PROVE UFFICIALI DEGLI ANNI PASSATI

IMAT

2011

A B ✓ D E

SVOLTA CON SOLUZIONI COMMENTATE

Il perché di ogni risposta

WHAT'S IN THIS DOCUMENT

Prova di ammissione IMAT 2011, 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

General Knowledge and Logical Reasoning	35 questions
Biology	15 questions
Chemistry	10 questions
Physics and Mathematics	10 questions
Total	**70 questions**

This version has **70 of the 80 questions** of the paper, the ones with our explained solution; the full paper is in the «official paper» file.

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.

GENERAL KNOWLEDGE AND LOGICAL REASONING

1 **Which of the following states is NOT a permanent member of the UNSecurity Council?**

A USA
B France
C United Kingdom
D **Japan**
E China

Correct answer: D

The UN Security Council has five **permanent members** granted seats and **veto power** in 1945. These nations were the main **Allied victors of World War II**. Japan lacks a permanent seat and participates through **rotating terms** after election. Thus, Japan is the only non-permanent option listed.

Why the other answers are wrong

- **A) USA**: The United States remains one of the five permanent members with unrestricted veto power.
- **B)** France is one of the original P-5 members and retains its permanent seat with veto authority.
- **C) United Kingdom**: The United Kingdom is one of the five founding permanent members and maintains its voting privileges.
- **E) China**: The People's Republic of China currently occupies the Chinese permanent seat and holds full permanent membership rights.

2 **Which ancient Greek is referred to as the father of Western medicine?**

A Aristotle
B **Hippocrates**
C Plato
D Aristophanes
E Socrates

Correct answer: B

Hippocrates lived around 460–370 BCE and moved medicine away from supernatural beliefs. He emphasized direct observation, rational diagnosis, and natural causes for illness. His collected writings established guidelines for patient care and professional behavior. This framework guided the development of modern scientific medicine.

Why the other answers are wrong

- **A)** Aristotle conducted extensive studies in biology and zoology, but his academic focus remained on general philosophy and logic. He never contributed to clinical treatment or medical ethics.
- **C)** Plato founded the Academy and wrote primarily about governance and metaphysics. He occasionally mentioned bodily wellness but never systematized healing techniques or diagnostic methods.
- **D)** Aristophanes was a celebrated theatrical writer known for political and social comedies. His literary output contained no medical theories or practical advice.
- **E)** Socrates developed a dialogical approach to moral inquiry and education. He produced no anatomical records or therapeutic procedures related to healthcare.

3 **Amnesty International (AI), a non-governmental organisation for the protection of human rights enshrined in the Universal Declaration of Human Rights, opposes the death penalty.**

Which one of the following reasons for opposing the death penalty is inconsistent with the principles of AI.

A The death penalty can be carried out on an innocent person
B The death penalty is not a deterrent against crime
C The death penalty is cruel, inhuman and degrading
D The death penalty, once carried out, cannot be reversed
E The death penalty is contrary to theological principles

Correct answer: E

Amnesty International functions as a strictly **secular** entity that grounds all campaigns in universally agreed **human rights frameworks**. It deliberately excludes religious doctrine to maintain institutional independence. Invoking **theological principles** therefore falls outside its official guidelines and contradicts its operational model.

Why the other answers are wrong

- **A) The death penalty can be carried out on an innocent person**: Judicial errors lead to wrongful convictions that cannot be corrected after execution, directly supporting AI's focus on procedural accuracy and the fundamental right to life.
- **B) The death penalty is not a deterrent against crime**: Statistical evidence demonstrates that executions do not reduce crime rates, offering an empirical justification that perfectly matches AI's data-driven advocacy.
- **C) The death penalty is cruel, inhuman and degrading**: This classification mirrors Article 5 of the Universal Declaration of Human Rights, which AI consistently uses to designate capital punishment as unacceptable treatment.
- **D) The death penalty, once carried out, cannot be reversed**: The irreversible nature of capital punishment blocks any reassessment of mitigating factors or legal mistakes, making it a central argument tied to due process guarantees.

4 **Three red balls, three yellow balls and one green ball are placed in a bag and the bag is shaken. I place my hand in the bag and pull out a red ball followed by a green ball. I do not replace either ball.**

Which one of the following statements is true?

A At least one of the next three balls must be red

B The next ball will definitely be yellow

C **At least one of the next three balls must be yellow**

D The next two balls cannot both be red

E The next ball could be any one of red, yellow or green

Correct answer: C

After removing one red and the single green ball, **five balls remain** with **two red and three yellow**. Drawing three balls guarantees that **at least one must be yellow** because there are only two red options. Even if the first two picks take the remaining reds, the third draw produces a forced yellow result.

Why the other answers are wrong

- **A) At least one of the next three balls must be red**: You could easily draw all three yellow balls first. Reaching three draws without red breaks the guarantee.
- **B) The next ball will definitely be yellow**: The next ball is not certain to be yellow since a red selection still exists. The chance equals $\frac{2}{5}$, so certainty fails.
- **D)** The next two balls can both be red. This happens with probability $\frac{2}{5} \times \frac{1}{4} = \frac{1}{10}$, contradicting "cannot".
- **E) The next ball could be any one of red, yellow or green**: The bag contains **zero green balls** after the first removal. Any future draw excludes green entirely.

5 **My friend has three children, Alice, George and Hannah and I need to buy two presents for them to share. I want to buy two different toys and I want to make sure that Alice, George and Hannah will each like at least one of them. I don't want the toys to have small parts.**

How much am I going to pay in total?

Toy	*Small Parts?*	*Liked by Alice?*	*Liked by George?*	*Liked by Hannah?*	*Price*
Jigsaw	Yes	No	Yes	Yes	€12
Building bricks	Yes	Yes	Yes	No	€9
Car	No	No	No	Yes	€12
Bear	No	Yes	No	Yes	€7
Train	No	No	Yes	No	€8

A 16
B 20
C 19
D 24
E **15**

Correct answer: E

You must pick two different toys **without small parts** that satisfy all three children's preferences. Only **three eligible toys** meet the safety rule: the Car ($€\,12$, liked by Hannah), the Bear ($€\,7$, liked by Alice and Hannah), and the Train ($€\,8$, liked by George). Evaluating all combinations shows that only the Bear plus the Train guarantees everyone likes at least one item, resulting in a **total cost** of $€\,15$.

Why the other answers are wrong

- **A) 16**: $€\,16$ comes from pairing the Bear ($€\,7$) with the Building Bricks ($€\,9$), but the Building Bricks contain small parts and are excluded.
- **B) 20**: $€\,20$ results from adding the Car ($€\,12$) and the Train ($€\,8$), but Alice does not like either option.
- **C) 19**: $€\,19$ corresponds to the Car ($€\,12$) combined with the Bear ($€\,7$), which leaves George without a liked toy.
- **D) 24**: $€\,24$ mixes the Jigsaw ($€\,12$) with the Car ($€\,12$), yet the Jigsaw has small parts and Alice would not enjoy either gift.

7 **The polis is the most important institutional expression of the classical Greek way of life.**

What type of state is it?

A A monarchical state
B A tyrannical state
C **A city state**
D A federal state
E A modern state

Correct answer: C

The term polis denoted an **autonomous community** centered on a city and its surrounding territory. Each polis maintained independent laws, military forces and religious practices. Historians translate it as **city-state** because sovereignty remained confined to the urban center and adjacent lands. This structure represents the fundamental political unit of classical Greece.

Why the other answers are wrong

- **A) A monarchical state**: Early Greek regions occasionally featured hereditary rulers, but classical society evolved toward shared governance models. The essential feature of a polis was self-government rather than royal succession.
- **B) A tyrannical state**: Tyranny described a specific and often transient leadership style within a Greek community. The concept of polis does not specify who holds power, as it functions identically under democratic, oligarchic or tyrannical regimes.
- **D)** A federal state unites multiple independent entities under a central authority. Although some Greek poleis formed alliances, the polis itself functioned as a single constituent rather than a federated arrangement.
- **E) A modern state**: Modern states developed after the Middle Ages with extensive bureaucracies and internationally recognized borders. Classical poleis lacked this administrative depth and operated as compact local societies.

8 **Which set of statements about Dante Alighieri is correct?**

A **he was from Florence, wrote poetry, died before 1400**

B he was from Tuscany, wrote poetry, was the son of Giulia Beccaria

C he was from Milan, was the son of Giulia Beccaria, wrote poetry

D he was of noble family, was born in the fourteenth century, wrote tragedies

E he was from Milan, was born in the thirteenth century, died before 1400

Correct answer: A

Dante was born in **Florence**, then an independent commune and now the chief city of Tuscany. He wrote **poetry**, including *The Divine Comedy* and shorter poems collected in *Vita Nuova* and *Convivio*. He died in Ravenna in **1321**, before 1400.

Why the other answers are wrong

- **B) he was from Tuscany, wrote poetry, was the son of Giulia Beccaria**: Florence is in Tuscany, and Dante wrote poetry. However, Giulia Beccaria was not his mother.
- **C) he was from Milan, was the son of Giulia Beccaria, wrote poetry**: Dante was not from Milan, and Giulia Beccaria, the mother of Alessandro Manzoni, lived centuries later and was not Dante's mother. Only the statement that he wrote poetry is correct.
- **D) he was of noble family, was born in the fourteenth century, wrote tragedies**: Dante's family belonged to the minor Florentine gentry, so calling him noble is debatable and usually avoided. He was born in 1265, in the thirteenth century, not the fourteenth. He did not write stage tragedies; he wrote epic and lyric poetry. Thus, two of the three statements are incorrect.
- **E) he was from Milan, was born in the thirteenth century, died before 1400**: Dante was Florentine, not from Milan. The other statements are correct: he was born in the thirteenth century and died before 1400.

9 **Which of the following is NOT true of the Enlightenment?**

A It was a cultural trend that highlighted all the social and economic inequalities, and paved the way for the French Revolution.

B It was a cultural trend that was based on the exaltation of reason that, eliminating any irrational element of knowledge, by itself, revealed the truth without the help of the transcendental realm. In France this lead to materialism and atheism.

C It was a cultural trend, according to which the only real art was rational, understandable by all, and identified itself with Greek and Roman art.

D **It was a cultural trend that spread across Europe, which emphasised the sovereignty of the people, as a carrier of values.**

E It was a cultural trend that spread across Europe, mainly in France, in the early 1700s.

Correct answer: D

The Enlightenment centered on **human reason** as the supreme authority, systematically questioning traditional hierarchies. Attributing a primary focus on popular sovereignty directly contradicts this rationalist critique of established power structures. Since philosophers prioritized logical scrutiny over democratic mandates, option D presents a historical inaccuracy. This factual mismatch identifies it as the only false statement. **Why the other options are not the answer Answer B**: Thinkers like Voltaire, Rousseau and the Encyclopaedists systematically exposed **feudal privileges** and clerical domination. Their critiques dismantled absolutist justifications and provided foundational arguments for political change. These publications directly supplied the ideological framework that fueled the French Revolution. **Answer C**: Early foundations relied on Locke, Newton and Bayle, but the movement peaked between **1715 and 1789**. Parisian salons and printing presses acted as central hubs before ideas diffused across the continent. This chronological and geographical trajectory aligns perfectly with documented historical expansion. **Answer D**: Aesthetic standards demanded **clarity, balance and universal intelligibility** derived from classical models. The prevailing artistic philosophy rejected emotional excess in favor of structured rationality. While sentimentalism offered minor counter trends, the era firmly equated authentic art with accessible logic. **Answer E**: Philosophers championed **unaided human reason** as fully capable of revealing truth and morality. This commitment deliberately excluded supernatural explanations from epistemological processes. French figures like Diderot, d'Holbach and Helvétius consequently transitioned toward systematic materialism and explicit atheism.

