CUET PG 2025 Food Engineering and Technology Question Paper with Solutions

Time Allowed :1 Hour 30 Mins	**Maximum Marks :**300	**Total Questions :**75

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The examination duration is 90 minutes. Manage your time effectively to attempt all questions within this period.
2. The total marks for this examination are 300. Aim to maximize your score by strategically answering each question.
3. There are 75 mandatory questions to be attempted in the Atmospheric Science paper. Ensure that all questions are answered.
4. Questions may appear in a shuffled order. Do not assume a fixed sequence and focus on each question as you proceed.
5. The marking of answers will be displayed as you answer. Use this feature to monitor your performance and adjust your strategy as needed.
6. You may mark questions for review and edit your answers later. Make sure to allocate time for reviewing marked questions before final submission.
7. Be aware of the detailed section and sub-section guidelines provided in the exam. Understanding these will aid in effectively navigating the exam.

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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: Stating the Gibbs-Dalton Law

The Gibbs-Dalton Law, often referred to simply as Dalton's Law of Partial Pressures, is a fundamental principle in the study of gas mixtures. It posits that for a mixture of non-reacting gases, the total pressure exerted by the mixture is the simple sum of the partial pressures of

each individual constituent gas. The partial pressure is defined as the pressure that each gas would exert if it were the sole occupant of the entire volume at the same temperature.
This law is rooted in the kinetic theory of gases, which assumes that gas molecules are far apart and have negligible intermolecular forces. Consequently, the molecules of one gas in a mixture behave independently of the molecules of the other gases.

Step 2: Application to an Atmospheric Air-Steam Mixture

This principle has a critical application in thermodynamics and psychrometrics, particularly when analyzing atmospheric air, which is a mixture of dry air and water vapor (steam).

- **Dry Air (a):** This is a composite of gases like Nitrogen (∼78%), Oxygen (∼21%), Argon, and others. For calculation purposes, it is treated as a single gas with its own partial pressure, p_a.
- **Water Vapor (w):** This is the gaseous phase of water present in the air, exerting its own partial pressure, p_w.
- **Total Pressure (P_T):** This is the overall pressure of the mixture, which is typically the measured barometric or atmospheric pressure (P_B).

According to the Gibbs-Dalton Law, the total atmospheric pressure is the sum of these two partial pressures.

$$P_{\text{Total}} = P_{\text{dry air}} + P_{\text{water vapor}} \tag{1}$$

This can also be written as:

$$P_T = p_a + p_w \tag{2}$$

This relationship is the foundation for understanding concepts like relative humidity, dew point, and various drying processes.

> 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.

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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: Analyzing the Metabolic Process

The core process described is the biological oxidation of ethyl alcohol (ethanol) into acetic acid. This is the defining chemical reaction in the production of vinegar. The overall reaction can be summarized as:

$$C_2H_5OH \text{ (Ethanol)} + O_2 \text{ (Oxygen)} \rightarrow CH_3COOH \text{ (Acetic Acid)} + H_2O \text{ (Water)} \quad (3)$$

This conversion requires an abundant supply of oxygen, making it an aerobic process.

Step 2: Identifying the Responsible Bacterial Genus

The microorganisms primarily responsible for this transformation belong to the genus ***Acetobacter***. These are a group of acetic acid bacteria (AAB) with specific characteristics:

- They are strictly aerobic, meaning they require oxygen to perform the oxidation of ethanol.
- They are naturally found on fruits, flowers, and in environments where alcoholic fermentation occurs (like breweries and wineries).
- Commercially, they are harnessed in controlled environments to produce vinegar from alcoholic bases like wine, cider, or fermented grain mash.

The same process is responsible for the spoilage of alcoholic beverages. When wine or beer is exposed to air, contaminating *Acetobacter* can convert the alcohol into acetic acid, resulting in a sour, vinegary taste.

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.

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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: Identifying the Common Name

The query identifies the microorganism by its common name, "bread mold." While several molds can grow on bread, the most famous and visually distinct is the black bread mold.

Step 2: Matching to the Scientific Name

The scientific name for the common black bread mold is ***Rhizopus stolonifer***. This is a widespread fungus belonging to the phylum Zygomycota. It is a classic example of a saprophytic organism, meaning it obtains nutrients by decomposing dead organic matter. Its structure includes:

- **Mycelia:** A network of thread-like filaments called hyphae that penetrate the substrate (e.g., bread) to absorb nutrients.
- **Stolons:** Horizontal hyphae that spread across the surface of the substrate.
- **Rhizoids:** Root-like structures that anchor the fungus.
- **Sporangiophores:** Upright stalks that grow from the mycelia.
- **Sporangia:** Globular structures at the top of the sporangiophores that contain black asexual spores. The release of these spores gives the mold its characteristic fuzzy, black appearance and allows it to propagate.

Beyond bread, *R. stolonifer* also causes soft rot spoilage in many fruits and vegetables.

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.

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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: Analyzing the Types of Microorganisms

The list includes **Coliforms** and **Enterococci**. These are not typically dangerous pathogens themselves but are used as *indicator organisms*. The principle of using indicator organisms is central to public health and water safety. Instead of testing for a wide array of dangerous, hard-to-detect pathogens (like *Salmonella*, *Vibrio cholerae*, or Norovirus), authorities test for these common, easily cultured intestinal bacteria.

Step 2: Determining the Most Common Source

The natural habitat for Coliforms and Enterococci is the intestinal tract of warm-blooded animals, including humans. Therefore, their presence in high numbers in water or food is a direct indication of **fecal contamination**.

- While these microbes can be found in soil or on animals, their collective presence in high concentrations, especially alongside intestinal viruses, points overwhelmingly to one source: **sewage**.
- Sewage is defined as wastewater from homes, businesses, and industries, containing human and animal waste. It is a concentrated source of all microbes found in the gut.

Therefore, detecting these indicator organisms is a primary method for identifying sewage spills and assessing the safety of drinking water, recreational beaches, and food production facilities.

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.

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5. *Thamnidium chaetocladioides* in meat produces:
(1) Ropiness
(2) Discoloration
(3) Phosphoresecence
(4) Whiskers

Correct Answer: (4)

Solution:

Step 1: Identifying the Specific Mold and its Substrate

The question concerns the mold ***Thamnidium chaetocladioides*** and its effect on meat. This mold is notable for its ability to grow at low temperatures (it is psychrotrophic), making it a specific concern for refrigerated meat products. It is most commonly found on large cuts of beef or lamb that are being aged or stored for extended periods in chillers.

Step 2: Recalling the Characteristic Spoilage Sign

The growth of *Thamnidium* on meat produces a very distinct and recognizable defect known as **"whiskers"**. This condition is characterized by the growth of long, delicate, fuzzy mycelia that extend outwards from the meat surface, resembling fine white or grey hairs.

- An important characteristic of this mold is that it is **non-toxigenic**, meaning it does not produce harmful toxins.

- Because the growth is superficial and non-toxic, the spoilage is considered an aesthetic defect. The standard practice in the meat industry is to simply trim the "whiskers" off the surface of the meat cut before it is further processed or sold.

Quick Tip

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

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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: Understanding the Goal

The objective is to assess the *internal* quality of an egg non-destructively to determine its freshness and suitability for grading and storage.

Step 2: Evaluating the Given Options

- **Candling:** This is the correct process. It involves shining a bright light through the egg to illuminate its internal structures. An inspector can observe several key quality indicators:
  - **Air Cell Size:** A fresh egg has a very small air cell. As the egg ages, moisture evaporates through the shell's pores, and the air cell enlarges.
  - **Yolk Condition:** The yolk should be well-centered with a faint outline. In an older egg, the yolk flattens and moves more freely.
  - **Albumen (White) Clarity:** The white should be thick and clear. The presence of blood spots or meat spots can also be detected.
  - **Shell Integrity:** Fine cracks that are not visible to the naked eye can be identified.
- **Washing:** This is a surface treatment to clean the exterior of the egg. It has no bearing on the internal quality.
- **Oiling/Waxing:** These are preservation techniques applied *after* quality has been determined. A thin layer of food-grade mineral oil or wax is applied to the shell to seal the pores, slowing down moisture loss and prolonging freshness. They are not methods for assessing quality.

Therefore, candling is the industry-standard method 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.

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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: Analyzing Types of Fat Degradation

Rancidity is the development of off-flavors and odors in fats and oils. In milk fat (butterfat), it primarily occurs through two distinct chemical pathways:

- **Hydrolysis (Hydrolytic Rancidity):** This pathway involves the enzymatic breakdown of triglycerides (the primary fat molecules) into glycerol and free fatty acids. The catalyst for this reaction is the enzyme **lipase**, which can be naturally present in the milk or introduced by microorganisms. This process is especially significant in milk because it releases short-chain fatty acids, like butyric acid, which have a characteristic sharp, "rancid" flavor. This corresponds to statement B.
- **Oxidation (Oxidative Rancidity):** This pathway involves the reaction of oxygen with the double bonds of unsaturated fatty acids. It is a self-propagating free-radical reaction that produces a wide range of volatile compounds, including aldehydes and ketones. These compounds result in "stale," "cardboard-like," or "painty" off-flavors. This process is accelerated by heat, light, and the presence of metal ions (like copper). This corresponds to statement A.

Step 2: Evaluating the Given Statements

- **A. Oxidation of unsaturated fatty acids:** This is a correct and major pathway for fat decomposition.
- **B. Hydrolysis of the butterfat to fatty acids:** This is the other major pathway.

- **C. Alkali production:** This is incorrect. Both pathways produce fatty *acids*, which are acidic, not alkaline.
- **D. Combined oxidation and hydrolysis to produce rancidity:** This is correct. "Rancidity" is the sensory outcome (off-flavors and odors) that results from these decomposition processes. Both contribute to the overall degradation of the fat.

Thus, statements A, B, and D correctly describe aspects of fat degradation in milk.

> 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.

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8. A 4% commercially available acetic acid is known as_____.
(1) Salt
(2) Brine
(3) Tartar
(4) Vinegar

Correct Answer: (4)

Solution:

Step 1: Defining the Substance

The question describes a 4% aqueous solution of acetic acid. This is a specific chemical definition.

Step 2: Identifying the Common Commercial Name

- **Vinegar** is, by definition, an aqueous solution of acetic acid produced by fermentation. Commercial standards typically require vinegar to contain between 4% and 7% acetic acid by volume. A 4% solution fits perfectly within this definition.

Distinguishing from Other Substances

To confirm the answer, it is useful to define the other options:

- **Salt:** The common chemical name for sodium chloride (NaCl).
- **Brine:** A high-concentration solution of salt (NaCl) in water, used for pickling or preserving foods.
- **Tartar (Cream of Tartar):** The common name for potassium bitartrate (KCHO), a powder that is a byproduct of winemaking.

Clearly, vinegar is the only correct commercial name for a 4% solution of acetic acid.

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%.

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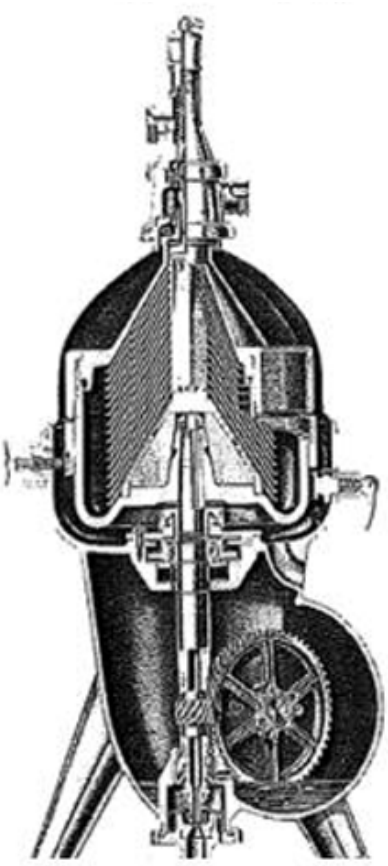
9. Identify the equipment in the image:



(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.

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10. Match the LIST-I with LIST-II

Average composition of Milk

LIST-I	**LIST-II**
(Constituents)	(Percentage %)
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: Understanding Milk Composition

Cow's milk is a complex biological fluid, best described as an emulsion of fat globules suspended in a water-based solution of proteins, lactose (a sugar), and minerals. Its composition can vary slightly by breed, diet, and stage of lactation, but typical values are well-established.

Step 2: Matching Each Constituent with its Approximate Percentage

A. Water Milk is overwhelmingly composed of water. The typical percentage is around **87-88%**. Therefore, A matches III (87.3%).

D. Total Solids This category represents everything in milk that is not water (fat, protein, lactose, minerals). It is calculated as 100% minus the water percentage. For milk with 87.3% water, the total solids would be 100 - 87.3 = **12.7%**. Therefore, D matches II (12.7%).

C. Lactose This is the primary carbohydrate or sugar in milk. Its typical concentration is about **4.8% to 5.0%**. Therefore, C matches I (5.0%).

B. Protein Milk contains two main types of protein: casein and whey. The total protein content is typically around **3.3% to 3.5%**. Therefore, B matches IV (3.3%).

Step 3: Combining the Matches

Based on the analysis, the correct matching is as follows:

- A - III
- B - IV
- C - I
- D - II

This combination corresponds to the correct option.

Quick Tip

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

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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.

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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: Understanding the Purpose of Pasteurization

Pasteurization is a critical food safety process involving the precise application of heat to a product like milk. Its primary purpose is to eliminate or reduce pathogenic (disease-causing)

microorganisms to a level at which they no longer pose a significant public health risk. A secondary benefit is the inactivation of spoilage enzymes, which extends the product's shelf life. It is crucial to note that pasteurization is not sterilization; it does not kill all microorganisms.

Step 2: Identifying the Key Indicator Enzyme

To ensure pasteurization is effective, quality control requires a reliable test. Instead of directly testing for pathogens—which is complex and time-consuming—the industry uses an indicator.

- **The Target Pathogen:** The thermal conditions for milk pasteurization (e.g., High-Temperature Short-Time or HTST at 72°C for 15 seconds) are specifically designed to be lethal to the most heat-resistant, non-spore-forming pathogen found in milk, *Coxiella burnetii* (the causative agent of Q fever).
- **The Indicator Enzyme:** Conveniently, raw milk naturally contains an enzyme called **alkaline phosphatase (ALP)**. The heat required to denature and inactivate this enzyme is slightly greater than the heat required to kill *Coxiella burnetii*.
- **The Principle:** This similarity in heat resistance makes ALP a perfect indicator. If a post-pasteurization test shows that ALP is absent (inactive), it provides strong evidence that the milk was heated sufficiently to also destroy the target pathogens. A positive ALP test indicates a failure in the pasteurization process (e.g., insufficient temperature or time, or contamination with raw milk). The other enzymes mentioned are more heat-stable and would 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.

