

Chemical Engineering

1. An 'isothermal' process is one that occurs at constant:

- A) Pressure
- B) Volume
- C) Temperature
- D) Enthalpy

Answer: C) Temperature

Explanation: In an isothermal process, any heat added to or removed from the system is transferred slowly enough to allow the temperature to remain uniform.

2. The tendency of a liquid to resist flowing is known as its:

- A) Density
- B) Viscosity
- C) Surface tension
- D) Compressibility

Answer: B) Viscosity

Explanation: Viscosity is a measure of a fluid's internal friction. Honey has a high viscosity, while water has a low viscosity.

3. Wien's displacement law for thermal radiation states that the wavelength of maximum emission is:

- A) Directly proportional to the absolute temperature.
- B) Inversely proportional to the absolute temperature.
- C) Proportional to the fourth power of the absolute temperature.
- D) Independent of the temperature.

Answer: B) Inversely proportional to the absolute temperature.

Explanation: This law explains why objects glow "red hot" at lower temperatures and "white hot" at higher temperatures, as the peak of the emission spectrum shifts to shorter wavelengths.

4. A 'trommel' is a piece of mechanical operations equipment used for:

- A) Grinding materials.
- B) Mixing powders.

C) Screening and separating materials by size.

D) Pumping slurries.

Answer: C) Screening and separating materials by size.

Explanation: A trommel is a large rotating cylindrical screen. As it rotates, smaller particles fall through the holes while larger particles are carried to the discharge end.

5. 'Weeping' in a tray distillation column occurs when:

A) The vapor velocity is so high that it blows the liquid up the column.

B) The liquid level on the tray is too high.

C) The vapor velocity is too low, allowing liquid to leak through the perforations in the tray.

D) The feed to the column is a subcooled liquid.

Answer: C) The vapor velocity is too low, allowing liquid to leak through the perforations in the tray.

Explanation: Weeping reduces the efficiency of the tray because it allows liquid to bypass the intended mass transfer zone.

6. The 'cloud point' of a petroleum product like diesel fuel is the temperature at which:

A) It becomes flammable.

B) It starts to boil.

C) Wax crystals first begin to form, giving the fuel a hazy appearance.

D) It completely solidifies.

Answer: C) Wax crystals first begin to form, giving the fuel a hazy appearance.

Explanation: The cloud point is a critical low-temperature property for diesel, as the formation of wax crystals can clog fuel filters and lines.

7. The main function of sulfuric acid in the production of superphosphate fertiliser is to:

A) Provide sulfur as a nutrient.

B) Act as a catalyst.

C) Convert insoluble phosphate rock into a water-soluble form (monocalcium phosphate).

D) Act as a binding agent.

Answer: C) Convert insoluble phosphate rock into a water-soluble form (monocalcium phosphate).

Explanation: This chemical reaction makes the phosphorus in the rock available for plants to absorb.

8. 'Sublimation' is the phase transition of a substance directly from the:

A) Solid to the liquid state.

- B) Liquid to the gas state.
- C) Solid to the gas state.
- D) Gas to the solid state.

Answer: C) Solid to the gas state.

Explanation: Sublimation occurs without passing through the intermediate liquid phase. Dry ice (solid carbon dioxide) sublimating into CO₂ gas is a common example.

9. The 'atomic weight' of an element is the:

- A) Number of protons in its nucleus.
- B) Sum of protons and neutrons in its nucleus.
- C) Weighted average mass of its naturally occurring isotopes.
- D) Mass of a single atom of the most common isotope.

Answer: C) Weighted average mass of its naturally occurring isotopes.

Explanation: This is why the atomic weights listed on the periodic table are not whole numbers.

10. 'Split-range control' is a strategy where:

- A) The output of one controller sets the setpoint for another.
- B) One controller output is used to manipulate two or more final control elements.
- C) A controller selects the highest of several measurements.
- D) The controller gain changes based on the process variable.

