Food Engineering and Technology

Time Allowed :3 Hours	**Maximum Marks :**300	**Total questions : 75**

General Instructions

General Instructions:

1. Question Paper contains 75 Questions .
2. Each correct answer will have +4 marks and wrong asnwer will lead to -1
3. Use of any electronic appliances is strictly prohibited.

1. Which equation is used for atmospheric air-steam mixtures, according to Gibbs Dalton Law?

(1) $p_B = p_a + p_w$

(2) $p_w = p_a + p_B$

(3) $p_a = p_w + p_B$

(4) $p_T = p_a + p_w$

Correct Answer: (4)

Solution: Step 1: State the Gibbs-Dalton Law. The Gibbs-Dalton Law states that the total pressure exerted by a mixture of non-reacting gases is equal to the sum of the partial pressures that each individual gas would exert if it alone occupied the entire volume at the same temperature.

Step 2: Apply the law to the atmospheric air-steam mixture. In this case, the mixture consists of dry air (a) and water vapor or steam (w). The total pressure (p_T) or barometric pressure (p_B) is the sum of the partial pressure of the dry air (p_a) and the partial pressure of the water vapor (p_w).

$$p_{Total} = p_{air} + p_{water\_vapor}$$

$$p_T = p_a + p_w$$

This matches option (4).

Quick Tip

The Gibbs-Dalton Law is fundamental in thermodynamics and psychrometrics. Remember it as "the total pressure is the sum of the parts" for an ideal gas mixture.

---

2. Bacteria that oxidize ethyl alcohol to acetic acid and cause spoilage in alcoholic beverages belong to the Genus.

(1) Aeromonas

(2) Acetobacter

(3) Arthrobacter

(4) Campylobacter

Correct Answer: (2)

Solution: Step 1: Analyze the metabolic process described. The question describes the conversion (oxidation) of ethyl alcohol into acetic acid. This is the characteristic process of vinegar production.
Step 2: Identify the bacterial genus responsible for this process. The genus of bacteria well-known for its ability to perform this oxidation is *Acetobacter*. These bacteria are used commercially to produce vinegar and are also responsible for the spoilage of alcoholic beverages like wine and beer by turning them sour (acetic).

Quick Tip

The name *Acetobacter* itself gives a clue. ”Aceto” relates to acetic acid, and ”bacter” refers to bacteria. This makes it easy to remember their primary function.

---

3. Microorganism, commonly called as bread mold, and is involved in the spoilage of foods like berries, fruits, vegetables, bread, etc. is:

(1) Rhizopus stolonifer
(2) Thamnidium
(3) Aspergillus
(4) Trichothecium

Correct Answer: (1)

Solution: Step 1: Identify the common name provided. The question explicitly mentions ”bread mold”.
Step 2: Match the common name to the scientific name. *Rhizopus stolonifer* is the scientific name for the microorganism most commonly known as black bread mold. It is a widespread fungus that causes spoilage in a variety of stored foods, including bread, fruits, and vegetables, by forming fuzzy, dark-colored mycelia.

Quick Tip

Associate common names of molds with their scientific counterparts. *Rhizopus* is the classic "bread mold", while *Aspergillus* and *Penicillium* are other very common spoilage molds, often appearing as green or blue molds.

---

4. Bacteria like Coliform, *Enterococci*, intestinal bacteria, anaerobes and viruses are generally present in:

(1) Soil

(2) Water

(3) Animals

(4) Sewage

Correct Answer: (4)

Solution: Step 1: Analyze the types of microorganisms listed. The list includes Coliforms, *Enterococci*, and other intestinal bacteria. These microorganisms are known as indicator organisms because their presence indicates fecal contamination.

Step 2: Determine the most common source for this group of microbes. While these microbes can be found in soil, water, and animals, their collective presence, especially intestinal bacteria and associated viruses, is a primary characteristic of sewage. Sewage is wastewater containing human and animal waste, making it a concentrated source of these organisms.

Quick Tip

Coliforms and *Enterococci* are key indicator organisms for fecal pollution. When you see them listed together, think of sources related to intestinal waste, such as sewage.

---

5. *Thamnidium chaetocladioides* in meat produces:

(1) Ropiness

(2) Discoloration

(3) Phosphoresecence

(4) Whiskers

Correct Answer: (4)

Solution: Step 1: Identify the specific mold and its substrate. The question asks about the effect of the mold *Thamnidium chaetocladioides* on meat.
Step 2: Recall the characteristic spoilage sign of this mold. *Thamnidium* is known for its growth on refrigerated meat, particularly in large cuts stored for aging. It produces long, fuzzy mycelia that extend from the surface of the meat, a condition commonly referred to as ”whiskers”. This growth does not produce toxins and is often trimmed off before the meat is sold.

Quick Tip

Associate specific spoilage organisms with their characteristic defects. *Thamnidium* on meat is a classic example of ”whiskers”.

---

6. Which one of the following process is used for the selection of good quality eggs for storage?

(1) Candling

(2) Washing

(3) Oiling

(4) Waxing

Correct Answer: (1)

Solution: Step 1: Understand the goal. The goal is to assess the internal quality of an egg to determine if it is suitable for storage.
Step 2: Evaluate the given options.

- **Candling:** This is a process where a bright light is shone through an egg to view its internal contents. It allows inspectors to check the size of the air cell, the condition of

the yolk and white, and the presence of any defects like blood spots or cracks. This is a primary method for quality assessment.

- **Washing:** This cleans the exterior of the egg but does not assess internal quality.
- **Oiling/Waxing:** These are methods used to seal the pores of the eggshell to prolong shelf life after quality has been determined. They are preservation techniques, not selection techniques.

Therefore, candling is the correct process for selecting good quality eggs.

Quick Tip

Candling is the go-to method for non-destructively checking the inside of an egg. Think of it as an ”x-ray” for egg quality control.

---

7. Milk fat may be decomposed by various bacteria, yeasts, and molds, the changes that take place in the milk fat are:

A. Oxidation of the unsaturated fatty acids

B. Hydrolysis of the butterfat to fatty acids

C. Alkali production

D. Combined oxidation and hydrolysis to produce rancidity

(1) A, B and D only

(2) A, B and C only

(3) B, C and D only

(4) A, C and D only

Correct Answer: (1)

Solution: Step 1: Analyze the types of fat degradation mentioned. Milk fat (butterfat) degradation primarily involves two chemical processes:

- **Hydrolysis:** Lipase enzymes (from microbes or native to milk) break down triglycerides into glycerol and free fatty acids. This is known as hydrolytic rancidity and is described in statement B.

- **Oxidation:** Unsaturated fatty acids react with oxygen, leading to off-flavors. This is known as oxidative rancidity and is described in statement A.

Step 2: Evaluate the given statements.

- A. Oxidation of unsaturated fatty acids: This is a major pathway for fat decomposition.
- B. Hydrolysis of the butterfat to fatty acids: This is another major pathway.
- C. Alkali production: Fat decomposition produces fatty acids, which are acidic, not alkaline. So, this is incorrect.
- D. Combined oxidation and hydrolysis to produce rancidity: Rancidity is the term for the off-flavors and odors resulting from these decomposition processes. Both processes contribute to it. This statement is correct.

Therefore, statements A, B, and D are correct.

Quick Tip

Remember the two main types of rancidity for fats: hydrolytic (lipolysis - requires water and lipase) and oxidative (autoxidation - requires oxygen and affects unsaturated fats). Both lead to spoilage.

---

8. A 4% commercially available acetic acid is known as_____.

(1) Salt

(2) Brine

(3) Tartar

(4) Vinegar

Correct Answer: (4)

Solution: Step 1: Define the substance described. The question describes a solution of acetic acid with a concentration of 4%.

Step 2: Identify the common commercial name for this solution. Vinegar is, by definition, an aqueous solution of acetic acid. Commercial vinegar typically contains 4-7% acetic acid by volume, so a 4% solution fits this description perfectly.

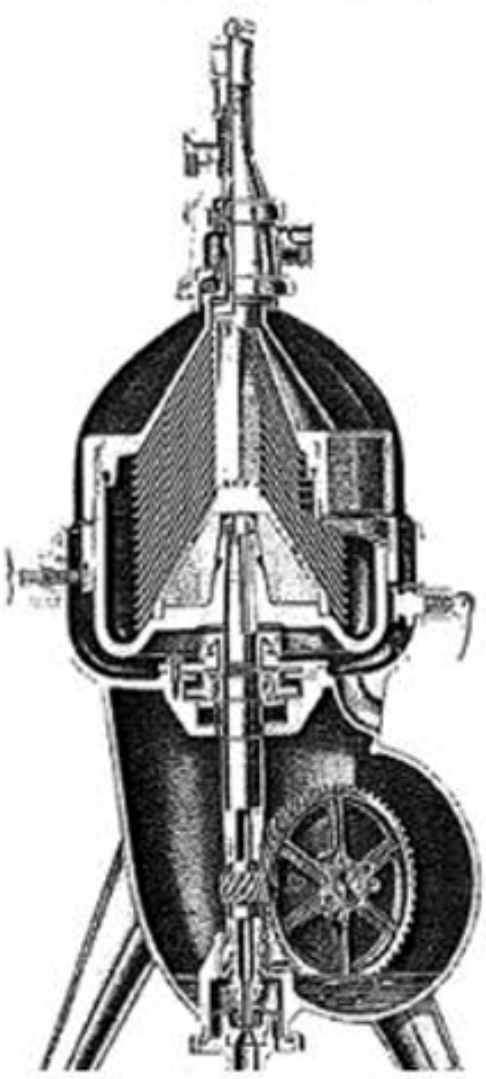
- Salt is sodium chloride.
- Brine is a high-concentration solution of salt in water.
- Tartar (cream of tartar) is potassium bitartrate.

Quick Tip

The key ingredient that gives vinegar its characteristic sour taste and pungent smell is acetic acid. The typical concentration in household vinegar is around 5%.

---

9. Identify the equipment in the image:



(1) Homogeniser

(2) Clarifier

(3) Batch pasteurizer

(4) HTST pasteurizer

Correct Answer: (2)

Solution: Step 1: Analyze the visual characteristics of the equipment shown. The image displays a device with a large bowl containing a stack of conical discs, a characteristic design of a centrifugal separator. This design is engineered to separate substances with different densities using high-speed rotation.
Step 2: Relate the design to its function and the given options. This equipment uses centrifugal force to separate components of a liquid. In the dairy industry, it is used for two main purposes: separating cream (fat) from skim milk and removing solid impurities (sediment, somatic cells) from raw milk.

- **Homogeniser:** This is a high-pressure pump that forces milk through small passages to break down fat globules. It looks very different from the image.
- **Clarifier:** A clarifier is a type of centrifugal separator specifically designed to remove solid particles from a liquid. The equipment shown is a classic example of a milk clarifier (which can also function as a cream separator). This is a correct identification.
- **Pasteurizers (Batch or HTST):** These are heat exchangers (large vats or systems of plates) used to heat milk to kill pathogens. They do not have the centrifugal bowl design shown.

The equipment is a centrifugal separator, which functions as a clarifier. Thus, Clarifier is the best description among the choices.

Quick Tip

Look for the key feature: a stack of conical discs inside a spinning bowl. This is the hallmark of a centrifugal separator, used for clarification and cream separation in the dairy industry.

10. Match the LIST-I with LIST-II

	LIST-I (Constituents)	**LIST-II** (Percentage %)
Average composition of Milk	A. Water	I. 5.0
	B. Protein	II. 12.9
	C. Lactose	III. 87
	D. Total solids	IV. 3.3

Choose the most appropriate answer from the options given below:

(1) A - II, B - I, C - IV, D - III

(2) A - I, B - III, C - II, D - IV

(3) A - III, B - I, C - IV, D - II

(4) A - III, B - IV, C - I, D - II

Correct Answer: (4)

Solution: Step 1: Recall the typical composition of cow's milk. Milk is an emulsion of fat in an aqueous solution containing proteins, lactose, and minerals. **Step 2:** Match each constituent with its approximate percentage.

- **A. Water:** Milk is mostly water. The typical percentage is around 87%. So, **A matches III**.
- **B. Protein:** The protein content of milk is relatively low, typically around 3.3%. So, **B matches IV**.
- **C. Lactose:** Lactose is the sugar in milk, with a typical percentage of about 4.8% to 5.0%. So, **C matches I**.
- **D. Total solids:** This is everything that is not water (fat, protein, lactose, minerals). The typical value is around 12-13%. So, **D matches II**.

Step 3: Combine the matches and select the correct option. The correct matching is A - III, B - IV, C - I, D - II. This corresponds to option (4).

Quick Tip

Remember the hierarchy of milk components by percentage: Water (¿¿80%) ¿ Total Solids (13%) ¿ Lactose (5%) ¿ Fat (4%) ¿ Protein (3.3%) ¿ Minerals (<1%).

