

Chemical Engineering

1. The ideal gas law is most accurate at:

- A) Low pressure and high temperature.
- B) High pressure and low temperature.
- C) Low pressure and low temperature.
- D) High pressure and high temperature.

Answer: A) Low pressure and high temperature.

Explanation: At low pressures and high temperatures, the volume of gas molecules and the intermolecular forces between them are negligible, which are the core assumptions of the ideal gas model.

2. A fluid in which the viscosity changes with the applied shear stress is called a:

- A) Newtonian fluid.
- B) Ideal fluid.
- C) Non-Newtonian fluid.
- D) Compressible fluid.

Answer: C) Non-Newtonian fluid.

Explanation: Non-Newtonian fluids, like ketchup or cornstarch solutions, do not have a constant viscosity; it can depend on the shear rate (shear thinning/thickening) or time (thixotropic/rheoplectic).

3. The Log Mean Temperature Difference (LMTD) is used for the design of:

- A) Packed beds.
- B) Distillation columns.
- C) Heat exchangers.
- D) Centrifugal pumps.

Answer: C) Heat exchangers.

Explanation: LMTD is a logarithmic average of the temperature difference between the hot and cold fluids at each end of the exchanger, providing a more accurate driving force for heat transfer calculations than a simple arithmetic average.

4. 'Sedimentation' is a mechanical operation used to separate particles from a fluid based on:

- A) Their size using a screen.
- B) Their magnetic properties.
- C) Their settling velocity under the influence of gravity.
- D) Their solubility.

Answer: C) Their settling velocity under the influence of gravity.

Explanation: In a sedimentation process, denser particles settle out of a fluid over time due to gravity. This is used in clarifiers and thickeners in wastewater treatment and mineral processing.

5. The 'Sherwood number' (Sh) in mass transfer is analogous to which dimensionless number in heat transfer?

- A) Reynolds number (Re).
- B) Prandtl number (Pr).
- C) Nusselt number (Nu).
- D) Grashof number (Gr).

Answer: C) Nusselt number (Nu).

Explanation: The Nusselt number is the ratio of convective to conductive heat transfer, while the Sherwood number is the ratio of convective to diffusive mass transport. Both represent the ratio of total transport to molecular transport.

6. The 'Octane number' of gasoline is a measure of its:

- A) Energy content.
- B) Resistance to knocking or auto-ignition in an engine.
- C) Viscosity.
- D) Sulfur content.

Answer: B) Resistance to knocking or auto-ignition in an engine.

Explanation: A higher octane number indicates greater resistance to engine knock, which is the premature detonation of the fuel-air mixture.

7. The 'prilling' process in fertiliser technology is used to:

- A) Produce solid, spherical particles from a molten material.
- B) Grind raw materials.
- C) Mix different types of fertilisers.

D) Remove impurities.

Answer: A) Produce solid, spherical particles from a molten material.

Explanation: In a prilling tower, molten urea or ammonium nitrate is sprayed downwards and solidifies into small spheres ("prills") as it falls, making it easy to handle and apply.

8. 'Leaching' is a chemical process that involves:

- A) Separating a liquid mixture by boiling.
- B) Extracting a soluble component from a solid mixture by dissolving it in a liquid solvent.
- C) Reacting a gas with a solid catalyst.
- D) Grinding a solid to a fine powder.

Answer: B) Extracting a soluble component from a solid mixture by dissolving it in a liquid solvent.

Explanation: An everyday example of leaching is brewing coffee or tea, where the soluble flavor components are extracted from the solid grounds or leaves into hot water.

9. A 'mole' is a fundamental unit in stoichiometry that represents:

- A) A specific mass of a substance.
- B) Avogadro's number (approx. 6.022×10^{23}) of particles (atoms, molecules, etc.).
- C) The volume of a gas at standard conditions.
- D) The number of protons in an atom.

Answer: B) Avogadro's number (approx. 6.022×10^{23}) of particles (atoms, molecules, etc.).