Answer: B) One controller output is used to manipulate two or more final control elements.

Explanation: A common example is controlling vessel pressure, where the same controller output signal might control both a vent valve (for high pressure) and a nitrogen makeup valve (for low pressure), each operating over a different portion of the output range.

11. The 'quality' of a saturated liquid-vapor mixture (steam quality) is defined as the:

- A) Ratio of the mass of vapor to the mass of liquid.
- B) Ratio of the mass of liquid to the total mass.
- C) Ratio of the mass of vapor to the total mass.
- D) Temperature of the mixture.

Answer: C) Ratio of the mass of vapor to the total mass.

Explanation: A quality of 0 indicates a saturated liquid, while a quality of 1 (or 100%) indicates a saturated vapor.

12. A 'semibatch reactor' is one where:

- A) Reactants are charged all at once and products are removed at the end.
- B) Reactants and products flow continuously.
- C) One reactant is initially charged, and another is added continuously over time.
- D) The reaction is carried out in a series of small CSTRs.

Answer: C) One reactant is initially charged, and another is added continuously over time.

Explanation: This mode of operation is useful for controlling reaction rates, managing heat release in highly exothermic reactions, or when one reactant is a gas that needs to be bubbled through a liquid.

13. 'Coal' is primarily classified based on its:

- A) Color.
- B) Hardness.
- C) Rank, which reflects its degree of metamorphism and carbon content.
- D) Geographical origin.

Answer: C) Rank, which reflects its degree of metamorphism and carbon content.

Explanation: The ranks of coal, from lowest to highest, are lignite, sub-bituminous, bituminous, and anthracite. Higher-rank coals have higher carbon content and heating value.

14. 'Hydrogen embrittlement' is a material failure mechanism that can occur in steels when they:

- A) Are exposed to very high temperatures.
- B) Absorb atomic hydrogen, which reduces their ductility and toughness.
- C) Are repeatedly stressed and unstressed.
- D) Are placed in contact with a more noble metal.

Answer: B) Absorb atomic hydrogen, which reduces their ductility and toughness.

Explanation: Hydrogen atoms are small and can diffuse into the metal lattice, causing internal pressure and leading to brittle fracture at stress levels below the normal yield strength.

15. A 'bellows' is a flexible, accordion-like element used in piping systems and equipment to:

- A) Measure flow rate.
- B) Absorb mechanical movement, such as that caused by thermal expansion.
- C) Provide a seal around a rotating shaft.
- D) Increase the pressure of a fluid.

Answer: B) Absorb mechanical movement, such as that caused by thermal expansion.

Explanation: A bellows expansion joint can be installed in a long pipe run to prevent the stress that would otherwise build up as the pipe heats and cools.

16. The 'capital cost' of a project refers to the:

- A) Total expenditure required to construct the plant and bring it to operation.
- B) Annual cost of raw materials.
- C) Cost of labor and supervision.
- D) Annual maintenance cost.

Answer: A) Total expenditure required to construct the plant and bring it to operation.

Explanation: This includes the cost of equipment, installation, piping, instrumentation, buildings, and engineering. It is also known as the fixed capital investment.

17. The 'critical mass' of a fissile material is the:

- A) Mass of a single uranium atom.
- B) Total mass of fuel in a reactor.
- C) Minimum amount of fissile material needed to sustain a nuclear chain reaction.
- D) Mass that is converted to energy during fission.

Answer: C) Minimum amount of fissile material needed to sustain a nuclear chain reaction.

Explanation: The critical mass depends on the material's properties, its shape, and its density. For a given material, a sphere has the smallest critical mass.

18. 'Heat treatment' is a general term for various processes of heating and cooling metals to:

- A) Change their chemical composition.
- B) Alter their physical and mechanical properties.
- C) Polish their surface.
- D) Clean them.

Answer: B) Alter their physical and mechanical properties.

Explanation: Processes like annealing, quenching, and tempering are used to control properties like hardness, strength, and ductility.

