Water & minerals	Food conduction
Components	Tracheids, vessels, fibers, parenchyma	Sieve tubes, companion cells, fibers, parenchyma
Cell state	Mostly dead	Mostly living

114. **Explanation:**

- **Correct Answer: (b) Meiosis**
- Analysis:
  Organisms that reproduce sexually need a mechanism to reduce their chromosome number by half in the gametes. This ensures that when two gametes fuse during fertilization, the offspring has the correct number of chromosomes, not a doubled number. Meiosis is this special type of cell division.
- **NCERT Reference:**
  - Class 10 - Science, Chapter 8: How do Organisms Reproduce?: The chapter introduces the concept: "Meiosis is the process that ensures the production of haploid phase in the life cycle of sexually reproducing organisms, whereas fertilization ensures the restoration of diploid phase." It explains that this reduction is crucial for maintaining the stability of the DNA of a species.

Table: Mitosis vs. Meiosis

Feature	Mitosis	Meiosis
Purpose	Growth, repair, asexual reproduction	Production of gametes for sexual reproduction

Number of Divisions	One	Two
Daughter Cells	Two diploid (2n) cells	Four haploid (n) cells
Chromosome Number	Same as parent cell	Half of parent cell

115. **Answer: (b) It is the site where spindle fibers attach**
Explanation:

- The **kinetochore** is a protein complex at the **centromere** of chromosomes.
- It is the attachment site for **spindle microtubules** during **mitosis and meiosis**, enabling **chromosome segregation**.
- **Telomeres** protect chromosome ends; **chromonema** is the coiled DNA thread; **centriole** organizes the spindle, but spindle doesn't attach directly to it.

Diagram (Simplified):
Chromosome:
[Chromatid] – Centromere – Kinetochore → Spindle fiber attachment
NCERT Class 10: *How do Organisms Reproduce?* – Fig. 8.12 Mitosis diagram

116. **Answer: (b) Metabolic disorders**
Explanation:

- Malfunction of allosteric enzymes → **loss of feedback regulation** → accumulation or deficiency of metabolites.
- **Example:** Phosphofructokinase defect → glycolysis disruption; HMG-CoA reductase regulation → cholesterol imbalance.

Indian Express, 2022: "Allosteric enzyme defects and human metabolic diseases"

117. Answer: (b) 1, 2 and 4
Explanation:

- **Prokaryotes:** E. coli (bacterium), Lactobacillus (bacterium), Cyanobacteria (blue-green algae).
- **Amoeba:** Eukaryote (protist).
- Prokaryotes **lack nucleus**, have circular DNA, 70S ribosomes.

Diagram (Descriptive):
Prokaryotes: E. coli, Lactobacillus, Cyanobacteria → No nucleus
Eukaryotes: Amoeba → True nucleus
Source: NCERT Class 9 – *The Fundamental Unit of Life*

118. Answer: (a) 1 and 3 only
Explanation:

- **Prokaryotes:** No nucleus, no membrane-bound organelles; ribosomes are **70S**.
- **Eukaryotes:** True nucleus with nuclear envelope; ribosomes **80S**.
- **Cell wall:** Present in **most prokaryotes** (peptidoglycan) and in **plants/fungi**, absent in animals.

Feature	Prokaryote	Eukaryote
Nucleus	Absent	Present (with nuclear envelope)
Ribosome	70S	80S
Cell wall	Usually present	Plants/fungi only
Membrane-bound organelles	Absent	Present

Source: NCERT Class 9 & 10 – *The Fundamental Unit of Life*, *Life Processes*

119. **Answer: (b) 3-1-4-2**

Timeline:

Event	Year	Significance
DNA Fingerprinting (Jeffreys)	1984	Forensic genetics
PCR Technique (Mullis)	1983 (published 1985)	DNA amplification
Human Genome Project Launch	1990	Mapping entire human DNA
Dolly Cloning	1996	Cloning technology milestone

Source: NCERT Class 10 Science – Heredity; The Hindu archives on "50 years of DNA Fingerprinting".