Explanation: The mole is the standard unit for the amount of a substance, providing a bridge between the macroscopic mass of a substance and the microscopic number of its constituent particles.

10. The 'offset' in a process control system is the:

- A) Time it takes for the system to respond.
- B) Difference between the setpoint and the process variable in steady state.
- C) Maximum value of the process variable.
- D) Noise in the measurement signal.

Answer: B) The difference between the setpoint and the process variable in steady state.

Explanation: Offset is a persistent, steady-state error that is characteristic of purely proportional controllers. It can be eliminated by adding integral action to the controller.

11. 'Entropy' is a measure of the:

- A) Total energy of a system.
- B) Heat content of a system.
- C) Disorder or randomness of a system.
- D) Pressure of a system.

Answer: C) Disorder or randomness of a system.

Explanation: The Second Law of Thermodynamics states that the entropy of an isolated system always tends to increase over time, meaning systems spontaneously move towards a state of greater disorder.

12. A 'catalyst' increases the rate of a chemical reaction by:

- A) Increasing the reaction temperature.
- B) Increasing the concentration of reactants.
- C) Providing an alternative reaction pathway with a lower activation energy.
- D) Shifting the equilibrium towards the products.

Answer: C) Providing an alternative reaction pathway with a lower activation energy.

Explanation: A catalyst participates in the reaction but is not consumed. By lowering the energy barrier (activation energy), it allows the reaction to proceed much faster.

13. 'Flue gas' is the gas that:

- A) Is used as fuel in a furnace.
- B) Exits a combustion process, such as a furnace or boiler, via the flue or chimney.
- C) Is recycled back to the combustion chamber.
- D) Is used to cool the furnace.

Answer: B) Exits a combustion process, such as a furnace or boiler, via the flue or chimney.

Explanation: Flue gas consists mostly of nitrogen, carbon dioxide, and water vapor, along with unreacted oxygen and pollutants like NO_x and SO_x.

14. 'Galvanic corrosion' occurs when:

- A) A single metal corrodes uniformly.
- B) Two dissimilar metals are in electrical contact in the presence of an electrolyte.
- C) A metal is exposed to a high-velocity fluid.

D) A metal corrodes under a cyclic stress.

Answer: B) Two dissimilar metals are in electrical contact in the presence of an electrolyte.

Explanation: A galvanic cell is formed, and the more active (anodic) metal corrodes at an accelerated rate, while the less active (cathodic) metal is protected.

15. A 'reboiler' is a piece of equipment used in conjunction with a distillation column to:

A) Condense the overhead vapor.

B) Provide the heat required to vaporize the liquid at the bottom of the column.

C) Pump the liquid feed into the column.

D) Cool the final product.

Answer: B) Provide the heat required to vaporize the liquid at the bottom of the column.

Explanation: The vapor generated by the reboiler flows up the column, providing the vapor traffic necessary for the separation process.

16. A 'sunk cost' in economic analysis is a cost that:

A) Is expected to be incurred in the future.

B) Varies with the level of production.

C) Has already been incurred and cannot be recovered.

D) Is the same as the initial investment.

Answer: C) Has already been incurred and cannot be recovered.

Explanation: Sunk costs are irrelevant to future decisions because they cannot be changed, regardless of what course of action is taken.

17. The purpose of a 'breeder reactor' in nuclear power engineering is to:

A) Generate more fissile material than it consumes.

B) Use only liquid fuels.

C) Operate at very low temperatures.

D) Generate electricity without producing any waste.

Answer: A) Generate more fissile material than it consumes.

Explanation: Breeder reactors are designed to convert fertile isotopes (like Uranium-238) into fissile isotopes (like Plutonium-239) by capturing neutrons, thereby creating new fuel.

18. 'Sintering' is a process used in furnace and refractory technology to:

- A) Melt a material completely.
- B) Bond particles of a powder together by heating them below the melting point.
- C) Cool a material rapidly.
- D) Carve a shape out of a solid block.

Answer: B) Bond particles of a powder together by heating them below the melting point.