Why the other answers are wrong

10 **Two security guards, Dave and Geoff, are patrolling an airbase. Dave passes the front gate every 8 minutes. Geoff passes the front gate every 15 minutes. They have just set off on their individual routes at the start of their shift.**

How long will it be before they meet up at the front gate again?

A 1h 30mins
B 2h 30mins
C 1h 00mins
D **2h 00mins**
E 3h 00mins

Correct answer: D

To determine when both guards coincide, calculate the **least common multiple** of their patrol **intervals** of $8\ \text{min}$ and $15\ \text{min}$. Decomposing into prime factors yields 2^3 and 3×5, giving $2^3 \times 3 \times 5 = 120\ \text{min}$. This converts to $2\ \text{h}$ after starting together.

Why the other answers are wrong

- **A) 1h 30mins**: $90\ \text{min}$ aligns with Geoff but fails for Dave because 90 is not **divisible by 8**, meaning his actual visits occur at $88\ \text{min}$ and $96\ \text{min}$.
- **B) 2h 30mins**: $150\ \text{min}$ matches Geoff's schedule but leaves Dave mid-circuit as $150 \div 8 = 18.75$.
- **C) 1h 00mins**: $60\ \text{min}$ suits Geoff yet misses Dave since $60 \div 8 = 7.5$, placing him between $56\ \text{min}$ and $64\ \text{min}$.
- **E) 3h 00mins**: $180\ \text{min}$ satisfies Geoff but still skips Dave because $180 \div 8 = 22.5$, indicating a half-cycle offset.

11 **Employees at a printing company are paid a basic rate of €11 per hour during the day Monday to Friday. During weekday evenings and on Saturdays they are paid at one and a half times the basic rate and on Sundays they are paid at double the basic rate.The table below shows the hours worked by employees last week: Which employee earned most last week?**

	Mon-Fri daytime	Mon-Fri evenings and Saturdays	Sundays
Alice	32	8	6
Ben	27	8	8
Chetan	36	8	2
Daniel	30	8	6
Ellen	35	8	4

A Daniel
B Ellen
C Chetan
D Ben
E Alice

Correct answer: E

Pay rates derive from the **basic rate** of 11.00. Weekday evenings and Saturdays use 16.50, while Sundays apply 22.00. Multiplying each worker's recorded hours by these three rates yields **Alice** as the highest earner at 616.00.

Why the other answers are wrong

- **A)** Daniel accumulates $30 \times 11.00 + 8 \times 16.50 + 6 \times 22.00 = 594.00$. He records the same evening and Sunday shifts as Alice but starts with two fewer daytime hours, directly lowering his final wage.
- **B)** Ellen finishes $35 \times 11.00 + 8 \times 16.50 + 4 \times 22.00 = 385.00 + 132.00 + 88.00 = 605.00$. Her strong daytime block and standard Saturday roster match the others closely, but reducing Sunday presence keeps her total five euros below the leader.
- **C)** Chetan logs $36 \times 11.00 + 8 \times 16.50 + 2 \times 22.00 = 396.00 + 132.00 + 44.00 = 572.00$. Maximizing daytime hours compensates for the base rate, but cutting Sunday work nearly in half drags the premium component down to a record low.
- **D)** Ben completes $27 \times 11.00 + 8 \times 16.50 + 8 \times 22.00 = 297.00 + 132.00 + 176.00 = 605.00$. His heavier Sunday load boosts the subtotal, yet his significantly shorter Monday–Friday day shift prevents him from overtaking Alice.

12 **A teacher in a school for children from 11 to 16 years old sets a code number to unlock his classroom door. He has a method for remembering his code.**

He uses:
- the 2 digits of his birth month reversed (for example, February would be 02 reversed to 20);
- then the age of the children in his class at the start of the year with the digits reversed;
- and finally, the date of his birthday in the month, also reversed.

Which one of the following could not be the code to unlock his door?

A 903121
B 701131
C 215150
D **602124**
E 115191

Correct answer: D

The six-digit code consists of three two-digit blocks. **Reversing each block** must yield values within **valid ranges**: months 01–12, ages 11–16 (displayed as 11, 21, 31, 41, 51, or 61), and calendar days 01–31. Evaluating the options against these constraints identifies the only code that **fails**.

Why the other answers are wrong

- **A) 903121**: The pairs 90, 31, and 21 reverse to month 09 (September), age 13, and day 12. All components satisfy the teacher's method.
- **B) 701131**: The pairs 70, 11, and 31 reverse to month 07 (July), age 11, and day 13. All components satisfy the teacher's method.
- **C) 215150**: The pairs 21, 51, and 50 reverse to month 12 (December), age 15, and day 05. All components satisfy the teacher's method.
- **E) 115191**: The pairs 11, 51, and 91 reverse to month 11 (November), age 15, and day 19. All components satisfy the teacher's method.

13 **It has long been thought that birds are much less intelligent than humans and apes. But now it seems that some species of birds have the same kind of thinking skills as apes. Crows can create and use tools and are socially sophisticated when finding and protecting food. So how can a bird with a walnut-size brain be capable of such achievements? The answer is that both crows and apes have much bigger brains than you would expect from the size of their bodies. The same pattern is found in humans, parrots and chimps - all intelligent animals.**

Which one of the following can be drawn as a conclusion from the above passage?

A Animals that cannot create tools are not intelligent.

B It could be argued that birds are as intelligent as apes.

C **Relative brain size is a better indicator of intelligence than absolute brain size.**

D Apes are not as similar to humans as had been thought.

E Crows are more intelligent than other species of birds.

Correct answer: C

The passage contrasts the tiny cranial volume of crows with their complex problem solving, noting that highly capable mammals and birds possess disproportionately large heads compared to their physical build. This consistent biological pattern points to **relative brain size** as a stronger predictor of **cognitive capacity** than absolute dimensions or overall creature mass.

Why the other answers are wrong

- **A) Animals that cannot create tools are not intelligent.**: The text never establishes tool creation as a mandatory prerequisite for mental acuity. It only cites crow behavior as a single example of advanced capability.
- **B) It could be argued that birds are as intelligent as apes.**: Broad categorizations completely ignore the author's explicit scope limitation. Reported findings apply exclusively to particular members of the bird kingdom, not the entire class.
- **D) Apes are not as similar to humans as had been thought.**: The narrative emphasizes a shared anatomical trajectory between primates and people, directly contradicting suggestions of growing distance. Evidence confirms matching neurological scaling trends.
- **E) Crows are more intelligent than other species of birds.**: The excerpt provides zero comparative metrics between corvids and other feathered varieties. Author claims remain strictly limited to select species exhibiting primate parallels.

14 **There is a higher than average risk of death or injury to young drivers and their passengers. In 2007, 32 per cent of car driver deaths and 40 per cent of car passenger deaths were people aged between 17 and 24. Young male drivers were much more likely to be killed or seriously injured than young female drivers. So in order to reduce the number of road accidents and the numbers of people killed or injured, young people should not be allowed to drive until they reach the age of 24.**

Which one of the following is an assumption on which this argument depends?

A **Most of the accidents involving young people were the fault of the young drivers.**
B Young people would not accept the raising of the legal driving age.
C The driving test does not effectively test the skill of drivers.
D The majority of drivers aged between 17 and 24 drive dangerously.
E Amongst drivers aged between 17 and 24 there are more male drivers than female drivers.

Correct answer: A

The data shows high fatality rates among young road users but does not identify who causes the collisions. The proposal assumes that **young drivers** are primarily responsible for these incidents. Without this causal link, **restricting** their access would not reliably reduce overall accidents or casualties.

Why the other answers are wrong

- **B) Young people would not accept the raising of the legal driving age.**: Social acceptance or political feasibility has no bearing on whether the measure actually lowers fatality numbers.
- **C) The driving test does not effectively test the skill of drivers.**: Training effectiveness falls entirely outside the statistical evidence and requires assumptions not present in the original reasoning.
- **D) The majority of drivers aged between 17 and 24 drive dangerously.**: Assuming most drivers are reckless sets an unnecessarily high threshold, as the argument only requires a subset to cause frequent incidents.
- **E) Amongst drivers aged between 17 and 24 there are more male drivers than female drivers.**: The gender ratio is irrelevant to the age-based risk analysis and does not impact the predicted safety outcome.

15 **Some disabled people find it difficult to gain access to some of our older public buildings because the entrances have steps. The problem is most often solved by installing ramps. All public buildings must be accessible to everyone therefore they must all install ramps. Which one of the following identifies the flaw in this argument?**

A It is unreasonable to suggest that disabled people should be able to access all public buildings.

B Disabled people must have access to all buildings not just public ones so all buildings should have ramps.

C Some older public buildings without ramps may be accessible to disabled people.

D Installing ramps in all public buildings would be extremely expensive.

E Inaccessible public buildings should be replaced by buildings accessible to all.

Correct answer: C

The passage notes that ramps typically resolve step-related access issues in older public buildings. It does not logically follow that every facility must install one, since some structures may already guarantee entry through **level floors** or **integrated layouts**. Applying a single workaround universally ignores this existing access.

Why the other answers are wrong

- **A) It is unreasonable to suggest that disabled people should be able to access all public buildings.**: The flaw targets the proposed means of access rather than the goal of accessibility.
- **B) Disabled people must have access to all buildings not just public ones so all buildings should have ramps.**: It shifts the scope to non-public buildings instead of identifying the logical gap.
- **D) Installing ramps in all public buildings would be extremely expensive.**: Cost considerations do not demonstrate that ramps are necessary for access in every building.
- **E) Inaccessible public buildings should be replaced by buildings accessible to all.**: It suggests a different solution but does not explain why the conclusion itself is flawed.

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16 **A street of houses is numbered starting on one side with 1,2,3,4. At the far end the numbers continue down the other side in the opposite direction so the largest number is opposite number 1. The houses are of identical widths so each house has another directly opposite it. If number 17 is directly opposite number 56, how many houses are there in the street?**

A 37

B 39

C 73

D 36

E 72

Correct answer: E

Let n be the number of houses on each side, so there are $2n$ houses in total. The house **opposite** number k is number $2n - k + 1$, so $56 = 2n - 17 + 1$ and $2n = 72$. Therefore, the street has **72** houses.

Why the other answers are wrong

- **A) 37**: The total of 37 is odd, so it would mean $37/2$ houses on each side, which is impossible.
- **B) 39**: The total of 39 is odd, so it would mean $39/2$ houses on each side, which is impossible.
- **C) 73**: The total of 73 is odd, so it would mean $73/2$ houses on each side, which is impossible.
- **D) 36**: This would give $n = 18$. The house opposite number 17 would be $2 \cdot 18 - 17 + 1 = 20$, not 56.

