CUET PG 2025 Textile Engineering Question Paper with Solutions

Time Allowed :1 Hour 45 Mins	**Maximum Marks :**300	**Total Questions :**75

General Instructions

General Instructions:

1. Question Paper contains 75 Questions .
2. Each correct answer will have +4 marks and wrong asnwer will lead to -1

1. In _____, the package is driven in frictional contact with the drum.
(A) Drum driven winding
(B) Spindle driven winding
(C) Pirn winding
(D) Weft winding

Correct Answer: (A) Drum driven winding

Solution: Step 1: Deconstruct the question's core mechanism. The question highlights a specific method of winding where the package of yarn is not directly rotated by its core. Instead, its rotation is induced by "frictional contact" with another component, a "drum." This means the surface of the package is in contact with the surface of the driving drum, and as the drum turns, it forces the package to turn.
Step 2: Evaluate the winding methods provided as options.
- **(A) Drum driven winding:** This method, also known as surface winding, operates precisely as described. A rotating drum maintains contact with the outer surface of the yarn package. The friction between the two surfaces transmits the rotational force, causing the package to wind the yarn. The surface speed of the package remains constant and equal to the drum's surface speed. This is a perfect match.
- **(B) Spindle driven winding:** This method involves mounting the package on a spindle, which is then directly rotated by a motor. The driving force is applied to the center (the axis) of the package, not its surface. This is a positive drive, fundamentally different from the frictional surface drive described.
- **(C) Pirn winding** and **(D) Weft winding:** These terms describe the *purpose* of the winding (creating pirns or weft packages) rather than the driving mechanism itself. A pirn winder, for example, is typically a spindle-driven machine. Therefore, these options do not describe the driving principle in question.

Quick Tip

In winding technology, the key distinction is how the package is rotated. If rotation is due to surface contact with a roller/drum, it's "drum driven" or "surface driven." If the package holder itself is rotated, it's "spindle driven."

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2. In _____, the yarn passes through two plates in which one plate is the baseplate and the other is a weighing plate.
(A) Electronic tensioner
(B) Additive type tensioner
(C) Multiplicative type tensioner
(D) Roller tensioner

Correct Answer: (C) Multiplicative type tensioner

Solution: Step 1: Analyze the described tensioning mechanism. The key components are a pair of plates: one is a stationary "baseplate," and the other is a "weighing plate" that

applies a force. The yarn is guided to run between these two plates. The pressure exerted by the weighing plate on the yarn creates frictional drag, which in turn imparts tension.
Step 2: Compare this mechanism with the classifications of tensioners.
- **(C) Multiplicative type tensioner:** This category of tensioner, often called a disc or plate tensioner, functions by applying pressure to the yarn surface. The outgoing tension (T_{out}) is related to the incoming tension (T_{in}) by the formula $T_{out} = T_{in} \cdot e^{\mu\theta}$, where μ is the coefficient of friction and θ is the wrap angle. The pressure from the weighing plate directly influences the frictional force. This "multiplies" the incoming tension, fitting the description perfectly.
- **(B) Additive type tensioner:** This type works differently, by deflecting the yarn path over a series of posts or pulleys, often with a weighted arm or "dancer arm." The tension is added by the force required to deflect the yarn, not by pinching it.
- **(A) Electronic tensioner:** This refers to the control system, not the mechanical principle. An electronic tensioner uses sensors and actuators to maintain a constant tension, but the underlying mechanical system could be multiplicative, additive, or something else.
- **(D) Roller tensioner:** This type uses rollers to control tension, either by braking one of the rollers or by creating a complex yarn path around them. It does not use the plate-and-weight system described. The classic design of a baseplate and a pressure-applying weighing plate is the hallmark of a multiplicative tensioner.

Quick Tip

Tensioners are classified by how they apply force. "Multiplicative" tensioners use friction by pinching the yarn (e.g., discs). "Additive" tensioners add tension by using weights or springs to deflect the yarn path.

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3. In case of plain weave fabric, the respective warp and weft counts are 30 tex and 20 tex, with 40 ends per cm and 30 picks per cm. The warp has 10% crimp and weft also 10% crimp. Calculate the weight of fabric in grams/square meter.
(A) 178
(B) 188
(C) 198
(D) 208

Correct Answer: (C) 198

Solution: Step 1: Establish the fundamental principle for calculating fabric weight (GSM). The total weight of a fabric in Grams per Square Meter (GSM) is the sum of the weight of all the warp yarns within one square meter and the weight of all the weft yarns within that same square meter. To find the weight of each yarn system, we need to calculate the total length of yarn present (accounting for crimp) and multiply it by the yarn's linear density (mass per unit length).
The formula for yarn weight is: Weight = Total Yarn Length $\times$ Linear Density.
Step 2: Calculate the weight contribution of the warp yarns.
- Warp Linear Density (Tex): 30 tex = 30 grams per 1000 meters = 0.03 g/m. - Warp Density (Ends): 40 ends/cm = 40 $\times$ 100 = 4000 ends/m. - Warp Crimp: 10% or 0.10. This means for

every 1 meter of fabric length, the warp yarn is actually $1 \times (1 + 0.10) = 1.1$ meters long. - Total length of warp yarn in 1 m^2 of fabric = (Number of ends in 1 meter width) $\times$ (Length of each end in 1 meter of fabric) = 4000 ends $\times$ 1.1 m/end = 4400 meters. - Weight of warp per m^2 = Total length $\times$ Linear Density = 4400 m $\times$ 0.03 g/m = 132 grams.
Step 3: Calculate the weight contribution of the weft yarns.
- Weft Linear Density (Tex): 20 tex = 20 grams per 1000 meters = 0.02 g/m. - Weft Density (Picks): 30 picks/cm = 30 $\times$ 100 = 3000 picks/m. - Weft Crimp: 10% or 0.10. For every 1 meter of fabric width, the weft yarn is $1 \times (1 + 0.10) = 1.1$ meters long. - Total length of weft yarn in 1 m^2 of fabric = (Number of picks in 1 meter length) $\times$ (Length of each pick in 1 meter of fabric) = 3000 picks $\times$ 1.1 m/pick = 3300 meters. - Weight of weft per m^2 = Total length $\times$ Linear Density = 3300 m $\times$ 0.02 g/m = 66 grams.
Step 4: Calculate the total fabric weight (GSM) and analyze the result.
- Total GSM = Warp Weight + Weft Weight = 132 g + 66 g = 198 g/m^2.
Conclusion: The calculation based on standard textile principles yields a result of 198 GSM. This corresponds to option (C). There appears to be an error in the original provided "Correct Answer" of (B) 188. The methodical calculation confirms that 198 g/m^2 is the correct answer based on the data given.

Quick Tip

To calculate fabric weight (GSM), always calculate the warp and weft contributions separately and then add them. The formula is: Total yarn length in $1m^2$ (including crimp) $\times$ yarn linear density (in g/m). Remember to convert all units consistently (e.g., ends/cm to ends/m).

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4. In _____ system, a warping beam with a complex pattern of colored stripes is obtained.
(A) Direct beam warping
(B) Ball warping
(C) Sectional warping
(D) Warp sizing machine

Correct Answer: (C) Sectional warping

Solution: Step 1: Understand the objective. The goal is to create a weaver's beam where yarns of multiple colors are arranged in a specific, often intricate, sequence to form a striped pattern in the final fabric. This requires precise placement of colored ends across the entire width of the beam.
Step 2: Evaluate the capabilities of each warping system.
- **(C) Sectional warping:** This method is explicitly designed for this purpose and is sometimes called pattern warping. The total warp width is divided into smaller, manageable "sections." The creel is loaded with the colors needed for a small part of the pattern, and this section is wound onto a large drum. The machine then moves, and the next section of the pattern is wound right beside the first. This process is repeated until the full width and color pattern are built up on the drum. Finally, the entire sheet of yarn is transferred from the drum to the final weaver's beam. This allows for meticulous control over color placement.

- **(A) Direct beam warping:** This is a high-speed process where all the yarns for the beam (often thousands) are wound simultaneously from a large creel directly onto the beam. While simple stripes can be made by arranging colors in the creel, it is extremely inefficient and impractical for complex, repeating patterns. Its primary use is for solid-color warps.
- **(B) Ball warping:** This process gathers yarns from a creel into a thick rope-like bundle called a "ball warp," which is later dyed and re-beamed. It is a step in rope-dyeing (common for denim) and does not create a patterned weaver's beam.
- **(D) Warp sizing machine:** This is a subsequent process. Its function is to apply a protective size coating to the yarns on a beam that has already been prepared by a warping machine. It does not create or alter the color pattern.
Conclusion: For producing beams with complex colored stripe patterns, sectional warping is the industry-standard method.

Quick Tip

Remember the main purpose of different warping methods: - **Direct/Beam Warping:** High speed for single-color (solid) warps. - **Sectional Warping:** Slower, for complex multi-colored stripe patterns.

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5. In the slasher sizing machine, the principle involved in drying the wet warp sheet by physical contact with a hot drum surface is _____.
(A) Conduction
(B) Convection
(C) Radiation
(D) Combined convection and radiation

Correct Answer: (A) Conduction

Solution: Step 1: Identify the key action in the question. The question specifies the drying of a wet warp sheet through "physical contact" with a "hot drum surface." This describes the direct interaction between the yarn and the heat source.
Step 2: Define the fundamental modes of heat transfer.
- **(A) Conduction:** This is the transfer of heat energy between objects that are in direct physical contact. Heat flows from the object at a higher temperature (the hot drum) to the object at a lower temperature (the wet yarn) at the point of contact.
- **(B) Convection:** This is the transfer of heat through the movement of fluids (like air or water). In a sizing machine, this would occur if hot air was blown over the yarn to dry it (as in a hot-air oven dryer).
- **(C) Radiation:** This is the transfer of heat through electromagnetic waves, such as infrared radiation. It does not require any medium or contact. An example would be drying the yarn under infrared lamps.
Step 3: Apply the definitions to the scenario. The question's explicit mention of "physical contact" between the yarn and the hot drum is the defining characteristic of heat transfer by conduction. While minor amounts of convective and radiative heat transfer may also occur from the surrounding air and hot surfaces, the dominant and principled method described by the direct contact is conduction.

Quick Tip

Think of the modes of heat transfer: - **Conduction** = Contact - **Convection** = Current (fluid movement) - **Radiation** = Rays (waves) The question specifies "physical contact," which directly points to conduction.

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6. To prevent the growth of microorganisms, _____ is added to the size paste.
(A) Adhesive material
(B) Softener
(C) Antistatic agent
(D) Antiseptic agent

Correct Answer: (D) Antiseptic agent

Solution: Step 1: Understand the problem to be solved. The objective is to stop or "prevent the growth of microorganisms" like bacteria, mildew, and fungi within the size paste. Size pastes, particularly those based on natural starches, are warm, wet, and nutrient-rich, making them an ideal environment for microbial proliferation, which can lead to spoilage and fabric defects.
Step 2: Analyze the function of each listed additive.
- **(A) Adhesive material:** This is the primary functional ingredient (e.g., starch, PVA, CMC). Its purpose is to form a film on the yarn to provide strength and abrasion resistance. It is the "food" for the microorganisms, so it does not prevent their growth.
- **(B) Softener:** This ingredient, such as tallow or wax, is added to lubricate the yarn and make the size film more flexible, reducing harshness and brittleness. It has no antimicrobial properties.
- **(C) Antistatic agent:** This is included to help dissipate electrical charges that can build up on yarns, especially synthetics, during processing. Its function is electrical, not biological.
- **(D) Antiseptic agent:** This is a general term for a substance that inhibits or kills microorganisms. Other names include biocides, fungicides, or preservatives. Its sole purpose is to prevent the spoilage of the size paste and protect the sized yarn from mildew. This directly addresses the problem.
Conclusion: The correct additive to prevent microbial growth is an antiseptic agent.

Quick Tip

Break down the components of a size paste by function: - **Adhesive:** The "glue" (starch, PVA). - **Lubricant/Softener:** For flexibility (oils, waxes). - **Antiseptic:** To prevent spoilage/mildew. - **Antistat:** To reduce static.

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7. The material flow of the warp sheet through different zones in a sizing machine is _____.
A. Drying zone
B. Size box zone

C. Beaming zone
D. Creel zone
(A) A, C, B, D
(B) D, B, A, C
(C) C, A, D, B
(D) B, D, C, A

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

Solution: Step 1: Visualize the journey of the yarn through the sizing process. Sizing is a continuous process that takes unsized yarn from multiple beams and delivers a single, sized loom beam. We need to trace the path of the yarn sheet from beginning to end.
Step 2: Logically sequence the operational zones.
- **Start (Yarn Supply):** The process must begin with the source of the yarn. This is the **D. Creel zone**, where multiple warping beams are mounted to supply a continuous sheet of parallel yarns.
- **Application:** From the creel, the yarn sheet travels to the application area. This is the **B. Size box zone**, where the yarn is immersed in the liquid size paste and squeezed by rollers to ensure proper penetration and pickup.
- **Drying:** After becoming saturated with wet size, the yarn must be dried. It immediately enters the **A. Drying zone**, which typically consists of steam-heated cylinders or a hot air chamber to evaporate the water.
- **End (Winding):** Once the yarn is dry and sized, it is collected onto its final package. It passes through splitting rods to separate individual ends and is then wound onto the weaver's beam in the **C. Beaming zone** (also known as the headstock).
Step 3: Form the sequence and match it with the options. The logical flow of material is: Creel Zone → Size Box Zone → Drying Zone → Beaming Zone. This corresponds to the sequence D, B, A, C, which is option (B).

Quick Tip

The sizing process follows a logical path: 1. **Unwind** the yarn (Creel). 2. **Apply** the size (Size Box). 3. **Dry** the yarn (Drying Zone). 4. **Rewind** onto the final beam (Beaming Zone).

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8. The _____ machine is used to produce a suitable package of weft yarn for a shuttle loom.
(A) Pirn winding
(B) Cone winding
(C) Sectional warping
(D) Two for one twister

Correct Answer: (A) Pirn winding

Solution: Step 1: Identify the specific application from the question. The application is creating a "weft yarn package" specifically for a "shuttle loom."

Step 2: Understand the unique requirements of a shuttle loom's weft supply. A shuttle is a physical projectile that carries the weft yarn as it travels through the shed. To fit inside the shuttle, the yarn package must be small, compact, and typically tapered. This special package is known as a pirn.
Step 3: Evaluate the given machine options based on this requirement.
- **(A) Pirn winding:** This is the specific manufacturing process whose sole purpose is to wind yarn onto pirns. The machines are designed to create the precise shape and density required for efficient unwinding inside the shuttle during weaving. This is the correct answer.
- **(B) Cone winding:** This process creates large, conical packages. Cones are used as a universal supply package for many subsequent processes, including warping and as the weft supply for modern shuttleless looms (which pull yarn from a stationary package), but they are far too large to fit inside a shuttle.
- **(C) Sectional warping:** This is a warp preparation process. It creates the weaver's beam (the warp supply), not the weft packages.
- **(D) Two for one twister:** This is a yarn manufacturing machine used to insert twist into yarns. It does not produce the final package used on a loom.

Quick Tip

Remember the specific packages for looms: - **Shuttle Looms** use **Pirns**. - **Shuttleless Looms** often use large **Cones** or other large packages as weft supply.

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9. Match Type of shed with Position of warps.

LIST I **Type of shed**	**LIST II** **Position of warps**
A. Fully open shed	I. All warp returns to mid-position before the next shedding
B. Semi-open shed	II. All ends come down to the bottom position before the next shedding
C. Center closed shed	III. Unnecessary movements of the warps are avoided
D. Bottom closed shed	IV. A few healds move half the distance from the depth of the shed and go back to their top position for next shedding

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

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

Solution: Step 1: Systematically define each type of shed from List I based on warp movement.
- **A. Fully open shed:** In this highly efficient shedding motion, the warp threads only move if their position in the next shed is different from their current one. If a thread is up and

needs to be up for the next pick, it stays up. This principle minimizes strain and energy consumption. This action is best described as avoiding unnecessary movement.
- **B. Semi-open shed:** This is a more complex motion where threads that need to stay up do so, but threads moving up from the bottom only travel halfway, where they meet threads that are moving down from the top. This description of healds moving half the distance is very specific.
- **C. Center closed shed:** After each pick insertion, all warp threads, regardless of their previous up or down position, are brought to a neutral, level line in the middle. The new shed is then formed from this central starting point.
- **D. Bottom closed shed:** This is similar to the center closed shed, but the neutral reset position for all warp threads is the bottom line of the shed. After every pick, the entire set of warp threads sinks to the bottom, and then the required threads are lifted to form the new top shed line.
Step 2: Match these definitions to the descriptions in List II.
- **A (Fully open shed)**'s principle of minimal movement matches perfectly with **III (Unnecessary movements of the warps are avoided)**.
- **B (Semi-open shed)**'s characteristic halfway motion is precisely described in **IV (A few healds move half the distance...)**.
- **C (Center closed shed)**'s return to a neutral middle line is clearly stated in **I (All warp returns to mid-position...)**.
- **D (Bottom closed shed)**'s return to the lowest point is explicitly described in **II (All ends come down to the bottom position...)**.
Step 3: Compile the matched pairs. The correct pairings are A-III, B-IV, C-I, D-II. This combination corresponds to option (C).

Quick Tip

Associate a key position with each shed type: - **Closed Sheds:** All warps return to a common line. - **Center Closed:** Return to the middle. - **Bottom Closed:** Return to the bottom. - **Open Sheds:** Warps only move when they have to change position. - **Fully Open:** Up threads stay up if needed again. - **Semi-Open:** Involves a halfway meeting point.

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10. In _____, an external device is required to close the hook of needle during loop formation.
(A) Latch Needle
(B) Compound Needle
(C) Bearded Needle
(D) Sewing Needle

Correct Answer: (C) Bearded Needle

Solution: Step 1: Understand the critical action of hook closure in knitting. To form a new loop and securely cast off the previous one, a knitting needle's hook must be temporarily closed. The question asks which needle type relies on an "external device" to accomplish this action.

