PROVE UFFICIALI DEGLI ANNI PASSATI

IMAT 2026

A B ✓ D E

SVOLTA CON SOLUZIONI COMMENTATE

Il perché di ogni risposta

WHAT'S IN THIS DOCUMENT

Prova di ammissione IMAT 2026, pubblicata dal Ministero dell'Università e della Ricerca (accessoprogrammato.mur.gov.it). Versioni, soluzioni e commenti di TestBuddy, che non è collegata al Ministero.

- The questions with the answers in random order
- Under each question the correct answer and why every other answer is wrong

Reading skills and knowledge acquired during studies	1 questions
Questions	43 questions
Logical reasoning and problem-solving	5 questions
Biology	1 questions
Chemistry	6 questions
Physics and Mathematics	4 questions
Total	**60 questions**

HOW TO USE IT

1 · TIMED

Give yourself about a minute and a half per question, no notes, as in the exam.

2 · CHECK

Mark the wrong answers and read why each one is wrong, not only the right one.

3 · REVIEW

Go back to the topics where you made most mistakes and redo the questions in the app.

READING SKILLS AND KNOWLEDGE ACQUIRED DURING STUDIES

1 **Fake news is not a new problem in communication. Deceptive communication has always existed: after the first sin recounted in the Bible, Adam and Eve clumsily try to hide their transgression from God; soon afterwards, Cain once again tries to deceive God about the murder of his brother Abel. The insightful scholar Gregory Bateson (1972; Italian trans. 1976, pp. 160–161) observed that animals communicate with a naturalness and innocence that human beings have lost, since human behaviour "is corrupted by deceit — even self-deceit — by purpose, and by self-consciousness." The capacity to lie is therefore bound up with the superior cognitive abilities of human beings and presupposes a high degree of awareness and reflexivity. This makes human communication immensely richer and more multifaceted than animal communication, but at the same time more demanding, opaque, duplicitous, and exposed to the risk of domination and deception.**

Tracing back through the history of fake news, the historian Robert Darnton (2017) assembled a selection of cases ranging from the early Middle Ages to eighteenth-century France, among which the malicious rumours that shaped the reputation and fate of Queen Marie Antoinette are particularly striking. Again with reference to France, the historian of the Revolution Georges Lefebvre devoted a famous book to the phenomenon of the "Great Fear", which spread with lightning speed through certain rural regions in the summer of 1789 on the basis of unchecked rumours about an aristocratic conspiracy, an imminent foreign invasion, and bands of brigands who were killing people and destroying crops; these rumours led the peasants to arm themselves and rise up against the aristocracy (1932).

But all ages have had their share of fake news, including important cases, such as the forged Donation of Constantine, a medieval apocryphal document used to legitimise the temporal power of the Church and only debunked many centuries later, in 1517, by the humanist Lorenzo Valla on the basis of its historical and linguistic inconsistencies.

Translated from G. Gili e G. Maddalena, Post-verità e fake news: radici, significati attuali, inattesi protagonisti e probabili vittime, in Media Education. Studi, ricerche e buone pratiche, 9 (2018), pp. 1-16

According to the text, the phenomenon of fake news:

A Is due to the human capacity to always distinguish the truth

B Is the result of a historical process that began in the Middle Ages

C Has deep historical roots, but technically began in 1789

D Acquired a different role in the modern age, because only in the modern age have people come to understand that human beings and animals are distinct

E Has always existed, albeit in different forms

Correct answer: E

The text states that deceptive communication has always existed and notes that all eras have experienced similar phenomena. Historical examples from biblical narratives to medieval forgeries demonstrate that misleading information has consistently emerged in various contexts. Human cognitive traits enable complex interaction but also introduce risks of manipulation. Therefore, the issue reflects a pattern of historical continuity rather than a recent development.

Why the other answers are wrong

- **A) Is due to the human capacity to always distinguish the truth**: The passage associates misleading information with the human ability to lie, not with an innate skill to identify facts. It emphasizes reflexivity and purposeful behavior instead.

- **B) Is the result of a historical process that began in the Middle Ages**: The text traces misleading narratives back to pre-medieval accounts like Genesis. Attributing the origin solely to the Middle Ages ignores these earlier documented cases.
- **C) Has deep historical roots, but technically began in 1789**: The option incorrectly claims a technical starting point in 1789. The text explicitly provides earlier instances that prove this anachronistic start is inaccurate.
- **D) Acquired a different role in the modern age, because only in the modern age have people come to understand that human beings and animals are distinct**: This choice misinterprets the comparison between humans and animals. The author uses animal communication to highlight lost innocence, not to define modern self-awareness or assign a new role to falsehoods.

QUESTIONS

2 **Read the text and answer the question only on the basis of the information it contains explicitly or implicitly and not on what you already know about the topic.**
Why is it that we worship sacrifice in a mother? Where did this inhuman idea of maternal self-immolation come from? From mother to daughter, for centuries, servitude has been handed on. It is a monstrous chain. At some point in life, all of us become conscious of all that the woman who bore us did for our sake; and with that consciousness comes the remorse of not having adequately repaid her total sacrifice. Then we lavish upon our children all that we did not give our mothers, denying ourselves and offering a fresh example of mortification, of self-annihilation. If only, once and for all, that fatal chain were broken, and a mother did not suppress the woman within herself, and a child were to behold in her an example of dignity. Then one would begin to understand that the duty of parents begins long before the birth of their children, and that their responsibility must be felt beforehand, precisely at that moment when selfish life presses most imperiously, most seductively.
Translated from S. Aleramo, Una Donna, Feltrinelli, Milano, 2002
In which of the following does Aleramo identify the reason why mothers' self-sacrifice is perpetuated?

- **A** **From one generation to the next, women hand down a condition of servitude associated with motherhood**
- B From one generation to the next, children learn from their mothers an example of dignity
- C From one generation to the next, parental responsibility, especially that of mothers, begins before a child is born
- D From one generation to the next, a condition is handed down that leads daughters to rebel against their mothers
- E From one generation to the next, women deny their own children and offer an example of mortification

Correct answer: A

The text explains that **servitude** passes from mother to daughter, establishing a continuous **cycle**. Daughters experience **remorse** regarding past sacrifices and **repeat** the same pattern of self-denial when they have children.

Why the other answers are wrong

- **B) From one generation to the next, children learn from their mothers an example of dignity**: Showing dignity is framed as a potential outcome that would only occur once the historical chain is broken.
- **C) From one generation to the next, parental responsibility, especially that of mothers, begins before a child is born**: Acknowledging responsibility before birth is proposed as a preventive measure to break the cycle, not as the cause of its continuation.
- **D) From one generation to the next, a condition is handed down that leads daughters to rebel against their mothers**: The described cycle involves remorse and repetition across generations, not active rebellion against mothers.
- **E) From one generation to the next, women deny their own children and offer an example of mortification**: The passage explicitly states that women deny themselves rather than denying their children.

3 **Read the text and answer the question only on the basis of the information it contains explicitly or implicitly and not on what you already know about the topic.**

"[...] The enduring European pre-eminence of Italian literature has coincided with its ability to act as a crossroads of cultures. We forget this too often, just as we forget the fact that the very first book printed in Arabic type was produced not in Syria or Egypt, but in Rome in 1514. [...] It is the cities that have been the pivot around which the history of our country has turned, and not only its literary history. If books are readily written in villas, it is in the bustle of urban centres that people meet and ideas spread."

Translated from Luzzatto, Pedullà, Atlante della letteratura italiana, Introduzione, Einaudi, Torino, 2010-2012

The polycentric character of Italian culture is primarily due to:

A the flourishing of cities, where people meet and books are written

B **The flourishing of cities, where people meet and ideas spread.**

C the spread of ideas between town and countryside

D the possibility of writing in peace in order to sustain literary life in the cities

E both the flourishing of cities and the tranquillity of villas outside the city

Correct answer: B

The passage identifies **cities** as the pivot of Italian history. In urban centres, people **meet** and **ideas spread**, which explains the polycentric character of Italian culture.

Why the other answers are wrong

- **A) the flourishing of cities, where people meet and books are written**: The passage associates writing books with villas, while cities are where people meet and ideas spread.
- **C) the spread of ideas between town and countryside**: The passage describes ideas spreading in urban centres, not between cities and the countryside.
- **D) the possibility of writing in peace in order to sustain literary life in the cities**: The passage does not say that peaceful writing sustains literary life in cities. It contrasts writing in villas with the meetings and exchange of ideas in urban centres.
- **E) both the flourishing of cities and the tranquillity of villas outside the city**: Villas are mentioned as places where books may be written, not as an equal source of cultural exchange. The passage presents cities as the places where people meet and ideas spread.