19. A 'basic refractory' is a material that is chemically resistant to:

- A) Acidic slags and environments.
- B) Basic slags and environments.
- C) Neutral environments only.

D) All chemical environments.

Answer: B) Basic slags and environments.

Explanation: Basic refractories, such as magnesite (MgO) and dolomite (CaO·MgO), are used in steelmaking furnaces and other processes where the slags are basic.

20. A 'catalytic converter' in a car's exhaust system uses catalysts to:

A) Improve fuel efficiency.

B) Convert harmful pollutants like CO, NO_x, and unburned hydrocarbons into less harmful substances like CO₂, N₂, and H₂O.

C) Muffle the engine noise.

D) Cool the exhaust gases.

Answer: B) Convert harmful pollutants like CO, NO_x, and unburned hydrocarbons into less harmful substances like CO₂, N₂, and H₂O.

Explanation: This is a key emission control technology that uses precious metal catalysts like platinum, palladium, and rhodium.

21. 'Plasticizers' are additives used in polymers to:

A) Make them harder and more rigid.

B) Increase their flexibility, ductility, and softness.

C) Make them resistant to UV radiation.

D) Add color to them.

Answer: B) Increase their flexibility, ductility, and softness.

Explanation: Plasticizers are small molecules that fit between the polymer chains, increasing the spacing and allowing them to slide past each other more easily. Polyvinyl chloride (PVC) is often plasticized to make it flexible.

22. A 'pitot tube' is an instrument used to measure:

A) The local velocity of a fluid.

B) The average velocity in a pipe.

C) The viscosity of a fluid.

D) The density of a fluid.

Answer: A) The local velocity of a fluid.

Explanation: A pitot tube works by converting the kinetic energy of the fluid at a single point into potential energy in the form of a pressure difference (stagnation pressure vs. static pressure), which can then be related to the fluid velocity.

23. The 'NTU' (Number of Transfer Units) method is used for:

- A) Designing heat exchangers.
- B) Calculating the pressure drop in a pipe.
- C) Sizing a pump.
- D) Designing a distillation column.

Answer: A) Designing heat exchangers.

Explanation: The NTU method is an alternative to the LMTD method and is particularly useful when the outlet temperatures of the fluids are not known. NTU is a measure of the "thermal size" of the heat exchanger.

24. A 'thickener' is a piece of equipment used to:

- A) Increase the concentration of a slurry by allowing the solids to settle.
- B) Grind solids into a fine powder.
- C) Increase the viscosity of a liquid.
- D) Mix two slurries together.

Answer: A) Increase the concentration of a slurry by allowing the solids to settle.

Explanation: Thickeners are large, circular tanks where a dilute slurry is fed to the center. Solids settle to the bottom and are raked to a central outlet, while clear liquid overflows from the perimeter.

25. The interface between two immiscible liquid phases is at 'equilibrium' when the:

- A) Concentration of the solute is the same in both phases.
- B) Temperature and pressure are the same in both phases.
- C) Chemical potential (or fugacity) of the solute is the same in both phases.
- D) Volume of the two phases is equal.

Answer: C) The chemical potential (or fugacity) of the solute is the same in both phases.

Explanation: This is the fundamental thermodynamic criterion for phase equilibrium. It means there is no net driving force for the solute to move from one phase to the other.

26. The 'Reid Vapor Pressure' (RVP) is a standardized measure of the:

- A) Volatility of gasoline and other petroleum products.
- B) Density of crude oil.
- C) Flash point of kerosene.

D) Viscosity of lubricating oil.

Answer: A) Volatility of gasoline and other petroleum products.

Explanation: RVP is important for blending gasoline and is regulated for environmental reasons, as volatile components can evaporate and contribute to smog formation.

27. 'Diammonium phosphate' (DAP) is a popular fertiliser because it:

A) Has a very high nitrogen content only.

B) Is a liquid.

C) Supplies both nitrogen and phosphorus in a single compound.