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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: Understanding the Function of the Rumen

The rumen is the largest of the four stomach compartments in ruminant animals such as cows, sheep, and goats. It is not a true stomach but a highly specialized fermentation vat. It houses a dense and diverse population of symbiotic microorganisms, including bacteria, protozoa, and fungi. These microbes perform the functions that the ruminant's own enzymes cannot, primarily the breakdown of complex carbohydrates like cellulose from plant matter.

Step 2: Identifying Vitamins Synthesized by Rumen Microbes

This symbiotic relationship extends beyond digestion. The microbial population within the rumen has the metabolic capability to synthesize essential nutrients for the host animal.

- **Synthesized Vitamins:** The rumen microbes are prolific producers of all **B-complex vitamins** (such as Thiamine (B1), Riboflavin (B2), Niacin (B3), Cobalamin (B12), etc.) and **Vitamin K**. The cow absorbs these synthesized vitamins further down the digestive tract, making it largely independent of a dietary supply for these specific nutrients.
- **Non-Synthesized Vitamins:** The fat-soluble vitamins—**A, D, and E**—are not synthesized by the rumen microbiota. These must be obtained by the cow through other means:
  - **Vitamin A:** Obtained from the diet, typically from beta-carotene in green forage.
  - **Vitamin D:** Synthesized in the animal's skin through exposure to UV radiation from sunlight, or from dietary supplements.
  - **Vitamin E:** Obtained from the diet, particularly fresh forages.

Step 3: Evaluating the Options

Based on the metabolic capabilities of the rumen ecosystem, Vitamin K is the correct answer as it is reliably synthesized by the microbes, unlike vitamins A, D, and E.

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.

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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: Defining "Concentrated Milk"

The term "concentrated milk" refers to any milk product where the primary processing step is the removal of a significant portion of its water content. The goal of this process is to increase the concentration of total milk solids (fat, protein, lactose, minerals), thereby reducing volume and increasing shelf life.

Step 2: Evaluating the Options Based on this Definition

- **Vitamin D Milk:** This is milk that has been fortified by adding Vitamin D. Its water content and concentration of milk solids are unchanged. This is not a concentrated milk.
- **Condensed Milk:** This product is made by evaporating a large percentage of the water from milk, often under vacuum to prevent heat damage. The result is a viscous, concentrated liquid. (Sweetened condensed milk also has a large amount of sugar added as a preservative). This perfectly matches the definition of concentrated milk.
- **Soft Curd Milk:** This is milk that has been treated (e.g., by heat, enzymes, or ion exchange) to alter the casein proteins so they form a softer, more digestible curd in the stomach. The water content is not changed.
- **Standardized Milk:** This refers to adjusting the fat content of milk to meet a specific legal requirement (e.g., 1%, 2%, or 3.5% for whole milk). This is typically done by removing or adding cream. While it alters the ratio of components, it does not significantly change the overall water content.

Therefore, condensed milk is the only product on the list created by the process of concentration.

Quick Tip

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

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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: Analyzing the Major Steps in Cheesemaking

Cheesemaking is a process of controlled milk coagulation and dehydration. The general sequence involves acidifying the milk, using an enzyme (rennet) to form a curd, cutting the curd to separate it from the whey (the liquid portion), and then salting, shaping, and ripening the final curd.

Step 2: Placing the Steps in Logical Order for Roquefort

Roquefort is a specific type of blue cheese, which requires an additional inoculation step.

1. **B. Addition of Lactic acid producing starter culture:** This is the initial step. Bacteria are added to the milk to begin fermentation, converting lactose into lactic acid. This acidifies the milk, which is essential for proper coagulation and flavor development.
2. **D. Formation of firm curd and cutting of curd:** After a period of acidification, rennet is added to coagulate the milk proteins (casein) into a solid gel, or curd. This curd is then cut into small pieces. Cutting dramatically increases the surface area, allowing the whey to drain away from the solid curds.
3. **A. Inoculation of *Penicillium roqueforti*:** For a blue cheese like Roquefort, the characteristic blue mold must be introduced. Spores of *P. roqueforti* are typically added to the milk or, more commonly, sprinkled over the curds after the whey has been drained. This must happen before the curds are pressed into their final form.
4. **C. Hooped and pressed:** The inoculated curds are placed into hoops (molds), which give the cheese its final shape. They are then pressed (often just under their own weight for Roquefort) to expel the remaining whey and consolidate the curd. (The term "Hopped" is a clear typographical error for "Hooped").

The only logical and practical sequence for these steps is $\mathbf{B} \rightarrow \mathbf{D} \rightarrow \mathbf{A} \rightarrow \mathbf{C}$.

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.

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16. Among the following, the egg yolk protein is_____.
(1) Livetin
(2) Ovalbumin
(3) Avidin
(4) Conalbumin

Correct Answer: (1)

Solution:

Step 1: Differentiating Egg Yolk and Egg White Proteins

An egg is composed of two main protein-rich components: the albumen (egg white) and the yolk. The types and proportions of proteins are significantly different between these two parts. The egg white is primarily a protective protein solution, while the yolk contains proteins combined with lipids (lipoproteins) to serve as a nutrient source for the embryo.

Step 2: Classifying the Listed Proteins

- **Ovalbumin:** The most abundant protein in the **egg white**, making up over 50% of its protein content.
- **Conalbumin (also called Ovotransferrin):** A major protein of the **egg white** with antimicrobial properties due to its ability to bind iron, making it unavailable for microbial growth.
- **Avidin:** A minor protein found in the **egg white**, notable for its very strong binding affinity for the B-vitamin biotin.
- **Livetin:** This is a class of proteins found exclusively in the **egg yolk**. Livetins are water-soluble proteins of the yolk plasma and are derived from the blood serum proteins of the hen.

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

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.

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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: Understanding Egg Protein Coagulation

Coagulation is the process where liquid egg proteins, when heated, unfold (denature) and bond with each other to form a three-dimensional solid network, turning the liquid egg into a solid. The specific temperature at which this occurs can be manipulated by adding other ingredients. The goal is to identify an ingredient that causes coagulation to happen at a *lower* temperature.

Step 2: Analyzing the Effect of Each Ingredient

- **Water and Milk:** These ingredients act as diluents. They increase the space between the protein molecules. For coagulation to occur, these molecules must collide and bond. Dilution means more kinetic energy (i.e., a higher temperature) is required to make this happen. Both *raise* the coagulation temperature.

- **Sugar:** Sugar has a significant stabilizing effect on egg proteins. It physically hinders protein molecules from bonding and also competes for water, which helps maintain the proteins' structure. Consequently, a much higher temperature is needed to overcome this stabilization. Sugar *raises* the coagulation temperature substantially.
- **Lemon Juice (Acid):** Acidity alters the electrical charges on the surface of the protein molecules. This disruption weakens the forces holding the proteins in their natural, folded state, causing them to partially denature. Because the proteins are already destabilized and "primed" for coagulation, less heat energy is needed to complete the process. Therefore, acid *decreases* the coagulation temperature.

Lemon juice is the correct choice as it lowers 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: Identifying the Cause of Browning

The browning that occurs during the drying and storage of egg powder is a classic example of the **Maillard reaction**. This is a form of non-enzymatic browning that is responsible for many desirable (e.g., toast, roasted coffee) and undesirable (e.g., browning in egg powder) changes in food. It is a chemical reaction between an amino group (from a protein) and a reducing sugar (in eggs, this is primarily glucose).

Step 2: Determining How to Prevent the Reaction

To prevent a chemical reaction, one of the key reactants must be removed. Since the protein is the valuable component of the egg powder, the logical strategy is to remove the **glucose** from the liquid egg before it is dried.

Step 3: Evaluating the Proposed Methods

- **A. Glucose Oxidase:** This is a highly specific enzyme that catalyzes the oxidation of glucose into gluconic acid. Gluconic acid is not a reducing sugar and cannot participate in the Maillard reaction. This enzymatic de-sugaring is a very common and effective industrial method.
- **B. Yeast:** Specific strains of food-grade yeast can be added to the liquid egg. The yeast ferments the glucose, converting it into ethanol and carbon dioxide, thereby effectively removing it. This is another well-established industrial method.
- **C. Lactic Acid Bacteria:** While these bacteria consume sugars, they are not the preferred method for de-sugaring eggs, as they can produce unwanted flavor compounds (like lactic acid) and are less efficient for this specific application.
- **D. Syringing:** This is a method of injection and is completely irrelevant to the chemical processing of a bulk liquid like egg.

Therefore, both glucose oxidase and yeast are effective and established methods for preventing the Maillard reaction in egg powder.

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: Identifying the Topic

The question relates to comminution, which is the mechanical process of reducing the size of solid materials (e.g., crushing rock, milling grain). The field seeks to relate the energy consumed by a machine to the amount of size reduction achieved.

Step 2: Defining the Relevant Laws

Three classical theories attempt to model this energy-size relationship:

- **Rittinger's Law (1867):** This law states that the energy required for size reduction is directly proportional to the *new surface area created*. It assumes that all the input energy is used to create new surfaces. This model is most accurate for fine grinding of brittle materials, where the increase in surface area is very large.
- **Kick's Law (1885):** This law posits that the energy required is proportional to the reduction ratio. It assumes that the energy required to break a particle is related to its volume, not its surface area. This model works best for coarse crushing of very large particles.
- **Bond's Law (1952):** This is a more practical, intermediate law that is widely used in industry. It states that the energy required is proportional to the new crack length produced, effectively representing the work needed to break particles from a given size to a smaller size. It is considered more accurate across a broader range of particle sizes than either Rittinger's or Kick's laws.

Step 3: Matching the Statement to the Law

The question explicitly states that the energy is "proportional to the change in surface area". This is the direct 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: Defining a Perennial Plant

In botany, plants are classified by their life cycle duration. A perennial is a plant that lives for more than two years. Unlike annuals and biennials, which die after flowering and producing seed, perennials often regrow from their existing root system each spring.

Step 2: Classifying the Listed Vegetables

- **Artichoke:** The globe artichoke is a true perennial. It is a member of the thistle family, and a single plant can produce edible flower buds for several years.
- **Celery:** Botanically, celery is a biennial. In its first year, it produces the stalks and leaves we eat. If left for a second year, it would flower, produce seeds, and then die. However, it is almost always cultivated as an annual.
- **Knol-khol (Kohlrabi):** This is also a biennial, typically grown and harvested as an annual for its swollen stem.
- **Leek:** Like celery and kohlrabi, the leek is botanically a biennial but is cultivated as an annual.

Among the given options, the artichoke is the only true perennial vegetable.

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: Understanding Cereal Germination

Germination is the process by which a seed sprouts and begins to grow into a plantlet. To fuel this initial growth, the seed embryo must utilize the energy reserves stored within the seed's endosperm. In cereals like barley and wheat, this primary energy reserve is starch.

Step 2: Identifying the Key Enzymes

The stored starch is a large polysaccharide (a long chain of glucose molecules) and cannot be directly used by the embryo. It must first be broken down into simple sugars (like maltose and glucose). This breakdown is accomplished by a group of enzymes called amylases.

- During germination, the activity of amylase enzymes increases dramatically.
- **α-amylase** attacks the starch chains at random points, breaking them into smaller fragments.

- **β-amylase** works on the ends of the starch chains, clipping off units of maltose (a two-glucose sugar).
- While other enzymes like proteases (which break down proteins) and lipases (which break down fats) also increase in activity, the most significant metabolic event is the mobilization of the vast starch reserve.

The activity of β-amylase is particularly crucial for producing the fermentable sugars that are essential in the malting process for brewing and distilling. Therefore, among the choices, the increase in β-amylase activity is a hallmark of cereal germination.

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: Identifying Key Deterioration Factors

Cereals are seeds and are naturally designed for long-term stability when kept dry. However, they can deteriorate through biological activity (microorganisms, insects, grain respiration) and chemical reactions (oxidation). The goal of storage is to control the factors that promote this deterioration.

Step 2: Evaluating the Role of Each Factor

- **A. Moisture Content:** This is universally considered the single most important factor. Water is essential for life. High moisture content (or more precisely, high water activity) allows for the growth of spoilage molds, yeasts, and bacteria. It also accelerates enzymatic and chemical reactions. Keeping grain below a critical moisture threshold is the primary principle of safe storage.

- **B. Temperature:** Temperature governs the rate of all biological and chemical processes. Higher temperatures accelerate microbial growth, insect reproduction and feeding, and the rate of oxidative rancidity. Cool storage conditions are always preferred.
- **D. Presence of Oxygen:** Oxygen is required for two major spoilage pathways: (1) the growth of aerobic microorganisms, including most spoilage molds, and (2) the chemical oxidation of lipids (fats) located in the cereal germ, which leads to oxidative rancidity and off-flavors.
- **C. pH:** The pH of cereals is naturally near-neutral and does not vary significantly. It is not considered a primary controlling factor for the stability of dry cereals, unlike in high-acid or fermented foods where pH is a major hurdle for microbial growth.

Therefore, the primary factors governing cereal deterioration are moisture, temperature, and oxygen.

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.

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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: Outlining the Goal of Milling

The fundamental goal of modern wheat milling is to separate the three anatomical parts of the wheat kernel—the starchy endosperm, the fibrous bran, and the nutrient-rich germ—and to grind the endosperm into fine flour. This requires a multi-step, gradual process.

Step 2: Arranging the Steps in a Logical Sequence

1. **A. Cleaning:** This is unequivocally the first stage. The incoming wheat must be thoroughly cleaned to remove all foreign materials, such as stones, dirt, chaff, weed seeds, and metal fragments, to ensure food safety and protect the milling equipment.

2. **C. Dry Scouring:** This is a specific, more aggressive cleaning step that follows the initial separation. A scourer uses abrasion to scrub the surface of the wheat kernel, removing attached impurities, dust, and the outer bran layers.
3. **D. Conditioning (or Tempering):** After the wheat is clean, a specific amount of water is added, and the wheat is allowed to rest for many hours. This process toughens the bran, making it leathery and less likely to shatter into small specks during grinding. Simultaneously, it softens the endosperm, making it easier to grind and separate. Conditioning is essential for an efficient separation.
4. **B. Separation of the endosperms from the bran and germ:** This is the heart of the milling process, known as the "break system." The conditioned wheat is passed through a series of corrugated rollers (break rolls) that are set to shear the kernel open rather than crush it. This action scrapes the endosperm away from the bran. Subsequent sifting separates the freed endosperm particles from the larger pieces of bran and germ, which are then sent to further processing stages.

