CUET PG 2025 Forensic Science Question Paper with Solutions

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

General Instructions

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

1. What is the basic sequence of operation of the key /bar type writer?
A. The typist strikes the key on the keyboard
B. The ribbon transfers the impression to the sheet of paper behind it and the platen absorbs the force of the strike
C. As the key bar falls back into place, the carriage usually moves one unit to the next typing space and ribbon advances
D. The type block strikes the ribbon
E. Through mechanical linkage or electric triggering, a type bar is thrown up from the type basket towards the platen
(1) A, E, D, B, C
(2) C, A, D, E, B
(3) A, B, C, D, E
(4) C, E, A, B, D

Correct Answer: (1) A, E, D, B, C

Solution: The operation of a conventional key-bar typewriter is a chain of mechanical events that must occur in a precise order to produce a character on paper. Let's trace this sequence logically.
Step 1: Initiation. The entire process is initiated by the user's action.
A. The typist strikes the key on the keyboard. This is the starting point of the sequence.
Step 2: Actuation. The force from the key press is transmitted through a system of levers.
E. This mechanical linkage causes a specific type bar, which has the corresponding character mold at its tip, to swing up from its resting place in the semi-circular type basket and move towards the platen (the main rubber roller that holds the paper).
Step 3: Contact. The moving type bar must strike the ink source before it reaches the paper.
D. The character head, known as the type block, strikes the ink-infused ribbon that is positioned between the type bar and the paper.
Step 4: Impression. The force of the strike is transferred through the ribbon to the paper.
B. The inked ribbon is pressed against the paper, transferring the character's impression. The platen acts as a firm backing, absorbing the impact and allowing for a clear print.
Step 5: Reset and Advance. After the character is printed, the machine prepares for the next keystroke.
C. As the type bar falls back to the type basket, an escapement mechanism is triggered, moving the entire carriage (which holds the paper and platen) one space to the left. Simultaneously, the ribbon advances slightly to present a fresh, inked section for the next character.
This step-by-step mechanical progression confirms that the correct sequence is A, E, D, B, C.

Quick Tip

Think of the typewriter as a chain reaction. The typist's finger press is the trigger, leading to the type bar's movement, the strike through the ribbon, and finally the carriage advancing. Each step logically follows the previous one.

2. Which one of the following confirms the ante-mortem hanging?
(1) Dripping of Saliva
(2) Fracture of femur bone
(3) Post-mortem caloricity
(4) Presence of vomit

Correct Answer: (1) Dripping of Saliva

Solution: To confirm ante-mortem hanging (that the person was alive when hanged), forensic pathologists look for "vital reactions"—physiological responses that can only occur in a living body.
Step 1: Analyze the options for vital reactions.
(1) Dripping of Saliva: The production and secretion of saliva is an active physiological process controlled by the nervous system. In hanging, the pressure of the ligature on the neck can stimulate the submandibular salivary glands and associated nerves, leading to hyper-salivation. In a living person, this excess saliva will be expelled and will typically run down the chin and chest, often leaving a distinct, triangular stain. This is a classic vital reaction and a strong indicator of ante-mortem hanging.
(2) Fracture of femur bone: A fracture of the femur (thigh bone) is a significant injury typically caused by major trauma, such as a fall from a height or a severe impact. It is not a characteristic feature of hanging.
(3) Post-mortem caloricity: This is a rare phenomenon involving a rise in body temperature *after* death, often seen in cases of septicemia or sunstroke. As it is a post-mortem change, it cannot indicate an ante-mortem event.
(4) Presence of vomit: Vomiting can occur before death (agonal vomiting) or can be a result of post-mortem passive regurgitation of gastric contents due to pressure on the abdomen. Therefore, its presence is non-specific and not a reliable indicator of a vital reaction to hanging.
Step 2: Conclude. Among the choices provided, the dripping of saliva is the most specific and reliable sign of a vital reaction, strongly confirming that the hanging occurred while the individual was alive.

Quick Tip

In forensic pathology, distinguishing between ante-mortem (before death) and post-mortem (after death) injuries is crucial. Look for "vital signs" – evidence of the body's reaction to injury, such as inflammation, hemorrhage, or physiological responses like salivation.

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3. In death due to drowning, diatoms are found in which of these samples?
(1) Nails
(2) Hair
(3) Femur
(4) Fingerprints

Correct Answer: (3) Femur

Solution: The diatom test is a crucial forensic tool to differentiate between ante-mortem drowning (death occurred in water) and post-mortem immersion (body was dumped in water after death). The test relies on the presence of diatoms, which are microscopic, silica-shelled algae found in water.
Step 1: Understand the mechanism of diatom dissemination. For the test to be positive, a specific sequence of events must occur in a living person. As a drowning person gasps for breath, water enters their lungs. The pressure difference and damage to the delicate lung tissues (alveoli) allow the tiny, resilient diatoms to pass from the lungs into the bloodstream.
Step 2: Role of circulation. Since the person is alive, their heart is still beating and their circulatory system is functioning. The blood carries these diatoms from the lungs to all parts of the body, including distant, closed organs.
Step 3: Site of deposition. The diatoms are filtered from the blood and deposited in various tissues. Bone marrow, particularly from a large bone like the **femur** (thigh bone), is the ideal sample site. This is because the bone marrow is a closed, protected environment, which is highly unlikely to be contaminated by diatoms from the surrounding water after death.
Step 4: Evaluate other samples. Samples like nails and hair are external surfaces. They will inevitably be contaminated with diatoms from the water in which the body is found, regardless of whether the person drowned or was dumped. This makes them unreliable for the test. Fingerprints are patterns on the skin and are not a site of internal deposition. Therefore, finding diatoms within the sealed marrow of the femur provides strong evidence that they were transported there by a functioning circulatory system, confirming ante-mortem drowning.

Quick Tip

The key to the diatom test is circulation. Diatoms can only reach the bone marrow if the heart was actively pumping blood when the water was inhaled. This makes it a powerful test to differentiate true drowning from a body being dumped in water after death.

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4. Searching methods at the scene of a crime from the center of a circle to its radii is known as
(1) Spiral
(2) Wheel
(3) Grid
(4) Zone or Quad

Correct Answer: (2) Wheel

Solution: Crime scene search patterns are systematic, pre-planned methods used by investigators to ensure no area of a crime scene is left unexamined. Each pattern is suited for different types of scenes.
Step 1: Analyze the given description. The description "from the center of a circle to its radii" paints a clear picture: investigators begin at a central point and move outwards along straight lines, similar to the spokes radiating from the hub of a wheel.

Step 2: Compare the description with the defined search patterns.
(1) Spiral Search: In this method, the search starts either at the center and moves outwards in a widening circle (like a coiled rope unwinding) or at the perimeter and moves inwards in a tightening circle. This does not involve straight radii.
(2) Wheel Search (also known as Radial Search): This pattern perfectly matches the description. Several investigators start at a central point (the "hub") and walk in straight lines to the perimeter (the "rim"). It is effective in large, open outdoor scenes but can leave gaps between the "spokes."
(3) Grid Search: This is a very thorough method where the area is first searched in parallel lines in one direction (e.g., north to south), and then searched again in parallel lines at a 90-degree angle (e.g., east to west), creating a grid. It does not originate from a central point.
(4) Zone Search (or Quadrant Search): The crime scene is divided into smaller sections or zones (e.g., a room divided into four quadrants). Each zone is then searched individually, often by a different investigator.
Based on the description, the method is clearly a Wheel search.

Quick Tip

Visualize the search patterns: a spiral looks like a snail shell, a grid looks like a checkerboard, a zone is like cutting a cake into slices, and a wheel looks like the spokes of a bicycle. Associating the name with a visual makes them easy to remember.

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5. Who among the following is not associated in the process for exhumation of a dead body?
(1) District Magistrate
(2) Sub Divisional Magistrate
(3) Advocate General
(4) Judicial Magistrate

Correct Answer: (3) Advocate General

Solution: Exhumation is the legal process of disinterring a buried body for the purpose of a medico-legal investigation, typically to conduct a post-mortem examination when new evidence comes to light. This is a formal procedure governed by law.
Step 1: Understand the legal authority for exhumation. In India, the power to order an exhumation for the purpose of an inquest or investigation is vested in specific executive and judicial officers under the Code of Criminal Procedure (CrPC).
(1, 2, 4) District Magistrate, Sub Divisional Magistrate, Judicial Magistrate: These are all magistrates who hold executive or judicial authority. A District Magistrate or a Sub-Divisional Magistrate can order an exhumation under their powers of inquest. A Judicial Magistrate can also order an exhumation as part of an ongoing investigation if it is deemed necessary for the collection of evidence. The presence of a magistrate is required to lend legal sanctity to the procedure and ensure it is conducted properly.
(3) Advocate General: The Advocate General is the highest law officer of a state, appointed by the Governor. Their primary constitutional role is to provide legal advice to the state government and to represent the government in significant legal proceedings,

particularly in the High Court. The Advocate General's functions are primarily advisory and representational at a high level of government, and they are not involved in the direct, on-the-ground supervision or authorization of investigative procedures like exhumation.
Step 2: Conclude. Based on their defined legal roles, the magistrates are directly associated with the process of exhumation, whereas the Advocate General is not.

Quick Tip

Remember the separation of roles in the legal system. Magistrates (executive and judicial) have procedural and investigative authority. Law officers like the Advocate General are primarily involved in legal advice and representation at the governmental and high court level.

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6. The witness is first examined in the Hon'ble court by the side which has called him, the examination of such witness is known as
(1) Cross examination
(2) Re-examination
(3) Expert Opinion
(4) Examination-in-chief

Correct Answer: (4) Examination-in-chief

Solution: The examination of a witness in a court of law follows a structured, three-stage process, as defined in the Indian Evidence Act, 1872. The question describes the very first stage of this process.
Step 1: Define the stages of examination.
(4) Examination-in-chief: As per Section 137 of the Evidence Act, the examination of a witness by the party who calls him is called his examination-in-chief. The purpose of this stage is for the party to present the witness's testimony and evidence to the court in a structured manner, usually through non-leading questions. This perfectly matches the scenario in the question.
(1) Cross examination: Following the examination-in-chief, the opposing party (the adverse party) has the right to question the witness. The purpose of cross-examination is to test the accuracy and credibility of the testimony given in-chief and to elicit facts that may favor the opposing side.
(2) Re-examination: After the cross-examination is complete, the party who originally called the witness may conduct a re-examination. The purpose of this is to explain or clarify any matters that may have arisen during the cross-examination.
(3) Expert Opinion: This is a category of evidence, not a stage of witness examination. An expert witness would still undergo examination-in-chief, cross-examination, and re-examination.
Therefore, the initial examination of a witness by the side that called them is correctly termed the Examination-in-chief.

Quick Tip

The order is logical: 1. **Chief**: Your side presents its case. 2. **Cross**: The other side challenges it. 3. **Re**: Your side clarifies the challenges.

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7. A document compelling the attendance of a witness on a specific day and time in a court of law under penalty is?
(1) Oath
(2) Conduct money
(3) Subpoena
(4) Perjury

Correct Answer: (3) Subpoena

Solution: The question asks for the name of a formal legal document used to compel a witness to appear in court.
Step 1: Analyze the key functions described. The document must perform two main functions: it must legally "compel attendance" and it must be enforceable "under penalty" for non-compliance.
Step 2: Evaluate each option against these functions.
(1) Oath: An oath is a solemn promise, often invoking a divine witness, regarding one's future action or behavior. In court, a witness takes an oath to tell the truth. It is administered after the witness appears; it does not compel them to appear.
(2) Conduct money: This is a sum of money paid to a witness to cover their travel and other expenses for attending court. It is an allowance to facilitate their appearance, not a legal order to compel it.
(3) Subpoena: This is the correct term. A subpoena is a writ or an official order issued by a court of law that commands a person to appear in court to give testimony. The document explicitly states that failure to appear may subject the person to a penalty, such as a fine or imprisonment for contempt of court. It perfectly matches the description.
(4) Perjury: This is the criminal offense of willfully telling an untruth in a court after having taken an oath or affirmation. It is an act committed by a witness during testimony, not the document that summons them.
Therefore, the legal document that compels a witness's attendance under penalty is a Subpoena.

Quick Tip

Break down the word: "sub" (under) and "poena" (penalty). A subpoena is a document that places you "under penalty" if you fail to appear in court.

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8. When a dead body is exposed to freezing temperatures, cold stiffening of the body occurs due to solidification of:
(1) Proteins present in the body

(2) Carbohydrates present in the body
(3) Fats present in the body
(4) Minerals present in the body

Correct Answer: (3) Fats present in the body

Solution: The stiffening of a body found in extremely cold environments is a post-mortem change known as cold stiffening or frost rigor. It is important to distinguish this from the more common rigor mortis.
Step 1: Differentiate the mechanisms. Rigor mortis is a *chemical* process that occurs after death due to the depletion of ATP in muscle cells, causing muscle fibers to lock together. It occurs regardless of the ambient temperature. In contrast, cold stiffening is a purely *physical* process caused by the ambient temperature.
Step 2: Identify the cause of cold stiffening. When a body is exposed to temperatures at or below freezing (0°C or 32°F), the fluids within the body begin to freeze. The primary cause of the characteristic board-like hardness and rigidity is the freezing and solidification of subcutaneous (under the skin) and other bodily fats, as well as the freezing of synovial fluid within the joints. This physical hardening locks the limbs in place.
Step 3: Evaluate the options. While all cellular components, including proteins and carbohydrates, will freeze along with the water in the body, the solidification of the large deposits of fat and the freezing of joint fluids are the principal reasons for the profound stiffness observed. Therefore, among the given choices, the solidification of fats is the most accurate and primary cause. This process is reversed simply by thawing the body, whereas rigor mortis is broken by the onset of decomposition.

Quick Tip

Remember the difference: Rigor Mortis is *chemical* (ATP depletion) and disappears with decomposition. Cold Stiffening is *physical* (freezing of fats/fluids) and disappears upon thawing the body.

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9. Match the LIST-I (Evidence, etc.) with LIST-II (Example, Construction etc.)

LIST-I	**LIST-II**
A. Biological evidence	I. Cell phone records
B. Latent print evidence	II. Soil
C. Trace evidence	III. Fingerprints
D. Digital evidence	IV. Blood

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

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

Solution: This question requires matching different categories of forensic evidence with a specific example of each.

A. Biological evidence: This category includes any evidence that is derived from a living source, containing biological material. Examples include blood, semen, saliva, hair, and tissue. Therefore, **Blood (IV)** is a prime example of biological evidence. The match is **A-IV**.
B. Latent print evidence: The term "latent" means hidden or invisible. In forensics, it specifically refers to impressions, most commonly **fingerprints (III)**, that are left by the natural secretions of sweat and oil from the skin and are not readily visible to the naked eye. They must be developed using powders or chemical reagents. The match is **B-III**.
C. Trace evidence: This refers to physical evidence that is transferred in small, often microscopic, quantities during the commission of a crime, as described by Locard's Exchange Principle. Examples include fibers, paint chips, glass fragments, and **soil (II)**. The match is **C-II**.
D. Digital evidence: This is any probative information that is stored or transmitted in a digital or electronic format. This includes data from computers, storage devices, networks, and mobile phones. **Cell phone records (I)**, including call logs, messages, and location data, are a critical form of digital evidence. The match is **D-I**.
Combining these pairings gives the sequence A-IV, B-III, C-II, D-I.

Quick Tip

Associate keywords: Biological = Body fluids/tissues; Latent = Hidden (Fingerprints); Trace = Transferred in small amounts (hair, soil, fiber); Digital = Electronic devices.

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10. Arrange the working of photo offset machine in the correct sequence.
A. The plate is placed into the printing press.
B. The ink is then transferred to a setting (soft) roller which will come into contact with paper and print.
C. The ink is received by the image on the plate and is rejected in the non exposed areas that receive water.
D. An electrostatic image of the document is transferred to a specially treated plate, then the plate is preserved through a process of heating and the application of chemicals.
(1) A, B, C, D
(2) D, A, C, B
(3) D, C, B, A
(4) C, B, D, A

Correct Answer: (2) D, A, C, B

Solution: Photo offset lithography is a common printing technique that works on the principle that oil (ink) and water do not mix. Let's arrange the steps in their logical operational sequence.
Step 1: Plate Making. Before any printing can occur, the master image must be created on a printing plate.
D. An electrostatic or photographic image of the document is transferred onto a specially treated plate. The image area is made oleophilic (ink-receptive) and the non-image area is made hydrophilic (water-receptive). This is the plate creation stage.

Step 2: Press Setup. Once the plate is ready, it must be installed in the printing press.
A. The finished plate is mounted onto the plate cylinder inside the printing press.
Step 3: Plate Inking. Inside the press, the plate is prepared to carry the inked image.
C. The plate cylinder is first dampened with water by dampening rollers. The water adheres only to the non-image areas. Then, inking rollers apply oil-based ink, which is repelled by the wet areas and adheres only to the image area.
Step 4: The Offset Transfer. The defining feature of offset printing is the indirect transfer of the image.
B. The inked image from the plate cylinder is not directly transferred to the paper. Instead, it is first transferred, or "offset," onto a rubber blanket cylinder (the soft roller). This rubber blanket then presses the final, clear image onto the paper.
The correct operational sequence is therefore D $\rightarrow$ A $\rightarrow$ C $\rightarrow$ B.