4 **The economic system in which digital technologies, the Internet and ICT (nformation and Communication Technologies) are central to production, distribution and exchange is commonly referred to as:**

A The mobile systems economy
B The big data economy
C The technological economy
D The global economy
E The digital economy

Correct answer: E

The **digital economy** describes a system where **digital technologies**, the **Internet**, and **ICT** drive core market activities. This framework covers how goods and services are produced, distributed, and exchanged.

Why the other answers are wrong

- **A)** The mobile systems economy is not a recognized academic term for this concept.
- **B)** The big data economy highlights the commercial value of massive datasets, which represents only one application within the wider digital framework.
- **C)** The technological economy is a vague label that does not specifically denote systems reliant on internet and communication networks.
- **D)** The global economy refers to international trade and financial flows across borders, without emphasizing the specific role of digital infrastructure.

LOGICAL REASONING AND PROBLEM-SOLVING

5 **In the sequence $1, 2, 5, x, 29, 70, 169, \ldots$, what is the value of x?**

A 24
B 16
C **12**
D 11
E 8

Correct answer: C

The sequence follows a **recurrence relation** where each term equals **twice the previous term plus the one before it**. Applying this rule confirms $5 = 2(2) + 1$. Calculating the unknown position gives $x = 2(5) + 2 = 12$. The pattern remains consistent with $29 = 2(12) + 5$ and $70 = 2(29) + 12$.

Why the other answers are wrong

- **A) 24**: Substituting the terms into $2(5) + 2$ yields 12, ruling out 24.
- **B) 16**: Computing $2(5) + 2$ results in 12, which does not equal 16.
- **D) 11**: The expression $2(5) + 2$ evaluates to 12, so 11 is incorrect.
- **E) 8**: Following the established rule produces 12, leaving 8 as an invalid choice.

6 **Which of the following is a true logical proposition?**

A A square has three diagonals
B A pentagon has six diagonals
C A triangle has two diagonals
D **A hexagon has nine diagonals**
E An octagon has eighteen diagonals

Correct answer: D

The general **polygon** diagonal count follows the **formula** $n(n-3)/2$. Substituting $n = 6$ for a **hexagon** yields $6(6-3)/2 = 9$, confirming nine diagonals.

Why the other answers are wrong

- **A) A square has three diagonals**: A square uses $n = 4$, resulting in $4(4-3)/2 = 2$ diagonals instead of three.
- **B) A pentagon has six diagonals**: A pentagon uses $n = 5$, resulting in $5(5-3)/2 = 5$ diagonals instead of six.
- **C) A triangle has two diagonals**: A triangle uses $n = 3$, resulting in $3(3-3)/2 = 0$ diagonals instead of two.
- **E) An octagon has eighteen diagonals**: An octagon uses $n = 8$, resulting in $8(8-3)/2 = 20$ diagonals instead of eighteen.

7 **If $s = 3t$ and $t = 9u$ then:**

A $u = s/27$
B $s = 3u$
C $u = 27s$
D $t = 27s$
E $s = 18u$

Correct answer: A

Substitute $t = 9u$ into $s = 3t$ to obtain $s = 3(9u) = 27u$. **Divide** both sides by 27 to isolate u, yielding $u = s/27$.

Why the other answers are wrong

- **B)** $s = 3u$: Incorrect because the combined multiplication **factor** is 27, not 3.
- **C)** $u = 27s$: Incorrect because the derived relationship is $s = 27u$, not $u = 27s$.
- **D)** $t = 27s$: Incorrect because the initial condition $s = 3t$ means $t = s/3$, contradicting any scaling upward.
- **E)** $s = 18u$: Incorrect because $3 \times 9 = 27$, not 18.

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8 **20% of a company's employees work part-time. The rest work full-time. At the end of the year, 20% of the full-time employees receive a bonus. If 48 employees received the bonus, how many employees does the company have?**

A **300**
B 96
C 150
D 600
E 1200

Correct answer: A

Since 80% of employees work full-time and 20% of those receive a bonus, bonus recipients make up $0.80 \times 0.20 = 0.16$ of all employees. The company has $48/0.16 = 300$ employees.

Why the other answers are wrong

- **B) 96**: With 96 employees, $96 \times 0.16 = 15.36$ would receive a bonus, not 48.
- **C) 150**: With 150 employees, $150 \times 0.16 = 24$ would receive a bonus, not 48.
- **D) 600**: With 600 employees, $600 \times 0.16 = 96$ would receive a bonus, not 48.
- **E) 1200**: With 1200 employees, $1200 \times 0.16 = 192$ would receive a bonus, not 48.

9 **Based on the statements:**
"Some felines are carnivores. Carnivores eat meat."
Which of the following statements is correct?

A Meat is the favourite food of animals
B **Some animals are carnivores**
C Animals cannot survive without meat
D Not all animals eat meat
E All animals eat meat

Correct answer: B

The premises state that **some felines** are **carnivores**. Since felines belong to the broader class of **animals**, this logical chain proves that a portion of animals share that trait. Consequently, the only valid inference is that **some animals** meet the description.

Why the other answers are wrong

- **A) Meat is the favourite food of animals**: Describing a behavioral habit does not establish an emotional preference or favorite status.
- **C) Animals cannot survive without meat**: Biological survival needs are never introduced in the premises, making any claim about necessities a pure assumption.
- **D) Not all animals eat meat**: The provided statements give no information about non-carnivore diets, leaving the question of meat avoidance completely unresolved.
- **E) All animals eat meat**: The original text only defines traits of carnivores, so it cannot justify a universal claim covering every animal.

BIOLOGY

10 **What is the main function of red blood cells in the blood?**

- A To transport CO_2 to the liver
- B To regulate body temperature
- C To fight infections
- D To clot the blood
- **E To transport oxygen to the tissues**

Correct answer: E

Red blood cells contain **hemoglobin** to bind **oxygen** in the lungs. This specialized protein delivers the gas efficiently to peripheral tissues for cellular metabolism.

Why the other answers are wrong

- **A) To transport CO_2 to the liver**: Erythrocytes carry CO_2 but direct it toward pulmonary exhalation instead of hepatic processing.
- **B) To regulate body temperature**: Thermoregulation relies on general blood volume shifts near the skin, not a direct erythrocyte function.
- **C) To fight infections**: Pathogen defense is strictly managed by leukocytes and associated immune cells.
- **D) To clot the blood**: Coagulation requires activated platelets and soluble clotting factors in plasma.

QUESTIONS

11 **Which structure of the respiratory system is the primary site of gas exchange?**

A Aorta
B **Alveoli**
C Left atrium of the heart
D Diaphragm
E Trachea

Correct answer: B

The **alveoli** are microscopic air sacs located at the terminal branches of the respiratory tree. They are densely enveloped by pulmonary capillaries and possess exceptionally thin epithelial layers. This anatomical configuration enables rapid diffusion of oxygen into the circulation and carbon dioxide removal from the blood.

Why the other answers are wrong

- **A) Aorta**: The aorta carries oxygenated blood from the left ventricle to the systemic circulation and lacks any respiratory function.
- **C) Left atrium of the heart**: The left atrium collects oxygen-rich blood returning via the pulmonary veins to forward it to the left ventricle.
- **D) Diaphragm**: The diaphragm provides the mechanical force needed for lung inflation during ventilation cycles.
- **E) Trachea**: The trachea acts only as a rigid conductive tube that transports inspired air toward the bronchi.

12 **What is the primary function of flagella in prokaryotic cells?**

A To aid in cell division
B To transport materials within the cell
C To allow the cell to move
D To facilitate the exchange of genetic material between cells
E To help the cell adhere to other cells

Correct answer: C

Flagella are long, rotating structures that **propel** prokaryotic cells through their environment. Their primary biological role is to enable cellular **motility** for navigating chemical gradients and seeking nutrients.

Why the other answers are wrong

- **A) To aid in cell division**: Flagella do not participate in partitioning cellular components. Cellular reproduction relies on internal protein rings and peptidoglycan synthesis rather than external appendages.
- **B) To transport materials within the cell**: Intracellular trafficking depends on vesicular transport and cytoplasmic motors, whereas flagella operate exclusively outside the plasma membrane as mechanical drives.
- **D) To facilitate the exchange of genetic material between cells**: DNA exchange requires specialized **conjugation pili** that form temporary physical bridges between donor and recipient cells during bacterial mating.
- **E) To help the cell adhere to other cells**: Surface attachment relies on **fimbriae**, which are short adhesive fibers distinct from the long helical tails used for propulsion.