The correct, logical process flow is $\mathbf{A} \rightarrow \mathbf{C} \rightarrow \mathbf{D} \rightarrow \mathbf{B}$.

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.

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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: Understanding the Parboiling Process

Parboiling is a hydrothermal pre-milling treatment applied to paddy (un-husked rice). It consists of three main steps: (1) soaking the raw paddy in water until saturated, (2) steaming the soaked paddy under pressure, and (3) carefully drying the steamed paddy before it is milled.

Step 2: Evaluating the Effects of this Process

- **C. Increase in nutritive value of rice:** This is a primary advantage. During the soaking and steaming steps, water-soluble nutrients, particularly B-vitamins (like thiamine) and minerals that are concentrated in the bran and germ layers, migrate into the starchy endosperm. When the bran is later removed during milling, these nutrients are retained within the milled kernel, making parboiled white rice significantly more nutritious than regular milled white rice.
- **A. Greater resistance to insects and fungus infection:** The heat from steaming cooks, or gelatinizes, the starch. Upon drying, the starch retrogrades into a hard, compact, almost glassy structure. This physical change makes the kernel much harder and less permeable, increasing its resistance to penetration by insects and fungi.
- **B. Grain becomes weak: This is incorrect.** The gelatinization process actually makes the grain tougher and more resilient. It heals pre-existing small cracks in the kernel, which significantly reduces the amount of breakage during the subsequent milling process. This leads to a higher yield of whole grains (head rice).
- **D. Dehusking of parboiled rice is easy:** The steaming and drying process causes the kernel to swell and then shrink, which effectively loosens the firm bond between the outer husk and the kernel itself. This makes the husk easier and more efficient to remove during milling.

Thus, A, C, and D are all significant advantages of the parboiling process.

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.

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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:

Detailed Explanation

The process described pertains to the extraction of oil from rice bran, a nutrient-rich byproduct of rice milling. The solution can be expanded as follows:

- **Step 1: Understanding the Context of "Polishing" and Solvent Extraction.** In rice milling, "polishing" is the process that transforms brown rice into white rice. This is achieved by abrading the outer layers, which include the bran and germ. The rice bran is particularly valuable as it is rich in oil (typically 15-25%). To efficiently extract this oil for food use (as rice bran oil), a method called solvent extraction is employed. This is a chemical process where a solvent is used to dissolve the oil from the solid bran material.
- **Step 2: Identifying the Standard Solvent - Hexane.** For food-grade oil extraction from plant materials like rice bran, soybeans, or canola, **n-hexane** is the industry-standard solvent. Its widespread use is due to a combination of highly desirable properties:
  - **High Solvency:** Hexane is a non-polar solvent, making it extremely effective at dissolving non-polar lipids (oils and fats).
  - **Low Boiling Point:** Hexane has a boiling point of approximately 69°C (156°F). This is crucial because, after the oil has been extracted, the solvent must be removed from both the oil and the residual bran. A low boiling point allows for this separation via distillation at relatively low temperatures, which prevents degradation of the oil and minimizes energy costs.
  - **High Volatility:** It evaporates easily, ensuring that minimal residue is left in the final product.
  - **Low Cost:** It is an economically viable solvent for large-scale industrial applications.
  - **Chemical Stability:** It is relatively inert and does not readily react with the oil or other components of the bran.

  Other solvents are generally not used for food oil extraction due to significant drawbacks. For example, acetone is more expensive and can react with oils, while ethanol is less efficient for oil extraction and requires more energy to remove. Safety and regulatory approval are also paramount, and hexane has a long history of established use and safety protocols in the food industry.

Summary of Process

The overall process involves percolating hexane through a bed of rice bran. The hexane dissolves the oil, creating a solution called "miscella." The miscella is then heated to evaporate the hexane, which is captured, condensed, and recycled. The remaining crude rice bran oil is further refined, while the de-oiled bran is often used in animal feed.

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.

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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:

Detailed Explanation

The phenomenon described is a fundamental process in food science known as starch gelatinization. This is the process that occurs when cooking starchy foods like rice, pasta, or potatoes, or when thickening a sauce with flour or cornstarch.

- **Step 1: Analyzing the Described Phenomenon.** The question highlights key events that happen when starch granules are heated in water:
  - **Swelling:** The granules absorb a significant amount of water and increase in size.
  - **Loss of Crystalline Structure:** Starch granules are semi-crystalline, meaning they have regions of highly ordered polymer chains. This crystalline structure gives them the property of **birefringence**, which is the ability to refract light into two slightly different directions. This can be observed under a polarized light microscope as a characteristic "Maltese cross" pattern. When heated, this ordered structure is disrupted, and the birefringence is irreversibly lost.
- **Step 2: Matching with the Correct Scientific Term.** This entire process is the definition of **gelatinization**. It is the irreversible transition of starch from an ordered, granular state to a disordered, amorphous state in the presence of heat and water. This process leads to tangible changes in food:
  - **Increase in Viscosity:** As the granules swell and leach amylose (a linear starch polymer), the mixture becomes thicker. This is the principle behind using starch as a thickener.
  - **Formation of a Gel:** Upon cooling, the dispersed starch molecules (primarily amylose) can re-associate to form a three-dimensional network that traps water, resulting in a gel.

  The other options are incorrect as they describe different processes: **Oxidation** and **reduction** are chemical reactions involving the transfer of electrons. **Freezing** is a physical change of state from liquid to solid. Neither of these accurately describes the specific structural changes occurring to starch in hot water.

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:

Detailed Explanation

This question tests the understanding of the systematic nomenclature of saturated fatty acids, where the name directly relates to the number of carbon atoms.

- **Step 1: Determine Carbon Atoms from Names (LIST-I).** The prefixes used in the names of organic molecules indicate the number of carbon atoms in the main chain. For fatty acids, these prefixes are standard:
  - **A. Heptanoic acid:** The prefix *Hept-* signifies 7 carbon atoms.
  - **B. Hexanoic acid:** The prefix *Hex-* signifies 6 carbon atoms.
  - **C. Pentanoic acid:** The prefix *Pent-* signifies 5 carbon atoms.
  - **D. Tetranic acid:** This is noted as a likely typo for **Tetradecanoic acid**. The prefix *Tetra-deca-* means four plus ten, signifying 14 carbon atoms.
- **Step 2: Determine Carbon Atoms from Structures (LIST-II).** The general chemical formula for a saturated fatty acid is given as $\mathbf{CH_3(CH_2)_nCOOH}$. To find the total number of carbons, one must sum all the carbon atoms:
  - 1 carbon in the methyl group (CH_3).
  - 'n' carbons in the methylene groups ($(CH_2)_n$).
  - 1 carbon in the carboxyl group (COOH).

  Therefore, the total number of carbons is $1 + n + 1 = n + 2$.
  - **I. $\mathbf{CH_3(CH_2)_{12}COOH}$:** Here, n=12. Total carbons = 12 + 2 = **14**.
  - **II. $\mathbf{CH_3(CH_2)_4COOH}$:** Here, n=4. Total carbons = 4 + 2 = **6**.
  - **III. $\mathbf{CH_3(CH_2)_3COOH}$:** Here, n=3. Total carbons = 3 + 2 = **5**.
  - **IV. $\mathbf{CH_3(CH_2)_5COOH}$:** Here, n=5. Total carbons = 5 + 2 = **7**.

- **Step 3: Match the Names with the Structures.** By matching the number of carbons from Step 1 with the number of carbons from Step 2, we get the correct pairings:
  - A. Heptanoic (7C) → IV (7C)
  - B. Hexanoic (6C) → II (6C)
  - C. Pentanoic (5C) → III (5C)
  - D. Tetradecanoic (14C) → I (14C)

  The final correct matching is **A - IV, B - II, C - III, D - I**.

> 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:

Detailed Explanation

This solution addresses the chemical degradation of cooking oil under the harsh conditions of deep frying, focusing on the primary reaction that causes a noticeable physical change (thickening).

- **Step 1: Consider the Conditions of Deep Frying.** Deep frying involves heating oil to high temperatures (160-190°C) for extended periods. The process inherently involves three key components that drive chemical reactions:
  - **High Temperature (Heat):** Provides the energy needed to initiate and sustain chemical reactions.
  - **Oxygen (Air):** The oil is exposed to atmospheric oxygen, leading to oxidation.
  - **Water:** Moisture from the food being fried is introduced into the hot oil, leading to hydrolysis.
- **Step 2: Analyze the Dominant Chemical Change.** Under these conditions, several reactions occur, including hydrolysis, oxidation, and polymerization. While **oxidation** is a significant process that leads to the formation of volatile compounds causing rancidity and off-flavors, it is **polymerization** that is the key reaction responsible for the increase in the oil's viscosity.

- **Polymerization:** At high frying temperatures, the unsaturated fatty acid chains (especially polyunsaturated ones) can break down and then react with each other. Through a series of complex reactions, individual fatty acid molecules (monomers) link together to form much larger molecules called dimers, trimers, and eventually polymers.
- **Effect on Viscosity:** This formation of larger, heavier polymer molecules significantly increases the molecular weight of the oil. The larger molecules are less mobile and have stronger intermolecular forces, which manifests as a noticeable increase in the oil's viscosity, causing it to become thicker and more syrupy.
- **Other Effects:** These polymers also contribute to other undesirable changes, such as darkening of the oil's color and an increase in its refractive index.

Hydrogenation is an industrial process that adds hydrogen to unsaturated fats to make them more solid (e.g., making margarine) and requires a catalyst; it is not a primary reaction in frying. **Termination** is merely one step within a free-radical chain reaction (like oxidation or polymerization), not the overall process itself.

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.

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30. Triple helical structure of protein is also called
(1) Peptide bond
(2) Collagen helix
(3) Tropocollagen
(4) Tertiary structure

Correct Answer: (3)

Solution:

Detailed Explanation

This question requires an understanding of the specific terminology used to describe the hierarchical structure of collagen, the most abundant protein in mammals.

- **Step 1: Define the Terms.** It is crucial to differentiate between the levels of collagen's structure:
  - **Peptide bond:** The fundamental covalent bond that links amino acids together to form a polypeptide chain. This is a general term for all proteins, not specific to collagen's unique structure.
  - **Collagen helix:** This refers to the unique, left-handed helical structure of a *single* individual polypeptide chain (an alpha chain) of collagen. It is a more open helix than the more common alpha-helix found in other proteins.

- **Tropocollagen:** This is the fundamental structural unit of a collagen fibril. It is a macromolecule formed when three individual left-handed collagen helices (alpha chains) wrap around each other to form a right-handed **triple helix**. This triple-helical structure is stabilized by numerous hydrogen bonds.
- **Tertiary structure:** This term describes the overall three-dimensional folding of a *single* polypeptide chain. While tropocollagen has a 3D structure, the term "tertiary structure" is typically used for globular proteins and does not adequately describe the specific triple-helix assembly of three separate chains. The structure of tropocollagen is more accurately described as a type of quaternary structure.

- **Step 2: Match the Definition to the Question.** The question asks for the name of the **triple helical structure** itself, which is formed by three intertwined polypeptide chains. Based on the definitions above, the correct term is **tropocollagen**. While "collagen helix" describes a component part (a single chain), "tropocollagen" refers to the complete three-chain unit that then assembles into larger fibrils and fibers.

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".

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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:

Detailed Explanation

This question assesses knowledge about the nutritional composition of Spirulina, a popular dietary supplement.

- **Step 1: Identify Spirulina.** Spirulina is not a true algae but a type of **cyanobacteria**, often referred to as blue-green algae. It is cultivated worldwide for use as a food supplement due to its impressive nutritional profile. It is typically sold in powder or tablet form.
- **Step 2: Recall its Primary Nutritional Characteristic.** Spirulina's most notable feature is its exceptionally high protein content. On a dry weight basis, Spirulina is one of the most protein-dense foods available. Scientific literature and nutritional analyses

consistently report that its protein content typically ranges from **55% to 70%**. This protein is also considered high-quality as it contains all essential amino acids.

- **Step 3: Compare this with the Given Options.** The question asks to identify the correct range for protein content. Given the established range of 55% to 70%, the option of **50 - 60%** is the most appropriate and conservative estimate provided. While the protein content can be higher, reaching up to 70%, the 50-60% range represents a very common and widely accepted value for commercial Spirulina products. Other macronutrient compositions are significantly lower; for instance, carbohydrates typically range from 15-25% and fats from 6-9%.

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%.

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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:

Detailed Explanation

This is a straightforward matching question that tests the knowledge of the scientific names for several common B vitamins.

- **Step 1: Match Each B Vitamin with its Scientific Name.** The B-complex vitamins are a group of eight essential water-soluble vitamins that play critical roles in cell metabolism. Each has a number designation and a scientific name.
  - **A. Vitamin B-1** is scientifically known as **Thiamine**. So, **A matches IV**.
  - **B. Vitamin B-2** is scientifically known as **Riboflavin**. So, **B matches III**.

- **C. Vitamin B-6** is scientifically known as **Pyridoxine**. So, **C matches I**.
- **D. Vitamin B-12** is scientifically known as **Cobalamin**, due to the presence of a cobalt atom in its structure. So, **D matches II**.

- **Step 2: Combine the Matches and Select the Correct Option.** By assembling the individual matches, we arrive at the correct combination:

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

  This corresponds to the correct option provided in the problem context.

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).

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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:

Detailed Explanation

This question differentiates between two fundamental types of heat exchangers used in the food industry: non-contact (indirect) and direct contact.

- **Step 1: Define a Non-Contact (Indirect) Heat Exchanger.** In a non-contact, or indirect, heat exchanger, the product being processed and the heating/cooling medium (like steam, hot water, or a refrigerant) are kept physically separate by a solid barrier, typically a metal wall. Heat is transferred through this barrier via conduction. This prevents any mixing of the product and the medium, which is essential for maintaining the product's integrity, safety, and composition.

- **Step 2: Evaluate the Options.** We must analyze the mechanism of each listed heat exchanger:

  - **Steam Infusion:** In this method, the liquid food product is sprayed into a chamber filled with high-pressure steam. The steam condenses directly onto the droplets of the food, transferring its latent heat of vaporization very rapidly and efficiently. Because the steam and the product physically mix, this is a **direct contact method**.