Step 2: Analyze the hook-closing mechanism of each needle type.
- **(A) Latch Needle:** This needle has a small, pivoting latch built into its shank. As the existing loop slides up the needle, it flips the latch over, which then closes the hook. This mechanism is entirely self-actuating and requires no external components.
- **(B) Compound Needle:** This needle is constructed from two parts: the main hook element and a sliding "tongue" or closing element. These two parts move relative to each other, controlled by the cam system, to open and close the hook. The closing mechanism is internal to the needle itself.
- **(C) Bearded Needle:** This needle has a long, flexible hook tip called a "beard." To close the hook, this beard must be physically pressed back into a groove on the needle's shank. This pressing action is performed by a separate machine element, a "presser bar," which moves in to contact all the needles at the correct moment. Thus, it requires an external device.
- **(D) Sewing Needle:** This is not a knitting needle. It is used to pass a thread through layers of fabric and does not form loops in the manner of a knitting machine.
Conclusion: The bearded needle is the only type on the list that depends on an external device (the presser bar) to close its hook.

Quick Tip

Memorize the hook closing mechanism for each knitting needle type: - **Latch Needle:** Self-closing with a pivoting latch. - **Bearded Needle:** Needs an external "presser" to bend the beard closed. - **Compound Needle:** Has its own internal sliding part to close the hook.

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11. In _____ weft knitting machine, the needles in the two beds are not face to face but needles in one bed are in between the needles of the other bed.
(A) Single jersey circular machine
(B) Rib knitting
(C) Interlock knitting
(D) Purl knitting **Correct Answer:** (C) Interlock knitting

Solution: Step 1: Interpret the question's description of needle arrangement. The question describes a double-bed knitting machine (two sets of needles, e.g., cylinder and dial). The crucial detail is the "gating," or the alignment of the needles between the two beds. The needles are described as "not face to face" but staggered, so a needle in one bed is positioned directly opposite the space between two needles in the other bed.
Step 2: Analyze the gating for each type of knitting.
- **(A) Single jersey circular machine:** This machine has only one bed of needles, so the concept of gating between two beds is not applicable.
- **(B) Rib knitting:** This process uses two needle beds where the needles are positioned directly "face to face" or opposite each other. This is known as "rib gating." It allows needles from both beds to knit simultaneously to produce the vertical columns of face and back loops characteristic of rib fabric.
- **(C) Interlock knitting:** This process specifically uses the staggered arrangement described in the question, known as "interlock gating." Because the needles are not opposite

each other, it's impossible for opposing needles to knit at the same time. Instead, two separate cam tracks are used to select alternate needles (e.g., long and short needles) in each bed to knit at different times, creating two inter-knitted 1x1 rib fabrics.
- **(D) Purl knitting:** This can use two needle beds (or double-headed needles) that are typically in a rib gating arrangement to allow for the transfer of loops from one set of needles to the other to create purl stitches.
Conclusion: The staggered, "in between" arrangement of needles is the definition of interlock gating, which is used to produce interlock fabrics.

> Quick Tip
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> Remember the two main double-jersey gatings: - **Rib Gating:** Needles are face-to-face (opposite). Produces rib fabrics. - **Interlock Gating:** Needles are staggered (in-between). Produces interlock fabrics.

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12. In the warp knitting machine, _____ of the guide bar takes place either from the front of the needles to the back or from the back of the needles to the front.
(A) Swinging motion
(B) Shogging motion
(C) Vertical motion
(D) Circular motion

Correct Answer: (A) Swinging motion

Solution: Step 1: Understand the role of the guide bar in warp knitting. The guide bar holds the yarn guides, and its complex movement is what wraps yarn around the needles to form loops. This movement is a composite of a few fundamental motions.
Step 2: Define the distinct, component motions of the guide bar.
- **(A) Swinging motion:** This is the movement of the guide bar in an arc, passing *through* the plane of the needles. It moves from the front of the machine to the back, and then from the back to the front. This motion is responsible for laying the yarn into the needle hooks (the swing-in) and then clearing the needles on the return path. This perfectly matches the question's description.
- **(B) Shogging motion:** This is a lateral, or sideways, movement of the guide bar, parallel to the needle bar. This motion is what moves the yarn from one needle to the next, creating the underlaps that connect the loops and form the fabric structure. The shog happens after the swing.
- **(C) Vertical motion:** This is primarily the motion of the needles themselves, which move up to clear old loops and receive new yarn, and down to cast off the old loops. The guide bar does not have a primary vertical motion.
- **(D) Circular motion:** While the path of a single yarn guide through a full cycle might appear somewhat circular or elliptical, this is a result of the combination of the swing and shog motions. It is not a fundamental, named component of the guide bar's movement.
Conclusion: The motion described as moving from the front of the needles to the back is unequivocally the swinging motion.

Quick Tip

The two fundamental guide bar motions in warp knitting are: - **Swing:** In-and-out, through the needles (front-to-back). - **Shog:** Sideways, along the needles (left-to-right).

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13. In nonwoven fabric manufacturing, the melt spinning process produces _____.

(A) Spun bonded web
(B) Aerodynamically formed web
(C) mechanically formed web
(D) wetlaid web

Correct Answer: (A) Spun bonded web

Solution: Step 1: Understand the "melt spinning process" in the context of nonwovens. This refers to a technology where a thermoplastic polymer (like polypropylene) is heated to a molten state, extruded through small holes in a spinneret to form continuous filaments, and then these filaments are laid down to form a fabric web. It is a direct polymer-to-web process.
Step 2: Evaluate which nonwoven technology is based on this principle.
- **(A) Spun bonded web:** The spunbond process is the exact definition of the process described above. It involves melting the polymer, spinning it into continuous filaments, drawing (stretching) the filaments, and then depositing them onto a conveyor belt to form a web. The name itself, "spunbond," reflects that the web is formed directly from the spinning process.
- **(B) Aerodynamically formed web (Airlaid):** This process starts with short, pre-made staple fibers. It uses air currents to separate and transport these fibers and deposit them in a random orientation onto a moving screen to form the web. It does not involve melting or spinning.
- **(C) Mechanically formed web:** This is a broad term, with the most common method being carding. Carding also uses staple fibers, which are opened, aligned, and formed into a web through the mechanical action of rotating, wire-covered cylinders. No melting is involved.
- **(D) Wetlaid web:** This process uses staple fibers suspended in a large volume of water. This slurry is then deposited onto a moving screen, where the water is drained away, leaving the fibers behind as a web, similar to papermaking. No melting is involved.
Conclusion: The direct conversion of molten polymer into a web via spinning is characteristic of the spunbond process, which produces a spun bonded web.

Quick Tip

Connect the raw material and process for nonwovens: - **Molten Polymer** → Melt Spinning → **Spunbond** / **Meltblown**. - **Staple Fibers** → Carding/Airlaid/Wetlaid → Mechanically/Aerodynamically/Wetlaid formed webs.

14. Match Direction with Orientation of fibers on the web.

LIST I **Direction**	**LIST II** **Orientation of fibers**
A. Longitudinal orientation	I. Not oriented
B. Transverse orientation	II. Fibres laid in machine direction and width-wise directions
C. Cross directional web	III. Fibres laid in a machine direction
D. Random oriented web	IV. Fibres laid in a width-wise direction

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

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

Solution: Step 1: Define each term for fiber orientation from List I.
- **A. Longitudinal orientation:** This means the majority of fibers are aligned parallel to the direction of the web's travel through the machine. This direction is also known as the Machine Direction (MD).
- **B. Transverse orientation:** This means the majority of fibers are aligned perpendicular to the machine direction, i.e., across the width of the web. This is also known as the Cross Direction (CD).
- **C. Cross directional web:** This describes a web that has been constructed to have strength in both the longitudinal and transverse directions. This is typically achieved by layering multiple webs, often by using a device called a cross-lapper to place layers at 90-degree angles to each other.
- **D. Random oriented web:** In this web, the fibers have no preferred direction of alignment; they are laid down haphazardly. This results in a web with isotropic properties (similar strength in all directions).
Step 2: Match these definitions with the descriptions in List II.
- **A (Longitudinal)** directly corresponds to **III (Fibres laid in a machine direction)**.
- **B (Transverse)** directly corresponds to **IV (Fibres laid in a width-wise direction)**.
- **C (Cross directional)** corresponds to **II (Fibres laid in machine direction and width-wise directions)**, as it implies a multi-directional layup.
- **D (Random oriented)** directly corresponds to **I (Not oriented)**.
Step 3: Assemble the final matched set. The correct pairings are A-III, B-IV, C-II, and D-I. This combination matches option (D).

Quick Tip

Think of the directions on a map: - **Longitudinal** = North-South (Machine Direction). - **Transverse** = East-West (Cross Direction). - **Cross** = Both N-S and E-W layers. - **Random** = No specific direction.

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15. In non-woven fabric manufacturing, the surgical face masks are produced by _____.

(A) Spunbond technology
(B) Meltblown technology
(C) Carded web
(D) Wet laid technology

Correct Answer: (B) Meltblown technology

Solution: Step 1: Identify the primary functional requirement of a surgical face mask. A mask's most crucial job is to act as a barrier, filtering out microscopic airborne particles like bacteria and viruses, while still being breathable. This requires a material with very fine pores.
Step 2: Assess the suitability of each nonwoven technology for this purpose.
- **(B) Meltblown technology:** This process is unique in its ability to produce extremely fine microfibers (often less than 1 micron in diameter). When these fibers are collected as a web, they create a dense structure with a vast number of small pores, making it an exceptional medium for filtering microscopic particles via electrostatic charge and physical interception. This is the key filtration component.
- **(A) Spunbond technology:** This process creates webs from coarser continuous filaments. Spunbond fabrics are strong, durable, and provide a good barrier to larger droplets, but they lack the fine pore structure needed for high-efficiency filtration of microscopic particles. They are used as the inner and outer layers of a mask for strength and comfort.
- **(C) Carded web** and **(D) Wet laid technology:** Both of these processes use staple fibers. While they can create filtration media for some applications, they generally cannot achieve the combination of high filtration efficiency for sub-micron particles and low breathing resistance required for medical-grade masks as effectively as meltblown technology.
Step 3: Conclude based on the critical function. A typical surgical mask is a composite fabric, most often SMS (Spunbond-Meltblown-Spunbond). However, the *essential filtration layer* that gives the mask its protective quality is made using meltblown technology. Therefore, among the choices given, meltblown technology is the most critical and defining process.

Quick Tip

For surgical masks, remember the structure **SMS**: - **S**punbond (Outer layers for strength and fluid resistance). - **M**eltblown (Middle layer for **M**icro-filtration). - **S**punbond (Inner layer for comfort and strength). Meltblown is the key functional component.

16. Calculate the production per shift of 8 hrs of a loom running at 200 picks/min with 90% efficiency. The number of picks per inch inserted in the cloth is 56.
(A) 10.4 yards
(B) 20.0 yards
(C) 30.0 yards
(D) 42.86 yards

Correct Answer: (D) 42.86 yards

Solution: Step 1: Calculate the total number of effective picks inserted during the shift. This calculation determines how many weft insertions actually occur after accounting for machine downtime.
- Loom Speed: 200 picks/minute - Shift Duration: 8 hours = 8 × 60 = 480 minutes - Efficiency: 90% = 0.90 - Total Effective Picks = (Speed) × (Time) × (Efficiency) - Total Effective Picks = 200 picks/min × 480 min × 0.90 = 86,400 picks.
Step 2: Determine the total length of fabric produced in inches. The density of the picks (picks per inch) tells us how much length is produced for a given number of insertions.
- Picks per Inch (PPI): 56 - Fabric Length (inches) = Total Effective Picks / Picks per Inch - Fabric Length (inches) = 86,400 picks / 56 picks/inch ≈ 1542.86 inches.
Step 3: Convert the fabric length from inches to yards. The final answer is required in yards, so a unit conversion is necessary.
- Conversion Factor: 1 yard = 36 inches - Fabric Length (yards) = Fabric Length (inches) / 36 - Fabric Length (yards) = 1542.86 inches / 36 inches/yard ≈ 42.857 yards.
Step 4: Compare the calculated result with the given options. The calculated value of 42.86 yards matches option (D).

Quick Tip

The formula for loom production in length is: Production = $\frac{\text{Loom Speed (picks/min)} \times \text{Time (min)} \times \text{Efficiency}}{\text{Picks per unit length}}$ Ensure all units are consistent (e.g., if picks/inch, the result will be in inches).

17. In _____ mechanism, the shuttle passes through the shed from one shuttle box to the opposite shuttle box.
(A) Shedding
(B) Picking
(C) Beat up
(D) Let off

Correct Answer: (B) Picking

Solution: Step 1: Recall the three primary motions of weaving. Fabric formation on a loom is accomplished through a precise, repeating sequence of three essential actions. Secondary motions like let-off and take-up support this core cycle.

Step 2: Define the function of each primary motion.
- **(A) Shedding:** This is the first action. The warp threads are separated into two layers, an upper layer and a lower layer. This creates a triangular opening or tunnel known as the "shed," preparing a path for the weft yarn carrier.
- **(B) Picking:** This is the second action. The weft yarn is inserted through the open shed. In the context of the question, this is achieved by propelling the shuttle, which contains the weft package (pirn), from its box on one side of the loom, through the shed, to a corresponding box on the other side. This action of inserting the weft is called picking.
- **(C) Beat up:** This is the third action. The reed, a comb-like device, swings forward and pushes the newly inserted weft yarn (the pick) firmly against the previously woven part of the fabric, a point called the "fell." This compacts the structure.
- **(D) Let off:** This is a secondary motion responsible for unwinding fresh warp yarn from the main beam as fabric is produced.

Step 3: Match the question's description to the correct mechanism. The description of a shuttle "pass[ing] through the shed from one shuttle box to the opposite" is the literal definition of the picking motion on a shuttle loom.

Quick Tip

Remember the three primary weaving motions in order: 1. **Shedding:** Open the warp. 2. **Picking:** Insert the weft. 3. **Beat-up:** Push the weft into place.

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18. In _____ rapier, the gripper heads are propelled by flexible tape.
(A) Telescopic
(B) Double bonded rigid
(C) Flexible
(D) Single head rigid **Correct Answer:** (C) Flexible

Solution: Step 1: Understand the role of a rapier in weaving. A rapier loom is a type of shuttleless loom that uses a finger-like projectile, the rapier, to carry the weft yarn across the shed. The key distinction between rapier systems lies in the construction of the element that carries the gripper head.
Step 2: Categorize the different types of rapier systems. Rapiers can be broadly divided into two main families based on their physical properties:
- **Rigid Rapiers:** These use a solid, inflexible rod or shaft to propel the gripper head. They are fast and precise but have a major drawback: they require a large amount of floor space on the sides of the loom to house the full length of the rapier when it is withdrawn from the shed. Options (A) Telescopic, (B) Double bonded rigid, and (D) Single head rigid all fall into this category. A telescopic rapier is a specialized type of rigid rapier that retracts into itself to reduce this space requirement, but it is still fundamentally rigid.
- **Flexible Rapiers:** These systems address the space issue of rigid rapiers. They use a pliable but strong element, such as a carbon fiber composite tape or a steel band, to propel the gripper head. Because this "tape" is flexible, it can be wound onto a wheel or coiled inside a compact housing as it exits the shed. This significantly reduces the overall width of the weaving machine.

Step 3: Match the description to the category. The question's description of gripper heads being "propelled by flexible tape" is the defining characteristic of a flexible rapier system.

Quick Tip

The key difference between rapier types is how they are stored outside the shed: - **Rigid Rapier:** Needs large side housing for the rigid rod. - **Flexible Rapier:** The flexible tape coils up, saving space.

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19. In case of weft knitted fabric _____ structure, each wale consists of alternate face and back loops.
(A) Rib
(B) Plain single jersey
(C) Interlock
(D) Purl

Correct Answer: (D) Purl

Solution: Step 1: Understand the terminology. A "wale" is a vertical column of loops in a knitted fabric. A "face loop" (or knit stitch) and a "back loop" (or purl stitch) are mirror images of each other. The question asks to identify the structure where both types of loops appear one after the other *within the same vertical column (wale).*
Step 2: Analyze the structure of each fabric type.
- **(B) Plain single jersey:** In this basic structure, all loops are of the same type (all face loops on one side, all back loops on the other). Therefore, every wale consists of only one type of loop.
- **(A) Rib:** This structure is characterized by alternating *wales* of face loops and back loops. For example, in a 1x1 rib, one entire wale will be face loops, the next entire wale will be back loops, and so on. Within any single wale, all the loops are still of the same type.
- **(C) Interlock:** This is a variation of rib knitting (two 1x1 ribs inter-knitted). On both faces of the fabric, all the visible wales are composed of face loops.
- **(D) Purl:** This is the only basic structure where face and back loops can alternate within the same wale. This is achieved by transferring loops between two needle beds or by using special double-headed needles. This alternation of loop types in the same vertical line gives the fabric its characteristic horizontal stretch and reversible appearance.
Conclusion: The structure where a single wale is composed of alternating face and back loops is the definition of a purl knit.

Quick Tip

Differentiate knit structures by the loop arrangement: - **Jersey:** All loops same in all wales. - **Rib:** Alternate *wales* of face and back loops. - **Purl:** Alternate *loops* of face and back in the same wale. - **Interlock:** Two inter-knitted rib structures.

20. A cotton fabric is treated with a finishing chemical of 6.0 % concentration. If the wet pick up is 80 %, the add-on of chemical on fabric is _____.
(A) 1.48 %
(B) 4.8 %
(C) 3.48 %
(D) 0.48 %

Correct Answer: (B) 4.8 %

Solution: Step 1: Define the key terms in the calculation.
- **Chemical Concentration:** This represents the amount of active chemical present in the finishing solution. A 6.0% concentration means that for every 100 grams of the solution, there are 6 grams of dry chemical and 94 grams of water.
- **Wet Pick Up (WPU):** This is the weight of the solution that the fabric absorbs, expressed as a percentage of the fabric's original dry weight. An 80% WPU means that 100 grams of dry fabric will weigh 180 grams immediately after padding, having picked up 80 grams of the solution.
- **Add-on %:** This is the final amount of dry chemical deposited onto the fabric, also expressed as a percentage of the fabric's original dry weight.
Step 2: Formulate the relationship and perform the calculation. The total add-on is the fraction of the picked-up liquid that is actual chemical. We can think of it logically: the fabric picks up 80% of its weight in liquid, and 6.0% of that liquid is the chemical.
The formula is: Add-on % = (Wet Pick Up % / 100) × (Concentration %)
Substituting the values:
Add-on % = (80 / 100) × 6.0% = 0.80 × 6.0% = 4.8%.
Alternatively, one can calculate it directly: Add-on % = (WPU × Concentration) / 100
Add-on % = (80 × 6.0) / 100 = 480 / 100 = 4.8%. This means 4.8 grams of dry chemical are now on the initial 100 grams of fabric.