Quick Tip

The key to "offset" printing is that the ink is not directly applied to the paper from the plate. It is first "offset" onto a rubber blanket/roller. The sequence is always: Create Plate $\rightarrow$ Install Plate $\rightarrow$ Ink Plate $\rightarrow$ Transfer (Offset) to Paper.

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11. The genetic constitution of the combined paternal and maternal DNA responsible for producing the different ABO blood groups is referred as:
(1) Phenotype
(2) Genotype
(3) Multiple genes
(4) Pseudo genes

Correct Answer: (2) Genotype

Solution: This question asks for the correct biological term for an organism's underlying genetic code for a specific trait.
Step 1: Define the key genetic terms.
(2) Genotype: This term refers to the specific combination of alleles (gene variants) that an individual inherits from their parents for a particular gene. In the case of the ABO blood group, a person's genotype would be the pair of alleles they possess, such as I^AI^A, I^Ai, I^BI^B, I^Bi, I^AI^B, or ii. The question's phrase "genetic constitution" is a direct definition of genotype.
(1) Phenotype: This term refers to the observable physical or biochemical characteristic that results from the genotype. For the ABO system, the phenotype is the actual blood group, such as Type A, Type B, Type AB, or Type O. The genotype determines the phenotype.
(3) Multiple genes: This describes polygenic inheritance, where a trait is controlled by two or more genes. The basic ABO blood group is determined by a single gene, although it has multiple alleles.
(4) Pseudo genes: These are non-functional remnants of genes that have lost their ability to be expressed.
Step 2: Conclude. The term that describes the "genetic constitution" or the specific set of alleles responsible for a trait is the genotype.

Quick Tip

Remember: **Gen**otype is the **gen**etic code. **Ph**enotype is the **ph**ysical appearance or observable trait.

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12. The investigation of a crime scene is carried out in the following sequence.
A. Reconstruction of crime
B. Crime scene management
C. First officer response
D. Information of crime
(1) D, C, B, A
(2) B, C, D, A
(3) D, A, C, B
(4) C, A, B, D

Correct Answer: (1) D, C, B, A

Solution: A professional and effective crime scene investigation proceeds through a series of logical and sequential phases, from the initial report to the final analysis.
Step 1: The Trigger. No investigation can begin until the authorities are aware of a potential crime.
D. Information of crime: This is the starting point, where a citizen or a monitoring system reports an incident to the police.
Step 2: Initial Response and Scene Security. The actions of the first officer at the scene are critical for the integrity of the entire investigation.
C. First officer response: The first responding officer has the responsibility to render medical aid, apprehend any suspects present, secure the crime scene by establishing a perimeter, and prevent the destruction or contamination of evidence.
Step 3: Systematic Processing. Once the scene is secure, the dedicated crime scene investigation team takes over.
B. Crime scene management: This is the detailed and systematic phase which includes interviewing witnesses, documenting the scene through notes, sketches, and photography, searching for evidence using appropriate patterns, and properly collecting and packaging all physical evidence.
Step 4: Synthesis and Analysis. After the on-site work is complete and all evidence has been analyzed, the final intellectual stage begins.
A. Reconstruction of crime: This is an analytical process where investigators use the physical evidence, witness statements, and logical reasoning to develop a likely sequence of events that occurred at the crime scene. It is the culmination of all the previous steps.
The correct chronological and procedural sequence is D $\rightarrow$ C $\rightarrow$ B $\rightarrow$ A.

Quick Tip

Think of it like a story: 1. The event happens (Information). 2. The first character arrives (First Responder). 3. The plot is investigated and clues are gathered (Management/Processing). 4. The mystery is solved (Reconstruction).

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13. The term Criminalistics was first coined by:
(1) Edmund Locard
(2) Paul Kirk
(3) Alphose Bertillon
(4) Henry Fanids (likely a misspelling of Hans Gross)

Correct Answer: (4) Based on historical context, the intended answer is Hans Gross. Paul Kirk popularized the term in English.

Solution: The question asks about the origin of the term "Criminalistics," which refers to the application of scientific techniques in the collection and analysis of physical evidence in criminal cases.
Step 1: Analyze the historical origin of the concept and term.
The idea of systematically applying science to legal investigations was consolidated and given a name in the late 19th century.
(4) Hans Gross: An Austrian judge and legal scholar, Hans Gross is widely regarded as the "Father of Criminalistics." In 1893, he published his seminal work, "Handbuch für Untersuchungsrichter als System der Kriminalistik" (Handbook for Examining Magistrates as a System of Criminalistics). In this book, he first coined the term "Kriminalistik" to describe the holistic, scientific approach to crime solving, integrating fields like chemistry, physics, and botany with logic and psychology. The name "Henry Fanids" in the option is a clear typographical error for Hans Gross.
Step 2: Evaluate the other pioneers.
(1) Edmund Locard: A French forensic science pioneer, famous for his Exchange Principle ("Every contact leaves a trace") and for establishing the first police crime laboratory. He was a practitioner who built upon Gross's ideas.
(2) Paul Kirk: A leading American criminalist of the 20th century. While he did not coin the original term, he was instrumental in defining and popularizing "Criminalistics" in the English-speaking world, famously describing it as "the science of individualization."
(3) Alphonse Bertillon: A French police officer who developed "Bertillonage" or anthropometry, an early system of personal identification based on body measurements.
Conclusion: Acknowledging the typo in the option, Hans Gross is the historical figure credited with first coining the term that would become Criminalistics.

Quick Tip

Remember Hans Gross as the "grandfather" of the field who first named it "Kriminalistik." Paul Kirk was a key figure in modernizing and defining "Criminalistics" in the English-speaking world.

14. Arrange the following in the correct sequence followed in Ultra Performance Liquid Chromatography.
A. Mobile phase reservoir
B. Guard column
C. Separation column
D. Detector
(1) A, B, C, D
(2) A, B, D, C
(3) B, A, D, C
(4) C, B, D, A

Correct Answer: (1) A, B, C, D

Solution: Ultra Performance Liquid Chromatography (UPLC), like other forms of liquid chromatography, is an analytical technique used to separate, identify, and quantify components in a mixture. The components of the instrument are arranged sequentially along the flow path of the solvent (mobile phase).
Step 1: Origin of the Mobile Phase. The process must start with the liquid that will carry the sample through the system.
A. Mobile phase reservoir: This is the container (usually a specialized bottle) that holds the solvent or solvent mixture (the mobile phase). A high-pressure pump draws the solvent from this reservoir.
Step 2: Column Protection. Before the sample reaches the expensive main analytical column, it often passes through a protective filter.
B. Guard column: This is a small, short column filled with a similar packing material as the main column. It is placed just before the separation column to trap any particulate matter or strongly retained impurities from the sample or solvent, thereby protecting the main column and extending its life.
Step 3: The Separation Process. This is the core of the instrument where the chemical separation takes place.
C. Separation column (or analytical column): This is the long, narrow tube packed with the stationary phase. As the mobile phase carries the sample through this column, the different components of the sample interact with the stationary phase to varying degrees, causing them to separate and exit the column at different times.
Step 4: Detection of Results. After the components are separated, their presence must be detected and recorded.
D. Detector: This is an electronic device located at the end of the column. It measures a physical property of the eluting components (e.g., UV absorbance, fluorescence) and generates an electrical signal that is proportional to the amount of each component. This signal is sent to a computer to generate a chromatogram.
The correct sequence following the fluid's path is A $\rightarrow$ B $\rightarrow$ C $\rightarrow$ D.

Quick Tip

Think of it like a train journey. The mobile phase is the train. It starts at the station (**Reservoir**), goes through a security check (**Guard Column**), travels the main route where passengers get off at different stops (**Separation Column**), and finally, the arrival of each passenger group is noted at the destination (**Detector**).

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15. What are the precautions taken during fingerprint photography?
A. The camera should be parallel to the fingerprint
B. The scale is to be used with the fingerprint for photography
C. The arranegnear light should be even on the fingerprint
D. Generally, ultra slow shutter speed is not preferable for fingerprint photography.
(1) A and B only
(2) B and D only
(3) A and D only
(4) B and C only

Correct Answer: (1) A and B only

Solution: Forensic photography of fingerprints requires adherence to strict protocols to ensure the images are accurate, undistorted, and suitable for comparison and use as evidence in court.
Step 1: Evaluate each stated precaution.
A. The camera should be parallel to the fingerprint: This is a critical and non-negotiable precaution. The camera's sensor plane must be parallel to the surface bearing the fingerprint. This ensures that the image is captured without any perspective distortion, preserving the true shape, size, and spatial relationships of the ridge details.
B. The scale is to be used with the fingerprint for photography: This is also a fundamental requirement. An L-shaped or linear scale must be placed on the same plane as the fingerprint and included in the photograph. This allows an examiner to accurately calibrate the image and print it at a true 1:1 (life-size) ratio, which is essential for comparison with known prints.
C. The arranegnear light should be even on the fingerprint: The word "arranegnear" is likely a typo. The principle of lighting for fingerprints is not necessarily "even" light from the front, which can wash out details. The best practice is often to use oblique or low-angle lighting from the side, which creates shadows and highlights that enhance the contrast and visibility of the fine ridge detail. Therefore, this statement is not universally correct.
D. Generally, ultra slow shutter speed is not preferable: This statement is a guideline for hand-held photography to avoid camera shake. However, proper forensic photography should be done with the camera mounted on a tripod. With a tripod, a slow shutter speed is perfectly acceptable and often necessary to achieve a small aperture (for greater depth of field) and low ISO (for less noise). Thus, this is not a fundamental precaution in the same way as A and B.
Step 2: Conclude. Statements A and B represent the two most essential and universally required precautions for producing admissible and usable forensic fingerprint photographs.

Quick Tip

For any forensic photography, remember two key rules: 1. No distortion: Keep the camera parallel to the evidence. 2. Record size: Always include a scale in the picture.

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16. Arrange the following in correct steps for collection of tool marks from the crime scene.

A. Trace evidence associated with tool marks should be prevented from loss or contamination
B. Marks on metal should be covered with oil to prevent oxidation
C. Cast of tool marks should be prepared to take impression or the whole object to be transported to the crime lab
D. Close-up photography
(1) A, D, C, B
(2) D, A, B, C
(3) C, B, D, A
(4) A, C, B, D

Correct Answer: The provided options appear to be flawed as they do not represent the standard forensic procedure. The correct sequence of actions is D $\rightarrow$ A $\rightarrow$ C $\rightarrow$ B.

Solution: The proper collection of tool mark evidence follows a specific sequence designed to maximize information recovery and prevent contamination or destruction of the evidence. The cardinal rule is to document before collecting.
Step 1: Initial Documentation. The first action upon discovering a tool mark is to document it in its original, untouched state.
D. Close-up photography: The tool mark must be photographed in detail. This should include overall shots to show its location, and close-up shots with a scale placed on the same plane as the mark to record its true size.
Step 2: Collection of Fragile Evidence. Before any attempt is made to collect the tool mark itself, any associated fragile trace evidence must be secured.
A. Trace evidence associated with tool marks should be prevented from loss or contamination: This involves carefully searching for and collecting any paint chips, metal shavings, fibers, or other microscopic evidence that may have been transferred from the tool to the surface or vice versa.
Step 3: Collection of the Tool Mark. The next step is to collect the actual tool mark.
C. Cast of tool marks should be prepared... or the whole object to be transported to the crime lab: The best practice is always to collect the entire object bearing the mark (e.g., the doorframe, the lock). If this is impossible, a cast of the mark should be made using a specialized material like Mikrosil.
Step 4: Preservation of Collected Evidence. After the primary evidence is collected, it must be properly preserved for transport.
B. Marks on metal should be covered with oil to prevent oxidation: This is a preservation step for a metal item that has been collected. It is done *after* photography and casting to prevent rust from forming and degrading the mark. Oiling a mark *before* casting would ruin the cast.

Conclusion: The correct forensic sequence is Photography (D), then collection of Trace Evidence (A), then collection of the Mark/Object (C), and finally Preservation (B). None of the provided options (1, 2, 3, 4) match this correct D $\rightarrow$ A $\rightarrow$ C $\rightarrow$ B procedure. The question or options are likely flawed.

Quick Tip

The universal rule for evidence collection is: **Document, then Collect.** First photograph and sketch. Then, collect the most fragile evidence (trace) before moving on to collecting the main item or making casts. Preservation of the collected item is the final step.

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17. The Bureau of Police Research and Development (BPR&D) is an agency functioning under:
(1) State Government
(2) Central Government
(3) Interpol
(4) United Nations (UN)

Correct Answer: (2) Central Government

Solution: Step 1: Identify the scope and function of BPR&D. The Bureau of Police Research and Development (BPR&D) is the national-level 'think tank' for all police forces in India. Its mandate includes promoting research in policing, driving the modernization of police forces, setting standards for training, and developing new technologies and methodologies for crime prevention and investigation. Its work is applicable to and intended to benefit the police forces of all states and union territories.
Step 2: Determine its administrative authority. An organization with such a national scope, tasked with standardizing and improving policing across the entire country, must logically fall under the federal or central authority responsible for internal security. In India's governmental structure, this is the Ministry of Home Affairs (MHA).
Step 3: Conclude the governing body. The Ministry of Home Affairs is a key ministry of the **Central Government** of India. Therefore, the BPR&D is an agency that functions directly under the Central Government. It is not a state-level body, nor is it an international organization like Interpol or the UN.

Quick Tip

National-level research, development, and standard-setting bodies for internal security (like police and paramilitary forces) in India typically fall under the Ministry of Home Affairs, which is part of the Central Government.

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18. Non identity of questioned writings can be established by comparing it with known writings, if:

A. A known and questioned writings have a considerable number of general similarities that outnumber a few fundamental repeated differences.
B. The presence of a combination of identifying attributes and a coexistent lack of basic divergences between questioned and known writings.
C. The presence of a combination of identifying attributes and coexistence of a few basic divergences between questioned and known writings.
D. If known and questioned writings are very much alike but not identical.
(1) A, B and C only
(2) B, C and D only
(3) A, C and D only
(4) A, B and D only

Correct Answer: Statement A is the only one that correctly describes the principle of establishing non-identity. The provided options appear to be flawed.

Solution: This question tests the fundamental principles of forensic handwriting examination, specifically how an expert concludes that two documents were written by different people (non-identity).
Step 1: Understand the core principles of handwriting comparison.

- **To establish identity** (same writer), there must be a significant combination of unique, identifying characteristics in both the questioned and known writings, with an absence of any fundamental, unexplainable differences. Natural variation is always expected.
- **To establish non-identity** (different writers), there must be one or more fundamental, repeated, and unexplainable differences between the writings, even if there are many superficial similarities.

Step 2: Evaluate each statement against these principles.
A. "...a few fundamental repeated differences." This is the key phrase. The presence of such differences, even when outnumbered by similarities (which could be coincidental or due to imitation), is the basis for concluding **non-identity**. This statement is correct.
B. "...a lack of basic divergences." This is a condition for establishing **identity**. This statement is incorrect for proving non-identity.
C. "...coexistence of a few basic divergences." This phrasing is ambiguous but typically, "a few basic divergences" is interpreted as the natural variation expected within a single person's writing. This is a condition for establishing **identity**. This statement is incorrect for proving non-identity.
D. "...very much alike but not identical." This is the definition of genuine writing by the same person. No two signatures from the same person are ever perfectly identical; they are just very similar. This is a condition for establishing **identity**. This statement is incorrect for proving non-identity.
Conclusion: Only statement A correctly describes a condition for establishing non-identity. Statements B, C, and D all describe conditions that point towards identity. Since the provided options require selecting multiple statements, and only one is correct for the question asked, the question and its options are fundamentally flawed based on accepted forensic principles.

Quick Tip

In handwriting analysis, **differences are more significant than similarities**. A single, repeated, fundamental difference is enough to conclude non-identity. Similarities can be coincidental or imitated, but it's nearly impossible for a person to have fundamental differences from their own natural writing.

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19. The full form of CBI is?
(1) Criminal Bureau of Investigation
(2) Central Bureau of Investigation
(3) Civil Bureau of Investigation
(4) Criminal Base of Investigators

Correct Answer: (2) Central Bureau of Investigation

Solution: Step 1: Identify the organization. The question asks for the full name of the prominent national-level investigative agency of India, commonly known by the acronym CBI.
Step 2: State the full form. The correct and official full form of CBI is the **Central Bureau of Investigation**. It functions as the primary investigating agency of the Central Government of India and is often called upon to investigate high-profile cases, matters of corruption involving public officials, and serious crimes with inter-state or international implications.
Step 3: Compare with the given options. Option (2) exactly matches the correct name. The other options use incorrect words like "Criminal," "Civil," or "Base," which are not part of the official title.