- **Scraped Surface:** This exchanger consists of a jacketed cylinder. The product flows inside the cylinder, and the heating/cooling medium flows within the outer jacket. A rotating shaft with blades continuously scrapes the product from the inner wall to ensure uniform heat transfer and prevent fouling. The product and medium are separated by the cylinder wall, making this a **non-contact** method.
- **Shell and Tube:** This common design involves a bundle of tubes enclosed within a larger cylindrical shell. One fluid flows through the small tubes, and the other fluid flows outside the tubes within the shell. The tube walls act as the barrier, making this a classic **non-contact** method.
- **Tubular:** Similar to the shell and tube, a tubular heat exchanger involves one tube inside another (or a tube surrounded by a jacket). The product and the medium flow in their respective channels, separated by the tube wall. This is a **non-contact** method.

Conclusion: Based on the analysis, steam infusion is the only method listed where the heating medium (steam) comes into direct physical contact with the food product. Therefore, it is the direct contact method among the choices.

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.

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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:

Detailed Explanation

This question concerns the methods used in food preservation specifically to control and inhibit the activity of endogenous enzymes, which can cause spoilage, browning, and off-flavors.

- **Step 1: Understand the Goal of Enzyme Inhibition in Food.** Many fresh foods, especially fruits and vegetables, contain active enzymes. After harvesting, these enzymes can initiate reactions that degrade the quality of the food. For example, polyphenol oxidase causes enzymatic browning in cut apples and potatoes. Pectinases can cause softening of texture. The goal of enzyme inhibition is to slow down or completely stop these undesirable reactions to extend the shelf life and maintain the quality of the food.
- **Step 2: Analyze the Given Techniques.**
  - **A. Heat:** Applying heat, as in blanching or pasteurization, is a highly effective method. Heat provides energy that disrupts the delicate three-dimensional structure of the enzyme protein, causing it to unfold or **denature**. This change is irreversible and permanently inactivates the enzyme.
  - **B. Sugar:** High concentrations of sugar are used in making jams, jellies, and preserves. Sugar's primary role in preservation is to lower the **water activity ($\mathbf{a}_w$)** of the food. It does this by binding to water molecules, making them unavailable for microbial growth. While this reduction in free water also hinders enzyme mobility and can slow their function, its main purpose is antimicrobial. Therefore, it's considered a secondary or less direct method of enzyme inhibition compared to others.
  - **C. Variation of pH:** Every enzyme has an optimal pH range in which it functions most efficiently. Drastically altering the pH by adding an acid (like citric acid from lemon juice or acetic acid from vinegar) moves the enzyme out of its optimal range. This change in pH can alter the ionization of amino acid residues in the enzyme's active site, disrupting its structure and function and thus inhibiting its activity.
  - **D. Sulphur Dioxide:** Sulphites, including sulfur dioxide (SO_2), are powerful chemical inhibitors. They are particularly effective against the polyphenol oxidase enzyme, preventing enzymatic browning in dried fruits and wine. They act directly on the enzyme to inhibit its function.

Conclusion: All four methods are used in food preservation. However, Heat (A), pH variation (C), and chemical inhibitors like Sulphur dioxide (D) are all *primary and direct* methods specifically targeted at inactivating enzymes. Sugar (B) is also effective, but its primary mechanism is generally considered to be the control of water activity for microbial inhibition. Therefore, the combination of A, C, and D represents the most direct and fundamental techniques for controlling enzyme activity in food.

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.

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35. All amino acids have a chiral centre, except
(1) Lysine
(2) Arginine
(3) Histidine
(4) Glycine

Correct Answer: (4)

Solution:

Detailed Explanation

This question explores the concept of chirality as it applies to the standard amino acids, identifying the unique exception to the general rule.

- **Step 1: Define a Chiral Center.** A chiral center, also known as an asymmetric carbon, is a carbon atom that is bonded to **four different** atoms or groups of atoms. A molecule containing a chiral center is non-superimposable on its mirror image and is thus a chiral molecule.
- **Step 2: Examine the General Structure of an Amino Acid.** The 20 standard proteinogenic amino acids share a common backbone structure. There is a central carbon atom, called the alpha-carbon (α-carbon), which is bonded to:
  1. An amino group ($-NH_2$)
  2. A carboxyl group ($-COOH$)
  3. A hydrogen atom ($-H$)
  4. A variable side chain, known as the R group.
- **Step 3: Analyze the Condition for Chirality.** For the α-carbon of an amino acid to be a chiral center, the four groups attached to it must all be different. This means the R group must be different from the other three constant groups: $-H$, $-NH_2$, and $-COOH$.
- **Step 4: Identify the Exception - Glycine.** For 19 of the 20 standard amino acids, the R group is a unique carbon-containing side chain, which is different from the other three groups. Therefore, their α-carbons are chiral centers.

  The exception is **Glycine**. For Glycine, the R group is simply another **hydrogen atom ($-H$)**. This means the α-carbon in Glycine is bonded to two identical substituents (two hydrogen atoms). Because it is not bonded to four *different* groups, the α-carbon of Glycine is not a chiral center. Consequently, Glycine is an **achiral** molecule.

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.

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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:

Detailed Explanation

This question asks for a logical sequence of steps involved in the production of purified oil from various raw materials, both plant and animal. The key is to understand that the overall process moves from extraction (getting crude oil out) to refining (purifying the crude oil).

- **Step 1: Define the Different Oil Processing Steps.** The steps provided are distinct methods of extraction or a final stage of purification.
  - **Extraction Methods (Getting crude oil):**
    - **D. Rendering:** This is an extraction method used for **animal fats** (e.g., lard from pork fat, tallow from beef fat). It involves using heat to melt the fat, causing it to separate from the solid tissues.
    - **B. Pressing (Expelling):** This is a mechanical extraction method used for **oilseeds** (e.g., sunflower, canola, sesame). The seeds are squeezed under high pressure to force the oil out.
    - **C. Solvent Extraction:** This is a chemical extraction method. It uses a solvent (typically hexane) to wash the oil out of the source material. It is highly efficient and is often used on the "press cake" that remains after mechanical pressing to extract the residual oil and maximize yield.
  - **Purification Stage:**
    - **A. Refining:** This is the final stage that all crude oils, regardless of their source or extraction method, must undergo to become edible. Refining is a multi-step process that includes degumming, neutralizing, bleaching, and deodorizing. Its purpose is to remove impurities like free fatty acids, phospholipids, pigments, and volatile compounds that affect the oil's quality, flavor, and stability.

- **Step 2: Construct a Logical Sequence.** A comprehensive sequence for oil processing must start with one or more extraction methods and must end with refining.

  1. **Start with Extraction:** Rendering (D), Pressing (B), and Solvent Extraction (C) are all methods to obtain crude oil. They represent the beginning of the process. For many oilseeds, a common industrial practice is to use pressing (B) first, followed by solvent extraction (C) on the remaining solid material. Rendering (D) is a separate path for animal fats.
  2. **End with Refining:** After any extraction method, the result is crude oil, which is not yet suitable for consumption. Therefore, refining (A) is the universal final step that follows all extraction processes.

  A logical sequence that represents the various extraction possibilities followed by the mandatory purification step is **D, B, C, A**. This sequence lists the different types of extraction methods first (D, B, C) and concludes with the universal final step (A).

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).

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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:

Detailed Explanation

This question focuses on the precise definition of a "hazard" within the framework of food safety, particularly in the context of the Hazard Analysis and Critical Control Points (HACCP) system.

- **Step 1: Analyze the Definition Provided.** The question defines something as an *"agent... with the potential to cause an adverse health effect"*. The crucial phrase here is **"potential to cause harm."** This means it is the *source* of the danger, not the danger or illness itself.
- **Step 2: Compare This with the Definitions of the Options.**

- **Food-borne illness:** This is the *result* or sickness that occurs after consuming contaminated food (e.g., Salmonellosis). It is the outcome of the hazard, not the hazard itself.
- **Suitability:** This is a broader term referring to whether food is acceptable for consumption. It can include quality attributes like spoilage or wholesomeness, not just safety. A food might be unsuitable (e.g., stale bread) without necessarily being hazardous.
- **Contaminant:** This is any substance that is not intentionally added to food. While many contaminants are indeed hazards, the term "hazard" is more specific. For example, a piece of plastic in food is a contaminant, and it is also a physical hazard because it has the potential to cause harm (e.g., choking or injury). The term "hazard" directly addresses the potential to cause an adverse health effect.
- **Hazard:** In the context of HACCP, a hazard is defined precisely as a biological, chemical, or physical agent in food with the potential to cause an adverse health effect. This definition perfectly matches the one given in the question.
  * **Biological Hazards:** Bacteria (e.g., *Salmonella*), viruses, parasites.
  * **Chemical Hazards:** Pesticides, cleaning agents, allergens.
  * **Physical Hazards:** Glass, metal, plastic, bones.

Conclusion: The term **hazard** is the most accurate and specific term for an agent that has the *potential* to cause harm, as defined in established food safety systems like HACCP.

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.

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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 → B → A → 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).

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39. 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: Understanding the Concept:
Size reduction, or comminution, is a mechanical process of breaking down solid particles into smaller ones. The effectiveness of this process and the choice of equipment depend on several properties of the food material being processed.

Step 2: Detailed Explanation:
Let's analyze each factor:
A. Friability of the food: Friability is the tendency of a solid substance to break into smaller pieces under stress. A highly friable food is easier to grind, directly impacting the effectiveness of size reduction. This is a critical factor.
B. Bulk density: Bulk density is the mass of a material in a given volume, including the space between particles. While important for hopper design, material handling, and equipment capacity, it is less of a primary factor determining the *effectiveness* of the particle breakdown itself compared to the material's intrinsic properties.
C. Moisture content: Moisture content significantly affects grinding. High moisture can make materials sticky and clog the equipment, reducing efficiency. Very low moisture can sometimes make materials harder or create dust explosion hazards. It directly influences how the material behaves during size reduction.
D. Heat sensitivity of the food: Many food components are sensitive to heat. The mechanical energy used in grinding generates heat, which can degrade vitamins, denature proteins, or melt fats. This factor is crucial for selecting an appropriate method (e.g., cryogenic grinding for heat-sensitive spices) and determines the operational limits.

Step 3: Final Answer:
Based on the analysis, Friability (A), Moisture content (C), and Heat sensitivity (D) are the primary factors that determine the effectiveness of the size reduction process itself. Bulk density (B) is more related to material handling and equipment throughput. Therefore, the most appropriate combination is A, C, and D.

Quick Tip

When analyzing questions with multiple factors, distinguish between primary factors that affect the core process (like the actual breaking of particles) and secondary factors that relate to handling, storage, or capacity. Effectiveness is a primary concern.

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40. 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: Understanding the Concept:
This question asks to identify a specific type of food packaging based on its functionality. The key functions described are sensing changes and responding by modifying package properties. Let's define the options.

Step 2: Detailed Explanation:
(A) Aseptic Packaging: This involves sterilizing the food product and the packaging material separately and then combining them in a sterile environment. Its goal is to create a shelf-stable product without refrigeration. It does not inherently sense or respond to changes.
(B) Passive Packaging: This is traditional packaging that provides a simple physical barrier to protect the food from outside elements like moisture, oxygen, and light. It does not have any dynamic function. Examples include glass jars or simple plastic bags.
(C) Active Packaging: This type of packaging actively changes the conditions within the package to improve safety or extend shelf life. It interacts with the food or the headspace. Examples include oxygen scavengers, ethylene absorbers, and moisture absorbers. It acts, but doesn't necessarily sense and then act.
(D) Intelligent Packaging: This type of packaging system is designed to monitor and communicate information about the condition of the food or the environment inside the package. The core function is to **detect or sense** changes. This information can be communicated through indicators (e.g., time-temperature indicators, freshness indicators that change color). The phrase "modification of package properties in response" refers to this communication function—the property that changes is the visual indicator on the package.

Step 3: Final Answer:
The description "detects or senses changes" is the defining characteristic of intelligent packaging. While active packaging acts on the environment, intelligent packaging monitors it. Therefore, intelligent packaging is the correct answer.

Quick Tip

Remember the key difference: Active packaging *acts* (e.g., removes oxygen), while Intelligent packaging *informs* (e.g., changes color to indicate spoilage). The question's emphasis on "detects or senses" points directly to "intelligent".

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41. Match the LIST-I with LIST-II

LIST-I (Diffusion Coefficients of Gases in Water at 20 °C)		**LIST-II D (x10^{-9} m^2/s)**	
A	Chlorine	I	2.1
B	Carbon dioxide	II	1.9
C	Nitrogen	III	1.6
D	Oxygen	IV	1.8

Choose the most appropriate answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
Diffusion coefficient (D) is a measure of how quickly a substance diffuses through another. Generally, for gases diffusing in a liquid like water, smaller, lighter molecules diffuse faster than larger, heavier molecules. We need to match the gases to their known diffusion coefficients in water at 20 °C.

Step 2: Detailed Explanation:
Let's analyze the gases based on their molar masses and general properties:
- **Oxygen (O_2)**: Molar mass $\approx$ 32 g/mol.
- **Nitrogen (N_2)**: Molar mass $\approx$ 28 g/mol. It is slightly smaller and lighter than O_2.
- **Carbon dioxide (CO_2)**: Molar mass $\approx$ 44 g/mol. It is larger than O_2 and N_2.
- **Chlorine (Cl_2)**: Molar mass $\approx$ 71 g/mol. It is the largest and heaviest molecule among the four.

Based on the principle that larger molecules diffuse more slowly, we would expect the diffusion coefficients to be in the order: N_2 ¿ O_2 ¿ CO_2 ¿ Cl_2. However, experimental values are influenced by molecular shape and interactions with water.

Let's look at the standard experimental values for diffusion coefficients (D) in water at or near 20-25 °C (in $\times 10^{-9}$ m^2/s):
- **Oxygen (D)**: $\approx$ 2.1
- **Carbon dioxide (B)**: $\approx$ 1.9
- **Nitrogen (C)**: $\approx$ 1.8 - 1.9
- **Chlorine (A)**: $\approx$ 1.6 - 1.7

Now let's match these with the values given in LIST-II:
- The highest value is **I (2.1)**, which corresponds to **D (Oxygen)**.
- The next value is **II (1.9)**, which corresponds to **B (Carbon dioxide)**.
- The next value is **IV (1.8)**, which corresponds to **C (Nitrogen)**.
- The lowest value is **III (1.6)**, which corresponds to **A (Chlorine)**.

Step 3: Final Answer:
The correct matching is:
- A $\rightarrow$ III
- B $\rightarrow$ II
- C $\rightarrow$ IV
- D $\rightarrow$ I

This corresponds to option (B).

Quick Tip

For diffusion questions, remember the general rule: smaller, lighter molecules diffuse faster. While experimental values can have slight deviations, you can often rank the substances by molar mass to get a good estimate. Chlorine (Cl_2) is significantly heavier than the others, so it will have the lowest diffusion coefficient.