> Quick Tip
>
> The formula is: **Add-on % = Wet Pick Up % × Concentration %**. Think of it logically: The fabric picks up a certain amount of liquid (Wet Pick Up), and that liquid contains a certain amount of chemical (Concentration). The product of the two gives the amount of dry chemical on the fabric.

21. The process of removal of protruding fibers from the surface of fabric is called as _____.
(A) Singeing
(B) Bleaching
(C) Shearing
(D) Cropping **Correct Answer:** (A) Singeing

Solution: Step 1: Understand the objective. The goal is to achieve a very smooth,

clean fabric surface by completely removing the fine, protruding fibers (fuzz or hairiness) that are common after spinning and weaving. This is done to improve the fabric's appearance, reduce pilling tendency, and ensure clear print definition.
Step 2: Evaluate the mechanisms of the given processes.
- **(A) Singeing:** This is a thermal process. The fabric is passed at a very high speed through a controlled gas flame or over a heated plate. The temperature and speed are set so that the fine, protruding fibers are instantly burned off, while the main body of the fabric, being much denser, remains unharmed. This results in a very clean removal of surface fuzz.
- **(B) Bleaching:** This is a chemical process aimed at removing the natural color from fibers to achieve a white base for dyeing. It does not affect the physical structure of surface fibers.
- **(C) Shearing** and **(D) Cropping:** These terms refer to the same mechanical process. The fabric surface is passed over a set of rotating helical blades, similar to a precision lawnmower. This action *cuts* the protruding fibers to a uniform height. While it reduces hairiness, it is primarily used to create a level pile (like on velvet or corduroy) or to trim fibers, not necessarily to remove them completely for a perfectly clean surface like singeing does.
Conclusion: The process of *removing* protruding fibers by burning them off is specifically called singeing.

Quick Tip

Distinguish between surface finishing processes: - **Singeing:** *Burns* away fuzz for a clean surface. - **Shearing/Cropping:** *Cuts* fibers to a uniform height. - **Brushing/Napping:** *Raises* fibers to create a soft, fuzzy surface.

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22. Match Machine with Principle.

LIST I **Machine**	**LIST II** **Principle**
A. Tub dyeing	I. Moving the textile material through the stationary dye liquor.
B. Jigger dyeing	II. Pumping the dye liquor through the stationary textile.
C. Package dyeing	III. Moving the textile material and dyeing liquor simultaneously.
D. Jet dyeing	IV. Textile materials and dye liquor are stationary.

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

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

Solution: Step 1: Analyze the principle of each dyeing machine based on what moves: the textile, the liquor, or both.

- **B. Jigger dyeing:** Fabric in open-width is passed back and forth between two large rollers, running through a small trough of concentrated dye liquor at the bottom. The **textile moves** while the **liquor is stationary**. This clearly matches I.
- **C. Package dyeing:** Yarn is wound onto a perforated spool (a package), which is then placed in a sealed vessel. The dye liquor is forcefully **pumped through the stationary textile package**. The textile does not move. This clearly matches II.
- **D. Jet dyeing:** Fabric in a rope form is transported through a closed-loop system by a high-velocity jet of the dye liquor itself. Therefore, **both the textile material and the dye liquor are moving** together. This clearly matches III.
- **A. Tub dyeing:** With the other three options clearly matched, this leaves Tub dyeing to be matched with IV. This represents the most basic form of dyeing, such as in a simple vat or tub where the material is immersed and the liquor is not actively circulated by a pump, and the material is not actively moved by machinery. In this sense, both are considered stationary, relying on simple immersion and occasional manual agitation.

Step 2: Assemble the combination. Based on the analysis, the correct matches are B-I, C-II, and D-III. This leaves A to be matched with IV. The complete sequence is A-IV, B-I, C-II, D-III, which corresponds to option (A).

Quick Tip

Focus on what moves in dyeing machinery: - **Jigger:** Fabric moves, liquor is stationary. - **Package/Beam:** Fabric is stationary, liquor is pumped through it. - **Winch:** Fabric moves, liquor is mostly stationary. - **Jet:** Both fabric and liquor move.

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23. Objectives of scouring of cotton.
A. To remove natural fatty matter from textiles.
B. To remove added fatty matter from textiles.
C. To remove pectins from textiles.
D. To remove coloring matter from textiles.
(A) A, B and D only
(B) A and C only
(C) A, B, C and D
(D) C and D only

Correct Answer: (B) A and C only

Solution: Step 1: Define the primary purpose of scouring. Scouring is a crucial pre-treatment step for cotton, using a hot alkaline solution (like caustic soda). Its main goal is to remove the natural, non-cellulosic impurities from the raw fiber. This purification process is essential to make the cotton uniformly absorbent for subsequent wet processes like bleaching and dyeing.
Step 2: Analyze the specific impurities targeted by scouring.
- **A. To remove natural fatty matter from textiles:** Raw cotton contains a protective layer of natural waxes and fats that makes it hydrophobic (water-repellent). The hot alkali in the scouring bath saponifies these fats (turns them into soluble soaps), allowing them to be washed away. This is a primary objective to achieve absorbency.

- **C. To remove pectins from textiles:** Pectins and other gummy substances act as a binding agent, holding other impurities to the fiber. Scouring degrades these pectins, helping to release the waxes and other dirt. This is also a primary objective.
- **B. To remove added fatty matter from textiles:** "Added" matter, such as sizing agents applied for weaving or knitting oils, are removed in a process called "desizing," which typically occurs *before* scouring. Scouring specifically targets the *natural* impurities.
- **D. To remove coloring matter from textiles:** While scouring may remove a small amount of the natural yellowish color of cotton, the dedicated process for removing color and achieving a high degree of whiteness is bleaching, which follows scouring. Therefore, color removal is the main objective of bleaching, not scouring.
Step 3: Conclude based on the primary objectives. The core functions of scouring are the removal of natural waxes/fats (A) and pectins (C). Therefore, option (B) is the correct choice.

Quick Tip

Remember the specific roles of pre-treatments: - **Singeing:** Removes surface fuzz. - **Desizing:** Removes added size. - **Scouring:** Removes *natural* waxes and pectins for absorbency. - **Bleaching:** Removes *natural* color for whiteness.

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24. Process sequence for polyester/wool blended knitted goods (Crisp handle).
A. Light brushing.
B. Open steam (allowing full relaxation).
C. Decatising.
D. Close cropping on face side of fabric.
(A) A, B, C, D
(B) A, C, B, D
(C) B, A, D, C
(D) C, B, D, A **Correct Answer:** (C) B, A, D, C

Solution: Step 1: Understand the objective and the material. The goal is to finish a polyester/wool knit fabric to give it a "crisp handle." This implies a final product that is dimensionally stable, smooth, free of excessive fuzz, and has a clean surface appearance.
Step 2: Establish a logical sequence for the finishing processes. Finishing generally proceeds from foundational steps to surface treatments, and finally to setting the final properties.
1. Stabilization: Knitted fabrics, especially blends, can hold a lot of stress from the knitting process. The first logical step is to relieve these stresses. **B. Open steam** is a relaxation process that allows the fabric to shrink and achieve a more stable, stress-free state. 2. Surface Preparation: To achieve a clean surface, any loose fibers must be dealt with. **A. Light brushing** is done to gently lift these fibers from the fabric surface, making them accessible for the next step. 3. Surface Refinement: Once the fibers are raised, they can be leveled. **D. Close cropping on face side** (also called shearing) is a mechanical cutting process that trims the raised fibers to a uniform, short length, creating a very smooth and clean surface. This must logically follow brushing. 4. Final Setting: After the fabric has been stabilized and

its surface perfected, the final step is to lock in these properties. **C. Decatising** is a process that uses steam and pressure to set the fabric, improve its handle and drape, and impart a subtle luster. It is a final setting process.
Step 3: Assemble the sequence. The logical flow is: Relaxation (B) → Brushing (A) → Cropping/Shearing (D) → Final Setting (C). This corresponds to the sequence B, A, D, C, which is option (C).

Quick Tip

Finishing sequences generally follow a pattern: 1. **Relax/Stabilize** the fabric structure. 2. **Prepare the surface** (e.g., brushing). 3. **Refine the surface** (e.g., cropping/shearing). 4. **Set the final properties** (e.g., decatising, heat-setting).

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25. The reactive dyes are applied to Cellulosic fiber in an alkaline dyeing bath, by chemically reacting to form _____ with the hydroxyl group of the fiber.
(A) Salt linkage
(B) Hydrogen bond
(C) Ionic bond
(D) Covalent bond

Correct Answer: (D) Covalent bond

Solution: Step 1: Understand the nature of "reactive" dyes. The name itself is the most important clue. These dyes are designed to be chemically reactive. Their molecules contain a special group (the "reactive group") that is capable of forming a strong, direct chemical bond with the fiber molecule under the right conditions.
Step 2: Analyze the chemical environment and the participating molecules. The fiber is cellulosic (like cotton), which is a polymer rich in hydroxyl (-OH) groups. The dyeing process is conducted in an alkaline bath. The alkali activates the hydroxyl groups on the cellulose, making them ready to react. The dye molecule then reacts with this activated site on the fiber.
Step 3: Differentiate between the types of chemical bonds. - (A) Salt linkage and (C) Ionic bond are the same thing. They involve electrostatic attraction between positively and negatively charged ions. This is the primary bonding mechanism for acid dyes on protein fibers like wool. - (B) Hydrogen bond is a weaker electrostatic attraction between molecules, not a true chemical reaction. It's the primary force for direct dyes on cotton. - (D) Covalent bond is a strong, stable chemical bond formed by the sharing of electrons between atoms. This is the result of a true chemical reaction.
Conclusion: The reaction between the reactive group of the dye and the hydroxyl group of the cellulose fiber results in the formation of a strong, permanent covalent bond. This is why reactive dyes are known for their excellent wash fastness—the dye becomes a physical part of the fiber molecule.

Quick Tip

Associate dye classes with their primary bond type: - **Reactive Dyes** on Cotton → **Covalent** - **Direct Dyes** on Cotton → Hydrogen bonds, Van der Waals forces - **Vat/Sulphur Dyes** on Cotton → Mechanical entrapment - **Acid Dyes** on Wool/Nylon → **Ionic** (salt linkage) - **Disperse Dyes** on Polyester → Solid solution (Van der Waals forces)

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26. Desizing of a grey cotton fabric having a starch-based size can not be done using _____.
(A) Amylase enzyme
(B) Dilute hydrochloric acid
(C) DMDHEU
(D) Hydrogen peroxide **Correct Answer:** (C) DMDHEU

Solution: Step 1: Understand the goal of desizing. Desizing is the process of removing the size material (in this case, starch) that was applied to warp yarns to protect them during weaving. Starch is a large polymer that is insoluble in water. To remove it, it must be chemically broken down (degraded) into smaller, water-soluble molecules that can be washed away.
Step 2: Evaluate the chemical action of each option on starch. - **(A) Amylase enzyme:** Amylase is a biological catalyst (an enzyme) whose specific function is to break down starch into simple sugars (like maltose and glucose) through hydrolysis. This is the most common, efficient, and fiber-safe method for desizing starch. - **(B) Dilute hydrochloric acid:** Strong acids, even when dilute, can catalyze the hydrolysis of starch, breaking the glycosidic bonds that link the glucose units together. This method works but is harsh and risks damaging the cotton cellulose if not perfectly controlled. - **(D) Hydrogen peroxide:** This is a strong oxidizing agent. Oxidative desizing works by attacking and breaking down the large starch molecule into smaller, soluble fragments. - **(C) DMDHEU (Dimethylol Dihydroxy Ethylene Urea):** This is a resin cross-linking agent. Its function is completely different. It is used in the *final finishing* stage to form covalent cross-links between cellulose chains to impart wrinkle-resistance. It has no chemical mechanism to break down starch; in fact, its purpose is to build chemical bonds, not break them.
Conclusion: Amylase, dilute acid, and hydrogen peroxide are all capable of degrading starch. DMDHEU is a finishing resin and cannot be used for desizing.

Quick Tip

Starch is a polymer. To remove it, you need to break it down (hydrolyze or oxidize it). The common methods are: - **Enzymatic:** Amylase (most popular). - **Acidic:** Dilute acids. - **Oxidative:** Hydrogen peroxide, persulfates. A cross-linking resin like DMDHEU is used for an entirely different purpose (wrinkle-free finishing).

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27. Which among the following is not a characteristic of a binder?
A. Capable of application by dry cure to form a film, trapping the pigment on the surface of the substrate
B. Provide adhesion of the pigment to the substrate surface
C. Able to crosslink in order to form a protective film
D. Non-elastic properties to allow for bending and stretching of the substrate after printing
(A) A
(B) B
(C) C
(D) D **Correct Answer:** (D) D

Solution: Step 1: Understand the function of a binder in pigment printing/dyeing. Pigments are colored particles that have no natural attraction (affinity) for textile fibers. A binder is essentially a polymer "glue" that is mixed with the pigment. This mixture is applied to the fabric, and when heated (cured), the binder forms a clear, durable film that physically locks the pigment particles onto the fiber surface.
Step 2: Analyze the necessary properties of this "glue". - A & B (Film formation and Adhesion): The binder must be capable of forming a continuous film that encapsulates the pigment particles and provides strong adhesion to the fabric surface. These are its most basic functions. - C (Cross-linking): During the curing process, the binder molecules must react with each other (cross-link) to form a tough, three-dimensional network. This network makes the film insoluble and durable, so the color doesn't wash or rub off. - D (Elasticity): A textile fabric is a flexible material that bends, stretches, and folds during use. The binder film, which sits on the surface, must be able to withstand these deformations without cracking or flaking off. Therefore, a crucial characteristic of a good binder is that it must be flexible and elastic, not rigid or non-elastic.
Conclusion: The statement that a binder should have "Non-elastic properties" (D) is incorrect. This is an undesirable property that would lead to a stiff handle and poor durability. Therefore, this is not a characteristic of a good binder.

Quick Tip

Think of a binder as a high-performance paint. It needs to: - **Stick** to the fabric (adhesion). - **Hold** the color particles (pigment). - **Harden** into a tough layer (crosslink/cure). - Be **Flexible** so it doesn't crack when the fabric moves.

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28. The Pad - Dry - Cure process is followed in _____.
(A) Reactive Dyeing
(B) Pigment dyeing
(C) Vat dyeing
(D) Direct dyeing

Correct Answer: (B) Pigment dyeing

Solution: Step 1: Break down the "Pad - Dry - Cure" process sequence. - Pad: The fabric is passed through a bath (the padder) to be impregnated with the dyeing or finishing chemicals. - Dry: The fabric is then dried, usually in a hot air oven (a stenter), to remove the water or solvent. - Cure: This is the critical step. Curing involves heating the dry fabric to a high temperature (typically 130-180°C) for a specific time. This high temperature is required to initiate a chemical reaction, such as polymerization or cross-linking.
Step 2: Match this sequence to the fixation mechanism of each dye class. - (B) Pigment dyeing: Pigment coloration relies on a binder to glue the pigment to the fiber. The "Cure" step is essential to polymerize and cross-link this binder, forming a durable, insoluble film. The Pad-Dry-Cure sequence is the standard application method for pigments. - (A) Reactive Dyeing: Fixation requires alkali and either time at room temperature (Pad-Batch method) or high-temperature steam (Pad-Dry-Pad-Steam method). It does not typically use a dry heat "cure." - (C) Vat dyeing: Fixation is a multi-step chemical process involving reduction (vatting), oxidation, and soaping. It uses steam, not a dry heat cure. - (D) Direct dyeing: These dyes fix onto the fiber through weak intermolecular forces (exhaustion dyeing). There is no chemical reaction and thus no curing step.
Conclusion: The high-temperature "Cure" step is the defining characteristic of the fixation process for pigment dyeing, where it is necessary to set the binder.

Quick Tip

Associate the fixation step with the dyeing method: - **Pigment** → **Cure** (High heat to set the binder). - **Reactive** → Alkali + Time (Pad-Batch) or Steam (Pad-Steam). - **Vat** → Reduce, Oxidize. - **Disperse** → Thermofixation (High heat to make dye diffuse into fiber).

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29. The after treatment of certain direct dyes with 0.25-2% copper sulphate and 1% acetic acid for 20-30 mins at 60°C to improve _____.
(A) Washing fastness
(B) Light fastness
(C) Light and washing fastness both
(D) Perspiration fastness

Correct Answer: (B) Light fastness

Solution: Step 1: Identify the process and chemicals involved. The process is an "after treatment" applied after dyeing with "certain direct dyes." The key chemical is copper sulphate, a metallic salt.
Step 2: Understand the inherent weaknesses of direct dyes. Direct dyes are popular for their ease of application, but they are generally known for having poor to moderate wash fastness (they bleed easily) and, for many shades, only moderate light fastness (they can fade in sunlight).
Step 3: Analyze the specific effect of copper sulphate treatment. A special sub-class of direct dyes, known as "after-coppering dyes," are designed with specific chemical groups that can chelate, or form a stable complex, with metal ions like copper (Cu^{2+}). When the

dyed fabric is treated with copper sulphate, the copper ions are taken up by the dye molecules already inside the fiber. This new copper-dye complex is significantly more stable and resistant to degradation by the energy from photons (light). This chemical change specifically enhances the dye's ability to resist fading.
Conclusion: While this treatment might offer a very minor improvement in wash fastness, its primary, intended, and most significant effect is the improvement of the dye's light fastness. Treatments with cationic fixing agents are used to improve wash fastness.