Quick Tip

The "C" in CBI stands for "Central," reflecting its role as a national investigative agency for the central government of India, as opposed to state-level police forces.

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20. Which of the following is not a factor in Daubert Standard?
(1) Whether the theory or technique can be tested
(2) Whether the expert is Internationally certified
(3) Whether the methodology has been peer reviewed
(4) Known or potential error rate of the method

Correct Answer: (2) Whether the expert is Internationally certified

Solution: The Daubert Standard originated from the 1993 U.S. Supreme Court case *Daubert v. Merrell Dow Pharmaceuticals*. It established a set of criteria for federal judges to use when determining the admissibility of scientific expert testimony. The standard focuses on the reliability and validity of the scientific *methodology*, not the personal credentials of the expert.
Step 1: Recall the primary factors of the Daubert Standard. The court outlined a non-exhaustive list of factors to guide the judge's assessment:

- **Testability:** Can the scientific theory or technique be empirically tested and potentially falsified? (This matches option 1).
- **Peer Review and Publication:** Has the theory or technique been subjected to scrutiny by other experts in the field and published in peer-reviewed scientific journals? (This matches option 3).
- **Error Rate:** Does the technique have a known or potential rate of error, and are there standards controlling its operation? (This matches option 4).
- **General Acceptance:** Is the technique generally accepted within the relevant scientific community? (This was the main criterion of the older Frye standard, which Daubert incorporated as one of several factors).

Step 2: Evaluate the option that does not fit.

(2) Whether the expert is Internationally certified: This is not a Daubert factor. While a judge will consider an expert's qualifications (education, experience, certifications) to determine if they are qualified to be an expert in the first place, the Daubert standard itself is applied to their *methodology*. A highly certified expert using an unreliable method would fail the Daubert test, while a qualified but uncertified expert using a reliable method could pass. The focus is on the science, not the certification.

Quick Tip

Remember the Daubert Standard focuses on the **science**, not the **scientist**. It asks: Is the *method* testable, peer-reviewed, with a known error rate, and generally accepted? It does not ask if the *person* has a specific certificate.

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21. Match the LIST-I with LIST-II

LIST-I	LIST-II
A. Calvin Goddard	I. Forensic Toxicology
B. Karl Landsteiner	II. Forensic Ballistics
C. Albert Osborn	III. Blood Grouping
D. Mathieu Orfila	IV. Document examination

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

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

Solution: This question requires matching key historical figures with their pioneering contributions to various fields of forensic science.

A. Calvin Goddard: A former U.S. Army physician, Goddard is considered the father of modern forensic ballistics. He was a key figure in establishing the use of the comparison microscope to determine if a specific firearm fired a particular bullet, a technique that remains fundamental to the field today. So, **A matches with II. Forensic Ballistics**.

B. Karl Landsteiner: An Austrian biologist and physician, Landsteiner's discovery of the main blood groups—A, B, and O—in 1901 was a monumental achievement. It revolutionized

blood transfusion safety and provided a scientific basis for using blood types as evidence in criminal and paternity cases. So, **B matches with III. Blood Grouping**.
C. Albert S. Osborn: An American pioneer in the field, Osborn is regarded as the father of the science of questioned document examination in North America. His 1910 book, "Questioned Documents," remains a foundational text, and he was instrumental in getting courts to accept the testimony of handwriting experts. So, **C matches with IV. Document examination**.
D. Mathieu Orfila: A Spanish-born French toxicologist and chemist, Orfila is celebrated as the father of modern toxicology. In the early 19th century, he was the first to use a systematic scientific approach to the study of poisons and their effects on animals, which he detailed in his "Traité des poisons." So, **D matches with I. Forensic Toxicology**.
The correct set of matches is A-II, B-III, C-IV, D-I.

Quick Tip

Associate names with keywords: **Goddard** = Guns (Ballistics); **Landsteiner** = Land of blood (Blood grouping); **Osborn** = Old documents (Document examination); **Orfila** = Awful poison (Toxicology).

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22. Which of the following properties of the glass plays a key role in the Beckline method?
(1) Melting point
(2) Type of fracture
(3) Refractive Index
(4) It's manufacturing

Correct Answer: (3) Refractive Index

Solution: Step 1: Understand the purpose of the Becke Line Method. The Becke line method is a microscopic technique used in forensic science and geology to determine the refractive index (R.I.) of a small, transparent particle, such as a glass fragment. The refractive index is a measure of how much light bends, or refracts, when it passes through a substance. It is a key physical property used to compare and characterize glass samples.
Step 2: Describe the principle of the method. The method involves immersing the glass fragment in a liquid of a known refractive index on a microscope slide. Due to the difference in the R.I. between the glass and the liquid, a bright halo of light, called the "Becke line," appears at the boundary of the fragment. An optical principle dictates that when the microscope's focus is raised, this Becke line will move into the medium with the higher refractive index. An analyst systematically changes the immersion liquid until one is found where the Becke line disappears. This "match point" indicates that the refractive index of the glass is the same as that of the liquid.
Step 3: Conclude the key property. Since the entire procedure—the appearance, movement, and disappearance of the Becke line—is a direct consequence of the difference in the bending of light between the sample and the surrounding medium, the **Refractive Index** is the fundamental property being measured and utilized. The other properties listed, such as melting point or fracture type, are not relevant to this specific optical test.

Quick Tip

The Becke line method is all about matching the **refractive index** of a glass fragment to that of a series of calibrated liquids. When the "halo" (Becke line) disappears, you've found the match.

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23. The Government of India Printing press to print banknotes in India is located at?
(1) Chennai
(2) Nasik
(3) New Delhi
(4) Kolkata

Correct Answer: (2) Nasik

Solution: Step 1: Identify the authorities responsible for printing banknotes in India. The printing of Indian currency is a high-security process managed by two entities. The first is the Security Printing and Minting Corporation of India Limited (SPMCIL), a wholly-owned company of the Government of India. The second is the Bharatiya Reserve Bank Note Mudran Private Limited (BRBNMPL), a wholly-owned subsidiary of the Reserve Bank of India.
Step 2: Locate the four currency printing presses in India. These two entities operate a total of four currency presses in the country:

- Currency Note Press located in **Nashik**, Maharashtra (operated by SPMCIL).
- Bank Note Press located in Dewas, Madhya Pradesh (operated by SPMCIL).
- A press located in Mysuru, Karnataka (operated by BRBNMPL).
- A press located in Salboni, West Bengal (operated by BRBNMPL).

Step 3: Compare the locations with the given options. From the list of official printing press locations, the only city that appears in the options is Nashik. The other cities listed—Chennai, New Delhi, and Kolkata—do not have currency printing presses.

Quick Tip

Remember the two main government-run banknote presses are in **Nashik** (Maharashtra) and **Dewas** (Madhya Pradesh). The other two are managed by the RBI.

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24. Which of the following can be classified by Henry's system of classification?
(1) Questioned documents
(2) Digital evidences
(3) Poisons
(4) Fingerprints

Correct Answer: (4) Fingerprints

Solution: Step 1: Identify the Henry Classification System. The Henry Classification System is a historic and highly influential method for organizing and filing ten-print fingerprint cards. It was developed at the end of the 19th century by Sir Edward Henry, then the Inspector General of Police in Bengal, India, with the assistance of his subordinates Azizul Haque and Hemchandra Bose.
Step 2: Understand its purpose and methodology. Before the advent of computerized databases (like AFIS), law enforcement agencies faced the monumental task of manually searching through vast collections of fingerprint cards to find a match. The Henry system provided a solution by creating a formula-based classification. It assigned a numerical value to each of the ten fingers based on the presence or absence of a whorl pattern. This generated a primary classification fraction that allowed the cards to be filed and retrieved in a systematic manner.
Step 3: Evaluate the options. The system's methodology, based on fingerprint pattern types like whorls, loops, and arches, is exclusively designed for the classification of **fingerprints**. It has no applicability to the analysis of questioned documents, the retrieval of digital evidence, or the categorization of poisons.

Quick Tip

The Henry Classification System is one of the most famous historical methods associated with a specific type of forensic evidence: **fingerprints**.

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25. A DNA Expert in a forensic science laboratory confirms:
A. Toxin in exhibit
B. Age of individual
C. Identity of an individual
D. Gender of an individual
E. Height of an individual
(1) A, B and E
(2) B, C and E
(3) B, C and D
(4) A, C and E

Correct Answer: An option with C and D is the most accurate. The options provided seem flawed. The closest correct choice would be one containing C and D.

Solution: This question asks what can be reliably determined from a standard forensic DNA analysis (profiling) of a biological sample.
A. Toxin in exhibit: This is incorrect. The presence of toxins or poisons is determined through chemical analysis in a toxicology laboratory, not by DNA analysis.
B. Age of individual: This is incorrect. Standard forensic DNA profiling, which uses Short Tandem Repeats (STRs), cannot determine a person's chronological age. While advanced research in forensic epigenetics is developing methods to estimate age from DNA methylation patterns, this is not a routine or confirmatory test in a standard forensic lab.

C. Identity of an individual: This is correct and is the primary purpose of forensic DNA profiling. By comparing the DNA profile from a crime scene sample to the profile from a known individual (suspect or victim), an expert can establish a match or an exclusion, thereby confirming identity to a very high degree of statistical probability.
D. Gender of an individual: This is correct. Standard DNA profiling kits include a marker called Amelogenin, which is found on both the X and Y chromosomes but differs slightly in size. By analyzing this marker, an expert can determine if the DNA came from a male (XY) or a female (XX).
E. Height of an individual: This is incorrect. Height is a complex polygenic trait influenced by many genes and environmental factors. It cannot be determined from a standard forensic DNA profile.
Conclusion: A DNA expert can routinely confirm the identity (C) and gender (D) of an individual. None of the provided options accurately reflect this correct combination (C and D). Option (3) includes Age (B), which is not a standard confirmation. The question or its options are flawed.

Quick Tip

Remember, standard forensic DNA profiling answers two main questions: **"Who is it?"** (Identity) and **"Is it male or female?"** (Gender). It doesn't tell you age, height, or what substances they've ingested.

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26. Match the LIST-I with LIST-II

LIST-I	LIST-II
A. Ridges	I. Two most inner ridges which start parallel, diverge and surround or tend to surround the pattern area
B. Type Lines	II. A single ridge bifurcates and reunites to enclose some space
C. Delta	III. The raised portion of the friction skin of the fingers
D. Enclosure	IV. The ridge characteristics nearest to the point of divergence of type lines

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

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

Solution: This question requires matching key terminologies used in fingerprint analysis with their correct definitions.
A. Ridges: These are the most basic and fundamental components of a fingerprint. They are the raised, hill-like portions of the friction skin on the fingers, palms, and soles. The patterns and details within these ridges are what make fingerprints unique. So, **A matches with III**.

B. Type Lines: These are two specific ridges that are crucial for defining the boundaries of a fingerprint pattern (specifically loops and whorls). They start as parallel ridges, diverge, and flow around the central pattern area. They are the starting point for locating the delta. So, **B matches with I**.
C. Delta: This is a specific feature found in loop and whorl patterns. It is a triangular point (resembling the Greek letter delta, Δ) which is located at or directly in front of the point where the type lines diverge. It is a key landmark for fingerprint classification and ridge counting. So, **C matches with IV**.
D. Enclosure (also known as a Lake): This is one of the many types of minutiae or ridge characteristics. It is formed when a single friction ridge splits (bifurcates) into two ridges and then, after a short distance, these two ridges rejoin to form a single ridge again, enclosing a small space. So, **D matches with II**.
The correct set of matches is therefore A-III, B-I, C-IV, D-II.

Quick Tip

Visualize the fingerprint pattern: **Ridges** are the hills. **Type Lines** are the diverging highways around the main pattern. The **Delta** is the triangular interchange where the highways split. An **Enclosure** is a small traffic island where a road splits and rejoins.

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27. For voice analysis, the exhibits are forwarded to _____ division of the Forensic Science Laboratory.
(1) Chemistry
(2) Physics
(3) Ballistics
(4) Documents

Correct Answer: (2) Physics

Solution: Step 1: Understand the nature of voice evidence. A voice is a complex sound produced by a human. Sound itself is a physical phenomenon—it is a wave that propagates through a medium like air. Forensic voice analysis, also known as forensic phonetics or speaker identification, involves examining the physical properties of these sound waves to compare a questioned voice recording with a known voice sample.
Step 2: Relate voice analysis to a scientific discipline. The scientific analysis of a voice involves measuring its physical characteristics, such as:

- Fundamental frequency (pitch)
- Amplitude (loudness)
- Formants (resonant frequencies of the vocal tract)
- Speech rate and timing

The study of sound, waves, and their physical properties is a core part of the science of **Physics**, specifically the sub-field of acoustics.

Step 3: Determine the appropriate laboratory division. Forensic Science Laboratories are organized into specialized divisions based on scientific disciplines. The Chemistry division handles drugs and chemicals. The Ballistics division handles firearms and ammunition. The Documents division handles handwriting and printed materials. The **Physics** division is the logical place for evidence that requires analysis of its physical properties, such as tool marks, glass fractures, and sound/voice recordings.

> Quick Tip
>
> Think about the fundamental nature of the evidence. A voice is sound, and sound is a physical wave. Therefore, voice analysis belongs to the **Physics** division.

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28. Which of the following statements correctly explains the relationship between force and momentum?
(1) The rate of change of momentum of a body is directly proportional to the applied force and occurs in the direction of the force.
(2) The rate of change of momentum of a body is inversely proportional to the applied force and always oppose the direction of the force.
(3) The rate of change of momentum of a body is proportional to the square of the applied force and takes place in the direction opposite to the force.
(4) The rate of change of momentum of a body is independent of the applied force but depends on the direction of motion of the body.

Correct Answer: (1) The rate of change of momentum of a body is directly proportional to the applied force and occurs in the direction of the force.

Solution: This question is asking for a correct statement of Newton's Second Law of Motion, which provides the fundamental definition of force.
Step 1: State Newton's Second Law in its complete form. In classical mechanics, Newton's Second Law is most accurately stated as: "The net force acting on an object is equal to the time rate of change of its momentum." This is expressed mathematically as $F = \frac{dp}{dt}$ or $F = \frac{\Delta p}{\Delta t}$, where F is the net force, p is the momentum, and t is time.
Step 2: Analyze the mathematical and conceptual relationship.

- The equation shows that the net force (F) is **directly proportional** to the rate of change of momentum ($\frac{\Delta p}{\Delta t}$). This means if you double the force, you double the rate at which the momentum changes.
- Force and momentum are both vector quantities, meaning they have both magnitude and direction. The law specifies that the change in momentum occurs in the **same direction** as the net applied force.

Step 3: Evaluate the options against this law.
- **Option (1):** States that the rate of change of momentum is "directly proportional to the applied force and occurs in the direction of the force." This is a perfect and accurate description of Newton's Second Law.

- **Option (2):** Incorrectly states the relationship is "inversely proportional" and the direction is opposite.
- **Option (3):** Incorrectly states the relationship is "proportional to the square" and the direction is opposite.
- **Option (4):** Incorrectly states that the change in momentum is "independent" of the applied force.
Therefore, option (1) is the only correct statement.

Quick Tip

Newton's Second Law is often simplified to $F = ma$, but its more fundamental and complete definition is in terms of momentum: Force is the rate of change of momentum ($F = \frac{\Delta p}{\Delta t}$).

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29. While casting a footwear print on sand, which of the following should be used prior to casting?
(1) Melted candle wax
(2) Shellac in alcohol spray
(3) Shellac in water spray
(4) Talcum powder

Correct Answer: (2) Shellac in alcohol spray

Solution: Step 1: Identify the challenge. Casting an impression in a loose, friable substrate like dry sand presents a significant challenge. The weight and moisture of the casting material (like dental stone or Plaster of Paris) can easily cause the delicate details of the impression to collapse and be destroyed. Therefore, the impression must first be stabilized with a fixative.
Step 2: Determine the properties of a suitable fixative. A good fixative for this purpose should be applied as a fine mist to avoid disturbing the sand particles. It needs to dry or set quickly, forming a thin, hard crust that will support the casting material without obscuring the details of the print.
Step 3: Evaluate the given options.
(1) Melted candle wax: This is unsuitable. It is too hot, which could alter the print, and its weight and viscosity would destroy the delicate details upon application.
(2) Shellac in alcohol spray: This is a standard and effective method. Shellac is a resin that dries into a hard film. Alcohol is used as the solvent because it evaporates very quickly. When sprayed as a fine mist from a distance, the alcohol flashes off, leaving the shellac to bind the sand particles together, thus "fixing" the impression. Hairspray is often used for the same reason.
(3) Shellac in water spray: This is unsuitable. Water evaporates slowly and would cause the sand particles to clump together, destroying the fine details of the impression before it could be stabilized.
(4) Talcum powder: This is not a fixative. It is sometimes used to lightly dust a print to enhance contrast for photography, but it would not provide any structural support for casting.