17 **A courier starts the day in London and makes two round trips to Prague in the day. When she arrives at either airport, she takes the next available flight back.**

How long is the courier's day from first take-off to last landing?

London depart	Prague arrive	Prague depart	London arrive
06 : 30	09 : 30	10 : 10	11 : 20
09 : 45	12 : 45	13 : 25	14 : 35
12 : 30	15 : 30	16 : 40	17 : 50
15 : 45	18 : 45	19 : 55	21 : 05

A **11 hours 20 minutes**

B 4 hours 50 minutes

C 14 hours 35 minutes

D 8 hours 20 minutes

E 8 hours 5 minutes

Correct answer: A

The courier completes two London–Prague–London **circuits** by selecting the **earliest available flights**. Departing London at $06{:}30$, she arrives in Prague at $09{:}30$ and boards the $10{:}10$ return, landing in London at $11{:}20$. The subsequent departure is $12{:}30$, reaching Prague at $15{:}30$, followed by the $16{:}40$ flight back to London at $17{:}50$. The **total duration** from first take-off ($06{:}30$) to final landing ($17{:}50$) equals $11 \text{ hours } 20 \text{ minutes}$.

Why the other answers are wrong

- **B) 4 hours 50 minutes**: This interval represents a single outbound and return leg, such as the $06{:}30$ departure concluding at $11{:}20$; it accounts for only one circuit rather than the required two.
- **C) 14 hours 35 minutes**: An elapsed time of $14 \text{ hours } 35 \text{ minutes}$ would necessitate starting with the $09{:}45$ departure to finish at $21{:}05$, which introduces an **idle morning gap** and results in a slower schedule than beginning at $06{:}30$.
- **D) 8 hours 20 minutes**: No matching pair of departure and arrival times in the schedule produces exactly $8 \text{ hours } 20 \text{ minutes}$ while adhering to the rule of always taking the immediately next available flight for both outbound and return journeys.
- **E) 8 hours 5 minutes**: Calculating from $06{:}30$ to $14{:}35$ yields $8 \text{ hours } 5 \text{ minutes}$, but this timeline covers only one complete round trip plus a partial second leg; it fails to finish two full circuits.

18 **My three local supermarkets all currently have offers on my favourite breakfast cereal as follows:**

1. Buy one standard pack get a second half price
2. Price of a standard pack reduced by 1/3
3. Normal price of a standard pack, pack contains 25% extra

Which of the offers are equivalent in terms of price per unit amount of cereal?

A 1, 2 and 3
B 1 and 2 only
C 2 and 3 only
D 1 and 3 only
E none

Correct answer: E

1. We assign the standard price P and a **baseline** quantity of 1 unit. 2. Offer 1 requires paying $1.5P$ for two packs, resulting in a unit **cost** of $0.75P$. 3. Offer 2 applies a $\frac{1}{3}$ **discount**, leaving a price of $\frac{2}{3}P \approx 0.667P$ per single unit. 4. Offer 3 keeps the cost at P but increases the contents to 1.25 units, yielding a **rate** of $0.8P$. Since these calculated **ratios** differ, no packages share an identical cost structure.

Why the other answers are wrong

- **A) 1, 2 and 3**: Selecting all three would demand perfect alignment of the rates, yet every independent calculation reveals a distinct monetary figure.
- **B) 1 and 2 only**: Pairing the first and second options highlights a clear discrepancy between the $0.75P$ charge and the lower $0.667P$ valuation.
- **C) 2 and 3 only**: The second promotion costs roughly $0.667P$ per unit against the $0.8P$ fee of the third deal, confirming they do not match.
- **D) 1 and 3 only**: The first deal yields $0.75P$ per unit whereas the third charges $0.8P$, proving they are not mathematically equivalent.

20 **87% of the world population are right-handed. The human world is organised to make success in life easier for the majority. Left-handed people should therefore be considered as having a disability and receive appropriate support.**

Which one of the following, if true, weakens this argument?

A Left-handed people have poorer spatial skills which makes them more likely to have car crashes and other serious accidents.

B Hand tools, musical instruments and scissors are designed for use by the majority.

C **Amongst top scientists, sportsmen, actors, musicians and politicians the percentage of left-handed people is much higher than 13%.**

D Left-handed people are more likely to have health problems such as allergies, depression, epilepsy and sleeping disorders.

E Many left-handed people were forced to write with their right hand when they were at school.

Correct answer: C

The argument claims that a society designed for right-handed people limits success for left-handed individuals, justifying a **disability classification**. Evidence showing left-handed people hold disproportionately high representation among top professionals directly contradicts this premise. Such **disproportionate success** demonstrates adequate performance without requiring special accommodations or support.

Why the other answers are wrong

- **A) Left-handed people have poorer spatial skills which makes them more likely to have car crashes and other serious accidents.**: Reporting lower spatial abilities and higher accident rates introduces additional difficulties. These facts reinforce the notion of added challenges instead of undermining the claim.
- **B) Hand tools, musical instruments and scissors are designed for use by the majority.**: Describing tools built for the majority confirms the disadvantages mentioned in the argument. It provides concrete examples of environmental bias rather than challenging the conclusion.
- **D) Left-handed people are more likely to have health problems such as allergies, depression, epilepsy and sleeping disorders.**: Listing increased risks for allergies, depression, and sleep issues points to potential health vulnerabilities. Such information would logically justify medical support rather than weaken the claim.
- **E) Many left-handed people were forced to write with their right hand when they were at school.**: Noting historical coercion to switch hands highlights past discrimination and adaptive pressures. This historical context still supports the existence of systemic hurdles.

21 **In North America in the 1800s, arguments were often settled by gunfights, in which two people stood face to face a distance apart and tried to shoot one another. Recent experiments on human response times have shown that people act more quickly when responding to an action than when they are the first to move. This supports the view that our brain uses different routes in our nervous system to send messages for intentional and reactive movements.**

Which one of the following can be drawn as a conclusion from the above passage?

- **A** **Gunfighters are best advised to wait for their opponents to move to fire.**
- **B** Gunfighters who wait for their opponent to move first would always win.
- **C** Humans can be trained to react more quickly.
- **D** Brains cannot control our reactive movements.
- **E** Scientific experiments produce interesting findings.

Correct answer: A

Experiments show people react faster to another person's movement than when they initiate action themselves. This suggests the nervous system uses separate pathways for **intentional** and **reactive** commands. Therefore, waiting for an opponent to fire first provides a measurable **speed advantage**.

Why the other answers are wrong

- **B) Gunfighters who wait for their opponent to move first would always win.**: Superior reaction speed reduces initial delay effectively. It cannot override external variables such as precision, equipment failure, or environmental conditions. Quickness alone never ensures absolute success.
- **C) Humans can be trained to react more quickly.**: The research focuses exclusively on comparing baseline reaction intervals. It offers zero insight into whether practice could modify those inherent physiological limits. Training falls completely outside the studied parameters.
- **D) Brains cannot control our reactive movements.**: The passage confirms the brain utilizes dedicated neural pathways for these motions. This evidence proves the brain successfully controls them. It directly refutes the claim of inability.
- **E) Scientific experiments produce interesting findings.**: This choice merely states a broad subjective viewpoint. The text relies on empirical data to demonstrate a neurological mechanism. It establishes no broader philosophical conclusions about science.

22 **A taxi driver charges €1.00 per kilometre for the first 3 kilometres of a journey, and 70c per kilometre for the rest of the journey. I travel home from the train station by taxi. I pay the taxi driver €10.00 including a tip of 70c.**

How far is my house from the station?

A 10 kilometres
B 14 kilometres
C 9 kilometres
D 13 kilometres
E **12 kilometres**

Correct answer: E

1. Subtract the tip from the total payment to determine the **actual fare**: $€10.00 - €0.70 = €9.30$. 2. Compute the expense for the opening leg at the **base rate**: $3\ \text{km} \times €1.00\ \text{km}^{-1} = €3.00$. 3. Find the **remaining amount** needed to cover the rest of the trip: $€9.30 - €3.00 = €6.30$. 4. Translate this surplus into distance using the **reduced tariff**: $€6.30 \div €0.70\ \text{km}^{-1} = 9\ \text{km}$. 5. Sum both segments to establish the **total journey**: $3\ \text{km} + 9\ \text{km} = 12\ \text{km}$.

Why the other answers are wrong

- **A) 10 kilometres**: It derives from dividing the adjusted fare entirely by the initial rate instead of applying the lower tier. The computed cost is $3\ \text{km} \times €1.00 + 7\ \text{km} \times €0.70 = €7.90$. This figure remains far below the required $€9.30$.
- **B) 14 kilometres**: It usually stems from neglecting to deduct the tip and mishandling the two different pricing stages. A fourteen-kilometre route demands $3\ \text{km} \times €1.00 + 11\ \text{km} \times €0.70 = €10.70$ upfront, inflating the final sum well past the actual payment.
- **C) 9 kilometres**: It happens when the solver omits the first three kilometres after extracting the nine kilometres from the remainder. A nine-kilometre path produces exactly $€6.30$ in charges, leaving the majority of the fare unaccounted for.
- **D) 13 kilometres**: It overestimates the travel length by adding ten extra kilometres at the discounted price. The resulting bill reaches $3\ \text{km} \times €1.00 + 10\ \text{km} \times €0.70 = €10.00$ before gratuity, surpassing the target by one euro.

25 **"If more workers worked for only four days each week there would be fewer commuters, and therefore less traffic congestion and less pollution. Also, fewer people would be unemployed because there would be more work to go around. There is evidence that part-time workers are absent from work less often than full-time workers, so a person working a four-day week would be more productive. Less work means less pressure, which means less stress and people would be happier."**

Which one of the following can be drawn as a conclusion from the above passage?

A The government should enforce a four-day working week.

B There would be less pressure on the health services if most workers were on a four-day week.

C **There would be many benefits to working a four-day week.**

D People choosing to work a four-day week would have to take a 20% pay cut.

E The economy would be more competitive if people worked more productively.

Correct answer: C

The passage highlights several positive outcomes of a **four-day work week**, including reduced traffic, lower unemployment, higher productivity, and greater happiness. These points collectively demonstrate that shifting to this schedule yields multiple advantages. Therefore, the statement that there would be many benefits logically follows from the text.

Why the other answers are wrong

- **A) The government should enforce a four-day working week.**: Listing personal and environmental advantages does not justify a legislative mandate forcing employers to adopt it.
- **B) There would be less pressure on the health services if most workers were on a four-day week.**: The text mentions reduced stress but provides no information regarding its impact on healthcare systems.
- **D) People choosing to work a four-day week would have to take a 20% pay cut.**: The argument contains no details about salary reductions or mandatory income decreases.
- **E) The economy would be more competitive if people worked more productively.**: While higher individual productivity is noted, the author never discusses broader national market performance.

26 **Migratory birds which are unable to fly long distances without resting have to use the shortest distance over water in their flights to and from Africa, and so they cross at the Straits of Gibraltar. It is essential for these birds, some of which are very rare, that the route remains open. For that reason, it is important that plans to build electricity-generating wind farms on the hills surrounding the Straits of Gibraltar do not go ahead.**

Which one of the following is an assumption on which this argument depends?