Explanation: Sintering is used to create dense, strong ceramic objects (like refractory bricks) from fine powders through diffusion and particle fusion.

19. The 'porosity' of a refractory brick is the ratio of the:

- A) Volume of open pores to the bulk volume of the brick.
- B) Weight of the brick to its volume.
- C) Crushing strength to the density.
- D) Thermal conductivity to the heat capacity.

Answer: A) The volume of open pores to the bulk volume of the brick.

Explanation: Porosity affects many properties of a refractory, including its strength, thermal conductivity, and resistance to slag penetration.

20. 'Activated sludge' is a process used in wastewater treatment that involves:

- A) Filtering water through sand and gravel.
- B) Aerating sewage to promote the growth of microorganisms that consume organic pollutants.
- C) Disinfecting water with chlorine.
- D) Removing dissolved salts by reverse osmosis.

Answer: B) Aerating sewage to promote the growth of microorganisms that consume organic pollutants.

Explanation: This biological process uses a mixed community of microorganisms (the activated sludge) to break down organic matter in wastewater into carbon dioxide, water, and more microorganisms.

21. 'Thermoplastics' and 'thermosets' are two major classes of polymers. The key difference is that thermoplastics:

- A) Are more resistant to chemicals.
- B) Cannot be recycled.

C) Can be repeatedly softened by heating and hardened by cooling.

D) Are always transparent.

Answer: C) Can be repeatedly softened by heating and hardened by cooling.

Explanation: Thermoplastics have linear or branched chains with weak intermolecular forces, allowing them to be remolded. Thermosets form a rigid, cross-linked network upon curing and cannot be remelted.

22. A 'manometer' is a device used to measure:

A) Flow rate.

B) Temperature.

C) Pressure difference.

D) Viscosity.

Answer: C) Pressure difference.

Explanation: A U-tube manometer measures pressure difference by balancing it against the weight of a column of liquid (like water or mercury). The difference in the liquid levels in the two arms indicates the pressure difference.

23. The 'fouling' of a heat exchanger refers to the:

A) Accumulation of unwanted deposits on the heat transfer surfaces.

B) Cracking or leaking of the tubes.

C) Vibration of the tubes.

D) Incorrect fluid flow path.

Answer: A) The accumulation of unwanted deposits on the heat transfer surfaces.

Explanation: Fouling (from scale, sediment, or biological growth) adds a layer of thermal resistance, which reduces the heat transfer coefficient and the overall efficiency of the exchanger.

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

A) Separate solid particles or liquid droplets from a gas stream using centrifugal force.

B) Grind solid materials.

C) Mix liquids.

D) Cool a hot gas stream.

Answer: A) Separate solid particles or liquid droplets from a gas stream using centrifugal force.

Explanation: The gas stream is forced into a vortex. The inertia of the heavier particles causes them to move outward, hit the wall, and fall to the bottom, while the clean gas exits from the top.

25. 'Azeotrope' is a liquid mixture that:

- A) Cannot be separated by distillation because the vapor has the same composition as the liquid.
- B) Has a very high boiling point.
- C) Is completely immiscible.
- D) Reacts with itself upon heating.

Answer: A) Cannot be separated by distillation because the vapor has the same composition as the liquid.

Explanation: At the azeotropic point, the mixture boils at a constant temperature without changing its composition, behaving like a pure substance.

26. 'Alkylation' is a refinery process that:

- A) Removes sulfur from gasoline.
- B) Increases the octane number by combining light olefins with isobutane.
- C) Breaks down heavy oils into lighter fractions.
- D) Converts straight-chain alkanes into aromatics.

Answer: B) Increases the octane number by combining light olefins with isobutane.

Explanation: Alkylation produces a high-octane gasoline blending component called alkylate, which is prized for its clean-burning properties.

27. The primary nutrients that fertilisers are designed to supply to plants are:

- A) Carbon, hydrogen, and oxygen.
- B) Nitrogen, phosphorus, and potassium.
- C) Calcium, magnesium, and sulfur.
- D) Iron, manganese, and zinc.