Quick Tip

Remember common after-treatments for direct dyes: - **Cationic fixing agents:** Improve **wash fastness**. - **Copper Sulphate:** Improves **light fastness** (for specific 'after-coppering' dyes).

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30. Vatting process does not accelerate due to _____.
(A) Temperature
(B) Concentration of alkali
(C) Concentration of reducing agent
(D) Time

Correct Answer: (D) Time

Solution: Step 1: Define the "vatting" process and its nature. Vatting is a chemical reaction—specifically, the reduction of an insoluble vat dye pigment into its water-soluble "leuco" form. This reaction is a prerequisite for the dye to be able to enter the fiber. Like most chemical reactions, its speed (or rate) can be influenced by several factors. The question asks which factor does *not* increase this speed.
Step 2: Analyze the role of each factor in chemical kinetics. - **(A) Temperature:** According to chemical kinetics, increasing the temperature provides more energy to the reacting molecules, increasing their collision frequency and effectiveness. This almost always accelerates the rate of a reaction. Vatting is typically done at elevated temperatures (e.g., 60°C) to speed it up. - **(B) Concentration of alkali** and **(C) Concentration of reducing agent:** The alkali (e.g., caustic soda) and the reducing agent (e.g., sodium hydrosulphite) are reactants. The Law of Mass Action states that the rate of a reaction is proportional to the concentration of the reactants. Increasing the concentration of either (within optimal limits) will increase the reaction rate. - **(D) Time:** Time is not a factor that influences the rate of a reaction. Rather, it is the dimension over which the reaction progresses. A certain amount of time is the *result* of the reaction's rate; a fast reaction requires less time, and a slow reaction requires more time. Time itself does not cause the reaction to speed up.
Conclusion: Temperature and the concentrations of the reactants are factors that can accelerate the vatting process. Time is the duration required for the process to occur, not a factor that accelerates it.

Quick Tip

In kinetics, the rate of a reaction is affected by temperature, concentration of reactants, catalysts, and surface area. Time is the dimension in which the reaction's progress is measured, not a factor that influences its speed.

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31. The light fastness of azoic dyed material decreases mainly due to _____.
(A) Depth of color
(B) Type of fabric
(C) Humidity
(D) Type of substrate

Correct Answer: (A) Depth of color

Solution: Step 1: Understand the phenomenon of light fastness and fading. Light fastness is a measure of a dye's resistance to fading when exposed to light. Fading is a photochemical process where energy from light (especially UV radiation) breaks down the chemical structure of the dye molecules, rendering them colorless.
Step 2: Analyze the role of dye concentration (Depth of color). The perceived fading of a fabric depends on what percentage of the total dye molecules have been destroyed. - In a **pale shade (low depth of color)**, the concentration of dye molecules on the fiber is low. If a certain absolute number of dye molecules are destroyed by light, this represents a large *percentage* of the total dye present. The change in color is therefore very noticeable, and the light fastness is rated as poor. - In a **deep shade (high depth of color)**, the concentration of dye is much higher. If the same absolute number of molecules are destroyed, they represent a much smaller percentage of the total. The visible change in color is far less apparent, and the light fastness is rated as good.
Step 3: Evaluate the other factors. While factors like humidity (C) and the specific substrate (D) can influence the rate of fading to some extent, the effect of dye concentration (A) is the most dominant and universally observed factor for nearly all dye classes, including azoics. The question asks what causes fastness to *decrease*, which is directly linked to a low depth of color.
Conclusion: The most significant reason for a decrease in the light fastness of an azoic (or most other) dyeing is a low depth of color.

Quick Tip

General Rule for Light Fastness: For most dyes, light fastness is lowest in pale shades and highest in deep shades. Think of it like a painted wall: a single scratch is very visible on a thinly painted surface but less noticeable on a surface with many thick coats of paint.

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32. In the pad-steam process of vat dye, intermediate drying is carried out for _____.

(A) Better fixation
(B) Prevention of pigment migration
(C) Increase in color depth
(D) Avoiding color change

Correct Answer: (B) Prevention of pigment migration

Solution: Step 1: Understand the process sequence. The question refers to a multi-stage continuous dyeing process. Specifically, a step where fabric is padded with vat dye pigment, then dried, and then padded again with reducing chemicals before steaming. The key is to understand the purpose of the "intermediate drying" step.
Step 2: Analyze the state of the dye after the first padding. After the first padding, the fabric is wet, and the insoluble vat dye particles are suspended in the water held by the fabric. At this stage, the dye particles are not fixed and are free to move with the water.
Step 3: Define "migration" and identify its cause. Migration is the unwanted movement of dye particles on a fabric during drying or processing, leading to unlevelness, blotches, or speckiness. If the wet fabric from the first pad were to go directly into the nip of the second chemical pad (a wet-on-wet process), the squeezing pressure of the rollers would cause the water and the suspended dye particles to move, concentrating them in some areas and depleting them in others.
Step 4: Explain the role of intermediate drying. By drying the fabric after the first padding, the water is removed, and the vat pigment particles are deposited and "locked" onto the surface of the fibers. They are now immobilized. When this dry fabric enters the second chemical pad, the chemicals are absorbed, but the original, even distribution of the dye pigment is maintained. This ensures a level and uniform final dyeing.
Conclusion: The primary purpose of the intermediate drying step is to fix the position of the unfixed dye particles on the fabric to prevent their migration during the subsequent wet chemical padding step.

Quick Tip

Whenever you see "intermediate drying" in a multi-stage padding process, the primary reason is almost always to prevent the migration of dyes or chemicals. Drying "locks" the substances in place before the next wet step.

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33. Which dye is responsible for tendering of cotton?
(A) Reactive dye
(B) Basic dye
(C) Sulphur dye
(D) Azoic dye

Correct Answer: (C) Sulphur dye

Solution: Step 1: Define "tendering." In textiles, tendering refers to the chemical degradation of a fiber, leading to a significant loss of its tensile strength. A tendered fabric becomes weak, brittle, and can be easily torn.

Step 2: Analyze the chemistry of Sulphur dyes. Sulphur dyes are complex macromolecules containing sulphide (-S-) and disulphide (-S-S-) linkages. During application, these are reduced to a soluble form and then oxidized back to their insoluble state inside the fiber.
Step 3: Explain the mechanism of tendering. A potential problem with some sulphur dyes, particularly sulphur blacks, is that over time, especially during storage in warm and humid conditions, some of the sulphur within the dye molecule can slowly oxidize. This oxidation process can form small amounts of sulphuric acid (H_2SO_4). Sulphuric acid is a strong acid that attacks the cellulose polymer of the cotton fiber. It catalyzes the hydrolysis of the glycosidic bonds linking the glucose units, effectively breaking the long polymer chains into shorter ones. This drastic reduction in chain length causes a severe loss of fiber strength, leading to tendering.
Step 4: Evaluate the other dye classes. - (A) Reactive dye: Forms a very stable covalent bond and is not known to cause tendering. - (B) Basic dye: Not used for cotton without a mordant; not associated with tendering cotton. - (D) Azoic dye: Formed inside the fiber; not known to cause chemical degradation.
Conclusion: Sulphur dyes are uniquely known for their potential to cause tendering in cotton due to the possible formation of sulphuric acid during storage.

Quick Tip

Associate specific problems with dye classes: - **Sulphur Dyes** → Tendering (acid formation). - **Vat Dyes** → Phototendering (certain yellow/orange dyes can degrade fiber in sunlight). - **Azoic Dyes** → Poor rub fastness (surface deposits). - **Direct Dyes** → Poor wash fastness.

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34. The maximum damage to cotton in sodium hypochlorite is found at _____ pH.
(A) 3 to 4
(B) 5 to 6
(C) 7 to 8
(D) 9 to 10 **Correct Answer:** (C) 7 to 8

Solution: Step 1: Understand the chemical nature of sodium hypochlorite (NaOCl) solutions. Sodium hypochlorite is an oxidizing agent used for bleaching. In a water solution, it exists in a chemical equilibrium with hypochlorous acid (HOCl): $NaOCl + H_2O \rightleftharpoons NaOH + HOCl \rightleftharpoons Na^+ + OCl^- + H_2O$ The position of this equilibrium is highly dependent on the pH of the solution.
Step 2: Analyze the active species at different pH levels. - High pH (Alkaline, pH 9-11): The equilibrium is shifted to the left. The dominant species is the hypochlorite ion (OCl^-). This ion is a relatively mild and slow-acting oxidizing agent, which allows for controlled bleaching of cotton with minimal damage. This is the recommended pH range for industrial bleaching. - Low pH (Acidic, pH ¡ 5): The equilibrium shifts to the right, favoring the formation of hypochlorous acid (HOCl), and can even lead to the release of toxic chlorine

gas. - Neutral pH (pH 7-8): At or near neutral pH, the concentration of the undissociated hypochlorous acid (HOCl) species is at its maximum.
Step 3: Relate the active species to cellulose damage. The damage to cotton (cellulose) during bleaching is caused by oxidation, which breaks the polymer chains. Hypochlorous acid (HOCl) is a much more powerful and aggressive oxidizing agent than the hypochlorite ion (OCl^-). Because the concentration of this highly destructive HOCl species is greatest at a neutral pH, the rate of cellulose degradation and fiber damage is also at its maximum in this range.
Conclusion: The maximum damage to cotton during hypochlorite bleaching occurs at a neutral pH of 7 to 8, which is known as the "danger zone" and is always avoided in practice.

Quick Tip

For hypochlorite bleaching of cotton: - **Safe Zone (Controlled Bleaching):** Alkaline pH (9-11). Active species: OCl^- (mild). - **Danger Zone (Maximum Damage):** Neutral pH (7-8). Active species: HOCl (aggressive).

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35. _____ has the highest Biological Oxygen Demand (BOD).
(A) Corn starch
(B) British gum
(C) C. M. C.
(D) Polyvinyl alcohol

Correct Answer: (A) Corn starch

Solution: Step 1: Define Biological Oxygen Demand (BOD). BOD is a measure of water pollution. It quantifies the amount of dissolved oxygen that aerobic microorganisms consume while breaking down organic matter in the water. A substance with a high BOD is highly biodegradable—it acts as a rich food source for bacteria, whose population explodes, consuming a large amount of oxygen from the water, which can be harmful to aquatic life. Desizing effluent is a major contributor to the BOD of a textile mill.
Step 2: Analyze the biodegradability of each sizing agent. - (A) Corn starch: This is a natural polysaccharide. It is essentially a chain of glucose molecules, making it a very easily digestible food source for a wide range of bacteria. Consequently, its decomposition consumes a large amount of oxygen, giving it a very high BOD. - **(B) British gum:** This is a type of dextrin, which is simply a modified, partially broken-down starch. It is also highly biodegradable and has a high BOD, comparable to that of native starch. - **(C) C. M. C. (Carboxymethyl cellulose):** This is a chemically modified version of cellulose. The chemical modification makes it much more resistant to enzymatic attack by microorganisms. It biodegrades very slowly and has a low BOD. - **(D) Polyvinyl alcohol (PVA):** This is a synthetic polymer. While certain grades can be broken down by specialized bacteria, it is generally much less biodegradable than natural starch and has a significantly lower BOD.
Step 3: Compare the options. Among the choices, natural corn starch is the most readily and completely biodegradable, and therefore exerts the highest biological oxygen demand when released into wastewater.

Quick Tip

In textile sizing, there is a trade-off between biodegradability and pollution: - **Natural Sizes (Starch):** Highly biodegradable, but this leads to very high BOD in effluent. - **Synthetic Sizes (PVA, CMC):** Less biodegradable, leading to lower BOD, but they can persist in the environment as chemical pollution (measured by COD - Chemical Oxygen Demand).

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36. In wet spinning process, the solvent removal and fiber solidification takes place during _____ stage.
(A) Drawing
(B) Wet coagulation
(C) Span finish
(D) Heat setting **Correct Answer:** (B) Wet coagulation

Solution: Step 1: Understand the principle of Wet Spinning. Wet spinning is a fiber manufacturing process used for polymers that cannot be melted and must be dissolved in a solvent to be spun. The process involves extruding the polymer solution (dope) through a spinneret directly into a liquid bath.
Step 2: Analyze the function of the liquid bath and define "coagulation." The liquid in this bath is chosen so that the polymer is insoluble in it, but the solvent (in which the polymer is dissolved) is soluble. When the stream of polymer solution enters the bath, a rapid exchange occurs: the solvent diffuses out of the filament and into the bath, while some of the bath liquid may diffuse in. This removal of the solvent causes the dissolved polymer to precipitate, or solidify, out of the solution, forming a solid filament. This process of solidification by precipitation in a liquid bath is called **coagulation**.
Step 3: Evaluate the other listed stages. - (A) Drawing: This is a subsequent mechanical step where the already solidified fibers are stretched to improve their strength and orientation. - (C) Span finish: This refers to the application of a processing lubricant (spin finish) onto the fiber surface after it has been formed. - (D) Heat setting: This is a thermal treatment, typically applied after drawing, to impart dimensional stability to thermoplastic fibers.
Conclusion: In wet spinning, the critical stage where the solvent is removed and the liquid polymer stream is transformed into a solid fiber is the wet coagulation stage.

Quick Tip

Remember the solidification methods for different spinning processes: - **Melt Spinning:** Solidifies by **Cooling**. - **Dry Spinning:** Solidifies by **Evaporating** the solvent in hot air. - **Wet Spinning:** Solidifies by **Coagulating** in a liquid bath.

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37. The Transmission Electron Microscopy (TEM) is used for the study of _____ structure of fibrous material.
(A) Surface

(B) Internal
(C) Localised
(D) External

Correct Answer: (B) Internal

Solution: Step 1: Differentiate between the two major types of electron microscopy based on their operational principle. The name of each technique provides a strong clue to its function.
- **Scanning Electron Microscopy (SEM):** This technique works by scanning a focused beam of electrons across the **surface** of a sample. Detectors then collect various signals (like secondary electrons or backscattered electrons) that are emitted from the surface as it is struck by the beam. The resulting image provides a detailed, often 3D-like, view of the sample's surface topography and texture. - **Transmission Electron Microscopy (TEM):** This technique works by passing (or **transmitting**) a broad beam of electrons **through** an extremely thin slice of the sample. The electrons that successfully pass through are then focused by magnetic lenses to form an image. Because the beam must pass through the material, TEM reveals the sample's **internal** structure at extremely high resolution, allowing scientists to see features like crystalline regions, micro-voids, or different phases within the material.
Step 2: Apply this understanding to the question. The question asks what type of structure TEM is used to study. Since TEM relies on transmitting electrons through the sample, it is the appropriate tool for investigating the internal structure. "External" structure (D) is synonymous with "Surface" structure (A), which is the domain of SEM.
Conclusion: TEM is used for the high-resolution study of the internal structure of materials, including fibers.

Quick Tip

A simple way to remember the difference: - **S**EM = **S**urface (Scanning across the surface). - **T**EM = **T**hrough (Transmitting through the sample).

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38. The term wash and wear is used in the case of polyester fiber due to its _____.
(A) High amorphousity and high water absorption
(B) Low crystalline and low water absorption
(C) Poor water absorption and high crease recovery
(D) High water absorption and low crease recovery

Correct Answer: (C) Poor water absorption and high crease recovery

Solution: Step 1: Define the practical meaning of "wash and wear." A garment described as "wash and wear" offers the convenience of being wearable soon after washing with little to no need for ironing. This performance depends on two key physical properties of the fiber.

1. Quick Drying: The fabric must not hold onto a large amount of water after washing, allowing it to dry rapidly. 2. Wrinkle Resistance: The fabric must not form creases easily during washing and wearing, or if it does, the creases must relax and fall out on their own.
Step 2: Relate these performance characteristics to the intrinsic properties of polyester fiber. - Quick Drying: Polyester is a highly crystalline and hydrophobic fiber. Its chemical nature repels water, leading to a very low moisture regain (around 0.4- Wrinkle Resistance: Polyester's polymer chains are resilient. After being deformed (bent or creased), they have a strong tendency to return to their original, un-creased state. This property is known as **high crease recovery** or high elastic recovery.
Step 3: Evaluate the options. - (A) and (D) are incorrect because polyester has low/poor water absorption. - (B) is incorrect because polyester is a highly crystalline fiber. - (C) correctly identifies the two crucial properties: Poor water absorption (leading to quick drying) and high crease recovery (leading to wrinkle resistance).
Conclusion: The excellent wash and wear performance of polyester is a direct result of its combination of poor water absorption and high crease recovery.

Quick Tip

Wash and Wear = Quick to Dry + Doesn't Wrinkle. - **Quick to Dry** → Low Water Absorption (Hydrophobic). - **Doesn't Wrinkle** → High Crease Recovery (Resilience). Polyester excels at both. Cotton is the opposite (high water absorption, low crease recovery).

39. The glass fiber is _____ fiber.
(A) Protein
(B) Inorganic
(C) Cellulosic
(D) Elastomeric

Correct Answer: (B) Inorganic

Solution: Step 1: Analyze the fundamental composition of glass fiber. Glass fiber is manufactured by melting sand, which is primarily composed of silica (silicon dioxide, SiO_2), along with various other mineral oxides. The resulting material is a non-carbon-based substance derived directly from geological sources.
Step 2: Differentiate between major fiber classifications based on their chemical origin.
- **Organic fibers** are fundamentally built upon carbon atom chains and rings. This category encompasses all fibers derived from living organisms, such as cellulosic fibers from plants (e.g., cotton) and protein fibers from animals (e.g., wool), as well as all synthetic polymers like polyester and nylon, which are created through organic chemistry.
- **Inorganic fibers** are materials that do not have a carbon-based polymer backbone. Their chemistry is rooted in minerals and other non-living sources. Examples include fibers made from glass (silicates), carbon (pure carbon atoms in a specific structure), and various ceramic or metallic materials.
Step 3: Evaluate the given options against the classification.
- (A) Protein fibers, such as wool and silk, are organic polymers composed of amino acid chains. This is incorrect.

- (B) Inorganic fibers are derived from minerals. Since glass is a silica-based mineral product, this classification is perfectly accurate.
- (C) Cellulosic fibers, such as cotton and linen, are organic polymers made of glucose units. This is incorrect.
- (D) Elastomeric fibers, such as spandex, are synthetic organic polymers specifically designed for high stretch and recovery. This is incorrect.
Conclusion: Based on its mineral origin and silica-based chemical structure, glass fiber is correctly classified as an inorganic fiber.