D) Is a slow-release fertiliser.

Answer: C) Supplies both nitrogen and phosphorus in a single compound.

Explanation: DAP is a high-analysis fertiliser that provides two essential nutrients, making it efficient to transport and apply.

28. A 'purge' stream is used in a process with a recycle loop to:

A) Increase the concentration of the product.

B) Prevent the buildup of inerts or undesired by-products that enter with the feed.

C) Add more catalyst to the system.

D) Cool the reactor.

Answer: B) Prevent the buildup of inerts or undesired by-products that enter with the feed.

Explanation: A small fraction of the recycle stream is continuously bled off as a purge to keep the concentration of non-reactive components from building up to a level that would adversely affect the process.

29. 'Standard Temperature and Pressure' (STP) in chemistry traditionally refers to:

A) 0 degrees Celsius and 1 atm pressure.

B) 25 degrees Celsius and 1 atm pressure.

C) 0 Kelvin and 1 atm pressure.

D) 100 degrees Celsius and 1 bar pressure.

Answer: A) 0 degrees Celsius and 1 atm pressure.

Explanation: These conditions are often used as a standard reference point for expressing the properties of gases, such as molar volume.

30. 'Feedback control' is a strategy where the controller takes action based on:

- A) A measurement of a disturbance variable.
- B) A measurement of the controlled process variable.
- C) A predictive model of the process.
- D) The time of day.

Answer: B) A measurement of the controlled process variable.

Explanation: This is the most common control strategy. The controller measures the output of the process, compares it to the desired setpoint, and makes a corrective adjustment to the input. It is a reactive strategy.

31. The 'triple point' of a substance is the unique condition of:

- A) Temperature and pressure at which the solid, liquid, and gas phases can coexist in equilibrium.
- B) Temperature above which a substance cannot be liquefied.
- C) Pressure at which a substance boils at room temperature.
- D) Temperature at which a substance has zero entropy.

Answer: A) Temperature and pressure at which the solid, liquid, and a gas phase can coexist in equilibrium.

Explanation: The triple point of water is a defining point for the Kelvin temperature scale.

32. A 'fluidized bed reactor' (FBR) is a reactor where:

- A) The catalyst is in a fixed, packed bed.
- B) The fluid flows through a tube with no mixing.
- C) A fluid (gas or liquid) is passed upward through a bed of solid catalyst particles at a velocity high enough to suspend the particles.
- D) The reaction is carried out in batches.

Answer: C) A fluid (gas or liquid) is passed upward through a bed of solid catalyst particles at a velocity high enough to suspend the particles.

Explanation: This causes the entire bed of solids to behave like a vigorously boiling liquid, which provides excellent mixing, temperature uniformity, and heat transfer.

33. 'Soot' is a form of impure, amorphous carbon that results from:

- A) Complete combustion of hydrocarbons.
- B) Incomplete combustion of hydrocarbons.
- C) Gasification of coal.
- D) Nuclear fission.

Answer: B) Incomplete combustion of hydrocarbons.

Explanation: Soot formation occurs in fuel-rich conditions where there is not enough oxygen to convert all the carbon in the fuel to CO₂.

34. A 'pipe schedule' number is used to specify a pipe's:

- A) Length.
- B) Material of construction.
- C) Wall thickness.
- D) Outside diameter.

Answer: C) Wall thickness.

Explanation: For a given nominal pipe size, a higher schedule number corresponds to a thicker pipe wall, which allows it to withstand higher pressures.

35. A 'butterfly valve' provides flow control by:

- A) Lifting a plug off a seat.
- B) Sliding a flat gate across the flow path.
- C) Rotating a disc within the flow path.
- D) Pinching a flexible tube.

Answer: C) Rotating a disc within the flow path.

Explanation: A butterfly valve is a quarter-turn valve that is lightweight, low-cost, and fast-acting, making it suitable for on/off and throttling services, especially in large pipe sizes.