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13 **What is the primary digestive function of the stomach?**

A To transport food to the large intestine
B To produce bile
C To absorb nutrients
D To filter toxins
E To break down food using enzymes and acids

Correct answer: E

The stomach mixes food with **gastric acid** and **digestive enzymes**, beginning its chemical breakdown, especially of proteins.

Why the other answers are wrong

- **A) To transport food to the large intestine**: The stomach passes partially digested food to the **small intestine**, not the large intestine.
- **B) To produce bile**: Bile is produced by the **liver**, not by the stomach.
- **C) To absorb nutrients**: Most nutrient absorption occurs in the **small intestine**.
- **D) To filter toxins**: Detoxification of toxins is primarily a function of the **liver**.

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14 **What is the primary site of protein translation in prokaryotic cells?**

A Between the plasma membrane and the cell wall
B In the nucleus
C **On ribosomes in the cytoplasm**
D On the plasma membrane
E In the flagellum

Correct answer: C

Prokaryotic cells synthesize proteins on **ribosomes** located freely in the **cytoplasm**. The absence of a **nucleus** allows transcription and translation to proceed simultaneously. Free **mRNA** binds directly to these complexes for immediate peptide assembly.

Why the other answers are wrong

- **A) Between the plasma membrane and the cell wall**: The region between the membrane and cell wall facilitates nutrient exchange and osmoregulation, not ribosomal translation.
- **B) In the nucleus**: Prokaryotes completely lack membrane-bound organelles, eliminating any nuclear compartment for genetic processing.
- **D) On the plasma membrane**: Although some ribosomes anchor to the membrane for secretory pathways, free cytoplasmic ribosomes handle the vast majority of protein production.
- **E) In the flagellum**: Flagella serve exclusively for cellular motility and do not contain translational machinery.

15 **Which main components make up the plasma membrane?**

A RNA and amino acids
B Carbohydrates and DNA
C **Phospholipids and proteins**
D Fatty acids and sugars
E Lipids and glycogen

Correct answer: C

The plasma membrane is primarily composed of a **phospholipid bilayer** with **proteins** embedded within or attached to it. Phospholipids provide the fundamental structural barrier, while proteins facilitate essential functions like molecular transport and cellular signaling.

Why the other answers are wrong

- **A) RNA and amino acids**: Neither RNA nor free amino acids build the membrane; amino acids act only as protein building blocks, and RNA handles genetic expression.
- **B)** Carbohydrates appear on the outer surface but are not primary components, whereas DNA remains confined to the nucleus and never forms membrane structures.
- **D)** Fatty acids and sugars modify certain lipids, yet this combination ignores the critical protein component and misses the defining bilayer structure.
- **E) Lipids and glycogen**: While lipids are abundant, glycogen serves exclusively as a cytoplasmic energy reserve and plays no role in membrane architecture.

16 **What is the primary function of channel proteins in the cell membrane?**

A To store energy for active transport
B To transfer DNA out of the cell
C To regulate membrane fluidity
D To permit specific substances to pass through the membrane
E To catalyse protein synthesis

Correct answer: D

Channel proteins form **selective pores** through the lipid bilayer, allowing specific ions or molecules to cross down their **electrochemical gradient** via passive diffusion.

Why the other answers are wrong

- **A) To store energy for active transport**: They do not store energy; active transport relies on carrier proteins like ATP-driven pumps.
- **B) To transfer DNA out of the cell**: Transporting DNA is not performed by channel proteins, which only move small solutes.
- **C) To regulate membrane fluidity**: Membrane fluidity depends primarily on lipid composition and cholesterol concentration.
- **E) To catalyse protein synthesis**: Protein synthesis occurs on ribosomes, not at membrane channels.

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17 **What is the primary function of a tendon?**

A To connect muscles to bones
B To protect the heart
C To control the production of actin
D To transmit nervous impulses to the muscle
E To store energy for the muscle

Correct answer: A

A **tendon** connects a **muscle** to a **bone** and transmits the **force** generated by **contraction**. This arrangement enables movement of the skeleton.

Why the other answers are wrong

- **B) To protect the heart**: Protecting the heart is not a physiological function of tendons. Organ shielding belongs to the rib cage and surrounding tissues.
- **C) To control the production of actin**: Tendons do not control the synthesis of this muscle protein. Actin production is regulated by cellular machinery inside muscle fibers.
- **D) To transmit nervous impulses to the muscle**: Nerves transmit electrical impulses to muscles. Tendons do not handle nervous signaling.
- **E) To store energy for the muscle**: Tendons can temporarily store elastic energy, but their primary function is to connect muscles to bones. Energy retention is a secondary mechanical property.

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18 **Restriction enzymes are:**

A Oxidoreductases
B Ligases
C **Endonucleases**
D Isomerases
E Transferases

Correct answer: C

Restriction enzymes recognize specific DNA sequences and cleave **phosphodiester bonds** within the nucleic acid strand. This internal cutting activity classifies them as **endonucleases**.

Why the other answers are wrong

- **A)** Oxidoreductases mediate redox reactions by shuttling electrons from donors to acceptors.
- **B)** Ligases synthesize covalent bonds to attach separate DNA fragments rather than severing them.
- **D)** Isomerases drive intramolecular rearrangements that reposition atoms within a single compound.
- **E)** Transferases catalyze the transfer of functional groups between distinct molecules.

19 **A bacterium is said to be transformed when:**

A It is able to grow under anaerobic conditions
B **It has taken up foreign DNA directly from the environment**
C It undergoes gene mutations caused by mutagens
D It has a cell wall similar to that of plant cells
E It is engulfed by a macrophage through phagocytosis

Correct answer: B

Bacterial transformation occurs when a microorganism acquires **foreign DNA** directly from its surroundings. This genetic material can integrate into the host chromosome or function as an independent plasmid, enabling new traits without sexual reproduction.

Why the other answers are wrong

- **A) It is able to grow under anaerobic conditions**: Surviving without oxygen depends on alternative metabolic pathways, which describe physiological adaptation instead of environmental DNA import.
- **C) It undergoes gene mutations caused by mutagens**: Treatments with harmful agents trigger random changes in the existing nucleotide sequence, a process defined as mutation rather than horizontal gene transfer.
- **D) It has a cell wall similar to that of plant cells**: Structural composition varies across kingdoms because bacterial surfaces utilize peptidoglycan while plant tissues rely on cellulose, making wall chemistry irrelevant to genetic exchange.
- **E) It is engulfed by a macrophage through phagocytosis**: This mechanism involves host immune cells internalizing pathogens, representing defensive consumption rather than bacterial uptake of external nucleic acids.

20 **The epiglottis is primarily composed of:**

A A vertebra
B A gland
C **Cartilage**
D A muscle
E A nerve

Correct answer: C

The epiglottis is primarily composed of **elastic cartilage**. This flexible tissue forms a protective flap that prevents food and liquids from entering the airway during swallowing.

Why the other answers are wrong

- **A)** A vertebra is a bone belonging to the spinal column and does not constitute the epiglottis.
- **B) A gland**: Glands produce and release substances, whereas the epiglottis is a cartilaginous structure.
- **D) A muscle**: Muscles can help move the epiglottis, but they are not its primary component.
- **E) A nerve**: Nerves transmit electrical signals and do not form the structural framework of the epiglottis.

21 **Which hormone primarily stimulates uterine contractions during labour?**

A Insulin
B **Oxytocin**
C Thyrotropin
D Luteinising hormone
E Follicle-stimulating hormone

Correct answer: B

Oxytocin stimulates **uterine smooth muscle** contractions during labour. Cervical stretching increases oxytocin secretion, which maintains the contraction cycle via **positive feedback**.

Why the other answers are wrong

- **A)** Insulin controls blood glucose metabolism and does not influence uterine activity.
- **C)** Thyrotropin activates the thyroid gland to produce thyroid hormones and serves no function in parturition.
- **D)** Luteinising hormone induces ovulation and regulates steroid hormone synthesis without affecting labour contractions.
- **E)** Follicle-stimulating hormone initiates follicular maturation in the ovaries and is unrelated to contractile mechanisms.