Quick Tip

Fiber Classification by Origin: - **Organic (Carbon-based):** - *Natural:* Cotton (cellulose), Wool (protein). - *Synthetic:* Polyester, Nylon. - **Inorganic (Mineral-based):** - Glass, Carbon, Asbestos, Ceramic fibers.

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40. The wool fiber exhibits high elastic recovery among the natural fibers due to its _____.
(A) Strong inter-molecular linkages
(B) Weak lateral forces
(C) Poor molecular arrangement
(D) High crystalline region **Correct Answer:** (A) Strong inter-molecular linkages

Solution: Step 1: Define the property of "high elastic recovery." This property describes the ability of a fiber to return to its original shape and length after being stretched or deformed. For wool, this is the reason it resists wrinkling so effectively; the fibers spring back into place after being bent.
Step 2: Examine the molecular architecture of wool. Wool is a protein fiber composed of keratin. The long keratin polymer chains are naturally arranged in a coiled, spring-like structure known as an alpha-helix. Critically, these coiled chains are interconnected by several types of chemical bonds.
Step 3: Identify the specific linkages responsible for the elastic property. While weaker hydrogen bonds exist, the most significant bonds for elastic recovery are the strong, covalent **disulphide bonds** (also called cystine linkages). These act as robust cross-links between adjacent keratin chains. When wool is stretched, the alpha-helical coils are straightened out. However, the strong disulphide bonds are not broken; instead, they store the energy of deformation. When the stretching force is released, these powerful cross-links act like miniature springs, actively pulling the polymer chains back into their original coiled configuration. This structural mechanism is the primary source of wool's exceptional resilience.
Step 4: Assess the provided options in light of this understanding.
- (A) Strong inter-molecular linkages: This is the correct description. The covalent disulphide bonds are exceptionally strong cross-links that anchor the polymer chains, enabling recovery.
- (B) Weak lateral forces: This is incorrect. Although weaker forces are present, the defining characteristic for wool's elasticity is its network of strong covalent bonds.

- (C) Poor molecular arrangement: This is incorrect. Wool possesses a highly sophisticated and organized molecular structure (the alpha-helix) that is specifically adapted for its properties.
- (D) High crystalline region: This is incorrect. High crystallinity is associated with rigidity and strength (like in cotton), not high elasticity. Wool's structure is more amorphous, which allows the chains the flexibility to uncoil and recoil.
Conclusion: The high elastic recovery of wool is a direct result of its strong inter-molecular linkages, specifically the covalent disulphide cross-links that restore the coiled shape of its polymer chains after stretching.

Quick Tip

Wool's secret to resilience is its structure: a coiled spring (alpha-helix) held together by strong cross-links (disulphide bonds). When you stretch it, you uncoil the spring, and the cross-links pull it back into shape.

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41. The outstanding features of polyamide fiber are _____.
A. Good dimensional stability.
B. High wet modulus.
C. High resistance to alkali.
D. Low strength and high elongation.
(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: (B) A, B and C only

Solution: Step 1: Characterize the essential properties of polyamide fibers, such as Nylon. Polyamides are synthetic polymers renowned in the textile industry for their exceptional durability, which includes high strength, toughness, and resistance to abrasion.
Step 2: Systematically evaluate each feature presented.
- **A. Good dimensional stability:** This statement is correct. Polyamides are thermoplastic, meaning they can be shaped with heat. Through a process called heat-setting, the molecular structure can be locked into a stable configuration. This makes the final fabric resistant to shrinking, stretching, or losing its shape during washing and wear.
- **B. High wet modulus:** This statement is correct. Modulus refers to a material's resistance to being deformed elastically when a force is applied (i.e., its stiffness). Many fibers, notably rayon, lose a substantial amount of their stiffness and strength when wet. Polyamides, however, retain a large percentage of their modulus when saturated with water, making them reliable for applications where wet performance is important.
- **C. High resistance to alkali:** This statement is correct. The amide linkage (-CO-NH-) that forms the backbone of the polyamide polymer is chemically stable in the presence of alkaline solutions (bases). This allows polyamide fabrics to be safely laundered and processed with common alkaline detergents and scouring agents. Conversely, they are susceptible to degradation by strong acids.

- **D. Low strength and high elongation:** This statement is definitively incorrect. Polyamide fibers are engineered for *high strength* (tenacity) and excellent abrasion resistance. They are among the strongest and toughest commodity synthetic fibers available, which is why they are used for ropes, carpets, and apparel requiring high durability.
Step 3: Synthesize the findings. The valid, outstanding features of polyamide fibers are A (Good dimensional stability), B (High wet modulus), and C (High resistance to alkali). Feature D is a direct contradiction of a primary characteristic of polyamides. Consequently, the correct combination of features is A, B, and C only.

Quick Tip

Key properties of Nylon (Polyamide): - **Strong and Tough:** Excellent tenacity and abrasion resistance. - **Good Elasticity.** - **Good Dimensional Stability** (when heat-set). - **Good Alkali Resistance**, but poor acid resistance.

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42. Arrange the following transition temperatures given by Differential Scanning Calorimetry (DSC) in ascending order.
A. Melting temperature
B. Crystallization temperature
C. Degradation temperature
D. Glass transition temperature
(A) D, B, A, C
(B) A, C, B, D
(C) B, A, D, C
(D) C, B, D, A **Correct Answer:** (A) D, B, A, C

Solution: Step 1: Define each thermal transition in the context of heating a semi-crystalline polymer from a solid state.
- **D. Glass transition temperature (Tg):** This is the lowest temperature transition. It is not a true phase change but a change in the mobility of the polymer chains in the *amorphous* (disordered) regions. Below Tg, the amorphous regions are rigid and glassy. Above Tg, the chains have enough energy to move, and these regions become soft and rubbery.
- **B. Crystallization temperature (Tc):** This temperature is relevant when heating an initially amorphous polymer. Once the temperature is above Tg, the chains are mobile. If held at Tc, these mobile chains have the optimal energy to rearrange themselves from a disordered state into a highly ordered, crystalline structure. This is an exothermic process. In a cooling scan from a melt, Tc is the temperature at which crystals form. It occurs at a temperature higher than Tg but lower than Tm.
- **A. Melting temperature (Tm):** This is the temperature at which the ordered *crystalline* regions of the polymer absorb enough energy to break apart, transitioning the entire polymer into a disordered, viscous liquid state (a melt). This is a true first-order phase transition and always occurs at a significantly higher temperature than Tg.
- **C. Degradation temperature (Td):** This is the highest temperature in the sequence. At Td, the thermal energy is so high that it begins to break the strong covalent bonds forming

the polymer backbone itself. This is an irreversible chemical decomposition of the material, not a physical transition.
Step 2: Logically sequence these events based on increasing temperature (energy input). The process unfolds as follows: first, the amorphous regions soften (Tg), then the chains may organize into crystals (Tc), then the crystals melt into a liquid (Tm), and finally, at a much higher temperature, the polymer itself breaks down chemically (Td).
Therefore, the correct sequence in ascending order of temperature is D (Glass transition), B (Crystallization), A (Melting), and C (Degradation).

Quick Tip

Think of the states of a semi-crystalline polymer as you heat it: 1. **Glassy Solid** (Amorphous part is frozen). 2. Heat past **Tg** → **Rubbery Solid** (Amorphous part is mobile). 3. (Sometimes) Heat further → **Crystallization (Tc)** (Mobile chains organize). 4. Heat past **Tm** → **Liquid Melt**. 5. Heat much further → **Degradation (Td)** (Burning/Decomposition). So, Tg ¡ (Tc) ¡ Tm ¡ Td.

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43. Match Fibre with Application.

LIST I **Fibre**	**LIST II** **Application**
A. Silk fibre	I. Fire retardant
B. Wool fibre	II. Directional lustre
C. Nomex fibre	III. Bulletproof
D. Kevlar fibre	IV. Thermal insulation

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

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

Solution: Step 1: Analyze each fiber in List I and identify its most prominent characteristic and associated application.
- **A. Silk fibre:** Silk is prized for its unique visual appeal. Its filaments have a smooth surface and a distinctive triangular cross-section. This shape acts like a prism, scattering light in a way that produces a deep, shimmering appearance that changes with the angle of light. This property is accurately described as directional lustre.
- **B. Wool fibre:** Wool fibers have a natural three-dimensional crimp (waviness). When spun into yarn, this crimp creates a bulky structure that traps millions of tiny air pockets. Since stationary air is a very poor conductor of heat, this trapped air provides excellent thermal insulation, which is why wool garments are valued for their warmth.
- **C. Nomex fibre:** Nomex is a brand name for a meta-aramid polymer. Its molecular structure is inherently stable at high temperatures and resistant to combustion. When exposed to intense heat, it does not melt or drip; instead, it carbonizes and thickens, forming

a protective barrier. This makes it an ideal material for fire retardant protective clothing for firefighters, industrial workers, and motorsports professionals.
- **D. Kevlar fibre:** Kevlar is a brand name for a para-aramid polymer. Its long, rigid, and highly aligned molecular chains create a fiber with an extraordinary tensile strength-to-weight ratio, many times stronger than steel. This exceptional ability to absorb and dissipate immense amounts of energy makes it the primary material for constructing ballistic-resistant articles like bulletproof vests and armor.
Step 2: Formulate the correct pairings between List I and List II based on the analysis.
- A (Silk fibre) logically matches with II (Directional lustre).
- B (Wool fibre) logically matches with IV (Thermal insulation).
- C (Nomex fibre) logically matches with I (Fire retardant).
- D (Kevlar fibre) logically matches with III (Bulletproof).
Step 3: Identify the option that reflects this complete set of pairings. The correct combination is A-II, B-IV, C-I, D-III, which corresponds to option (C).

Quick Tip

Memorize key applications for high-performance fibers: - **Silk:** Lustre. - **Wool:** Insulation (Warmth). - **Nomex: No mex** with fire (Fire retardant). - **Kevlar:** Ballistic protection (Bulletproof).

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44. The monomer used in the manufacture of Nylon 6 fiber is _____.
(A) Hexamethylene diamine
(B) Adipic acid
(C) Caprolactam
(D) Terephthalic acid

Correct Answer: (C) Caprolactam

Solution: Step 1: Deconstruct the nomenclature of Nylon polymers. The numerical designation in a Nylon's name provides crucial information about the monomers used in its synthesis. - A single digit, as in **Nylon 6**, signifies that the polymer is formed from a single type of monomer which contains that number of carbon atoms. - Two digits separated by a comma, as in **Nylon 6,6**, signify that the polymer is formed from two different monomers. The first digit corresponds to the number of carbons in the diamine monomer, and the second digit to the number of carbons in the diacid monomer.
Step 2: Apply this rule to identify the specific monomer for Nylon 6. Since the name is "Nylon 6," we are looking for a single monomer that contains exactly 6 carbon atoms.
- The polymerization process for Nylon 6 is a ring-opening polymerization. The monomer is a cyclic molecule called **(C) Caprolactam**. This ring structure contains six carbon atoms and one amide group. When heated, the ring opens up and links with other opened rings to form the long linear polymer chain of Nylon 6.
Step 3: Evaluate the other options to confirm the answer.
- **(A) Hexamethylene diamine** and **(B) Adipic acid** are the two monomers used to make Nylon 6,6. Hexamethylene diamine is a 6-carbon diamine, and adipic acid is a 6-carbon

diacid, which explains the "6,6" designation. - **(D) Terephthalic acid** is an aromatic dicarboxylic acid. It is a key monomer, along with ethylene glycol, for producing polyester (specifically PET), not polyamide.
Conclusion: The monomer that undergoes ring-opening polymerization to produce Nylon 6 fiber is Caprolactam.

Quick Tip

Remember the key monomers for common polymers: - **Nylon 6:** Caprolactam (1 monomer, 6 carbons). - **Nylon 6,6:** Hexamethylene diamine + Adipic acid (2 monomers, 6 carbons each). - **Polyester (PET):** Ethylene glycol + Terephthalic acid.

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45. On mercerization, moisture regain of cotton fiber _____.
(A) Decreases
(B) Remain unchanged
(C) Increases
(D) Indeterminate

Correct Answer: (C) Increases

Solution: Step 1: Define the process of mercerization. Mercerization is a critical finishing treatment for cotton materials (yarn or fabric) involving exposure to a cold, concentrated solution of an alkali, typically sodium hydroxide (caustic soda), under tension.
Step 2: Examine the changes in fiber structure caused by this treatment. The potent alkali penetrates the cotton fiber, causing two major transformations. First, the fiber swells significantly, changing its cross-sectional shape from a flattened, kidney-bean profile to a more circular one. Second, and more importantly for moisture regain, the treatment alters the polymer's internal morphology. The native crystalline structure of cellulose (known as Cellulose I) is permanently converted into a more thermodynamically stable but less-packed crystalline form (Cellulose II). This rearrangement effectively increases the volume of amorphous (non-crystalline) regions and makes the hydroxyl (-OH) functional groups within these regions more physically accessible.
Step 3: Connect these structural changes to the property of moisture regain. Moisture regain refers to the ability of a fiber to absorb water vapor from the atmosphere. Water molecules are absorbed primarily into the amorphous regions of the fiber, where they can form hydrogen bonds with the abundant, polar hydroxyl groups of the cellulose chains. Since mercerization increases the amount and accessibility of these amorphous regions, it creates more available sites for water molecules to attach. As a result, the fiber's capacity to absorb moisture is enhanced.
Conclusion: By altering the crystal lattice and increasing the accessibility of its internal structure, mercerization leads to a distinct and measurable increase in the moisture regain of cotton fiber, typically raising it from a baseline of 7-8% to a higher value of 9-10%.

Quick Tip

Mercerization of cotton improves several properties: - **Lustre:** Increases (due to smoother, rounder fiber surface). - **Strength:** Increases. - **Dye Affinity:** Increases (more accessible regions for dye). - **Moisture Regain:** Increases (more accessible amorphous regions).

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46. The essential requirements of fiber forming polymers are _____.
A. Linear polymer
B. Three dimensional polymer
C. High molecular weight
D. Strong lateral forces
(A) A, B and D only
(B) A, B and C only
(C) A, C and D only
(D) A, C and D only

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

Solution: Step 1: Define a "fiber forming polymer." This is a class of polymers possessing a specific combination of chemical and physical properties that allow them to be processed into long, thin filaments that are strong, pliable, and stable enough for textile applications.
Step 2: Critically evaluate each listed requirement for its role in forming a useful fiber.
- **A. Linear polymer:** This is an absolute requirement. The polymer chains must be long and linear (unbranched) so they can be aligned parallel to the fiber axis during the drawing process. This parallel alignment is fundamental to achieving high tensile strength and creating a cohesive fiber structure.
- **B. Three dimensional polymer:** This is the opposite of a requirement. A three-dimensional polymer, also known as a cross-linked or network polymer (like a thermoset resin), forms a rigid, infusible, and insoluble mass. Its chains are locked in a network and cannot be aligned, making it impossible to draw into a fiber.
- **C. High molecular weight:** This is an essential requirement. The polymer chains must be very long (i.e., have a high degree of polymerization). Long chains allow for significant entanglement and a large cumulative effect of intermolecular forces along their length. Short chains would result in a weak, brittle fiber that easily pulls apart.
- **D. Strong lateral forces:** This is an essential requirement. Once the linear chains are aligned, there must be strong intermolecular forces (also called lateral or cohesive forces) acting between them. These forces, such as hydrogen bonds (in nylon and cellulose) or strong dipole-dipole interactions, act like glue, holding the aligned chains together and preventing them from slipping past each other when the fiber is put under tension.
Step 3: Synthesize the essential characteristics. A viable fiber-forming polymer must be composed of long, linear chains (A and C) that can be aligned and held together by strong intermolecular forces (D). A three-dimensional structure (B) is prohibitive. Therefore, the correct combination of requirements is A, C, and D.

Quick Tip

To form a strong fiber, a polymer needs to be like a bundle of long, strong ropes tied together: - **Linear Polymer:** The ropes are long and straight, not a tangled mess (A). - **High Molecular Weight:** The ropes are very long (C). - **Strong Lateral Forces:** The ropes are held together tightly (D).

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47. The acrylic fiber is called artificial wool due to _____ formed on removal of solvent during manufacturing.
(A) Twist
(B) Serrations
(C) Voids
(D) Faults **Correct Answer:** (C) Voids

Solution: Step 1: Identify the reason for the "artificial wool" comparison. Acrylic fibers are widely used as a wool substitute because they share key desirable properties: they are lightweight, have a bulky handle, and provide excellent thermal insulation, meaning they feel warm.
Step 2: Examine the manufacturing process for acrylic fibers. Acrylic polymer is typically spun into fiber using either wet spinning or dry spinning. In both methods, the polymer is first dissolved in a suitable solvent to create a liquid spinning solution (dope). This dope is then extruded through a spinneret. In the subsequent step, the solvent is rapidly removed—either by a liquid coagulation bath (wet spinning) or by evaporation in hot gas (dry spinning).
Step 3: Connect the manufacturing process to the fiber's final structure and properties. As the solvent rapidly leaves the extruded filament, the polymer structure solidifies. This rapid diffusion process is often uneven, causing the internal structure to collapse in on itself in a non-uniform way. This results in the formation of countless microscopic, hollow spaces, or **voids**, within the core of the fiber. These voids become filled with air. Since trapped, stationary air is an excellent thermal insulator, this porous internal structure is directly responsible for the fiber's low density (making it lightweight and bulky) and its exceptional warmth-retention properties, thus mimicking the primary function of wool.
Conclusion: The formation of internal voids during the solvent-removal stage of manufacturing is the key structural feature that endows acrylic fiber with its characteristic wool-like bulk, low density, and high thermal insulation.

Quick Tip

The "secret" to acrylic's warmth is trapped air. This air is trapped in microscopic **voids** or pores created when the solvent is removed during the spinning process. More trapped air means better insulation.