36. The 'Net Present Value' (NPV) of a project is the:

- A) Total profit the project will generate over its lifetime.
- B) Sum of the present values of all cash inflows minus the sum of the present values of all cash outflows.
- C) Initial cost of the investment.
- D) Time it takes for the project to become profitable.

Answer: B) The sum of the present values of all cash inflows minus the sum of the present values of all cash outflows.

Explanation: NPV is a standard method for evaluating projects. A positive NPV indicates that the projected earnings, when discounted to the present day, are greater than the initial investment, making the project acceptable.

37. The process of 'nuclear fusion' involves:

- A) The splitting of a heavy atomic nucleus into smaller ones.

- B) The combining of light atomic nuclei to form a heavier nucleus.
- C) The decay of a radioactive isotope.
- D) The conversion of a fertile isotope into a fissile one.

Answer: B) The combining of light atomic nuclei to form a heavier nucleus.

Explanation: Fusion, the process that powers the sun, releases an enormous amount of energy. Harnessing fusion for power generation on Earth is a major area of ongoing research.

38. 'Quenching' is a heat treatment process where a metal is:

- A) Heated to a high temperature and then cooled very rapidly.
- B) Heated to a high temperature and then cooled very slowly.
- C) Cooled to a very low temperature.
- D) Repeatedly heated and cooled.

Answer: A) Heated to a high temperature and then cooled very rapidly.

Explanation: Quenching (typically in water, oil, or air) is used to harden steel by trapping it in a hard, brittle martensitic phase. The steel is almost always tempered afterward to improve its toughness.

39. 'Refractory castables' are materials that are:

- A) Pre-fired bricks or shapes.
- B) A mixture of refractory aggregates and a binder that can be mixed with a liquid and installed by pouring or casting.
- C) Insulating fibers.
- D) A type of mortar.

Answer: B) A mixture of refractory aggregates and a binder that can be mixed with a liquid and installed by pouring or casting.

Explanation: Castables (or refractory concrete) provide great flexibility, allowing for the easy installation of monolithic linings in complex shapes.

40. A 'cyclone' is an environmental engineering device that is most efficient at removing:

- A) Very fine particulate matter (less than 1 micron).
- B) Gaseous pollutants.
- C) Coarse particulate matter (greater than 10 microns).
- D) Liquid mists.

Answer: C) Coarse particulate matter (greater than 10 microns).

Explanation: Cyclones are simple, low-cost mechanical collectors that use centrifugal force to separate particles. Their collection efficiency drops off significantly for smaller particles.

41. 'Polyethylene Terephthalate' (PET) is a polymer commonly used for:

- A) Plastic bags and films.
- B) Disposable beverage bottles and food containers.
- C) Pipes and plumbing fittings.
- D) Electrical insulation.

Answer: B) Disposable beverage bottles and food containers.

Explanation: PET is a strong, lightweight, and clear polyester that provides a good barrier to gases like oxygen and carbon dioxide, making it ideal for packaging carbonated drinks.

42. 'Stoke's Law' describes the:

- A) Pressure drop for turbulent flow in a pipe.
- B) Drag force on a small spherical particle moving at a very low Reynolds number in a fluid.
- C) Rate of heat transfer by convection.
- D) Rate of mass transfer by diffusion.

Answer: B) Drag force on a small spherical particle moving at a very low Reynolds number in a fluid.

Explanation: Stoke's Law is applicable for "creeping flow" conditions and is used in calculations for sedimentation, centrifugation, and viscosity measurement.

43. 'Blackbody' is an idealized object in heat transfer that:

- A) Reflects all incident radiation.
- B) Absorbs all incident radiation.
- C) Transmits all incident radiation.
- D) Has an emissivity of zero.

Answer: B) Absorbs all incident radiation.

Explanation: A blackbody is a perfect absorber and also a perfect emitter of thermal radiation, serving as a standard against which the radiative properties of real surfaces are compared.

