PROVE UFFICIALI DEGLI ANNI PASSATI

IMAT 2025

A B ✓ D E

SVOLTA CON SOLUZIONI COMMENTATE

Il perché di ogni risposta

ALLENATI SULL'APP TESTBUDDY

TESTBUDDY.IT

WHAT'S IN THIS DOCUMENT

Prova di ammissione IMAT 2025, 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	2 questions
Questions	39 questions
Logical reasoning and problem-solving	2 questions
Biology	3 questions
Chemistry	7 questions
Physics and Mathematics	6 questions
Total	**59 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 **"Other serious conditions (the frequency cannot be determined based on available data): yellowing of the skin or the whites of the eyes (indicative of severe liver cell damage or jaundice), or symptoms such as fever, rash, and kidney enlargement. These may sometimes be accompanied by painful urination and lower back pain (signs of severe kidney inflammation), which can potentially progress to kidney failure."**
From the informational leaflet for Teva Pantoprazolo
Which of the following statements is the correct interpretation of the information contained in this excerpt?

- **A** **Using this medication could lead to serious kidney problems.**
- **B** Those with kidney failure may benefit from using this medication.
- **C** Using this medication always leads to yellowing of the skin.
- **D** Using this medication could lead to pancreatic problems.
- **E** Using this medication never leads to urinary tract problems.

Correct answer: A

The excerpt explicitly links the medication to severe kidney inflammation and potential progression to **kidney failure**. This confirms that serious renal issues represent a documented risk.

Why the other answers are wrong

- **B) Those with kidney failure may benefit from using this medication.**: Renal failure appears as a potential negative consequence, not as a condition treated by the drug.
- **C) Using this medication always leads to yellowing of the skin.**: The leaflet describes skin yellowing as a possible adverse event rather than an **inevitable** outcome.
- **D) Using this medication could lead to pancreatic problems.**: Pancreatic disorders are not mentioned anywhere in the provided text.
- **E) Using this medication never leads to urinary tract problems.**: Painful urination is cited as a symptom of severe kidney inflammation, ruling out any guarantee of absence from urinary tract effects.

2 **"The Information and Communication Technology sector in Apulia is in full recovery. After the 2.4% decline recorded in 2020, the Apulian digital market -- valued just under three billion -- is regaining ground, resuming the steady growth seen in recent years. Despite the difficulties companies face in finding all the specific professionals, whom the university system can only partially train, the upward trend has resumed.**
As demonstrated by the results of Exprivia, active in ICT and listed on the MTA market of the Milan Stock Exchange, in the first quarter, the revenue of this big player -- total revenues in 2020 at 167.8 million, 2,400 professionals distributed in 7 countries worldwide -- grew by 5.4% compared to the same period in 2020, rising from 38 to 41 million. Profitability has grown and continues to grow, which in 2020 was 12.7 percent. 'Companies,' explains Gianni Sebastiano, Investor Relator of the group led by Domenico Favuzzi, 'are recovering profitability because they are revising their processes. The more digitalization you put into processes, the more you impact efficiency and costs: this is the great lesson of the pandemic.' The Apulian company aims to consolidate the growth recorded in recent months in all the markets in which it operates as a system integrator: public administration, banks, aerospace, local health, telemedicine."
from "Il Sole 24 ore" 28 June 2021
Indicate which of the following statements is not correct:

A the growth of the Apulian digital sector is due to, among other reasons, revisions in company processes.

B despite shortages in the number of adequate professionals, the Apulian digital sector has recorded increased profitability over the past year.

C the pandemic was one the factors that led to the digitalization of company processes.

D **the pandemic ensured the growth of the Apulian digital sector because companies in the sector transformed into digital companies.**

E the digitalization of company processes is one of the principle causes for the economic growth of the sector.

Correct answer: D

The text explicitly states that the sector **declined by** 2.4% **in 2020** and later **resumed prior growth**. The crisis functioned as a stimulus for workflow optimization rather than a guarantor of immediate expansion or a force that converted all firms into digital entities overnight. Therefore, attributing ensured growth directly to the pandemic is incorrect. **Why the other options are not the answer Answer B**: Consistent with the report, which highlights the crisis as a catalyst for prioritizing **technological integration**. The author notes that expanding digital adoption directly enhances operational speed and minimizes overhead expenses. **Answer C**: Matches the cited mechanism behind the financial rebound: continuous **process revision**. Enterprises are restructuring their internal methodologies to restore profitability after initial losses. **Answer D**: Aligns with the documented challenge where a persistent **staff shortage** failed to halt commercial progress. The data illustrates this resilience through Exprivia, whose quarterly turnover climbed from 38 million to 41 million while maintaining an annual profit margin of 12.7%. **Answer E**: Confirms the established relationship between modernization and market expansion. Streamlining activities via digital tools generates higher output relative to input, which fundamentally sustains the regional industry's appreciation.

Why the other answers are wrong

QUESTIONS

3 **"This animal catches a man and straightway kills him; after he is dead, it weeps for him with a lamentable voice and many tears. Then, having done lamenting, it cruelly devours him. It is thus with the hypocrite, who, for the smallest matter, has his face bathed with tears, but shows the heart of a tiger and rejoices in his heart at the woes of others, while wearing a pitiful face."**
The Notebooks of Leonardo da Vinci
Which animal is the author talking about in this text?

A Boa
B Tiger
C Panther
D **Crocodile**
E Lion

Correct answer: D

The text refers to the **crocodile**, which historically embodies the idiom “crocodile tears” for insincere mourning. The narrative describes an animal that sheds tears over a victim it just killed before consuming it. This imagery serves as a direct allegory for the **hypocrite** who feigns sorrow while secretly delighting in others' suffering.

Why the other answers are wrong

- **A) Boa**: The behavior of crying over killed victims is never attributed to boas in historical or literary contexts.
- **B) Tiger**: The tiger metaphorically represents the hypocrite's cruel heart rather than identifying the weeping animal itself.
- **C) Panther**: The passage does not associate panthers with shedding tears over their prey.
- **E) Lion**: The described display of false grief is not culturally or textually linked to lions.

4 **In 1955, Dr. Vincent Zigas discovered that kuru, a deadly inflammation of the brain widespread among the indigenous people of New Guinea, was caused by a practice linked to a local funeral rite: eating the brains of deceased relatives. Another encephalopathy that resembles kuru is Creutzfeldt-Jakob disease, which is not only found in New Guinea. Creutzfeldt-Jakob is rare and a difficult-to-diagnose problem, as it is sometimes confused with diseases like Alzheimer's. Both kuru and Creutzfeldt-Jakob are caused by an infectious protein, the prion, present in the tissues of the affected individuals even after death.**
G. Maga Batteri spazzini e virus che curano Zanichelli
Only one of the following statements is coherent with the excerpt:

A Creutzfeldt-Jakob Disease is widespread in New Guinea as a result of the practice of consuming the brains of deceased relatives

B **Kuru, Creutzfeldt-Jakob Disease and Alzheimer's are diseases whose diagnoses can be confused with each other**

C the prion is a bacterium which develops after death inside tissue proteins

D Alzheimer's is recognizable as a development of Creutzfeldt-Jakob Disease

E Vincent Zigas discovered a cure for the negative effects of prions

Correct answer: B

The excerpt notes that Creutzfeldt-Jakob disease resembles kuru and is frequently **confused** with Alzheimer's during clinical assessment. This statement aligns perfectly with the provided text.

Why the other answers are wrong

- **A) Creutzfeldt-Jakob Disease is widespread in New Guinea as a result of the practice of consuming the brains of deceased relatives**: The controversial dietary habit is directly **linked** to kuru outbreaks in Papua New Guinea. Creutzfeldt-Jakob disease appears globally without connection to that ritual.
- **C) the prion is a bacterium which develops after death inside tissue proteins**: Pathological agents causing these illnesses are explicitly classified as infectious **proteins**. They remain stable in human tissue post-mortem instead of originating after death.
- **D) Alzheimer's is recognizable as a development of Creutzfeldt-Jakob Disease**: The text describes diagnostic overlap between separate neurological disorders. There is no mention of Alzheimer's evolving from Creutzfeldt-Jakob disease.
- **E) Vincent Zigas discovered a cure for the negative effects of prions**: Dr. Zigas identified a funeral ritual associated with kuru transmission rather than discovering a treatment. The excerpt contains zero references to a cure for prion-related conditions.

LOGICAL REASONING AND PROBLEM-SOLVING

5 **Consider this statement:**
The number two is a prime number.
Which of the following statements is deducible from the given statement?

A No number is a prime number.
B At least one number is not a prime number.
C All numbers are prime numbers.
D **At least one prime number exists.**
E No prime numbers exist.

Correct answer: D

The premise explicitly states that 2 is a **prime** number. This fact alone guarantees that a prime number **exists**. Consequently, the existential claim follows directly without additional assumptions.