---

42. 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: Understanding the Concept:
This question asks for the definition of a specific psychrometric (properties of moist air) term. We need to evaluate the definitions of the given options.

Step 2: Detailed Explanation:
(A) Relative Humidity (RH): Relative humidity is a measure of the amount of water vapor present in the air compared to the maximum amount of water vapor the air can hold at that specific temperature. It is formally defined as the ratio of the partial pressure of water vapor (p_w) to the saturation vapor pressure of water (p_{ws}) at the same temperature. For ideal gases, this pressure ratio is equal to the mole fraction ratio.

$$\text{RH} = \frac{p_w}{p_{ws}} \times 100\% = \frac{x_w}{x_{ws}} \times 100\%$$

where x_w is the mole fraction of water vapor in the sample and x_{ws} is the mole fraction in a saturated sample. The question describes this exact ratio.

(B) Specific Volume: This is the volume occupied by a unit mass of moist air. It is an intensive property, typically expressed in m^3/kg of dry air. It is not a ratio of mole fractions.

(C) Wet Bulb Temperature: This is the temperature a parcel of air would have if it were cooled to saturation (100% relative humidity) by the evaporation of water into it, with the latent heat supplied by the parcel. It is measured with a thermometer whose bulb is covered

in a wet wick.

(D) Dew-Point Temperature: This is the temperature to which air must be cooled, at constant pressure and water content, for it to become saturated with respect to water. It is the temperature at which dew starts to form.

Step 3: Final Answer:
The definition provided in the question—the ratio of the mole fraction of water vapor in a sample to the mole fraction in a saturated sample at the same temperature and pressure—is the precise definition of Relative Humidity.

Quick Tip

Remember the core definitions in psychrometry. Relative Humidity is a "ratio" or "percentage" that tells you how 'full' the air is with water vapor. Dew point and wet-bulb are "temperatures" that describe specific states or processes.

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43. 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: Understanding the Concept:
The question requires identifying the type of evaporator shown in the schematic diagram. We

need to analyze the flow paths of the feed, heating medium (steam), and product.

Step 2: Detailed Explanation:
Let's break down the diagram:
1. **Feed Inlet:** The liquid feed is introduced at the bottom of a bundle of vertical tubes.
2. **Heating Medium:** Steam is supplied to the shell side (the 'jacket' surrounding the tubes), where it condenses and releases latent heat. The condensate is removed from the bottom of the shell.
3. **Process Flow:** The heat from the steam causes the liquid inside the tubes to boil. The formation of vapor bubbles reduces the density of the fluid inside the tubes. This creates a thermosiphon effect, causing the liquid and vapor to flow upwards together through the tubes as a film.
4. **Product Outlet:** At the top, the vapor and the concentrated liquid are separated. The vapor goes to a condenser or vacuum system, and the concentrated liquid product is collected.

This specific configuration, where the feed enters the bottom and travels upwards through heated tubes as it boils, is characteristic of a **Rising-film Evaporator**. It is also a type of natural-circulation evaporator, but "rising-film" is a more specific and accurate classification for this design (often called a Long-Tube Vertical or LTV evaporator).

Comparing with other options:
- **Falling-film evaporator:** The feed would be introduced at the top and flow down the inside of the tubes as a thin film.
- **Batch-type pan evaporator:** This is typically a single large, shallow vessel heated by a steam jacket, not a set of vertical tubes.
- **Natural-circulation evaporator:** While this is a type of natural circulation evaporator, "Rising-film evaporator" is the specific name for this configuration. In exams, the most specific correct term is usually preferred.

Step 3: Final Answer:
The diagram clearly depicts the operation of a rising-film evaporator.

Quick Tip

In evaporator diagrams, always trace the feed path. If the feed enters the bottom of vertical tubes and exits the top, it's a rising-film. If it enters the top and exits the bottom, it's a falling-film.

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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: Understanding the Concept:
This question asks for the definition of a term related to the process of freezing. A "rate" in physics and engineering typically refers to a change in a quantity divided by the time it takes for that change to occur.

Step 2: Key Formula or Approach:
The general formula for a rate of change is:

$$\text{Rate} = \frac{\Delta(\text{Quantity})}{\Delta(\text{Time})}$$

In this case, the quantity changing is temperature.

Step 3: Detailed Explanation:
The question describes the following calculation:

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

This is the change in temperature (ΔT) divided by the time taken (Δt). This calculation gives the average speed at which the temperature drops during the freezing process. This is, by definition, the **Freezing Rate**.

Let's look at the other options:
- **Freezing Time:** This is the denominator of the expression, not the expression itself. It is the total time required for the product to freeze.
- **Thawing Time / Thawing Rate:** These terms relate to the process of thawing (melting), not freezing. Thawing rate would be the rate of temperature increase during melting.

Step 4: Final Answer:
The expression "difference between the initial and the final temperature divided by the freezing time" precisely defines the freezing rate.

Quick Tip

Look for keywords. "Divided by time" almost always indicates a "rate". Since the process is freezing, the term must be "Freezing Rate". This helps you quickly eliminate other options like "Freezing Time".

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: Understanding the Concept:
The question asks to identify the major functional components of a typical microwave oven from a given list.

Step 2: Detailed Explanation:
Let's analyze each component listed:
A. Wave guide: This is a hollow metal tube that directs the high-frequency microwaves from the magnetron to the cooking cavity. It is an essential component for guiding the energy. This is a major component.
B. Magnetron: This is the core component of a microwave oven. It is a high-powered vacuum tube that generates the microwaves used for heating the food. This is a major component.
C. Channel: This is not a standard technical term for a major component in a microwave oven. Components might be housed in channels, but "channel" itself is not a primary functional part like a magnetron or waveguide.
D. Stirrer: This is a fan-like metal blade, usually located at the top of the oven cavity. It rotates to reflect and distribute the microwaves in different directions, ensuring more uniform heating of the food and preventing hot and cold spots. This is a major component for cooking uniformity. (In many domestic ovens, a turntable serves a similar purpose).

Step 3: Final Answer:
The essential major components from the list are the Magnetron (to generate waves), the Wave guide (to direct them), and the Stirrer (to distribute them). Therefore, the correct combination is A, B, and D.

Quick Tip

To solve component-based questions, think about the function of the device. A microwave oven needs to: 1. Generate microwaves (Magnetron), 2. Get them into the oven (Wave guide), and 3. Spread them out for even cooking (Stirrer/Turntable).

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 in the processed fluids on the heat transfer surface.
B	Freezing	II	Heat transfer surface reacts with ambient and corrodes.
C	Particulate	III	Solidification of liquid components on subcooled surfaces.
D	Corrosion	IV	Precipitation of dissolved substances. Salts such as $CaSO_4$, $CaCO_3$ cause scaling.

Choose the most appropriate answer from the options given below:

(A) A - II, B - I, C - III, D - IV
(B) A - I, B - III, C - II, D - IV
(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: Understanding the Concept:
Fouling is the accumulation of unwanted material on solid surfaces, especially heat transfer surfaces, which impedes performance. This question requires matching different types of fouling to their corresponding mechanisms.

Step 2: Detailed Explanation:
Let's match each type of fouling in LIST-I with its description in LIST-II.
A. Precipitation Fouling: This occurs when dissolved substances become insoluble and precipitate onto the surface. This is often caused by temperature changes or concentration exceeding the solubility limit. A common example is the formation of scale from salts like calcium carbonate ($CaCO_3$) or calcium sulfate ($CaSO_4$). This perfectly matches description **IV**.
A $\rightarrow$ IV

B. Freezing Fouling: This happens when a component of the process fluid freezes and solidifies on a surface that is below the freezing point of that component (a subcooled surface). This perfectly matches description **III**.
B $\rightarrow$ III

C. Particulate Fouling: This is the deposition of solid particles that are suspended (not dissolved) in the fluid onto the heat transfer surface. This is also known as sedimentation fouling. This perfectly matches description **I**.
C $\rightarrow$ I

D. Corrosion Fouling: This occurs when the heat transfer surface material itself reacts chemically with the fluid, creating a layer of corrosion products. This perfectly matches description **II**.
D → II

Step 3: Final Answer:
Combining our matches, we get the set: A-IV, B-III, C-I, D-II. This corresponds to option (C).

> Quick Tip
>
> For fouling questions, focus on the state of the foulant. - **Precipitation**: Dissolved → Solid (Scaling) - **Particulate**: Suspended Solid → Deposited Solid - **Freezing**: Liquid → Solid (on a cold surface) - **Corrosion**: Surface Material → Corrosion Product

---

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 solution

Choose the most appropriate answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
This question requires matching different types of fluid rheological behaviors with common food examples. The classification is based on how a fluid's viscosity changes with applied shear stress.
- **Newtonian:** Viscosity is constant. - **Shear-thinning (Pseudoplastic):** Viscosity decreases as shear rate increases. - **Shear-thickening (Dilatant):** Viscosity increases as shear rate increases. - **Bingham plastic:** A certain amount of stress (yield stress) is needed before the fluid starts to flow.

Step 2: Detailed Explanation and Addressing Ambiguity:
Standard textbook examples are: - Shear-thinning → Tomato Ketchup (I) - Newtonian → Wa-

ter, Milk (II) - Shear-thickening → Corn starch solution (IV) - Bingham plastic → Toothpaste, Mayonnaise, Whipped Cream (III)
The standard, unambiguous matching would be A-I, B-II, C-IV, D-III. However, this combination is not available in the options, which indicates an error in the question or options, or a non-standard classification is being used. We must find the "best fit" among the given choices.
Let's re-evaluate the classifications, considering potential overlaps: - **Tomato Ketchup (I):** It is famously shear-thinning, but it also exhibits a yield stress, so it can also be classified as a Bingham plastic (or more accurately, a Herschel-Bulkley fluid). - **Whipped Cream (III):** It is a Bingham plastic (needs stress to flow), but once it flows, its viscosity can decrease with shear, so it also has shear-thinning properties.
Let's analyze the given options to find the most plausible intended answer: - Option (A) and (B) start with A-I (Shear-thinning → Ketchup). If this is correct, then the rest of the matches in (A) and (B) are incorrect (e.g., B-IV Newtonian → Starch is wrong). - Option (C) presents the matching: A-III, B-II, C-IV, D-I. - **A. Shear-thinning → III. Whipped cream:** This is plausible. After overcoming its yield stress, whipped cream does exhibit shear-thinning behavior. - **B. Newtonian → II. Milk:** This is correct. - **C. Shear-thickening → IV. 40% raw corn starch solution:** This is the classic example and is correct. - **D. Bingham plastic → I. Tomato ketchup:** This is plausible. Ketchup has a distinct yield stress (it doesn't flow until the bottle is shaken or squeezed).
Step 3: Final Answer:
Given that the standard matching is not an option, option (C) provides a consistent and plausible set of classifications, despite using less common examples for shear-thinning and Bingham plastic fluids. It correctly identifies Milk as Newtonian and Corn Starch solution as shear-thickening, which are unambiguous. The classification of whipped cream as shear-thinning and ketchup as Bingham plastic is a valid, alternative interpretation of their complex behaviors. Therefore, this is the most likely correct answer.

Quick Tip

In rheology matching questions, some foods can fit multiple classifications. If your primary matching isn't an option, look for alternative but valid classifications. Ketchup can be seen as both shear-thinning and Bingham plastic. Identify the most unambiguous pairs first (like Newtonian fluid or dilatant fluid) to narrow down the options.

---

48. Match the LIST-I with LIST-II

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

Choose the most appropriate answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
This question tests the knowledge of the approximate viscosity of common substances at room temperature. Viscosity is a measure of a fluid's resistance to flow. The unit used is Pascal-second (Pa·s). A higher value means the fluid is 'thicker'.

Step 2: Detailed Explanation:
Let's estimate the viscosity of each substance and match it to the given orders of magnitude.
- **A. Air:** Air is a gas and has a very low viscosity. The standard value at 20 °C is about 1.8 $\times 10^{-5}$ Pa·s. This matches the order of magnitude of **III (10^{-5})**.
A $\rightarrow$ III

- **B. Water:** Water is the standard reference for viscosity. At 20 °C, its viscosity is approximately 1.0 $\times 10^{-3}$ Pa·s (or 1 centipoise). This matches **I (10^{-3})**.
B $\rightarrow$ I

- **C. Olive Oil:** Olive oil is significantly more viscous than water. Its viscosity is typically around 0.05 to 0.1 Pa·s. This matches the order of magnitude of **IV (10^{-1})**.
C $\rightarrow$ IV

- **D. Liquid Honey:** Honey is very viscous. Its viscosity varies greatly with type and temperature but is typically in the range of 2 to 10 Pa·s at room temperature. This matches the order of magnitude of **II (10^{1})**.
D $\rightarrow$ II

Step 3: Final Answer:
Combining the matches, we get the sequence: A-III, B-I, C-IV, D-II. This corresponds to option (B).

Quick Tip

When estimating viscosities, it's helpful to rank the substances from least viscous to most viscous first: Air < Water < Olive Oil < Honey. Then, match this ranking to the given viscosity values sorted in ascending order: $10^{-5} < 10^{-3} < 10^{-1} < 10^{1}$. This makes the matching process straightforward.

49. 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: Understanding the Concept:
This question asks for a specific biochemical fact: the number of carbon atoms in arachidonic acid. Arachidonic acid is an important polyunsaturated fatty acid found in the body.

Step 2: Detailed Explanation:
Fatty acids are classified by the length of their carbon chains. Arachidonic acid (AA) is a well-known omega-6 fatty acid. Its chemical notation is 20:4(n-6), which provides the key information: - **20**: The first number indicates the total number of carbon atoms in the chain. - **4**: The second number indicates the number of carbon-carbon double bonds. - **n-6** (or ω-6): This indicates that the first double bond is located at the sixth carbon atom from the methyl end (the omega end) of the chain.
Therefore, arachidonic acid is composed of a 20-carbon chain.

Step 3: Final Answer:
Based on its chemical definition and notation, arachidonic acid has 20 carbon atoms.

Quick Tip

For questions on fatty acids, memorizing the carbon chain lengths of common ones is useful. For example: Palmitic acid (C16), Stearic acid (C18), Oleic acid (C18), Linoleic acid (C18), and Arachidonic acid (C20).

---

50. Instrument used for measuring the humidity is _____

(A) Thermometer
(B) Hygrometer
(C) Pyrometer
(D) Penetrometer

Correct Answer: (B) Hygrometer

Solution:

Step 1: Understanding the Concept:
The question asks to identify the scientific instrument used for measuring humidity. We need to know the function of each instrument listed.