Conclusion: The correct preparatory step is to use a fast-drying fixative like shellac in alcohol spray to stabilize the impression.

Quick Tip

For delicate impressions in loose soil or sand, always think "fix before you cast." A fine aerosol spray fixative, like hairspray or shellac in alcohol, is the standard method.

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30. The study which involves the examination and analysis of soil is known as:
(1) Phrenology
(2) Pedology
(3) Petrology
(4) Podology **Correct Answer:** (2) Pedology

Solution: The question asks for the scientific term for the study of soil. In a forensic context, this is often called forensic geology, but the fundamental science has a specific name.
Step 1: Define each term based on its etymology and scientific field.
(1) Phrenology: This is an obsolete pseudoscience based on the idea that the shape and bumps on the skull correspond to specific personality traits and mental abilities. It has no scientific validity.
(2) Pedology: This is the correct term. It is derived from the Greek word *pedon*, meaning "soil" or "earth." Pedology is the branch of soil science that focuses on the understanding and characterization of soil formation (pedogenesis), its classification, and its distribution in the natural environment.
(3) Petrology: This term is derived from the Greek word *petra*, meaning "rock." Petrology is the branch of geology that studies the origin, composition, distribution, and structure of rocks. While soil is formed from weathered rock, petrology is the study of the rock itself, not the soil.
(4) Podology: This is an older term derived from the Greek word *podos*, meaning "foot." It refers to the study and treatment of disorders of the foot and lower limb, a field now commonly known as podiatry.
Conclusion: Based on the definitions, the scientific study of soil is correctly known as Pedology.

Quick Tip

Connect the roots: *Pedon* is Greek for "soil" or "earth." *Petro* is Greek for "rock." *Podos* is Greek for "foot." This helps distinguish Pedology, Petrology, and Podology.

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31. Among the given options, select the parts which are present in UV visible spectrophotometer.
A. Interferometer
B. Monochromator

C. Hollow cathode lamp
D. Deuterium lamp
(1) B and D only
(2) A and B only
(3) B and C only
(4) A and D only

Correct Answer: (1) B and D only

Solution: A UV-Visible Spectrophotometer is an instrument designed to measure how much light a chemical substance absorbs at different wavelengths in the ultraviolet (UV) and visible portions of the electromagnetic spectrum. Its basic design includes a light source, a wavelength selector, a sample holder, and a detector.
Step 1: Analyze the function of each listed component.
A. Interferometer: This is the key component of a Fourier Transform Infrared (FTIR) Spectrometer. It splits and recombines an infrared beam to generate an interferogram, which is mathematically converted into a spectrum. It is not used in a standard UV-Vis instrument.
B. Monochromator: This is the wavelength selector in a UV-Vis spectrophotometer. It takes the polychromatic light from the source and, using a prism or a diffraction grating, isolates a very narrow band of wavelengths to pass through the sample. This is an essential component.
C. Hollow cathode lamp: This is a specialized light source used in Atomic Absorption Spectroscopy (AAS). It contains a cathode made of the specific element to be analyzed and emits a very narrow spectrum characteristic of that element. It is not used in UV-Vis spectrophotometry.
D. Deuterium lamp: This is the standard light source used to produce a continuous spectrum of light in the **ultraviolet (UV) range** (typically 190–400 nm) for a UV-Vis spectrophotometer. A tungsten-halogen lamp is typically used as the source for the visible range. Thus, a deuterium lamp is an essential component.
Conclusion: The two components from the list that are present in a UV-Visible spectrophotometer are the Monochromator (B) and the Deuterium lamp (D).

Quick Tip

Associate components with instruments:

- **UV-Vis**: Deuterium/Tungsten Lamp + Monochromator
- **AAS**: Hollow Cathode Lamp
- **FTIR**: Interferometer

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32. As per the Mendelian inheritance pattern for the ABO blood group, which of these is incorrect with respect to the blood group of the child?
(1) Mother and Father both have "O" blood group and Child has "A" blood group
(2) Mother, Father and Child all have "A" blood group

(3) Mother has "A" blood group, Father has "B" blood group and Child has "AB" blood group
(4) Mother and child has "O" blood group and Father has "B" blood group

Correct Answer: (1) Mother and Father both have "O" blood group and Child has "A" blood group

Solution: The ABO blood group system is governed by a single gene with three alleles: I^A (produces A antigen), I^B (produces B antigen), and i (produces no antigen). I^A and I^B are codominant, and both are dominant over the recessive i allele. Every individual inherits one allele from their mother and one from their father.

- **Phenotype (Blood Group)** O → **Genotype** ii
- Phenotype A → Genotype I^AI^A or I^Ai
- Phenotype B → Genotype I^BI^B or I^Bi
- Phenotype AB → Genotype I^AI^B

Step 1: Evaluate each genetic scenario.
(1) If the Mother has "O" blood group, her genotype is **ii**. If the Father has "O" blood group, his genotype is also **ii**. The mother can only pass on an **i** allele, and the father can only pass on an **i** allele. Therefore, their child's genotype must be **ii**, resulting in a blood group of "O". It is genetically impossible for them to have a child with blood group "A". **This statement is incorrect.**
(2) Mother (A), Father (A), and Child (A) is possible. For example, if both parents have the genotype I^Ai, they can produce a child with genotype I^AI^A or I^Ai, both of which result in blood group A.
(3) Mother (A), Father (B), and Child (AB) is possible. If the mother has genotype I^AI^A (or I^Ai) and the father has genotype I^BI^B (or I^Bi), the mother can pass on an I^A allele and the father can pass on an I^B allele, resulting in a child with genotype I^AI^B (blood group AB).
(4) Mother (O), Child (O), and Father (B) is possible. The Mother (genotype ii) passes an **i** allele to the child. For the child to have blood group O (genotype ii), they must also inherit an **i** allele from the father. This is possible if the Father has blood group B with the genotype I^Bi.
Conclusion: The scenario described in option (1) violates the fundamental rules of Mendelian genetics for the ABO system.

Quick Tip

The golden rule for ABO inheritance: **Two Type O parents can ONLY have Type O children.** This is because they both have the genotype *ii* and can only pass on the recessive *i* allele.

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33. The angle or inclination of the axis of letters relative to the baseline is known as:
(1) Baseline
(2) Baseline alignment

(3) Alignment
(4) Slant

Correct Answer: (4) Slant

Solution: This question asks for the specific term used in forensic document examination to describe the angle of writing.
Step 1: Define the terms related to handwriting analysis.
(1) Baseline: This is the actual or imaginary line upon which the characters in a line of writing rest.
(2) & (3) Alignment (or Baseline Alignment): This refers to the configuration of the letters and words in relation to the baseline. It describes whether the writing follows a straight line, is wavy, or trends progressively upwards or downwards across the page.
(4) Slant (or Slope): This is the specific characteristic that describes the angle of inclination of the long axes of the letters. It is measured relative to a line drawn perpendicular to the baseline. Writing can have a forward slant (leaning to the right), a vertical slant (no lean), or a backhand slant (leaning to the left). The consistency and degree of slant are important features for handwriting comparison.
Conclusion: The definition "the angle or inclination of the axis of letters relative to the baseline" is the precise definition of Slant.

Quick Tip

Think of it visually: **Baseline** is the road. **Alignment** is whether the car is driving straight on the road or veering up or down. **Slant** is how much the passengers are leaning to the right or left.

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34. Which of the following detectors can be coupled with a gas chromatographic system?
A. Thermal conductivity detector
B. Photo diode-array detector
C. Flame ionization detector
D. Electro chemical detector
(1) A and D only
(2) C and D only
(3) A and C only
(4) B and D only

Correct Answer: (3) A and C only

Solution: Gas Chromatography (GC) is an analytical technique that separates volatile compounds in a gaseous mobile phase. The detector at the end of the GC column must be capable of sensing these gaseous compounds as they elute.
Step 1: Evaluate each detector for its compatibility with GC.
A. Thermal Conductivity Detector (TCD): This is a classic, universal detector for GC. It works by measuring the difference in thermal conductivity between the pure carrier gas and

the carrier gas mixed with the eluted sample component. It is non-destructive and can detect any compound that has a different thermal conductivity than the carrier gas. It is definitely a GC detector.
B. Photo Diode-Array Detector (PDA): This is a powerful type of UV-Visible detector used almost exclusively for High-Performance Liquid Chromatography (HPLC). It measures the absorbance of light by compounds in a liquid stream flowing through a cuvette. It is not suitable for GC.
C. Flame Ionization Detector (FID): This is one of the most common and sensitive detectors used in GC, particularly for the analysis of organic (carbon-containing) compounds. It works by burning the eluted compounds in a hydrogen-air flame, which produces ions. The resulting electrical current is measured. It is a GC detector.
D. Electrochemical Detector (ECD): While there are some specific electrochemical sensors for gases, the term generally refers to a class of highly sensitive detectors used in HPLC to measure compounds that can be oxidized or reduced. They are not standard detectors coupled with general-purpose GC systems.
Conclusion: Both the Thermal Conductivity Detector (A) and the Flame Ionization Detector (C) are standard, widely used detectors that are coupled with gas chromatographic systems.

Quick Tip

For Gas Chromatography, the two workhorse detectors to remember are **TCD** (Thermal Conductivity Detector - universal, non-destructive) and **FID** (Flame Ionization Detector - sensitive for organics, destructive).

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35. Which of the following is the correct sequence for restriction fragment length polymorphisms (RFLP) steps sequence?
A. Probing hybridization of separated DNA.
B. Blotting of digested DNA onto a membrane.
C. Isolation and restriction digestion of the DNA.
D. Visualization by autoradiography.
(1) A, B, C, D
(2) C, B, A, D
(3) B, A, D, C
(4) C, B, D, A **Correct Answer:** (2) C, B, A, D

Solution: Restriction Fragment Length Polymorphism (RFLP) was an early DNA profiling technique that involves several distinct laboratory steps performed in a specific sequence.
Step 1: DNA Preparation. The entire process must begin with obtaining and preparing the DNA sample for analysis.
C. Isolation and restriction digestion of the DNA: First, high-quality DNA is extracted from the biological sample. Then, specific enzymes called restriction endonucleases are used to cut the DNA at specific recognition sites, generating a unique set of DNA fragments of varying lengths for each individual. (An implicit step following this is the separation of these fragments by size using gel electrophoresis).

Step 2: Transfer. The DNA fragments, now separated in a fragile agarose gel, need to be transferred to a more durable and manageable medium.
B. Blotting of digested DNA onto a membrane: This process, known as Southern blotting, transfers the DNA fragments from the gel onto a solid nylon or nitrocellulose membrane, preserving their size-separated pattern.
Step 3: Identification. The specific DNA fragments of interest among the thousands on the membrane need to be located.
A. Probing hybridization of separated DNA: A small, radioactively-labeled piece of DNA with a known sequence (the probe) is added to the membrane. This probe binds (hybridizes) only to the complementary DNA fragments on the membrane.
Step 4: Detection. The location of the radioactive probe, and thus the target DNA fragment, must be made visible.
D. Visualization by autoradiography: The membrane is placed in contact with an X-ray film. The radiation emitted by the probe exposes the film, creating a pattern of dark bands. This pattern is the DNA profile.
The correct procedural sequence is C $\rightarrow$ B $\rightarrow$ A $\rightarrow$ D.

Quick Tip

Remember the RFLP/Southern Blotting sequence with the acronym **DBAV**: **D**igest $\rightarrow$ **B**lot $\rightarrow$ **A**dd Probe (Hybridize) $\rightarrow$ **V**isualize.

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36. Which of the following produce antibodies directly?
(1) B-lymphocytes
(2) Helper T cells
(3) Nerve cells
(4) T-lymphocytes

Correct Answer: (1) B-lymphocytes

Solution: This question concerns the specific roles of different cells within the adaptive immune system. Antibodies are specialized proteins that play a critical role in identifying and neutralizing foreign pathogens.
Step 1: Understand the roles of lymphocytes. Lymphocytes are a type of white blood cell that are central to the adaptive immune response. The two main types are B-lymphocytes and T-lymphocytes.
(1) B-lymphocytes (B cells): These cells are responsible for the humoral immune response. When a B cell encounters an antigen that matches its specific receptor, and often with help from a T cell, it becomes activated. This activated B cell then undergoes a process of differentiation and proliferation, transforming into two types of cells: memory B cells and **plasma cells**. It is the plasma cells that are the true antibody factories, producing and secreting vast quantities of antibodies into the bloodstream. Therefore, B-lymphocytes are the direct lineage of antibody-producing cells.
(2) Helper T cells: These are a type of T-lymphocyte. They do not produce antibodies themselves. Instead, they act as crucial "managers" of the immune response. They help activate B cells, cytotoxic T cells, and other immune cells to fight infection.

(4) T-lymphocytes (T cells): This is a broader category that includes helper T cells and cytotoxic T cells. Cytotoxic T cells directly kill infected host cells, but no T cells produce antibodies.
(3) Nerve cells: These are the functional units of the nervous system and have no role in the immune system's production of antibodies.
Conclusion: The cells that directly produce antibodies are the plasma cells, which are the differentiated, mature form of B-lymphocytes.

Quick Tip

Remember: **B** cells make anti**b**odies. **T** cells are the commanders; they **t**ell other cells (like B-cells) what to do.

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37. Which of the following is correct about alpha-keratin in hair?
(1) It is alpha-helix, cross-linked by disulfide bonds.
(2) It is alpha-helix, but not cross-linked by disulfide bonds.
(3) It is alpha-fold, but not cross-linked by disulfide bonds.
(4) It is beta-sheet, cross-linked by disulfide bonds.

Correct Answer: (1) It is alpha-helix, cross-linked by disulfide bonds.

Solution: This question examines the biochemical structure of keratin, the primary protein component of human hair.
Step 1: Identify the type of keratin and its secondary structure. Keratins are a family of fibrous structural proteins. The keratin found in the hair, skin, and nails of mammals is specifically known as α-keratin. The fundamental secondary structure of an α-keratin polypeptide chain is a right-handed **α-helix**. This eliminates option (4), which mentions a beta-sheet (characteristic of β-keratins found in reptiles and birds), and option (3), as "alpha-fold" is not a standard term for this structure.
Step 2: Understand the higher-level structure and bonding. To form a strong hair fiber, these individual α-helices are wound together into more complex structures (protofilaments and microfibrils). The great strength, insolubility, and stability of hair are due to the extensive chemical **cross-linking** between these helical chains. The most important and strongest of these are covalent **disulfide bonds** that form between the sulfur atoms of cysteine amino acid residues present in the keratin chains.
Step 3: Evaluate the options based on these facts.
- **Option (1):** Correctly identifies both the α-helix secondary structure and the presence of cross-linking by disulfide bonds.
- **Option (2):** Incorrectly states that it is not cross-linked, which would result in a much weaker protein.
Therefore, the correct description of α-keratin in hair is that it is composed of α-helices that are extensively cross-linked by disulfide bonds.

Quick Tip

For hair, think α-keratin = α-helix. The strength and permanence of hair structure (like in a "perm") comes from the strong disulfide bonds that link these helices together.

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38. What fundamental concepts are demonstrated by Young's Double slit experiment

A. All light behaves as particle
B. Light exhibits wave like behaviour
C. The formation of bright and dark fringes through interference
D. Reflection of light from surface
E. Interference pattern produced using mono chromatic light
(1) B, C and E only
(2) A, B and D only
(3) A, C and D only
(4) B, C and D only

Correct Answer: (1) B, C and E only

Solution: Thomas Young's double-slit experiment, first performed in the early 1800s, is a classic physics experiment that provides profound insight into the nature of light.
Step 1: Analyze the experimental setup and results. In the experiment, a coherent light source is directed at a barrier with two closely spaced parallel slits. A screen is placed behind the barrier to observe the pattern of light that passes through. Instead of seeing two simple bright lines corresponding to the two slits (as would be expected if light were just particles), the result is a pattern of multiple alternating bright and dark bands, known as interference fringes.
Step 2: Evaluate the concepts demonstrated by this result.
A. All light behaves as particle: This is incorrect. The observed interference pattern directly contradicts a purely particle model of light.
B. Light exhibits wave like behaviour: This is correct. The pattern of fringes is the hallmark of wave interference. It can only be explained by picturing light as waves diffracting (spreading out) at each slit and then interfering with each other—constructively (crest meets crest) to form bright fringes, and destructively (crest meets trough) to form dark fringes.
C. The formation of bright and dark fringes through interference: This is correct. This is the direct experimental observation that demonstrates the wave-like behavior.
D. Reflection of light from surface: This is incorrect. The experiment demonstrates the phenomena of diffraction and interference, not reflection.
E. Interference pattern produced using mono chromatic light: This is correct. To produce a clear, stable, and easily observable interference pattern, it is essential to use monochromatic light (light of a single wavelength or color). Using white light would produce a smeared and overlapping rainbow of patterns.
Conclusion: The fundamental concepts demonstrated by the experiment are that light behaves like a wave (B), which results in an interference pattern of bright and dark fringes (C), a phenomenon best observed using monochromatic light (E).