22 **What is the primary role of carbohydrates in cellular catabolism?**

A They are converted into fats for storage

B They are broken down to produce energy for cellular activities

C They are used exclusively for protein synthesis

D They are not involved in energy metabolism

E They are used only as an energy reserve

Correct answer: B

During cellular **catabolism**, carbohydrates enter metabolic routes like **glycolysis** to yield **ATP**. These high-energy molecules directly sustain physiological work.

Why the other answers are wrong

- **A) They are converted into fats for storage**: Incorrect because lipid accumulation activates only during caloric surplus, while immediate oxidative breakdown defines the central catabolic mandate.
- **C) They are used exclusively for protein synthesis**: Incorrect because catabolic breakdown targets ATP generation instead of feeding amino acid assembly or peptide chain construction.
- **D) They are not involved in energy metabolism**: Incorrect because carbohydrates function as primary fuels that directly initiate metabolic cascades rather than remaining metabolically inert.
- **E) They are used only as an energy reserve**: Incorrect because stored polysaccharides must be rapidly hydrolyzed to provide immediate phosphorylating capacity rather than persisting as passive deposits.

23 **Which of the following statements about metabolism is true?**

A It focuses only on the synthesis of molecules

B It is a process that occurs only in animal cells

C It occurs only in the presence of sunlight

D It does not involve chemical reactions

E It includes both catabolism and anabolism

Correct answer: E

Metabolism encompasses all **chemical reactions** inside a **cell** or **organism**. It links **catabolism** that degrades compounds with **anabolism** that synthesizes them.

Why the other answers are wrong

- **A) It focuses only on the synthesis of molecules**: Metabolism also includes the breakdown of molecules alongside synthesis.
- **B) It is a process that occurs only in animal cells**: Plants, fungi, and microorganisms also carry out metabolism.
- **C) It occurs only in the presence of sunlight**: Many metabolic reactions occur without sunlight.
- **D) It does not involve chemical reactions**: Metabolism fundamentally consists of chemical reactions.

24 **What is the main function of enzymes in metabolic reactions?**

A To be consumed during the process

B To speed up reactions without being consumed

C To provide chemical energy for the reactions

D To increase the reaction temperature

E To be transformed into substrates

Correct answer: B

Enzymes are **biological catalysts** that lower the **activation energy** of metabolic reactions. This speeds up the reactions without consuming the enzymes.

Why the other answers are wrong

- **A) To be consumed during the process**: Enzymes are not consumed during the process. They remain available for reuse after a reaction.
- **C) To provide chemical energy for the reactions**: Enzymes catalyse reactions, but they do not supply the chemical energy for them.
- **D) To increase the reaction temperature**: Enzymes speed up reactions without increasing the reaction temperature.
- **E) To be transformed into substrates**: Enzymes act on substrates; they are not transformed into substrates.

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25 **Photosynthesis takes place in which cell organelle?**

A Mitochondrion

B Ribosome

C Nucleus

D Endoplasmic reticulum

E Chloroplast

Correct answer: E

Photosynthesis takes place in **chloroplasts**, which contain **chlorophyll** to capture solar energy. This pigment absorbs light to drive chemical reactions that convert carbon dioxide and water into glucose.

Why the other answers are wrong

- **A) Mitochondrion**: These structures carry out cellular respiration to produce ATP instead of conducting photosynthesis.
- **B) Ribosome**: These organelles synthesize proteins for cellular functions instead of performing photosynthesis.
- **C) Nucleus**: This region stores DNA and regulates gene expression while having no role in light-driven reactions.
- **D) Endoplasmic reticulum**: This network assists in synthesizing and transporting proteins and lipids without capturing solar energy.

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26 **Which organelles are the main site of cellular respiration in eukaryotic cells?**

A Chloroplasts
B Ribosomes
C Lysosomes
D Endoplasmic reticulum
E Mitochondria

Correct answer: E

Mitochondria host the **citric acid cycle** and **oxidative phosphorylation**, which generate most of the cell's **ATP**. These coupled pathways define them as the primary location for aerobic respiration in eukaryotes.

Why the other answers are wrong

- **A) Chloroplasts**: They capture solar energy to fix carbon dioxide during photosynthesis in autotrophic organisms.
- **B) Ribosomes**: They focus exclusively on translating genetic code into polypeptides rather than harvesting energy.
- **C) Lysosomes**: They function as intracellular recycling units that degrade damaged organelles and debris.
- **D) Endoplasmic reticulum**: They specialize in folding nascent proteins and manufacturing membrane lipids.

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27 **Which of the following features distinguishes meiosis from mitosis?**

A It requires the use of microtubules
B It occurs only in unicellular organisms
C It occurs in somatic cells
D The production of genetically diverse haploid cells
E The production of cells is identical to the parent cell

Correct answer: D

Meiosis produces **haploid** cells with half the parent cell's chromosome number. **Crossing over** and **independent assortment** make these cells **genetically diverse**, unlike the cells produced by mitosis.

Why the other answers are wrong

- **A) It requires the use of microtubules**: Both meiosis and mitosis use microtubules to separate chromosomes during division.
- **B) It occurs only in unicellular organisms**: Meiosis occurs in multicellular organisms, including humans, rather than only in unicellular organisms.
- **C) It occurs in somatic cells**: Mitosis occurs in somatic cells, while meiosis occurs in cells that give rise to gametes.
- **E) The production of cells is identical to the parent cell**: Mitosis generally produces daughter cells genetically identical to the parent cell, whereas meiosis does not.

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28 **Which of the following statements about the chromosomal theory of inheritance is true?**

A Chromosomes do not contain genes
B Genes are found only in RNA
C Genes are independent of chromosomes
D Chromosome segregation does not occur during meiosis
E Genes are located on chromosomes

Correct answer: E

According to the chromosomal theory of inheritance, **genes** are specific DNA segments situated on **chromosomes**. This physical positioning explains how traits follow predictable patterns as chromosomes divide and pass to offspring.

Why the other answers are wrong

- **A) Chromosomes do not contain genes**: Chromosomes are physical structures that directly contain genes.
- **B) Genes are found only in RNA**: Genes consist of DNA sequences instead of RNA, and both are carried on chromosomes.
- **C) Genes are independent of chromosomes**: Genes cannot act independently because they are physically located on chromosomes.
- **D) Chromosome segregation does not occur during meiosis**: Homologous chromosomes physically segregate during meiosis I.

29 **Which technique was used by Rosalind Franklin to obtain images of DNA?**

A Electron microscopy
B X-ray crystallography
C Chromatography
D Magnetic resonance imaging
E Electrophoresis

Correct answer: B

Rosalind Franklin used **X-ray crystallography**, specifically X-ray diffraction, to obtain images of DNA fibres. The diffraction patterns provided evidence for DNA's **helical structure**.

Why the other answers are wrong

- **A)** Electron microscopy uses electrons to form images; Franklin's DNA images came from X-ray diffraction.
- **C)** Chromatography separates components of a mixture; it was not the technique used to image DNA.
- **D)** Magnetic resonance imaging uses magnetic fields to image structures; Franklin did not use it for DNA.
- **E)** Electrophoresis separates molecules by their movement in an electric field; it did not produce Franklin's DNA images.

30 **Which of the following statements correctly describes the structure of DNA?**

A It has no hydrogen bonds between the bases

B **It has a double-stranded helical structure.**

C It consists of a single chain of nucleotides

D It contains only two nitrogenous bases

E It is made up of three nucleotide strands

Correct answer: B

DNA consists of two nucleotide strands twisted into a **double helix**. Complementary bases on opposite sides are linked by **hydrogen bonds**.

Why the other answers are wrong

- **A) It has no hydrogen bonds between the bases**: False because complementary bases are specifically connected by hydrogen bonds across the two strands.
- **C) It consists of a single chain of nucleotides**: False because DNA is naturally composed of two paired nucleotide chains rather than a single strand.
- **D) It contains only two nitrogenous bases**: False because the genetic molecule contains four distinct nitrogenous bases: adenine, thymine, cytosine, and guanine.
- **E) It is made up of three nucleotide strands**: False because the stable biological configuration is a double helix formed by exactly two strands, not three.

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31 **Which of the following statements about the haemoglobin in patients with sickle-cell anaemia is true?**

A **Their haemoglobin has a different structure from normal haemoglobin**

B Their haemoglobin does not undergo mutations

C Their haemoglobin is produced in greater quantities

D Their haemoglobin does not transport oxygen

E Their haemoglobin is identical to that found in all individuals

Correct answer: A

HbS has a **different structure** from normal haemoglobin because a mutation in the β-globin gene replaces glutamic acid with valine. At low oxygen levels, HbS can form long fibres.