Step 2: Detailed Explanation:
- **(A) Thermometer:** An instrument used for measuring temperature.
- **(B) Hygrometer:** An instrument used for measuring the amount of water vapor in the air, in soil, or in confined spaces. This is the definition of a humidity-measuring device. A psychrometer is a specific type of hygrometer that uses wet-bulb and dry-bulb thermometers.
- **(C) Pyrometer:** An instrument for measuring high temperatures from a distance by detecting the object's thermal radiation. It is used for objects that are too hot to touch, like molten metal.
- **(D) Penetrometer:** An instrument used to measure the hardness or consistency of a substance (like soil, asphalt, or food products like cheese and fruits) by measuring the depth or rate of penetration of a rod or needle.

Step 3: Final Answer:
The correct instrument for measuring humidity is the hygrometer.

Quick Tip

Break down the names of instruments if possible. "Hygro-" is a prefix derived from Greek 'hugros' meaning moist or wet. "Thermo-" relates to heat, "Pyro-" relates to fire/high heat. This can help you deduce the correct answer.

---

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

(A) 0%
(B) 75%
(C) 50%
(D) 100%

Correct Answer: (D) 100%

Solution:

Step 1: Understanding the Concept:
This question asks for the relative humidity of saturated air. We need to understand the definitions of "saturated air" and "relative humidity."

Step 2: Detailed Explanation:
Relative Humidity (RH): It is the ratio of the actual amount of water vapor in the air to the maximum amount of water vapor the air can hold at that temperature, expressed as a

percentage.

$$\text{RH} = \frac{\text{Actual water vapor content}}{\text{Maximum possible water vapor content (at same T)}} \times 100\%$$

Saturated Air: Air is said to be "saturated" when it is holding the maximum possible amount of water vapor at its current temperature. Any further addition of water vapor or any decrease in temperature will cause condensation.

By combining these two definitions, if the air is saturated, its actual water vapor content is equal to its maximum possible water vapor content. Therefore, the ratio is 1, and the relative humidity is 100%.

Step 3: Final Answer:
By definition, saturated air has a relative humidity of 100%.

> Quick Tip
>
> Think of saturation as a container being "full". If the air is "full" of water vapor, its relative humidity is 100%. If it's completely dry, its RH is 0%.

---

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: Understanding the Concept:
This question is about interpreting a psychrometric chart, which is a graphical representation of the properties of moist air. We need to identify the significance of the topmost curve on this chart.

Step 2: Detailed Explanation:
A psychrometric chart plots various properties of air, such as dry-bulb temperature (horizontal axis), humidity ratio (vertical axis), wet-bulb temperature, enthalpy, and relative humidity.
The chart features a set of curved lines that represent constant relative humidity. These lines typically range from 10% near the bottom right to 100% at the top left boundary.
The topmost, leftmost boundary curve of the chart represents the condition where the air is fully saturated with water vapor. At any point on this line, the air cannot hold any more

moisture at that temperature. This line is known as the **saturation line** or the **saturation curve**. By definition, any air sample whose state point lies on this curve has a relative humidity of **100%**. Also, on this line, the dry-bulb, wet-bulb, and dew-point temperatures are all equal.

Step 3: Final Answer:
The topmost curve on the psychrometric chart is the saturation line, which represents 100% relative humidity.

> Quick Tip
>
> When looking at a psychrometric chart, remember the key boundaries. The bottom horizontal line (humidity ratio = 0) represents dry air (0% RH). The top curved line represents saturated air (100% RH). All other RH curves fall between these two extremes.

---

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: Understanding the Concept:
This is a mass balance problem in a drying process. The key principle is that the mass of the dry solids in the material remains constant throughout the drying process; only the mass of water changes.

Step 2: Key Formula or Approach:
1. Calculate the initial mass of dry solids. 2. The final mass of dry solids is the same as the initial mass. 3. Use the final mass of dry solids and the final solids percentage to calculate the final total weight of the product.
Mass of solids = Total Mass $\times$ (1 - Moisture Content)

Step 3: Detailed Explanation:
Initial State:
- Initial total weight of potatoes, $W_{initial} = 100$ kg.
- Initial moisture content (wet basis) = 85% = 0.85.
- Initial solids content = 100% - 85% = 15% = 0.15.

- Mass of dry solids = $W_{initial}$ × (Initial solids content).

$$\text{Mass of dry solids} = 100\,\text{kg} \times 0.15 = 15\,\text{kg}$$

Final State:
- The mass of dry solids remains constant = 15 kg.
- Final moisture content (wet basis) = 10% = 0.10.
- Final solids content = 100% - 10% = 90% = 0.90.
- The 15 kg of dry solids now constitutes 90% of the final product's weight. Let the final weight be W_{final}.

$$15\,\text{kg} = W_{final} \times 0.90$$

- Now, we solve for W_{final}:

$$W_{final} = \frac{15\,\text{kg}}{0.90}$$
$$W_{final} = 16.666...\,\text{kg}$$

Step 4: Final Answer:
The final weight of the product is approximately 16.66 kg.

> Quick Tip
>
> In drying calculations, always focus on the component that doesn't change: the dry solids. Calculate the initial mass of solids, and then use that constant value to find the final total mass based on the final composition.

---

54. Freeze drying is also known as

(A) Crystallization
(B) Gelatinization
(C) Homogenization
(D) Lyophilization

Correct Answer: (D) Lyophilization

Solution:

Step 1: Understanding the Concept:
The question asks for a synonym for the process of freeze drying.

Step 2: Detailed Explanation:
Let's define the terms:
Freeze Drying: A low-temperature dehydration process that involves freezing the product, lowering pressure, and then removing the ice by sublimation (transitioning directly from solid

to gas). It is used to preserve perishable materials and make them more convenient for transport.

(A) Crystallization: The process by which a solid forms, where the atoms or molecules are highly organized into a structure known as a crystal. It is used in sugar production, for example.
(B) Gelatinization: The process of breaking down the intermolecular bonds of starch molecules in the presence of water and heat, allowing the hydrogen bonding sites to engage more water. This irreversibly dissolves the starch granule in water, and is what happens when cooking starchy foods like pasta or rice.
(C) Homogenization: A process of reducing the size of particles in a fluid, such as fat globules in milk, so that they remain evenly distributed and do not separate.
(D) Lyophilization: This is the scientific term for freeze drying. It comes from Greek 'lyo' (meaning 'solvent') and 'philic' (meaning 'loving'), referring to the fact that the resulting dried product readily reabsorbs water.

Step 3: Final Answer:
Lyophilization is the technical synonym for freeze drying.

Quick Tip

Associate "Lyophilization" with freeze drying. It's a common term in the pharmaceutical and food industries for this specific preservation technique. The other options are distinct unit operations with different purposes.

---

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: Understanding the Concept:
Spray drying is a process where a liquid feed is atomized into a hot gas stream to produce a dry powder. The question asks which factors influence the properties of the resulting powder

particles. We need to evaluate the role of each listed factor.

Step 2: Detailed Explanation:
A. Nozzle pressure: In pressure nozzle atomizers, the pressure directly controls the atomization process. Higher pressure results in a finer spray and smaller dried particles. This affects size and density. So, A is a factor.

B. Liquid viscosity: The viscosity of the feed liquid affects how easily it can be atomized. Higher viscosity liquids are harder to break up into fine droplets, typically resulting in larger final particles. This affects size, shape, and density. So, B is a factor.

C. Surface tension: Surface tension is the property of a liquid that resists the formation of new surface area. A lower surface tension allows the liquid to form smaller droplets more easily during atomization, leading to smaller final particles. So, C is a factor.

D. Nature of the solids: The type of solids dissolved or suspended in the feed is crucial. Properties like solubility, heat sensitivity, stickiness, and crystallinity determine the final particle's structure (e.g., hollow or solid), its surface characteristics, and its rehydration properties (solubility). For example, crystalline solids like salt will form different particles than amorphous solids like maltodextrin. So, D is a factor.

Step 3: Final Answer:
All four listed parameters—nozzle pressure, liquid viscosity, surface tension, and the nature of the solids—are critical variables that significantly affect the final properties of a spray-dried powder. Therefore, the correct choice includes all of them.

Quick Tip

In spray drying, remember that final particle properties are determined by two main stages: atomization and drying. Factors A, B, and C primarily influence atomization (droplet formation), while factor D (and drying temperatures) influences what happens as the droplet dries into a solid particle. All are important.

---

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) Ficks' Law
(D) Rittingers' Law

Correct Answer: (A) Kicks' Law

Solution:

Step 1: Understanding the Concept:
The energy required for crushing or grinding materials (size reduction, or comminution) is described by three empirical laws, each applicable to different particle size ranges. These laws relate the energy input (E) to the initial (D_f) and final (D_p) particle diameters.

Step 2: Detailed Explanation:
Let's define the relevant laws:

- **Rittinger's Law (1867):** States that the energy required is proportional to the new surface area created. It is most applicable for fine grinding where a large increase in surface area occurs.

$$E \propto \left(\frac{1}{D_p} - \frac{1}{D_f} \right)$$

- **Kick's Law (1885):** States that the energy required for a given size reduction is proportional to the logarithm of the reduction ratio. It assumes that the energy required to break a particle is proportional to its volume. This law is most accurate for coarse crushing of large particles.

$$E \propto \log \left(\frac{D_f}{D_p} \right)$$

- **Bond's Law (1952):** States that the work required is proportional to the square root of the surface-to-volume ratio. It acts as an intermediate law, applicable to a wider range of particle sizes than the other two.

$$E \propto \left(\frac{1}{\sqrt{D_p}} - \frac{1}{\sqrt{D_f}} \right)$$

- **Fick's Law:** This law is unrelated to size reduction. It describes mass diffusion, stating that mass flux is proportional to the concentration gradient.

The question explicitly asks for the law where energy is "proportional to the logarithm of size reduction ratio," which is the definition of Kick's Law.

Step 3: Final Answer:
The law that relates size reduction energy to the logarithm of the reduction ratio is Kick's Law.

Quick Tip

To remember the three laws of comminution, associate them with the particle size they best describe:

- **Kick's Law** for **Kicking** large rocks (coarse crushing).
- **Rittinger's Law** for g**ritting** into fine powder (fine grinding).
- **Bond's Law** is the **bond** between the two, covering the intermediate range.

---

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: Understanding the Concept:
A hammer mill is a type of size reduction equipment. Its mechanism determines the type of force that is primarily responsible for breaking down the material.

Step 2: Detailed Explanation:
A hammer mill consists of a rotating shaft to which a series of hammers are attached. The material is fed into the mill, and the high-speed rotating hammers strike the material with great force and velocity. This sudden, high-energy collision is known as **impact**. The material shatters upon impact with the hammers, as well as upon collision with the mill's inner wall and other particles.
Let's analyze the other forces:

- **Compressive force:** This is a squeezing force, dominant in equipment like jaw crushers or roller mills.
- **Shear force:** This is a cutting or tearing force, often combined with compression in grinding operations.
- **Centrifugal force:** This force pushes the particles outwards against the grinding chamber but is not the primary breaking force itself. The breaking is caused by the hammers hitting the particles.

While other forces may be present to a lesser extent, the overwhelming and dominant mechanism for size reduction in a hammer mill is impact.

Step 3: Final Answer:
The dominant force in hammer mill operations is impact force.

Quick Tip

Associate different mills with their primary force:

- **Hammer Mill** → High-speed **Impact**.
- **Jaw/Gyratory Crusher** → Slow **Compression**.
- **Ball Mill** → **Impact** and **Attrition** (rubbing).
- **Roller Mill** → **Compression** and **Shear**.

---

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: Understanding the Concept:
The "Centrifuge effect" refers to the Relative Centrifugal Force (RCF), also known as G-force. It is a dimensionless quantity that compares the centrifugal acceleration (a_c) experienced by a sample in the centrifuge to the standard acceleration due to gravity (g).

Step 2: Key Formula or Approach:
The formula for Relative Centrifugal Force (RCF) is:

$$\text{RCF} = \frac{a_c}{g} = \frac{\omega^2 r}{g}$$

Where:
ω = angular velocity in radians per second (rad/s)
r = radius in meters (m)
g = acceleration due to gravity (≈ 9.81 m/s^2)

Step 3: Detailed Explanation:
1. Identify the given values:
Angular velocity, $\omega = 523.6$ /sec (this is implicitly in rad/s).

Maximum radius, $r = 10$ cm.

2. Convert units to be consistent (SI units):
The radius must be in meters.

$$r = 10\,\text{cm} = 0.1\,\text{m}$$

3. Substitute the values into the RCF formula:

$$\text{RCF} = \frac{(523.6\,\text{rad/s})^2 \times (0.1\,\text{m})}{9.81\,\text{m/s}^2}$$

$$\text{RCF} = \frac{274156.96\,\text{rad}^2/\text{s}^2 \times 0.1\,\text{m}}{9.81\,\text{m/s}^2}$$

$$\text{RCF} = \frac{27415.696\,\text{m/s}^2}{9.81\,\text{m/s}^2}$$

$$\text{RCF} \approx 2794.668$$

Step 4: Final Answer:
The calculated Centrifuge effect (RCF) is approximately 2794.7, which matches option (A).

Quick Tip

The most common mistake in RCF calculations is a unit mismatch. Always convert the radius to meters and ensure the angular velocity is in radians per second. If the speed is given in RPM (revolutions per minute), use the conversion $\omega(\text{rad/s}) = \text{RPM} \times \frac{2\pi}{60}$.

---

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: Understanding the Concept:
Sedimentation is the process where particles suspended in a fluid settle out under the influence of gravity. The rate of settling is governed by the balance of forces acting on the particle. For low Reynolds number flow, this is described by Stokes' Law.

Step 2: Key Formula or Approach:
The terminal settling velocity (v_t) of a spherical particle according to Stokes' Law is given by:

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

Where:
- g is the acceleration due to **gravitational pull (A)**.
- d is the **size (diameter) of the particle (D)**.
- ρ_p is the **density of the particle (B)**.
- ρ_f is the density of the fluid. The term $(\rho_p - \rho_f)$ represents the effective density difference, which accounts for the upward **buoyancy force (C)**. The buoyancy force is proportional to the fluid density (ρ_f).
- μ is the viscosity of the fluid.

Step 3: Detailed Explanation:
Let's analyze how each factor from the list affects the settling rate:
- **A. Gravitational pull:** This is the primary downward force causing the particle to settle. A stronger gravitational pull (higher g) increases the settling rate.
- **B. Density of the particle:** A higher particle density (ρ_p) increases the particle's weight, leading to a faster settling rate.
- **C. Buoyancy force:** This is the upward force exerted by the fluid, opposing gravity. It is proportional to the fluid's density. A higher buoyancy force reduces the net downward force and slows the settling rate.
- **D. Size of the particle:** The settling rate is proportional to the square of the particle's diameter (d^2). Larger particles have a much faster settling rate.