Why the other answers are wrong

- **A) No number is a prime number.**: Claiming no number qualifies as prime also conflicts with the established fact about 2.
- **B) At least one number is not a prime number.**: The given information does not describe non-prime numbers. It remains neutral regarding their existence or properties.
- **C) All numbers are prime numbers.**: The original statement only references 2. It provides no logical basis for extending this property to every number.
- **E) No prime numbers exist.**: Asserting that zero prime numbers exist directly contradicts the initial premise.

6 **From the given statements**
If today is Saturday, then I am a philosopher
I am not a philosopher
Which conclusion can be deduced?

A Today is Saturday.
B None of the other choices is correct.
C Today is Friday.
D **Today is not Saturday.**
E I am a philosopher.

Correct answer: D

Define S as today being Saturday and P as being a philosopher. The **premises** state $S \Rightarrow P$ and $\neg P$. Applying **modus tollens** yields the **conclusion** $\neg S$, meaning today is not Saturday.

Why the other answers are wrong

- **A) Today is Saturday.**: Assuming Saturday leads to being a philosopher, which directly contradicts the stated fact that you are not a philosopher.
- **B) None of the other choices is correct.**: Option B provides a valid logical outcome, making this choice incorrect.
- **C) Today is Friday.**: Proving the day is not Saturday leaves multiple remaining possibilities without identifying any specific weekday.
- **E) I am a philosopher.**: This option restates the negated premise, so it cannot serve as the logical deduction.

QUESTIONS

7 **Alberto, Beatrice, Carlo, and Daniela are dining at the same square table, each seated on one side of the table. Alberto is seated to the left of Beatrice but not to the right of Carlo. Which of the following statements can be deduced?**

A **Daniela is seated to the right of Carlo.**
B Daniela is seated to the left of Beatrice.
C Alberto is seated to the left of Carlo.
D Beatrice is seated across from Alberto.
E Carlo is seated across from Beatrice.

Correct answer: A

Alberto sits **immediately** to Beatrice's left, placing them on **adjacent** sides. The rule forbids Carlo from taking the seat that would put Alberto to his right. Carlo must therefore claim the **remaining** position opposite Beatrice. Daniela fills the last chair, standing to Carlo's **right**.

Why the other answers are wrong

- **B) Daniela is seated to the left of Beatrice.**: Alberto already occupies the specific location to Beatrice's left.
- **C) Alberto is seated to the left of Carlo.**: Alberto faces Carlo directly rather than sitting beside him.
- **D) Beatrice is seated across from Alberto.**: They occupy neighboring sides instead of facing each other across the table.
- **E) Carlo is seated across from Beatrice.**: The seat directly opposite Beatrice belongs to Daniela, not to Carlo.

8 **Three pills — coloured blue, red, and green, respectively, — are each placed individually inside three small boxes of the same colours — blue, red, and green — in such a way that no pill is inside the box of its own colour. Additionally, the blue pill is not in the green box. Which pill is in which box?**

A The blue pill is in the green box, the green pill is in the red box, the red pill is in the blue box.

B **The green pill is in the blue box, the red pill is in the green box, the blue pill is in the red box.**

C The blue pill is in the blue box, the green pill is in the green box, the red pill is in the red box.

D The red pill is in the blue box, the green pill is in the green box, the blue pill is in the red box.

E The green pill is in the blue box, the red pill is in the blue box, the blue pill is in the green box.

Correct answer: B

The **blue pill** cannot share a color with its container or occupy the **green box**, so it must go into the **red box**. The red pill then takes the only remaining mismatched slot, and the green pill fills the last available container.

Why the other answers are wrong

- **A) The blue pill is in the green box, the green pill is in the red box, the red pill is in the blue box.**: Incorrectly positions the blue pill in the green container, which contradicts the problem statement.
- **C) The blue pill is in the blue box, the green pill is in the green box, the red pill is in the red box.**: Puts every pill directly into a box matching its own color.
- **D) The red pill is in the blue box, the green pill is in the green box, the blue pill is in the red box.**: Violates the rule by placing the green pill inside the green container.
- **E) The green pill is in the blue box, the red pill is in the blue box, the blue pill is in the green box.**: Assigns two pills to the same box and places the blue pill inside the forbidden green container.

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9 **At this moment, an analogue clock is showing exactly 3:00 PM. After the minute hand has completed 1.75 full rotations from its current position, what time will the clock indicate?**

A **4:45 PM**

B 5:00 PM

C 3:35 PM

D 4:30 PM

E 1:25 PM

Correct answer: A

The **minute hand** requires 60 minutes for a **full rotation**. Multiplying the given rotations by this period yields $1.75 \times 60 = 105$ minutes. Adding this duration to $3{:}00\ \mathrm{PM}$ indicates **4:45 PM**.

Why the other answers are wrong

- **B) 5:00 PM**: This choice assumes a two-hour shift from the starting point instead of the calculated duration.
- **C) 3:35 PM**: This option corresponds to only 35 minutes added to the starting time.
- **D) 4:30 PM**: This result accounts for merely 90 minutes elapsed rather than 105 minutes.
- **E) 1:25 PM**: This time occurs before $3{:}00\ \mathrm{PM}$ and does not match the required 105 minute progression.

BIOLOGY

10 **During lactic fermentation, pyruvic acid is:**

A phosphorylated
B dephosphorylated
C **reduced**
D oxidised
E decarboxylated

Correct answer: C

Pyruvic acid is reduced to lactic acid during this metabolic pathway. It gains electrons and hydrogen from $NADH$, which is converted to NAD^+. This transfer maintains the redox balance needed for glycolysis to continue.

Why the other answers are wrong

- **A) phosphorylated**: Phosphorylation would require adding a phosphate group, but none is transferred to pyruvic acid.
- **B) dephosphorylated**: Dephosphorylation involves removing a phosphate group, which pyruvic acid lacks entirely.
- **D) oxidised**: Oxidation requires losing electrons, whereas pyruvic acid actually gains them. The coenzyme $NADH$ is the substance that undergoes oxidation.
- **E) decarboxylated**: Decarboxylation releases carbon dioxide, yet no carbon atoms are removed from the three-carbon chain.

11 **Which of the following statements about glycolysis is correct?**

A Phosphofructokinase catalyses the conversion of fructose 1,6-bisphosphate to dihydroxyacetone phosphate.
B In the first part, $FADH_2$ is formed.
C Triose phosphate isomerase catalyses the conversion of dihydroxyacetone phosphate to 1,3-bisphosphoglycerate.
D When a molecule of glucose is converted to pyruvate in glycolysis, CO_2 is produced.
E **When a molecule of glucose is converted to pyruvate in glycolysis, 2 NAD^+ are reduced.**

Correct answer: E

Each glucose molecule yields two molecules of **glyceraldehyde 3-phosphate**. Oxidation of these trioses reduces one NAD^+ per molecule. Consequently, **two** NAD^+ are **reduced** per glucose.

Why the other answers are wrong

- **A)** Phosphofructokinase converts **fructose 6-phosphate** into **fructose 1,6-bisphosphate**. Aldolase performs the subsequent cleavage step.
- **B) In the first part, $FADH_2$ is formed.**: The preparatory phase only consumes **ATP** through phosphorylation. $FADH_2$ formation never occurs in glycolysis.
- **C)** Triose phosphate isomerase interconverts **dihydroxyacetone phosphate** and **glyceraldehyde 3-phosphate**. It does not catalyse reactions involving **1,3-bisphosphoglycerate**.
- **D) When a molecule of glucose is converted to pyruvate in glycolysis, CO_2 is produced.**: Glycolysis retains all six carbons of glucose. No CO_2 is generated in this pathway.

12 **Each acetyl-CoA molecule that enters the Krebs cycle produces:**

A **3 NADH, 1 $FADH_2$, 1 GTP and 2 molecules of CO_2**
B 3 NADH, 1 $FADH_2$, 2 GTP and 3 molecules of CO_2
C 2 NADH, 2 $FADH_2$, 2 GTP and 2 molecules of CO_2
D 3 NADH, 1 $FADH_2$, 1 GTP and 3 molecules of CO_2
E 1 NADH, 3 $FADH_2$, 1 GTP and 2 molecules of CO_2

Correct answer: A

One turn of the Krebs cycle per acetyl-CoA produces $3\ NADH$, $1\ FADH_2$, $1\ GTP$ and $2\ CO_2$. The two CO_2 molecules are released during the cycle's two decarboxylation reactions.

Why the other answers are wrong

- **B) 3 NADH, 1 $FADH_2$, 2 GTP and 3 molecules of CO_2**: It lists $2\ GTP$ and $3\ CO_2$. The cycle generates just $1\ GTP$ and $2\ CO_2$ molecules.
- **C) 2 NADH, 2 $FADH_2$, 2 GTP and 2 molecules of CO_2**: It claims $2\ NADH$, $2\ FADH_2$ and $2\ GTP$. The actual production is $3\ NADH$, $1\ FADH_2$ and $1\ GTP$.
- **D) 3 NADH, 1 $FADH_2$, 1 GTP and 3 molecules of CO_2**: It incorrectly states 3 molecules of CO_2. The cycle releases only $2\ CO_2$ per acetyl-CoA.
- **E) 1 NADH, 3 $FADH_2$, 1 GTP and 2 molecules of CO_2**: It swaps the counts for $NADH$ and $FADH_2$. The correct yield is $3\ NADH$ and only $1\ FADH_2$.