Why the other answers are wrong

- **B) Their haemoglobin does not undergo mutations**: HbS results from a **mutation** in the gene encoding β-globin. Strictly, genes mutate; haemoglobin proteins do not.
- **C) Their haemoglobin is produced in greater quantities**: Sickle-cell anaemia is not caused by **increased haemoglobin production**.
- **D) Their haemoglobin does not transport oxygen**: HbS still **transports oxygen**, although affected red blood cells can impair oxygen delivery.
- **E) Their haemoglobin is identical to that found in all individuals**: HbS is not identical to normal haemoglobin because its **amino acid sequence** differs.

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32 **Which of the following statements about the structure of messenger RNA is true?**

A mRNA does not carry information for protein synthesis

B mRNA consists of two polynucleotide strands

C mRNA is longer than DNA

D mRNA contains the nitrogenous base thymine

E **mRNA consists of a single polynucleotide strand**

Correct answer: E

Messenger RNA forms a **single polynucleotide chain**. This polymer carries the exact **nucleotide sequence** required to guide ribosomal translation.

Why the other answers are wrong

- **A) mRNA does not carry information for protein synthesis**: It contradicts the core biological role since mRNA actively transports the **codon code** directing amino acid assembly.
- **B) mRNA consists of two polynucleotide strands**: The molecule maintains a linear conformation rather than forming a **double helix** through complementary base pairing.
- **C) mRNA is longer than DNA**: Transcription copies only specific gene segments, making the final transcript substantially shorter than the original **DNA template**.
- **D) mRNA contains the nitrogenous base thymine**: Structural differences arise because RNA molecules substitute **uracil** instead of thymine when pairing with adenine.

CHEMISTRY

33 **Which of the following statements about the Mg^{2+} ion is correct?**

A The Mg^{2+} ion has a larger radius than the Mg atom

B None of the other statements is correct

C The ion has two more electrons than the neutral atom

D **The ion has 8 electrons in its outermost electron shell**

E The two chemical species (the ion and the neutral atom) have the same number of protons, electrons, and neutrons

Correct answer: D

A neutral Mg atom contains 12 electrons with the ground state **configuration** $1s^2 2s^2 2p^6 3s^2$. The ion forms when the atom **loses** its two $3s$ valence electrons. The outermost occupied energy level then becomes the second shell, which holds **eight** electrons.

Why the other answers are wrong

- **A) The Mg^{2+} ion has a larger radius than the Mg atom**: Removal of the outermost electron shell reduces electron-electron repulsion and decreases the overall size, making the cation significantly **smaller** than the original neutral atom.
- **B) None of the other statements is correct**: This option is invalid because statement D accurately describes the electronic structure of the ion.
- **C) The ion has two more electrons than the neutral atom**: The formation of this positive cation involves **losing** electrons rather than gaining them, so the ion actually contains two fewer electrons than the neutral species.
- **E) The two chemical species (the ion and the neutral atom) have the same number of protons, electrons, and neutrons**: Both species retain the same number of protons and neutrons, but the ion possesses two fewer electrons than the neutral atom due to the loss of valence electrons during ionization.

34 **Balance the following reaction equation:** $Cu + HNO_3 \rightarrow Cu(NO_3)_2 + NO + H_2O$

- **A** **3, 8, 3, 2, 4**
- **B** 3, 8, 3, 2, 6
- **C** 3, 8, 3, 1, 4
- **D** None of the other options is correct
- **E** 2, 6, 3, 2, 4

Correct answer: A

Balancing the equation requires 3 copper atoms and 8 nitric acid molecules, giving $3\mathrm{Cu} + 8\mathrm{HNO_3} \rightarrow 3\mathrm{Cu(NO_3)_2} + 2\mathrm{NO} + 4\mathrm{H_2O}$. Each element is properly **balanced** with matching **atoms** on both sides.

Why the other answers are wrong

- **B) 3, 8, 3, 2, 6**: Hydrogen is mismatched as the water coefficient makes 12 H atoms on the right against 8 on the left.
- **C) 3, 8, 3, 1, 4**: Nitrogen is not balanced because the right side contains only 7 N atoms instead of 8.
- **D) None of the other options is correct**: Incorrect because option A already gives the correct **coefficients**.
- **E) 2, 6, 3, 2, 4**: Copper is incorrect since the left side has 2 Cu atoms but the product side requires 3.

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35 **The rate law for the reaction $A + B \rightarrow C$ is:**

- **A** $v = k[A][B]$
- **B** $v = k[C]$
- **C** **To be determined experimentally**
- **D** $v = k[A][B]/[C]$
- **E** $v = k[C]/([A][B])$

Correct answer: C

The chemical equation only shows the **stoichiometry** of the transformation. It does not reveal the **reaction mechanism** or how the **rate** depends on species concentrations. Therefore the rate law must be **determined experimentally** unless the step is explicitly labeled elementary.

Why the other answers are wrong

- **A)** $v = k[A][B]$: This rate law matches the stoichiometry only if the reaction proceeds as a single elementary step. The problem statement does not provide this information.
- **B)** $v = k[C]$: A rate depending solely on the product implies zero-order decay or autocatalysis. The given equation contains no indicators of these conditions.
- **D)** $v = k[A][B]/[C]$: The balanced equation provides no basis for placing product concentration in the denominator. Rate expressions are derived from reactant interactions during the slow step.
- **E)** $v = k[C]/([A][B])$: This functional form suggests inverse reactant dependence and direct product dependence. Such behavior cannot be deduced from the overall stoichiometric coefficients.

36 **How many valence electrons does the Cl^- anion have?**

A 6
B 8
C 7
D 35
E 17

Correct answer: B

Chlorine belongs to **group 17** and holds 7 valence electrons initially. The Cl^- ion **gains** one electron to form. This completes the **outer shell** configuration, yielding 8 valence electrons.

Why the other answers are wrong

- **A)** 6 falls below the 7 valence electrons present in a neutral atom.
- **C)** 7 matches the valence count of neutral chlorine before the additional electron is added.
- **D)** 35 is the approximate atomic mass and does not indicate any electron count.
- **E)** 17 represents the atomic number, counting total protons instead of valence electrons.

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37 **When sodium bromide is dissolved in water, the result is:**

A A strongly basic aqueous solution
B A weakly acidic aqueous solution
C A strongly acidic aqueous solution
D A weakly basic aqueous solution
E A neutral aqueous solution

Correct answer: E

Sodium bromide fully dissociates into Na^+ and Br^-. These ions derive from the **strong base** NaOH and the **strong acid** HBr. Consequently, neither cation nor anion undergoes **hydrolysis**. The equilibrium concentrations of $\mathrm{H_3O}^+$ and OH^- remain equal. The resulting mixture is therefore **neutral**.

Why the other answers are wrong

- **A) A strongly basic aqueous solution**: Br^- is the conjugate base of a strong acid and does not accept protons from water. It cannot generate a significant concentration of OH^-.
- **B) A weakly acidic aqueous solution**: Na^+ has negligible acidity as a closed-shell alkali metal ion. It does not interact with water molecules to release $\mathrm{H_3O}^+$.
- **C) A strongly acidic aqueous solution**: Na^+ is the spectator ion of a strong base and lacks any tendency to donate protons. It cannot increase the $\mathrm{H_3O}^+$ concentration.
- **D) A weakly basic aqueous solution**: Br^- exhibits negligible basicity because its parent compound HBr completely dissociates in aqueous media. The hydrolysis constant is effectively zero.

38 **When sodium acetate is dissolved in water, the result is:**

- **A** **A basic aqueous solution**
- **B** No solution is formed because it does not dissolve
- **C** An acidic aqueous solution
- **D** An alcoholic solution
- **E** A neutral aqueous solution

Correct answer: A

Sodium acetate dissolves completely in water. The **acetate ions** undergo **hydrolysis**, reacting with water to form acetic acid and hydroxide ions: $\mathrm{CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-}$. The released hydroxide ions increase the pH, producing a **basic** solution.

Why the other answers are wrong

- **B) No solution is formed because it does not dissolve**: Sodium acetate is highly soluble in water due to strong ion-dipole interactions.
- **C) An acidic aqueous solution**: Acetate acts as the conjugate base of acetic acid, so it increases the hydroxide concentration rather than the acidity.
- **D) An alcoholic solution**: Dissolving sodium acetate in water does not produce an alcohol.
- **E) A neutral aqueous solution**: The hydrolysis reaction generates hydroxide ions, which shift the pH away from neutrality.