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48. The objective of the filament drawing process is to improve the _____ of a fibre.
(A) Crystallinity
(B) Molecular orientation
(C) Density
(D) Thickness

Correct Answer: (B) Molecular orientation

Solution: Step 1: Define the filament drawing process. Drawing is a crucial post-spinning manufacturing step for nearly all synthetic fibers. It involves mechanically stretching the as-spun filaments, which are in a relatively weak and unorganized state, to several times their original length between two sets of rollers moving at different speeds.
Step 2: Describe the transformation at the molecular level during drawing. Before drawing, the long polymer chains within the filament are in a largely random, amorphous, and tangled arrangement. The mechanical force of stretching pulls these chains, causing them to slip past one another, uncoil, and align themselves in a direction parallel to the length of the fiber. This process of aligning the polymer chains along the fiber axis is precisely defined as improving **molecular orientation**.
Step 3: Analyze the consequences of improved molecular orientation. This parallel alignment is the *primary goal* because it unlocks the fiber's potential strength. Once oriented, the chains are much closer together, which allows the intermolecular forces between them to act much more effectively, significantly increasing the fiber's tensile strength (tenacity) and stiffness (modulus). Other properties change as a *consequence* of this orientation: - (A) Crystallinity often increases because the aligned chains can pack into ordered crystalline structures more easily (a phenomenon called stress-induced crystallization). - (C) Density increases slightly as the molecules become more tightly packed. - (D) Thickness (or denier) decreases as the filament is elongated. However, these are secondary effects. The fundamental purpose and direct change being engineered is the improvement of molecular orientation.
Conclusion: The principal objective of the drawing process is to transform the random arrangement of polymer chains into a structure that is highly aligned along the fiber axis, thereby maximizing the fiber's strength. This is known as improving molecular orientation.

Quick Tip

Think of drawing like combing tangled hair. - **Before Drawing:** Polymer chains are tangled and random. - **After Drawing:** Polymer chains are combed straight and aligned (**molecular orientation**). This alignment makes the fiber much stronger.

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49. The melting temperature of Nylon 6 fiber is _____.
(A) 180° C
(B) 120° C
(C) 218° C
(D) 265° C

Correct Answer: (C) 218° C

Solution: Step 1: Recognize that melting temperature (Tm) is a distinct physical property for crystalline polymers. It represents the temperature at which the ordered crystalline regions of the polymer gain enough energy to transition into a disordered molten state. This property is critical for determining processing parameters and end-use limitations (e.g., maximum safe ironing temperature).
Step 2: Differentiate between the melting points of the two most common nylons: Nylon 6 and Nylon 6,6. These two materials have similar chemistry but different molecular structures that lead to different physical properties. - **Nylon 6,6** is made from two symmetrical monomers. This structural regularity allows its polymer chains to pack very efficiently into a crystalline lattice with highly effective and uniform hydrogen bonding between chains. This strong intermolecular attraction requires a large amount of thermal energy to overcome, resulting in a high melting point, typically around **265°C**. - **Nylon 6** is made from a single monomer (caprolactam). Its polymer chain is less symmetrical than that of Nylon 6,6. This results in slightly less perfect packing and hydrogen bonding within its crystalline regions. Consequently, it requires less energy to melt, and its melting point is significantly lower, typically in the range of 215–225°C.
Step 3: Match the known values to the given options. - The value of 218°C falls squarely within the established range for Nylon 6. - The value of 265°C is the characteristic melting point of Nylon 6,6. - The other values are too low for either of these polyamide fibers.
Conclusion: Based on the established physical properties of polyamides, the melting temperature of Nylon 6 fiber is approximately 218°C.

Quick Tip

Memorize the approximate melting points of major synthetic fibers: - Polypropylene: ∼165°C - **Nylon 6:** ∼220°C - Polyester (PET): ∼260°C - **Nylon 6,6:** ∼265°C Note that Nylon 6,6 has a higher melting point than Nylon 6.

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50. The primary functions of Spin finish are _____.
A. Lubrication of fiber surface
B. Drawing of filaments
C. Antistatic action
D. Cohesion of filaments
(A) A, C and D only
(B) A, B and C only
(C) A, B, C and D
(D) B, C and D only

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

Solution: Step 1: Define Spin Finish and its point of application. A spin finish is a carefully formulated liquid mixture, often an emulsion, that is applied to the surface of synthetic filaments immediately after they are extruded and have solidified, but before they are wound onto a package. It is a processing aid essential for all subsequent high-speed operations.
Step 2: Analyze each listed item to determine if it is a function of the spin finish.

- **A. Lubrication of fiber surface:** This is a primary function. The spin finish provides a low-friction surface on the filaments. This lubrication is vital to reduce the friction between the rapidly moving yarn and static machine parts like guides, rollers, and godets. It prevents filament breakage, reduces abrasion, and minimizes wear on machinery.
- **B. Drawing of filaments:** This is not a function of the finish. Drawing is a separate, mechanical process where filaments are stretched to orient their molecules. The spin finish is applied *to facilitate* smooth running during drawing by providing lubrication, but the finish itself does not perform the act of drawing.
- **C. Antistatic action:** This is a critical function. Most synthetic fibers are excellent electrical insulators, causing them to build up significant static electricity due to friction during processing. This static charge causes individual filaments to repel each other ("ballooning") and cling to machine parts, leading to chaos. Spin finishes contain antistatic agents that increase the surface conductivity, allowing this charge to dissipate safely.
- **D. Cohesion of filaments:** This is an important function. A multifilament yarn consists of many individual fine filaments. The spin finish provides a slight stickiness or tackiness that holds these filaments together as a compact, coherent bundle. This cohesion prevents the yarn from becoming overly fluffy or having individual filaments snag, ensuring it can be processed smoothly as a single unit.

Step 3: Consolidate the true functions of the spin finish. The essential roles of a spin finish are to provide lubrication (A), to prevent static buildup (C), and to maintain the integrity of the filament bundle through cohesion (D). Drawing (B) is a mechanical process that the finish helps, but is not a function of the finish itself.

Quick Tip

A spin finish gives a synthetic yarn the properties it needs to be processed. Think of it as a "processing aid" that provides: - **Lubrication** (to slide easily). - **Antistatic** (to prevent static buildup). - **Cohesion** (to hold the bundle together).

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51. The strength of yarn decreases with the increase in specimen length due to more chances of the occurrence of _____ places in longer specimen.
(A) Faults
(B) Strong
(C) Weak
(D) Very strong

Correct Answer: (C) Weak

Solution: Step 1: Introduce the guiding principle: the "Weakest Link Theory." This theory posits that the strength of a chain-like structure is not determined by its average strength or its strongest part, but rather by the strength of its single weakest point. A textile yarn, being a long, slender assembly of fibers, behaves exactly like a chain in this regard.
Step 2: Consider the inherent variability of yarn. A real spun yarn is never perfectly uniform. Due to the random distribution of fibers, there are natural, unavoidable variations in its mass per unit length. This means that along its length, there will be sections that are slightly thicker and stronger, and sections that are slightly thinner and weaker.

Step 3: Analyze the effect of specimen length from a statistical perspective. When a short length of yarn is tested, it represents a small sample of these variations. It might, by chance, contain no particularly weak spots. However, as the length of the test specimen increases, the statistical probability of encountering a more extreme defect—an exceptionally thin and therefore **weak** spot—also increases. A 10-meter length is far more likely to contain a serious flaw than a 10-centimeter length. **Step 4: Apply the Weakest Link Theory to the test.** During a tensile test, the yarn will invariably fail at whatever point along the tested length is the weakest. Since longer specimens have a higher probability of containing a more severe weak spot, the breaking force measured for longer specimens will, on average, be lower than that measured for shorter specimens.
Conclusion: The observed decrease in measured yarn strength with increased test length is a direct consequence of the higher statistical probability of encompassing rarer, more severe weak places within the longer specimen.

Quick Tip

This is the "Weakest Link Effect": - A short chain might be lucky and have only strong links. - A very long chain is almost guaranteed to have at least one weak link somewhere. The chain (or yarn) always breaks at its weakest link, so longer yarns appear weaker on average when tested.

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52. The KES-FB module of Kawabata hand evaluation instruments gives _____.
A. Linearity of the load elongation curve.
B. Compression resilience.
C. Tensile energy.
D. Bending rigidity.
(A) A, C and D only
(B) A, B and C only
(C) A, B, C and D
(D) A, B and D only

Correct Answer: Note: The question is slightly ambiguous as KES-FB has multiple instruments. Assuming KES-FB1 (Tensile/Shear), KES-FB2 (Bending), and KES-FB3 (Compression) are considered collectively.

Solution: Step 1: Understand the purpose of the Kawabata Evaluation System for Fabrics (KES-FB). The KES-FB is not a single instrument but a suite of four integrated instruments designed to make objective, quantitative measurements of the low-stress mechanical properties of a fabric. These measurements correlate strongly with the subjective human perception of fabric "hand" or "feel."
Step 2: Assign the specific measurements to their corresponding KES-FB instruments. The system is typically composed of the following modules:
- **KES-FB1 (Tensile and Shear Tester):** This instrument pulls and shears the fabric at low loads. From its output, one can derive parameters related to how the fabric stretches. This includes **Tensile energy (C)** (the work done to stretch it) and the **Linearity of the**

load elongation curve (A). - **KES-FB2 (Pure Bending Tester):** This instrument measures the fabric's resistance to being bent. The primary output is a direct measure of stiffness, known as **Bending rigidity (D)**. - **KES-FB3 (Compression Tester):** This instrument measures how the fabric behaves when squeezed. It measures properties like compressibility, thickness, and the ability of the fabric to recover after being compressed, which is known as **Compression resilience (B)**. - **KES-FB4 (Surface Tester):** This instrument measures the frictional characteristics and geometric roughness of the fabric's surface.
Step 3: Evaluate the options provided in the question. Each of the listed properties—(A) Linearity of the load elongation curve, (B) Compression resilience, (C) Tensile energy, and (D) Bending rigidity—is a standard parameter measured by one of the core instruments within the comprehensive KES-FB system. Therefore, when considering the KES-FB "module" as the entire system, all four properties are given by it.

Quick Tip

The Kawabata Evaluation System (KES) is a comprehensive suite of tools to measure "fabric hand." It covers all the basic ways you can deform a fabric with your hands: - **Stretching** (Tensile) - KES-FB1 - **Bending** - KES-FB2 - **Squeezing** (Compression) - KES-FB3 - **Rubbing** (Surface) - KES-FB4 All the properties listed fall under these categories.

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53. The control and reduction of short fiber content have a direct impact on _____ in a yarn.
(A) Thin places
(B) Thick places
(C) Long thin places
(D) Neps **Correct Answer:** (D) Neps

Solution: Step 1: Define the terms "Short Fiber Content" (SFC) and "Neps." - **Short Fiber Content:** This refers to the population of fibers within a cotton sample that are significantly shorter than the main population. These fibers are difficult to process effectively. - **Neps:** These are small, tightly tangled knots or clumps of fibers that appear as thick, dot-like defects in the final yarn and fabric. They resist dye and create an uneven appearance.
Step 2: Analyze the mechanism of nep formation during yarn spinning. The primary machine for fiber individualization and cleaning is the carding machine. During carding, the goal is to straighten fibers and align them. Longer fibers are effectively controlled and parallelized by the moving wire surfaces. Short fibers, however, lack the length to be properly gripped and controlled by the carding action. They are more likely to be tumbled, rolled, and entangled, forming the small fiber knots that are defined as neps.
Step 3: Establish the direct cause-and-effect relationship. A higher population of short fibers in the raw material provides more raw material for nep formation. These uncontrolled short fibers are the primary source of neps. Therefore, controlling the level of short fibers in the cotton mix (by selecting better raw cotton or using a comber to remove

them) has a direct and significant impact on reducing the number of neps in the final yarn. While high SFC can also contribute to overall yarn unevenness (thin and thick places), its most direct and well-established consequence is the creation of neps.

Quick Tip

Think of it this way: - **Long fibers** = easy to comb and align. - **Short fibers** = difficult to control, they fly around and get tangled. These tangles are called **neps**. Therefore, Short Fibers → Neps.

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54. The periodic mass variations in yarn are mainly caused by _____.
(A) Machine faults
(B) Machine setting
(C) Random fiber arrangement
(D) Personal error

Correct Answer: (A) Machine faults

Solution: Step 1: Distinguish between different types of yarn mass variations. Yarn mass is never perfectly constant. The variations can be categorized: - **Random Variations:** These are short-term, unpredictable fluctuations in thickness caused by the inherent randomness of how staple fibers are arranged in the yarn structure. This is a natural feature of spun yarns. - **Periodic Variations:** These are non-random faults where a thick or thin spot repeats itself at a regular, fixed interval along the yarn's length.
Step 2: Analyze the origin of a repeating, regular pattern. A pattern that repeats at a consistent interval is a classic signature of a cyclical mechanical action. In a spinning mill, this points directly to a rotating component in the machinery. If a drafting roller is eccentric (off-center), has a dent, or has a lap of fiber stuck to it, it will create a thick or thin spot in the yarn once per revolution. Similarly, a gear with a broken or worn tooth will cause a periodic defect. The wavelength of the fault in the yarn will be directly related to the circumference of the faulty rotating part.
Step 3: Evaluate the alternative causes. - (B) Machine setting: An incorrect setting (e.g., wrong roller distance) would likely produce a yarn that is consistently poor (e.g., generally uneven or slubby) rather than one with a specific, repeating periodic fault. - (C) Random fiber arrangement: This is, by definition, the cause of random variations, not periodic ones. - (D) Personal error: An operator error is typically a one-off event and is extremely unlikely to produce a fault that repeats with machine-like precision over hundreds of meters of yarn.
Conclusion: The presence of periodic mass variations is a powerful diagnostic tool in yarn manufacturing, as it almost invariably indicates a mechanical problem, such as a faulty roller, gear, or apron, in the processing machinery.

Quick Tip

When analyzing yarn evenness: - **Random Faults** = Natural, unavoidable variation. - **Periodic Faults** = Mechanical problem (e.g., bad roller, broken gear). Look for a repeating pattern. The spectrogram is the tool used to diagnose these periodic faults.

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55. Match the LIST I with LIST II.

LIST I	LIST II
A. Tear strength	I. Contact angle test
B. Water repellency	II. Periodic faults
C. Seldom occurring faults	III. Impact principle
D. Spectrogram	IV. Classimat

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

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

Solution: Step 1: Analyze each term in List I and identify its corresponding testing method, instrument, or output from List II.
- **A. Tear strength:** This property measures the force needed to propagate an existing tear in a fabric. A standard instrument for this is the Elmendorf tester, which operates on the **impact principle**. A weighted pendulum is released, and the energy it loses while tearing the fabric over a fixed distance is measured, directly corresponding to the tear strength.
- **B. Water repellency:** This describes how well a fabric surface resists being wetted by water. A fundamental way to quantify this is the **contact angle test**. A droplet of water is placed on the fabric surface, and the angle it forms with the surface is measured. A high contact angle (¿90°) indicates a non-wetting, repellent surface (hydrophobic), while a low angle indicates a wetting surface (hydrophilic).
- **C. Seldom occurring faults:** These are large but infrequent yarn imperfections, such as slubs, thick places, and long thin places, which can cause major problems in fabric appearance and processing. The Uster **Classimat** is the specialized instrument designed specifically to detect, count, and classify these rare but critical faults into a matrix based on their size and length.
- **D. Spectrogram:** This is a graphical analysis tool used in yarn evenness testing. It decomposes the yarn's mass variation signal into its constituent wavelengths. This allows it to clearly identify **periodic faults**, which appear as distinct peaks on the graph, indicating a repeating thick or thin spot caused by a faulty mechanical part in the spinning machinery.
Step 2: Systematically form the correct pairings based on the analysis.
- A (Tear strength) matches with III (Impact principle). - B (Water repellency) matches with I (Contact angle test). - C (Seldom occurring faults) matches with IV (Classimat). - D (Spectrogram) matches with II (Periodic faults).
Step 3: Locate the option that reflects this complete set of pairings. The combination A-III, B-I, C-IV, D-II corresponds to option (C).

Quick Tip

Associate testing concepts with their methods/outputs: - **Tear Strength** → Elmendorf (Impact/Pendulum). - **Water Repellency** → Contact Angle. - **Periodic Faults** → Spectrogram. - **Objectionable/Rare Faults** → Classimat.

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56. The cotton fiber exhibits poor crease recovery due to _____.
(A) Strong lateral linkages
(B) Flexible polymer chain
(C) Weak lateral linkages
(D) Breakage of polymer chains

Correct Answer: (C) Weak lateral linkages

Solution: Step 1: Define crease recovery and relate it to cotton. Crease recovery, or wrinkle resistance, is the capacity of a fabric to spring back to its original flat state after being folded or crushed. Cotton is well-known for its poor crease recovery, meaning it wrinkles easily and holds those wrinkles.
Step 2: Examine the molecular structure of cotton. Cotton is composed of cellulose, a natural polymer. The cellulose molecules are long, linear, and relatively rigid chains. Within the fiber, these chains are packed closely together into highly ordered (crystalline) regions. The primary forces holding these adjacent chains together are a dense network of **hydrogen bonds**.
Step 3: Explain the mechanism of wrinkling at a molecular level. When cotton fabric is bent or creased (a process accelerated by moisture, which lubricates the chains), the energy applied is sufficient to break the relatively weak hydrogen bonds between the cellulose chains. This allows the chains to slip past one another into a new, displaced configuration. In this new wrinkled position, new hydrogen bonds immediately form, effectively locking the crease into place. Unlike wool, which has strong, covalent cross-links that act like elastic springs to pull the chains back to their original position, cotton lacks this internal recovery mechanism.
Step 4: Evaluate the given options based on this mechanism.
- (A) Strong lateral linkages: This is incorrect. Strong, permanent cross-links would result in good crease recovery, as seen in wool.
- (B) Flexible polymer chain: This is incorrect. The cellulose chain itself is quite stiff due to its chemical structure.
- (C) Weak lateral linkages: This is correct. The hydrogen bonds are weak enough to be easily broken and reformed, which allows the chains to slip into and become set in a wrinkled state.
- (D) Breakage of polymer chains: This is incorrect. Creasing is a physical rearrangement of chains, not a chemical degradation that breaks the chains themselves.