QUESTIONS

13 **Oxidative phosphorylation is a metabolic pathway:**

A through which the amino group resulting from the degradation of amino acids is eliminated

B which represents the final stage of the anabolism of amino acids, carbohydrates, and fatty acids

C through which fatty acid synthesis occurs

D through which fatty acids are broken down by removing two carbon atoms at a time

E through which the energy stored in reduced coenzymes is used for the synthesis of ATP

Correct answer: E

Oxidative phosphorylation captures energy from $mathrmNADH$ and $mathrmFADH_2$ to drive ATP production. Electrons flow through the respiratory complexes, establishing a **proton gradient** across the inner mitochondrial membrane. This electrochemical potential powers ATP synthase to convert ADP to ATP.

Why the other answers are wrong

- **A) through which the amino group resulting from the degradation of amino acids is eliminated**: Elimination of amino groups from degraded amino acids primarily occurs in the urea cycle.
- **B) which represents the final stage of the anabolism of amino acids, carbohydrates, and fatty acids**: This pathway functions during catabolism to extract energy, while anabolism consumes energy to build complex molecules.
- **C) through which fatty acid synthesis occurs**: Fatty acid synthesis is a distinct anabolic process that constructs carbon chains rather than degrading them.
- **D) through which fatty acids are broken down by removing two carbon atoms at a time**: This describes beta-oxidation, which sequentially cleaves two-carbon units from fatty acids.

14 **Cytochromes are:**

A inhibitors of oxidative phosphorylation
B transporters of hydrogen atoms in the respiratory chain
C **present in the respiratory chain**
D cofactors of glycolysis
E enzymes that synthesize ATP

Correct answer: C

Cytochromes are **haem-containing proteins** located in the respiratory chain. They transfer **electrons** between successive complexes during cellular respiration. This established function directly places them within the electron transport system.

Why the other answers are wrong

- **A) inhibitors of oxidative phosphorylation**: Cytochromes drive electron flow through the membrane complexes. They never act as metabolic blockers because their natural role is constructive rather than inhibitory.
- **B) transporters of hydrogen atoms in the respiratory chain**: These proteins move only electrons through redox changes of their iron center. Hydrogen carriers transport both protons and electrons, making the definition chemically inaccurate for this group.
- **D) cofactors of glycolysis**: Glycolysis utilizes soluble cofactors like NAD^+ and occurs in the cytosol without involving cytochromes.
- **E) enzymes that synthesize ATP**: Phosphorylation is exclusively handled by **ATP synthase**. Cytochromes lack synthetic enzymatic activity and solely relay charge.

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15 **Collagen is a protein that is:**

A **extracellular**
B abundant in the thick filament
C intracellular
D membranous
E nuclear

Correct answer: A

Collagen is a structural protein found mainly in the **extracellular matrix**, where it provides **structural support** to connective tissues.

Why the other answers are wrong

- **B) abundant in the thick filament**: Thick filaments in muscle tissue are composed mainly of **myosin** rather than collagen.
- **C) intracellular**: Cells produce collagen precursors intracellularly, but the mature protein is **secreted** and functions exclusively in the extracellular environment.
- **D) membranous**: Collagen is not a membrane protein; it lacks transmembrane domains and integral lipid interactions.
- **E) nuclear**: Collagen is not a component of the nucleus and does not participate in nuclear processes.

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16 **Muscle contraction is triggered by an increase in the concentration of calcium ions that bind to:**

- **A** **troponin**
- **B** myosin
- **C** actin
- **D** tropomyosin
- **E** vimentin

Correct answer: A

Calcium ions bind to **troponin** within the sarcomere. This interaction triggers a conformational shift that displaces **tropomyosin** from the myosin attachment regions on actin. The newly exposed binding sites enable cross bridge cycling and trigger muscle contraction.

Why the other answers are wrong

- **B) myosin**: Myosin generates force through ATP hydrolysis and power strokes. It interacts with actin strictly after calcium has already modified the troponin complex to expose the binding grooves.
- **C) actin**: Calcium does not bind directly to actin. Actin only serves as a structural filament and binding platform once the regulatory proteins move aside.
- **D) tropomyosin**: Tropomyosin physically blocks myosin sites during relaxation. It relocates passively following the troponin structural change and never acts as the primary calcium receptor.
- **E) vimentin**: Vimentin is classified as an intermediate filament protein. It maintains cellular architecture and mechanical stability rather than participating in excitation contraction coupling.

17 **Which of the following statements about myosin and actin is CORRECT?**

- **A** The binding of ATP to the actin-myosin complex promotes the formation of the complex.
- **B** The binding of calcium to troponin is necessary for the dissociation of the actin-myosin complex.
- **C** **The binding of ATP to the actin-myosin complex promotes the dissociation of the complex.**
- **D** Actin has ATPase activity.
- **E** Tropomyosin has ATPase activity.

Correct answer: C

Binding of **ATP** to the **myosin head** lowers its affinity for **actin**, forcing the complex to **dissociate**. The motor protein then **hydrolyses ATP** to reset for the next cycle.

Why the other answers are wrong

- **A) The binding of ATP to the actin-myosin complex promotes the formation of the complex.**: **ATP** binding causes the complex to separate rather than form. This reduced affinity ensures proper cross-bridge cycling.
- **B) The binding of calcium to troponin is necessary for the dissociation of the actin-myosin complex.**: **Calcium** binds to troponin to shift tropomyosin and allow myosin to attach to actin. Dissociation is triggered by ATP binding, not calcium interaction.
- **D) Actin has ATPase activity.**: **Actin** hydrolyses bound ATP only during filament assembly. The ATPase responsible for the contraction cycle is myosin.
- **E) Tropomyosin has ATPase activity.**: **Tropomyosin** acts as a physical regulator that covers myosin-binding sites on actin. It does not possess ATPase activity, which is exclusively provided by myosin to drive contraction.

18 **The Bohr effect is observed in tissues that are oxidizing large amounts of nutrients, generating hydrogen ions, and releasing CO_2 into the blood. This results in:**

A an increase in the total number of red blood cells
B **a decrease in oxygenated haemoglobin molecules**
C an increase in protein synthesis
D the denaturation of haemoglobin
E an increase in oxygenated haemoglobin molecules

Correct answer: B

Elevated $\mathrm{CO_2}$ and $\mathrm{H^+}$ concentrations in active tissues lower the local pH. This acidic environment causes **haemoglobin** to shift conformation, reducing its **oxygen affinity**. Oxygen then dissociates from the protein to diffuse into metabolizing cells, decreasing the amount of oxygenated haemoglobin.

Why the other answers are wrong

- **A) an increase in the total number of red blood cells**: The phenomenon adjusts haemoglobin functionality inside existing erythrocytes. It functions separately from stem cell differentiation and leaves the red blood cell count unchanged.
- **C) an increase in protein synthesis**: The Bohr effect regulates oxygen binding and release according to tissue acidity. It does not interact with mechanisms responsible for protein synthesis.
- **D) the denaturation of haemoglobin**: Haemoglobin reversibly alternates between tense and relaxed states during gas exchange. It preserves its tertiary structure and never reaches denaturation under normal physiological conditions.
- **E) an increase in oxygenated haemoglobin molecules**: Acidic environments and elevated $\mathrm{CO_2}$ drive oxygen off the globin chains. Therefore, the concentration of bound oxygen falls rather than rising.

19 **Which of the following compounds corresponds to the statement "a substance that increases the speed of a reaction and is found unchanged at the end of it"?**

A Effector
B Modulator
C Cofactor
D Cholesterol
E **Catalyst**

Correct answer: E

A **catalyst** increases the **reaction rate** by lowering the **activation energy**. It participates in intermediate steps but is regenerated as the original molecule, so it remains **unchanged** after the process.

Why the other answers are wrong

- **A) Effector**: An effector modulates biological pathways or protein activity but does not guarantee an increased reaction speed or chemical preservation.
- **B) Modulator**: A modulator adjusts molecular activity upward or downward without requiring the substance to remain chemically intact throughout the cycle.
- **C) Cofactor**: A cofactor supports enzyme action by binding to the active site, yet many are modified during catalysis or consumed in the process rather than returning to their initial state.
- **D)** Cholesterol functions primarily as a membrane lipid and structural component, lacking any role in accelerating general chemical reactions.

20 **In competitive inhibition:**

A the inhibitor binds to the allosteric site and prevents the substrate from binding to the enzyme
B the inhibitor prevents the release of products from the active site
C the inhibitor binds to the substrate, preventing a reaction with the enzyme
D the inhibitor binds to the enzyme-cholesterol complex
E the inhibitor and the substrate compete for the active site of the enzyme

Correct answer: E

In competitive inhibition, the inhibitor and substrate compete for the same **active site**. Increasing the **substrate** concentration reduces the inhibitor's effect.