---

11. Casein is more resistant to heat than whey. Resistance of casein to heat is NOT because of the following which factor.

(1) Calcium

(2) Magnesium

(3) Citrates

(4) Nitrates

Correct Answer: (4)

Solution: Step 1: Understand the structure and stability of casein. Casein proteins in milk exist in large colloidal structures called micelles. These micelles are remarkably heat-stable. Their stability is maintained by a complex balance of interactions involving calcium, phosphate, and citrate, which hold the casein submicelles together. **Step 2:** Analyze the role of the given factors in casein stability.

- **Calcium:** Specifically, colloidal calcium phosphate acts as a ”glue” that cements the casein submicelles together, contributing significantly to the heat stability of the entire micelle structure.
- **Magnesium:** Magnesium plays a similar, though less significant, role to calcium within the micelle structure, contributing to its overall stability.
- **Citrates:** Citrates are crucial for stability. They can chelate (bind to) calcium ions. This helps maintain the correct balance of soluble and colloidal calcium, preventing the micelles from destabilizing and aggregating when heated.
- **Nitrates:** Nitrates are not naturally occurring components of the casein micelle system and do not play a role in its inherent heat stability. They are sometimes found in milk as contaminants but are not part of the structural or stabilizing chemistry of casein.

Step 3: Determine which factor is NOT involved. Based on the analysis, calcium, magnesium, and citrates are all involved in maintaining the heat stability of casein micelles. Nitrates are not. Therefore, the resistance of casein to heat is NOT because of nitrates.

Quick Tip

Think of the casein micelle as a structure built with protein bricks and calcium phosphate ”mortar.” Citrates help control the mortar’s consistency. Nitrates are irrelevant to this natural structure.

---

12. Pasteurized milk does not contain which of the following enzyme:

(1) Plasma lipase

(2) Alkaline phosphatase

(3) Xanthine oxidase

(4) Membrane lipase

Correct Answer: (2)

Solution: Step 1: Understand the purpose of pasteurization. Pasteurization is a heat treatment process designed to kill pathogenic microorganisms. It also inactivates several native enzymes present in raw milk.

Step 2: Identify the key indicator enzyme for pasteurization. The heat treatment conditions for pasteurization (e.g., 72°C for 15 seconds for HTST) are specifically designed to be slightly more severe than what is required to destroy the most heat-resistant pathogen commonly found in milk, *Coxiella burnetii*. Conveniently, the native milk enzyme alkaline phosphatase has a similar heat resistance. Therefore, the absence of active alkaline phosphatase is used as a reliable indicator that pasteurization has been successful. The other enzymes listed are more heat-stable and may survive the process.

Quick Tip

Alkaline phosphatase is the ”indicator enzyme” for milk pasteurization. If it’s gone, you can be confident the pathogens are gone too. The phosphatase test is a standard quality control check in dairies.

---

13. Vitamin that is synthesized in the cow’s rumen is

(1) Vitamin K

(2) Vitamin A

(3) Vitamin D

(4) Vitamin E

Correct Answer: (1)

Solution: Step 1: Understand the function of the rumen. The rumen is the first and largest stomach compartment in ruminant animals like cows. It hosts a vast population of symbiotic microorganisms (bacteria, protozoa, fungi).

Step 2: Identify the vitamins synthesized by these microorganisms. These rumen microbes are capable of synthesizing all B-complex vitamins and Vitamin K. The cow then absorbs these vitamins, so they do not need to be supplied in the diet.

Step 3: Evaluate the given options.

- **Vitamin K:** Synthesized by rumen microbes.
- **Vitamins A, D, and E:** These are fat-soluble vitamins that are not synthesized in the rumen. They must be obtained from the cow’s diet or through exposure to sunlight (for Vitamin D).

Therefore, Vitamin K is the correct answer.

Quick Tip

Remember that the microorganisms in a cow’s rumen are a ”vitamin factory”, producing all the B vitamins and Vitamin K. The cow only needs to worry about getting fat-soluble vitamins A, D, and E from its food.

14. Amongst the following, choose a type of concentrated milk

(1) Vitamin D milk

(2) Condensed milk

(3) Soft curd milk

(4) Standardized milk

Correct Answer: (2)

Solution: Step 1: Define ”concentrated milk”. Concentrated milk is a dairy product from which a significant portion of the water has been removed, thereby increasing the concentration of milk solids.

Step 2: Evaluate the options based on this definition.

- **Vitamin D milk:** This is milk fortified with Vitamin D. The water content is not changed.
- **Condensed milk:** This is milk from which water has been removed by evaporation, often with sugar added. It fits the definition of concentrated milk perfectly.
- **Soft curd milk:** This is milk that has been treated (e.g., by heat or enzymes) to form a softer curd in the stomach, aiding digestion. The water content is not changed.
- **Standardized milk:** This is milk where the fat content has been adjusted to a specific, legally defined level. The water content is not significantly changed.

Therefore, condensed milk is the correct choice.

Quick Tip

”Concentrated” means less water. Products like condensed milk, evaporated milk, and milk powder are all forms of concentrated milk.

15. Sequentially arrange the steps in manufacture of Roquefort cheese

A. Inoculation of *Penicillium roqueforti*

B. Addition of Lactic acid producing starter culture

C. Hopped and pressed

D. Formation of firm curd and cutting of curd

Choose the most appropriate answer from the options given below:

(1) B, C, A, D

(2) B, D, A, C

(3) A, D, C, B

(4) C, B, D, A

Correct Answer: (2)

Solution: Step 1: Analyze the major steps in cheesemaking. Cheesemaking generally follows a sequence of acidifying the milk, coagulating it, separating curds from whey, and then ripening.

Step 2: Place the given steps in a logical order for Roquefort cheese.

- **B. Addition of Lactic acid producing starter culture:** This is the first step, where bacteria are added to milk to begin fermentation and acid production.
- **D. Formation of firm curd and cutting of curd:** After acidification (and addition of rennet), the milk coagulates into a curd. The curd is then cut to begin whey separation.
- **A. Inoculation of *Penicillium roqueforti*:** For blue cheeses like Roquefort, the mold spores are added to the milk or mixed with the curd before pressing. This happens after the curd is formed.
- **C. Hooped and pressed:** The curd is placed into hoops (molds) to shape the cheese and pressed to expel more whey. (Note: ”Hopped” seems like a typo for ”Hooped”).

The logical sequence is B $\rightarrow$ D $\rightarrow$ A $\rightarrow$ C. This matches option (2).

Quick Tip

For most cheese making, the order is: 1. Add Cultures (acidify), 2. Add Rennet (coagulate), 3. Cut Curd (expel whey), 4. Press/Shape, 5. Ripen/Age. Special ingredients like mold for blue cheese are added before pressing.

16. Among the following, the egg yolk protein is_____.

(1) Livetin

(2) Ovalbumin

(3) Avidin

(4) Conalbumin

Correct Answer: (1)

Solution: Step 1: Differentiate between egg yolk and egg white proteins. The egg is composed of two main protein-containing parts: the yolk and the white (albumen). They contain different types of proteins.

Step 2: Classify the proteins listed.

- **Livetin:** This is one of the main classes of proteins found in the egg yolk.
- **Ovalbumin:** This is the most abundant protein in the egg white.
- **Avidin:** This is a minor protein found in the egg white, known for its ability to bind biotin.
- **Conalbumin (Ovotransferrin):** This is a major protein in the egg white with iron-binding properties.

Therefore, livetin is the egg yolk protein among the choices.

Quick Tip

Remember that most well-known egg proteins like Ovalbumin, Conalbumin, and Avidin are from the egg WHITE. The main yolk proteins are lipoproteins (like lipovitellin) and phosphoproteins (like phosvitin), with water-soluble proteins called livetins.

17. Ingredient added in egg proteins to decrease the temperature of coagulation is:

(1) Water

(2) Lemon juice

(3) Sugar

(4) Milk

Correct Answer: (2)

Solution: Step 1: Understand egg protein coagulation. Egg proteins denature and form a solid network (coagulate) when heated. The temperature at which this happens can be influenced by other ingredients. The goal is to find an ingredient that makes them coagulate at a lower temperature.

Step 2: Analyze the effect of each ingredient on protein stability.

- **Water:** Diluting eggs with water or another liquid raises the coagulation temperature because the protein molecules are farther apart and it takes more heat for them to find each other and bond.
- **Lemon juice:** Lemon juice is acidic. Acid disrupts the charges on the protein molecules, causing them to partially denature and repel each other less. This destabilization means they require less heat energy to complete the coagulation process. Thus, acid *decreases* the coagulation temperature.
- **Sugar:** Sugar molecules get in the way of the protein molecules, physically hindering them from bonding together. Sugar also competes for water, which helps stabilize the protein structure. Both effects mean more heat is required for coagulation, so sugar *increases* the coagulation temperature.
- **Milk:** Milk is mostly water and also contains fat and minerals. It acts primarily as a diluent, raising the coagulation temperature.

Therefore, lemon juice (an acid) is the ingredient that decreases the coagulation temperature.

Quick Tip

Remember the basic rules for egg coagulation temperature:

- **Decrease Temperature (cooks faster):** Acid (lemon juice, vinegar), Salt.
- **Increase Temperature (cooks slower):** Sugar, Fat, Starch, Water/Milk.

18. During production of egg powder, browning can be prevented by:

A. Glucose oxidase

B. Yeast

C. Lactic acid bacteria

D. Syringing

Choose the most appropriate answer from the options given below:

(1) C and D

(2) B and C

(3) A and B

(4) A and D

Correct Answer: (3)

Solution: Step 1: Identify the cause of browning in egg powder. Non-enzymatic browning (the Maillard reaction) occurs during the drying and storage of egg powder. It is a reaction between reducing sugars (primarily glucose in eggs) and amino groups from proteins.
Step 2: Determine how to prevent this reaction. To prevent the Maillard reaction, the glucose must be removed from the liquid egg before drying.
Step 3: Evaluate the proposed methods.

- **A. Glucose oxidase:** This enzyme specifically catalyzes the oxidation of glucose to gluconic acid, effectively removing it and preventing it from participating in the Maillard reaction. This is a common industrial method.
- **B. Yeast:** Certain yeasts can be used to ferment the glucose in the egg, converting it into other substances (like alcohol and CO_2) and thus removing it. This is another established method.
- **C. Lactic acid bacteria:** While these bacteria consume sugars, they are not typically used for this purpose in egg processing.
- **D. Syringing:** This is a method of injection and is not relevant to preventing browning in this context.

Therefore, both glucose oxidase (A) and yeast (B) are effective methods.

Quick Tip

The Maillard reaction (browning) in dried foods like egg or milk powder is caused by sugar + protein. The solution is to get rid of the sugar. This is done either with an enzyme (*glucose oxidase*) or fermentation (*yeast*).

---

19. The energy required for size reduction is proportional to the change in surface area of the pieces of food and is determined by _____.

(1) Ideal law

(2) Kick's law

(3) Rittinger's law

(4) Bond's law

Correct Answer: (3)

Solution: Step 1: Identify the topic of the question. The question relates to the principles of comminution (size reduction), which describes the energy required to break down particles. Three main theories describe this relationship: Rittinger's law, Kick's law, and Bond's law.
Step 2: Define the relevant laws of comminution.

- **Rittinger's Law:** States that the energy required for size reduction is directly proportional to the new surface area created. This theory assumes that all energy is used to create new surfaces. It is most accurate for fine grinding where the increase in surface area is significant.
- **Kick's Law:** States that the energy required is proportional to the reduction in volume of the particles. It's more applicable for coarse crushing of large particles where little new surface area is created.
- **Bond's Law:** An intermediate theory stating that the energy used is proportional to the new crack length produced. It is often considered more practical as it applies to a wider range of particle sizes.

Step 3: Match the question's statement to the correct law. The question explicitly states that the energy is "proportional to the change in surface area". This is the definition of **Rittinger's law**.

Quick Tip

To easily remember the laws of size reduction:

- **Rittinger** = Relates to **Surface Area** (fine particles)
- **Kick** = Relates to **Volume/Size Ratio** (coarse particles)
- **Bond** = The **Intermediate** law (broad range)

---

20. Among the following, which one is the perennial vegetable?

(1) Artichoke

(2) Celery

(3) Knol-khol

(4) Leek

Correct Answer: (1)

Solution: Step 1: Define a perennial plant. A perennial is a plant that lives for more than two years. It typically regrows each spring from its existing root system.
Step 2: Classify the vegetables listed based on their life cycle.