A Electricity-generating wind farms have to be built on hills.

B There are no plans to build wind farms at other places along the coast.

C The birds that migrate across the Straits of Gibraltar are close to extinction.

D Other species of bird can fly further and can thus use other routes in their migration.

E The planned wind farms will make it dangerous for migratory birds to use their route.

Correct answer: E

The argument concludes that local wind farm plans must stop to protect an essential **route** for migrating birds. This logic only works if the turbines actually create a **danger** to their flight path. If the projects posed no risk, halting construction would be unnecessary. Thus, the reasoning depends on assuming the farms will endanger the birds.

Why the other answers are wrong

- **A) Electricity-generating wind farms have to be built on hills.**: The conclusion targets these specific proposed projects around the strait, not a universal rule about where all energy infrastructure must be placed.
- **B) There are no plans to build wind farms at other places along the coast.**: Potential wind farm developments elsewhere along the coastline remain entirely **irrelevant** to whether this particular project threatens the crucial migration passage.
- **C) The birds that migrate across the Straits of Gibraltar are close to extinction.**: The text notes some species are rare, but the logical structure does not require them to be near **extinction**.
- **D) Other species of bird can fly further and can thus use other routes in their migration.**: The argument focuses strictly on birds unable to fly long distances, not on other species that might naturally use alternative paths.

27 **When mobile phones were introduced there were concerns about the microwaves produced and the effects that these could have on the brain, given that phones would be held close to the ear when being used. These concerns have been shown to be mistaken since mobile phones are used for sending text messages far more than for making phone calls. Sending a text message does not require the phone to be anywhere near to the brain so it cannot cause any problems.**

Which one of the following identifies the flaw in this argument?

A It does not consider other technology such as wireless internet which could cause similar problems.

B It ignores evidence suggesting that text messaging is only popular in certain age groups.

C It ignores research showing that microwaves from the phones cannot penetrate far enough to reach the brain.

D It does not consider uses of mobile phones other than making phone calls and sending text messages.

E **It ignores the possible effects of the phone calls that are made.**

Correct answer: E

Texting more frequently does not eliminate **phone calls**. Calls still require holding the device near the ear. This leaves the original safety concern unaddressed.

Why the other answers are wrong

- **A) It does not consider other technology such as wireless internet which could cause similar problems.**: Bringing in wireless internet introduces **unrelated** devices. The argument examines mobile phones alone.
- **B) It ignores evidence suggesting that text messaging is only popular in certain age groups.**: Limiting popularity to specific age groups only narrows the usage scope. The logical error remains even if all users text frequently.
- **C) It ignores research showing that microwaves from the phones cannot penetrate far enough to reach the brain.**: Proof that radiation cannot reach deep tissues would directly **support** the conclusion. It misses the core reasoning gap entirely.
- **D) It does not consider uses of mobile phones other than making phone calls and sending text messages.**: Accounting for additional features might matter broadly. The premise admits calls occur, so overlooking their direct proximity impact constitutes the main **flaw**.

28 **I have two cousins. One was born the year before me, on June 3rd. The other was born the year after me, on April 28th.**

My birthday is May 15th.

For how many days each year am I the same age as one or other of my cousins?

A 35
B **36**
C 39
D 37
E 38

Correct answer: B

You share the same age as your cousins only during two short annual periods. With the older cousin, you match ages from **May 15** until **June 2**, totaling 19 days. With the younger cousin, you match ages from **April 28** until **May 14**, totaling 17 days. The sum equals 36 days, and leap years do not change this result since both intervals avoid February.

Why the other answers are wrong

- **A) 35**: Usually stems from omitting April 28 or May 15 from the boundary count, which removes a necessary day from the younger-cousin interval and drops the total to 35.
- **C) 39**: Assumes a continuous span from April 28 through June 3, overlooking that the age difference resets immediately after each birthday and resumes later in the calendar year.
- **D) 37**: Arises from double-counting a shared endpoint, such as treating both May 15 and June 3 as simultaneous age markers within a single period.
- **E) 38**: Typically results from manually padding each interval with an extra day, producing an incorrect breakdown of 20 plus 18 days instead of the correct 19 and 17.

29 **The table shows the number of people aged 20-35, 36-50 and 51-65 who participated in given sports at a leisure centre on a Sunday morning:**

In which of the other sports was the proportion of participants in the three age ranges closest to that for swimming?

Sport	$20-35$	$36-50$	$51-65$
Swimming	31	42	59
Squash	26	30	44
Aerobics	10	21	30
Tennis	40	35	32
Bowls	6	8	11
Table Tennis	28	32	46

A Aerobics
B Tennis
C Squash
D **Bowls**
E Table Tennis

Correct answer: D

First determine the **total participants** for swimming ($31+42+59=132$) and calculate the **percentage** for each age group ($\approx 23.5\%$, $\approx 31.8\%$, $\approx 44.7\%$). Apply the same calculation to every other sport. Compute the **absolute difference** between each age-group value and the swimming baseline, then sum these deviations. The sport with the **lowest sum** presents the closest proportion.

Why the other answers are wrong

- **A)** Aerobics involves 61 participants, yielding age-group shares of 16.4%, 34.4%, and 49.2%. Its youngest bracket falls far below the swimming baseline, creating a cumulative deviation of about 14.2 percentage points.
- **B)** Tennis covers 107 participants and results in 37.4%, 32.7%, and 29.9%. This pattern diverges heavily from the target distribution, producing a total difference near 29.6 due to an inflated 37.4% share in the 20–35 range compared to 23.5% for swimming.
- **C)** Squash accounts for 100 participants with proportions of 26%, 30%, and 44%. These figures generate a total difference of roughly 5.0, which is closer than Aerobics but still too high.
- **E)** Table Tennis comprises 106 participants and calculates to 26.4%, 30.2%, and 43.4%. The overall deviation sums to approximately 5.8 percentage points, performing worse than Squash.

30 **Apples cost 30c each, bananas cost 40c each and oranges cost 50c each. Daniel spends exactly €2 buying fruit.**

Which of the statements below are correct?

1. He cannot have exactly 3 apples
2. He must have at least one banana
3. He has 4, 5 or 6 fruits
4. If he has all 3 types of fruit, he must have fewer apples than bananas and oranges combined

A 1, 2, 3 and 4
B 2, 3 and 4 only
C 1, 2 and 4 only
D 1, 2 and 3 only
E 1, 3 and 4 only

Correct answer: E

Modeling the purchase with the **linear equation** $3a + 4b + 5o = 20$ produces exactly six valid integer triples. **Statement 2** falsely requires a banana despite finding **zero-banana cases** in the complete solution set. Statements 1, 3, and 4 correctly describe these results. Option D groups exactly those three verified claims.

Why the other answers are wrong

- **A) 1, 2, 3 and 4**: Groups all four statements together. It erroneously validates statement 2 by ignoring the explicitly listed banana-free scenarios. This single false inclusion prevents the choice from matching the actual constraints.
- **B) 2, 3 and 4 only**: Combines statements 2, 3, and 4. It wrongly keeps the false statement 2 and drops statement 1. Statement 1 is definitively true because scanning all six possible triples confirms that none contains exactly three apples.
- **C) 1, 2 and 4 only**: Combines statements 1, 2, and 4. Statement 2 contradicts the calculated outcomes $(5, 0, 1)$ and $(0, 0, 4)$. These two valid combinations contain no bananas at all.
- **D) 1, 2 and 3 only**: Combines statements 1, 2, and 3. It repeats the incorrect assumption from statement 2. The systematic evaluation of possible orange counts explicitly generates baskets with zero bananas. This makes the second claim mathematically impossible.

31 **A comparison has been made between fast food restaurants and factories. This is not as unrealistic as it might first appear. Fast food is mass-produced, as heavily processed as any other factory product, and restaurant workers have jobs which are just as routine and boring as those in manufacturing. So not only does fast food taste the same everywhere, but all workers involved are on low wages and have little power to improve their conditions.**

Which one of the following best expresses the conclusion of this argument?

- **A** **It is not unrealistic to compare fast food restaurants with factories.**
- **B** All fast food tastes the same because it is heavily processed.
- **C** Mass production in factories leads to poor working conditions.
- **D** Workers who do routine and boring jobs are often poorly paid.
- **E** Working in a fast food restaurant is no different from working in a factory.

Correct answer: A

The passage argues that **comparing** fast food restaurants with factories is not **unrealistic**. Evidence regarding identical production methods, repetitive jobs, and low pay directly **supports** this initial claim.

Why the other answers are wrong

- **B) All fast food tastes the same because it is heavily processed.**: This statement functions as a supporting detail about processing methods instead of the main conclusion.
- **C) Mass production in factories leads to poor working conditions.**: The argument never establishes a **causal link** between industrial mass production and worker conditions.
- **D) Workers who do routine and boring jobs are often poorly paid.**: This option presents a broad **generalisation** that extends well beyond the specific scope of the discussion.
- **E) Working in a fast food restaurant is no different from working in a factory.**: The text highlights specific **similarities** rather than asserting complete equivalence.

32 **Recent research suggests that people are becoming less inclined to follow medical advice about how to prevent ill-health. They say that there is too much advice and it is often contradictory. However the general population is living longer and is healthier. This suggests that people are more aware of what is good for their own health and wellbeing than the medical profession is.**

Which one of the following, if true, weakens this argument?

A Advances in medicine have meant that doctors give advice on a wider range of issues.

B People now have easy access to websites giving information on health.

C Doctors prefer to give advice rather than medication.

D People believe that they know better than doctors how to improve their own health and wellbeing.

E **The health improvements are in areas that exactly match the medical advice given by doctors.**

Correct answer: E

The argument concludes that the public surpasses doctors because **health improvements** occur despite low compliance with **medical advice**. If gains align exactly with professional guidance, they validate expert recommendations rather than proving superior public intuition. This undermines the premise that personal awareness drives positive outcomes.

Why the other answers are wrong

- **A) Advances in medicine have meant that doctors give advice on a wider range of issues.**: Advancements increase the number of topics covered, which explains why guidance is abundant but does not challenge the inference about superior knowledge.
- **B) People now have easy access to websites giving information on health.**: Access to online health resources may explain independent decision-making, which would potentially strengthen rather than weaken the original inference.
- **C) Doctors prefer to give advice rather than medication.**: A clinical preference for counseling over drugs is irrelevant to population health trends and does not address relative expertise.
- **D) People believe that they know better than doctors how to improve their own health and wellbeing.**: Subjective confidence in personal judgment does not demonstrate factual accuracy regarding health management or contradict the observed data.

33 **Over the last twenty years the number of people, including children, classed as overweight, and therefore at risk of serious health problems, has risen alarmingly. This trend could be caused by an increase in the amount people eat or by a decrease in the amount of exercise they take. Most of us exercise less than people did twenty years ago, and the average number of calories consumed per person is now less than it was twenty years ago. So the increase in the number of overweight people is clearly caused by lack of exercise. Thus the government does not need to worry about trying to change people's diets.**

Which one of the following identifies the flaw in this argument?