120. **Explanation:**

Correct Answer: (c) They are biological catalysts that speed up reactions without being consumed.

- **Enzymes** are **biological catalysts** — mostly proteins.
- They lower the **activation energy** of biochemical reactions.
- They work best under **optimum temperature and pH** conditions.

Example	Function	Optimum pH
Salivary amylase	Starch → Maltose	~7
Pepsin	Proteins → Peptides	~2

Trypsin	Peptides → Amino acids	~8

Sources:

- *NCERT Class 10 Science – Life Processes*
- *The Hindu (2022): "The science behind how enzymes sustain life"*

121. **Explanation:**

Correct Answer: (b) Salivary amylase

- **Salivary amylase (ptyalin)**, secreted by **salivary glands**, breaks **starch (polysaccharide)** into **maltose (disaccharide)**.
- The saliva also moistens food to form a **bolus**, aiding swallowing.

Enzyme	Source	Acts On	End Product
Salivary amylase	Saliva	Starch	Maltose
Pepsin	Stomach	Proteins	Peptides
Lipase	Pancreas	Fats	Fatty acids, Glycerol
Trypsin	Pancreas	Peptides	Amino acids

Sources:

- *NCERT Class 7 Science – Nutrition in Animals*
- *NCERT Class 10 Science – Life Processes*
- *Indian Express, Science Explained (2024): "Why saliva is more than just water"*

Diagram: Enzyme Action in Mouth

Starch → (Salivary Amylase) → Maltose

122. **Explanation:**

- **Correct Answer: (b) Promotes self-reliance (Atmanirbharta) by engaging MSMEs and startups in defense innovation.**
- Analysis:
  iDEX is a key component of the government's push for 'Atmanirbhar Bharat' (Self-Reliant India) in the critical defense sector. It aims to tap into the innovative potential of domestic industry and academia.
- Current Affairs & Government Source Reference:
  - Ministry of Defence, Government of India: The official iDEX portal states its aim is "to foster innovation and technology development in Defence and Aerospace by engaging Industries including MSMEs, startups, individual innovators, R&D institutes and academia." It provides grants and support to winners of its challenges.

123. **Answer: (b) Adult Somatic Cell**

Explanation:

- *Dolly (1996)* cloned by **Ian Wilmut** and colleagues at *Roslin Institute, Scotland*.
- Technique: **Somatic Cell Nuclear Transfer (SCNT)** – nucleus from adult cell inserted into enucleated egg cell → embryo → surrogate mother.

Simplified Diagram:

Somatic Cell Nucleus + Enucleated Egg → Fusion → Embryo → Surrogate → Clone (Dolly)

NCERT Source: Class 10, Chapter on *Heredity and Evolution*.

The Hindu Science: "Legacy of Dolly – 25 years later" (2021)

124. **Answer: (c) Energy flows from producers to consumers and is lost as heat at each step.**

Explanation:

- Energy flows **from the sun → producers → consumers → decomposers**, and **cannot be recycled**.
- At each trophic level, energy is lost as **heat (10% Law)**, making the flow **unidirectional**.
- Hence, energy never flows backward in an ecosystem.

- **NCERT Source:** *Class 10, Our Environment*
- **The Hindu:** "Energy pyramids and ecological balance" (Science Page, 2023)

Diagram:

Sun → Producers (Plants) → Herbivores → Carnivores → Top Predators
↓ (energy loss as heat)

125. **Answer: (a) Grass → Grasshopper → Frog → Snake → Hawk**

Explanation:

- **Grass (Producer) → Grasshopper (Primary Consumer) → Frog (Secondary Consumer) → Snake (Tertiary Consumer) → Hawk (Top Predator)**.
- This demonstrates a simple food chain and how energy moves upward.

NCERT Class 7, Chapter 10: "Producers and consumers in an ecosystem."

MoEFCC: National Biodiversity Strategy and Action Plan highlights the importance of food chain interlinkages in ecosystem stability.

Diagram (Simple Food Chain):

Sun → Grass → Grasshopper → Frog → Snake → Hawk