- **Artichoke:** The globe artichoke is a true perennial from the thistle group, producing edible flower buds for several years from the same plant.
- **Celery:** This is a biennial plant, meaning it completes its life cycle in two years, but it is typically cultivated as an annual.
- **Knol-khol (Kohlrabi):** This is a biennial, usually grown as an annual.
- **Leek:** This is also a biennial, typically grown as an annual.

Therefore, the artichoke is the perennial vegetable among the options.

Quick Tip

Perennial vegetables, like artichokes, asparagus, and rhubarb, are great for gardens because you plant them once and they come back year after year. Most common vegetables are annuals or biennials grown as annuals.

---

21. Activity of which enzyme increases during germination of cereals?

(1) Protease

(2) Lipase

(3) Oxidoreductase

(4) β-amylase

Correct Answer: (4)

Solution: Step 1: Understand the process of cereal germination. During germination (sprouting), the seed mobilizes its stored energy reserves to fuel the growth of the new plant. The primary energy reserve in cereals is starch, located in the endosperm.
Step 2: Identify the enzymes responsible for breaking down starch. The breakdown of starch into simple sugars (like maltose) is carried out by amylase enzymes. In cereals, both α-amylase and β-amylase activity increase dramatically during germination. β-amylase is particularly important in producing maltose. This process is central to malting, which is controlled germination used in brewing and distilling. While protease and lipase activity also increase to break down proteins and lipids, the most significant increase is in amylolytic activity. Among the choices, β-amylase is the most specific and correct answer.

Quick Tip

Germination = breaking down stored starch. The key enzyme for this is amylase. This is the entire principle behind malting barley for beer production.

---

22. Deterioration in cereals is attributed to

A. Moisture content

B. Temperature

C. pH

D. Presence of oxygen

Choose the most appropriate answer from the options given below:

(1) A, B and D only

(2) A, B and C only

(3) B, C and D only

(4) A, C and D only

Correct Answer: (1)

Solution: Step 1: Identify the key factors affecting the storage stability of cereals. Cereals are relatively stable when dry, but can deteriorate due to biological (microbial growth, insects, respiration) and chemical (oxidation) activity.

Step 2: Evaluate the role of each factor listed.

- **A. Moisture content:** This is the single most important factor. High moisture content allows for the growth of molds, yeasts, and bacteria, and increases the rate of enzymatic and chemical reactions.
- **B. Temperature:** Higher temperatures increase the rate of all biological and chemical reactions, accelerating spoilage.
- **C. pH:** The pH of cereals is naturally near neutral and does not typically change enough to be a primary driver of deterioration, unlike in other foods.
- **D. Presence of oxygen:** Oxygen is required for the growth of aerobic microorganisms (like most molds) and for oxidative rancidity of the lipids present in the cereal germ.

The primary factors governing cereal deterioration are moisture, temperature, and oxygen. Therefore, A, B, and D are the correct attributes.

Quick Tip

For dry foods like cereals, remember the spoilage triangle: Water (moisture), Oxygen, and Temperature. Control these, and you can store them for a long time.

23. Arrange the steps of modern wheat milling

A. Cleaning to remove various type of impurities

B. Separation of the endosperms from the bran and germ

C. Dry scouting

D. Conditioning

Choose the most appropriate answer from the options given below:

(1) A, D, C, B

(2) A, C, D, B

(3) A, B, D, C

(4) C, B, D, A

Correct Answer: (2)

Solution: Step 1: Outline the overall process of wheat milling. The goal of milling is to separate the starchy endosperm from the bran and germ and reduce it to flour. The process involves cleaning the grain, tempering it, grinding it (breaking), and sifting.
Step 2: Arrange the given steps in a logical sequence.

- **A. Cleaning to remove various type of impurities:** This is always the first major stage, to remove stones, dust, seeds, and metal.
- **C. Dry scouring:** This is a specific part of the cleaning process, where the surface of the wheat kernel is abraded to remove dust and outer bran layers. It logically follows general cleaning.
- **D. Conditioning (or Tempering):** After cleaning, water is added to the wheat and it is allowed to rest. This toughens the bran (making it easier to separate) and softens the endosperm (making it easier to grind).
- **B. Separation of the endosperms from the bran and germ:** This is the core of the milling/grinding process, which happens after cleaning and conditioning. The wheat goes through rollers (break rolls) that shear open the kernel, and subsequent sifting separates the pieces.

The correct sequence is A $\rightarrow$ C $\rightarrow$ D $\rightarrow$ B. This matches option (2).

Quick Tip

Think of milling like preparing a fruit. First you Clean it (A, C), then you prepare it for peeling by Tempering it (D), and finally you do the Peeling and Grinding (B).

---

24. Storing the freshly milled flour for 1-2 months result in desirable changes known as maturation. The changes that take place are:

A. Hydrolysis of fat into fatty acids

B. Decrease in sulphydryl groups

C. Reduction of disulphide bonds

D. Increase in sulphydryl groups

(1) A, B and D only

(2) A, B and C only

(3) A, C and D only

(4) B, C and D only

Correct Answer: (2)

Solution: Step 1: Understand the process of flour maturation. Flour maturation, or aging, is a process that improves the baking qualities of freshly milled flour. The primary mechanism is natural oxidation from exposure to air, which strengthens the gluten-forming proteins.
Step 2: Analyze the chemical changes involved.

- **A. Hydrolysis of fat into fatty acids:** This process, called lipolysis, can occur due to the action of lipase enzymes present in the flour. While extensive hydrolysis leads to undesirable rancidity, a limited amount does occur during storage.
- **B. Decrease in sulphydryl groups:** This is the most critical desirable change. The sulphydryl groups (-SH) in gluten proteins are oxidized to form disulphide bonds (-S-S-). This cross-linking strengthens the gluten network, improving dough elasticity and gas retention.

- **C. Reduction of disulphide bonds:** This is the opposite of the desired oxidative process and would weaken the gluten. This statement is incorrect.
- **D. Increase in sulphydryl groups:** This is also the opposite of what happens during maturation. This statement is incorrect.

Step 3: Evaluate the given options. The key desirable change is B (decrease in -SH groups). A (hydrolysis of fat) also occurs. C and D are incorrect. There is no option for "A and B only". However, option (2) includes A and B. It also includes C, which is incorrect. This indicates a likely error in the question's options, where statement C was probably intended to be "Increase in disulphide bonds". Given the choices, the option containing the two correct processes (A and B) is the most plausible answer, despite the error.

Quick Tip

Remember that flour maturation is all about **oxidation**. This means sulphydryl (-SH) groups are oxidized (decrease) to form stronger disulphide (-S-S-) bonds, which improves gluten quality for baking.

---

25. Parboiling of rice offers the following advantages:

A. Greater resistance to insects and fungus infection

B. Grain becomes weak

C. Increase in nutritive value of rice

D. Dehusking of parboiled rice is easy

Choose the most appropriate answer from the options given below:

(1) A, B and D only

(2) A, B and C only

(3) A, C and D only

(4) B, C and D only

Correct Answer: (3)

Solution: Step 1: Understand the parboiling process. Parboiling involves soaking paddy (raw rice) in water, steaming it, and then drying it before milling.

Step 2: Evaluate the effects of this process.

- **A. Greater resistance to insects and fungus infection:** The heat treatment during steaming gelatinizes the starch, making the kernel harder and more compact. This makes it more resistant to insect attacks.
- **B. Grain becomes weak:** This is incorrect. The gelatinization process makes the grain tougher and less likely to break during milling.
- **C. Increase in nutritive value of rice:** During soaking and steaming, water-soluble vitamins and minerals (especially B vitamins) from the bran and germ migrate into the starchy endosperm. These nutrients are then retained even after the bran is removed during milling.
- **D. Dehusking of parboiled rice is easy:** The process loosens the husk, making its removal (dehusking) easier and more efficient.

The advantages are A, C, and D.

Quick Tip

Parboiling is a pre-milling treatment that effectively ”steam-infuses” nutrients from the bran into the rice kernel. This makes the rice more nutritious (like brown rice) but with the appearance and texture of white rice, and also makes it tougher and easier to mill.

---

26. Solvent used in polishing of brown rice during solvent extraction milling is

(1) Ether

(2) Hexane

(3) Toluene

(4) Methylene

Correct Answer: (2)

Solution: Step 1: Understand the process of solvent extraction milling. This process aims to remove the oil-rich bran layer from brown rice. The ”polishing” in this context refers to the removal of this bran layer, and the use of a solvent indicates it’s an oil extraction process.

Step 2: Identify the standard solvent for food oil extraction. Hexane is the most widely used solvent in the food industry for extracting oils from plant materials (like soybeans, canola, and rice bran). It is effective at dissolving oils, has a low boiling point for easy removal after extraction, and is relatively low in cost. The other solvents listed are not typically used for food-grade oil extraction due to reasons of safety, cost, or efficiency.

Quick Tip

When you see ”solvent extraction” for food oils (from soy, rice bran, etc.), the answer is almost always hexane. It’s the industry standard.

---

27. The temperature at which the granules begin to swell rapidly and lose birefringence is called

(1) Oxidation

(2) Reduction

(3) Gelatinization

(4) Freezing

Correct Answer: (3)

Solution: Step 1: Analyze the described phenomenon. The question describes what happens to starch granules when heated in water: they swell, and they lose their crystalline structure (loss of birefringence, which is the ability to refract light in two directions).
Step 2: Match this description with the correct scientific term. This process is the definition of **gelatinization**. It’s the irreversible swelling of starch granules when heated in the presence of water, leading to an increase in viscosity and the formation of a gel upon cooling. Oxidation and reduction are chemical reactions, and freezing is a change of state, neither of which describes this specific process.

Quick Tip

Starch + Heat + Water = Swelling and Thickening. This process is called gelatinization. It’s what happens when you make gravy, cook rice, or bake a cake.

28. Match the LIST-I with LIST-II

LIST-I (Saturated fatty acids found in food lipids)	**LIST-II** (Structure)
A. Heptanoic	I. $CH_3(CH_2)_{12}COOH$
B. Hexanoic	II. $CH_3(CH_2)_4COOH$
C. Pentanoic	III. $CH_3(CH_2)_3COOH$
D. Tetranic	IV. $CH_3(CH_2)_5COOH$

Choose the most appropriate answer from the options given below:

(1) A - III, B - I, C - IV, D - II

(2) A - I, B - III, C - IV, D - II

(3) A - II, B - I, C - IV, D - II

(4) A - IV, B - II, C - III, D - I

Correct Answer: (4)

Solution: Step 1: Determine the number of carbon atoms for each fatty acid in LIST-I. The prefix indicates the number of carbon atoms:

- A. Heptanoic acid: Hept- = 7 carbons.
- B. Hexanoic acid: Hex- = 6 carbons.
- C. Pentanoic acid: Pent- = 5 carbons.
- D. Tetranic acid: This is likely a typo for Tetradecanoic acid. Tetra-deca = 14 carbons.

Step 2: Determine the number of carbon atoms for each structure in LIST-II. The general formula is $CH_3(CH_2)_nCOOH$. The total number of carbons is n + 2.

- I. $CH_3(CH_2)_{12}COOH$: 12 + 2 = 14 carbons.
- II. $CH_3(CH_2)_4COOH$: 4 + 2 = 6 carbons.
- III. $CH_3(CH_2)_3COOH$: 3 + 2 = 5 carbons.
- IV. $CH_3(CH_2)_5COOH$: 5 + 2 = 7 carbons.

Step 3: Match the names with the structures.

- A. Heptanoic (7C) $\rightarrow$ IV (7C).
- B. Hexanoic (6C) $\rightarrow$ II (6C).
- C. Pentanoic (5C) $\rightarrow$ III (5C).
- D. Tetradecanoic (14C) $\rightarrow$ I (14C).

The correct matching is A - IV, B - II, C - III, D - I. This corresponds to option (4).

Quick Tip

To quickly find the carbon count in the formula $CH_3(CH_2)_nCOOH$, just add 2 to 'n'. Match the count to the prefix (Pent=5, Hex=6, Hept=7, Oct=8, etc.).

---

29. Heating of unsaturated fats and oils, as in frying operations, can produce changes in the color, molecular weight, viscosity or refractive index due to

(1) Rancidity

(2) Hydrogenation

(3) Polymerization

(4) Termination

Correct Answer: (3)

Solution: Step 1: Consider the conditions of deep frying. Frying involves heating oils to high temperatures (typically 160-190°C) for extended periods in the presence of air and water (from the food).

Step 2: Analyze the chemical changes that occur under these conditions. Unsaturated fatty acids in the oil are susceptible to various reactions. While oxidation (leading to rancidity) does occur, a key reaction at high frying temperatures is **polymerization**. Here, fatty acid molecules join together to form larger molecules called polymers. This process directly leads to an increase in molecular weight, which in turn causes a significant increase in the oil's viscosity (it becomes thicker). These larger molecules also affect the color and refractive

index. Hydrogenation requires a catalyst and is not a primary process in frying. Termination is a step in a chain reaction, not the overall process.