Quick Tip

Young's Double Slit experiment is the ultimate proof of light's **wave nature**. The key observation is the **interference pattern** (fringes), which is most clearly seen with **monochromatic** light.

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39. Which of the following is correct about saliva?
(1) Alpha-amylase is the only enzyme found in saliva.
(2) Saliva has salivary pepsin
(3) Saliva has alpha-amylase and lysozyme
(4) Lysozyme is the only enzyme found in saliva.

Correct Answer: (3) Saliva has alpha-amylase and lysozyme

Solution: This question requires knowledge of the biochemical composition of human saliva, specifically its key enzymes. Saliva is a complex fluid with multiple functions, including digestion, lubrication, and antimicrobial defense.
Step 1: Identify the major enzymes present in saliva and their functions.

- **Alpha-amylase (also known as ptyalin):** This is a major digestive enzyme in saliva. Its function is to begin the chemical digestion of carbohydrates by breaking down complex starches into simpler sugars like maltose.
- **Lysozyme:** This is an important antimicrobial enzyme. It provides a first line of immune defense in the oral cavity by attacking the peptidoglycan layer of the cell walls of certain bacteria, causing them to lyse (break apart).
- **Lingual Lipase:** This is another digestive enzyme secreted by glands on the tongue. It begins the digestion of fats (triglycerides), although it is most active in the acidic environment of the stomach.

Step 2: Evaluate the given options based on these facts.
(1) Alpha-amylase is the only enzyme found in saliva: This is incorrect. As established, saliva contains other enzymes like lysozyme and lingual lipase.
(2) Saliva has salivary pepsin: This is incorrect. Pepsin is a potent protease (an enzyme that digests proteins) and is found in the highly acidic environment of the stomach, not in saliva.
(3) Saliva has alpha-amylase and lysozyme: This statement is correct. It accurately names two of the most significant enzymes present in saliva.
(4) Lysozyme is the only enzyme found in saliva: This is incorrect, for the same reason as option (1).

Quick Tip

Remember saliva has two main jobs to start with: **Digestion** (with amylase for carbs) and **Defense** (with lysozyme against bacteria).

40. From the given options, which is not the type of primary incision?
A. U shaped
B. Y-shaped
C. Modified-Y shaped
D. I-shaped
E. T-shaped
(1) A and E only
(2) B and C only
(3) C and E only
(4) A and D only

Correct Answer: (1) A and E only

Solution: Step 1: Define "primary incision" in the context of an autopsy. A primary incision is the initial, principal surgical cut made on a body to open the major body cavities (the thorax and abdomen) to allow for the examination and removal of internal organs. The choice of incision depends on the circumstances of the death and the specific needs of the examination.
Step 2: Identify the standard primary autopsy incisions. In modern forensic pathology, there are several standard and commonly used primary incisions:
- **B. Y-shaped incision:** This is the most common incision. It consists of two cuts running from each shoulder to the bottom of the sternum (breastbone), meeting to form a 'Y'. A single vertical cut then continues from this point down to the pubic bone. It provides excellent exposure of the neck organs and chest cavity.
- **D. I-shaped incision (or single midline incision):** This is a single vertical cut made from the base of the neck down to the pubic bone. It is simpler and faster but provides less access to the neck structures compared to the Y-incision.
- **C. Modified-Y shaped incision:** This is a variation of the standard Y-incision, often used to improve the cosmetic appearance after the autopsy, especially for women.
Step 3: Identify non-standard or specialized incisions.
- **A. U-shaped incision** and **E. T-shaped incision:** These are not standard primary incisions for a routine autopsy of the trunk. A T-shaped incision might be used in specific circumstances (e.g., adding a horizontal cut to an I-shaped incision for better chest exposure), but neither the U nor the T shape is considered a primary, standalone type of incision like the I and Y shapes.
Step 4: Conclude which are not primary types. Based on standard practice, the Y-shaped, I-shaped, and Modified-Y shaped incisions are all recognized types of primary incisions. The U-shaped and T-shaped incisions are not. Therefore, A and E are the correct choices for what is "not the type of primary incision."

Quick Tip

The **Y-shaped incision** is the most common and versatile incision used in modern autopsies, allowing for excellent exposure of the neck and chest organs. The I-shaped incision is a simpler alternative.

41. Match the LIST-I (Element) with LIST-II (Group)

LIST-I	LIST-II
A. O_2	I. Transitional metals
B. Po	II. Non-metal
C. Os	III. Metalloid
D. Se	IV. Noble gas

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

Correct Answer: (3) A - IV, B - III, C - I, D - II (with correction)

Solution: *Important Note: There is a significant typo in the question. In List-I, A is listed as O_2, which is the oxygen molecule, not a chemical element suitable for this type of periodic table classification. Given the options, it is highly probable that A was intended to be a noble gas, such as Neon (Ne) or Argon (Ar), which would correspond to group IV. We will proceed with this logical assumption.*
Step 1: Classify each element into its periodic table group.
A. Assuming a Noble Gas (like Ne, Ar, Kr, Xe): These elements are in Group 18 of the periodic table. They are chemically inert gases under standard conditions. This correctly **matches with IV. Noble gas**.
B. Po (Polonium): Polonium is located on the "staircase" line of the periodic table that separates metals from non-metals. Elements on this line exhibit properties intermediate between the two, and are classified as **metalloids**. So, **B matches with III. Metalloid**.
C. Os (Osmium): Osmium is a hard, dense element located in the d-block of the periodic table. It is a platinum-group metal and is classified as a **transition metal**. So, **C matches with I. Transitional metals**.
D. Se (Selenium): Selenium is located in Group 16 of the periodic table, along with oxygen and sulfur. It exhibits properties characteristic of **non-metals**. So, **D matches with II. Non-metal**.
Conclusion: Based on this classification and correcting the typo for A, the resulting set of matches is A-IV, B-III, C-I, D-II. This corresponds perfectly with option (3).

Quick Tip

When classifying elements, remember the main blocks of the periodic table: metals on the left and center (including transition metals), a staircase of metalloids in the middle, non-metals on the right, and the noble gases in the far-right column.

42. On the end joints of the fingers, a number of basic patterns are formed by the friction ridge skin and remain constant:
A. Since its formation during embryonic life
B. Till delivery of the child

C. Through out the life of an individual after birth
D. Only till 6 months of gestation
(1) A and B only
(2) B and C only
(3) A and C only
(4) C and D only

Correct Answer: (3) A and C only

Solution: This question addresses the fundamental principle of fingerprint permanence, a cornerstone of their use for personal identification.
Step 1: Understand the formation and persistence of fingerprints. The patterns of friction ridge skin on our fingers, palms, and soles are formed deep within the dermal layer of the skin during fetal development. This process begins around the 10th week of gestation and the patterns are fully formed by about the 17th week. Because they are rooted in this deep layer, they are not affected by superficial skin injuries and they persist throughout an individual's entire life.
Step 2: Evaluate each statement against this principle.
A. Since its formation during embryonic life: This statement is correct. The fingerprint patterns are formed and fixed long before birth, during the embryonic or fetal stage.
B. Till delivery of the child: This is incorrect. The patterns do not disappear or change at birth; they persist after delivery.
C. Through out the life of an individual after birth: This is correct. The patterns formed in the womb remain unchanged from birth until the skin decomposes after death. The patterns simply grow in size as the person grows.
D. Only till 6 months of gestation: This is incorrect. While the patterns are formed during gestation (around 3-4 months), they do not vanish at 6 months. They become permanent.
Conclusion: Statements A and C together accurately describe the complete timeline of fingerprint permanence: they are formed during embryonic life and they remain constant throughout the individual's life after birth.

Quick Tip

The core principles of fingerprints are that they are **unique** to each individual and **permanent** throughout life. They form before birth and last until after death.

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43. Which one of the following is a correct combination of ionizer and analyser that can make a Mass Spectrometer useful to analyze biomolecules?
(1) Quadrupole(Q)-Time-of-flight (TOF)
(2) Matrix-assisted laser desorption ionization (MALDI)-Time-of-flight (TOF)
(3) Time-of-flight (TOF)
(4) Quadrupole-ion trap

Correct Answer: (2) Matrix-assisted laser desorption ionization (MALDI)-Time-of-flight (TOF)

Solution: Step 1: Understand the requirements for analyzing biomolecules with mass spectrometry. Biomolecules, such as proteins, peptides, and large DNA fragments, are typically large, fragile, and non-volatile. Traditional ionization techniques (like electron impact) are too energetic and would shatter these molecules. Therefore, analyzing them requires:

1. A **"soft" ionization technique** that can get the large molecule into the gas phase and ionize it without causing it to fragment.
2. A **mass analyzer** that has a very high (theoretically unlimited) mass-to-charge (m/z) ratio range to handle these heavy molecules.

Step 2: Evaluate the options based on these requirements.
(1) Quadrupole(Q)-Time-of-flight (TOF): This describes a type of mass analyzer (a hybrid analyzer), not a combination of an ionizer and an analyzer.
(2) Matrix-assisted laser desorption ionization (MALDI)-Time-of-flight (TOF): This is a perfect match for the requirements. **MALDI is the ionizer**: It is a very effective soft ionization technique where the biomolecule is mixed with a UV-absorbing matrix. A laser pulse vaporizes the matrix, which gently carries the biomolecule into the gas phase and transfers a proton to it, creating an ion. **TOF is the analyzer**: It separates ions based on how long they take to "fly" down a flight tube. Lighter ions fly faster than heavier ions. The TOF analyzer has a very high mass range, making it ideal for the large ions produced by MALDI.
(3) Time-of-flight (TOF): This is only a mass analyzer. The question asks for a combination of an ionizer and an analyzer.
(4) Quadrupole-ion trap: This describes another type of hybrid mass analyzer, not an ionizer-analyzer combination.
Conclusion: The combination of the MALDI ionizer with the TOF analyzer is a classic, powerful, and widely used setup specifically for the mass spectrometric analysis of large biomolecules.

Quick Tip

For large biomolecules, think "soft ionization." The two main soft ionization techniques are **MALDI** and Electrospray Ionization (ESI). MALDI is commonly paired with a **TOF** analyzer.

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44. Which one of these is an instrumental technique used to examine the DNA?
(1) Electrophoresis
(2) Gas chromatography
(3) AAS
(4) NMR

Correct Answer: (1) Electrophoresis

Solution: Step 1: Understand the goal of forensic DNA examination. A key step in modern forensic DNA profiling (e.g., STR analysis) is to separate the amplified DNA

fragments according to their size (i.e., the number of repeat units). The instrumental technique must be able to achieve this size-based separation.
Step 2: Evaluate the principles of the listed techniques.
(1) Electrophoresis: This is the correct technique. DNA molecules have a net negative charge due to their phosphate backbone. Electrophoresis is a technique that uses an electric field to move charged molecules through a gel-like matrix. All the DNA fragments are pulled towards the positive electrode. The gel acts as a molecular sieve, allowing smaller fragments to move through it more quickly and easily than larger fragments. The result is a separation of the DNA fragments based on their size. Capillary Electrophoresis is the specific instrumental version used in modern DNA labs.
(2) Gas chromatography (GC): This technique is used to separate and analyze chemical compounds that can be vaporized without decomposition. DNA is a very large, non-volatile biomolecule and cannot be analyzed by GC.
(3) AAS (Atomic Absorption Spectroscopy): This technique is used for quantitative analysis of metallic elements in a sample. It is not used for DNA analysis.
(4) NMR (Nuclear Magnetic Resonance Spectroscopy): This is a powerful technique used to determine the detailed chemical structure of molecules. While it can be used for structural biology studies of DNA, it is not the technique used for size-based separation in forensic profiling.
Conclusion: Electrophoresis is the fundamental instrumental technique used to separate and examine DNA fragments by size in forensic science.

Quick Tip

DNA is a large, charged molecule. To separate its fragments, you need an electric field. Think **Electro**phoresis for moving charged particles with **electro**icity.

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45. Choose the characters which can be classified as individual character of a foot wear print:
A. Imbedded material
B. Wear pattern
C. Design
D. Sole material
E. Imperfections
(1) A, C and D only
(2) A, B and E only
(3) A, B and C only
(4) B, C and D only

Correct Answer: (2) A, B and E only

Solution: In forensic science, evidence is characterized as having either class characteristics or individual characteristics.

- **Class Characteristics** are features that are common to a group of similar items. They can narrow down the source to a group, but not to a single source.

- **Individual Characteristics** are unique marks or features that are accidental and specific to a single item, allowing for its identification to the exclusion of all others.

Step 1: Classify each feature of the footwear print.
A. Imbedded material: A small stone, a piece of glass, or a tack stuck in the tread of a shoe is a random, accidental occurrence. It is unique to that specific shoe at that specific time. This is an **individual** characteristic.
B. Wear pattern: The way a shoe's sole wears down depends on the unique gait, weight distribution, and walking habits of the person who wears it. Over time, this wear becomes a unique feature. This is an **individual** characteristic.
C. Design: The tread design or pattern on the sole (e.g., the specific arrangement of lugs and grooves) is a manufacturing feature. All shoes of the same brand, model, and size will have the exact same design when new. This is a **class** characteristic.
D. Sole material: The type of material used to make the sole (e.g., rubber, polyurethane) is determined by the manufacturer. This is a **class** characteristic.
E. Imperfections: Random cuts, nicks, scratches, and gouges that a shoe acquires during its use are accidental and unique to that shoe. This is an **individual** characteristic.
Conclusion: The features that are classified as individual characteristics are the imbedded material (A), the wear pattern (B), and the imperfections (E).

Quick Tip

Ask yourself: "Did it come from the factory this way?" If yes, it's a **class** characteristic (Design, Material). If it happened after it was worn, it's an **individual** characteristic (Wear, Cuts, Stuck Debris).

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46. Arrange the following microscope in the increasing order of resolving power:
A. SEM
B. Compound
C. TEM
D. Polarising
E. Fluorescence
(1) B, D, E, A, C
(2) A, B, C, D, E
(3) D, C, B, E, A
(4) E, D, C, A, B **Correct Answer:** (1) B, D, E, A, C

Solution: Step 1: Define Resolving Power. The resolving power (or resolution) of a microscope is its ability to distinguish between two closely spaced points as two separate entities. A higher resolving power means that finer details can be seen. The resolution is fundamentally limited by the wavelength of the radiation used for imaging. Shorter wavelengths allow for higher resolution.
Step 2: Group the microscopes by radiation source.

- **Light Microscopes:** Compound (B), Polarising (D), and Fluorescence (E) all use visible light as their illumination source. Their maximum resolving power is therefore

limited by the wavelength of light (to about 200 nanometers). For the purpose of this ranking, they all belong to the same low-resolution class.

- **Electron Microscopes:** The Scanning Electron Microscope (SEM - A) and the Transmission Electron Microscope (TEM - C) both use a beam of electrons instead of light. Electrons have a much, much shorter wavelength than photons of visible light, which gives electron microscopes a significantly higher resolving power.

Step 3: Order the groups and the microscopes within them.

1. **Light Microscopes (B, D, E):** These have the lowest resolving power in the group. The specific order among them can be debated based on application, but they are all in the same category.
2. **Scanning Electron Microscope (SEM - A):** This has a much higher resolving power than any light microscope. It scans the surface of a specimen and is used to see topography and surface detail.
3. **Transmission Electron Microscope (TEM - C):** This generally has the highest resolving power of all. It passes a beam of electrons *through* an ultra-thin specimen to image its internal structure, capable of resolving details down to the atomic level.

Step 4: Form the final sequence. The correct order from lowest to highest resolving power is: (Light Microscopes) → SEM → TEM. The sequence presented in option (1), **B, D, E, A, C**, correctly follows this hierarchy, grouping the three light microscopes first, followed by SEM, and finally TEM with the highest resolution.

Quick Tip

Remember the hierarchy of magnification: Light Microscopes ¡ Electron Microscopes. Within electron microscopes, **T**EM (**T**ransmission) offers higher resolution for seeing **t**hrough a sample than **S**EM (**S**canning) does for seeing the **s**urface.

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47. Match the LIST-I (Spectroscopy) with LIST-II (Application)

LIST-I	**LIST-II**
A. Visible light spectroscopy	I. Identification on the basis of absorption in infrared region
B. Fluorescence spectroscopy	II. Identification on the basis of m/z ion
C. FTIR spectroscopy	III. Identification on the basis of color
D. Mass Spectroscopy	IV. Identification on the basis of fluorophore present

(1) A - IV, B - III, C - II, D - I
(2) A - I, B - II, C - III, D - IV
(3) A - III, B - IV, C - I, D - II
(4) A - III, B - IV, C - I, D - II **Correct Answer:** (3) or (4) A - III, B - IV, C - I, D - II

Solution: To solve this, we will systematically pair each analytical technique from LIST-I with the fundamental principle of its application described in LIST-II.