Quick Tip

Why Cotton Wrinkles: 1. Cotton's polymer chains are held by **weak hydrogen bonds**. 2. When creased, these weak bonds break. 3. The chains slip into a new position. 4. New hydrogen bonds form, **locking the wrinkle in place**. There are no strong "springs" (like the cross-links in wool) to pull it back.

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57. With all other parameters constant, the fabric with a low cover factor effectively transmits water vapor by a diffusion mechanism in comparison with that of fabric with a high cover factor due to _____.
(A) More air space
(B) Less thickness
(C) High thickness
(D) Less air space

Correct Answer: (A) More air space

Solution: Step 1: Define Cover Factor and its structural implications. The cover factor of a woven or knitted fabric quantifies how much of the fabric's total area is physically covered by the yarns. - A **low cover factor** signifies that the yarns are spaced widely apart. This results in an open, porous structure with large gaps, or interstices, between the yarns. - A **high cover factor** signifies that the yarns are packed very tightly together, resulting in a dense, closed structure with very small gaps.
Step 2: Understand the mechanism of water vapor transmission in textiles. For a wearer to remain comfortable, water vapor (from perspiration) must be able to move from the high-humidity microclimate near the skin, through the fabric, to the lower-humidity ambient environment. This transport occurs primarily through a process of diffusion, where water vapor molecules move through the path of least resistance.
Step 3: Relate cover factor to the diffusion path. The two possible paths for water vapor are through the solid fibers themselves (a very slow process) or through the air-filled spaces between the fibers and yarns. Water vapor diffuses hundreds of times more easily through air than through solid polymer. Therefore, the dominant mechanism for breathability is diffusion through the air spaces within the fabric.
Step 4: Connect the structure to the function. A fabric with a low cover factor, by its very nature, has a greater volume of interconnected air spaces. This provides a wider, more open pathway for water vapor molecules to diffuse through. Conversely, a fabric with a high cover factor has significantly less air space, constricting the pathway and impeding the diffusion of water vapor. Thus, a low cover factor leads to higher water vapor permeability (better breathability).

Quick Tip

Think about breathability: - **Low Cover Factor** = Open structure = Like a mesh or net = **More air space** = High breathability. - **High Cover Factor** = Dense structure = Like a solid sheet = **Less air space** = Low breathability.

58. The strength of fiber is usually measured in bundle form because there is better correlation between fiber bundle strength and _____.
(A) Yarn hairiness
(B) Yarn unevenness
C) Yarn strength
(D) Yarn twist **Correct Answer:** (C) Yarn strength

Solution: Step 1: Acknowledge the purpose of fiber testing. The primary goal of testing raw fibers (the input material) is to predict the properties and performance of the final product, which is the yarn. This allows spinners to select appropriate raw materials and control their process.
Step 2: Analyze the structure of a spun yarn. A spun yarn is not a single monolithic filament; it is a complex assembly of thousands of short, individual staple fibers twisted together. The overall strength of the yarn is a composite property that depends on the collective contribution of all these fibers acting in unison.
Step 3: Compare single fiber testing with bundle testing. Testing the tensile strength of one single fiber at a time is a slow process and produces highly variable results due to natural imperfections. A single fiber's strength is not representative of the whole population. A fiber bundle test (performed on instruments like the HVI or Stelometer) measures the combined strength of many thousands of fibers at once. This method provides a more stable, average value for the fiber population and, more importantly, it better simulates how fibers are stressed together within the cross-section of an actual yarn. The collective behavior of fibers in a bundle is a much better physical analogy for the collective behavior of fibers in a yarn than a single fiber test is.
Conclusion: Because a yarn's strength is a result of the collective action of many fibers, measuring the strength of a fiber bundle provides a much more representative and predictive value. Extensive empirical evidence has shown a strong statistical correlation between fiber bundle strength and the final spun yarn strength, making it an indispensable test for quality control and process management in spinning mills.

Quick Tip

The goal of testing raw material (fiber) is to predict the quality of the final product (yarn). Testing a **bundle of fibers** is a better simulation of a **yarn cross-section** than testing a single fiber. Therefore, Fiber Bundle Strength → predicts Yarn Strength.

59. The thermal insulation of clothing mainly depends on fabric _____.
(A) Thickness
(B) Stiffness
(C) Crease recovery
(D) Weight **Correct Answer:** (A) Thickness

Solution: Step 1: Understand the primary mechanism of thermal insulation in clothing. The main function of winter clothing is to reduce the rate of heat loss from the human body to the colder environment. The most significant factor in achieving this is the entrapment of a layer of still, or immobile, air. Still air is an exceptionally poor conductor of heat and is therefore an excellent insulator.
Step 2: Analyze how different fabric properties contribute to trapping air. A fabric's ability to provide insulation is directly proportional to the amount of still air it can hold within its structure and between its layers. A fabric that is bulky, lofty, and porous is excellent at trapping air. The single most important physical dimension that quantifies this volume of trapped air is the fabric's **thickness**. A thicker fabric creates a thicker layer of trapped, still air, which provides a greater barrier to heat transfer.
Step 3: Critically evaluate the other options.
- (B) Stiffness and (C) Crease recovery are mechanical properties related to how a fabric feels and drapes; they do not have a primary role in its thermal properties.
- (D) Weight can be very misleading. For instance, a thin, heavy fabric like a dense canvas has a high weight but low thickness, offering poor insulation. Conversely, a down-filled jacket is extremely lightweight but very thick, offering outstanding insulation because it traps a large volume of air for its weight.
Conclusion: While other factors like fiber type and fabric construction play a role, the most dominant and critical parameter determining a fabric's thermal insulation value is the volume of still air it entraps, which is most directly measured by its thickness.

Quick Tip

Insulation = Trapped Air. The more air a fabric can trap, the warmer it is. The amount of trapped air is directly proportional to the fabric's **thickness**. This is why a thick, fluffy sweater is warmer than a thin, dense t-shirt of the same weight.

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60. A 100-meter skein of polyester filament yarn weighs 2.5 grams, calculate its tex number.
(A) 12 tex
(B) 25 tex
(C) 17 tex
(D) 21 tex

Correct Answer: (B) 25 tex

Step 1: State the definition of the Tex yarn numbering system. The Tex system is a direct measure of linear density. The Tex number is formally defined as the mass in **grams** of a **1,000-meter** length of yarn.
Formula: Tex = mass in grams for a 1000m length.
Step 2: Identify the information provided in the problem. We are given: - A specific length of yarn = 100 meters - The weight of that specific length = 2.5 grams
Step 3: Determine the goal of the calculation. Based on the definition of Tex, we need to calculate what the weight of 1,000 meters of this same yarn would be.

Step 4: Use a simple proportion to scale the given values. We can set up a direct ratio: If a length of 100 meters has a weight of 2.5 grams, Then a length of 1000 meters must have a weight of X grams.

$$\frac{2.5\,\text{grams}}{100\,\text{meters}} = \frac{X\,\text{grams}}{1000\,\text{meters}}$$

Step 5: Solve the equation for X.
To find X, we can rearrange the equation:

$$X = \frac{2.5\,\text{grams} \times 1000\,\text{meters}}{100\,\text{meters}}$$

$$X = 2.5 \times 10 = 25\,\text{grams}$$

This result tells us that 1,000 meters of the yarn weighs 25 grams.
Step 6: State the final Tex number.
According to the definition, since 1,000 meters of the yarn weighs 25 grams, the yarn count is 25 tex.

> Quick Tip
>
> The definition of Tex is simply "grams per 1000 meters". If you are given the weight for any other length, just calculate how much 1000 meters would weigh. In this case, 100m is 2.5g, so 1000m (10 times longer) must be 10 times heavier: $2.5 \times 10 = 25$g $\rightarrow$ 25 tex.

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61. The electrical conductivity of fiber _____ on increase in moisture absorption.
(A) increases
(B) decreases
(C) unchanged
(D) affected

Correct Answer: (A) increases

Solution: Step 1: Understand the inherent electrical properties of textile fibers. Most common textile polymers (like cotton, wool, polyester, nylon) are organic materials that are excellent electrical insulators. This means they have very high electrical resistivity and do not allow electric charge to flow easily. This high resistivity is the reason static electricity can build up on them during processing or wear.
Step 2: Consider the electrical properties of water. While pure water is not a great conductor, the water absorbed by fibers from the atmosphere contains dissolved ions and impurities, which makes it significantly more conductive than the fiber polymer itself.
Step 3: Analyze the effect of moisture absorption on the fiber system. When a fiber absorbs moisture from a humid environment, a microscopic layer of water molecules forms on the fiber's surface and penetrates its amorphous regions. This absorbed moisture creates a continuous conductive pathway along the fiber. Any static charge that develops on the fiber can now travel along this moisture pathway and dissipate to the ground or other

objects. The more moisture the fiber absorbs (i.e., the higher its moisture regain), the more extensive and effective this conductive pathway becomes.
Conclusion: As the amount of absorbed moisture in a fiber increases, it provides a better path for electricity to flow. Therefore, the overall electrical conductivity of the fiber increases, and its electrical resistance decreases. This is why static electricity problems are much more severe in dry conditions than in humid conditions.

Quick Tip

Think of static electricity in different weather: - **Dry Winter Day:** Low humidity → fibers are dry → high electrical resistance → lots of static shock. - **Humid Summer Day:** High humidity → fibers absorb moisture → low electrical resistance → static dissipates easily, no shocks. Therefore, more moisture = more conductivity.

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62. In the fineness measurement by Sheffield micronaire instrument, the flow of air through a plug of fibers is related to _____ of fiber.
(A) Area of cross section
(B) Perimeter
(C) Weight per unit length
(D) Specific surface

Correct Answer: (D) Specific surface

Solution: Step 1: Understand the operational principle of the Micronaire instrument. The Micronaire test is a standard method for assessing the fineness and maturity of cotton. The procedure involves placing a precise weight of cotton fibers into a chamber of a fixed volume, creating a porous "plug" of a specific density. A regulated volume of air is then forced to flow through this plug, and the instrument measures the resistance to this airflow.
Step 2: Analyze the factors affecting airflow through a porous medium. The ease with which air can flow through the plug of fibers depends on the size and complexity of the pathways between the fibers. The total surface area of the fibers within the plug creates frictional drag on the moving air. - If the fibers are **fine** (thin), a given weight of cotton will contain a very large number of fibers, resulting in a very high total surface area. This creates a dense network of small channels, offering high resistance to airflow, thus the measured airflow rate will be low. - If the fibers are **coarse** (thick), the same weight will consist of fewer fibers with a lower total surface area. This creates a more open structure with larger channels, offering low resistance, and the measured airflow rate will be high.
Step 3: Define the physical property being measured. The instrument is responding to the total surface area of fibers packed into a given mass. The scientific term for the total surface area per unit of mass is **Specific Surface Area** (e.g., measured in square meters per gram). Fine fibers have a high specific surface area, while coarse fibers have a low specific surface area. The Micronaire reading is therefore a direct function of the specific surface of the cotton sample.
Conclusion: The rate of airflow measured by the Micronaire instrument is inversely proportional to the resistance of the fiber plug, which is determined by the total surface area

of the fibers. This means the measurement is fundamentally related to the specific surface area of the fibers.

Quick Tip

The Micronaire principle is based on air resistance: - **Fine Fibers** = High Surface Area = High Air Resistance = Low Airflow. - **Coarse Fibers** = Low Surface Area = Low Air Resistance = High Airflow. The property that combines surface area and mass is the **specific surface**.

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63. Which of the following methods are indirect methods for determining the maturity of cotton fibers?
A. Polarised light method
B. Causticare method
C. Differential dyeing method
D. Caustic Soda swelling method
(A) Only A, B and D
(B) Only A, B and C
(C) Only C and D
(D) All A, B, C and D

Correct Answer: (C) Only C and D

Solution: Step 1: Define cotton fiber maturity and the distinction between direct and indirect measurement methods. Maturity refers to the degree of secondary wall thickening in a cotton fiber. A fully mature fiber has a thick wall and a small lumen, while an immature fiber has a thin wall. - **Direct methods** involve the physical observation and measurement of these dimensional characteristics, typically using a microscope. - **Indirect methods** measure a secondary property of the fiber that is known to correlate with maturity, rather than measuring the wall thickness itself.
Step 2: Analyze and classify each method listed.
- **A. Polarised light method:** This is a direct microscopic method. It relies on the principle that the thicker cellulosic wall of a mature fiber causes greater retardation of polarized light, producing different interference colors than a thin-walled immature fiber. It is a direct optical assessment of wall thickness.
- **B. Causticare method:** This is an instrumental method based on airflow, similar to the Micronaire test. It measures airflow resistance before and after treatment with caustic soda. Since it measures airflow, which relates to specific surface area, it is considered an indirect method of assessing maturity.
- **C. Differential dyeing method:** This is a classic indirect method. It relies on the fact that mature fibers (with more cellulose) have a greater affinity for certain dyes than immature fibers. A sample is dyed with a mixture of red and green dyes; mature fibers dye red, and immature fibers dye green. The overall color gives a qualitative assessment of maturity. It measures dye uptake, not physical dimensions.
- **D. Caustic Soda swelling method:** This is the benchmark direct microscopic method. Fibers are treated with an 18

Step 3: Evaluate the options based on the classifications. According to standard textile science classification, methods A and D are direct (microscopic), while methods B and C are indirect (based on airflow and dyeing properties, respectively). None of the available options perfectly match this correct classification (i.e., "Only B and C"). The provided answer key stating "(C) Only C and D" is definitively incorrect, as the Caustic Soda swelling method (D) is the very definition of a direct method. There is a clear error in the question's provided answer. However, if forced to interpret based on common usage, sometimes all non-microscopic instrumental methods are broadly grouped as "indirect," which would make B and C the indirect methods. Given the options, the question is flawed.

Quick Tip

To determine cotton maturity: - **Direct Methods:** You look at the fiber under a microscope and see how thick its wall is (e.g., Caustic Soda swelling test). - **Indirect Methods:** You measure another property that changes with maturity, like how it dyes (**Differential Dyeing**) or how air flows through it (**Causticare/Micronaire**).

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64. In the twisting zone, if the rear end of the fiber is not in the nip of the delivery rollers of the ringframe, the fiber will be under no control, which causes _____.

(A) Hairiness
(B) Nep
(C) Thick place
(D) Nap

Correct Answer: (A) Hairiness

Solution: Step 1: Visualize the twisting zone in a ring spinning frame. This is the area between the nip of the front delivery rollers and the traveler on the ring. In this zone, the strand of fibers (the "spinning triangle") is twisted into a yarn by the rotation of the traveler.
Step 2: Analyze the state of the fibers in this zone. For a fiber to be properly integrated into the yarn core, both of its ends should be under control, ideally with its rear end still gripped by the delivery rollers as its front end is twisted in. However, due to the natural variation in fiber length, some shorter fibers will exit the nip of the delivery rollers while their rear end is still free and untwisted.
Step 3: Consider the forces acting on an uncontrolled fiber end. Once a fiber's rear end is free, it is no longer under tension from the drafting system. The yarn is rotating at an extremely high speed (thousands of revolutions per minute). This rapid rotation generates a significant centrifugal force. This force acts on the free, uncontrolled trailing end of the fiber, causing it to be thrown outwards, away from the central axis of the yarn.
Conclusion: Instead of being neatly twisted into the yarn core, this protruding fiber end becomes a loop or a free end on the yarn's surface. The accumulation of millions of such protruding fibers is what constitutes yarn hairiness. Therefore, uncontrolled fiber ends in the twisting zone are a primary cause of hairiness.

Quick Tip

Think of a spinning figure skater. When they pull their arms in, they spin faster. When they extend their arms out, the arms fly outwards due to centrifugal force. An uncontrolled fiber end acts like the skater's extended arm, flying outwards and creating **hairiness**.

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65. The heart loop test of measurement of fabric stiffness is especially used for _____ fabrics.

(A) Heavy
(B) Stiff
(C) Limpy
(D) Knitted

Correct Answer: (C) Limpy

Solution: Step 1: Define fabric stiffness. Stiffness, or bending rigidity, is a fabric's resistance to being bent. It is a key component of how a fabric drapes and feels. Different testing methods are required for fabrics with vastly different levels of stiffness.
Step 2: Describe the "Heart Loop Test" method. In this test, a strip of fabric of standard dimensions is folded and fastened to form a loop. This loop is then suspended vertically. Under the force of its own weight, the loop deforms into a shape resembling a heart. The vertical length of this loop is then measured. A stiffer fabric will resist bending and form a short, wide loop. A less stiff fabric will bend more easily, resulting in a longer, narrower loop.
Step 3: Compare this method to the standard Cantilever test. The more common cantilever method involves sliding a fabric strip over a horizontal edge and measuring the length that overhangs before it droops to a specific angle. This method works well for most fabrics. However, for extremely flexible, soft, and drapeable fabrics—described as **"limpy"**—the cantilever method is ineffective. A limpy fabric has so little bending resistance that it will simply hang vertically as soon as it leaves the edge, making it impossible to get a meaningful measurement.
Conclusion: The Heart Loop test is specifically designed to be sensitive to very small differences in stiffness at the low end of the scale. It relies on the fabric's own weight to induce bending, making it the ideal and preferred method for characterizing the stiffness of very flexible and limpy fabrics where other methods fail.

Quick Tip

Remember the right tool for the job in stiffness testing: - **Most Fabrics:** Cantilever Test (Shirley Stiffness Tester). - **Very Limpy/Soft Fabrics:** Heart Loop Test. - **Very Stiff Fabrics:** Bending tests with higher force application.