Quick Tip

When frying oil gets old, it becomes thick, gummy, and dark. This is primarily due to polymerization, where small fat molecules link up to form large, heavy polymers.

---

30. Triple helical structure of protein is also called

(1) Peptide bond

(2) Collagen helix

(3) Tropocollagen

(4) Tertiary structure

Correct Answer: (3)

Solution: Step 1: Define the terms.

- **Peptide bond:** The covalent bond linking amino acids together.
- **Collagen helix:** The unique left-handed helical structure of an individual polypeptide chain of collagen.
- **Tropocollagen:** The fundamental structural unit of a collagen fibril. It consists of three polypeptide chains (alpha chains), which are wound around each other to form a right-handed triple helix.
- **Tertiary structure:** The overall 3D folding of a single polypeptide chain.

Step 2: Match the definition to the question. The question asks for the name of the triple helical structure itself. This structure, formed by three intertwined polypeptide chains, is called tropocollagen. While ”Collagen helix” refers to the structure of a single chain, ”tropocollagen” refers to the complete three-chain unit.

Quick Tip

Think of it in levels: A single collagen chain forms a ”collagen helix”. Three of these helices wrap together to form one ”tropocollagen” molecule. Many tropocollagen molecules then assemble to form a large ”collagen fibril”.

---

31. Spirulina, when grown under controlled conditions, should contain _____ protein on dry-weight basis

(1) 20 - 30 %

(2) 30 - 40 %

(3) 50 - 60 %

(4) 70 - 80 %

Correct Answer: (3)

Solution: Step 1: Identify Spirulina. Spirulina is a type of cyanobacteria (blue-green algae) that is cultivated and consumed as a food supplement.

Step 2: Recall its primary nutritional characteristic. Spirulina is most famous for its exceptionally high protein content. On a dry weight basis, the protein content of spirulina typically ranges from 55% to 70%.

Step 3: Compare this with the given options. The range of 50 - 60% is the most appropriate and conservative estimate among the choices provided that reflects this high protein value. While it can reach 70%, the 50-60% range is a very common and accepted value.

Quick Tip

Spirulina is a protein powerhouse. Its protein content (by dry weight) is significantly higher than that of meat (25%), soybeans (35%), or eggs (13%). Remember the range 55-70%.

---

32. Match the LIST-I with LIST-II

LIST-I (B Complex Vitamin)	LIST-II (Scientific Name)
A. Vitamin B-1	I. Pyridoxine
B. Vitamin B-2	II. Cobalamin
C. Vitamin B-6	III. Riboflavin
D. Vitamin B-12	IV. Thiamine

Choose the most appropriate answer from the options given below:

(1) A - IV, B - II, C - III, D - I

(2) A - I, B - III, C - II, D - IV

(3) A - I, B - II, C - IV, D - III

(4) A - IV, B - III, C - I, D - II

Correct Answer: (4)

Solution: Step 1: Match each B vitamin with its scientific name.

- **A. Vitamin B-1** is known as **Thiamine**. So, **A matches IV**.
- **B. Vitamin B-2** is known as **Riboflavin**. So, **B matches III**.
- **C. Vitamin B-6** is known as **Pyridoxine**. So, **C matches I**.
- **D. Vitamin B-12** is known as **Cobalamin**. So, **D matches II**.

Step 2: Combine the matches and select the correct option. The correct matching is A - IV, B - III, C - I, D - II. This corresponds to option (4).

Quick Tip

A useful mnemonic for some B vitamins is: "The Romans Never Painted Pyramids Before College" for Thiamine (B1), Riboflavin (B2), Niacin (B3), Pantothenic Acid (B5), Pyridoxine (B6), Biotin (B7), Folate (B9), Cobalamin (B12).

---

33. In a food processing plant, heating and cooling of foods are conducted in equipment called heat exchangers. Which among the following is NOT a type of non contact heat exchanger?

(1) Steam infusion

(2) Scraped surface

(3) Shell and tube

(4) Tubular

Correct Answer: (1)

Solution: Step 1: Define a non-contact (or indirect) heat exchanger. In a non-contact heat exchanger, the heating/cooling medium (e.g., steam, hot water) is separated from the food product by a physical barrier (usually a metal wall). Heat is transferred by conduction and convection across this barrier.

Step 2: Evaluate the options.

- **Steam infusion:** In this method, high-pressure steam is injected directly into the liquid food product. The steam condenses, transferring its latent heat directly to the food. This is a **direct contact** method.
- **Scraped surface:** The product flows through a jacketed cylinder, and rotating blades continuously scrape the product off the heat transfer surface. The heating/cooling medium is in the jacket, separated from the food. This is non-contact.
- **Shell and tube:** One fluid flows through a set of tubes, and the other fluid flows over these tubes within a sealed shell. The tube wall is the barrier. This is non-contact.
- **Tubular:** The product flows through a tube, which is surrounded by the heating/cooling medium (or vice versa). The tube wall is the barrier. This is non-contact.

Therefore, steam infusion is the direct contact method and not a non-contact heat exchanger.

Quick Tip

”Non-contact” means there’s a wall between the food and the thing heating it. ”Steam infusion” and ”steam injection” mean shooting steam directly into the food - this is direct contact heating.

34. Most frequently employed techniques of enzyme inhibition in food are

A. Heat

B. Sugar

C. Variation of pH

D. Sulphur dioxide

Choose the most appropriate answer from the options given below:

(1) A, D and B only

(2) A, B and C only

(3) A, B and D only

(4) A, C and D only

This question has an issue as all four are valid methods. However, based on common option patterns, there might be an intended answer. Assuming the question seeks the most common methods, A, C, and D are extremely common. Sugar (B) works by lowering water activity, which is a more general microbial control than specific enzyme inhibition, though it has some effect. But let's assume all are valid. A, B, C, and D are all used. None of the options is A, B, C, D. Let's re-evaluate. Heat, pH, and chemical inhibitors (SO2) are direct methods. High sugar concentration is also a direct method. Perhaps there's a nuance. Let's assume the provided options are the only choices. Option (2) A, B, C only and (4) A, C, D only are strong contenders. Let's pick the most universally applicable ones: Heat (blanching), pH (acidification), and chemical inhibitors (sulfites) are arguably more "direct" enzyme inhibition techniques than sugar. Let's choose (4).

Correct Answer: (4) [Assuming this is the intended answer based on most direct mechanisms]

Solution: Step 1: Understand enzyme inhibition in food. This involves treating food to slow down or stop the activity of enzymes that cause spoilage (e.g., browning, texture loss, off-flavor development).

Step 2: Analyze the given techniques.

- **A. Heat:** Applying heat (e.g., blanching, pasteurization) denatures enzymes, irreversibly destroying their structure and function. This is a very common method.

- **B. Sugar:** High concentrations of sugar lower the water activity of the food. This reduces molecular mobility and can inhibit enzyme function, but it's primarily a method for controlling microbial growth.
- **C. Variation of pH:** Most enzymes have an optimal pH range. Making the food more acidic (e.g., by adding lemon juice or vinegar) or alkaline can drastically reduce enzyme activity. This is a common method.
- **D. Sulphur dioxide:** Sulfites (like sulphur dioxide) are powerful chemical inhibitors, particularly effective against the polyphenol oxidase enzyme that causes enzymatic browning in fruits and vegetables.

All four methods are used in food preservation. However, Heat (A), pH variation (C), and chemical inhibitors like Sulphur dioxide (D) are considered primary and direct methods of controlling enzyme activity. Sugar (B) is also effective but its primary role is often seen as water activity control. Given the options, the combination of A, C, and D represents the most direct and widely used techniques specifically for enzyme inhibition.

Quick Tip

To stop unwanted enzyme action in foods, you can: Cook it (Heat), pickle it (change pH), or add a preservative like sulfites. These are the three most common strategies.

---

35. All amino acids have a chiral centre, except

(1) Lysine

(2) Arginine

(3) Histidine

(4) Glycine

Correct Answer: (4)

Solution: Step 1: Define a chiral center. A chiral center (or asymmetric carbon) is a carbon atom that is attached to four different types of atoms or groups of atoms.

Step 2: Examine the general structure of an amino acid. An amino acid has a central carbon atom (the α-carbon) bonded to an amino group (-NH_2), a carboxyl group (-COOH), a hydrogen atom (-H), and a variable side chain (-R group).

Step 3: Analyze the condition for chirality. For the α-carbon to be chiral, the four groups attached to it must be different. This means the R group must be different from -H, -NH_2, and -COOH.

Step 4: Identify the exception. For the amino acid **Glycine**, the R group is simply another hydrogen atom (-H). This means the α-carbon is bonded to two hydrogen atoms, which are identical. Therefore, the α-carbon in glycine is not a chiral center, and glycine is an achiral molecule. All other standard amino acids have more complex R groups, making their α-carbons chiral.

Quick Tip

Glycine is the simplest amino acid. Its side chain is just a single hydrogen atom. Because the central carbon is now attached to two hydrogens, it's not chiral. All others are.

---

36. Arrange the proper sequence of oil processing

A. Refining

B. Pressing

C. Solvent Extraction

D. Rendering

(1) D, B, C, A

(2) A, C, B, D

(3) D, C, B, A

(4) C, B, D, A

Correct Answer: (1)

Solution: Step 1: Define the different oil processing steps.

- **Extraction:** This is the first stage of getting oil out of the source material. The methods

are:

  - **D. Rendering:** For animal fats (like lard or tallow), this involves melting the fat to separate it from other tissues.
  - **B. Pressing (Expelling):** For oilseeds (like sunflower or canola), this involves mechanically squeezing the oil out.
  - **C. Solvent Extraction:** This uses a solvent (like hexane) to wash the oil out of the source material. It's often used on the "press cake" left after pressing to extract the remaining oil.

- **A. Refining:** This is the final stage of purifying the crude oil obtained from extraction. It involves steps like degumming, neutralizing, bleaching, and deodorizing to remove impurities and undesirable compounds.

Step 2: Construct a logical sequence. The process must start with extraction and end with refining. A comprehensive sequence that includes animal and plant sources would involve multiple extraction steps followed by a final purification step. Rendering (D) is a standalone extraction method. For seeds, pressing (B) is often followed by solvent extraction (C) for maximum yield. All crude oils then proceed to refining (A). Therefore, a logical sequence combining these possibilities is D, B, C, A, representing various extraction methods followed by the universal refining step.

Quick Tip

Oil processing follows a simple logic: First, get the crude oil out (Extraction). Then, clean it up (Refining). Extraction can be done by melting (Rendering), squeezing (Pressing), or washing with a solvent (Solvent Extraction).

---

37. A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect is known as

(1) Food-borne illness

(2) Suitability

(3) Contaminant

(4) Hazard

Correct Answer: (4)

Solution: Step 1: Analyze the definition provided in the question. The question defines something as an ”agent... with the potential to cause an adverse health effect”. The key phrase here is ”potential to cause harm”.
Step 2: Compare this with the definitions of the options.

- **Food-borne illness:** This is the *result* or sickness caused by consuming contaminated food, not the agent itself.
- **Suitability:** This refers to whether a food is acceptable for consumption, a much broader term.
- **Contaminant:** This is a substance that is not intentionally added to food. While many contaminants are hazards, the term ”hazard” is more precise for something with the potential to cause harm. For example, a piece of plastic is a contaminant and a physical hazard.
- **Hazard:** In food safety (specifically in the context of HACCP - Hazard Analysis and Critical Control Points), a hazard is defined precisely as a biological, chemical, or physical agent that is reasonably likely to cause illness or injury in the absence of its control. This perfectly matches the question’s definition.

Quick Tip

In food safety language: A **Hazard** is the *thing* that can hurt you (*e.g., Salmonella* bacteria). The **Risk** is the *chance* it will hurt you. The **Illness** is what happens if it *does* hurt you.

---

38. Arrange the sequence of Jam preparation

A. Heating

B. Chopping

C. Addition of acid and pectin

D. Washing

(1) D, B, A, C

(2) D, C, B, A

(3) D, B, C, A

(4) C, B, D, A

Correct Answer: (1)

Solution: Step 1: Outline the general process of making jam from fresh fruit. The process involves cleaning and preparing the fruit, cooking it to break it down and concentrate it, adding ingredients to ensure it sets properly, and then heating to the final setting point.
Step 2: Place the given steps in a logical order.