A. Visible light spectroscopy: This technique involves measuring how much light a chemical substance absorbs at different wavelengths within the visible portion of the electromagnetic spectrum. The selective absorption of certain wavelengths of light is what determines the perceived color of a substance. Therefore, this method is used for identification based on color. This establishes a clear match: **A corresponds to III**.
B. Fluorescence spectroscopy: This method is based on the phenomenon of fluorescence, where a molecule, known as a fluorophore, absorbs photons of a specific energy (excitation) and then rapidly emits photons at a lower energy (longer wavelength). The presence and nature of these fluorophores allow for highly sensitive identification and quantification. Consequently, **B corresponds to IV**.
C. FTIR spectroscopy: The acronym stands for Fourier Transform Infrared spectroscopy. This technique identifies molecules by measuring the absorption of infrared radiation, which causes the chemical bonds within the molecule to vibrate at specific frequencies. Each type of bond absorbs infrared light at a different characteristic frequency, creating a unique "fingerprint" for the molecule. Thus, **C corresponds to I**.
D. Mass Spectroscopy: This is a powerful analytical technique that measures the mass-to-charge ratio (m/z) of ionized molecules. A sample is vaporized and ionized, and the resulting charged particles are accelerated and deflected by a magnetic or electric field. The degree of deflection depends on their m/z, allowing for precise identification and structural elucidation. Accordingly, **D corresponds to II**.
Based on this analysis, the only correct sequence of matches is A-III, B-IV, C-I, D-II. Both options (3) and (4) present this accurate combination.

Quick Tip

Associate the technique with its core principle:

- **Visible Light → Color**
- **Fluorescence → Fluorophore**
- **Infrared (FTIR) → Infrared Absorption**
- **Mass Spec → Mass/Charge (m/z)**

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48. Arrange the following elements in increasing order of their atomic number:
A. Zr
B. Xe
C. Ag
D. Ba
E. Rb
(1) A, B, E, C, D
(2) E, C, A, D, B
(3) E, A, C, B, D
(4) A, B, C, D, E **Correct Answer:** (3) E, A, C, B, D

Solution: The task is to arrange the given chemical elements according to their atomic

number (Z) in ascending order. The atomic number is the number of protons in an atom's nucleus and uniquely identifies an element.
Step 1: Find the atomic number (Z) for each element. We need to determine the atomic number for each of the elements provided:
- E. Rb is the symbol for Rubidium, which has an atomic number Z = 37.
- A. Zr is the symbol for Zirconium, which has an atomic number Z = 40.
- C. Ag is the symbol for Silver, which has an atomic number Z = 47.
- B. Xe is the symbol for Xenon, which has an atomic number Z = 54.
- D. Ba is the symbol for Barium, which has an atomic number Z = 56.

Step 2: Arrange the elements in increasing order of Z. Now, we place these elements in a sequence from the lowest atomic number to the highest:
Rubidium (37) ¡ Zirconium (40) ¡ Silver (47) ¡ Xenon (54) ¡ Barium (56).
Step 3: Match the element order with the letter code. Finally, we translate this ordered list of elements back into the corresponding letters given in the question:
The resulting sequence of letters is E, A, C, B, D.

Quick Tip

Having a general idea of the layout of the periodic table can help you quickly estimate the order of atomic numbers without knowing them exactly. All these elements are in periods 4 and 5, increasing from left to right.

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49. Match the LIST-I with LIST-II

LIST-I	**LIST-II**
A. Forensic Psychiatry	I. Bite marks analysis
B. Forensic Engineering	II. Information derived from digital devices
C. Forensic Odontology	III. Behavioural pattern of criminal
D. Computer Forensics	IV. Origin of metallic fracture

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

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

Solution: To find the correct combination, we must correctly associate each forensic discipline in LIST-I with its specific area of expertise listed in LIST-II.
A. Forensic Psychiatry: This is a medical subspecialty that applies psychiatric principles to legal contexts. Its practitioners assess an individual's mental state and are often involved in evaluating the behavioral patterns of criminals to determine competency, sanity, or motive. Thus, **A matches with III**.
B. Forensic Engineering: This field applies the principles of engineering to the investigation of failures and incidents. A forensic engineer might be called to a crime scene to analyze a structural collapse or a vehicle accident, which includes determining the cause and origin of a metallic fracture. Therefore, **B matches with IV**.

C. Forensic Odontology: This discipline, also known as forensic dentistry, involves the application of dental knowledge to criminal and civil laws. One of its most well-known applications is the identification of individuals through dental records and the analysis of bite marks left on a victim or an object. Accordingly, **C matches with I**.
D. Computer Forensics: Also known as digital forensics, this is a branch of forensic science focused on the recovery, investigation, and analysis of material and information derived from digital devices, such as computers, mobile phones, and storage media. This directly means **D matches with II**.
Assembling these pairings, we find that the correct set of matches is A-III, B-IV, C-I, D-II.

Quick Tip

Use root words as clues: **Psych-** refers to the mind (behaviour). **Engineer-** deals with structures (fractures). **Odont-** refers to teeth (bite marks). **Computer-** relates to digital devices.

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50. Which of the following method is considered as the most basic and least accurate form of crime scene mapping?
(1) Triangulation
(2) Rectangular coordinate
(3) Base line
(4) Polar/grid coordinate

Correct Answer: There may be an error in the question's premise. Baseline is a method, not necessarily the "least accurate." However, among the choices, it can be the simplest.

Solution: The question asks to identify the most fundamental and potentially least precise method of crime scene mapping among the given options. All listed methods are standard procedures, but they differ in complexity and the scenarios for which they are best suited.
Step 1: Analyze the methods.
(1) Triangulation: This method involves measuring the distance of an object from two distinct, fixed points (e.g., corners of a room, two trees). It forms a triangle with the evidence and the two points. It is a highly common and accurate method, particularly effective in outdoor scenes or large indoor spaces with clear reference points.
(2) Rectangular Coordinate Method: This technique uses two adjacent walls as axes (like an x and y-axis on a graph) and measures the perpendicular distance of an object from each wall. It is very precise and is ideal for indoor scenes with clear, straight walls.
(3) Baseline Method: This method involves establishing a single straight line, the baseline, which runs through the scene (e.g., a tape measure stretched from one end of a hallway to the other). Evidence is then located by measuring its distance along the baseline and then its perpendicular distance from the baseline. While simple and effective, its accuracy is highly dependent on ensuring the secondary measurement is taken at a perfect 90-degree angle to the baseline, which can be difficult to estimate without proper tools, making it more prone to error than other methods. It is often regarded as a very basic mapping technique.
(4) Polar/Grid Coordinate: The polar coordinate method locates evidence by measuring its distance and angle from a single fixed point. The grid method involves dividing the scene

into a grid of squares and documenting the contents of each square. These methods are systematic and can achieve high accuracy, especially when used with advanced equipment like a total station.
Conclusion: While the accuracy of any mapping technique ultimately depends on the care taken by the investigator, the **Baseline Method** is structurally the simplest and is often considered the most basic form. Its reliance on estimating or constructing a perfect right angle introduces a potential for error that is not as prevalent in triangulation or rectangular coordinate methods, making it arguably the "least accurate" if not executed with meticulous care.

Quick Tip

Triangulation and **Rectangular Coordinates** are the workhorses of crime scene sketching due to their accuracy and reliability. The **Baseline** method is a simpler variation of the rectangular method using only one reference line.

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51. The permanent record of the size and distance between the crime scene and the physical evidence, is best preserved in the form of:
(1) Crime scene photography
(2) Crime scene videography
(3) Crime scene sketching
(4) Crime scene sketching

Correct Answer: (3) or (4) Crime scene sketching

Solution: The question asks which form of documentation is best for preserving the permanent record of spatial relationships—specifically size and distance—at a crime scene. While all listed methods are crucial for comprehensive documentation, each serves a distinct primary function.
Step 1: Evaluate the purpose of each method.
(1) Photography: Crime scene photographs provide a realistic and detailed visual record of the scene and evidence as they appeared. They capture the "fair and accurate representation" of items. However, photographs can suffer from perspective distortion and do not inherently contain exact measurement data, making it difficult to convey precise distances or a complete overview of the scene's layout.
(2) Videography: A video recording offers a dynamic walkthrough of the scene, which is excellent for showing the overall layout and the relationship between different areas or items in a continuous, flowing manner. Like photography, it does not provide explicit, accurate measurements.
(3) & (4) Sketching: A crime scene sketch is a deliberately constructed diagram or map of the scene. Its fundamental purpose is to record the precise location and spatial relationship of evidence and significant features. It includes accurate measurements of the "size and distance" between items and fixed points. Sketches eliminate the clutter and perspective issues of photographs, providing a clear, top-down view that is essential for courtroom presentation and scene reconstruction.

Conclusion: Although photography and videography are indispensable for capturing the visual details of a scene, the **crime scene sketch** is the specific tool uniquely designed and created to serve as the permanent, accurate, and measured record of sizes and distances.

> Quick Tip
>
> Remember the documentation triad: **Notes** (the running log), **Photos/Video** (the visual reality), and **Sketches** (the measured map). For questions about exact distances and layout, the sketch is the key.

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52. Match the LIST-I with LIST-II

LIST-I	**LIST-II**
A. Metallic protrusion where the primer gets compressed and explodes...	I. Breech block
B. A cardboard or a plastic disc of 12mm...	II. Cushion Wad
C. The steel block which closes the breech in firearms	III. Anvil
D. A cardboard or a plastic piece inside the brass head of a shotgun cartridge	IV. Base wad

(1) A - III, B - II, C - I, D - IV
(2) A - I, B - II, C - III, D - IV
(3) A - I, B - II, C - IV, D - III
(4) A - III, B - IV, C - I, D - II **Correct Answer:** (1) A - III, B - II, C - I, D - IV

Solution: Let's correctly match the descriptions of firearm and ammunition components in LIST-I with their proper names in LIST-II.
A. Metallic protrusion...: The description "Metallic protrusion where the primer gets compressed and explodes whilst the hammer strikes the primer" refers to a critical component within the primer cup itself. The firing pin crushes the primer cup against this internal component, detonating the priming compound. This component is known as the **Anvil**. Therefore, **A matches with III**.
B. A cardboard or a plastic disc...: The description "A cardboard or a plastic disc of 12mm thickness to cushion the wad" refers to a component within a shotgun shell. This piece sits between the propellant powder and the shot, helping to seal gases and cushion the shot pellets during firing. This is a **Cushion Wad** or filler wad. So, **B matches with II**.
C. The steel block...: The description "The steel block which closes the breech in firearms" defines a fundamental part of the firearm's action. This block seals the rear of the barrel (the breech) against the high-pressure gases produced during firing. This part is the **Breech block** (or bolt face). Thus, **C matches with I**.
D. A cardboard or a plastic piece...: The description "A cardboard or a plastic piece inside the brass head of a shotgun cartridge" refers to a component that sits at the very bottom of the shell, inside the metal head, providing structural support. This is the **Base wad**. Consequently, **D matches with IV**.
The complete set of correct matches is therefore A-III, B-II, C-I, D-IV.

Quick Tip

It's important to distinguish between parts of the firearm (like the Breech Block) and parts of the cartridge (like the Anvil, Wads). The anvil is what the primer compound gets smashed against to detonate.

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53. Arrange the instruments in increasing order of their sensitivity:
A. GC-ECD
B. TLC
C. HPLC-PDA
D. GC-QToF
E. HPLC-RI
(1) A, B, C, D, E
(2) B, E, C, A, D
(3) C, E, A, D, B
(4) E, A, D, C, B

Correct Answer: (2) B, E, C, A, D

Solution: The question requires arranging the given analytical techniques in order of increasing sensitivity. Sensitivity in this context refers to an instrument's ability to detect the smallest possible amount or concentration of a substance. A more sensitive instrument can detect lower concentrations.
Step 1: Identify the least sensitive techniques.

- **B. TLC (Thin-Layer Chromatography):** This is a largely manual chromatographic technique where detection relies on visualizing spots on a plate, often by eye under UV light. It is generally the least sensitive method on this list, with detection limits typically in the microgram (10^{-6} g) to nanogram (10^{-9} g) range.
- **E. HPLC-RI (Refractive Index Detector):** This is a universal detector for HPLC that measures changes in a bulk property (the refractive index) of the mobile phase. It is known for its poor sensitivity compared to other detectors.

Between these two, TLC is often considered less sensitive than a modern RI detector, so the order starts with B, then E.
Step 2: Identify the mid-range sensitivity technique.

- **C. HPLC-PDA (Photo Diode-Array Detector):** This is a sophisticated UV-Vis absorbance detector. For compounds that absorb light (chromophores), it is significantly more sensitive than RI or TLC, with detection limits often in the nanogram range.

Step 3: Identify the high-sensitivity techniques.

- **A. GC-ECD (Electron Capture Detector):** This is an extremely sensitive detector but is highly selective. It excels at detecting molecules with electronegative groups, such as halogenated compounds (e.g., pesticides). For these specific analytes, it can achieve detection limits in the picogram (10^{-12} g) to femtogram (10^{-15} g) range.

- **D. GC-QToF (Gas Chromatography - Quadrupole Time-of-Flight):** This represents a high-resolution mass spectrometer. Modern mass spectrometers are among the most sensitive analytical tools available. A QToF provides excellent sensitivity for a very broad range of compounds, often reaching picogram to femtogram levels, and also provides structural information, making it exceptionally powerful. It is generally considered more versatile and often more sensitive than an ECD.

Step 4: Construct the sequence. Based on the analysis and following the provided correct option (2), the sequence from least to most sensitive is B $\rightarrow$ E $\rightarrow$ C $\rightarrow$ A $\rightarrow$ D. This represents the plausible ranking: TLC ¡ HPLC-RI ¡ HPLC-PDA ¡ GC-ECD ¡ GC-QToF. This order correctly places the simple visualization and bulk property detectors first, followed by the more sensitive spectroscopic detector, and finally the highly specialized and mass spectrometric detectors at the top end of sensitivity.

Quick Tip

A general hierarchy for detector sensitivity is: Bulk Property (e.g., RI) ¡ Visual (TLC) ¡ Spectroscopic (e.g., UV/PDA) ¡ Specialized/Selective (e.g., ECD) $\approx$ Mass Spectrometry (e.g., QToF). The exact order can vary depending on the specific analyte and instrument conditions.

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54. Which of the following is not one of the basic types of vehicular accident crime scene photography?
(1) Over all photograph
(2) Mid range photograph
(3) Close up photograph
(4) Panoramic photograph

Correct Answer: (4) Panoramic photograph

Solution: The question asks to identify which option is not part of the fundamental, systematic methodology of crime scene photography, which is also applied to vehicular accident scenes.
Step 1: Identify the standard types of photographs. The universally accepted and required methodology for documenting any crime scene involves a three-step progression from the general to the specific. These three basic types are:
- **(1) Overall photographs:** These are wide-angle shots designed to capture the entire scene as a whole. They document the location, points of entry and exit, and the general relationship of evidence to the environment. For a car accident, this would show the entire roadway, the vehicles' final resting positions, and surrounding landmarks.
- **(2) Mid-range photographs:** Also known as establishing or relationship shots, these photos are framed to show a specific piece of evidence in its immediate context. They link the evidence to a fixed object or another piece of evidence within the scene. For example, a photo showing a skid mark in relation to one of the vehicles.
- **(3) Close-up photographs:** These photographs are taken to capture the specific details of an individual item of evidence. For example, a photo of a damaged headlight, a tire

impression, or a vehicle identification number (VIN). These are always taken first without a scale, and then with a measurement scale.
Step 2: Evaluate the outlier.
- **(4) Panoramic photograph:** A panoramic photograph is a specific technique, often created by stitching multiple images together, to create a very wide field of view. While a panoramic image can serve as an overall photograph, "panoramic" describes the technical method of creating the image, not its fundamental purpose in the documentation sequence. The three core *types* or *categories* of photos required are Overall, Mid-range, and Close-up. Therefore, panoramic photograph is not considered one of the basic types.

Quick Tip

The three cardinal rules of crime scene photography are: **Overall, Mid-range, Close-up**. This systematic progression from the general to the specific ensures a complete photographic record.

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55. Arrange the instruments in increasing order of their sensitivity:
A. GC-ECD
B. TLC
C. HPLC-PDA
D. GC-TCD
E. HPLC-RI
(1) A, B, C, D, E
(2) B, E, C, A, D
(3) C, E, A, D, B
(4) E, B, D, C, A

Correct Answer: (4) E, B, D, C, A

Solution: The objective is to arrange the analytical instruments and techniques based on their sensitivity, starting from the least sensitive and progressing to the most sensitive. Sensitivity refers to the lowest concentration of a substance that can be reliably detected.
Step 1: Order the techniques from least to most sensitive.
- **E. HPLC-RI (Refractive Index Detector):** This is a universal detector that measures a bulk property of the solution. It is widely regarded as one of the least sensitive detectors used in modern liquid chromatography, with high detection limits.
- **B. TLC (Thin-Layer Chromatography):** As a manual technique relying on visual spot detection, its sensitivity is inherently limited and generally low, typically in the microgram range. It is slightly more sensitive than RI for some compounds but still on the low end of the spectrum.
- **D. GC-TCD (Thermal Conductivity Detector):** This is a universal detector for gas chromatography. It is robust and reliable but has only moderate sensitivity compared to other GC detectors. It is less sensitive than detectors like FID and ECD.
- **C. HPLC-PDA (Photo Diode-Array Detector):** This is a UV-Vis absorbance detector that is quite sensitive for compounds that contain a chromophore (a light-absorbing part). Its sensitivity is significantly better than that of universal detectors like RI and TCD.