QUESTIONS

39 **Balance the following redox equation:** $PbBr_2 + FeBr_3 \rightarrow PbBr_4 + FeBr_2$

A $PbBr_2 + 3\ FeBr_3 \rightarrow PbBr_4 + 3\ FeBr_2$

B $2\ PbBr_2 + 3\ FeBr_3 \rightarrow 2\ PbBr_4 + 3\ FeBr_2$

C $2\ PbBr_2 + FeBr_3 \rightarrow 2\ PbBr_4 + FeBr_2$

D $PbBr_2 + 2\ FeBr_3 \rightarrow PbBr_4 + 2\ FeBr_2$

E $3\ PbBr_2 + FeBr_3 \rightarrow 3\ PbBr_4 + FeBr_2$

Correct answer: D

Lead increases its **oxidation** state from $+2$ to $+4$ and releases two **electrons**. Each **iron** ion decreases from $+3$ to $+2$ and accepts one electron. Two $\mathrm{FeBr_3}$ units must react with one $\mathrm{PbBr_2}$ unit to satisfy charge conservation. The total number of bromine atoms remains equal on both sides.

Why the other answers are wrong

- **A)** $PbBr_2 + 3\ FeBr_3 \rightarrow PbBr_4 + 3\ FeBr_2$: The coefficients pair one $\mathrm{PbBr_2}$ unit losing two electrons with three $\mathrm{FeBr_3}$ units gaining three electrons. The charge transfer remains unequal.
- **B)** $2\ PbBr_2 + 3\ FeBr_3 \rightarrow 2\ PbBr_4 + 3\ FeBr_2$: The coefficients involve two $\mathrm{PbBr_2}$ units releasing four electrons but only three $\mathrm{FeBr_3}$ units accepting three electrons. The redox balance fails.
- **C)** $2\ PbBr_2 + FeBr_3 \rightarrow 2\ PbBr_4 + FeBr_2$: The coefficients use two $\mathrm{PbBr_2}$ units losing four electrons while a single $\mathrm{FeBr_3}$ unit gains only one electron. The electron exchange does not match.
- **E)** $3\ PbBr_2 + FeBr_3 \rightarrow 3\ PbBr_4 + FeBr_2$: The coefficients employ three $\mathrm{PbBr_2}$ units dropping six electrons while a single $\mathrm{FeBr_3}$ unit captures only one electron. The mismatch invalidates the equation.

40 **Balance the following disproportionation reaction:** $KIO_2 \rightleftharpoons KI + KIO_3$

A $3\ KIO_2 \rightleftharpoons 2\ KI + KIO_3$

B $4\ KIO_2 \rightleftharpoons 2\ KI + KIO_3$

C $3\ KIO_2 \rightleftharpoons KI + 2\ KIO_3$

D $5\ KIO_2 \rightleftharpoons 3\ KI + 2\ KIO_3$

E $4\ KIO_2 \rightleftharpoons 3\ KI + KIO_3$

Correct answer: C

In $\mathrm{KIO_2}$, iodine has an **oxidation state of** $+3$. It **gains four electrons** to form KI with iodine at -1, while another iodine **loses two electrons** to form $\mathrm{KIO_3}$ at $+5$. Therefore, one KI molecule forms for every two $\mathrm{KIO_3}$ molecules. The equation $3\ \mathrm{KIO_2} \rightleftharpoons \mathrm{KI} + 2\ \mathrm{KIO_3}$ correctly balances potassium and oxygen.

Why the other answers are wrong

- **A)** $3\ KIO_2 \rightleftharpoons 2\ KI + KIO_3$: Incorrect because oxygen is not balanced.
- **B)** $4\ KIO_2 \rightleftharpoons 2\ KI + KIO_3$: Incorrect because neither potassium nor oxygen is balanced.
- **D)** $5\ KIO_2 \rightleftharpoons 3\ KI + 2\ KIO_3$: Incorrect because oxygen is not balanced.
- **E)** $4\ KIO_2 \rightleftharpoons 3\ KI + KIO_3$: Incorrect because oxygen is not balanced.

41 **HClO is:**

A An acidic hydroxide
B A hydrohalic acid
C An acid anhydride
D An acidic oxide
E An oxyacid

Correct answer: E

$HClO$ is hypochlorous acid. Because it contains hydrogen, oxygen, and chlorine, it is an **oxyacid**.

Why the other answers are wrong

- **A) An acidic hydroxide**: Hydroxides contain the **hydroxide group** OH^-, while $HClO$ is classified as an acid.
- **B) A hydrohalic acid**: **Hydrohalic acids**, such as HCl, contain hydrogen and a halogen but no oxygen. $HClO$ contains oxygen.
- **C) An acid anhydride**: An **acid anhydride** is an oxide that reacts with water to form an acid. $HClO$ is the acid itself.
- **D) An acidic oxide**: An **acidic oxide** contains oxygen and another element but no hydrogen. $HClO$ contains hydrogen.

42 **Substance A has a higher boiling point than Substance B if:**

A The intermolecular forces in A are stronger than those in B
B The intramolecular forces in A are weaker than those in B
C The intermolecular forces in A are weaker than those in B
D The intramolecular forces in A are stronger than those in B
E The intramolecular forces in A are stronger than those in B, but the intermolecular forces in A are weaker than those in B

Correct answer: A

A higher boiling point indicates stronger **intermolecular forces**. More **thermal energy** is required to overcome these attractions and allow the liquid to become a gas.

Why the other answers are wrong

- **B) The intramolecular forces in A are weaker than those in B**: Chemical bonds within individual molecules remain unchanged during vaporization, making their relative strength irrelevant to boiling point trends.
- **C) The intermolecular forces in A are weaker than those in B**: Diminished attractions between particles reduce the energy needed for separation, directly resulting in a lower boiling point.
- **D) The intramolecular forces in A are stronger than those in B**: Stronger chemical bonds inside molecules do not determine the temperature required to separate different molecules from each other.
- **E) The intramolecular forces in A are stronger than those in B, but the intermolecular forces in A are weaker than those in B**: Boiling separates distinct molecules rather than breaking **internal bonds**, so stronger intramolecular forces do not raise the boiling point, while weaker intermolecular forces lower it.

43 **Pentanones are:**

A Carboxylic acids
B Hydroxyketones
C **Ketones**
D Alcohols
E Lactones

Correct answer: C

Pentanones are five-carbon chains containing a **carbonyl group** ($C=O$) placed within the carbon backbone. This specific positioning classifies them as **ketones**, such as pentan-2-one and pentan-3-one.

Why the other answers are wrong

- **A)** Carboxylic acids terminate with a carboxyl group ($-COOH$), which represents a fully oxidized terminal carbon rather than the internal carbonyl placement found in ketones.
- **B)** Hydroxyketones possess both a ketone functionality and an additional hydroxyl substituent; the name "pentanone" strictly denotes the unmodified ketone without extra oxygenated groups.
- **D)** Alcohols are characterized by a hydroxyl group ($-OH$) bonded to a saturated carbon, entirely lacking the internal $C=O$ double bond required for pentanones.
- **E)** Lactones are cyclic esters formed by intramolecular esterification, differing fundamentally from open-chain carbonyl structures.

44 **Ethene is:**

A An alkyne
B A diene
C An alkenyne
D A non-existent molecule
E **An alkene**

Correct answer: E

Ethene (C_2H_4) contains a **double bond** between carbon atoms. Molecules with this feature are classified as **alkenes**. Its structure matches this category exactly.

Why the other answers are wrong

- **A)** An alkyne features a carbon–carbon triple bond instead of a double bond.
- **B)** A diene requires two carbon–carbon double bonds, unlike ethene which has only one.
- **C)** An alkenyne includes both a double bond and a triple bond in the same molecule.
- **D) A non-existent molecule**: Ethene is a real molecule that exists independently, contrary to the claim.

45 C_3H_6O **can be:**

- **A** **An alcohol, an aldehyde, or a ketone**
- **B** An alcohol or a ketone, but not an aldehyde
- **C** An alcohol or an aldehyde, but not a ketone
- **D** An alcohol, but neither an aldehyde nor a ketone
- **E** An aldehyde or a ketone, but not an alcohol

Correct answer: A

The molecular formula C_3H_6O indicates one degree of unsaturation, allowing multiple structural isomers. These isomers include allyl alcohol ($\mathrm{CH_2=CHCH_2OH}$), which is an **alcohol**. They also include propanal ($\mathrm{CH_3CH_2CHO}$), an **aldehyde**, and propanone ($\mathrm{CH_3COCH_3}$), a **ketone**. Consequently, the formula represents any of these three functional classes.