Why the other answers are wrong

- **A) the inhibitor binds to the allosteric site and prevents the substrate from binding to the enzyme**: Describes allosteric mechanisms. A competitive inhibitor binds at the active site, not an allosteric site.
- **B) the inhibitor prevents the release of products from the active site**: Confuses distinct enzymatic steps. The pathway blocks substrate binding, not product release.
- **C) the inhibitor binds to the substrate, preventing a reaction with the enzyme**: Incorrectly identifies the binding target. The inhibitor binds to the enzyme rather than the substrate.
- **D) the inhibitor binds to the enzyme-cholesterol complex**: Adds irrelevant biological molecules. Competitive inhibition does not involve an enzyme-cholesterol complex.

21 **Which of the following classes of digestive enzymes is involved in the digestion of proteins?**

A Peptidase
B Isomerase
C Transaminase
D Lipase
E Amylase

Correct answer: A

Peptidases catalyze the hydrolysis of **peptide bonds**, breaking down **proteins** into smaller fragments or free **amino acids**.

Why the other answers are wrong

- **B) Isomerase**: Rearranges internal atomic structures and does not perform any digestive functions.
- **C) Transaminase**: Facilitates the transfer of **amino groups** between molecules without cleaving peptide backbones.
- **D) Lipase**: Specifically hydrolyzes **lipids** instead of participating in proteolysis.
- **E) Amylase**: Catalyzes the breakdown of carbohydrates rather than protein chains.

22 **Oxidative phosphorylation involves:**

A **both membrane proteins and mobile molecules**
B exclusively mitochondrial matrix proteins
C only nuclear proteins
D exclusively integral membrane proteins
E exclusively peripheral proteins

Correct answer: A

Oxidative phosphorylation uses protein complexes in the **inner mitochondrial membrane** and **mobile electron carriers**. Ubiquinone moves within the membrane, while cytochrome c transfers electrons between complexes at its surface.

Why the other answers are wrong

- **B) exclusively mitochondrial matrix proteins**: The process depends on proteins embedded in the inner mitochondrial membrane, not exclusively on proteins in the mitochondrial matrix.
- **C) only nuclear proteins**: Oxidative phosphorylation takes place at the inner mitochondrial membrane, not in the nucleus, so nuclear proteins alone are not involved.
- **D) exclusively integral membrane proteins**: Mobile carriers also participate: ubiquinone moves within the membrane, and cytochrome c transfers electrons between complexes at its surface. Thus, oxidative phosphorylation does not involve only integral membrane proteins.
- **E) exclusively peripheral proteins**: The electron transport complexes and ATP synthase include **integral membrane proteins**, so the process does not involve exclusively peripheral proteins.

23 **How are the reduced coenzymes that are formed during biological oxidation reoxidized?**

A Through the process of beta oxidation
B By direct action of oxygen
C With the synthesis of hormones
D Through the passage of electrons in ATP synthase
E **Through the respiratory chain**

Correct answer: E

Reduced coenzymes such as NADH and $\mathrm{FADH_2}$ are reoxidized by transferring their **electrons** to the **respiratory chain**. The charge carriers move through successive protein complexes until they reach **oxygen**, which serves as the terminal acceptor. This mechanism efficiently regenerates the oxidized cofactors needed for ongoing metabolism.

Why the other answers are wrong

- **A) Through the process of beta oxidation**: The β**-oxidation** pathway degrades fatty acids to produce fresh reduced cofactors rather than restoring already used ones.
- **B) By direct action of oxygen**: Coenzymes do not react directly with atmospheric oxygen; they must route their electrons through intermediate membrane carriers first.
- **C) With the synthesis of hormones**: Hormone biosynthesis follows dedicated enzymatic routes and does not function as the general physiological system for cofactor recycling.
- **D) Through the passage of electrons in ATP synthase**: ATP synthase couples chemiosmotic potential to synthesize ATP, while electron transport is exclusively handled by the preceding chain.

24 **Which high-energy reserve compound contains phosphate groups and is present in muscles?**

A Creatinine phosphate
B Glucose 1-phosphate
C Carnitine phosphate
D Phosphofructokinase
E Creatine phosphate

Correct answer: E

Creatine phosphate acts as a rapid buffer for cellular energy storage in muscle tissue. It donates its phosphate group to ADP to quickly resynthesize **ATP** during short bursts of intense exercise. This system sustains immediate energy needs until oxidative phosphorylation takes over.

Why the other answers are wrong

- **A) Creatinine phosphate**: Creatinine is the non-enzymatic **breakdown** product of creatine phosphate. It is excreted by the kidneys and carries no metabolic energy potential.
- **B)** Glucose 1-phosphate serves as a metabolic intermediate during **glycogen** breakdown and synthesis. It does not function as a dedicated high-energy phosphate reserve for immediate use.
- **C)** Carnitine phosphate does not exist as a standard physiological compound. Carnitine actually facilitates the **transport** of long-chain fatty acids into mitochondria for beta-oxidation.
- **D)** Phosphofructokinase is a regulatory **enzyme** that catalyzes a key step in glycolysis. It functions as a protein catalyst rather than a molecular energy store.

25 **Which of the following metabolic processes occurs mainly in the liver?**

A Glycolysis
B Urea cycle
C The Krebs Cycle
D Transamination
E β-oxidation of fatty acids

Correct answer: B

The urea cycle occurs primarily in the liver. It converts toxic ammonia into **urea** for safe renal excretion.

Why the other answers are wrong

- **A)** Glycolysis is a universal pathway that occurs in nearly **all cells**, not mainly in the liver.
- **C) The Krebs Cycle**: The Krebs cycle operates in the **mitochondria** of many aerobic tissues, not mainly in the liver.
- **D)** Transamination occurs in many tissues, although the liver plays an important role.
- **E)** β-oxidation of fatty acids also occurs in other tissues, notably skeletal and cardiac **muscle**.

26 **It is more advantageous for humans to store energy as triglycerides in adipose tissue rather than as proteins in muscles because triglycerides in adipose tissue contain:**

- **A** **more calories and less water**
- **B** fewer calories and more water
- **C** more calories and more water
- **D** more oxygen and less nitrogen
- **E** fewer calories and less water

Correct answer: A

Triglycerides yield approximately $9\,\mathrm{kcal/g}$, while proteins provide only about $4\,\mathrm{kcal/g}$. They are also stored with minimal water compared to hydrated muscle tissue. This allows humans to pack significantly more energy into a smaller mass.

Why the other answers are wrong

- **B) fewer calories and more water**: Both stated relationships contradict established physiological facts regarding density and hydration.
- **C) more calories and more water**: Triglycerides do supply more calories, but adipose tissue actually retains far less water than muscle.
- **D) more oxygen and less nitrogen**: Triglycerides contain zero nitrogen, but they do not hold more oxygen than proteins. This elemental difference does not drive the storage advantage.
- **E) fewer calories and less water**: Adipose tissue does contain less water, yet triglycerides deliver more calories rather than fewer.

27 **Lysosomes are organelles:**

- **A** whose malfunction is currently not believed to be associated with diseases
- **B** **that form by budding from the Golgi apparatus**
- **C** equipped with enzymes that function optimally at a pH above 7
- **D** that form by budding from the smooth endoplasmic reticulum
- **E** responsible for the synthesis of proteins destined for secretion

Correct answer: B

Lysosomes form by budding from the Golgi apparatus. The Golgi packages the digestive enzymes that function inside these organelles.

Why the other answers are wrong

- **A) whose malfunction is currently not believed to be associated with diseases**: Lysosomal malfunction is well documented to cause diseases. It leads specifically to **lysosomal storage disorders**.
- **C) equipped with enzymes that function optimally at a pH above 7**: Lysosomal enzymes require an **acidic** environment to work optimally, typically around $\mathrm{pH}\ 5$.
- **D) that form by budding from the smooth endoplasmic reticulum**: Lysosomes do not originate from the smooth endoplasmic reticulum. They bud directly from the **Golgi apparatus**.
- **E) responsible for the synthesis of proteins destined for secretion**: Proteins destined for secretion are not made in lysosomes. They are synthesized by **ribosomes** attached to the rough endoplasmic reticulum.

28 **Which of the following statements is correct?**

A The rough endoplasmic reticulum contains the DNA necessary for protein synthesis.

B All cellular organelles possess a small amount of DNA.

C **The nucleus, mitochondria and chloroplasts all contain DNA.**

D Only the nucleus contains DNA while mitochondria and chloroplasts contain RNA.

E Prokaryotes have a well-defined nucleus containing DNA.

Correct answer: C

The nucleus contains most of a eukaryotic cell's DNA. Mitochondria and, in cells that have them, chloroplasts also contain their own DNA.

Why the other answers are wrong

- **A) The rough endoplasmic reticulum contains the DNA necessary for protein synthesis.**: Ribosomes attached to the rough endoplasmic reticulum translate messenger RNA. The rough endoplasmic reticulum itself does not contain **DNA**.
- **B) All cellular organelles possess a small amount of DNA.**: Many organelles, such as the **endoplasmic reticulum**, do not contain DNA.
- **D) Only the nucleus contains DNA while mitochondria and chloroplasts contain RNA.**: Mitochondria and chloroplasts contain **DNA** as well as RNA, so DNA is not found only in the nucleus.
- **E)** Prokaryotes have DNA, but they do not have a **membrane-bound nucleus**.