44. A 'Jaw Crusher' reduces the size of large rocks and ore by:

- A) Impact from high-speed hammers.
- B) Grinding between two rotating cylinders.
- C) Compression between a fixed jaw and a moving jaw.
- D) Attrition in a tumbling drum.

Answer: C) Compression between a fixed jaw and a moving jaw.

Explanation: Jaw crushers are used for primary crushing, taking large run-of-mine material and breaking it down into a smaller size for further processing.

45. The 'Henry's Law' constant relates the partial pressure of a gas above a liquid to the:

- A) Mole fraction of the gas in the liquid phase.
- B) Mole fraction of the gas in the vapor phase.
- C) Total pressure of the system.
- D) Temperature of the system.

Answer: A) Mole fraction of the gas in the liquid phase.

Explanation: Henry's Law is used to describe the solubility of gases in liquids and is particularly accurate for dilute solutions of gases that do not react with the solvent.

46. In petroleum refining, 'coke' is a:

- A) High-octane blending component for gasoline.
- B) Solid, carbon-rich material produced in severe cracking processes.
- C) Type of catalyst used for hydrotreating.
- D) Gaseous fuel.

Answer: B) Solid, carbon-rich material produced in severe cracking processes.

Explanation: Petroleum coke is a final, solid byproduct of upgrading the heaviest residual oils. It can be used as a fuel or for producing anodes for the aluminum and steel industries.

47. In fertiliser terminology, 'NPK' stands for:

- A) Nitrate, Phosphate, Calcium.
- B) Nitrogen, Phosphorus, Potassium.
- C) Ammonium, Phosphate, Kaolin.
- D) Nitrogen, Potash, Ketone.

Answer: B) Nitrogen, Phosphorus, Potassium.

Explanation: These are the three primary macronutrients essential for plant life.

48. A 'block flow diagram' (BFD) is the simplest type of process diagram and shows:

- A) All the details of the piping and instrumentation.
- B) The major process units as simple blocks with their input and output streams.
- C) The layout of the plant on a map.
- D) The electrical one-line diagrams.

Answer: B) The major process units as simple blocks with their input and output streams.

Explanation: A BFD provides the most basic overview of a process, showing the overall flow of materials from raw materials to final products.

49. The 'heat of reaction' is the:

- A) Change in enthalpy that occurs during a chemical reaction.
- B) Energy required to start a reaction.
- C) Heat capacity of the products.
- D) Rate at which heat is released.

Answer: A) The change in enthalpy that occurs during a chemical reaction.

Explanation: It is negative for an exothermic reaction (heat is released) and positive for an endothermic reaction (heat is absorbed).

50. The term 'actuator' in a control loop refers to the device that:

- A) Senses the process variable.
- B) Performs the control calculation.
- C) Provides the power or motive force to operate the final control element.
- D) Records the process data.

Answer: C) Provides the power or motive force to operate the final control element.

Explanation: For a control valve, the actuator is the part (e.g., a pneumatic diaphragm or an electric motor) that physically moves the valve stem in response to the controller's signal.

51. The 'Zeroth Law of Thermodynamics' states that:

- A) Energy is always conserved.
- B) The entropy of the universe is always increasing.
- C) If two bodies are each in thermal equilibrium with a third body, then they are in thermal equilibrium with each other.
- D) The absolute zero of temperature is unattainable.

Answer: C) If two bodies are each in thermal equilibrium with a third body, then they are in thermal equilibrium with each other.

Explanation: This law is the basis for the concept of temperature and the validation of thermometers.

52. A 'poison' in the context of catalysis is a substance that:

- A) Increases the activity of a catalyst.

- B) Acts as a support for the catalyst.
- C) Strongly adsorbs to the active sites of a catalyst, reducing its activity.
- D) Is a product of the reaction.

Answer: C) Strongly adsorbs to the active sites of a catalyst, reducing its activity.