Since all four factors are fundamentally included in the physics of sedimentation and explicitly appear in or are represented by terms in Stokes' Law, they all affect the rate of settling.

Step 4: Final Answer:
All four factors—Gravitational pull, Density of the particle, Buoyancy force, and Size of the particle—affect the sedimentation rate.

Quick Tip

Think of sedimentation as a battle of forces. Gravity (using the particle's density and size) pulls the particle down. Buoyancy and fluid drag push it up. All these factors (A, B, C, D) are essential components of this battle and thus determine the final settling speed.

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 gaseous 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) C, B, D, A

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

Solution:

Step 1: Understanding the Concept:
This question describes the process of mass transfer from a gas phase to a liquid phase, as explained by the Two-Film Theory. This theory postulates that there are stagnant or "quiescent" films on either side of the gas-liquid interface, and mass transfer through these films occurs primarily by molecular diffusion.

Step 2: Detailed Explanation:
Let's trace the path of a gas molecule from the inside of a bubble to the main body of the liquid:
1. **From Bulk Gas to Interface:** The molecule must first travel from the well-mixed interior (bulk) of the gas bubble to the boundary layer or surface of the bubble (the gas-liquid interface). This step is described by **D. The gaseous component transported from the bulk gas to gas-liquid interphase.**
2. **Crossing the Interface:** The molecule crosses the interface boundary and enters the liquid side. This is described by **B. The gaseous component enters into the liquid film.** This happens right after reaching the interface.
3. **Through the Liquid Film:** After entering the liquid side, the molecule must travel across the stagnant liquid film that surrounds the bubble. This transport is driven by a concentration gradient and occurs via diffusion. This is described by **A. The gaseous component diffused through the quiescent liquid film into the bulk liquid.** Note that the destination is the "bulk liquid", which means this step covers the entire journey through the film.
4. **Into the Bulk Liquid:** Once the molecule exits the liquid film, it enters the main body of the liquid, which is assumed to be well-mixed. Convective currents then rapidly distribute it. This final distribution step is described by **C. Transportation of the gaseous component into the well mixed bulk liquid.**

Step 3: Final Answer:
The logical sequence of these steps is D $\rightarrow$ B $\rightarrow$ A $\rightarrow$ C. This corresponds to option (A).

Quick Tip

Visualize the journey of a single molecule for mass transfer problems. The path is always Bulk → Film → Interface → Film → Bulk. Following this path logically will help you arrange the steps correctly.

---

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: Understanding the Concept:
This question asks for the fundamental driving force described in Fick's law of diffusion. Transport phenomena (like mass, heat, and momentum transfer) are driven by gradients.

Step 2: Key Formula or Approach:
Fick's first law of diffusion mathematically states:

$$J = -D\frac{\partial C}{\partial x}$$

Where:
- J is the mass flux (the amount of substance moving per unit area per unit time).
- D is the diffusion coefficient.
- $\frac{\partial C}{\partial x}$ is the **concentration gradient**, which is the change in concentration (C) over a change in position (x).

Step 3: Detailed Explanation:
The equation shows that the mass flux (J) 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, i.e., "down" the gradient.
Let's consider the other options:
- **Velocity gradient** is the driving force for momentum transfer (described by Newton's law of viscosity).
- **Temperature gradient** is the driving force for heat transfer (described by Fourier's law of heat conduction).
- **pH gradient** is a specific type of concentration gradient (for H^+ ions), but "concentration gradient" is the general and correct term for Fick's law.

Step 4: Final Answer:
Fick's law states that mass flux is directly proportional to the concentration gradient.

Quick Tip

Remember the analogies in transport phenomena:

- **Mass Transfer** (Fick's Law) is driven by a **Concentration Gradient**.
- **Heat Transfer** (Fourier's Law) is driven by a **Temperature Gradient**.
- **Momentum Transfer** (Newton's Law) is driven by a **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: Understanding the Concept:
Dimensionless numbers are used in fluid mechanics and transport phenomena to characterize a system's behavior. The Sherwood number (Sh) is a key dimensionless number in mass transfer. It represents the ratio of convective mass transfer to the rate of diffusive mass transport.

Step 2: Detailed Explanation:
The Sherwood number is the mass transfer equivalent of the Nusselt number (Nu) in heat transfer. Its value is typically determined using empirical correlations that depend on the nature of the fluid flow.

- **For forced convection mass transfer**, where flow is driven by an external force (like a pump or fan), the Sherwood number is a function of the Reynolds number (Re) and the Schmidt number (Sc).

$$Sh = f(Re, Sc)$$

- **Reynolds number (Re)** represents the ratio of inertial forces to viscous forces and characterizes the flow regime (laminar or turbulent). - **Schmidt number (Sc)** represents the ratio of momentum diffusivity (viscosity) to mass diffusivity. It relates the thickness of the hydrodynamic boundary layer and the mass-transfer boundary layer.

- **For natural convection mass transfer**, where flow is driven by density differences (e.g., due to concentration differences), the Sherwood number is a function of the Grashof number (Gr) and the Schmidt number (Sc).

Since the question does not specify the type of convection, the most common and general relationship taught, especially for introductory contexts, is for forced convection. Therefore, Sherwood number is considered a function of Reynolds' and Schmidt' numbers.

Step 3: Final Answer:
The Sherwood number is a function of the Reynolds' number and Schmidt number for forced convection mass transfer.

Quick Tip

Use the heat transfer analogy to remember mass transfer dimensionless numbers:

- Nusselt (Nu) in heat $\leftrightarrow$ **Sherwood (Sh)** in mass.
- Prandtl (Pr) in heat $\leftrightarrow$ **Schmidt (Sc)** in mass.
- Reynolds (Re) is used for forced convection in both.
- Grashof (Gr) is used for natural convection in both.

So, just as Nu = f(Re, Pr) for forced heat transfer, **Sh = f(Re, Sc)** for forced mass transfer.

---

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, A, C

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

Solution:

Step 1: Understanding the Concept:
The question asks for the correct sequence of steps to process coffee, from the bean stage (post-harvest) to the final beverage.

Step 2: Detailed Explanation:
Let's analyze the logical order of the given steps:
1. **Blending (D):** Green coffee beans from different origins are often mixed or blended to achieve a specific flavor profile. This is typically done before roasting.
2. **Roasting (B):** The green beans are roasted at high temperatures. This is a critical step that develops the characteristic aroma and flavor of coffee through chemical reactions like the Maillard reaction. Roasting must happen before grinding and brewing.
3. **Grinding (C):** After roasting and cooling, the beans are ground into a powder. This increases the surface area of the coffee, which is essential for efficient extraction of flavors during brewing. Grinding is done just before brewing for maximum freshness.
4. **Brewing (A):** This is the final step, where hot water is used to extract the soluble flavors from the ground coffee to create the beverage.

Based on this logical flow, the correct sequence is D $\rightarrow$ B $\rightarrow$ C $\rightarrow$ A.

Step 3: Final Answer:
The correct sequential arrangement of coffee processing steps is Blending, Roasting, Grinding, and Brewing. This matches option (A).

Quick Tip

For process sequence questions, think about the state of the material at each step. You start with raw beans (for blending), then you must develop flavor (roasting), then prepare for extraction (grinding), and finally make the drink (brewing). The final step is always consumption-related.

---

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: Understanding the Concept:
This question compares the chemical structure of lecithin to that of a typical fat (a triglyceride). We need to identify the key structural component that differentiates them.

Step 2: Detailed Explanation:

- **Fat (Triglyceride):** A fat molecule consists of a glycerol backbone esterified with three fatty acid chains.
- **Lecithin (Phosphatidylcholine):** Lecithin is a type of phospholipid. Its structure also starts with a glycerol backbone. However, only two of the glycerol's hydroxyl groups are esterified with fatty acids. The third hydroxyl group is esterified with a **phosphate group** (derived from phosphoric acid, H_3PO_4). This phosphate group is, in turn, linked to another small molecule, which in the case of lecithin is choline.

The presence of the phosphate group is the defining difference. This group gives the molecule a hydrophilic (water-loving) head, while the fatty acid tails remain hydrophobic (water-fearing), making lecithin an excellent emulsifier.

Step 3: Final Answer:
Lecithin is structurally like a fat but contains a phosphate group, which is derived from phosphoric acid.

Quick Tip

Remember the name "phospholipid". The name itself tells you the key components: "phospho-" referring to the phosphate group and "lipid" referring to the fat-like fatty acid tails. Lecithin is the most common example of a phospholipid.

---

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: Understanding the Concept:
Polymorphism is the ability of a substance, like a fat, to crystallize into several different crystal forms. These forms (α, β', β) have different melting points, stabilities, and physical properties (like texture and appearance). The question asks for the name of the process used to control which polymorphic form is created.

Step 2: Detailed Explanation:

- **Tempering:** This is a highly specific process of controlled heating and cooling of fats (most famously, cocoa butter in chocolate) to encourage the formation of a single, stable crystal polymorph. For chocolate, the goal is to form stable Form V (β) crystals, which results in a glossy finish, a firm "snap," and a melting point just below body temperature. Tempering involves melting the fat completely, cooling it to allow certain crystals to form, and then gently reheating it to melt away unstable crystal forms, leaving only the desired stable ones to seed further crystallization.
- **Conditioning:** This is a more general term for holding a product under specific temperature and humidity conditions. Tempering is a specific type of conditioning.
- **Hydrogenation:** This is a chemical process that adds hydrogen atoms to unsaturated fats, making them more saturated and solid at room temperature. It changes the fat's chemical makeup, not just its crystal structure.
- **Shortening:** This is a type of solid fat used in baking; it is a product, not a process.

The specific process designed to control and permit the formation of a desired polymorphic form in fats is tempering.

Step 3: Final Answer:
The process is known as tempering.

Quick Tip

When you see "polymorphic form" and "fats" in the same question, immediately think of "chocolate" and "tempering." Tempering is the key industrial process for achieving the desired texture and appearance in chocolate by controlling fat crystallization.

---

66. On treatment with alkali, chlorophyll changes to

(A) Pheophytin
(B) Chlorophyllin
(C) Xanthophyll
(D) Vitamin A

Correct Answer: (B) Chlorophyllin

Solution:

Step 1: Understanding the Concept:
Chlorophyll, the pigment responsible for the green color in plants, is chemically unstable and can be altered by pH, heat, and enzymes. This question asks about the specific change that occurs under alkaline (high pH) conditions.

Step 2: Detailed Explanation:
The chlorophyll molecule has a complex structure, including a porphyrin ring with a central magnesium ion and a long hydrocarbon tail called a phytyl group, attached by an ester bond.

- **Treatment with Acid (or prolonged heat):** Acidic conditions cause the central magnesium ion (Mg^{2+}) to be displaced and replaced by two hydrogen ions. This changes the molecule to **pheophytin**, which has a dull, olive-brown color. This is why green vegetables turn brownish when overcooked.
- **Treatment with Alkali:** Alkaline conditions, especially with heat, can cause a reaction called saponification. This reaction cleaves the ester linkage holding the phytyl tail. The loss of the long, fat-soluble tail results in a water-soluble molecule called **chlorophyllin**. Chlorophyllin has a stable, bright green color. This reaction is sometimes used commercially to preserve the green color in processed vegetables.
- **Xanthophyll** is a different type of plant pigment (a carotenoid), responsible for yellow colors.
- **Vitamin A** is a nutrient, structurally unrelated to chlorophyll.

Step 3: Final Answer:
Upon treatment with alkali, chlorophyll is converted to chlorophyllin.

Quick Tip

Remember the pH effect on chlorophyll color:

- **A**cid → **A**wful brown (Pheophytin).
- Al**k**ali → **K**eeps it green (Chlorophyllin).

---

67. Match the LIST-I with LIST-II

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

Choose the most appropriate answer from the options given below:

(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 - IV, C - I, D - III

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

Solution:

Step 1: Understanding the Concept:
This question requires matching enzymes with the products of the catabolic (breakdown) reactions they catalyze. We need to know the substrate and reaction for each enzyme.

Step 2: Detailed Explanation:

- **A. β-galactosidase:** This enzyme, commonly known as lactase, hydrolyzes the disaccharide lactose. Lactose is broken down into its two constituent monosaccharides: **galactose and glucose**. This matches **III**.
  A $\rightarrow$ III

- **B. Lecithinase (a type of phospholipase):** This enzyme breaks down lecithin, which is a phospholipid. The breakdown releases the components of lecithin: a diglyceride (a type of **fat**), a phosphate group ($\mathbf{H_3PO_4}$), and **choline**. This matches **I**.
  B $\rightarrow$ I

- **C. Urease:** This enzyme specifically catalyzes the hydrolysis of urea ($(NH_2)_2CO$) into **ammonia ($\mathbf{NH_3}$)** and **carbon dioxide ($\mathbf{CO_2}$)**. This matches **IV**.
  C $\rightarrow$ IV

- **D. Lipase:** This is a general term for enzymes that hydrolyze fats (lipids, specifically triglycerides). A triglyceride is broken down into a **glycerol** molecule and three **fatty acids**. This matches **II**.
  D $\rightarrow$ II

Step 3: Final Answer:
The correct set of matches is: A-III, B-I, C-IV, D-II. This corresponds to option (B).

Quick Tip

For enzyme matching questions, focus on the enzyme's name. It often indicates the substrate it acts upon.

- Galactosidase $\rightarrow$ acts on Galactose-containing sugars (like lactose).
- Lecithinase $\rightarrow$ acts on Lecithin.
- Urease $\rightarrow$ acts on Urea.
- Lipase $\rightarrow$ acts on Lipids (fats).

68. Bitterness is exhibited by alkaloids such as _____

(A) Quinine
(B) Beryllium salts
(C) Lead acetate
(D) Cyclamate

Correct Answer: (A) Quinine

Solution:

Step 1: Understanding the Concept:
This question tests knowledge of the taste properties of different chemical compounds, specifically asking for an example of a bitter alkaloid.

Step 2: Detailed Explanation:

- **Quinine:** A well-known alkaloid extracted from the bark of the cinchona tree. It is famous for its intense **bitter** taste and is the key flavoring ingredient in tonic water. Alkaloids as a class are often characterized by their bitterness.
- **Beryllium salts:** Salts of the element beryllium are known to have a potent **sweet** taste, but they are highly toxic.
- **Lead acetate:** Historically known as "sugar of lead" precisely because of its **sweet** taste. It is also extremely toxic.
- **Cyclamate:** An artificial sweetener that is about 30-50 times sweeter than sucrose (table sugar).