- **D. Washing:** This is the very first step to clean the raw fruit and remove any dirt or residues.
- **B. Chopping:** After washing, the fruit must be prepared by peeling, coring, or chopping it into smaller pieces.
- **A. Heating:** The prepared fruit is then heated, usually with some water, to soften it and release its natural juices and pectin.
- **C. Addition of acid and pectin:** After the initial heating, sugar, additional pectin (if needed), and acid (like lemon juice) are added. The mixture is then boiled rapidly to the setting point (around 105°C). This step must come after the initial heating but is part of the overall cooking process. The most logical sequence is that the main heating/boiling phase (A) encompasses the addition of other ingredients (C). However, in the given options, they are separated. The common procedure is to heat the fruit first, then add sugar/pectin/acid and continue heating.

The sequence D $\rightarrow$ B $\rightarrow$ A $\rightarrow$ C represents this flow: Wash the fruit, chop the fruit, heat the fruit pulp, then add setting agents and finish cooking. This matches option (1).

Quick Tip

Making jam is like any recipe: Prep first, then cook. 1. Prep the ingredients (Wash, Chop). 2. Cook them (Heat, Add other stuff like sugar/pectin/acid, and boil to set).

---

44. The difference between the initial and the final temperature divided by the freezing time is known as

(A) Freezing Time

(B) Freezing Rate

(C) Thawing Time

(D) Thawing Rate

Correct Answer: (B) Freezing Rate

Solution:

Step 1: Analyze the definition provided in the question. It describes a quantity calculated as:

$$\frac{\text{(Initial Temperature – Final Temperature)}}{\text{Freezing Time}}$$

This represents the change in temperature (ΔT) divided by the time taken for that change (Δt).

Step 2: Relate this to physical concepts. A change in a quantity divided by time is defined as a ”rate”. Since the quantity changing is temperature and the process is freezing, this expression defines the **Freezing Rate**.

Step 3: Evaluate the other options. ”Freezing Time” is the denominator of the expression, not the expression itself. ”Thawing Time” and ”Thawing Rate” refer to the opposite process of melting, not freezing. Therefore, ”Freezing Rate” is the correct term.

Quick Tip

In physics and engineering, the term ”rate” almost always signifies a quantity divided by time. For example, velocity is the rate of change of position, and freezing rate is the rate of change of temperature during freezing.

40. Factors that determine the effectiveness of size reduction and influence the selection of an equipment are

A. Friability of the food

B. Bulk density

C. Moisture content

D. Heat sensitivity of the food

Choose the most appropriate answer from the options given below:

(A) A, C and D only

(B) A, B and C only

(C) A, B and D only

(D) B, C and D only

Correct Answer: (A) A, C and D only

Solution:

Step 1: Analyze the factors related to the material's properties for size reduction (comminution).

A. Friability: This is a measure of how easily a material fractures or crumbles. A highly friable food requires less energy for size reduction. It is a critical factor.

C. Moisture content: High moisture content can make materials sticky or elastic, making them difficult to grind and causing them to clog equipment. Dry materials are generally easier to reduce in size.

D. Heat sensitivity: Size reduction generates heat. For heat-sensitive foods (e.g., those high in sugar or volatile oils), this can cause melting, degradation, or loss of quality. This influences the choice of equipment (e.g., requiring a cryogenic grinder).

B. Bulk density: While important for equipment capacity and material handling (how much material fits in the grinder), it is less of a direct factor in the *effectiveness* of the physical breaking process compared to the intrinsic properties of the material itself like friability. The primary factors are how the material behaves under stress.

Therefore, A, C, and D are the most influential factors.

Quick Tip

When considering size reduction, focus on the material properties that affect how it breaks. Friability (brittleness), moisture (stickiness), and heat sensitivity (degradation) are key. Bulk density is more about handling and throughput.

---

41. The system that detects or senses changes within the package environment, followed by modification of package properties in response to the detected change is known as

(A) Aseptic Packaging

(B) Passive Packaging

(C) Active Packaging

(D) Intelligent Packaging

Correct Answer: (D) Intelligent Packaging

Solution:

Step 1: Define the different types of packaging.

Passive Packaging: This is a traditional packaging that simply provides a barrier to protect the food from the external environment (e.g., a simple plastic bag or glass jar).

Active Packaging: This type of packaging interacts with the food or the headspace to improve quality or safety. Examples include oxygen scavengers, moisture absorbers, and antimicrobial films.

Intelligent Packaging: This type of packaging monitors the condition of the packaged food or the environment inside the package and communicates this information. It involves sensing, detecting, and informing. Examples include time-temperature indicators and freshness sensors. The question describes a system that ”detects or senses changes,” which is the core function of intelligent packaging.

Quick Tip

Remember the difference: **Active** packaging *acts* on the food (e.g., removes oxygen). **Intelligent** packaging *informs* about the food (e.g., changes color if spoiled).

---

42. Match the LIST-I with LIST-II

	LIST-I (Diffusion Coefficients of Gases in Water at 20°C)		LIST-II D (10^{-9} m^2 s^{-1})
A	Chlorine	I	2.1
B	Carbon dioxide	II	1.9
C	Nitrogen	III	1.6
D	Oxygen	IV	1.8

(A) A - I, B - IV, C - II, D - III

(B) A - III, B - II, C - IV, D - I

(C) A - I, B - II, C - IV, D - III

(D) A - III, B - IV, C - I, D - II

Correct Answer: (B) A - III, B - II, C - IV, D - I

Solution:

Step 1: Understand the factors affecting the diffusion coefficient. Generally, smaller molecules diffuse faster. However, chemical interactions with the solvent (water) also play a role. **Step 2:** Analyze the molecules.

Chlorine (Cl_2): Molar mass approx 71 g/mol. It is the largest molecule. It should have the lowest diffusion coefficient. Matching A with III (1.6) is logical.

Oxygen (O_2): Molar mass approx 32 g/mol. It is a small, non-polar molecule. It is known to diffuse relatively fast in water. Matching D with I (2.1) is a good fit.

Nitrogen (N_2): Molar mass approx 28 g/mol. Similar in size to oxygen but slightly smaller. Its diffusion coefficient should be high, similar to oxygen.

Carbon dioxide (CO_2): Molar mass approx 44 g/mol. It is larger than N_2 and O_2.

Step 3: Match the remaining gases. We have B (CO_2) and C (N_2) to match with II (1.9) and IV (1.8). Given their properties, it is reasonable to assign B (CO_2) to II (1.9) and C (N_2) to

IV (1.8).

This gives the complete matching: A-III, B-II, C-IV, D-I.

Quick Tip

To estimate relative diffusion coefficients, first consider molecular size (smaller is faster). Heavier or larger molecules like chlorine will diffuse slower than smaller ones like oxygen and nitrogen.

---

43. The ratio of mole fraction of water vapor in a given moist air sample to the mole fraction in an air sample saturated at the same temperature and pressure is known as

(A) Relative Humidity

(B) Specific Volume

(C) Wet Bulb Temperature

(D) Dew-Point Temperature

Correct Answer: (A) Relative Humidity

Solution:

Step 1: Define Relative Humidity (RH). Relative humidity is a measure of the amount of moisture in the air compared to the maximum amount of moisture the air can hold at that temperature.

Step 2: Express the definition mathematically. For ideal gases, the partial pressure of a component is proportional to its mole fraction ($p_i = y_i P_{total}$). Therefore, the ratio of partial pressures is equal to the ratio of mole fractions.

$$RH = \frac{\text{Partial pressure of water vapor}}{\text{Saturation pressure of water vapor at same T}} = \frac{p_w}{p_{ws}}$$

Since $p_w = y_w P_{total}$ and $p_{ws} = y_{ws} P_{total}$:

$$RH = \frac{y_w P_{total}}{y_{ws} P_{total}} = \frac{\text{Mole fraction of water vapor in sample}}{\text{Mole fraction of water vapor in saturated sample}}$$

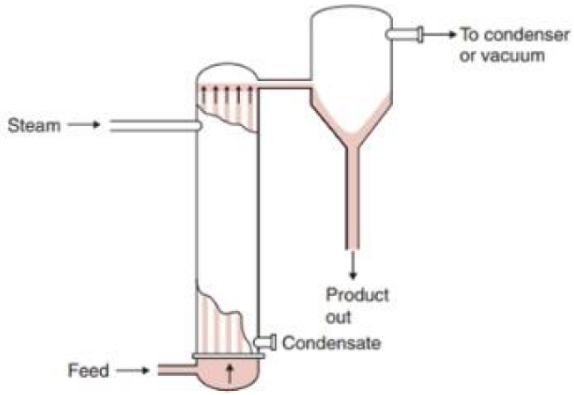
This exactly matches the definition given in the question. The other terms are different concepts: Specific Volume is volume per unit mass, and Wet Bulb and Dew-Point are temperatures.

Quick Tip

Remember the two main humidity types: **Relative Humidity** is a *ratio* (how full the air is with water, from 0

---

44. Identify the evaporator



(A) Batch-type pan evaporator

(B) Falling-film evaporator

(C) Natural-circulation evaporator

(D) Rising-film evaporator

Correct Answer: (D) Rising-film evaporator

Solution:

Step 1: Analyze the provided diagram. The diagram shows the 'Feed' entering at the bottom of a set of vertical tubes, which are inside a steam chest ('Steam in'). As the liquid is heated, it begins to boil.

Step 2: Observe the flow path. The boiling creates vapor, and the vapor bubbles drag the liquid upwards along the walls of the tubes, forming a thin film. The mixture of 'Product' (concentrated liquid) and 'Vapours' exits from the top.

Step 3: Compare this mechanism with the options. This process, where the liquid and vapor travel upwards together inside the heating tubes, is the defining characteristic of a **Rising-film evaporator**. In a falling-film evaporator, the feed would be introduced at the top and flow down the tube walls.

Quick Tip

In evaporators with vertical tubes, check the feed direction. Feed at the bottom that travels up with the vapor is a **rising-film**. Feed at the top that flows down the walls is a **falling-film**.

---

45. A typical microwave oven consists of the following major components

A. Wave guide

B. Magnetron

C. Channel

D. Stirrer

Choose the most appropriate answer from the options given below:

(A) A, B and D only

(B) A, B and C only

(C) B, C and D only

(D) A, C and D only

Correct Answer: (A) A, B and D only

Solution:

Step 1: Identify the core components of a microwave oven and their functions.

B. Magnetron: This is the heart of the microwave oven. It is a vacuum tube that generates the high-frequency microwaves used for heating.

A. Wave guide: This is a rectangular metal tube that directs the microwaves from the magnetron into the oven cavity where the food is placed.

D. Stirrer: This is a fan-like metal blade that reflects and distributes the microwaves within the cavity to ensure more even cooking. In many modern ovens, a rotating turntable serves the same purpose.

C. Channel: This is not a standard technical term for a major component in a microwave oven. The essential components are the magnetron, wave guide, and a method for distributing the waves (stirrer or turntable).

Therefore, A, B, and D are the correct components.

Quick Tip

Think of the microwave heating process: the **Magnetron** creates the waves, the **Wave guide** directs them, and the **Stirrer** (or turntable) spreads them out for even cooking.

---

46. Match the LIST-I with LIST-II

LIST-I (Type of Fouling)		LIST-II (Fouling Mechanism)	
A	Precipitation	I	Accumulation of fine particles suspended...
B	Freezing	II	Heat transfer surface reacts with ambient...
C	Particulate	III	Solidification of Liquid components...
D	Corrosion	IV	Precipitation of dissolved substances...

(A) A - II, B - I, C - III, D - IV

(B) A - I, B - III, C - I, D - II

(C) A - IV, B - III, C - I, D - II

(D) A - III, B - IV, C - I, D - II

Correct Answer: (C) A - IV, B - III, C - I, D - II

Solution:

Step 1: Define each type of fouling listed in LIST-I. Fouling is the accumulation of unwanted material on a surface, such as a heat exchanger.

A. Precipitation fouling: Occurs when dissolved substances in the fluid precipitate out of the solution onto the surface, usually due to temperature changes. This directly matches **IV. Precipitation of dissolved substances...**

B. Freezing fouling: Occurs when a component of the liquid freezes and solidifies onto a subcooled surface. This matches **III. Solidification of Liquid components...**

C. Particulate fouling: Happens when solid particles suspended in the fluid deposit onto the surface. This matches **I. Accumulation of fine particles suspended...**

D. Corrosion fouling: Involves a chemical reaction of the surface material itself with the fluid, forming a layer of corrosion products that acts as a fouling layer. This matches **II.**

Heat transfer surface reacts with ambient...

The correct set of matches is therefore A-IV, B-III, C-I, D-II.

Quick Tip

The names of the fouling types are descriptive: **Precipitation** from dissolved solids, **Freezing** is solidification, **Particulate** from suspended particles, and **Corrosion** is a reaction of the surface itself.