Answer: B) Nitrogen, phosphorus, and potassium.

Explanation: N, P, and K are the three primary macronutrients required in the largest amounts for healthy plant growth. The numbers on a fertiliser bag (e.g., 10-10-10) represent the percentage of N, P₂O₅, and K₂O.

28. 'Adsorption' is a process where:

- A) A substance is dissolved in the bulk of a liquid.
- B) A gas is converted into a liquid.
- C) Molecules of a substance adhere to the surface of a solid or liquid.
- D) A solid is melted.

Answer: C) Molecules of a substance adhere to the surface of a solid or liquid.

Explanation: Adsorption is a surface phenomenon, distinguished from absorption, where a substance permeates the entire bulk of another. Activated carbon is a common adsorbent used for purification.

29. The 'yield' of a chemical reaction is the:

- A) Rate at which the product is formed.
- B) Amount of product actually obtained compared to the theoretical maximum.
- C) Amount of catalyst used.
- D) Heat released by the reaction.

Answer: B) The amount of product actually obtained compared to the theoretical maximum.

Explanation: Percent yield is a measure of the efficiency of a reaction, calculated as (actual yield / theoretical yield) * 100%.

30. A 'rotameter' is a device used to measure:

- A) Pressure.
- B) Temperature.
- C) Fluid flow rate.
- D) Liquid density.

Answer: C) Fluid flow rate.

Explanation: A rotameter is a variable-area flowmeter. It consists of a tapered vertical tube with a float inside. The higher the flow rate, the higher the float rises in the tube.

31. A 'throttling' process in thermodynamics is one in which:

- A) The enthalpy of the fluid remains constant.
- B) The entropy of the fluid remains constant.
- C) The temperature of the fluid remains constant.
- D) The volume of the fluid remains constant.

Answer: A) The enthalpy of the fluid remains constant.

Explanation: Throttling is a rapid, irreversible expansion of a fluid through a restriction (like a valve) where there is no work done and negligible heat transfer.

32. A 'Plug Flow Reactor' (PFR) is an idealized reactor model where:

- A) The contents are perfectly mixed.
- B) The fluid flows as a series of plugs without any axial mixing.
- C) The reaction occurs in batches.
- D) The catalyst is fluidized.

Answer: B) The fluid flows as a series of plugs without any axial mixing.

Explanation: In a PFR, the concentration of reactants changes continuously along the length of the reactor, but there is no mixing in the direction of flow.

33. 'Orsat analysis' is a chemical method used to determine the:

- A) Calorific value of a fuel.
- B) Molar composition of a flue gas sample.
- C) Viscosity of a lubricating oil.
- D) Hardness of water.

Answer: B) The molar composition of a flue gas sample.

Explanation: The Orsat apparatus uses selective chemical absorption to measure the volume percentages of CO₂, O₂, and CO in a gas sample on a dry basis.

34. 'Case hardening' is a material treatment process that:

- A) Makes the entire component uniformly hard.
- B) Softens the surface of a component.
- C) Hardens the surface of a metal component while leaving the interior (core) tough and ductile.
- D) Coats a metal with a layer of another metal.

Answer: C) Hardens the surface of a metal component while leaving the interior (core) tough and ductile.

Explanation: This is done to improve wear resistance on the surface while maintaining the core's ability to withstand shock and impact. Carburizing and nitriding are common methods.

35. A 'gate valve' is a type of valve best suited for:

- A) Throttling or regulating flow.
- B) On/off service with minimal pressure drop when fully open.
- C) Preventing reverse flow.
- D) Controlling pressure.

Answer: B) On/off service with minimal pressure drop when fully open.

Explanation: A gate valve uses a flat gate that moves perpendicular to the flow. It is ideal for isolation because it offers very little resistance to flow when it is fully open.

36. 'Return on Investment' (ROI) is a performance measure used to evaluate the:

- A) Safety of a plant.
- B) Environmental impact of a project.
- C) Efficiency or profitability of an investment.
- D) Total cost of a project.