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29 **What is the main function of the plasma membrane in cells?**

A Synthesizing proteins

B Facilitating cell movement

C Containing the cell's genetic material

D Providing energy to the cell

E **Regulating exchanges between the inside and outside of the cell**

Correct answer: E

The plasma membrane acts as a **selectively permeable barrier** that controls substance traffic across the cell boundary. This regulation maintains **internal homeostasis** by allowing essential nutrients in and waste products out.

Why the other answers are wrong

- **A) Synthesizing proteins**: Proteins are assembled by ribosomes located in the cytoplasm or attached to the rough endoplasmic reticulum.
- **B) Facilitating cell movement**: Cell movement depends on specialized motor structures such as the cytoskeleton, cilia, or flagella.
- **C) Containing the cell's genetic material**: Genetic material is contained within the nucleus in eukaryotic cells or the nucleoid in prokaryotic cells.
- **D) Providing energy to the cell**: Energy production relies on metabolic pathways like glycolysis and oxidative phosphorylation that occur in the cytoplasm and mitochondria.

30 **Which reactions are defined as exergonic?**

A Reactions that occur only in the presence of light

B Reactions that release energy and occur spontaneously

C Reactions that produce chemical energy without the consumption of reactants

D Reactions that require heat to proceed

E Reactions that always involve the synthesis of new compounds

Correct answer: B

Exergonic reactions **release free energy** because their Gibbs free energy change is **negative** $\Delta G < 0$. This thermodynamic state allows the process to occur **spontaneously** without external input.

Why the other answers are wrong

- **A) Reactions that occur only in the presence of light**: The presence of light is not required to determine whether a reaction releases free energy. Light dependence describes photochemical pathways instead.
- **C) Reactions that produce chemical energy without the consumption of reactants**: All chemical reactions **consume reactants** to form products, so producing energy without consumption contradicts basic reaction mechanisms. This description does not match exergonic behavior.
- **D) Reactions that require heat to proceed**: Reactions requiring heat to proceed do not meet the definition of exergonic processes. Heat absorption relates to thermal conditions rather than free energy release.
- **E) Reactions that always involve the synthesis of new compounds**: Exergonic processes can also involve the **breakdown** of complex molecules into simpler ones. Synthesis is not a mandatory feature of energy-releasing reactions.

31 **What is the main role of osteoblasts?**

A Producing collagen and minerals for the bone matrix

B Regulating blood pH

C Breaking down damaged bone tissue

D Resorbing minerals from the bone

E Transporting nutrients in the bone marrow

Correct answer: A

Osteoblasts drive **bone formation** by synthesizing an organic framework rich in **collagen**. This framework becomes hardened through natural **mineralization** with calcium deposits. These actions directly match the description in option A.

Why the other answers are wrong

- **B) Regulating blood pH**: Balancing acidity levels depends on respiratory exchange, kidney filtration, and chemical buffers in circulation.
- **C) Breaking down damaged bone tissue**: Removing compromised bone sections during periodic renewal is strictly performed by specialized breaking-down cells.
- **D) Resorbing minerals from the bone**: Extracting minerals and degrading existing bone is handled by **osteoclasts**, which specialize in tissue breakdown.
- **E) Transporting nutrients in the bone marrow**: Delivered nutrients travel via blood vessels inside the marrow cavity, not through cellular activity of this type.

32 **Insulin:**

A **stimulates glucose uptake in muscle**
B inhibits fatty acid synthesis
C stimulates the breakdown of glycogen
D is a steroid hormone
E is secreted by the adrenal gland

Correct answer: A

Insulin lowers blood glucose concentrations by acting on skeletal muscle. It triggers the exocytosis of intracellular vesicles containing **GLUT4** transport proteins. These carriers fuse with the plasma membrane to enable direct **glucose uptake** from the bloodstream.

Why the other answers are wrong

- **B) inhibits fatty acid synthesis**: Elevated insulin levels indicate abundant caloric availability. This metabolic state strongly activates acetyl-CoA carboxylase to drive lipid deposition.
- **C) stimulates the breakdown of glycogen**: The primary physiological role is energy storage rather than mobilization. Enzymatic activation favors glycogen formation while completely suppressing enzymatic degradation pathways.
- **D) is a steroid hormone**: Chemical analysis reveals two distinct polypeptide chains cross-linked by sulfur bridges. Such macromolecular architecture defines it as a peptide-based signaling molecule.
- **E) is secreted by the adrenal gland**: Insulin is synthesized exclusively within the pancreas. Functional **beta cells** located in the Islets of Langerhans produce and secrete it directly into systemic circulation.

CHEMISTRY

33 **The equation of state for ideal gases is:**

A $nV = PRT$

B $V = RT/(Pn)$

C $PV = nRT$

D $V = Pn/(RT)$

E $Pn = VRT$

Correct answer: C

The **correct equation** for an ideal gas describes the relationship between physical state variables. It is expressed as $PV = nRT$, where P denotes pressure, V represents volume, n is the amount of substance in moles, R is the universal gas constant, and T stands for absolute temperature.

Why the other answers are wrong

- **A)** $nV = PRT$: This variant incorrectly associates the amount of substance with volume. The standard form maintains **variable pairing** by keeping moles separate from spatial quantities.
- **B)** $V = RT/(Pn)$: Proper algebraic rearrangement isolates volume, resulting in $V = \frac{nRT}{P}$. This option mistakenly divides by both pressure and amount of substance simultaneously.
- **D)** $V = Pn/(RT)$: Solving for volume yields $\frac{nRT}{P}$ according to the defined constants. This choice erroneously flips the fraction and places pressure and amount of substance in the numerator.
- **E)** $Pn = VRT$: This formulation incorrectly pairs pressure with the amount of substance. The fundamental law requires a **pressure-volume product** on one side of the equation.

34 **In which of these compounds does Cl have an oxidation number of +3:**

A Cl_2

B $HClO_3$

C HCl

D $HClO$

E $HClO_2$

Correct answer: E

Assign the standard oxidation states to **hydrogen** $(+1)$ and **oxygen** (-2) in a neutral molecule. The sum of all oxidation numbers must equal zero. For $\mathrm{HClO_2}$, the calculation $+1 + x + 2(-2) = 0$ gives **oxidation number** $x = +3$.

Why the other answers are wrong

- **A)** Cl_2: Chlorine in its elemental form $\mathrm{Cl_2}$ always has an oxidation state of 0.
- **B)** $HClO_3$: Chlorine reaches $+5$ because three oxygens contribute -6 and hydrogen is $+1$, requiring $+5$ to balance the charge.
- **C)** HCl: Hydrogen provides $+1$, so chlorine takes -1 to cancel the charge in hydrochloric acid.
- **D)** $HClO$: With one oxygen (-2) and one hydrogen $(+1)$, chlorine must be $+1$ to keep the molecule neutral.

35 **An oxidation number cannot be:**

A a positive number
B a number with a decimal point
C **an irrational number**
D zero
E a negative number

Correct answer: C

Oxidation states derive from **integer charges** divided by **atom counts**, guaranteeing **rational values**. Fractional averages are allowed, but mathematical constants like π or $\sqrt{2}$ never arise from these discrete stoichiometric calculations.

Why the other answers are wrong

- **A) a positive number**: Positive numbers are valid, since sodium exhibits an oxidation state of $+1$ in NaCl .
- **B) a number with a decimal point**: Decimal points are valid when calculating weighted averages, such as each oxygen atom reaching -0.5 in the superoxide ion $\mathrm{O_2^-}$.
- **D) zero**: Zero is valid for free elements, like oxygen gas $\mathrm{O_2}$ in its standard elemental form.
- **E) a negative number**: Negative numbers are valid, as chlorine takes an oxidation state of -1 in NaCl.

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36 **What kind of solid is NaCl?**

A **Ionic**
B Metallic
C Amorphous
D Molecular
E Covalent network

Correct answer: A

NaCl is an **ionic solid** composed of $\mathrm{Na^+}$ and $\mathrm{Cl^-}$ ions arranged in a **crystal lattice**. The structural units are held together by strong **electrostatic forces**.

Why the other answers are wrong

- **B)** Metallic solids rely on delocalised electrons flowing between metal atoms. Sodium chloride consists of positive sodium and negative chlorine ions rather than a metallic electron sea.
- **C)** Amorphous materials feature a random and disordered atomic arrangement. Solid sodium chloride maintains a strict periodic geometric pattern throughout its bulk.
- **D)** Molecular compounds exist as discrete neutral particles linked by weak intermolecular forces. Sodium chloride forms an extended charged framework without isolated molecular units.
- **E) Covalent network**: A covalent network requires a continuous three-dimensional framework of shared electron pairs. Sodium chloride lacks covalent bonds entirely and depends solely on ion-ion attractions.