Explanation: Catalyst poisoning is a form of deactivation that can be either reversible or irreversible and is a major concern in industrial processes. Sulfur compounds are common poisons for many metal catalysts.

53. The 'Cetane number' is a measure of the:

- A) Energy content of diesel fuel.
- B) Ignition quality of diesel fuel.
- C) Viscosity of diesel fuel.
- D) Cloud point of diesel fuel.

Answer: B) The ignition quality of diesel fuel.

Explanation: The cetane number indicates the ignition delay, which is the time between the injection of fuel into the cylinder and the start of combustion. A higher cetane number means a shorter delay and smoother engine operation.

54. The type of steel most commonly used for constructing high-pressure vessels is:

- A) Cast iron.
- B) Low-carbon steel.
- C) High-strength, low-alloy (HSLA) steel.
- D) Tool steel.

Answer: C) High-strength, low-alloy (HSLA) steel.

Explanation: HSLA steels are designed to provide better mechanical properties and greater resistance to atmospheric corrosion than conventional carbon steels, allowing for stronger yet lighter vessels.

55. The 'packing' in a packed tower is designed to:

- A) Provide structural support for the tower.
- B) Catalyze the reaction.
- C) Provide a large surface area for contact between the gas and liquid phases.
- D) Filter out solid particles.

Answer: C) Provide a large surface area for contact between the gas and liquid phases.

Explanation: Packing materials (like Raschig rings or structured packing) are used in absorption, stripping, and distillation columns to promote efficient mass transfer.

56. 'Amortization' is an accounting term that refers to the process of:

- A) Paying off a debt over time in regular installments.
- B) Allocating the cost of an intangible asset over its useful life.
- C) Both A and B are correct.
- D) Calculating the salvage value of an asset.

Answer: C) Both A and B are correct.

Explanation: In finance, it refers to paying off a loan. In accounting, it is similar to depreciation but is used for intangible assets like patents, copyrights, and goodwill.

57. A 'meltdown' in a nuclear reactor is a severe accident where:

- A) The control rods fail to insert into the core.
- B) The reactor vessel ruptures due to high pressure.
- C) The fuel elements overheat and melt, leading to a loss of core integrity.
- D) The coolant pumps fail.

Answer: C) The fuel elements overheat and melt, leading to a loss of core integrity.

Explanation: A meltdown is caused by a loss of cooling to the reactor core, allowing the heat from radioactive decay to build up until the fuel and its cladding melt.

58. A 'burner management system' (BMS) in a furnace is a safety system designed to:

- A) Control the furnace temperature.
- B) Monitor and control the safe startup, operation, and shutdown of the combustion process.
- C) Adjust the air-to-fuel ratio for maximum efficiency.
- D) Control the pressure inside the furnace.

Answer: B) Monitor and control the safe startup, operation, and shutdown of the combustion process.

Explanation: A BMS is a critical safety interlock system that ensures a combustible mixture is not introduced into the furnace unless a flame is present, preventing furnace explosions.

59. The primary component of most 'insulating firebricks' is:

- A) Alumina and silica, with a high degree of porosity.
- B) Magnesite.

C) Silicon carbide.

D) Dense, high-purity alumina.

Answer: A) Alumina and silica, with a high degree of porosity.

Explanation: The high porosity traps air, which has a very low thermal conductivity. This makes insulating firebricks excellent for reducing heat loss but gives them lower strength and density compared to hard refractories.

60. 'Eutrophication' is an environmental problem caused by:

A) The release of toxic heavy metals into a waterway.

B) The enrichment of a body of water with nutrients, especially nitrogen and phosphorus.

C) An increase in the temperature of a body of water.

D) The presence of plastic waste.

Answer: B) The enrichment of a body of water with nutrients, especially nitrogen and phosphorus.

Explanation: This over-enrichment leads to excessive growth of algae (algal blooms). When the algae die and decompose, they consume large amounts of dissolved oxygen, creating hypoxic "dead zones" where fish and other aquatic life cannot survive.