Answer: C) The efficiency or profitability of an investment.

Explanation: ROI is calculated as $(\text{Net Profit} / \text{Cost of Investment}) * 100\%$. It is a simple way to compare the profitability of different investment opportunities.

37. A 'Pressurized Water Reactor' (PWR) is a type of nuclear reactor that:

- A) Uses molten sodium as a coolant.
- B) Boils water directly in the reactor core to create steam.
- C) Uses high-pressure water as both a coolant and a moderator, which is kept from boiling.
- D) Uses natural uranium as fuel.

Answer: C) Uses high-pressure water as both a coolant and a moderator, which is kept from boiling.

Explanation: The high-pressure, hot water from the primary loop then transfers its heat to a secondary loop in a steam generator, where steam is produced to drive the turbines.

38. 'Fluidized bed combustion' is a furnace technology that:

- A) Burns fuel in a suspended bed of solid particles, providing excellent mixing and heat transfer.
- B) Burns liquid fuel in a fine spray.
- C) Burns fuel at extremely high temperatures in an electric arc.
- D) Burns fuel with pure oxygen instead of air.

Answer: A) Burns fuel in a suspended bed of solid particles, providing excellent mixing and heat transfer.

Explanation: This technology is known for its ability to burn a wide variety of fuels efficiently and with lower emissions of pollutants like NOx and SOx (if a sorbent like limestone is added to the bed).

39. 'Thermal shock' is the failure of a refractory material due to:

- A) Slow, uniform heating.
- B) Chemical attack by slags.
- C) Abrasion and erosion.
- D) Rapid changes in temperature causing internal stresses.

Answer: D) Rapid changes in temperature causing internal stresses.

Explanation: Good thermal shock resistance is crucial for refractories used in applications with frequent heating and cooling cycles.

40. The 'greenhouse effect' is the warming of the Earth's surface due to:

- A) The depletion of the ozone layer.
- B) The absorption and re-radiation of infrared radiation by certain gases in the atmosphere.
- C) The release of particulate matter from industrial processes.
- D) Acid rain.

Answer: B) The absorption and re-radiation of infrared radiation by certain gases in the atmosphere.

Explanation: Gases like carbon dioxide, methane, and water vapor act like a blanket, trapping heat that would otherwise escape into space.

41. 'Extrusion' is a polymer processing technique where:

- A) A polymer is injected into a closed mold.
- B) A sheet of polymer is heated and stretched over a mold.
- C) A molten polymer is forced through a die to create a continuous profile or shape.
- D) A hollow object is formed by inflating a heated tube of polymer.

Answer: C) A molten polymer is forced through a die to create a continuous profile or shape.

Explanation: Extrusion is used to make products with a constant cross-section, such as pipes, films, sheets, and fibers.

42. 'Cavitation' in a pump is the formation and collapse of:

- A) Air bubbles in the lubricating oil.
- B) Vapor bubbles in the pumped liquid due to low pressure.
- C) Solid particles from a slurry.
- D) A vortex at the pump inlet.

Answer: B) Vapor bubbles in the pumped liquid due to low pressure.

Explanation: If the pressure at the pump's suction drops below the vapor pressure of the liquid, the liquid boils. These vapor bubbles then collapse violently when they reach a higher pressure region, causing noise, vibration, and severe damage to the pump impeller.

43. 'Filmwise condensation' and 'dropwise condensation' are two modes of condensation. Which one provides a much higher heat transfer coefficient?

- A) Filmwise condensation.
- B) Dropwise condensation.
- C) Both provide the same coefficient.
- D) The coefficient is independent of the mode.

Answer: B) Dropwise condensation.

Explanation: In dropwise condensation, the condensate forms droplets that quickly roll off the surface, leaving it exposed for further condensation. In filmwise, a continuous film of liquid insulates the surface. Dropwise condensation is difficult to sustain, so equipment is usually designed assuming the less efficient filmwise mode.