- **A. GC-ECD (Electron Capture Detector):** This is a highly selective and exceptionally sensitive detector. It is designed to detect molecules containing electronegative atoms, such as halogens found in pesticides or PCBs. For these target compounds, it is one of the most sensitive detectors available, capable of detecting femtogram (10^{-15} g) amounts.
Step 2: Form the sequence.
Based on this established hierarchy of sensitivity, the correct order from least sensitive to most sensitive is: HPLC-RI ¡ TLC ¡ GC-TCD ¡ HPLC-PDA ¡ GC-ECD.
Translating this order into the given letter codes results in the sequence E $\rightarrow$ B $\rightarrow$ D $\rightarrow$ C $\rightarrow$ A.

Quick Tip

As a rule of thumb for sensitivity: Universal detectors (RI, TCD) are often less sensitive than selective detectors (PDA, ECD). The **Electron Capture Detector (ECD)** is famously sensitive for specific classes of compounds like pesticides and PCBs.

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56. The Gustafson Method is used to calculate the age of human beings":
(1) Above 21 years
(2) Upto 10 years
(3) Foetus in womb
(4) Between 10-20 years

Correct Answer: (1) Above 21 years

Solution: To answer this question, we must understand what the Gustafson Method is and the population for which it is applicable.
Step 1: Understand the Gustafson Method. Gustafson's method is a well-known technique in forensic odontology (forensic dentistry) used to estimate the chronological age of an individual.
Step 2: Identify the basis of the method. The method is not based on developmental markers (like tooth eruption, which is used for children) but on degenerative, age-related changes that occur in adult teeth over time. Gustafson identified six key regressive changes to score:

1. Attrition: The wear and tear on the chewing surfaces of the teeth.
2. Periodontosis: The recession of the gum line, exposing more of the root.
3. Secondary dentin formation: The gradual deposition of dentin inside the pulp cavity, making it smaller.
4. Cementum apposition: The addition of new layers of cementum at the apex of the root.
5. Root resorption: The gradual dissolving of the root tip.
6. Transparency of the root: The dentin at the root tip becomes more translucent with age.

Step 3: Determine the applicable age range. These degenerative changes are only significant and measurable after the permanent dentition is complete and has been in use for

some time. Therefore, the method is specifically designed for estimating the age of adults, generally considered to be individuals **above 21 years** of age. For younger individuals (fetuses, children, adolescents), age is estimated using developmental charts for tooth formation, eruption, and bone fusion.

Quick Tip

Remember, methods for age estimation are different for developing individuals versus adults. **Developmental** methods (tooth eruption, bone growth) are for the young. **Degenerative** methods (tooth wear, arthritis), like Gustafson's, are for adults.

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57. Which acid is known as aqua fortis?
(1) Sulphuric acid
(2) Nitric acid
(3) Hydrochloric acid
(4) Carbonic acid

Correct Answer: (2) Nitric acid

Solution: The question asks for the modern chemical name of the substance historically known as "aqua fortis."
Step 1: Understand the term. "Aqua fortis" is a historical name originating from the time of alchemists. It is a Latin phrase that translates directly to "strong water."
Step 2: Identify the acid. This name was given to the acid due to its powerful corrosive nature and its ability to dissolve most metals known at the time, with the notable exception of gold. The acid renowned for these properties and historically called aqua fortis is nitric acid, with the chemical formula HNO_3.
Step 3: Evaluate the options. By comparing this historical knowledge with the modern chemical names provided in the options, it is clear that nitric acid is the correct answer. It is also worth noting that a mixture of nitric acid and hydrochloric acid was named "aqua regia" or "royal water" by alchemists because it was even more powerful, capable of dissolving gold.

Quick Tip

Remember these historical alchemical names:

- **Aqua Fortis** ("strong water") = **Nitric Acid**
- **Spirit of Salt** = **Hydrochloric Acid**
- **Oil of Vitriol** = **Sulphuric Acid**

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58. The composition of gun powder is:
(1) Potassium nitrate 75%, Sulphur 15%, Charcoal 10%
(2) Nitroglycerin 30%, Nitrocellulose 65%, Mineral jelly 5%

(3) Nitrated wood Cellulose 20%, Potassium Nitrate 60%, Carbon 20%
(4) Nitroglycerin 58%, Nitrocellulose 37%, Mineral jelly 5%

Correct Answer: (1) Potassium nitrate 75%, Sulphur 15%, Charcoal 10%

Solution: The question asks for the composition of traditional "gunpowder." It is important to distinguish this from modern "smokeless powder."
Step 1: Identify the substance. Gunpowder, also commonly known as black powder, is the earliest known chemical explosive and propellant. It is a low explosive, meaning it deflagrates (burns rapidly) rather than detonates.
Step 2: Recall its composition. Black powder is a granular mixture of three key ingredients that each serve a specific role in the chemical reaction:

- **Potassium nitrate (KNO_3), also known as saltpeter:** This is the oxidizer, which supplies the oxygen for the reaction to burn quickly without requiring atmospheric oxygen.
- **Charcoal (primarily Carbon):** This serves as the primary fuel for the reaction.
- **Sulphur:** This acts as a secondary fuel, but more importantly, it lowers the ignition temperature of the mixture, increases the speed of combustion, and helps to stabilize the mixture.

Step 3: Check the proportions. The widely accepted optimal composition for black powder by weight is approximately 75% potassium nitrate, 15% charcoal, and 10% sulfur. Option (1) in the question lists 75% potassium nitrate, 15% sulfur, and 10% charcoal. This ratio is a common and effective variation. In contrast, options (2) and (4) describe double-base smokeless powders (like cordite), which are based on nitroglycerin and nitrocellulose. Option (3) presents an incorrect mixture. Therefore, option (1) is the correct answer representing the composition of classic gunpowder.

Quick Tip

Remember the classic recipe for gunpowder: a 75/15/10 mix of Potassium Nitrate (oxidizer), Charcoal (fuel), and Sulfur (stabilizer). Don't confuse it with modern smokeless powders which are based on nitroglycerin and nitrocellulose.

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59. Which metal poisoning caused Minamata disease which took place in Japan by eating contaminated fish in 1956?
(1) Lead
(2) Arsenic
(3) Mercury
(4) Thallium

Correct Answer: (3) Mercury

Solution: To answer this question, we must recall the specific details of the historical environmental disaster known as Minamata disease.

Step 1: Recall the Minamata disease event. Minamata disease is a severe neurological syndrome caused by heavy metal poisoning. It is named after the city of Minamata in Kumamoto prefecture, Japan, where the poisoning was first discovered in the 1950s.
Step 2: Identify the cause. The source of the poisoning was the release of industrial wastewater from a chemical factory operated by the Chisso Corporation. This wastewater was heavily contaminated with methylmercury, a highly toxic organic compound of mercury.
Step 3: Explain the pathway. The methylmercury was discharged into Minamata Bay and the Shiranui Sea. It was absorbed by microorganisms and then moved up the food chain, becoming increasingly concentrated in fish and shellfish—a process known as biomagnification. The local population, whose diet heavily relied on seafood from the bay, consumed this contaminated fish, leading to the accumulation of toxic levels of mercury in their bodies. This caused severe and often fatal neurological damage.
Step 4: Conclude. Therefore, the specific heavy metal responsible for causing Minamata disease was mercury.

Quick Tip

Associate key poisoning events with their cause:

- **Minamata Disease** → **Mercury** (from fish)
- **Itai-itai Disease** → **Cadmium** (from rice)

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60. Match the LIST-I with LIST-II

LIST-I	LIST-II
A. Ricin	I. Snake venom
B. Abrin	II. Stops protein synthesis
C. Hyaluronidase	III. Used to lull cattle's
D. Histamines	IV. Bee and wasp venom

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

Correct Answer: A correct matching would be A-II, C-I, D-IV. None of the options are fully correct.

Solution: To solve this, we must correctly match each toxic substance in List-I with its source, mechanism of action, or associated description in List-II.
A. Ricin: This is a potent cytotoxin, a type of protein known as a ribosome-inactivating protein (RIP), which is naturally found in the seeds of the castor oil plant. Its mechanism of toxicity is to irreversibly inactivate ribosomes, thereby halting all protein synthesis within a cell, leading to cell death. Thus, **A should correctly match with II**.
B. Abrin: This is another extremely toxic protein, similar to ricin, found in the seeds of the rosary pea. It also functions as a ribosome-inactivating protein and stops protein synthesis. List-II does not provide a unique match for Abrin, as its mechanism is the same as Ricin's. Item III, "Used to lull cattle's," appears to be nonsensical and is likely a typographical error.

C. Hyaluronidase: This is an enzyme frequently found as a component in various venoms, particularly snake venom. It is often referred to as a "spreading factor" because it catalyzes the breakdown of hyaluronic acid, a key component of the extracellular matrix in tissues. This degradation allows other toxins in the venom to penetrate the tissues more rapidly and effectively. Therefore, **C should correctly match with I**.
D. Histamines: These are organic nitrogenous compounds involved in local immune responses. They are a significant component of the venom injected by bees and wasps. Histamines are primarily responsible for the immediate pain, inflammation, swelling, and itching associated with stings. Consequently, **D should correctly match with IV**.
Conclusion: The accurately determined pairings are A-II, C-I, and D-IV. Since none of the provided multiple-choice options reflect this correct set of matches, the question itself is flawed.

Quick Tip

Remember these toxin facts: Ricin and Abrin are plant-derived protein synthesis inhibitors. Hyaluronidase is the "spreading factor" in snake venom. Histamine is the chemical that causes the immediate pain and swelling from bee stings.

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61. Kozelka and Hine test is used to detect
(1) Blood Alcohol
(2) Metallic poisons in blood
(3) Drugs in blood
(4) Blood sugar **Correct Answer:** (1) Blood Alcohol

Solution: The question asks for the specific application of the Kozelka and Hine test in forensic science.
Step 1: Identify the test. The Kozelka and Hine test is a classic, quantitative analytical method from the field of forensic toxicology. It is a wet chemistry technique, meaning it involves reactions in a solution.
Step 2: Determine its purpose. The primary purpose of this method is to determine the concentration of volatile substances, specifically ethanol (beverage alcohol), in biological samples like blood or tissue. The procedure involves isolating the alcohol from the biological matrix, typically through distillation, and then quantifying it using an oxidation-reduction reaction with a standard solution of potassium dichromate. The amount of dichromate consumed is proportional to the amount of alcohol present.
Step 3: Conclude. Therefore, the Kozelka and Hine test is used specifically to detect and quantify Blood Alcohol.

Quick Tip

While modern labs often use Gas Chromatography (GC) for blood alcohol analysis, older chemical methods like the Kozelka and Hine test are historically significant and still valid for demonstrating the principles of alcohol detection.

62. CNS depressant Speed balls are combination of:
(1) Cannabis and cocaine
(2) Alcohol and chloral
(3) Heroin and cocaine
(4) Heroin and opium

Correct Answer: (3) Heroin and cocaine

Solution: To answer this, we need to correctly identify the components of the drug combination known as a "speedball."
Step 1: Define "Speedball". In drug terminology, a "speedball" is a specific mixture of a central nervous system (CNS) stimulant and a CNS depressant, typically an opioid. This combination is usually administered simultaneously, most often through intravenous injection. The question's prefix "CNS depressant Speed balls" is slightly inaccurate, as the mixture's defining characteristic is the presence of *both* a depressant and a stimulant.
Step 2: Identify the classic combination. The most notorious and widely recognized combination referred to as a speedball is the mixture of heroin, which is a powerful opioid depressant, and cocaine, which is a potent stimulant. Users seek the intense initial rush from the cocaine followed by a sustained period of euphoria from the heroin, which is intended to blunt the anxiety and crash associated with the cocaine wearing off.
Step 3: Evaluate the options. Option (3) correctly identifies the mixture of heroin and cocaine. The other options are incorrect: (1) combines a depressant/hallucinogen with a stimulant, (2) combines two depressants, and (4) combines two opioid depressants.

Quick Tip

Think of the name: "Speed" refers to the stimulant (cocaine), and "ball" (as in having a ball, relaxing, or the 'down' effect) refers to the depressant (heroin). The combination produces an intense rush followed by a potent euphoric state.

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63. Which of the following statements are true?
A. Ganja is prepared from dried root and stem
B. Majoon is prepared by combining ganja with opium
C. Ganja is also known as ganjhabhanga
D. Hashish is a viscous oil obtained from Cannabis Sativa
(1) B and D only
(2) B and C only
(3) A and D only
(4) C and D only

Correct Answer: The statements are mostly inaccurate, making the question flawed.

Solution: We must carefully evaluate the accuracy of each statement regarding different products derived from the cannabis plant.

A. Ganja is prepared from dried root and stem: This statement is false. Ganja specifically refers to the dried flowering tops (or buds) of the female cannabis plant. These parts are harvested because they contain the highest concentration of the primary psychoactive compound, tetrahydrocannabinol (THC). The roots and stems contain negligible amounts of THC and are not used to prepare ganja.
B. Majoon is prepared by combining ganja with opium: This statement is false. Majoon is a traditional cannabis-infused edible, often a sweet confection or paste. Its defining ingredient is cannabis, not a combination with opium. While illicit preparations might be adulterated with opium, it is not part of the standard definition of majoon.
C. Ganja is also known as ganjhabhanga: This statement is not standard terminology. "Bhang" is a distinct, less potent preparation made from the mature leaves and seeds of the cannabis plant. Combining the terms "ganja" and "bhanga" is confusing and not a recognized synonym.
D. Hashish is a viscous oil obtained from Cannabis Sativa: This statement is false. Hashish (also known as charas) is the compressed resin, or trichomes, which are scraped or separated from the leaves and flowers of the cannabis plant. It is a solid or semi-solid substance. The viscous oil extracted from cannabis is known as "hash oil" or "cannabis oil," which is a different product derived from the plant or from hashish itself.
Conclusion: Based on the standard and correct definitions of these cannabis products, all four statements contain significant inaccuracies. Therefore, the question is fundamentally flawed as none of the statements can be definitively declared "true."

Quick Tip

Remember the main parts of the cannabis plant used for drugs:

- **Ganja:** Dried flowering tops (buds).
- **Hashish/Charas:** The collected resin.
- **Bhang:** Mature leaves and seeds.

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64. The method which is used for three dimensional reconstruction of crime scene that requires many parts of the crime scene to be measured for determining the height and size of evidence is known as:
(1) Anthropometry
(2) Photogrammetry
(3) Geometry
(4) Micro colourmetry

Correct Answer: (2) Photogrammetry

Solution: The question describes a specific technique for creating a 3D model of a crime scene from which measurements can be taken. We need to identify the correct scientific term for this process.
Step 1: Analyze the description. The key elements of the description are: (a) three-dimensional reconstruction, and (b) determining height and size of evidence by

measuring parts of the scene. This implies using images or photographs to create a measurable 3D model.
Step 2: Define the terms.
(1) Anthropometry: This is the scientific study and measurement of the human body and its proportions. It is used in forensic anthropology for identification but is not a method for reconstructing an entire scene.
(2) Photogrammetry: This is the science of making measurements from photographs. The process involves taking overlapping photographs of an object or scene from multiple angles and using software to calculate positions of points to generate a detailed 3D model. This model can then be used to accurately measure distances, sizes, and heights. This definition perfectly matches the process described in the question.
(3) Geometry: This is a fundamental branch of mathematics that deals with points, lines, shapes, and space. While photogrammetry is heavily based on geometric principles, geometry is the underlying theory, not the name of the applied technique itself.
(4) Micro colourmetry: This is the measurement of color on a microscopic scale and is unrelated to 3D scene reconstruction.
Conclusion: The method described, which uses measurements from images to create a 3D reconstruction, is correctly termed Photogrammetry.

Quick Tip

Break down the word: **Photo** (light/picture) + **Gram** (drawing/writing) + **Metry** (measurement). Photogrammetry is literally "measuring from pictures."

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65. Irradiation of a mixture of ethylene and mercury vapor with light of wavelength 253.7nm brings about the dissociation of ethylene. The reaction is an example of:
(1) Chemiluminescence
(2) Bioluminescence
(3) Photosensitized reaction
(4) Internal conversion reaction

Correct Answer: (3) Photosensitized reaction

Solution: To classify this reaction, we must analyze the role of each component—ethylene, mercury vapor, and light.
Step 1: Analyze the process. The core process is the dissociation (breaking apart) of ethylene molecules, which is a chemical reaction. This reaction is initiated by light energy. Crucially, the light at 253.7 nm is not absorbed by the ethylene molecules themselves. Instead, it is absorbed by the mercury vapor atoms. The mercury atoms become electronically excited. These excited mercury atoms then collide with the ethylene molecules, transferring their excess energy. This transferred energy is sufficient to cause the ethylene molecules to dissociate.
Step 2: Define the reaction types.
(1) Chemiluminescence: This is a process where a chemical reaction releases energy in the form of light. The described reaction absorbs light, so this is incorrect.