---

47. Match the LIST-I with LIST-II

LIST-I (Fluid)		LIST-II (Typical example)	
A	Shear-thinning	I	Tomato ketchup
B	Newtonian	II	Milk
C	Shear-thickening	III	Whipped cream
D	Bingham plastic	IV	40% raw corn starch sclution

(A) A - I, B - IV, C - II, D - III

(B) A - I, B - II, C - IV, D - III

(C) A - III, B - II, C - IV, D - I

(D) A - I, B - II, C - III, D - IV

Correct Answer: (B) A - I, B - II, C - IV, D - III

Solution:

Step 1: Define the fluid behaviors.

A. Shear-thinning (Pseudoplastic): Viscosity decreases as shear rate increases. Shaking or stirring makes it flow more easily. **Tomato ketchup** is a classic example. So, **A-I**.

B. Newtonian: Viscosity is constant regardless of shear rate. **Milk** (and water) behaves approximately as a Newtonian fluid. So, **B-II**.

C. Shear-thickening (Dilatant): Viscosity increases as shear rate increases. It becomes thicker when stirred or hit. A concentrated **corn starch solution** is the prime example. So, **C-IV**.

D. Bingham plastic: Behaves as a rigid solid at low stress but flows like a viscous fluid at high stress. It has a ”yield stress”. **Whipped cream**, toothpaste, and mayonnaise are examples. So, **D-III**.

The correct set of matches is A-I, B-II, C-IV, D-III.

Quick Tip

Think about real-world examples: Ketchup gets **thinner** when you shake it (shear-thinning). A cornstarch-water mix gets **thicker** when you stir it fast (shear-thickening). Toothpaste needs a push to start flowing (Bingham plastic).

---

48. Arachidonic acid is composed of how many carbon atoms in its chain?

(A) 20

(B) 18

(C) 16

(D) 12

Correct Answer: (A) 20

Solution: Step 1: Recall the structure of common fatty acids. Fatty acids are classified by their carbon chain length and number of double bonds. **Step 2:** Specifically identify Arachidonic acid. Arachidonic acid is a polyunsaturated omega-6 fatty acid. Its lipid shorthand notation is 20:4(n-6), which indicates:

- **20** carbons in its chain.
- **4** cis-double bonds.
- The first double bond is at the 6th carbon from the omega end.

Therefore, it is composed of 20 carbon atoms.

Quick Tip

Memorize the carbon numbers for key fatty acids: Palmitic (16:0), Stearic (18:0), Oleic (18:1), Linoleic (18:2), and **Arachidonic (20:4)**.

49. Match the LIST-I with LIST-II

	LIST-I (Liquid)		LIST-II (Viscosity at room temperature. Approximate) (Pa . s)
A	Air	I	10^{-5}
B	Water	II	10^{-3}
C	Olive Oil	III	10^{-1}
D	Liquid Honey	IV	10^{1}

(A) A - III, B - IV, C - I, D - II

(B) A - I, B - II, C - III, D - IV

(C) A - II, B - III, C - I, D - IV

(D) A - I, B - IV, C - I, D - III

Correct Answer: (B) A - I, B - II, C - III, D - IV

Solution:

Step 1: Understand viscosity. Viscosity is a measure of a fluid's resistance to flow. A higher value means the fluid is "thicker".

Step 2: Rank the substances in LIST-I by their expected viscosity, from lowest to highest. Air (a gas) will have the lowest viscosity. Water is a common reference fluid, much more viscous than air. Olive Oil is noticeably more viscous than water. Liquid Honey is extremely viscous and flows very slowly. The correct order of increasing viscosity is Air $<$Water $<$Olive Oil $<$Liquid Honey.

Step 3: Rank the viscosity values in LIST-II from lowest to highest. $10^{-5} < 10^{-3} < 10^{-1} < 10^{1}$.

Step 4: Match the ranked lists.

A. Air $\rightarrow$I. 10^{-5} Pa.s

B. Water $\rightarrow$II. 10^{-3} Pa.s (The viscosity of water is approximately 1 mPa.s or 0.001 Pa.s)

C. Olive Oil $\rightarrow$III. 10^{-1} Pa.s

D. Liquid Honey $\rightarrow$IV. 10^{1} Pa.s

The correct set of matches is A-I, B-II, C-III, D-IV.

Quick Tip

For matching questions with ordered values, first rank the items in one list (e.g., least viscous to most viscous). Then, rank the values in the other list. The matching should then be straightforward.

---

50. Instrument used for measuring the humidity is

(A) Thermometer

(B) Hygrometer

(C) Pyrometer

(D) Penetrometer

Correct Answer: (B) Hygrometer

Solution:

Step 1: Define the function of each instrument.

Thermometer: Measures temperature.

Hygrometer: Measures humidity, which is the amount of water vapor in the air. A psychrometer is a type of hygrometer.

Pyrometer: Measures high temperatures from a distance by detecting thermal radiation.

Penetrometer: Measures the hardness or consistency of a substance (like soil, asphalt, or food) by measuring the depth of penetration of a needle or cone.

The correct instrument for measuring humidity is the hygrometer.

Quick Tip

Break down the word roots: ”Thermo” for heat/temperature, ”**Hygro**” for moisture, ”Pyro” for fire/high-heat, and ”Penetro” for penetration.

---

51. Saturated air has a relative humidity (RH) of

(A) 0%

(B) 75%

(C) 50%

(D) 100%

Correct Answer: (D) 100%

Solution:

Step 1: Define Relative Humidity (RH). Relative humidity is the ratio of the actual amount of water vapor present in the air to the maximum amount of water vapor the air could hold at that specific temperature.

Step 2: Define ”saturated air”. Saturated air is air that is holding the absolute maximum amount of water vapor possible at its temperature. Any additional water vapor would condense into liquid water.

Step 3: Combine the definitions. Since saturated air contains the maximum possible amount of water vapor, the actual amount is equal to the maximum possible amount. Therefore, the ratio is 1, which is expressed as 100%.

Quick Tip

”Saturated” in the context of humidity means ”100% full”. The air cannot hold any more moisture as vapor.

---

52. The topmost curve in the psychrometric chart represents the saturation line with _____ % relative humidity.

(A) 100

(B) 75

(C) 50

(D) 0

Correct Answer: (A) 100

Solution:

Step 1: Describe a psychrometric chart. It is a graph that plots the thermodynamic properties of moist air. The horizontal axis is the dry-bulb temperature, and the vertical axis is the humidity ratio (or specific humidity).

Step 2: Identify the main curves on the chart. The chart contains various lines representing properties like wet-bulb temperature, specific volume, and relative humidity.
Step 3: Locate the saturation line. The prominent curved line that forms the upper-left boundary of the chart is the saturation curve. Along this entire line, the air is saturated with water vapor. By definition, saturated air has a relative humidity of 100%. Therefore, this curve represents 100% relative humidity.

Quick Tip

On a standard psychrometric chart, the main boundary curve on the top and left is always the 100

---

53. Potatoes with 85% moisture content on a wet basis are dried to a final moisture content of 10%. If we dry 100 kg of potatoes, what is the final weight of the product?
(A) 15.66 kg
(B) 16.66 kg
(C) 17.66 kg
(D) 18.66 kg

Correct Answer: (B) 16.66 kg

Solution:
Step 1: Identify the constant component. In a drying process, water is removed, but the mass of the solid material remains constant.
Step 2: Calculate the initial mass of solids.
Initial total weight = 100 kg
Initial moisture content = 85%
Initial solids content = 100% - 85% = 15%
Mass of solids = 100 kg * 0.15 = 15 kg.
Step 3: Use the constant mass of solids to find the final total weight.
Final moisture content = 10%
Final solids content = 100% - 10% = 90%

The 15 kg of solids now constitutes 90% of the final product's weight. Final Weight * 0.90 = 15 kg

Step 4: Solve for the Final Weight.

Final Weight = 15 kg / 0.90 = 16.666... kg.

Rounding to two decimal places gives 16.67 kg or 16.66 kg.

Quick Tip

For all drying and concentration problems, the key is to find the mass of the "bone-dry solids" first. This mass never changes. Then, use that solid mass to calculate the total weight at the new moisture content.

---

54. Freeze drying is also known as

(A) Crystallization

(B) Gelatinization

(C) Homogenization

(D) Lyophilization

Correct Answer: (D) Lyophilization

Solution:

Step 1: Define Freeze Drying.

Freeze drying is a dehydration process that involves freezing the product, lowering the pressure, and then adding heat to allow the frozen water in the material to sublime directly from the solid phase to the gas phase.

Step 2: Define the given options.

Crystallization: The process by which a solid forms, where the atoms or molecules are highly organized into a structure known as a crystal.

Gelatinization: The process of breaking down the intermolecular bonds of starch molecules in the presence of water and heat.

Homogenization: The process of reducing the size of particles in a liquid to make it uniform and stable.

Lyophilization: This is the scientific term for the freeze-drying process. ”Lyo” means solvent and ”phil” means loving, referring to the ease with which the dried product reabsorbs water.

Quick Tip

Lyophilization is the technical synonym for freeze-drying. It's a key process for preserving sensitive materials like vaccines, pharmaceuticals, and high-quality instant coffee.

---

55. The appearance, size, shape, density, and solubility of the final spray dried particle can be affected by

A. Nozzle pressure

B. Liquid viscosity

C. Surface tension

D. Nature of the solids

Choose the most appropriate answer from the options given below:

(A) A, B, and D only

(B) A, B, and C only

(C) A, B, C, and D

(D) B, C, and D only

Correct Answer: (C) A, B, C, and D

Solution:

Step 1: Analyze how each factor influences the spray drying process.

A. Nozzle pressure: Directly affects the energy of atomization, which in turn controls the initial droplet size. Smaller droplets dry faster and result in smaller final particles.

B. Liquid viscosity & C. Surface tension: These are properties of the liquid feed that resist atomization. Higher viscosity and surface tension make it harder to form small droplets, leading to larger final particles.

D. Nature of the solids: The type of solid (e.g., crystalline vs. amorphous), its concentration, and its properties affect how the particle forms as it dries. It influences the final particle's density, shape (e.g., hollow or solid), and solubility. Since all four factors have a significant impact on the final particle characteristics, the correct answer includes all of them.

Quick Tip

In spray drying, everything matters. The process variables (**nozzle pressure**), the feed properties (**viscosity, surface tension**), and the composition (**nature of solids**) all interact to determine the final powder's characteristics.

---

56. The energy required for size reduction is proportional to the logarithm of size reduction ratio, is given by _____ law.

(A) Kicks' Law

(B) Bonds' Law

(C) Ricks' Law

(D) Rittingers' Law

Correct Answer: (A) Kicks' Law

Solution:

Step 1: Recall the three main empirical laws of comminution (size reduction). These laws relate the energy input (E) to the change in particle size from an initial diameter (d_1) to a final diameter (d_2). **Rittinger's Law (1867):** States that the energy required is proportional to the new surface area created. It is most applicable to fine grinding.

$$E \propto \left(\frac{1}{d_2} - \frac{1}{d_1}\right)$$

Kick's Law (1885): States that the energy required is proportional to the logarithm of the reduction ratio. It is most applicable to coarse crushing of large particles.

$$E \propto \log\left(\frac{d_1}{d_2}\right)$$

Bond's Law (1952): States that the energy required is proportional to the crack length produced, and it is the most widely used law for general crushing and grinding.

$$E \propto \left(\frac{1}{\sqrt{d_2}} - \frac{1}{\sqrt{d_1}} \right)$$

The question specifically asks for the law involving the logarithm, which is Kick's Law.

Quick Tip

Remember the three laws by their mathematical form: **Rittinger** (1/d), **Kick** (log d), **Bond** ($\frac{1}{\sqrt{d}}$). Kick's law applies to coarse 'kicking' or crushing.

---

57. In hammer mill operations, the dominant force is

(A) Compressive force

(B) Shear force

(C) Impact force

(D) Centrifugal force

Correct Answer: (C) Impact force

Solution:

Step 1: Understand the mechanism of a hammer mill. A hammer mill consists of a rotating shaft to which a series of hammers are mounted. As the shaft rotates at very high speed, the hammers swing out and strike the material fed into the mill.

Step 2: Identify the primary action. The material is shattered and broken down by these high-speed collisions with the hammers. This action is defined as **impact**. While other forces like shear and compression (attrition) may also play a minor role as particles are pushed against the screen, the dominant and primary force responsible for size reduction is impact.

Quick Tip

The name of the equipment gives a strong clue to its mechanism. A **hammer** mill works by hitting or **impacting** the material. A roller mill works by compression. A disk mill works by shear/attrition.

58. Find the "Centrifuge effect" of the centrifuge, which spins at the angular velocity (ω=523.6 /sec) at a maximum radius of 10 cm.

(A) 2794.6

(B) 2694.6

(C) 2594.6

(D) 2494.6

Correct Answer: (A) 2794.6

Solution:

Step 1: Define the "Centrifuge effect". This term typically refers to the G-force, which is the ratio of the centrifugal acceleration (a_c) to the acceleration due to gravity (g).