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37 **In the periodic table, the atomic radius increases going:**

A from left to right and from top to bottom

B from right to left and from top to bottom

C from right to left and from bottom to top

D from left to right and from bottom to top

E from top to bottom but horizontally in a very irregularly way

Correct answer: B

Atomic radius increases from right to left across a period due to decreasing **effective nuclear charge** acting on valence electrons. It also increases from top to bottom within a group because each successive element adds a **new energy level**.

Why the other answers are wrong

- **A) from left to right and from top to bottom**: Incorrect because atomic size decreases from left to right across a period. The vertical trend matches reality, but the horizontal direction is reversed.
- **C) from right to left and from bottom to top**: Incorrect because atomic size increases from top to bottom down a group. Moving from bottom to top reduces the number of occupied shells.
- **D) from left to right and from bottom to top**: Incorrect because both stated directions oppose the established periodic trends. Radius shrinks when moving left to right and expands when moving bottom to top.
- **E) from top to bottom but horizontally in a very irregularly way**: Incorrect because horizontal trends follow a consistent pattern rather than being irregular. Radius steadily increases from right to left.

38 **A pure covalent bond is a bond that forms between:**

A two atoms with very different electronegativity

B two identical ions

C two atoms of the same element

D two atoms with no electronegativity

E two atoms with quite similar electronegativity

Correct answer: C

A pure covalent bond relies on the **equal sharing of electrons** between two atoms. When the bonded partners belong to the **same element**, their electronegativity is identical, preventing any unequal pull on the shared pair.

Why the other answers are wrong

- **A) two atoms with very different electronegativity**: Two atoms with very different electronegativity cause electron density to shift toward the more attractive atom, which favors an **ionic bond** or a strongly polar covalent bond instead.
- **B) two identical ions**: Covalent bonds require neutral atoms to share electrons, while identical ions carry the same charge and would experience strong electrostatic repulsion rather than electron sharing.
- **D) two atoms with no electronegativity**: Pure covalency depends on matched electronegativity values, not missing ones; all atoms exhibit some electron-attracting ability, so zero electronegativity does not exist for this purpose.
- **E) two atoms with quite similar electronegativity**: Atoms with quite similar electronegativity still possess a measurable difference that creates a minor charge imbalance, resulting in a slightly polar bond rather than a completely pure covalent interaction.

39 **The pH of an aqueous solution of a monoprotic weak acid with the constant $K_a = 1.0 \times 10^{-5}$ and concentration 0.001 M is:**

A 5.5
B 8
C **4**
D 3
E 10^{-8}

Correct answer: C

For a monoprotic **weak acid**, the equilibrium relation is $K_a = x^2/(C - x)$ with $x = [\mathrm{H}^+]$ and $C = 0.001\,\mathrm{M}$. The **approximation** $x \ll C$ simplifies the calculation to $x \approx \sqrt{K_a C} = \sqrt{10^{-5} \times 10^{-3}} = 10^{-4}\,\mathrm{M}$. Applying the definition $\mathrm{pH} = -\log_{10}[\mathrm{H}^+]$ yields **4**.

Why the other answers are wrong

- **A) 5.5**: It implies a significantly lower hydrogen-ion concentration than the calculated equilibrium value.
- **B) 8**: An aqueous solution of this acid is inherently acidic, making a basic result chemically impossible.
- **D) 3**: It would require $[\mathrm{H}^+] = 0.001\,\mathrm{M}$, assuming complete dissociation instead of partial ionization.
- **E)** 10^{-8}: The value 10^{-8} represents $[\mathrm{H}^+]^2$ in M^2, not the logarithmic pH.

QUESTIONS

40 **What is the pH of a 0.7 M aqueous solution of KBr?**

A 10^{-7}
B **7**
C $10^{-0.7}$
D 0.7
E 13.3

Correct answer: B

KBr dissociates completely into potassium and bromide ions in water. Both originate from a strong base and a strong acid respectively. These ions do not hydrolyze or interact with water molecules. Consequently the aqueous mixture remains **neutral** with a pH of 7 at standard conditions.

Why the other answers are wrong

- **A)** 10^{-7} denotes the hydrogen ion concentration in $\mathrm{mol\,L^{-1}}$ at 25\,^\circ\mathrm{C} not the pH value. Calculating the actual pH requires taking the negative logarithm of that concentration to obtain 7.
- **C)** $10^{-0.7}$ evaluates to approximately 0.2 which is chemically meaningless here. It stems from applying an **exponential** function to the given concentration instead of using logarithmic pH definitions.
- **D)** 0.7 corresponds to the initial **molarity** of the dissolved salt rather than a measure of acidity. Concentration values on the linear scale do not convert directly to logarithmic pH readings.
- **E)** 13.3 implies a highly alkaline environment that KBr cannot produce. The compound lacks proton-accepting capabilities so it does not shift the equilibrium toward hydroxide generation.

42 **The activation energy of a reaction represents:**

A the difference between the energy of the products and that of the reactants
B the energy that is released only in the initial phase of any reaction in solution
C the energy released during the progress of a reaction
D the difference between the kinetic energy and the potential energy of the reactants
E **the energy barrier that the reactants must overcome to transform into products**

Correct answer: E

Activation energy is the **minimum energy** required to reach the transition state. It functions as an **energy barrier** that reactants must surmount to transform into products.

Why the other answers are wrong

- **A) the difference between the energy of the products and that of the reactants**: This describes the net **overall energy change** between reactants and products, not the starting threshold needed to initiate the chemical process.
- **B) the energy that is released only in the initial phase of any reaction in solution**: The term refers to an unavoidable hurdle that is never emitted, and it applies universally regardless of the physical state or solvent used.
- **C) the energy released during the progress of a reaction**: It denotes a mandatory input that molecules must absorb, directly contradicting the idea of energy being released during progression.
- **D) the difference between the kinetic energy and the potential energy of the reactants**: Activation energy is not derived from a calculation comparing kinetic and potential energy values.

43 **In benzene:**

A all the carbon atoms are sp^2 hybridized and the molecule has a chair or boat structure

B all the carbon atoms are sp hybridized

C three carbon atoms are sp^3 hybridized and three atoms are sp^2 hybridized

D all the carbon atoms are sp^2 hybridized and the molecule has a planar structure

E all the carbon atoms are sp^3 hybridized and the molecule has a planar structure

Correct answer: D

Each carbon atom forms three σ bonds using sp^2 orbitals. The remaining p orbital participates in the delocalized π **system**. This geometry guarantees a perfectly **planar** ring.

Why the other answers are wrong

- **A) all the carbon atoms are sp^2 hybridized and the molecule has a chair or boat structure**: Chair and boat conformations describe saturated **cyclohexane** derivatives. Benzene maintains constant bond angles and electron distribution that prevent distortion.
- **B) all the carbon atoms are sp hybridized**: Linear sp **hybridization** permits only two σ bonds per atom. Benzene connects each carbon to three neighbors through double-bond resonance and perpendicular atomic orbitals.
- **C) three carbon atoms are sp^3 hybridized and three atoms are sp^2 hybridized**: Every carbon in the ring shares identical connectivity and electronic environment. The structure consists solely of equivalent centers without mixed bonding types.
- **E) all the carbon atoms are sp^3 hybridized and the molecule has a planar structure**: Benzene carbons employ sp^2 hybridization instead of sp^3 states. The framework is rigidly flat while the proposed bonding model contradicts experimental data.

44 **Glycogen:**

A is a storage molecule present in both animal and plant cells

B is a disaccharide

C is a homopolysaccharide

D is a heteropolysaccharide

E is a polypeptide

Correct answer: C

Glycogen is a **homopolysaccharide** composed exclusively of **glucose** monomers. It acts as the primary energy reserve in **animal** tissues.

Why the other answers are wrong

- **A) is a storage molecule present in both animal and plant cells**: Plants store carbohydrates mainly as **starch**, so glycogen does not occur in plant cells.
- **B) is a disaccharide**: Disaccharides consist of exactly two sugar units, while glycogen is built from hundreds or thousands of them.
- **D) is a heteropolysaccharide**: Heteropolysaccharides contain multiple different types of monosaccharides, but glycogen uses only one type.
- **E) is a polypeptide**: Polypeptides are formed by **amino acid** chains, not sugar polymers.

45 **The compound $FeCO_3$ is:**

A none of the other answers is correct
B **ferrous carbonate**
C iron pentacarbonyl
D ferric carbonate
E iron oxide

Correct answer: B

The **carbonate ion** CO_3^{2-} carries a charge of -2. To maintain electrical neutrality the **iron** atom must adopt the Fe^{2+} oxidation state. The classical name for iron(II) is **ferrous**. These stoichiometric requirements define the compound name ferrous carbonate.

Why the other answers are wrong

- **A) none of the other answers is correct**: Option B accurately identifies the substance so this alternative is invalid.
- **C) iron pentacarbonyl**: Iron pentacarbonyl is a metal carbonyl complex with the formula $Fe(CO)_5$.
- **D) ferric carbonate**: Ferric refers to the iron(III) oxidation state corresponding to Fe^{3+} ions.
- **E) iron oxide**: An oxide contains the oxide ion O^{2-} instead of a carbonate polyatomic group.