(2) Bioluminescence: This is simply chemiluminescence that occurs within a living organism (e.g., fireflies). This is incorrect.
(3) Photosensitized reaction: This is a photochemical reaction where the reactant molecule does not directly absorb the light. Instead, another species, the "photosensitizer" (in this case, mercury), absorbs the light energy and then transfers that energy to the reactant molecule, causing the reaction to occur. This definition precisely describes the events in the question.
(4) Internal conversion reaction: This is a photophysical process, not a chemical reaction. It's a non-radiative pathway by which an excited molecule relaxes to a lower energy state without emitting light.
Conclusion: The reaction is a classic example of a photosensitized reaction, where mercury acts as the photosensitizer for the dissociation of ethylene.

Quick Tip

In a photosensitized reaction, think of the sensitizer (mercury) as a "middleman." It absorbs the light energy and then "hands it off" to the reactant (ethylene) to make the reaction happen.

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66. When a person leans up against an object present at the scene of crime and leaves behind the pattern of his or her clothing, is called as:
(1) Biofing impression
(2) Fiber impression
(3) Fabric impression
(4) Ligature impression

Correct Answer: (3) Fabric impression

Solution: The question asks for the correct forensic term for a pattern left by clothing at a crime scene.
Step 1: Analyze the evidence described. The evidence is not just individual threads or a generic mark, but a distinct "pattern" of the clothing. This pattern would reflect the specific weave of the cloth (e.g., plain, twill, satin).
Step 2: Evaluate the options.
(1) Biofing impression: This is not a recognized or standard term in forensic science.
(2) Fiber impression: This term would imply an impression left by a single fiber or a small, unorganized group of fibers. It does not accurately describe the transfer of a structured weave pattern from a whole piece of clothing.
(3) Fabric impression: This term precisely describes an impression, either two-dimensional (a print left in dust or blood) or three-dimensional (an imprint in a soft material like mud or putty), that shows the characteristic weave pattern of a piece of fabric. This is the correct term for the evidence described.
(4) Ligature impression: This refers specifically to a mark or impression left on a surface (most often skin) by a ligature, which is something used for tying or binding, such as a rope, cord, or wire. This is not applicable to a clothing pattern.

Conclusion: The correct and most accurate term for the pattern left behind by clothing is a fabric impression.

> Quick Tip
>
> Distinguish between the levels of detail: Individual strands are **fibers**. The woven pattern of those strands is the **fabric**. The mark left by the weave is a **fabric impression**.

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67. If two bodies named A and B exert force F_{AB} and F_{BA} on each other, the expression $F_{AB} = -F_{BA}$ signifies which law?
(1) Newton's law
(2) Bernoulli's Principle
(3) Boyle's law
(4) Kepler's law

Correct Answer: (1) Newton's law

Solution: We need to identify the physical law represented by the given mathematical expression.
Step 1: Analyze the equation. The equation is $F_{AB} = -F_{BA}$. Let's break down its meaning:

- F_{AB} represents the force that body A exerts on body B.
- F_{BA} represents the force that body B exerts on body A.
- The equals sign (=) indicates that the magnitudes of these two forces are identical.
- The negative sign (-) indicates that the direction of force F_{AB} is exactly opposite to the direction of force F_{BA}.

So, the equation states that the force exerted by A on B is equal in magnitude and opposite in direction to the force exerted by B on A.
Step 2: Identify the corresponding law. This statement is the precise formulation of Newton's Third Law of Motion. This law is commonly paraphrased as, "For every action, there is an equal and opposite reaction." The two forces in the equation, F_{AB} and F_{BA}, constitute an action-reaction pair.
Step 3: Evaluate other options.

- Bernoulli's Principle deals with the relationship between pressure, velocity, and potential energy in a moving fluid.
- Boyle's Law describes the inverse relationship between the pressure and volume of a gas at constant temperature.
- Kepler's Laws describe the motion of planets around the Sun.

None of these other laws are represented by the given equation.
Conclusion: The expression $F_{AB} = -F_{BA}$ is the mathematical representation of Newton's Third Law of Motion.

Quick Tip

Newton's Third Law is the "action-reaction" law. If you push on a wall (action), the wall pushes back on you with an equal force in the opposite direction (reaction). This is why $F_{AB} = -F_{BA}$.

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68. Which of the following acid is also known as spirit of salts?
(1) Sulphuric acid
(2) Nitric acid
(3) Hydrochloric acid
(4) Oxalic acid **Correct Answer:** (3) Hydrochloric acid

Solution: This question asks for the modern chemical name of a substance known by its archaic, alchemical name.
Step 1: Understand the term. The name "spirit of salt" originates from early chemistry. The term "spirit" was often used to describe volatile substances (liquids that evaporate easily) or gases that were distilled or released from a solid.
Step 2: Identify the acid. The name specifically refers to how the substance was historically produced. Alchemists and early chemists prepared this acid by reacting sulfuric acid (then called oil of vitriol) with common table salt (sodium chloride, $NaCl$). The volatile, acidic gas that was produced, hydrogen chloride (HCl), could be dissolved in water to form the acid. Because this potent "spirit" was derived from "salt," it became known as the spirit of salt.
Step 3: Conclude. The modern chemical name for the substance produced by dissolving hydrogen chloride gas in water is hydrochloric acid. Therefore, hydrochloric acid is the substance also known as spirit of salt.

Quick Tip

Link the old name to the source: **Spirit of Salt** comes from reacting an acid with **salt** ($NaCl$) to produce **Hydrochloric Acid**.

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69. Pure alkaloidal cocaine which can also be smoked is commonly known as?
(1) Eve
(2) Crystal
(3) Base ball
(4) Angel dust

Correct Answer: (3) Base ball

Solution: The question asks for a common slang term for the specific form of cocaine that is pure, alkaloidal, and smokable.
Step 1: Differentiate forms of cocaine. Cocaine exists in two main forms in the illicit market. The most common is cocaine hydrochloride, a salt. It is a crystalline powder that is water-soluble, making it suitable for snorting (insufflation) or dissolving for injection. However, its high vaporization temperature makes it inefficient to smoke. The second form is the "base" or alkaloidal form. This is cocaine that has been chemically treated to remove the hydrochloride salt, resulting in a purer, free-alkaloid form.
Step 2: Identify the smokable form. This "base" form of cocaine, commonly known as freebase or crack cocaine, has a much lower melting point, which allows it to be vaporized and smoked for rapid absorption into the bloodstream via the lungs. The question specifically refers to this pure, smokable, alkaloidal form.
Step 3: Evaluate the slang terms. We must check which of the given slang terms refers to this form of cocaine.
- (1) Eve: This is a common slang term for the psychoactive drug MDEA (3,4-methylenedioxy-N-ethylamphetamine), a substance related to MDMA.
- (2) Crystal: This is a very common slang term for crystalline methamphetamine ("crystal meth").
- (3) Base ball: This is a known slang term for freebase or crack cocaine. The term "base" in the name directly refers to the chemical nature of the substance (cocaine base).
- (4) Angel dust: This is the most common slang term for the dissociative anesthetic drug PCP (Phencyclidine).
Conclusion: Among the choices provided, "Base ball" is the slang term that correctly identifies the pure alkaloidal, or base, form of cocaine that is suitable for smoking.

Quick Tip

Cocaine salt (powder) is for snorting. Cocaine **base** is for smoking. Slang terms like "free**base**", "crack", and "(**base**)ball" all refer to this smokable form.

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70. Match the LIST-I (CPO) with LIST-II (Motto)

LIST-I	**LIST-II**
A. CRPF	I. Seva aur Nishtha
B. SSB	II. Seva Parmo Dharma
C. ITBP	III. Shaurya, Dridhata, Karm Nishtha
D. Assam Rifles	IV. Sanrakshan, Seva, Samikshan

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

Correct Answer: A-I and C-III are correct pairings. The question is flawed as other mottos are incorrect for the given forces.

Solution: To answer this question, we must match each Central Police Organisation (CPO) or paramilitary force from LIST-I with its official motto from LIST-II.

A. CRPF (Central Reserve Police Force): The official and long-standing motto of the CRPF is "**Seva aur Nishtha**," which translates to "Service and Loyalty." Therefore, **A correctly matches with I**.
B. SSB (Sashastra Seema Bal): The official motto of the SSB is "Seva, Suraksha, Bhaichara," meaning "Service, Security, Brotherhood." The motto listed as II, "Seva Parmo Dharma" ("Service is the highest duty"), is actually the motto of the BSF (Border Security Force). Therefore, **the pairing of B with II is incorrect**.
C. ITBP (Indo-Tibetan Border Police): The motto of the ITBP is "**Shaurya, Dridhata, Karm Nishtha**," which translates to "Valour, Determination, Devotion to Duty." Therefore, **C correctly matches with III**.
D. Assam Rifles: The official motto of the Assam Rifles is "Sentinels of the North East." The phrase listed as IV, "Sanrakshan, Seva, Samikshan," is not the official motto of any major CPO. Therefore, **the pairing of D with IV is incorrect**.
Conclusion: Based on official information, only the pairings A-I and C-III are correct. Since the mottos provided for SSB and Assam Rifles are incorrect, none of the comprehensive options can be fully correct, indicating a flaw in the question's construction.

Quick Tip

It's useful to learn the mottos of major forces:

- **CRPF:** Seva aur Nishtha
- **BSF:** Seva Parmo Dharma (Duty Unto Death)
- **ITBP:** Shaurya, Dridhata, Karm Nishtha
- **SSB:** Seva, Suraksha, Bhaichara

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71. Arrange in the proper sequence the process/procedure for making paper.
A. The pulp is cooled in large digesters.
B. The pulp is sent to refiners where the fibers are cut to a standard size.
C. It is bleached and put into a beater where color and size can be added.
D. It is blown under pressure to separate the fibers and remove extraneous materials.
E. The paper is dried and calendered.
(1) A, B, C, D, E
(2) A, D, C, B, E
(3) A, C, B, D, E
(4) A, C, D, B, E

Correct Answer: None of the options present a fully logical sequence. A more plausible sequence would be D $\rightarrow$ B $\rightarrow$ C $\rightarrow$ E.

Solution: To determine the correct sequence, we need to understand the logical progression of the industrial papermaking process, from raw material to finished product.
Step 1: Pulping. The initial stage involves breaking down the raw material (e.g., wood chips) into a fibrous slurry called pulp. This is typically done by cooking the material under pressure in a large vessel called a digester.

- **D.** After cooking, the contents of the digester are "blown under pressure" into a tank. This rapid pressure change helps to separate the cellulose fibers and remove lignin and other unwanted materials. This is one of the first steps after cooking.
- **A.** The pulp is cooled. This would logically happen after the high-temperature cooking and blowing stages.

Step 2: Stock Preparation. The raw pulp is then processed to achieve the desired characteristics for the final paper.

- **B.** The pulp is sent to refiners. In this mechanical process, the fibers are frayed and partially cut, which increases their surface area and flexibility, promoting better bonding in the final paper sheet.
- **C.** It is bleached (to whiten it) and put into a beater where additives like sizing agents (to control water resistance) and color dyes can be mixed in thoroughly.

Step 3: Papermaking and Finishing. The prepared pulp suspension, now called "furnish," is made into paper.

- **E.** The furnish is formed into a continuous sheet, pressed to remove water, and then run through a series of heated rollers to be dried. Finally, it is calendered (passed through smooth, heavy rollers) to achieve the desired smoothness and thickness.

Conclusion: A logical sequence for these specific steps would be something like D $\rightarrow$ A $\rightarrow$ B $\rightarrow$ C $\rightarrow$ E. Since none of the provided options match this logical flow, and all options incorrectly start with step A ("The pulp is cooled"), the question and its options are flawed. Cooling cannot be the first step; it must follow the heating/cooking process.

Quick Tip

The basic paper making process is: **Pulping** (making the slush) $\rightarrow$ **Beating/Refining** (preparing the pulp) $\rightarrow$ **Forming** (making the sheet on a screen) $\rightarrow$ **Drying/Finishing** (pressing and smoothing).

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72. The United States Department of Justice started a training programme called ICITAP mainly to train police officers of which part of the world?
(1) Middle East
(2) Indian Subcontinent
(3) Oceania
(4) Latin America

Correct Answer: (4) Latin America

Solution: The question asks about the primary initial geographical focus of the U.S. Department of Justice's ICITAP program.
Step 1: Identify ICITAP. ICITAP is the acronym for the International Criminal Investigative Training Assistance Program. It is a key foreign assistance organization within the U.S. Department of Justice.

Step 2: Understand its initial focus. ICITAP was established in 1986. Its creation was part of a broader U.S. foreign policy initiative during the Cold War era. The program's primary mission at its inception was to support and strengthen emerging democracies by helping them develop professional, accountable, and human rights-respecting civilian police forces. The initial and most significant focus of these efforts was in Latin America, particularly in Central American countries like El Salvador, which were transitioning from civil wars and military dictatorships to democratic governance.
Step 3: Conclude. Although ICITAP has since expanded its operations to become a global program working in many regions, it was started mainly to provide training and assistance to police organizations in Latin America.

Quick Tip

ICITAP's origins are rooted in the U.S. foreign policy of the 1980s, which strongly focused on promoting democracy and stability in Central and South America.

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73. The Cobra battalion works under the operational command of which of the following Police organization?
(1) SSB
(2) CRPF
(3) ITBP
(4) CISF

Correct Answer: (2) CRPF

Solution: The question asks to identify the parent organization of the CoBRA battalions.
Step 1: Define CoBRA. CoBRA is an acronym for Commando Battalion for Resolute Action. It is a highly specialized elite unit of a Central Armed Police Force in India. CoBRA personnel are extensively trained in guerrilla warfare, jungle warfare, and counter-insurgency operations.
Step 2: Identify its parent organization. The CoBRA units were specifically created and established as an integral and specialized wing of the Central Reserve Police Force (CRPF). Their primary mandate is to counter the Naxalite-Maoist insurgency in India, operating in the challenging jungle terrain where these groups are active.
Step 3: Conclude. Therefore, the CoBRA battalion is not an independent entity but works directly under the operational command and administrative control of the CRPF.

Quick Tip

Think of CoBRA as the CRPF's specialized jungle warfare commando wing, similar to how other services have their own special forces units.

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74. The Ministry which governs BSF is :
(1) Ministry of Defense

(2) Ministry of Home Affairs
(3) Ministry of Foreign Affairs
(4) Directly under PMO

Correct Answer: (2) Ministry of Home Affairs

Solution: To answer this, we need to understand the administrative structure of India's security forces.
Step 1: Identify BSF. The BSF, or Border Security Force, is India's primary border guarding organization. It is tasked with guarding India's land border during peacetime and preventing transnational crime.
Step 2: Classify the BSF. The BSF is classified as one of the seven Central Armed Police Forces (CAPFs) of India. Other CAPFs include the CRPF, CISF, ITBP, and SSB. These forces are distinct from the Indian Armed Forces (Army, Navy, Air Force).
Step 3: Determine the governing body. In the Indian governmental structure, the Indian Armed Forces are under the command of the Ministry of Defence. The Central Armed Police Forces, which handle internal security, border guarding, and disaster relief, fall under the administrative control of the Ministry of Home Affairs (MHA).
Conclusion: As a Central Armed Police Force, the BSF is governed by and reports to the Ministry of Home Affairs.

Quick Tip

A simple rule for Indian forces: The Army, Navy, and Air Force are under the Ministry of **Defence**. The Central Armed Police Forces (BSF, CRPF, ITBP, etc.) are under the Ministry of **Home Affairs**.

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75. The Headquarters of Assam rifles is located at:
(1) Shillong
(2) Dibrugarh
(3) Guwahati
(4) New Delhi **Correct Answer:** (1) Shillong

Solution: The question asks for the location of the headquarters of the Assam Rifles.
Step 1: Identify the Assam Rifles. The Assam Rifles is the oldest paramilitary force of India, with its origins tracing back to a unit raised in 1835. It plays a dual role of maintaining internal security in the Northeastern region and guarding the Indo-Myanmar border. While it is under the administrative control of the Ministry of Home Affairs, its operational control falls under the Indian Army.
Step 2: Locate its headquarters. The administrative headquarters of the force, known as the Directorate General of Assam Rifles (DGAR), is located in Shillong, the capital city of the state of Meghalaya. This location has historically been a key administrative and military center in Northeast India.
Conclusion: The headquarters of the Assam Rifles is located at Shillong.

Quick Tip

The Assam Rifles are known as the "Sentinels of the North East." It's fitting that their headquarters is located in a major city central to the region: Shillong.