Why the other answers are wrong

- **B) An alcohol or a ketone, but not an aldehyde**: This option incorrectly excludes aldehydes. The molecular formula accommodates propanal, which contains a terminal carbonyl group.
- **C) An alcohol or an aldehyde, but not a ketone**: This option incorrectly excludes ketones. Propanone is a valid ketone structure that matches the given molecular formula.
- **D) An alcohol, but neither an aldehyde nor a ketone**: This option incorrectly excludes aldehydes and ketones. The formula actually produces propanal as an aldehyde and propanone as a ketone.
- **E) An aldehyde or a ketone, but not an alcohol**: This option incorrectly excludes alcohols. The isomer prop-2-en-1-ol exists within this formula and functions as an unsaturated alcohol.

46 **For an ideal gas undergoing an isothermal process, what happens as the volume increases?**

- **A** The pressure increases in direct proportion
- **B** The temperature increases
- **C** The pressure remains unchanged
- **D** **The pressure decreases in inverse proportion**
- **E** The pressure decreases in direct proportion

Correct answer: D

In an isothermal process the **temperature** remains **constant**. For a fixed mass of ideal gas $PV = nRT$ yields a constant product, so $P \propto 1/V$. As volume expands, pressure **decreases** following an **inversely proportional** trend.

Why the other answers are wrong

- **A) The pressure increases in direct proportion**: Asserts a rise, but gas law dictates that volume expansion causes pressure to fall.
- **B) The temperature increases**: Implies warming, yet the term isothermal strictly forbids thermal variation.
- **C) The pressure remains unchanged**: Claims stability, but constant temperature forces a simultaneous decline in pressure as space widens.
- **E) The pressure decreases in direct proportion**: States linear linkage, whereas the governing equation defines a reciprocal relationship between the two variables.

47 **In an exothermic reaction:**

A The reaction rate is always very high

B The reactants have lower chemical potential energy than the products

C **The products have lower chemical potential energy than the reactants**

D The products have the same chemical potential energy as the reactants

E Heat is absorbed from the surroundings

Correct answer: C

An exothermic reaction releases energy to the surroundings. This energy loss ensures the products retain lower **chemical potential energy** than the reactants.

Why the other answers are wrong

- **A) The reaction rate is always very high**: The quantity of released energy affects thermodynamics, not the **reaction speed** itself.
- **B) The reactants have lower chemical potential energy than the products**: Claiming reactants hold less energy reverses the fundamental direction, which actually characterizes an endothermic pathway.
- **D) The products have the same chemical potential energy as the reactants**: The energies cannot match because the system emits energy, creating a clear difference between the two states.
- **E) Heat is absorbed from the surroundings**: An exothermic process by definition moves **thermal energy** outward instead of absorbing it.

PHYSICS AND MATHEMATICS

48 **Which physical quantity measures how quickly a point particle changes its position over time?**

A Natural angular frequency
B **Velocity**
C Frequency
D Acceleration
E Centripetal acceleration

Correct answer: B

Velocity measures the rate at which a point particle changes its **position** over **time**. It combines both the speed of motion and its specific direction.

Why the other answers are wrong

- **A)** Natural angular frequency defines the angular rate of a system during free oscillations, unrelated to linear translation.
- **C)** Frequency counts how many cycles occur per unit time without indicating spatial movement.
- **D)** Acceleration quantifies how fast velocity changes over time instead of tracking direct location shifts.
- **E)** Centripetal acceleration tracks velocity changes directed toward the centre of a curved path, not the displacement rate.

49 **In which case of relative motion between two observers are Galilean transformations valid?**

A **Uniform rectilinear motion of one observer relative to the other**
B Non-uniform rectilinear motion of one observer relative to the other
C Combined rotational and translational motion of one observer relative to the other
D Uniformly accelerated rectilinear motion of one observer relative to the other
E Rotational motion of one observer relative to the other at constant angular velocity

Correct answer: A

Galilean transformations apply to **inertial frames** moving at **constant relative velocity**. Uniform rectilinear motion satisfies this requirement. Spatial coordinates transform as $x' = x - vt$ while time remains **invariant** $t' = t$. These equations preserve classical mechanics without introducing fictitious forces.

Why the other answers are wrong

- **B)** Non-uniform rectilinear motion involves variable speed over time. Any change in velocity generates acceleration, which excludes the frame from Galilean compatibility.
- **C) Combined rotational and translational motion of one observer relative to the other**: The combined motion inherits the rotational component directly. That specific aspect alone prevents the system from functioning as an inertial reference frame.
- **D) Uniformly accelerated rectilinear motion of one observer relative to the other**: Uniform acceleration violates the constant velocity condition. A linearly accelerating frame introduces fictitious forces that require revised mathematical relations.
- **E)** Rotational motion creates a non-inertial environment even at constant angular velocity. Continuous directional changes produce centripetal acceleration that breaks inertial assumptions.

50 **What is the kinetic energy of an object of mass 20 kg moving at 36 km/h?**

- **A** **1000 J**
- **B** 2500 J
- **C** 200 J
- **D** 2000 J
- **E** 720 J

Correct answer: A

Convert the speed to standard units: $36\ \mathrm{km/h} = 10\ \mathrm{m/s}$. Apply the **kinetic energy** formula $E_k = \frac{1}{2}mv^2$ using the given mass and the converted velocity. The calculation produces $\frac{1}{2} \times 20\ \mathrm{kg} \times (10\ \mathrm{m/s})^2 = 1000\ \mathrm{J}$.

Why the other answers are wrong

- **B) 2500 J**: $2500\ \mathrm{J}$ is too high because substituting the properly converted speed of $10\ \mathrm{m/s}$ yields exactly $1000\ \mathrm{J}$.
- **C) 200 J**: $200\ \mathrm{J}$ is too low and does not result from the correct application of the physical formula.
- **D) 2000 J**: $2000\ \mathrm{J}$ equals mv^2, omitting the required factor of $\frac{1}{2}$.
- **E) 720 J**: $720\ \mathrm{J}$ comes from calculating 20×36, which incorrectly uses the speed in $\mathrm{km/h}$ without conversion.

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51 **If a point particle slides down an inclined plane with friction, its mechanical energy:**

- **A** **decreases**
- **B** increases
- **C** becomes zero
- **D** remains constant
- **E** doubles

Correct answer: A

The sliding particle encounters a **frictional force** that performs **negative work** along the path. This interaction transforms part of the **mechanical energy** directly into **thermal energy**. As a result, the total mechanical energy steadily **decreases**.

Why the other answers are wrong

- **B) increases**: Boosting mechanical energy requires net positive work from external agents or active sources. Sliding with resistive forces strictly drains the system rather than adding to it.
- **C) becomes zero**: Friction continuously extracts energy from motion, but the removal stops once the particle comes to rest. The remaining amount depends on the instantaneous speed and height at that moment, so reaching exactly zero is highly improbable without specific initial conditions.
- **D) remains constant**: Conservation laws hold only when non-conservative forces vanish. Kinetic friction breaks this condition by converting orderly mechanical work into disordered heat.
- **E) doubles**: Passive dissipation cannot amplify the energy budget. Friction actively drains mechanical energy instead of generating additional amounts.

QUESTIONS

52 **To what depth must one dive in the sea for the pressure to double relative to that at the surface?**

A Approximately 2m
B Approximately 10m
C Approximately 15m
D Approximately 5m
E Approximately 20m

Correct answer: B

At depth h, the **total pressure** equals atmospheric pressure plus hydrostatic pressure. To **double** the surface value, the **water column** must supply exactly one atmosphere. Solving $\rho g h = P_{\text{atm}}$ with standard constants yields $h \approx 10\ \text{m}$. This matches option B.

Why the other answers are wrong

- **A) Approximately 2m**: The added hydrostatic pressure is far too small to reach the required one atmosphere.
- **C) Approximately 15m**: The added pressure exceeds one atmosphere, so the absolute pressure more than doubles.
- **D) Approximately 5m**: The added water pressure amounts to only about half an atmosphere, leaving the total near $1.5\ \text{atm}$.
- **E) Approximately 20m**: The added pressure reaches roughly two atmospheres, making the **total** pressure about three times the surface value.