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46 **How many electrons can occupy an orbital?**

A Just one
B Four
C **Two with antiparallel spins**
D Two with parallel spins
E Three

Correct answer: C

An orbital accommodates a maximum of **two** electrons. According to the **Pauli exclusion principle**, these particles must possess **opposite spins**. This specific configuration corresponds to antiparallel alignment.

Why the other answers are wrong

- **A) Just one**: An orbital can hold a second electron if its spin is opposite to the first.
- **B) Four**: An orbital cannot hold more than two electrons.
- **D) Two with parallel spins**: Two electrons in the same orbital must have opposite spins.
- **E) Three**: An orbital cannot hold more than two electrons.

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47 **Which of the following statements about amino acids is true?**

- **A** **They contain an amine group and a carboxyl group**
- **B** They are one of the main constituents of carbohydrates
- **C** They are normally poorly soluble in water
- **D** They have no acid/base activity
- **E** They dissolve well in hexane

Correct answer: A

Amino acids possess both an amino group ($-\mathrm{NH_2}$) and a carboxyl group ($-\mathrm{COOH}$). These functional groups define the fundamental structure of these molecules.

Why the other answers are wrong

- **B) They are one of the main constituents of carbohydrates**: These molecules serve as the primary building blocks of proteins, whereas carbohydrates are composed of sugar units.
- **C) They are normally poorly soluble in water**: Amino acids are generally **soluble** in water because they readily form charged zwitterions in aqueous environments.
- **D) They have no acid/base activity**: The $-\mathrm{NH_2}$ and $-\mathrm{COOH}$ groups can accept and donate **protons**, which directly contradicts the claim that they lack acid–base activity.
- **E) They dissolve well in hexane**: Hexane is a strictly **nonpolar** solvent, making it unsuitable for dissolving inherently polar or ionic amino acids.

PHYSICS AND MATHEMATICS

48 **What is the solution to the inequality $\sqrt{2x} < 1 + x$?**

A $\forall x \neq 0$

B R

C $\forall x > 0$

D $\forall x \geq 0$

E $\varnothing$

Correct answer: D

The square root imposes a **domain** restriction of $x \geq 0$. On this interval both sides are non-negative, so **squaring** both sides preserves the inequality direction. This yields $2x < (1 + x)^2$, which simplifies to $0 < 1 + x^2$. The resulting **polynomial** is strictly positive for every real number. Intersecting this result with the initial domain gives $x \geq 0$.

Why the other answers are wrong

- **A)** $\forall x \neq 0$: This option includes negative values where the square root is not defined, while simultaneously excluding the valid boundary case $x = 0$.
- **B)** R: The square root function is undefined for negative inputs, so the entire set of real numbers cannot be the solution.
- **C)** $\forall x > 0$: The option incorrectly excludes $x = 0$, which satisfies the original inequality since $\sqrt{0} < 1 + 0$ holds true.
- **E)** $\varnothing$: Every value in the derived domain actually satisfies the original inequality, making an empty set incorrect.

49 **Which of the following inequalities is satisfied for every real value of x ?**

A $2\sin^2 x - \sin x - 1 > 0$

B $\tan^2 x - 2\tan x + 1 > 0$

C $\sin^2 x + \sin x - 2 \leq 0$

D $\cos^2 x - \cos x - 2 \geq 0$

E $2\cos^2 x + \cos x - 1 < 0$

Correct answer: C

Making the **substitution** $y = \sin x$ confines the variable to the **interval** $[-1, 1]$. The inequality transforms into $y^2 + y - 2 \leq 0$, which reaches its roots via **factorization** to $(y + 2)(y - 1) \leq 0$. Throughout this domain, the first factor stays positive while the second remains non-positive. Their product is therefore always less than or equal to zero for any real x.

Why the other answers are wrong

- **A)** $2\sin^2 x - \sin x - 1 > 0$: Substituting $x = 0$ gives $\sin x = 0$. Calculating the polynomial provides $2(0)^2 - 0 - 1 = -1$. This negative outcome contradicts the requirement of being positive.
- **B)** $\tan^2 x - 2\tan x + 1 > 0$: The expression is equivalent to $(\tan x - 1)^2$. At $x = \pi/4$ we obtain $\tan x = 1$, so the evaluation yields exactly 0. The strict inequality requires a value above zero, causing a violation.
- **D)** $\cos^2 x - \cos x - 2 \geq 0$: At $x = 0$ the cosine equals 1. Inserting this value results in $1^2 - 1 - 2 = -2$. Since -2 falls below zero, it fails the non-negative condition.
- **E)** $2\cos^2 x + \cos x - 1 < 0$: Using $x = 0$ with $\cos 0 = 1$ produces $2(1)^2 + 1 - 1 = 2$. The resulting positive number directly conflicts with the demand for a strictly negative value.

50 **What does the Cartesian product of a set A and a set B correspond to?**

A The set consisting of the products of corresponding numerical elements of A and B

B The representation of the union set of A and B

C **The set of all possible ordered pairs having as the first component an element of A and as the second component an element of B**

D The representation of the intersection set of A and B

E The representation of the difference set of A and B

Correct answer: C

The Cartesian product $A \times B$ consists of all **ordered pairs** (a, b) where the first component belongs to set A and the second belongs to set B. The sequence of elements determines the unique composition of each pair.

Why the other answers are wrong

- **A) The set consisting of the products of corresponding numerical elements of A and B**: This describes arithmetic multiplication of corresponding values instead of combining set elements into coordinate pairs.
- **B) The representation of the union set of A and B**: A union combines distinct elements from both sets into a single collection rather than generating structured pairs.
- **D) The representation of the intersection set of A and B**: An intersection selects only the elements present in both sets simultaneously.
- **E) The representation of the difference set of A and B**: A difference isolates elements that belong exclusively to A while excluding those shared with B.

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51 **The trinomial $a^2 - 4ab + 4b^2$ is equal to:**

A $a^2 - b^2$

B $(a - 2b)^2$

C $(a + 2b)^2$

D $a^2 + b^2$

E $2(a + b)^2$

Correct answer: B

Performing the **expansion** of $(a - 2b)^2$ reproduces the original polynomial. This structural pattern identifies the expression as a **perfect square**. The computed result forms an **exact match** with the given trinomial.

Why the other answers are wrong

- **A)** $a^2 - b^2$: The structure relies on a difference of squares that removes any interaction between the variables. The squared second variable carries a negative sign rather than a positive one.
- **C)** $(a + 2b)^2$: Performing the multiplication generates $a^2 + 4ab + 4b^2$. The sign of the central component contradicts the given trinomial.
- **D)** $a^2 + b^2$: The polynomial includes a crossed term $-4ab$ that this option completely omits. Additionally, the coefficient of b^2 equals one instead of four.
- **E)** $2(a + b)^2$: Distributing the scalar factor produces $2a^2 + 4ab + 2b^2$. Every numerical coefficient differs from the original expression.

52 **In a rectangle ABCD the base AB is $5/4$ of the height BC and the perimeter is 72 cm. What are the dimensions of the rectangle?**

- **A** **AB = 20 m; BC = 16 m**
- **B** AB = 18 m; BC = 16 m
- **C** AB = 20 m; BC = 18 m
- **D** AB = 10 m; BC = 8 m
- **E** AB = 12 m; BC = 10 m

Correct answer: A

Set $BC = h$. Then $AB = \frac{5}{4}h$. The **perimeter formula** yields $2\left(h + \frac{5}{4}h\right) = 72\ \text{cm}$. **Solving** gives $h = 16\ \text{cm}$ and $AB = 20\ \text{cm}$. Option D shows the correct **numerical values**, though the printed units are incorrectly marked as metres instead of centimetres.

Why the other answers are wrong

- **B) AB = 18 m; BC = 16 m**: The ratio $18/16$ does not equal $5/4$, and these side lengths produce a perimeter of $68\ \text{cm}$ instead of $72\ \text{cm}$.
- **C) AB = 20 m; BC = 18 m**: The ratio $20/18$ is not equivalent to $5/4$, and the corresponding perimeter would be $76\ \text{cm}$.
- **D) AB = 10 m; BC = 8 m**: These measurements yield a perimeter of $36\ \text{cm}$, exactly half of the required total.
- **E) AB = 12 m; BC = 10 m**: Using these dimensions results in a perimeter of $44\ \text{cm}$, which fails the given condition.

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53 **For which values of a is the equation $3x + a = 3$ determined?**

- **A** For no value of a
- **B** For $a \neq -3$
- **C** For $a \neq 0$
- **D** **For any value of a**
- **E** For $a \neq 3$

Correct answer: D

The coefficient of x is 3, which is **never zero**. This guarantees that the equation always yields a **unique solution** expressed as $x = \frac{3-a}{3}$. Therefore the relationship holds for **any value** of the parameter.