A Some people may exercise more than the average.

B **Some individuals may have increased their calorie intake.**

C The government may need to worry about costs to the health service.

D Children may use up more calories through exercise than adults.

E Some individuals may have health problems which cause an increase in weight.

Correct answer: B

The argument claims that **lack of exercise** caused rising obesity rates because the **average** calorie consumption has fallen. However, population averages can drop while **specific individuals** actually eat more. If **increased calorie intake** still occurs among certain groups, dietary factors could remain a primary driver of weight gain. Dismissing dietary advice based on aggregated data therefore contains a fundamental logical gap.

Why the other answers are wrong

- **A) Some people may exercise more than the average.**: Noting that some people exercise more fits the premise that most people move less. It fails to undermine the dismissal of dietary interventions.
- **C) The government may need to worry about costs to the health service.**: This introduces a separate economic concern rather than challenging the causal reasoning. It does not address the statistical flaw in the argument.
- **D) Children may use up more calories through exercise than adults.**: Comparing energy use between age groups ignores how the author misapplied consumption statistics. It does not correct the misunderstanding of average data.
- **E) Some individuals may have health problems which cause an increase in weight.**: While medical issues might cause weight gain in isolated cases, this does not expose the error of using population means to rule out dietary influences.

34 **In 2005, Peter's age was exactly four times that of his son, Quentin. In 2021, Peter will be exactly twice Quentin's age.**

What is the difference between their ages?

A 20

B **24**

C 16

D 28

E 36

Correct answer: B

1. Define P_{2005} and Q_{2005} as the **ages in 2005**. 2. The initial relation is $P_{2005} = 4Q_{2005}$. 3. After 16 years the second condition becomes $P_{2005} + 16 = 2(Q_{2005} + 16)$. 4. **Substitution** yields $4Q_{2005} + 16 = 2Q_{2005} + 32$, giving $2Q_{2005} = 16$ and $Q_{2005} = 8$. 5. Peter's age is 32, so the **difference** is $32 - 8 = 24$.

Why the other answers are wrong

- **A) 20**:
- **C) 16**:
- **D) 28**:
- **E) 36**:

35 **I have far too much small change in my pocket: 6 x 1c coins, 3 x 2c coins, 2 x 5c coins, 3 x 10c coins and 2 x 50c coins.**

I want to buy a chocolate bar for 37c using as many coins as possible.

What is the largest number of coins I can use to pay the exact price?

- **A** **12**
- **B** 9
- **C** 14
- **D** 5
- **E** 10

Correct answer: A

We own six 1 c, three 2 c, two 5 c, and three 10 c coins, summing to 52 c. Removing any single coin leaves at least 42 c, **ruling out** thirteen or fourteen options. Combining all low-denomination pieces with two 10 c and one 5 c yields exactly **37 c** using **twelve coins**. Fewer large coins cannot cover the remainder, establishing this count as the maximum.

Why the other answers are wrong

- **B) 9**: Selecting one 1 c, three 2 c, one 5 c, and three 10 c reaches the target amount, yet nine pieces do not maximize the selection.
- **C) 14**: Assuming fourteen coins forces the usage of every small denomination available, which produces 52 c instead of the required 37 c.
- **D) 5**: Picking one 5 c, two 10 c, one 2 c, and one 1 c delivers the absolute minimum of five pieces, far from the largest possible set.
- **E) 10**: Choosing three 1 c, three 2 c, one 5 c, and three 10 c also equals 37 c, but ten coins remain below the optimal threshold.

37 **The general public cannot understand laws and legal documents unless they are written in clear and simple language. Therefore, the traditional style in which laws and legal documents are written must change. Citizens in a democracy must be able to understand what their legal rights and duties are.**

Which one of the following best expresses the conclusion of this argument?

A If citizens can understand laws and legal documents, they will be able to play their proper role in a democracy.

B It is necessary in a democracy for citizens to know their legal rights and duties.

C **There must be a change in the style in which laws and legal documents are written.**

D Many laws and legal documents are written in old-fashioned and complicated language.

E The general public can fully understand only those laws and documents written in simple language.

Correct answer: C

The argument presents two premises: the public requires **clear language** to comprehend legal texts, and citizens must understand their **rights and duties**. These requirements logically force the main point that the existing writing convention is inadequate. The author therefore concludes that the traditional legal style **must change**.

Why the other answers are wrong

- **A) If citizens can understand laws and legal documents, they will be able to play their proper role in a democracy.**: The reasoning stays focused on legal knowledge. It never connects that knowledge to wider civic engagement or democratic participation.
- **B) It is necessary in a democracy for citizens to know their legal rights and duties.**: This option restates a supporting premise about democratic needs rather than the inferred result. It explains why the reform is desired instead of what the author argues should happen.
- **D) Many laws and legal documents are written in old-fashioned and complicated language.**: This describes the likely current situation behind the phrase traditional style. It identifies the status quo instead of stating the prescribed action demanded by the argument.
- **E) The general public can fully understand only those laws and documents written in simple language.**: The text links comprehension to simplicity but stops short of claiming that simplicity guarantees total understanding. It confuses a necessary condition with a sufficient one.

38 **Many countries spent billions on vaccines in response to advice that a virus had the potential to kill millions. These countries are now trying to sell the stockpiles of vaccines which they do not need. There is concern that advice given by officials may have been influenced by pharmaceutical companies. Clearly, such companies would have an interest in making sure that governments spent large quantities of money on vaccines that they produced. It is essential that an investigation into this matter takes place as soon as possible so that those responsible can be held to account.**

Which one of the following is an assumption on which this argument depends?

A Groups with financial interests do not advise officials in other areas of decision making.

B It will not be possible for the stockpiles of vaccines to be sold.

C **The advice given by officials was not appropriate.**

D The pharmaceutical companies influenced the advice given by officials.

E The pharmaceutical companies misjudged the dangers of the virus.

Correct answer: C

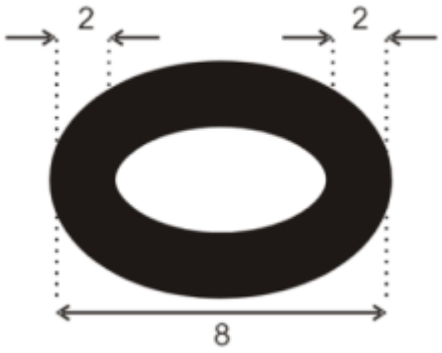
The argument concludes that an investigation must happen to ensure accountability. This logical leap requires the premise that the initial advice was flawed. Surplus supplies alone prove poor planning, which justifies official scrutiny.

Why the other answers are wrong

- **A) Groups with financial interests do not advise officials in other areas of decision making.**: External advisory contexts remain entirely outside the logical boundary. Cross-sector comparisons cannot validate the current conclusion.
- **B) It will not be possible for the stockpiles of vaccines to be sold.**: The investigation demand operates independently of commercial results. Resale feasibility does not impact the need to review policy decisions.
- **D) The pharmaceutical companies influenced the advice given by officials.**: Suspected bias stays hypothetical inside the prompt. Launching a probe requires suspicion, not prior proof.
- **E) The pharmaceutical companies misjudged the dangers of the virus.**: The core concern targets potential corporate pressure rather than scientific accuracy. Factual error claims distract from the accountability focus.

39 **A chain link has the following dimensions:**

If you join six of these links together, and stretch the chain to its full extent, what is the total length of the chain?



A 30
B **28**
C 32
D 36
E 24

Correct answer: B

The **outer length** of each link measures 8, and the wire thickness at both ends is 2, creating an **inner opening** of $8 - 2 - 2 = 4$. Six disconnected links span $6 \times 8 = 48$, but the assembled chain contains exactly 5 **connection points** where adjacent pieces share that gap. Each shared gap removes an **overlapping space** of 4 from the total span. Subtracting the combined reduction of $5 \times 4 = 20$ from the starting length yields $48 - 20 = 28$.

Why the other answers are wrong

- **A) 30**: This value results from removing 18 from 48, which corresponds to 4.5 non-existent junctions.
- **C) 32**: This figure matches $48 - 16$, indicating only 4 overlaps were calculated instead of the actual 5 intervals.
- **D) 36**: This option computes 6×6, completely ignoring the internal gaps and treating every link as a solid unit with no interlocking space.
- **E) 24**: This choice subtracts 24 from 48, assuming 6 reduced sections instead of 5. It incorrectly applies the gap width to the very first link.

40 **Consider the following statements:**

1. There are fewer rats than people
2. There are not more people than rats
3. There are at least as many rats as people
4. There are not more rats than people

Which two of the above statements are equivalent?

A 2 and 4
B 1 and 4
C **2 and 3**
D 1 and 3
E 3 and 4

Correct answer: C

Translate each statement into an inequality using R for rats and P for people. Statement 2 establishes $P \leq R$. This mathematical expression is identical to $R \geq P$. Statement 3 explicitly states $R \geq P$. Both define the **identical condition** regarding the population sizes. This confirms their **logical equivalence**.

Why the other answers are wrong

- **A) 2 and 4**: Statement 2 defines $R \geq P$ and statement 4 defines $R \leq P$. These are inverse constraints. Each formula allows one group to exceed the other. They only overlap when the counts are exactly equal.
- **B) 1 and 4**: Statement 1 uses $R < P$ while statement 4 uses $R \leq P$. The first represents a **strictly less than** relationship. It excludes the possibility of equal populations. The second inequality permits equality instead.
- **D) 1 and 3**: Statement 1 requires $R < P$ and statement 3 requires $R \geq P$. These ranges are completely opposite. A set of numbers cannot satisfy both conditions simultaneously.
- **E) 3 and 4**: Statement 3 provides $R \geq P$ and statement 4 provides $R \leq P$. These mathematical expressions point in opposite directions. They share validity solely in the exact case of equality. They do not represent the same general relationship.

BIOLOGY

41 **In a DNA sample, the percentage of guanine present was 28%. What is the percentage of thymine in the sample?**

- **A** **0.22**
- **B** 0.44
- **C** 0.54
- **D** 0.27
- **E** 0.28

Correct answer: A

DNA base pairing follows **Chargaff's rules**, which establish that complementary strands maintain equal quantities of paired bases: $G = C$ and $A = T$. With a known guanine fraction of $28\ \%$, cytosine must match at $28\ \%$. Subtracting these from the total genome gives $100\ \% - 56\ \% = 44\ \%$ for the unassigned adenine and thymine bases. Splitting this remainder equally results in $\%T = 22\ \%$ (0.22).

Why the other answers are wrong

- **B) 0.44**: Reports the joint concentration of adenine and thymine rather than isolating the individual proportion belonging specifically to thymine.
- **C) 0.54**: Exceeds the maximum allowable budget for the remaining bases, making it mathematically incompatible with the starting guanine measurement.
- **D) 0.27**: Applies an arbitrary decimal without performing the required subtraction or respecting the fixed ratio between complementary nucleotides.
- **E) 0.28**: Mistakenly pairs thymine with guanine instead of cytosine, which directly contradicts molecular bonding principles and would force the total composition past the physical limit of $100\ \%$.