44. 'Froth flotation' is a mechanical operation used in mineral processing to:

- A) Separate minerals based on differences in their surface hydrophobicity.
- B) Separate minerals based on their density.
- C) Grind ore to a fine powder.
- D) Separate minerals based on their magnetic properties.

Answer: A) Separate minerals based on differences in their surface hydrophobicity.

Explanation: Air bubbles are passed through a slurry of the ore. Hydrophobic (water-repelling) mineral particles attach to the bubbles and are floated to the surface as a froth, which is then skimmed off.

45. 'Relative volatility' is a measure used in distillation that compares the:

- A) Boiling points of two components.

B) Vapor pressures of two components at a given temperature.

C) Densities of two components.

D) Viscosities of two components.

Answer: B) The vapor pressures of two components at a given temperature.

Explanation: It indicates how easy or difficult it is to separate two components by distillation. A high relative volatility (much greater than 1) means the separation is easy.

46. 'Visbreaking' is a mild thermal cracking process in a refinery used to:

A) Produce high-octane gasoline.

B) Reduce the viscosity and pour point of heavy fuel oil.

C) Remove sulfur from kerosene.

D) Produce petroleum coke.

Answer: B) Reduce the viscosity and pour point of heavy fuel oil.

Explanation: Visbreaking (viscosity breaking) is a relatively simple and low-cost way to upgrade heavy residual oils into more valuable and easier-to-handle fuel oils.

47. 'Ammonium nitrate' is a nitrogen fertilizer known for its:

A) Low nitrogen content.

B) High nitrogen content and its use as an explosive.

C) Slow-release properties.

D) Liquid form at room temperature.

Answer: B) High nitrogen content and its use as an explosive.

Explanation: Ammonium nitrate is an excellent fertilizer, but its dual nature as a powerful oxidizing agent means its sale and handling are often strictly regulated.

48. A 'material balance' is an application of the:

A) Law of conservation of energy.

B) Law of conservation of mass.

C) Ideal gas law.

D) First law of thermodynamics.

Answer: B) The law of conservation of mass.

Explanation: It is an accounting of all the material that enters, leaves, accumulates in, or is generated/consumed within a process system, based on the principle that mass cannot be created or destroyed.

49. 'Degrees of freedom' analysis in stoichiometry is used to determine if:

- A) A material balance problem is solvable.
- B) A reaction will be spontaneous.
- C) A fluid flow will be laminar or turbulent.
- D) A process will be profitable.

Answer: A) A material balance problem is solvable.

Explanation: It involves comparing the number of unknown variables with the number of independent equations. If the degrees of freedom are zero, the problem is well-defined and has a unique solution.

50. A 'control valve' is considered the 'final control element' in a process loop. Its function is to:

- A) Measure the process variable.
- B) Compare the process variable to the setpoint.
- C) Directly manipulate a process stream (e.g., flow rate) to influence the process variable.
- D) Display the output of the controller.

Answer: C) Directly manipulate a process stream (e.g., flow rate) to influence the process variable.

Explanation: The controller sends a signal (e.g., 4-20 mA) to the control valve, which then opens or closes to change the flow of a fluid, thereby bringing the measured process variable back to its setpoint.

51. An 'adiabatic' process is one in which:

- A) The temperature of the system remains constant.
- B) The pressure of the system remains constant.
- C) The volume of the system remains constant.
- D) No heat is transferred between the system and its surroundings.

Answer: D) No heat is transferred between the system and its surroundings.

Explanation: An adiabatic process can be either reversible (isentropic) or irreversible. A perfectly insulated system is an example of an adiabatic system.

52. The 'order of a reaction' with respect to a particular reactant is the:

- A) Stoichiometric coefficient of that reactant in the balanced chemical equation.
- B) Exponent of that reactant's concentration term in the experimentally determined rate law.
- C) Number of molecules of that reactant.
- D) Temperature at which the reaction occurs.

Answer: B) The exponent of that reactant's concentration term in the experimentally determined rate law.