Why the other answers are wrong

- **A) For no value of a**: Incorrect because the equation possesses a unique solution for every value of a, directly contradicting the claim that it works for none.
- **B) For $a \neq -3$**: Incorrect because the restriction $a \neq -3$ is unfounded since substituting $a = -3$ into the derivation still produces a valid unique solution.
- **C) For $a \neq 0$**: Incorrect because the exclusion $a \neq 0$ mistakenly implies the equation becomes indeterminate at this point, whereas it remains fully solvable.
- **E) For $a \neq 3$**: Incorrect because assigning $a = 3$ merely computes $x = 0$ and does not interfere with the guarantee of a single unique solution.

QUESTIONS

54 **Given the equation $(a+3)x=5$, which of the following values of a is impossible?**

A $a=3$
B $a=-5$
C $a=5$
D $a=-3$
E $a=0$

Correct answer: D

If $a=-3$, the coefficient $a+3$ becomes 0. The equation turns into $0x=5$, which admits **no solution** because multiplying zero by any number never yields five.

Why the other answers are wrong

- **A)** $a=3$: Substituting $a=3$ gives $6x=5$, yielding $x=\frac{5}{6}$, which satisfies the original equation.
- **B)** $a=-5$: Substituting $a=-5$ gives $-2x=5$, yielding $x=-\frac{5}{2}$, which satisfies the original equation.
- **C)** $a=5$: Substituting $a=5$ gives $8x=5$, yielding $x=\frac{5}{8}$, which satisfies the original equation.
- **E)** $a=0$: Substituting $a=0$ gives $3x=5$, yielding $x=\frac{5}{3}$, which satisfies the original equation.

55 **Two cars, A and B, are moving in uniform rectilinear motion with speeds of 120 km/h and 80 km/h, respectively. If at the initial moment A is 500 meters behind B, after one minute:**

A A will never overtake B
B A will overtake B after a much longer time than one minute
C **A has overtaken B**
D A has exactly reached B
E A has not yet overtaken B

Correct answer: C

The **relative speed** between the vehicles is $120\ \mathrm{km/h}-80\ \mathrm{km/h}=40\ \mathrm{km/h}$. In one minute, car A reduces the **initial gap** by $\frac{40}{60}\ \mathrm{km}=\frac{2}{3}\ \mathrm{km}\approx 667\ \mathrm{m}$. This distance exceeds the starting separation, confirming that car A has already passed car B.

Why the other answers are wrong

- **A) A will never overtake B**: Car A travels faster than car B while starting at a finite distance behind, so an overtake is guaranteed.
- **B) A will overtake B after a much longer time than one minute**: Car A catches car B after only $45\ \mathrm{s}$ instead of requiring much longer than one minute.
- **D) A has exactly reached B**: Car A reaches the position of car B before the minute is over rather than arriving exactly at the one-minute mark.
- **E) A has not yet overtaken B**: Car A covers more distance relative to car B than the initial $500\ \mathrm{m}$ gap within sixty seconds.

56 **An electric circuit consists of 100 branches connected in parallel. Each branch has 10 resistors in series, each with a value of R. What is the equivalent resistance?**

- **A** $R/10$
- **B** $10R$
- **C** $R/100$
- **D** R
- **E** $100R$

Correct answer: A

Each branch contains 10 resistors in **series**, producing a branch resistance of $10R$. Combining these 100 identical branches in **parallel** divides that value equally, yielding an **equivalent resistance** of $R/10$.

Why the other answers are wrong

- **B)** $10R$: This value corresponds solely to the resistance of one complete branch, overlooking the current division across the other 99 branches.
- **C)** $R/100$: This figure assumes 100 isolated resistors sharing the same nodes, failing to recognize that every single path contains ten resistors stacked together.
- **D)** R: This result ignores both the additive nature of components in a series loop and the dividing effect of multiple parallel paths.
- **E)** $100R$: Parallel arrangements always reduce total resistance as additional paths open for the current, making a larger sum physically impossible here.

57 **Which of these particles move in a straight horizontal metal wire carrying a current from left to right?**

- **A** **Only the electrons moving from right to left**
- **B** Only the electrons moving from left to right
- **C** Only the protons moving from right to left
- **D** The electrons moving from left to right and the protons from right to left
- **E** Only protons moving from left to right

Correct answer: A

In a metal wire, **electrons** act as the sole mobile charge carriers. Conventional **current** flows left to right, meaning negatively charged particles drift right to left. **Protons** stay bound in the solid crystal structure.

Why the other answers are wrong

- **B) Only the electrons moving from left to right**: Incorrect because electrons drift opposite to the direction of conventional current.
- **C) Only the protons moving from right to left**: Incorrect because protons do not move through the wire.
- **D) The electrons moving from left to right and the protons from right to left**: Incorrect because electrons drift from right to left, while protons remain fixed.
- **E) Only protons moving from left to right**: Incorrect because protons do not move through the wire.

58 **An astronaut takes a spacewalk at a distance from the Earth's surface equal to three times the Earth's radius. What fraction of g corresponds to the acceleration experienced by the astronaut?**

A $1/6$
B $1/4$
C $1/3$
D $1/16$
E $1/9$

Correct answer: D

The astronaut floats at a height of $3R$ above the surface, making the total **distance** from the **Earth's centre** equal to $R + 3R = 4R$. Gravitational strength follows an **inverse-square law** relative to that radial separation. Substituting the expanded radius into the proportionality yields exactly $1/16$ of g.

Why the other answers are wrong

- **A)** $1/6$: Cannot be derived from the actual centre distance of $4R$.
- **B)** $1/4$: Uses an inverse-distance model rather than the necessary squared relationship.
- **C)** $1/3$: Applies a linear inverse rule instead of squaring the radius ratio.
- **E)** $1/9$: Chooses $1/9$ by mistaking the altitude $3R$ for the direct distance from the centre instead of adding it to the base radius.

59 **A car with a mass of 2.0×10^3 kg travels in a straight line at a constant speed on a flat road. Its speed is 15 m/s. At a certain moment ($t = 0$) it accelerates with a constant acceleration of 2.0 m/s^2, in the same direction as the velocity. The constant friction force is 2000 N. The forces F1 e F2 exerted by the engine in the first and second segments, respectively, are:**

A $F1 = 2000$ **N,** $F2 = 6000$ **N**

B $F1 = F2 = 2000$ N

C $F1 = 0$, $F2 = 6000$ N

D $F1 = 0$, $F2 = 4000$ N

E $F1 = 30 \times 10^3$ N, $F2 = 4000$ N

Correct answer: A

At constant speed, the **net force** is zero, so the engine thrust balances the **friction** force. During acceleration, **Newton's second law** requires a net force of $F_{\text{net}} = ma = (2.0 \times 10^3\ \text{kg})(2.0\ \text{m s}^{-2}) = 4000\ \text{N}$. The engine must supply this net force plus overcome friction, yielding $F_2 = 4000\ \text{N} + 2000\ \text{N} = 6000\ \text{N}$.

Why the other answers are wrong

- **B)** $F1 = F2 = 2000$ **N**: Assigning identical forces to both phases fails to reflect the transition from equilibrium to accelerated motion. Sustaining only $2000\ \text{N}$ during the second segment would cancel out the friction completely and produce zero acceleration.
- **C)** $F1 = 0$, $F2 = 6000$ **N**: The first value assumes no propulsion is needed, which contradicts the requirement to balance friction at constant velocity. The second value matches the correct acceleration phase calculation but cannot stand alongside an incorrect initial force.
- **D)** $F1 = 0$, $F2 = 4000$ **N**: Both values omit the constant resistive force entirely. The first force incorrectly implies zero resistance during cruising, while the second force provides only the calculated net force for acceleration without covering friction losses.
- **E)** $F1 = 30 \times 10^3$ **N,** $F2 = 4000$ **N**: The initial force vastly exceeds the $2000\ \text{N}$ needed to maintain uniform motion. The second force incorrectly treats the $4000\ \text{N}$ net force as the total engine output, ignoring the additive friction term.

60 **A stationary liquid exerts on the walls of the container that holds it:**

A forces in any direction relative to the walls

B forces equal to zero

C forces always parallel to the walls at every point

D no forces on the walls, only pressure

E forces always perpendicular to the walls at every point

Correct answer: E

A stationary liquid applies pressure against the container boundaries. The resulting force acts **perpendicular** to the surface at every contact point. Fluids at rest lack the mechanical properties required to generate tangential or **shear** forces.

Why the other answers are wrong

- **A) forces in any direction relative to the walls**: Pressure generates normal forces directed outward from the fluid, so forces do not act in arbitrary directions relative to the walls.
- **B) forces equal to zero**: The weight and static pressure of the liquid create measurable contact forces wherever the fluid touches the container surfaces.
- **C) forces always parallel to the walls at every point**: Parallel forces would represent shear stresses, which only occur in moving fluids, not in hydrostatic conditions.
- **D) no forces on the walls, only pressure**: Pressure is defined as force per unit area, so it necessarily produces distributed mechanical forces on the container walls.

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