42 **Which property of water is most important when heat is lost from human skin?**

A water density is greatest at 4°C
B high specific heat capacity
C **latent heat of vaporisation**
D boiling point of water
E dipole properties so salts can dissolve in sweat

Correct answer: C

Evaporative cooling relies on a **phase change** from liquid to vapour. Each gram of sweat absorbs approximately $2.4\ \mathrm{kJ\ g^{-1}}$ of **thermal energy** to vaporise at body temperature. This energy transfer draws heat directly from the skin, producing efficient cooling.

Why the other answers are wrong

- **A) water density is greatest at 4°C**: A density maximum at $4\ ^{\circ}\mathrm{C}$ prevents lakes from freezing solid and protects aquatic habitats. This behaviour is completely unrelated to thermoregulation or the evaporative cooling mechanism in humans.
- **B) high specific heat capacity**: High specific heat capacity provides **temperature stability** inside the body by minimising temperature shifts during heat exchange. Sweating depends on the liquid-to-gas transition rather than gradual warming of the liquid, making latent heat decisive for surface cooling.
- **D) boiling point of water**: A relatively high **boiling point** ensures biological fluids remain liquid under physiological conditions. Evaporation operates efficiently at skin temperature well below this threshold, so the boiling limit does not drive heat loss.
- **E) dipole properties so salts can dissolve in sweat**: Water polarity allows salt dissolution and establishes **osmotic balance** to draw fluid into sweat glands. These dissolved ions do not participate in the heat extraction process during evaporation.

44 **Which of the features below may be present in both prokaryotic cells and eukaryotic animal cells?**
(Consider features of the cell as a whole, and for DNA consider the main chromosomal DNA rather than organelle DNA.)

1. glycogen
2. a cell wall
3. DNA in loops
4. cytoplasm containing ribosomes

- **A** **1 and 4 only**
- **B** 1, 2 and 3 only
- **C** 1 and 2 only
- **D** none
- **E** 1 only

Correct answer: A

1. **Glycogen** operates as a carbohydrate reserve in animal tissues and many prokaryotes. 2. Both cell types contain **cytoplasm with ribosomes** for protein synthesis. 3. Animal cells entirely lack a **cell wall**. 4. The **main chromosomal DNA** exists as linear strands in animal nuclei instead of circular loops.

Why the other answers are wrong

- **B) 1, 2 and 3 only**: Incorrect because it groups together two absent features: the external wall and the circular form of nuclear DNA.
- **C) 1 and 2 only**: Incorrect because it includes feature 2, which animal cells completely lack.
- **D) none**: Wrong because two confirmed common traits actually exist between the two cell types.
- **E) 1 only**: Incomplete since it omits feature 4, which is equally present in both systems.

45 **Which is likely to contain the most mitochondria?**

A red blood cell
B epidermal cell
C lymphocyte (white blood cell)
D cheek cell
E cardiac muscle cell

Correct answer: E

The heart requires constant energy for its relentless contractions. These cells produce massive amounts of **ATP** through **oxidative phosphorylation** inside **mitochondria**. Consequently, cardiac myocytes fill 30–40 \% of their internal space with these organelles. This extreme density directly matches their nonstop mechanical workload.

Why the other answers are wrong

- **A) red blood cell**: Mature mammalian erythrocytes completely eject internal organelles during development. They survive solely by relying on **anaerobic glycolysis** for sugar breakdown.
- **B) epidermal cell**: Outer epidermal cells form a protective barrier, divide slowly, and become **keratinized** into non-living plates. Their low metabolic rate relative to muscle yields very scarce organelles.
- **C) lymphocyte (white blood cell)**: Activated lymphocytes temporarily boost metabolism, but most circulate at rest with only intermittent energy needs. They contain far fewer energy producers than continuously active cardiac cells.
- **D) cheek cell**: Cheek epithelial cells line the oral cavity and maintain basic survival functions. Their demand covers membrane upkeep and secretion rather than sustained physical contraction, keeping content modest.

47 **A food item was burned in pure oxygen and released 830 kJ of energy.**
An identical food item of the same mass was found to produce 8 ATP's in respiration.

Assuming it takes 31 kJ to produce one ATP molecule, estimate the efficiency of respiration.

- **A** **0.3**
- **B** 0.45
- **C** 0.5
- **D** 0.25
- **E** 0.1

Correct answer: A

1. The total energy released during combustion is $830\ \mathrm{kJ}$. 2. The energy captured as chemical potential equals $8 \times 31\ \mathrm{kJ} = 248\ \mathrm{kJ}$. 3. The **efficiency** is the **ratio** of useful output to total input: $\frac{248\ \mathrm{kJ}}{830\ \mathrm{kJ}} \approx 0.299$, which rounds to 0.30.

Why the other answers are wrong

- **B) 0.45**: This value exceeds realistic limits; it implies each ATP carries ~$46\ \mathrm{kJ}$ or that the sample contained only ~$550\ \mathrm{kJ}$, contradicting the stated figures.
- **C) 0.5**: This outcome is physically unrealistic; capturing exactly half the initial energy would demand far more than 8 ATP molecules to match the measured yield.
- **D) 0.25**: This option indicates a lower percentage; it would only apply if each ATP required roughly $26\ \mathrm{kJ}$ or if the denominator used $1000\ \mathrm{kJ}$ instead of $830\ \mathrm{kJ}$.
- **E) 0.1**: This result suffers from a magnitude mistake; you would get 0.1 only if the numerator were divided by $2480\ \mathrm{kJ}$, tripling the actual heat released.

48 **The statements below show three stages in glycolysis.**

1. 2 x 3 carbon compounds
2. 6 carbon compound
3. phosphorylated 6 carbon compound

The correct sequence is:

A 1, 2, 3
B 3, 2, 1
C **2, 3, 1**
D 2, 1, 3
E 1, 3, 2

Correct answer: C

Glycolysis begins with an unmodified C_6 sugar. The molecule undergoes **phosphorylation** while maintaining its carbon backbone. Enzymatic **cleavage** subsequently yields two C_3 intermediates. This corresponds to sequence 2 → 3 → 1.

Why the other answers are wrong

- **A) 1, 2, 3**: Starts with two three-carbon fragments before any C_6 substrate appears. This arrangement completely reverses the standard metabolic progression.
- **B) 3, 2, 1**: Orders phosphorylation prior to the existence of the free C_6 compound. It also misplaces the cleavage event at the terminus rather than after modification.
- **D) 2, 1, 3**: Correctly establishes the initial C_6 stage but swaps the modification and splitting steps. In vivo precedence requires phosphate addition before the carbon skeleton fractures.
- **E) 1, 3, 2**: Opens with split products, then reverts to a modified C_6 intermediate. It closes with an unmodified C_6 molecule, which follows a regressive pathway opposite to biological reality.

49 **During vigorous exercise a variety of products will be generated in muscle cells.**

Which answer correctly lists some of the products?

A water, sweat, heat and lactic acid
B carbon dioxide, lactic acid and ethanol
C useable energy (ATP), heat, glycogen and carbon dioxide
D usable energy (ATP), carbon dioxide and oxygen
E **water, lactic acid, heat and carbon dioxide**

Correct answer: E

During intense exercise, contracting muscle fibers rely on both **aerobic respiration** and **anaerobic fermentation**. The oxidative pathway releases **carbon dioxide** and **water** while transferring electrons in the mitochondria. When oxygen delivery lags behind demand, pyruvate converts into lactate. Inefficient ATP cycling continuously dissipates **heat**. These four substances represent the actual biochemical outputs inside working muscle cells.

Why the other answers are wrong

- **A) water, sweat, heat and lactic acid**:
- **B) carbon dioxide, lactic acid and ethanol**:
- **C) useable energy (ATP), heat, glycogen and carbon dioxide**:
- **D) usable energy (ATP), carbon dioxide and oxygen**:

50 **Haemophilia is caused by a recessive allele carried only on the X chromosome. A carrier female and a non-haemophiliac male decide to have a child.**

Which of the following four statements are correct?

1. they have a 25% chance of producing a haemophiliac son
2. they have a 25% chance of producing a haemophiliac daughter
3. they have a 25% chance of producing a carrier son
4. they have a 25% chance of producing a carrier daughter

A 2 and 4 only
B 3 and 4 only
C 2 and 3 only
D 1 and 2 only
E 1 and 4 only

Correct answer: E

The **carrier** mother ($X^H X^h$) and normal **father** ($X^H Y$) produce four equally probable offspring combinations. Each outcome occurs with a 25% probability: $X^H X^H$, $X^H Y$, $X^H X^h$, and $X^h Y$. Statement 1 is true because $X^h Y$ corresponds to a **haemophiliac** son. Statement 4 is true because $X^H X^h$ corresponds to a carrier daughter.

Why the other answers are wrong

- **A) 2 and 4 only**: Statement 3 is genetically impossible because males possess a single X chromosome and cannot carry hidden recessive alleles, leaving only statement 4 as accurate.
- **B) 3 and 4 only**: Statement 2 remains false for the same genetic reason, so pairing it with statement 4 does not yield a correct set.
- **C) 2 and 3 only**: Both statements are invalid; statement 2 implies an impossible homozygous recessive condition, while statement 3 suggests a male can be **heterozygous**, which contradicts standard chromosomal inheritance.
- **D) 1 and 2 only**: Statement 2 is false; a haemophiliac daughter would require an $X^h X^h$ genotype, but the father provides only a healthy X^H allele, making the probability 0%.

51 **Cross over values (COV's) can be considered as the relative distance between genes and are used to help construct chromosome maps. Four genes, called P, Q, R and S, are found on the same chromosome. Use the following COV's to work out the sequence of the four genes.**

P to Q = 33
Q to R = 8
R to S = 15
P to S = 10
P to R = 25

The sequence of the genes is

A **P S R Q**
B R S P Q
C Q S R P
D S P Q R
E P Q R S

Correct answer: A

The smallest cross over values identify **adjacent** genes. We start with two linked pairs based on Q–$R = 8$ and P–$S = 10$. Extending these links gives P–$R = 10 + 15 = 25$ and P–$Q = 10 + 15 + 8 = 33$. Every reported distance matches this layout, confirming the correct **sequence** P S R Q.

Why the other answers are wrong

- **B) R S P Q**: Ordering the genes R S P Q expands the Q–R interval across four segments, producing a total of $15 + 10 + 33 = 58$. This result clashes with the specified distance of 8.
- **C) Q S R P**: Arranging the genes Q S R P separates P and S by two intermediate segments, which yields a summed distance of $15 + 8 = 23$. The problem explicitly requires this interval to equal 10.
- **D) S P Q R**: Placing the genes as S P Q R forces the R–S distance to span three segments, yielding a calculated value of $10 + 33 = 43$. This value directly contradicts the required distance of 15.
- **E) P Q R S**: Mapping the genes as P Q R S stretches the P–S gap across three sections, resulting in an additive total of $33 + 8 + 15 = 56$. This conflicts with the given value of 10.

52 **In a dihybrid cross between two heterozygous individuals, which is the most likely combination in their offspring?**

- **A** **AaBb**
- **B** aaBb
- **C** AABB
- **D** aaBB
- **E** AaBB

Correct answer: A

In a dihybrid cross between two **heterozygotes** ($AaBb \times AaBb$), the two genes **assort independently**. The probability of obtaining a **heterozygous** genotype at a single locus is $\frac{1}{2}$. Multiplying the **independent probabilities** gives $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ for $AaBb$, which is the **highest frequency** among the choices.