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66. Choose the correct answer from the options given below:

Arrange the machines of a ring spinning line in the sequence.
A. Ring Frame
B. Carding
C. Speed frame
D. Draw frame
(A) A - I, B - II, C - III, D - IV
(B) A - III, B - I, C - II, D - IV
C) A - II, B - I, C - IV, D - III
(D) A - III, B - I, C - IV, D - II **Correct Answer:** (C) B, D, C, A

Solution: Step 1: Understand the overall goal of the spinning process. The objective is to convert a bulk mass of disorganized staple fibers into a fine, strong, continuous strand of yarn. This is achieved through a multi-stage process of cleaning, opening, parallelizing, drafting (attenuating), and twisting.
Step 2: Determine the function and position of each machine in this process flow. - **B. Carding:** This is the first machine in this sequence. It takes opened and cleaned tufts of fiber and performs the critical task of disentangling them into individual fibers, removing impurities, and forming them into a continuous, thick, untwisted strand called a "sliver." - **D. Draw frame:** This machine comes after carding. Its purpose is to perfect the sliver. It does this by combining (doubling) several slivers together and then drafting them to improve evenness, and by further drafting to straighten and parallelize the fibers along the sliver axis. - **C. Speed frame (Roving frame):** This is the intermediate step between drawing and final spinning. It takes the perfected sliver from the draw frame and drafts it significantly to make it much thinner, producing a strand called "roving." It also adds a small amount of twist to give the roving enough strength to be handled. - **A. Ring Frame:** This is the final machine in the sequence. It takes the roving, drafts it down to the final desired fineness (yarn count), inserts a high level of twist to impart strength, and winds the resulting yarn onto a bobbin.
Step 3: Assemble the machines into the correct logical sequence. The material flows from a thick, unorganized state to a thin, organized one. The correct sequence is: Carding (creates sliver) → Draw frame (improves sliver) → Speed frame (creates roving from sliver) → Ring Frame (creates yarn from roving). This corresponds to the order B, D, C, A.

Quick Tip

The spinning process is a gradual attenuation of the fiber stream: - **Carding:** Creates the first "Sliver". - **Drawing:** Perfects the "Sliver". - **Speed Frame:** Attenuates sliver into "Roving". - **Ring Frame:** Attenuates roving into "Yarn".

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67. Match the LIST-I with LIST-II.

LIST-I Machine part	LIST-II Function
A. Taker-in	I. Individualisation of fibres
B. Cylinder	II. Takes the fibers from cylinder surface
C. Flats	III. Pluck the flocks from feed roller
D. Doffer	IV. Elimination of neps

(A) A, B and D only
(B) A, B and C only
C) A, B, C and D
(D) C and D only

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

Solution: Step 1: Identify the machine these parts belong to. Taker-in, Cylinder, Flats, and Doffer are the primary working elements of a **Carding machine**, which is responsible for opening fiber tufts into a web of single fibers.
Step 2: Describe the role of each part in the machine's operational sequence.
- **A. Taker-in:** This is the input component. It's a fast-rotating roller with coarse, saw-toothed wire that takes material from the feed system. Its primary, aggressive action is to **pluck the flocks from the feed roller**, performing the initial opening of the fiber tufts.
- **B. Cylinder & C. Flats:** These two components work together to perform the main "carding action." The Taker-in transfers fibers to the large, very fast-rotating Cylinder. The fibers are carried by the cylinder past the slowly moving Flats, which are positioned just above it. The opposing wire points and close setting between the Cylinder and Flats perform the two crucial functions of the machine: the ultimate **individualisation of fibres** (B) and the **elimination of neps** and fine trash (C).
- **D. Doffer:** This is the output component. The Doffer is a smaller roller that rotates much more slowly than the cylinder. Its wire points are angled to lift, or "doff," the individualized fibers off the cylinder's surface. Its function is to **take the fibers from the cylinder surface** and condense them into a coherent web, which is then gathered to form the card sliver.
Step 3: Match the machine parts in List I with their specific functions in List II.
- A (Taker-in) correctly matches with III (Pluck the flocks from feed roller). - B (Cylinder) correctly matches with I (Individualisation of fibres, its main task with the flats). - C (Flats) correctly matches with IV (Elimination of neps, its main task with the cylinder). - D (Doffer) correctly matches with II (Takes the fibers from cylinder surface).
Step 4: Select the option that represents the correct set of pairings. The correct matching sequence is A-III, B-I, C-IV, D-II, which is presented in option (D).

Quick Tip

Think of the carding machine as a fiber assembly line: 1. **Taker-in:** Grabs and opens the raw material. 2. **Cylinder/Flats:** The main work station for individualizing fibers and removing neps. 3. **Doffer:** Collects the finished single fibers from the cylinder.

68. Choose the correct tasks of the rotor spinning machine.
A. Fibre separation
B. Ordering the fibres in the strand
C. Imparting strength by twisting
D. Removal of neps
(A) Airjet spinning
(B) Ring spinning
C) Open end spinning
(D) Friction spinning

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

Solution: Step 1: Understand the fundamental principle of Rotor (or Open-End) Spinning. This technology is fundamentally different from ring spinning because it involves a "break" in the process flow. A continuous sliver is fed in, completely disintegrated into individual fibers, and then reassembled into a yarn.
Step 2: Analyze each task in the context of this process.
- **A. Fibre separation:** This is the first and most critical step. The incoming sliver is fed to a high-speed opening roller (or beater), which is covered with wire teeth. This roller completely combs apart the sliver, separating it into a stream of individual fibers. This is the "open-end" step.
- **B. Ordering the fibres in the strand:** The separated fibers are carried by an air current through a transport channel and deposited into a groove on the inner wall of a rapidly spinning rotor. Centrifugal force holds the fibers in this groove, collecting them and aligning them into a uniform, continuous ribbon or strand.
- **C. Imparting strength by twisting:** A "seed" yarn is introduced into the rotor and is continuously pulled out. As it is withdrawn, it peels fibers off the ribbon collected in the groove, and the high-speed rotation of the rotor twists these newly added fibers onto the "open end" of the forming yarn. This twisting action binds the fibers together and provides the yarn's tensile strength.
- **D. Removal of neps:** While the aggressive action of the opening roller does remove heavy trash and dust particles (which are extracted by air suction), it is not designed as a primary nep removal device. Its main function is fiber individualization. Significant nep removal must be accomplished earlier in the process, primarily at the carding machine.
Step 3: Conclude which tasks are the core functions. The essential and defining tasks of a rotor spinning machine are the separation of fibers (A), the ordering of these fibers into a new strand inside the rotor (B), and the subsequent imparting of twist to create a strong yarn (C).

Quick Tip

The three key actions in Rotor Spinning are: 1. **Open:** Separate the sliver into single fibers. 2. **Assemble:** Collect and order the fibers in the rotor groove. 3. **Twist:** Spin the rotor to twist the fibers into yarn as they are pulled out.

69. In _____ modern spinning system, the rotation of yarn arises from the rotary movement of the two drums and is generated by frictional contact at the drum surface.
(A) Middle and front rollers
(B) Front roller and spindle
C) Back and middle rollers
(D) Cool and back roller

Correct Answer: (D) Friction spinning

Solution: Step 1: Deconstruct the mechanism described in the question. The key features are: - The method of twist insertion is yarn rotation. - The rotation is caused by the movement of "two drums." - The twisting force is transmitted via "frictional contact" between the yarn and the drum surfaces.
Step 2: Evaluate each of the major modern spinning systems against this description.
- **Airjet spinning:** In this system, fibers are wrapped around a core using jets of compressed air in a vortex. It does not use rotating drums for twist insertion.
- **Ring spinning:** Twist is inserted by a traveler that revolves around a stationary ring, pulled by the yarn being wound onto a rapidly rotating spindle. This involves a spindle and traveler, not two drums.
- **Open end (Rotor) spinning:** Twist is inserted by the very high-speed rotation of a single, cup-shaped component called a rotor. It does not use two drums.
- **Friction spinning (e.g., DREF systems):** This technology perfectly matches the description. Individualized fibers are fed into the nip formed between two parallel, perforated drums that are rotating in the same direction. The fibers are held against the drums by air suction and are rolled and twisted into a yarn by the frictional force exerted by the moving surfaces of the two drums. The yarn forms in the nip and rotates due to this frictional contact.
Conclusion: The spinning system that utilizes two rotating drums to generate twist through frictional contact is known as friction spinning.

Quick Tip

Link the twisting method to the spinning system name: - **Ring** → Ring and Traveler. - **Rotor** → Rotor. - **Airjet** → Air Jet/Vortex. - **Friction** → **Friction** Drums.

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70. In the drafting system of a ring frame, the break draft is applied between _____.
(A) Middle and front rollers
(B) Front roller and spindle
C) Back and middle rollers
(D) Cool and back roller **Correct Answer:** (C) Back and middle rollers

Solution: Step 1: Describe a typical ring frame drafting system. A standard ring frame employs a multi-roller drafting system, most commonly a 3-over-3 arrangement (three

pairs of rollers). These roller pairs are designated as the back, middle, and front rollers. They rotate at progressively increasing surface speeds, with the back rollers being the slowest and the front rollers being the fastest. This speed differential is what attenuates, or drafts, the roving.
Step 2: Define the distinct drafting zones within this system. The total draft applied to the roving is split into two distinct zones: - The **Main Draft Zone** is located between the middle rollers and the very fast front rollers. This is where the majority of the attenuation occurs, often controlled by aprons to guide the fibers. - The **Break Draft Zone** (also called the back draft zone) is located between the slow back rollers and the slightly faster middle rollers.
Step 3: Explain the purpose and location of the break draft. A small amount of draft (typically between 1.1 and 1.4) is applied in this back zone. This is the "break draft." Its function is not to significantly thin the roving but to prepare it for the main draft. It gently stretches the roving, which helps to straighten the fibers and overcome the fiber-to-fiber cohesion from the roving's slight twist, allowing the fibers to move more freely and evenly in the subsequent high-draft main zone.
Conclusion: The break draft is, by definition, the draft that is applied in the first or back zone of the drafting system, which is the region between the back and middle rollers.

Quick Tip

Visualize the 3-roller drafting system: - (Back Roller) → *Break Draft Zone* → (Middle Roller) → *Main Draft Zone* → (Front Roller) - The **Break Draft** happens first, in the **Back** zone.

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71. Match the LIST-I with LIST-II

LIST-I Machine	**LIST-II Material**
A. Blow room	I. Sliver
B. Carding	II. Yarn
C. Speed frame	III. Lap
D. Ring frame	IV. Roving

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

Solution: Step 1: Trace the transformation of cotton material through the spinning process, identifying the output of each machine.
- **A. Blow room:** This is the first stage of processing. It takes compressed bales of cotton, opens them into tufts, cleans them, and delivers the material to the next stage. In older, conventional systems, the final product of the blow room is a rolled sheet of fiber called a **lap**, which is then fed to the card.

- **B. Carding:** This machine receives the lap (or tufts from a chute feed system) and performs the crucial task of disentangling the fibers into a web of individual fibers. This web is then condensed into a thick, untwisted rope-like strand known as a **sliver**.
- **C. Speed frame (or Roving Frame):** This machine takes the sliver after it has been processed by the draw frame. It drafts the sliver to make it much thinner and adds a slight amount of twist for cohesion. The output of the speed frame is an intermediate product called **roving**.
- **D. Ring frame:** This is the final spinning stage. It takes the roving as its input material, drafts it to the final desired fineness, inserts a high degree of strength-giving twist, and winds the final product, the **yarn**, onto a bobbin.

Step 2: Assemble the correct pairings of machine and its material product.
- A (Blow room) produces III (Lap). - B (Carding) produces I (Sliver). - C (Speed frame) produces IV (Roving). - D (Ring frame) produces II (Yarn).

Step 3: Identify the option that reflects this correct sequence of pairings. The combination A-III, B-I, C-IV, D-II matches the sequence in option (C).

Quick Tip

Follow the material transformation in a spinning mill: Bale → **Blow Room** → Lap → **Card** → Sliver → Draw Frame → Sliver → **Speed Frame** → Roving → **Ring Frame** → Yarn.

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72. On a _____ machine, two or more single yarns are plied and twisted together.
(A) Ring frame
(B) Two for one twister
C) Yarn winding
(D) Speed frame

Correct Answer: (B) Two for one twister

Solution: Step 1: Clearly define the process being described. The action of combining "two or more single yarns" is called plying or doubling. The action of twisting these combined yarns around each other is called twisting. The overall process creates a plied or folded yarn, which is typically stronger, more balanced, and more uniform than the single yarns it is made from.

Step 2: Evaluate the function of each machine listed to see if it performs this specific task.
- **A. Ring frame:** This is a spinning machine. Its function is to produce a *single* yarn from an input of roving. It does not combine multiple yarns.
- **B. Two for one twister (TFO):** This machine is specifically engineered for the purpose of plying and twisting. It takes two or more packages of single yarn, draws the ends together, and then inserts twist into the combined strand. It is called "two-for-one" because its design ingeniously inserts two turns of twist for every single mechanical rotation of its spindle, making it a highly productive and standard machine for this task.

- **C. Yarn winding:** A winding machine's primary purpose is to transfer yarn from small spinning bobbins onto larger, more convenient packages like cones. While a doubling winder can ply yarns together, it does not typically insert the high level of twist required for a stable plied yarn.
- **D. Speed frame:** This is a pre-spinning machine that produces roving from sliver. It operates on a single strand and does not ply yarns.
Conclusion: The machine specifically designed to efficiently ply and twist multiple single yarns together into a single, stronger yarn is the Two-for-one twister.

> Quick Tip
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> Distinguish spinning from post-spinning: - **Spinning** (Ring Frame, Rotor): Makes SINGLE yarn. - **Twisting/Plying** (TFO Twister): Combines MULTIPLE single yarns.

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73. In the spinning process, a precisely predetermined quantity of short fibers are eliminated in _____.
(A) Comber
(B) Draw frame
C) Speed frame
(D) Carding

Correct Answer: (A) Comber

Solution: Step 1: Analyze the key phrase in the question: "precisely predetermined quantity of short fibers are eliminated." This implies a deliberate, controlled process aimed specifically at removing short fibers to improve quality, where the amount of removal is a key process parameter.
Step 2: Evaluate the function of each machine with respect to fiber removal.
- **A. Comber:** The combing machine is an optional and expensive step in the production of high-quality cotton yarn. Its sole purpose is to upgrade the quality of the sliver. It does this by using fine-toothed combs to comb through a fringe of fibers, physically removing any fibers shorter than a predetermined length, along with remaining neps and impurities. The amount of waste removed, called noil, is a critical setting that is precisely controlled (e.g., 14- **B. Draw frame:** The purpose of this machine is to improve sliver evenness and fiber parallelization. It does not eliminate fibers.
- **C. Speed frame:** This machine's function is to draft sliver into roving. It does not eliminate fibers.
- **D. Carding:** The carding machine does remove some waste, which contains short fibers and trash. However, its primary function is to individualize fibers. The removal of short fibers is a secondary effect and is not as precisely controlled or as significant as in combing.
Conclusion: The Comber is the unique machine in the spinning line specifically designed to eliminate a precisely controlled percentage of short fibers, thereby producing a cleaner, stronger, and more lustrous yarn known as combed yarn.

Quick Tip

Remember the difference between Carded and Combed yarns: - **Carded Yarn:** All fibers are included (except for some waste). Standard quality. - **Combed Yarn:** Short fibers are intentionally and precisely removed by a **Comber**. Premium quality.

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74. The main objective of the ginning process is _____.
(A) Separation of seeds from cotton fibers
(B) Opening and cleaning
C) Trash removal
(D) Parallelization of fibers **Correct Answer:** (A) Separation of seeds from cotton fibers

Solution: Step 1: Define the ginning process and its place in the cotton supply chain. Ginning is a crucial, non-textile process that occurs after cotton is harvested from the field and before it is shipped to a spinning mill. The material arriving from the field is called "seed cotton."
Step 2: Understand the composition of seed cotton. Harvested seed cotton is a mixture of the valuable cotton fibers (known as lint) and the cottonseed to which these fibers are attached. It also contains varying amounts of field trash such as leaves, stems, and dirt.
Step 3: Identify the primary transformation that must occur. Before the lint can be spun into yarn, it must be completely detached from the seeds. This detachment is the fundamental and defining purpose of the ginning process. Machines like saw gins or roller gins are specifically designed to grip the fibers and pull them away from the seeds. While modern ginning lines also perform significant opening, cleaning, and trash removal (options B and C), these are secondary functions. The process would be pointless without its core objective. Parallelization of fibers (D) is a task performed much later in the spinning mill by machines like the card and draw frame.
Conclusion: The main and indispensable objective of the ginning process is the mechanical separation of the cottonseed from the cotton fibers (lint), thereby converting the unusable harvested material into a valuable raw material for the textile industry.

Quick Tip

Ginning is the bridge from the farm to the mill. - **Farm product:** Seed Cotton (Fiber + Seed). - **Ginning Process:** Separates the two. - **Mill input:** Lint Cotton (Fiber only).

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75. In a ring bobbin, the actual yarn weight is 75 grams with count 30 tex, calculate the length of the yarn in meters.
(A) 7500 meters
(B) 250 meters
C) 25 meters
(D) 2500 meters

Correct Answer: (D) 2500 meters

Solution: Step 1: Understand the meaning of the given yarn count. The yarn count is specified as 30 tex. By the definition of the Tex system, this means that a length of 1,000 meters of this specific yarn has a mass of exactly 30 grams.

$$\text{This can be written as a ratio: } \frac{30\,\text{grams}}{1000\,\text{meters}}$$

Step 2: Identify the knowns and the unknown in the problem. - Known yarn count: 30 tex (or 30 g / 1000 m) - Known total weight of yarn on the bobbin: 75 grams - Unknown: The total length of the yarn in meters.

Step 3: Set up a proportion to solve for the unknown length. We can equate the ratio from the count definition to the ratio of the total weight and unknown length (L).

$$\frac{30\,\text{grams}}{1000\,\text{meters}} = \frac{75\,\text{grams}}{L\,\text{meters}}$$

Step 4: Solve the proportion for L. To find L, we can cross-multiply and rearrange the equation:

$$30 \times L = 75 \times 1000$$
$$L = \frac{75 \times 1000}{30}$$

Step 5: Perform the calculation.

$$L = \frac{75000}{30}$$
$$L = \frac{7500}{3}$$
$$L = 2500\,\text{meters}$$

Conclusion: A 75-gram package of yarn with a count of 30 tex contains 2500 meters of yarn.

Quick Tip

The formula connecting Tex, weight, and length is:

$$\text{Length (m)} = \frac{\text{Weight (g)} \times 1000}{\text{Tex}}$$

Plugging in the values: Length $= \frac{75 \times 1000}{30} = 2500$ meters.