Step 2: Write the formula for centrifugal acceleration.

$$a_c = \omega^2 r$$

where ω is the angular velocity in radians per second and r is the radius in meters.

Step 3: Convert units and plug in the values. ω = 523.6 rad/s (The unit /sec implies rad/sec as it's an angular velocity)

r = 10 cm = 0.1 m

$$a_c = (523.6 \text{ rad/s})^2 \times 0.1 \text{ m} = 274156.96 \text{ s}^{-2} \times 0.1 \text{ m} = 27415.7 \text{ m/s}^2$$

Step 4: Calculate the G-force. Use g $\approx$ 9.81 m/s^2.

$$\text{G-force} = \frac{a_c}{g} = \frac{27415.7 \text{ m/s}^2}{9.81 \text{ m/s}^2} \approx 2794.67$$

This value matches option (A).

Quick Tip

The formula for centrifugal acceleration is $a_c = \omega^2 r$. To find the G-force, divide this by g ($\approx$ 9.81 m/s^2). Always ensure your units are consistent (meters and radians/sec).

59. In the sedimentation process, the rate of settling (moving) particles is affected by

A. Gravitational pull

B. Density of the particle

C. Buoyancy force

D. Size of the particle

Choose the most appropriate answer from the options given below:

(A) A, B, C and D

(B) A, B and C only

(C) A, B and D only

(D) B, C and D only

Correct Answer: (A) A, B, C and D

Solution:

Step 1: Recall the principles of sedimentation, governed by Stokes' Law for particles in the laminar flow regime. The terminal settling velocity (v_t) is given by:

$$v_t = \frac{gD_p^2(\rho_p - \rho_f)}{18\mu}$$

Step 2: Analyze how each factor in the options relates to the formula.

A. Gravitational pull (g): This is the primary driving force for settling and is present in the formula.

B. Density of the particle (ρ_p): The settling rate is proportional to the density difference between the particle and the fluid. Particle density is a key part of this.

C. Buoyancy force: This upward force is represented by the density of the fluid (ρ_f). The net downward force depends on the difference between particle density and fluid density ($\rho_p - \rho_f$). So buoyancy is crucial.

D. Size of the particle (D_p): The velocity is proportional to the square of the particle diameter. Larger particles settle much faster.

All four factors are fundamentally important in determining the settling rate.

Quick Tip

Think of Stokes' Law. Settling is a battle between gravity pulling a particle down and buoyancy/drag holding it up. Gravity depends on mass (size and density), buoyancy depends on fluid density, and drag depends on size and fluid viscosity. All listed factors are involved.

---

60. Arrange the steps involved in the gas transfer from gas bubble into bulk liquid

A. The gaseous component diffused through the quiescent liquid film into the bulk liquid.

B. The gaseous component enters into the liquid film.

C. Transportation of the gaseous component into the well mixed bulk liquid.

D. The aeseous component transported from the bulk gas to gas-liquid interphase.

Choose the most appropriate answer from the options given below:

(A) D, B, A, C

(B) D, C, B, A

(C) C, D, B, A

(D) D, B, C, A

Correct Answer: (A) D, B, A, C

Solution:

Step 1: Apply the two-film theory of mass transfer to visualize the process. This theory posits a stagnant gas film and a stagnant liquid film at the gas-liquid interface.

Step 2: Trace the path of a gas molecule from the bubble to the liquid.

1. (D) The molecule must first travel from the interior (bulk) of the gas bubble to the surface of the bubble (the gas-liquid interface).

2. (B) The molecule then crosses the interface and enters the stagnant liquid film that surrounds the bubble.

3. (A) The molecule must then travel across this stagnant liquid film via molecular diffusion.

4. (C) Once it exits the film, it is transported into the main body (bulk) of the liquid, which is assumed to be well-mixed, usually by convection.

The correct logical sequence is D $\rightarrow$ B $\rightarrow$ A $\rightarrow$ C.

Quick Tip

The path for mass transfer across an interface is always: Bulk of Phase 1 $\rightarrow$ Film in Phase 1 $\rightarrow$ Interface $\rightarrow$ Film in Phase 2 $\rightarrow$ Bulk of Phase 2. The question combines some of these steps, but the overall sequence remains the same.

---

61. Ficks' law of diffusion states that mass flux per unit area of a component is directly proportional to its _____.

(A) Velocity gradient

(B) Temperature gradient

(C) Concentration gradient

(D) pH gradient

Correct Answer: (C) Concentration gradient

Solution:

Step 1: State Fick's First Law of Diffusion. The law describes the relationship between the flux of a component and its concentration profile.

Step 2: Write the mathematical expression for the law.

$$J = -D\frac{dC}{dx}$$

Where:

- J is the mass flux (mass flowing per unit area per unit time).
- D is the diffusion coefficient (a proportionality constant).
- $\frac{dC}{dx}$ is the **concentration gradient**, which is the change in concentration (dC) over a change in position (dx).

The law explicitly states that the flux is directly proportional to the concentration gradient. The negative sign indicates that diffusion occurs from a region of higher concentration to a region of lower concentration.

Quick Tip

Remember the analogies for transport phenomena:

- Mass Transfer (Fick's Law): Flux $\propto$ **Concentration Gradient**
- Heat Transfer (Fourier's Law): Flux $\propto$ **Temperature Gradient**
- Momentum Transfer (Newton's Law): Flux $\propto$ **Velocity Gradient**

---

62. Sherwood number is a function of

(A) Reynolds' number and Rayleigh number

(B) Rayleigh number and Grashof number

(C) Reynolds' number and Grashof number

(D) Reynolds' number and Schmidt number **Correct Answer:** (D) Reynolds' number and

Schmidt number

Solution:

Step 1: Define the Sherwood Number (Sh). It is a dimensionless number used in mass transfer operations that represents the ratio of convective mass transfer to the rate of diffusive mass transport.

Step 2: Recall the common correlations for convective mass transfer. For forced convection, the rate of mass transfer (represented by Sh) depends on the flow conditions and the fluid's properties related to mass diffusion.

Step 3: Define the related dimensionless numbers. **Reynolds number (Re):** Represents the ratio of inertial forces to viscous forces, characterizing the flow regime (laminar or turbulent). **Schmidt number (Sc):** Represents the ratio of momentum diffusivity (kinematic viscosity) to mass diffusivity. It is the mass transfer equivalent of the Prandtl number. For forced convection mass transfer, the Sherwood number is typically expressed as a function of the Reynolds number and the Schmidt number: Sh = f(Re, Sc).

Quick Tip

The Chilton-Colburn analogy provides a useful way to remember the relationships:

- Heat Transfer: **Nusselt (Nu)** is a function of **Reynolds (Re)** and **Prandtl (Pr)**.
- Mass Transfer: **Sherwood (Sh)** is a function of **Reynolds (Re)** and **Schmidt (Sc)**.

---

63. Sequentially arrange the processing steps of coffee

A. Brewing

B. Roasting

C. Grinding

D. Blending

Choose the most appropriate answer from the options given below:

(A) D, B, C, A

(B) D, C, B, A

(C) B, A, D, C

(D) B, D, C, A

Correct Answer: (D) B, D, C, A

Solution:

Step 1: Analyze the logica

l flow of coffee preparation from raw bean to cup. **1. (B) Roasting:** This is the first major step. Green coffee beans are heated to develop their characteristic aroma and flavor.
2. (D) Blending: After roasting, beans from different origins or with different roast profiles are often blended to create a balanced and consistent flavor profile. (Blending can sometimes occur before roasting, but post-roast blending is very common for specialty coffees).
3. (C) Grinding: The roasted, blended beans must be ground into smaller particles to increase the surface area for extraction. This is done shortly before brewing for optimal freshness.

4. (A) Brewing: This is the final step where hot water is used to extract the soluble flavors from the ground coffee to create the beverage.

The correct sequence is Roasting → Blending → Grinding → Brewing, which corresponds to B, D, C, A.

Quick Tip

Think of making coffee at home. You start with roasted beans, grind them, and then brew them. Blending is the commercial step that usually happens after roasting to create a specific product.

---

64. Lecithin is structurally like fat but contain

(A) Amino acid

(B) Hydrochloric acid

(C) Phosphoric acid

(D) Sugar **Correct Answer:** (C) Phosphoric acid

Solution:

Step 1: Describe the structure of a typical fat (a triglyceride). A fat molecule consists of a glycerol backbone attached to three fatty acid chains.

Step 2: Describe the structure of Lecithin. Lecithin is a type of phospholipid, specifically phosphatidylcholine. Its structure consists of a glycerol backbone, but it is attached to only two fatty acid chains. The third position on the glycerol is occupied by a phosphate group (**derived from phosphoric acid**), which is in turn attached to a choline molecule.

Step 3: Identify the key difference. The presence of the phosphate group is the defining structural feature that distinguishes a phospholipid like lecithin from a triglyceride (fat).

Quick Tip

Lecithin is a **phospho**lipid. The name itself tells you it contains a **phosphorus** group, which comes from phosphoric acid.

---

65. The process which permits the formation of the polymorphic form in fats is known as

(A) Conditioning

(B) Hydrogenation

(C) Tempering

(D) Shortening

Correct Answer: (C) Tempering

Solution:

Step 1: Define polymorphism in fats. Polymorphism is the ability of a substance to crystallize in more than one distinct crystal form. Fats like cocoa butter have several polymorphic forms, each with different melting points and physical properties (e.g., snap, gloss).

Step 2: Define the given processes.

Hydrogenation: A chemical process that adds hydrogen to unsaturated fats, making them more solid and stable.

Tempering: A process of carefully controlled heating and cooling of fats (most famously chocolate) to encourage the formation of a specific, stable polymorphic crystal form. This ensures desirable qualities like a glossy finish and a firm snap.

Conditioning/Shortening: These are broader terms. Shortening is a type of fat, and conditioning can refer to various treatments. Tempering is the specific process for controlling polymorphism.

Quick Tip

The classic example of controlling fat polymorphism is the **tempering** of chocolate. This careful heating and cooling process is done to ensure the cocoa butter crystallizes in its most stable and desirable form.

---

66. On treatment with alkali, chlorophyll changes to

(A) Pheophytin

(B) Chlorophyllin

(C) Xanthophyll

(D) Vitamin A

Correct Answer: (B) Chlorophyllin

Solution:

Step 1: Briefly describe the structure of chlorophyll. It has a porphyrin ring with a magnesium ion at its center and a long hydrocarbon tail called a phytol group. This tail makes chlorophyll fat-soluble.

Step 2: Describe the effect of alkali treatment. When chlorophyll is treated with a strong alkali (like NaOH or KOH), a process called saponification occurs. The ester linkage holding the phytol tail is cleaved, removing the tail.

Step 3: Identify the resulting product. The product is a salt called **chlorophyllin**. It still contains the magnesium ion and the porphyrin ring, so it retains a bright green color, but without the phytol tail, it becomes water-soluble.

In contrast, acid treatment removes the central magnesium ion, replacing it with hydrogen, to form the dull olive-brown compound pheophytin.

Quick Tip

Remember the two main reactions of chlorophyll during processing:

- **Acid + Heat** $\rightarrow$ Removes Mg^{2+} $\rightarrow$ **Pheophytin** (olive brown)
- **Alkali** $\rightarrow$ Removes phytol tail $\rightarrow$ **Chlorophyllin** (bright green, water-soluble)

---

67. Arrange the sequence of steps involved in the production of sauerkraut

A. Pasteurization

B. Salting

C. Fermentation

D. Shredding

Choose the most appropriate answer from the options given below:

(A) D, B, C, A

(B) D, B, A, C

(C) C, A, B, D

(D) C, B, D, A

Correct Answer: (A) D, B, C, A

Solution:

Step 1: Understand the fundamental process of making sauerkraut, which is fermented cabbage.

Step 2: Order the steps logically from the raw material (cabbage) to the final product.

1. (D) Shredding: The process must begin with preparing the cabbage. Whole cabbages are cored and finely shredded to increase the surface area and help release juices when salted.

2. (B) Salting: Salt is thoroughly mixed with the shredded cabbage. This is a critical step that draws water out of the cabbage via osmosis to create a brine. The salt also inhibits the growth of undesirable spoilage bacteria while favoring the growth of lactic acid bacteria.

3. (C) Fermentation: The salted cabbage is packed tightly into an anaerobic (oxygen-free) container. Naturally occurring lactic acid bacteria on the cabbage leaves begin to ferment the sugars in the cabbage, producing lactic acid. This acid acts as a preservative and gives sauerkraut its characteristic tangy flavor.

4. (A) Pasteurization: For commercially produced, shelf-stable sauerkraut, pasteurization (heating) is often the final step. It stops the fermentation process and kills any remaining microorganisms to extend shelf life. This step happens after the desired level of fermentation is complete.