Why the other answers are wrong

- **B) aaBb**: Requires a homozygous recessive A locus paired with a heterozygous B locus. The probability is $\frac{1}{4} \times \frac{1}{2} = \frac{1}{8}$ (12.5%), still less common than $AaBb$.
- **C) AABB**: Requires both loci to be homozygous dominant. The probability is $\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$ (6.25%), tying for the rarest category among the provided options.
- **D) aaBB**: Requires both loci to be homozygous recessive at A and homozygous dominant at B. The probability is $\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$ (6.25%), much lower than the target frequency.
- **E) AaBB**: Requires one heterozygous and one homozygous dominant locus. The probability is $\frac{1}{2} \times \frac{1}{4} = \frac{1}{8}$ (12.5%), making it half as frequent as $AaBb$.

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53 **The base sequence of a section of DNA is shown below.**

C A T G C A C A T C G T G C C C A A

The maximum number of different amino acids this section codes for is:

- **A** 4
- **B** 18
- **C** 6
- **D** 9
- **E** **5**

Correct answer: E

DNA sequences are translated into **amino acids** in groups of three **bases** called **codons**. Dividing the 18 bases by 3 yields 6 triplets. Scanning the sequence identifies 5 distinct patterns, with CAT appearing twice and the others once. Since each unique codon can specify a different residue, the maximum count is 5.

Why the other answers are wrong

- **A) 4**: Incorrect because five distinct codons exist, making four too low.
- **B) 18**: Counts individual bases instead of triplet codons, which actually determine amino acids.
- **C) 6**: Would be correct only if all six triplets differed, but CAT is repeated.
- **D) 9**: Impossible since 18 bases produce at most 6 triplets, never 9.

54 **Which of the components of DNA listed below are found on the outside of a DNA double helix?**

1. Pentose sugar
2. Phosphate
3. Purine bases
4. Pyrimidine bases

A 2, 3 and 4 only
B 3 and 4 only
C 1, 2, 3 and 4
D 1, 2 and 3 only
E **1 and 2 only**

Correct answer: E

In the classical Watson-Crick model of B-DNA, the pentose sugar and phosphate form the alternating **sugar-phosphate backbone** on the outside of the double helix, exposed to the aqueous environment. The purine bases, adenine and guanine, and the pyrimidine bases, thymine and cytosine, point toward the **interior**, where complementary bases hydrogen-bond; the stacked base pairs are largely shielded from solvent.

Why the other answers are wrong

- **A) 2, 3 and 4 only**: This includes phosphate, which is on the outside, but leaves out the sugar, which is also on the outside. It also adds both kinds of bases, which are inside, so it combines one correct component with two incorrect ones.
- **B) 3 and 4 only**: This includes only the purine and pyrimidine bases. They reside in the interior of the double helix, not on the outside, so it identifies the wrong components.
- **C) 1, 2, 3 and 4**: This lists every component, but the bases (3 and 4) are not on the outside. The option is therefore overly inclusive.
- **D) 1, 2 and 3 only**: This correctly includes the sugar and phosphate but erroneously adds purine bases (3). Purines are on the inside, so including them makes the option incorrect.

55 **Which of the following organisms are subject to natural selection?**

1. prokaryotes that reproduce asexually
2. single-celled eukaryotes that reproduce sexually
3. organisms living in a changing environment
4. organisms living in a stable environment

A 1, 2 and 3 only
B 3 and 4 only
C 2 and 3 only
D **1, 2, 3 and 4**
E 1 and 2 only

Correct answer: D

Natural selection is the differential survival or reproduction of individuals with heritable traits. Populations can undergo it because they have genetic or epigenetic variation and individuals differ in reproductive success, regardless of cell type, mode of reproduction, or whether the environment is changing or stable. Even stable environments create **competition** through limited resources and biotic interactions, allowing advantageous traits to increase in frequency over generations.

Why the other answers are wrong

- **A) 1, 2 and 3 only**: It leaves out organisms in stable environments. Competition, predation, disease, and other factors can cause differences in reproductive success even when abiotic conditions are constant.
- **B) 3 and 4 only**: It omits both kinds of single-celled organisms. Their cellular organization or mode of reproduction does not exempt them from natural selection.
- **C) 2 and 3 only**: It excludes asexually reproducing prokaryotes and organisms in stable environments, which can also experience natural selection.
- **E) 1 and 2 only**: It ignores the effects of the environment. **Selection pressures** can arise in both changing and apparently stable environments, so both categories should be included.

56 **Which adaptation cannot help increase the speed of transmission in a motor neurone?**

A greater axon diameter
B presence of an insulating myelin sheath
C nodes of Ranvier
D **synapse**
E long axon

Correct answer: D

Synapses introduce a significant delay because the electrical impulse must undergo **chemical conversion**, trigger neurotransmitter release, and diffuse across the **synaptic cleft** before generating a new signal. This process typically adds approximately **0.5 ms** of lag per junction, meaning that additional synapses consistently slow neural transmission rather than accelerate it.

Why the other answers are wrong

- **A) greater axon diameter**: Increasing the internal width of the fiber significantly lowers axoplasmic resistance. Lower resistance permits local circuit currents to flow more freely and rapidly, directly boosting the conduction velocity of the action potential.
- **B) presence of an insulating myelin sheath**: The lipid-rich coating acts as an insulator that minimizes ion leakage and decreases membrane capacitance. These electrical properties enable rapid voltage changes and support fast jumping conduction at regular nodal intervals.
- **C) nodes of Ranvier**: These gaps within the myelin covering allow **saltatory conduction**, where the action potential jumps between nodes. By bypassing extensive membrane depolarization, this mechanism drastically accelerates signal propagation along the axon.
- **E) long axon**: An extended axon length delivers impulses directly to target tissues without requiring intermediate neuronal relays. Avoiding extra junctions eliminates cumulative delays, resulting in shorter overall transmission times from the central nervous system to the muscle.

57 **In the process of ventilation the following occur:**

1. pressure in thorax increases
2. volume of thorax increases
3. diaphragm goes down
4. rib-cage goes down

Which of these occur during inhalation?

A 1 and 3 only
B **2 and 3 only**
C 3 and 4 only
D 2 and 4 only
E 1 and 2 only

Correct answer: B

During normal inhalation the **diaphragm descends** and **external intercostals lift** the **rib-cage**. These coordinated movements **increase thoracic volume**, which directly **lowers intrathoracic pressure** relative to atmospheric pressure and draws air into the lungs. Statements 2 and 3 correctly identify these anatomical and physical changes.

Why the other answers are wrong

- **A) 1 and 3 only**: Pairs statement 3 with statement 1, repeating the fundamental error that pressure rises when it actually falls below atmospheric levels.
- **C) 3 and 4 only**: Links statement 3 with statement 4, but the rib-cage elevates upward during inhalation. This option also fails to acknowledge the essential increase in thoracic volume.
- **D) 2 and 4 only**: Associates statement 2 with statement 4, but the downward movement describes expiration while the rib-cage clearly moves outward and upward during inspiration.
- **E) 1 and 2 only**: Combines statement 2 with statement 1, which is physiologically false because intrathoracic pressure decreases during inspiration rather than increasing.

CHEMISTRY

60 **How many nitrogen electrons are involved in bond formation in $\mathrm{HONO_2}$?**

- **A** **5**
- **B** 4
- **C** 3
- **D** 6
- **E** 7

Correct answer: A

In nitric acid ($\mathrm{HONO_2}$), nitrogen acts as the **central atom** bonded to three oxygen atoms. The bonding scheme includes one σ single bond to OH, one $\sigma + \pi$ double bond to oxygen, and one **coordinate bond** where nitrogen supplies both electrons. This accounts for $1 + 2 + 2 = 5$ donated **valence electrons**, confirming option A.

Why the other answers are wrong

- **B) 4**: Assumes all nitrogen-oxygen connections share electrons equally, yielding four instead of five. It ignores the coordinate bond that requires two electrons solely from nitrogen.
- **C) 3**: Uses the three-bond model of ammonia ($\mathrm{NH_3}$) and counts only three electrons. Nitric acid actually forms four σ bonds and one π bond, necessitating more than three.
- **D) 6**: Proposes six contributed electrons, which surpasses the absolute maximum of five available to nitrogen.
- **E) 7**: Claims seven contributed electrons, directly contradicting the known electronic configuration and the atomic capacity of nitrogen.

61 **Which one of the following compounds can be made from ethanol using only a substitution reaction?**

A Ethoxyethane
B Ethene
C **Bromoethane**
D Ethanal
E Ethanoic acid

Correct answer: C

Ethanol converts to bromoethane by replacing the **hydroxyl group** with a **bromide ion**. The carbon skeleton and oxidation state remain unchanged. Common laboratory methods use concentrated HBr, $\mathrm{PBr_3}$, or $\mathrm{SOCl_2}$. These processes follow a **nucleophilic substitution** pathway where one functional group directly displaces another.

Why the other answers are wrong

- **A) Ethoxyethane**: Producing ethoxyethane occurs when two ethanol molecules couple under acidic conditions. The defining step eliminates water, classifying it as a condensation reaction.
- **B) Ethene**: Generating ethene depends on heating ethanol with strong acids or passing vapor over hot alumina. This strictly follows an elimination mechanism by removing a water molecule.
- **D) Ethanal**: Converting ethanol to ethanal requires an oxidation step that removes hydrogen atoms. This changes the electron density at the carbon center instead of substituting a group.
- **E) Ethanoic acid**: Forming ethanoic acid demands further oxidation of ethanol or the intermediate aldehyde. The reaction shifts the carbon oxidation state significantly rather than swapping substituents.

62 **An aromatic compound consists of two benzene rings joined together.**

Which of the following could be its formula?

1. $C_{10}H_8$
2. $C_{10}H_{10}$
3. $C_{10}H_{12}$
4. $C_{12}H_{10}$
5. $C_{12}H_{12}$

A 3 and 5
B 2 and 4
C 2 and 5
D 3 and 4
E **1 and 4**

Correct answer: E

Two intact benzene rings can combine while preserving full aromaticity. Fused rings share a carbon–carbon bond to yield $C_{10}H_8$. Linked rings connect via a single σ-bond to yield $C_{12}H_{10}$. Extra hydrogens force ring carbons into sp^3 hybridization, which disrupts the **conjugated system** and destroys **aromaticity**.

Why the other answers are wrong

- **A) 3 and 5**: Pairs $C_{10}H_{12}$ with $C_{12}H_{12}$. Neither molecular formula supports two intact benzene rings with continuous electron delocalization.
- **B) 2 and 4**: Pairs $C_{10}H_{10}$ with $C_{12}H_{10}$. The higher hydrogen count on the first formula requires saturated carbons, breaking the aromatic ring.
- **C) 2 and 5**: Pairs $C_{10}H_{10}$ with $C_{12}H_{12}$. Both compositions exceed the hydrogen limit for fully aromatic ring systems.
- **D) 3 and 4**: Pairs $C_{10}H_{12}$ with $C_{12}H_{10}$. Four additional hydrogens relative to the fused structure create multiple non-aromatic centres.