53 **What is the electric charge of a hydrogen atom?**

A +1 nC
B −2 pC
C +1 mC
D +2 nC
E 0 C

Correct answer: E

A hydrogen atom contains one proton with charge $+e$ and one electron with charge $-e$. These equal and opposite values **cancel** completely. The resulting **net** electric charge is $0\ \text{C}$.

Why the other answers are wrong

- **A) +1 nC**: Assigning a fixed positive charge implies an electron deficit or ionization. Standard atomic models assume exact **neutrality** through balanced constituent counts, leaving zero excess charge.
- **B) −2 pC**: There is no mechanism for surplus negative charge in this isolated system. The single electron precisely matches the proton, ruling out any net negative outcome.
- **C) +1 mC**: A single atom cannot sustain a millicoulomb magnitude. The **elementary** charge $e \approx 1.60 \times 10^{-19}\ \text{C}$ operates at microscopic scales, and internal contributions offset each other perfectly.
- **D) +2 nC**: No valid subatomic configuration yields a nanocoulomb surplus. The strict cancellation between proton and electron removes any chance of a residual positive amount.

54 **Two waves are said to be coherent if:**

A they have the same intensity
B they have the same amplitude
C **their phase difference remains constant over time**
D the phase difference varies randomly over time
E their wavelength lies in the visible region

Correct answer: C

Coherent waves have a **constant phase difference** over time, so their interference pattern remains **stable**.

Why the other answers are wrong

- **A) they have the same intensity**: Equal intensities are not required for coherence.
- **B) they have the same amplitude**: Equal amplitudes are not required for coherence.
- **D) the phase difference varies randomly over time**: A randomly varying phase difference describes incoherent waves.
- **E) their wavelength lies in the visible region**: Coherence is not limited to wavelengths in the visible region.

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55 **Which is the solution to the inequality $x^2 - 6x + 5 \leq 0$?**

A $-5 \leq x \leq -1$
B $x \leq 1\,; x \geq 5$
C None of the other options are correct
D $1 \leq x \leq 5$
E $x \leq -5\,; x \geq -1$

Correct answer: D

Factor the quadratic as $x^2 - 6x + 5 = (x-1)(x-5)$. The equation equals zero at the **roots** $x = 1$ and $x = 5$. Since the parabola opens upward, the inequality holds between the roots, giving $1 \leq x \leq 5$.

Why the other answers are wrong

- **A)** $-5 \leq x \leq -1$: This incorrectly assumes the roots are negative. The actual roots derived from factoring are 1 and 5.
- **B)** $x \leq 1\,; x \geq 5$: These represent the regions **outside** the roots, where the factored product yields non-negative values instead of negative or zero.
- **C) None of the other options are correct**: This is false because option D correctly identifies the interval between the roots.
- **E)** $x \leq -5\,; x \geq -1$: This extends to negative infinity and beyond -1, covering values like $x = 6$ that make the quadratic strictly **positive**.

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56 **Given $f(x) = e^x$, which of the following gives the solutions to the inequality $f(x) > 0$?**

A No real numbers

B **All real numbers**

C All real numbers greater than 1

D All real numbers greater than or equal to 1

E All positive real numbers

Correct answer: B

The **exponential function** $f(x) = e^x$ is **always positive** for any real input. This satisfies the inequality $e^x > 0$ for **all real numbers**.

Why the other answers are wrong

- **A) No real numbers**: Incorrect because the exponential function never yields non-positive outputs. It remains strictly greater than zero for every possible real value of x.
- **C) All real numbers greater than 1**: Incorrect because $x = 1$ and any lower real number work. Limiting solutions to values above 1 arbitrarily cuts off infinite valid cases.
- **D) All real numbers greater than or equal to 1**: Incorrect because inputs smaller than 1 produce valid positive results. Values below 1 clearly satisfy the original inequality.
- **E) All positive real numbers**: Incorrect because zero and negative numbers are fully valid solutions. Restricting the set to only positive reals ignores half of the actual domain.

57 **A circle has the equation $x^2 + y^2 + 5x + 4y = 0$. Which of the following statements is true?**

A It has its centre at the origin

B It has zero radius

C It is centred on the x-axis

D It is centred on the y-axis

E **It passes through the origin**

Correct answer: E

Substitute $x = 0$ and $y = 0$ into the equation $x^2 + y^2 + 5x + 4y = 0$. The calculation yields $0 = 0$, which proves that the circle **passes through the origin**.

Why the other answers are wrong

- **A) It has its centre at the origin**: The actual **centre coordinates** are $(-\frac{5}{2}, -2)$, differing from $(0, 0)$.
- **B) It has zero radius**: Completing the square reveals a **radius** of $\frac{\sqrt{41}}{2}$, not zero.
- **C) It is centred on the x-axis**: Placement on the horizontal axis would require a y-coordinate of zero, yet the centre sits at $y = -2$.
- **D) It is centred on the y-axis**: The vertical axis condition requires an x-coordinate of zero, but the centre lies at $x = -\frac{5}{2}$.

58 **A bag contains 12 balls that are indistinguishable by touch, 5 of which are red. Two balls are drawn without replacement. What is the probability that no red ball is drawn?**

A $\frac{15}{22}$
B $\frac{49}{132}$
C $\frac{25}{132}$
D $\frac{7}{22}$
E $\frac{49}{144}$

Correct answer: D

The bag initially contains 7 **non-red** balls out of 12 total. Since the selection is done **without replacement**, the composition changes after each step. The **probability** for the first draw is $\frac{7}{12}$. After removing one non-red ball, 6 favorable outcomes remain out of 11 total balls, making the second probability $\frac{6}{11}$. Multiplying these yields $\frac{7}{22}$.

Why the other answers are wrong

- **A)** $\frac{15}{22}$: This calculates the complementary scenario, representing the likelihood of obtaining at least one red ball rather than zero red balls.
- **B)** $\frac{49}{132}$: This mistake happens when only the total count drops to 11, while incorrectly keeping the favorable count at 7 instead of reducing it to 6.
- **C)** $\frac{25}{132}$: This fraction miscounts the reduced sample space after the first pick, failing to account correctly for the changing number of balls and remaining favorable outcomes.
- **E)** $\frac{49}{144}$: This value treats the draws as independent events made with replacement, leaving both the numerator and denominator unchanged between steps.

59 **The parabola with equation $y = kx^2 - x + 30$ passes through the point (5,0). What is the value of k?**

A 1
B 3
C 2
D −2
E **−1**

Correct answer: E

To find k, **substitute** $x = 5$ and $y = 0$ into the **equation** $y = kx^2 - x + 30$. This yields $0 = k(5)^2 - 5 + 30$, which **simplifies** to $0 = 25k + 25$. Dividing both sides by 25 gives $k = -1$.

Why the other answers are wrong

- **A) 1**: Using $k = 1$ results in $y = 1(5)^2 - 5 + 30 = 50$, which does not match the required coordinate $y = 0$.
- **B) 3**: Using $k = 3$ results in $y = 3(5)^2 - 5 + 30 = 100$, which does not match the required coordinate $y = 0$.
- **C) 2**: Using $k = 2$ results in $y = 2(5)^2 - 5 + 30 = 75$, which does not match the required coordinate $y = 0$.
- **D) −2**: Using $k = -2$ results in $y = -2(5)^2 - 5 + 30 = -25$, which does not match the required coordinate $y = 0$.

60 **Which is the solution to the following equation: $log_{10}x = 6$?**

A 10000
B 60
C 600
D 100000
E **1000000**

Correct answer: E

By the definition of a **logarithm**, $\log_{10} x = 6$ converts directly to **exponential form**. This gives $x = 10^6$. Evaluating the **power** yields $x = 1000000$, which matches option E.

Why the other answers are wrong

- **A) 10000**: The value 10000 equals 10^4, which corresponds to $\log_{10} x = 4$. It underestimates the necessary exponential growth by two powers of ten.
- **B) 60**: The value 60 is incorrect because it treats the exponent as a simple multiplier of ten. It fails to represent the required magnitude of 10^6.
- **C) 600**: The value 600 does not satisfy the equation because it differs significantly from 10^6. It incorrectly multiplies the exponent by the base instead of applying the exponential rule.
- **D) 100000**: The value 100000 equals 10^5, which would solve $\log_{10} x = 5$ instead of 6. It lacks exactly one zero compared to the correct solution.

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