The correct sequence is Shredding $\rightarrow$ Salting $\rightarrow$ Fermentation $\rightarrow$ Pasteurization, which corresponds to D, B, C, A.

Quick Tip

Remember the sauerkraut process with the mantra: ”Shred, Salt, Ferment, Preserve.” Each step logically follows the previous one, from preparing the raw vegetable to making it safe and stable for storage.

68. Match the LIST I (Enzyme) with LIST II (Catabolic Products)

LIST-I (Enzyme)		LIST-II (Catabolic Products)	
A	β-galactosidase	I	Choline + H_3PO_4 + fat
B	Lecithinase	II	Glycerol + fatty acids
C	Urease	III	Galactose + glucose
D	Lipase	IV	CO_2 + NH_3

(A) A - III, B - IV, C - I, D - II

(B) A - III, B - I, C - IV, D - II

(C) A - III, B - II, C - IV, D - I

(D) A - II, B - I, C - IV, D - III **Correct Answer:** (B) A - III, B - I, C - IV, D - II

Solution:

Step 1: Identify the substrate and products for each enzyme.

A. β-galactosidase: This enzyme, also known as lactase, hydrolyzes the disaccharide lactose into its constituent monosaccharides. This matches **III. Galactose + glucose**.

B. Lecithinase (Phospholipase): This enzyme breaks down lecithin (a phospholipid). The products include a diglyceride (fat), phosphoric acid, and choline. This matches **I. Choline + H_3PO_4 + fat**.

C. Urease: This enzyme catalyzes the hydrolysis of urea into ammonia and carbon dioxide. This matches **IV. CO_2 + NH_3**.

D. Lipase: This is an enzyme that breaks down fats (triglycerides) into their components. This matches **II. Glycerol + fatty acids**.

The correct set of matches is A-III, B-I, C-IV, D-II.

Quick Tip

The names of enzymes often indicate their substrate: β-galacto**sidase** acts on a galacto**side** (lactose), Lip**ase** acts on Lip**ids** (fats), Ure**ase** acts on Ure**a**.

69. Bitterness is exhibited by alkaloids such as _____

(A) Quinine

(B) Beryllinm salts

(C) Lead acetate

(D) Cyclamate

Correct Answer: (A) Quinine

Solution:

Step 1: Analyze the options provided.

Quinine: This is a well-known alkaloid compound derived from the bark of the cinchona tree. It is famous for its extremely bitter taste and is the key flavoring component in tonic water.

Beryllium salts: These are known to have a sweet taste, but are highly toxic.

Lead acetate: Also known as ”sugar of lead,” this compound has a sweet taste but is a potent poison.

Cyclamate: This is an artificial sweetener. Therefore, the only substance listed that is a bitter alkaloid is quinine.

Quick Tip

Many alkaloids are known for their bitter taste, which is often an evolutionary defense mechanism in plants. Quinine is the most famous example of a bitter alkaloid used in food and medicine.

---

70. Match the LIST I (Stage of Egg White foam) with LIST II (Uses)

LIST-I (Stage of Egg White foam)		**LIST-II** (Uses)	
A	Slightly beaten	I	Shirred egg
B	Stiff foam	II	Ice cream
C	Stiff	III	Thickening
D	Dry	IV	Meringues

(A) A - I, B - II, C - III, D - IV

(B) A - IV, B - III, C - I, D - II

(C) A - III, B - II, C - IV, D - I

(D) A - III, B - IV, C - II, D - I **Correct Answer:** (C) A - III, B - II, C - IV, D - I

Solution:

Step 1: Define the stages of egg white foam and their properties.

A. Slightly beaten (Frothy): Egg whites are just broken up and foamy. They are liquidy and used to add some leavening or bind ingredients. This is suitable for **III. Thickening** sauces or as a wash.

B. Stiff foam (Soft peaks): Foam is white and holds its shape, but the peaks curl over when the beater is lifted. This stage is good for folding into batters and mousses, or for use in products like **II. Ice cream** to add lightness.

C. Stiff (Stiff peaks): Foam is very white, holds its shape perfectly, and the peaks point straight up. This provides the most stable structure, essential for making **IV. Meringues**.

D. Dry (Overbeaten): The foam looks curdled and loses its gloss. The protein structure has been broken. It is generally not desirable for any use. The pairing with **I. Shirred egg** is likely a distractor or an error in the question, as shirred eggs use whole eggs, not foams.

Based on the strongest matches, A-III and C-IV are the most certain. Option (C) contains both of these certain matches.

Quick Tip

The key to egg white foams is the peak stage: soft peaks for folding, **stiff peaks for structure (meringues)**. Slightly beaten is just for binding or light aeration.

---

71. Match the LIST-I (Class of Meat) with LIST-II (Description)

LIST-I (Class of Meat)		**LIST-II** (Description)	
A	Veal	I	Flesh of a young ovine animal...
B	Beef	II	Carcasses of young sheep...
C	Mutton	III	Meat from cattle slaughtered 3 to 4 weeks...
D	Yearling mutton	IV	Meat of cattle over 1 year old

(A) A - III, B - IV, C - I, D - II

(B) A - IV, B - III, C - II, D - I

(C) A - I, B - II, C - IV, D - III

(D) A - III, B - IV, C - II, D - I

Correct Answer: (A) A - III, B - IV, C - I, D - II

Solution:

Step 1: Define the terms for meats based on animal type and age.

Cattle (Bovine): A. Veal: Meat from a very young calf (typically a few weeks to a few months old). This matches **III. Meat from cattle slaughtered 3 to 4 weeks after birth**.

B. Beef: Meat from mature cattle (typically over a year old). This matches **IV. Meat of cattle over 1 year old**. **Sheep (Ovine):**

Lamb: Meat from a young sheep (under 12 months old). This matches **I. Flesh of a young ovine animal whose age is 12 months or under**.

D. Yearling mutton: Meat from a sheep between 1 and 2 years old. This matches **II. Carcasses of young sheep II usually from 12 to 20 months old**.

C. Mutton: Meat from an adult sheep (over 2 years old). There is no perfect description for Mutton in List II. However, the options require matching C with I. While I describes Lamb, this is the intended match in the provided question structure. The best fit combination based on the options is A-III, B-IV, C-I, D-II.

Quick Tip

Remember the species and age for meat classification:

- **Bovine (Cattle):** Veal (young) $\rightarrow$ Beef (mature)
- **Ovine (Sheep):** Lamb (<1yr) $\rightarrow$ Yearling (1-2yr) $\rightarrow$ Mutton (¿2yr)

---

72. Arrange the steps involved in alkali processing of maity (maize)

A. Washing with fresh water

B. Steeping in water for 14 hours

C. Milling to obtain ”masa”

D. Mixing with water and lime at 90°C for 50 minutes

Choose the most appropriate answer from the options given below:

(A) D, B, C, A

(B) D, B, A, C

(C) B, A, D, C

(D) C, B, D, A

Correct Answer: (B) D, B, A, C

Solution:

Step 1: Understand the process of nixtamalization (alkali processing of maize). This traditional process makes the maize more nutritious and easier to grind.

Step 2: Order the steps logically. **1. (D) Cooking:** The first step is to cook the dried maize kernels in an alkaline solution, typically water with calcium hydroxide (lime). This softens the outer hull (pericarp).

2. (B) Steeping: After cooking, the maize is left to steep or soak in the cooking liquid, often overnight. This allows the alkali to continue its work, loosening the hull and causing chemical changes that release niacin.

3. (A) Washing: The steeped maize is then washed thoroughly to remove the cooking liquid and the loosened pericarp. **4. (C) Milling:** Finally, the washed, softened maize (now called nixtamal) is ground into a dough called masa, which is used to make tortillas and other products.

The correct sequence is D $\rightarrow$ B $\rightarrow$ A $\rightarrow$ C.

Quick Tip

The key to nixtamalization is ”cook with lime first”. After cooking comes soaking (steeping), then washing away the hull, and finally grinding to make the dough (masa).

---

73. Arrange the sequence of steps involved in the reaction of enzymatic browning

A. Formation of DOPA

B. Action of PPO enzyme on cut fruits

C. Polymerization of ortho-quinones to form melanins

D. Formation of ortho-quinones

Choose the most appropriate answer from the options given below:

(A) C, B, A, D

(B) B, D, C, A

(C) B, A, D, C

(D) B, A, C, D

Correct Answer: (C) B, A, D, C

Solution:

Step 1: Understand the trigger and key players in enzymatic browning. The reaction is initiated when tissue damage (cutting) exposes the enzyme polyphenol oxidase (PPO) and phenolic substrates to oxygen.

Step 2: Order the biochemical steps.

1. (B) Initial Action: The process begins with the **action of the PPO enzyme** on its substrates, which are present in the cut fruit tissue.

2. (A) Hydroxylation: PPO first catalyzes the hydroxylation of monophenols (like tyrosine) to form o-diphenols (like **DOPA**).

3. (D) Oxidation: PPO then catalyzes the oxidation of these o-diphenols into highly reactive **ortho-quinones**.

4. (C) Polymerization: These ortho-quinones are unstable and undergo further non-enzymatic reactions, including **polymerization**, to form the complex brown, black, or red pigments known as **melanins**.

The correct sequence is B $\rightarrow$ A $\rightarrow$ D $\rightarrow$ C.

Quick Tip

The enzymatic browning cascade is: Enzyme (PPO) acts $\rightarrow$ makes DOPA $\rightarrow$ makes Quinones $\rightarrow$ Quinones link together (polymerize) to make brown Melanins.

74. Arrange the steps involved in the production of soy sauce

A. Roasting of wheat

B. Moromi stage

C. Lactic/ethanolic fermentation

D. Fermentation at 25-30 °C for 2-3 days

Choose the most appropriate answer from the options given below:

(A) A, D, B, C

(B) A, C, B, D

(C) A, D, C, B

(D) C, B, D, A

Correct Answer: (A) A, D, B, C

Solution: Step 1: Outline the two main fermentation stages in traditional soy sauce production: Koji and Moromi.

Step 2: Arrange the steps in chronological order.

1. (A) Roasting of wheat: The process begins with preparing the raw materials. Soybeans are soaked and cooked, while wheat is roasted and crushed to develop flavor and prepare it for fermentation. This is the first step.

2. (D) Fermentation at 25-30 °C for 2-3 days: The cooked soybeans and roasted wheat are inoculated with a starter mold (*Aspergillus oryzae*). This mixture, called Koji, is allowed to undergo an aerobic fermentation for a few days to allow the mold to grow and produce enzymes. This step matches the description.

3. (B) Moromi stage: The completed Koji is then mixed with a high concentration salt brine to create a mash called Moromi. This marks the beginning of the second, much longer fermentation period.

4. (C) Lactic/ethanolic fermentation: During the long Moromi fermentation (which can last for months), salt-tolerant yeasts and lactic acid bacteria take over, producing alcohol and lactic acid which contribute significantly to the final flavor profile. This is the main flavor development stage.

The correct sequence is A $\rightarrow$ D $\rightarrow$ B $\rightarrow$ C.

Quick Tip

Soy sauce production has two key stages: first, the solid-state **Koji** fermentation (mold growth for a few days), followed by the long, liquid **Moromi** fermentation (yeast/bacteria action for months).

---

75. The bacteria most commonly associated with the soft rotting of carrots is

(A) Corynebacterium spp.

(B) Lactobacillus spp.

(C) Pectobacterium spp.

(D) Xanthomonas spp.

Correct Answer: (C) Pectobacterium spp.

Solution: Step 1: Define bacterial soft rot. This is a type of plant disease characterized by the breakdown and decay of plant tissues, resulting in a soft, watery, and often foul-smelling mass.

Step 2: Analyze the causative agents. The primary cause of this type of rot is the production of pectinolytic enzymes (pectinases) by bacteria, which break down the pectin that cements plant cells together.

Step 3: Evaluate the bacterial genera listed.

Pectobacterium spp.: This genus (which includes species formerly classified as *Erwinia*) is the most notorious and widespread cause of bacterial soft rot in numerous vegetables, including carrots. *Pectobacterium carotovorum* is a classic example. They are highly effective at producing pectinases.

Lactobacillus spp.: These are lactic acid bacteria used in fermentation and are not associated with plant disease.

Xanthomonas spp.: These are plant pathogens but typically cause different symptoms like leaf spots, blights, and cankers, not soft rot.

Corynebacterium spp.: While some species are plant pathogens, they are not the primary

agents of soft rot.

Therefore, *Pectobacterium* is the genus most commonly associated with soft rot.

Quick Tip

Remember the connection between the name and function: **Pecto**bacterium breaks down **pectin**, the glue holding plant cells together. This breakdown is what causes the characteristic ”soft rot” symptom.