Explanation: The order of a reaction can only be determined by experiment; it cannot be deduced from the reaction's stoichiometry.

53. The 'stoichiometric air-fuel ratio' is the ratio of the:

- A) Mass of air to the mass of fuel for complete combustion.
- B) Volume of air to the volume of fuel for complete combustion.
- C) Moles of air to the moles of fuel for complete combustion.
- D) All of the above are correct.

Answer: D) All of the above are correct.

Explanation: The air-fuel ratio can be expressed on a mass, molar, or volume basis, and the stoichiometric ratio is the ideal ratio needed for perfect, complete combustion with no excess air or fuel.

54. 'Pitting corrosion' is a form of:

- A) Uniform corrosion that spreads evenly over a surface.
- B) Localized corrosion that leads to the formation of small holes or pits in a metal.
- C) Corrosion that occurs at the grain boundaries of a metal.
- D) Corrosion that is accelerated by mechanical stress.

Answer: B) Localized corrosion that leads to the formation of small holes or pits in a metal.

Explanation: Pitting is a particularly dangerous form of corrosion because it can cause a component to fail due to perforation with only a small overall loss of mass.

55. A 'check valve' is a piece of process equipment that:

- A) Allows flow in only one direction and prevents reverse flow.
- B) Regulates the pressure in a pipe.
- C) Is used for throttling flow.

D) Shuts off flow in an emergency.

Answer: A) Allows flow in only one direction and prevents reverse flow.

Explanation: Check valves (or non-return valves) operate automatically based on the pressure differential across them and are used to protect equipment like pumps from backflow.

56. The 'break-even point' is the level of production at which:

- A) The total revenue equals the total cost.
- B) The profit is maximized.
- C) The fixed costs equal the variable costs.
- D) The plant is operating at full capacity.

Answer: A) The total revenue equals the total cost.

Explanation: At the break-even point, the company is making neither a profit nor a loss. Production above this point is profitable.

57. A 'Boiling Water Reactor' (BWR) is a type of nuclear reactor where:

- A) The coolant is kept at very high pressure to prevent boiling.
- B) Water boils directly in the reactor core to produce steam that drives the turbine.
- C) Molten salt is used as the coolant.
- D) Heavy water is used as the moderator.

Answer: B) The water boils directly in the reactor core to produce steam that drives the turbine.

Explanation: Unlike a PWR, a BWR has a simpler design as it does not require separate steam generators, since the steam is produced directly within the reactor vessel itself.

58. A 'regenerator' is a type of heat exchanger used in some furnace systems where:

- A) Hot and cold fluids flow continuously in separate channels.
- B) The same flow passage is alternately exposed to hot and cold gas streams.
- C) The fluids are mixed directly.
- D) Heat is transferred only by conduction.

Answer: B) The same flow passage is alternately exposed to hot and cold gas streams.

Explanation: A porous, high-heat-capacity material (the checkerwork) is first heated by the hot exhaust gas. The flow is then switched, and the incoming cold combustion air is preheated by passing through the hot material, greatly improving the furnace's thermal efficiency.

59. 'Spalling' is a type of refractory failure characterized by:

- A) The melting of the refractory.
- B) The chemical dissolution of the refractory by slag.
- C) The cracking or flaking off of pieces from the surface.
- D) The gradual erosion of the surface by flowing gases.

Answer: C) The cracking or flaking off of pieces from the surface.

Explanation: Spalling can be caused by thermal shock (rapid temperature changes) or by mechanical stresses.

60. 'Reverse osmosis' is an environmental engineering process used for:

- A) Removing suspended solids from water.
- B) Disinfecting water.
- C) Removing dissolved salts and impurities from water by forcing it through a semipermeable membrane.
- D) Aerating water to remove dissolved gases.

Answer: C) Removing dissolved salts and impurities from water by forcing it through a semipermeable membrane.

Explanation: By applying a pressure greater than the natural osmotic pressure, water molecules are forced to move from a region of high solute concentration to one of lower concentration, leaving the dissolved salts behind. It is a key technology for desalination.