From the options, only quinine is an alkaloid known for its bitterness. The other compounds are known for their sweetness.

Step 3: Final Answer:
Bitterness is exhibited by the alkaloid quinine.

Quick Tip

Associate "alkaloid" with "bitter". Many common bitter substances in food and medicine are alkaloids, such as caffeine in coffee, theobromine in cocoa, and quinine in tonic water.

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69. Match the LIST-I with LIST-II

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

Choose the most appropriate answer from the options given below:

(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: Understanding the Concept:
Egg whites can be beaten to different stages to form foams with different properties. Each stage is suitable for specific culinary applications. The question asks to match these stages to their uses. The terms "Stiff foam" and "Stiff" likely refer to the soft peak and stiff peak stages, respectively.

Step 2: Detailed Explanation:
Let's match each stage with its most appropriate use:

- **A. Slightly beaten:** The egg whites are just broken up and foamy, with large bubbles. This stage is useful for adding some body and binding without significant leavening. A good use is for **Thickening** sauces or custards.
  A → III

- **B. Stiff foam (Soft peaks):** The foam has developed structure, and when the beater is lifted, the peaks that form will droop over. This foam is stable but still soft enough to be easily folded into mixtures to add lightness, such as in mousses or **Ice cream**.
  B → II

- **C. Stiff (Stiff peaks):** The foam is very stable, glossy, and the peaks stand straight up when the beater is lifted. This strong structure is essential for providing the framework for products like **Meringues**.
  C → IV

- **D. Dry:** The foam has been overbeaten. It looks dull and lumpy, and it has started to separate. This stage is generally undesirable. By process of elimination from the option set that works for A, B, and C, it is matched with **Shirred egg**. While not an ideal use,

perhaps the question implies using it as a topping where the structure is less critical than for a meringue.

Step 3: Final Answer:
The most logical combination of matches is A-III, B-II, C-IV, D-I. This corresponds to option (C).

Quick Tip

Remember the progression of egg white foams and their stability. More stable foams (stiff peaks) are needed for structural purposes like meringues. Less stable foams (soft peaks) are better for folding into batters and mixtures to add airiness. Slightly beaten whites are used mainly for binding or thickening.

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70. Match the LIST-I with LIST-II

LIST-I (Class of Meat)		**LIST-II (Description)**	
A	Veal	I	Flesh of a young ovine animal whose age is 12 months or under
B	Beef	II	Carcasses of young sheep usually from 12 to 20 months old
C	Mutton	III	Meat from cattle slaughtered 3 to 4 weeks after birth
D	Yearling mutton	IV	Meat of cattle over 1 year old

Choose the most appropriate answer from the options given below:

(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: Understanding the Concept:
This question requires matching different classifications of meat with their correct definitions based on the animal species and age at slaughter. Note: There is a likely error in the description for Mutton (I) and Yearling Mutton (II). Mutton and Yearling Mutton are from sheep (ovine), not young ovine animals in general. The description for Mutton should refer to adult sheep. Let's proceed by matching the clearest definitions first.

Step 2: Detailed Explanation:

- **A. Veal:** Veal is the meat from very young cattle (calves). The description "Meat from cattle slaughtered 3 to 4 weeks after birth" fits this perfectly.
  A → III

- **B. Beef:** Beef is the meat from mature cattle. The description "Meat of cattle over 1 year old" is the standard definition for beef.
  B → IV

- **C. Mutton:** Mutton is meat from an adult sheep. Description I says "Flesh of a young ovine animal whose age is 12 months or under". This is the definition of lamb. Description II says "Carcasses of young sheep usually from 12 to 20 months old". This defines yearling mutton. The standard definition of mutton is a sheep over 2 years old. There seems to be an error in the question's descriptions. However, if we must choose, Mutton is from older sheep than Yearling Mutton. Let's look at the options. Options (A) and (D) match A-III and B-IV. Let's evaluate the rest of option (A): C-I and D-II. This would mean Mutton is matched with the definition for Lamb (I) and Yearling Mutton is matched with its correct definition (II). This seems like a plausible error in the question where the definition for Mutton was replaced with the one for Lamb. Let's re-evaluate: - **Veal** is from young cattle → **III**. - **Beef** is from adult cattle → **IV**. - **Yearling mutton** is from sheep aged 12-20 months → **II**. - **Mutton** is from adult sheep (over 2 years). The closest, albeit incorrect, description provided is **I**, which is actually for Lamb. Given the options, the question likely has an error and uses "Mutton" where "Lamb" was intended.

  The sequence that uses the most correct matches is A-III, B-IV, D-II. This leaves C to be matched with I. **A → III, B → IV, C → I, D → II**

Step 3: Final Answer:
Based on the best possible fit despite the error in the description for Mutton, the correct matching is A-III, B-IV, C-I, D-II. This corresponds to option (A).

Quick Tip

Memorize the basic meat classifications:

- **Cattle:** Veal (young calf) → Beef (adult).
- **Sheep (Ovine):** Lamb (¡1 year) → Yearling Mutton (1-2 years) → Mutton (¿2 years).
- **Pig:** Pork.

Even if a question has errors, matching the clear definitions first (like Veal and Beef) can help you eliminate incorrect options.

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71. Arrange the steps involved in alkali processing of 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: Understanding the Concept:
The question asks for the correct sequence of steps for the alkali processing of maize, a process also known as **nixtamalization**. This traditional method is used to produce masa, the dough for tortillas and other corn products. It improves the nutritional value and processability of the maize.

Step 2: Detailed Explanation:
Let's analyze the logical order of the nixtamalization process:
1. **Cooking with Alkali (D):** The first step is to cook the raw maize kernels in an alkaline solution. This is described by **D. Mixing with water and lime at 90 °C for 50 minutes**. Lime (calcium hydroxide) is the traditional alkali. This cooking step softens the pericarp (outer layer) of the kernel.
2. **Steeping (B):** After cooking, the maize is left to steep or soak in the cooking liquid, often overnight. This is described by **B. Steeping in water for 14 hours**. This step allows the alkaline solution to fully penetrate the kernels, loosening the pericarp and causing chemical changes that release niacin and improve protein quality.
3. **Washing (A):** After steeping, the softened pericarp is washed off. This is described by **A. Washing with fresh water**. The resulting clean, soft kernels are called nixtamal.
4. **Milling (C):** The final step is to grind the wet nixtamal into a dough, which is called masa. This is described by **C. Milling to obtain "masa"**.

Step 3: Final Answer:
The correct sequence of steps for nixtamalization is Cooking with lime (D), Steeping (B), Washing (A), and Milling (C). This corresponds to the sequence D, B, A, C.

Quick Tip

Think of nixtamalization as a "cook, soak, wash, grind" process. The key is the initial cooking step with an alkali like lime, which gives the process its name and unique benefits.

72. 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, C, D, A

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

Solution:

Step 1: Understanding the Concept:
Enzymatic browning is a chemical process that occurs in fruits and vegetables. It is caused by the enzyme polyphenol oxidase (PPO), which, in the presence of oxygen, oxidizes phenolic compounds, leading to the formation of brown pigments called melanins. The question asks for the correct sequence of this biochemical pathway.

Step 2: Detailed Explanation:
Let's break down the sequence of the reaction:
1. **Enzyme and Substrate Exposure (B):** The reaction starts when the fruit is cut or bruised. This damage breaks open plant cells, allowing the enzyme PPO (usually stored in plastids) to come into contact with its phenolic substrates (stored in the vacuole) in the presence of oxygen from the air. So, the first step is the **B. Action of PPO enzyme on cut fruits**.
2. **Hydroxylation (A):** PPO first acts on monophenols (like tyrosine) and hydroxylates them to form diphenols. A key example is the conversion of tyrosine to **DOPA** (dihydroxyphenylalanine). This is **A. Formation of DOPA**.
3. **Oxidation (D):** The same PPO enzyme then oxidizes the diphenols (like DOPA) into highly reactive molecules called **ortho-quinones**. This is **D. Formation of ortho-quinones**. These quinones are colorless but are the immediate precursors to the colored pigments.
4. **Polymerization (C):** The ortho-quinones are very unstable and undergo further non-enzymatic reactions. They polymerize, meaning they link together to form complex, large, brown, black, or red pigments known as **melanins**. This is **C. Polymerization of ortho-quinones to form melanins**. This is the final step that produces the visible browning.

Step 3: Final Answer:
The correct sequence of the enzymatic browning reaction is: Action of PPO (B) $\rightarrow$ Formation of DOPA (A) $\rightarrow$ Formation of ortho-quinones (D) $\rightarrow$ Polymerization to melanins (C). This corresponds to the sequence B, A, D, C.

Quick Tip

Remember the browning pathway as a chain reaction: Enzyme meets substrate → First product (DOPA) → Second, reactive product (quinone) → Final, colored product (melanin). The key is that the enzyme (PPO) starts the whole process.

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73. 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: Understanding the Concept:
Sauerkraut is a product made from fermented cabbage. The question asks for the correct order of the main steps in its production.

Step 2: Detailed Explanation:
Let's analyze the logical flow of making sauerkraut:
1. **Preparation of Cabbage (D):** The first step is to prepare the raw material. The cabbage is cored and finely cut or **shredded**. This increases the surface area and releases sugars for the fermentation microorganisms. So, the process starts with **D. Shredding**.
2. **Creating the Fermentation Environment (B):** Salt is added to the shredded cabbage. This step, **B. Salting**, is crucial for two reasons: it draws out water from the cabbage to create a brine, and it inhibits the growth of spoilage microorganisms while selecting for the desired salt-tolerant lactic acid bacteria.
3. **The Main Process (C):** The salted cabbage is packed into containers, creating an anaerobic (oxygen-free) environment. Lactic acid bacteria naturally present on the cabbage begin to multiply, converting the sugars in the cabbage into lactic acid. This is the **C. Fermentation** step, which preserves the cabbage and develops sauerkraut's characteristic sour flavor.
4. **Preservation for Shelf-Life (A):** Once the fermentation is complete and the desired acidity is reached, the sauerkraut is often heat-treated to stop the fermentation and kill any remaining microorganisms, making it shelf-stable. This final preservation step is **A. Pasteurization**. (Note: Raw, unpasteurized sauerkraut is also sold and must be refrigerated).

Step 3: Final Answer:
The correct sequence of steps for producing shelf-stable sauerkraut is: Shredding (D) → Salting (B) → Fermentation (C) → Pasteurization (A). This corresponds to the sequence D, B, C, A.

Quick Tip

For any food production process, think logically: Prepare the raw material first (Shredding), then set up the conditions for the main process (Salting), then perform the main process (Fermentation), and finally, preserve the finished product (Pasteurization).

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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: Understanding the Concept:
Soy sauce production is a two-stage fermentation process. The first stage is an aerobic solid-state fermentation to create "koji," and the second stage is an anaerobic brine fermentation to create "moromi," which is then aged and pressed.

Step 2: Detailed Explanation:
Let's arrange the given steps in the correct order:
1. **Preparation of Raw Materials (A):** Soybeans are soaked and cooked, and wheat is **roasted** and crushed. These are then mixed together. So, **A. Roasting of wheat** is one of the initial preparatory steps.
2. **Koji Fermentation (D):** The mixture of cooked soybeans and roasted wheat is inoculated with a starter culture (mold, typically *Aspergillus oryzae*) and allowed to ferment under controlled conditions. This aerobic, solid-state fermentation is the koji-making stage. It is described by **D. Fermentation at 25-30 °C for 2-3 days**. During this time, the mold grows and produces enzymes that will break down proteins and starches later.
3. **Moromi Fermentation (B):** The finished koji is mixed with a salt-water brine to form a mash called moromi. This is the **B. Moromi stage**. The high salt concentration inhibits

spoilage microbes and selects for desirable yeasts and lactic acid bacteria. This is the beginning of the second, long-term fermentation.
4. **Lactic/Ethanolic Fermentation (C):** During the long aging of the moromi (which can last for months), a complex sequence of microbial activity occurs. First, lactic acid bacteria carry out **lactic fermentation**, which lowers the pH. Then, salt-tolerant yeasts grow and perform **ethanolic fermentation**, producing alcohol and other key flavor compounds. So, **C. Lactic/ethanolic fermentation** occurs during the moromi stage.

Therefore, the logical sequence is: Prepare ingredients (A), perform the first fermentation (D), create the moromi mash (B), and then the second fermentation occurs (C).

Step 3: Final Answer:
The correct sequence is A, D, B, C. This corresponds to option (A).

Quick Tip

Remember that soy sauce fermentation has two key stages:

1. **Koji stage:** Solid, aerobic fermentation with mold (short, a few days).
2. **Moromi stage:** Liquid (brine), anaerobic fermentation with bacteria and yeast (long, months).

This two-stage concept will help you order the steps correctly.

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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: Understanding the Concept:
This question asks to identify the genus of bacteria primarily responsible for causing "soft rot" in carrots and other vegetables. Soft rot is a type of plant disease characterized by the breakdown and decay of plant tissues, resulting in a soft, watery mush.

Step 2: Detailed Explanation:
Let's analyze the options:

- **Corynebacterium spp.:** Some species are pathogenic to plants, but they are more commonly associated with diseases like ring rot of potato or wilt diseases, not typically soft rot.
- **Lactobacillus spp.:** These are lactic acid bacteria, primarily known for their role in food fermentation (e.g., yogurt, sauerkraut). They are generally not considered plant pathogens causing spoilage.
- **Pectobacterium spp.:** This genus, along with the closely related genus *Dickeya*, are the quintessential "soft-rot bacteria". They are famous for producing large quantities of extracellular enzymes, particularly **pectinases**. These enzymes degrade pectin, the substance that cements plant cells together in the middle lamella. The breakdown of pectin causes the plant tissue to lose its structure and turn into a soft, rotting mass. *Pectobacterium carotovorum* is a species named specifically for causing soft rot in carrots.
- **Xanthomonas spp.:** This is another significant genus of plant-pathogenic bacteria, but they are typically associated with different symptoms, such as leaf spots, blights, and black rot in crucifers, rather than the characteristic mushy soft rot.

The primary causal agent of soft rot is the degradation of pectin, and the bacteria named for this activity are *Pectobacterium*.

Step 3: Final Answer:
The bacteria most commonly associated with the soft rotting of carrots is *Pectobacterium* spp.

Quick Tip

Associate "soft rot" with the breakdown of "pectin". The bacterial genus *Pectobacterium* is named for its ability to break down pectin, making it the most logical answer for any question about bacterial soft rot in vegetables.