63 **8.0 g of copper oxide is reduced to 5.6 g of copper using hydrogen gas. [relative atomic mass: Cu=64, O=16]**

$$\mathrm{CuO} + \mathrm{H_2} \rightarrow \mathrm{Cu} + \mathrm{H_2O}$$

What is the yield of copper as a percentage of the theoretical maximum?

- **A** **87.5%**
- **B** 14.3%
- **C** 70.0%
- **D** 56.0%
- **E** 43.9%

Correct answer: A

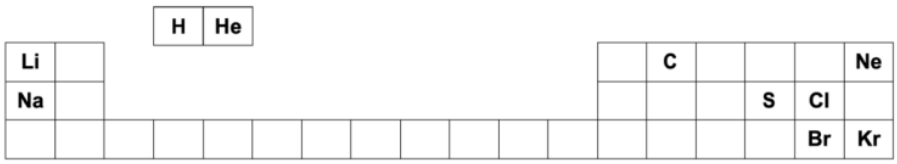
1. Calculate the **molar mass** of CuO: $M = 64 + 16 = 80\ \mathrm{g\,mol^{-1}}$. 2. Find the initial **moles** of reactant: $n = 8.0\ \mathrm{g} / 80\ \mathrm{g\,mol^{-1}} = 0.10\ \mathrm{mol}$. 3. Apply the reaction **stoichiometry** ($1:1$ ratio), which limits the product to $0.10\ \mathrm{mol}$ of Cu. 4. Determine the **theoretical mass** of copper: $0.10\ \mathrm{mol} \times 64\ \mathrm{g\,mol^{-1}} = 6.4\ \mathrm{g}$. 5. Compute the **percentage yield**: $(5.6\ \mathrm{g} / 6.4\ \mathrm{g}) \times 100 = 87.5\%$.

Why the other answers are wrong

- **B) 14.3%**:
- **C) 70.0%**:
- **D) 56.0%**:
- **E) 43.9%**:

64 **The positions of some elements in the Periodic Table are shown below.**

Which two of the elements shown react most energetically with each other?



- A C and He
- B **Na and Cl**
- C Li and Kr
- D Ne and Na
- E Li and Br

Correct answer: B

The most energetic reactions occur between **alkali** metals and **halogens**. Metals in Group 1 lose electrons easily due to low **ionization** energy, while Group 17 elements gain electrons readily because of high **electron** affinity. Among the given pairs, sodium and chlorine combine optimal reactivity levels and release the greatest amount of heat. The balanced equation is $2\ \mathrm{Na}(s) + \mathrm{Cl_2}(g) \rightarrow 2\ \mathrm{NaCl}(s)$.

Why the other answers are wrong

- **A) C and He**: Helium is also a noble gas that does not form bonds under standard conditions, making reaction with carbon impossible.
- **C) Li and Kr**: Krypton is a noble gas that remains chemically inert, so it cannot undergo an energetic reaction with lithium.
- **D) Ne and Na**: Neon is a noble gas with a complete valence shell and exhibits extreme chemical inertness, preventing any reaction with sodium.
- **E) Li and Br**: Lithium has higher ionization energy than sodium, and bromine has lower electron affinity than chlorine, resulting in a weaker exothermic reaction compared to the sodium–chlorine pair.

65 **Which one of the following is not an acid/base reaction?**

A $HNO_3 + HClO_4 \rightarrow H_2NO_3^+ + ClO_4^-$

B $CH_4 + H(SbF_6) \rightarrow CH_5^+ + SbF_6^-$

C $2NH_3 \rightleftharpoons NH_2^- + NH_4^+$

D $FeCl_3 + 6H_2O \rightarrow Fe(H_2O)_6^{3+} + 3Cl^-$

E $Al(H_2O)_6{}^{3+} + H_2O \rightarrow Al(H_2O)_5(OH)^{2+} + H_3O^+$

Correct answer: D

A Brønsted–Lowry acid–base reaction requires the **transfer of a proton** (H^+) between species. Equation E depicts the dissolution of solid $FeCl_3$ in water without any hydrogen ion moving from one molecule to another. Water molecules merely coordinate to the metal cation through their oxygen lone pairs. This process is classified as **ionization** and **solvation**, not a proton exchange.

Why the other answers are wrong

- **A)** $HNO_3 + HClO_4 \rightarrow H_2NO_3^+ + ClO_4^-$: Perchloric acid serves as the definitive proton donor in this mixture. It transfers a hydrogen atom to HNO_3 to generate an oxonium intermediate. The visible **acid–base equilibrium** hinges entirely on this single hydrogen shift.
- **B)** $CH_4 + H(SbF_6) \rightarrow CH_5^+ + SbF_6^-$: Hexafluoroantimonic acid acts as a powerful **superacid** in this system. It donates a proton directly to CH_4 to form a pentacoordinate carbocation. The reaction proceeds solely through a straightforward **proton capture** event.
- **C)** $2NH_3 \rightleftharpoons NH_2^- + NH_4^+$: Liquid NH_3 undergoes **autoprotolysis** in this equilibrium. One ammonia molecule donates a hydrogen ion while the other accepts it. The explicit hydrogen shift between identical species confirms a Brønsted–Lowry mechanism.
- **E)** $Al(H_2O)_6{}^{3+} + H_2O \rightarrow Al(H_2O)_5(OH)^{2+} + H_3O^+$: The hexaaqua aluminum cation behaves as a weak acid in water. A coordinated water molecule releases a proton to a solvent water molecule. This direct **hydrogen transfer** yields a hydroxo complex and a hydronium ion.

66 **What is the total number of electrons in an ammonium ion, NH_4^+?**

A 11

B 8

C 12

D 9

E **10**

Correct answer: E

Nitrogen has **atomic number** 7 and contributes 7 electrons; four hydrogen atoms contribute $4 \times 1 = 4$, so neutral NH_4 would have $7 + 4 = 11$ electrons. A 1^+ charge means **one electron is lost**, giving $11 - 1 = 10$ electrons.

Why the other answers are wrong

- **A) 11**: This counts the electrons in neutral NH_4 but neglects the ion's positive charge.
- **B) 8**: This would require losing three electrons or miscounting the atoms; neither matches ammonium.
- **C) 12**: This adds an extra electron, since $11 + 1 = 12$, as if the species were NH_4^- rather than NH_4^+.
- **D) 9**: This would require losing two electrons, since $11 - 2 = 9$, corresponding to an imaginary NH_4^{2+} ion, not NH_4^+.

67 **One group of elements in the Periodic Table contains, in descending order, boron, aluminium, gallium, indium and thallium.**

Which of the following are correct about these elements?

1. Indium forms the oxide $\ln_2 O_3$
2. Boron is the least reactive element in the group
3. Gallium forms the sulphate $GaSO_4$

A 1 only
B 1 and 3
C 1, 2 and 3
D 2 and 3
E **1 and 2**

Correct answer: E

These elements are Group 13, in the order B, Al, Ga, In, Tl, and become more metallic and reactive down the group. Indium's **most stable oxidation state** is $+3$, so it forms In_2O_3, analogous to Al_2O_3 and Ga_2O_3. Boron is the **least reactive** because it has high ionisation energy, a small atomic radius, and strong covalent bonding. Gallium's usual oxidation state is $+3$, so its sulfate is $Ga_2(SO_4)_3$, not $GaSO_4$.

Why the other answers are wrong

- **A) 1 only**: It omits statement 2, which is true. Boron is a metalloid with high ionisation energy, a small atomic radius, and strong covalent bonding, so it reacts only under vigorous conditions, for example with O_2 when finely divided and heated. Metallic character, and with it reactivity, increases down the group.
- **B) 1 and 3**: It includes statement 3, which is false. Gallium's **usual oxidation state** is $+3$, so its normal sulfate is $Ga_2(SO_4)_3$. The formula $GaSO_4$ would require Ga^{2+} (or Ga^{+}), which is not stable in aqueous chemistry.
- **C) 1, 2 and 3**: It counts statement 3 as correct, but gallium's normal sulfate is $Ga_2(SO_4)_3$, not $GaSO_4$. The latter would require Ga^{2+} (or Ga^{+}), which is not stable in aqueous chemistry.
- **D) 2 and 3**: It includes the incorrect statement 3 and omits the correct statement 1. Indium's most stable oxidation state is $+3$, so its oxide is In_2O_3.

68 **Sodium chloride (relative molecular mass = 58.5) has a solubility of $36.0\,\mathrm{g}$ per $100\,\mathrm{g}$ of water. The density of the solution is $1.13\,\mathrm{g/mL}$.**

Which of the following calculations would give the solubility in moles per litre?

A $36.0 \times 1000/(58.5 \times 1.13)$

B $36.0 \times 1000 \times 1.13/(58.5 \times 136)$

C $36.0 \times 10 \times 1.13/(58.5 \times 136)$

D $36.0 \times 10/58.5$

E $36.0 \times 10 \times 1.13/58.5$

Correct answer: B

1. Moles of solute: $36.0\,\mathrm{g}/58.5\,\mathrm{g\,mol^{-1}} = 36.0/58.5\,\mathrm{mol}$. 2. Calculate the **total mass** of solution: $36.0\,\mathrm{g} + 100\,\mathrm{g} = 136\,\mathrm{g}$. 3. Convert mass to volume using **density**: $136\,\mathrm{g}/1.13\,\mathrm{g\,mL^{-1}} = 136/1.13\,\mathrm{mL}$. 4. Molarity in moles per litre divides moles by volume in litres ($\mathrm{mL}/1000$), yielding $\dfrac{36.0 \times 1000 \times 1.13}{58.5 \times 136}\,\mathrm{mol\,L^{-1}}$.

Why the other answers are wrong

- **A)** $36.0 \times 1000/(58.5 \times 1.13)$: Places density in the denominator and omits the $100\,\mathrm{g}$ solvent mass. This missing mass leads to an overestimation of molarity by roughly a factor of 100.
- **C)** $36.0 \times 10 \times 1.13/(58.5 \times 136)$: Includes the $136\,\mathrm{g}$ total mass correctly, but retains the factor 10 instead of 1000 for the volume conversion. The result ends up being 100 times too small.
- **D)** $36.0 \times 10/58.5$: Ignores the **density** and the added solvent mass, and applies the wrong conversion factor of 10. Both the volume and mass calculations are therefore mishandled.
- **E)** $36.0 \times 10 \times 1.13/58.5$: Uses a **conversion factor** of 10 instead of 1000 for millilitres to litres and omits the solvent mass. Consequently it gives a value that is too high and off by an order of magnitude.

69 **Which one of the following is not an oxidation/reduction reaction?**

A $2Fe + 3Cl_2 \rightarrow 2FeCl_3$

B The electrolysis of sodium chloride solution

C $KClO_4 \rightarrow KCl + 2O_2$

D $Cl_2 + H_2O \rightarrow HCl + HClO$

E $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

Correct answer: E

A reaction is classified as **redox** only when at least one element changes its **oxidation-state**. Checking every atom in reaction D shows that sodium stays $+1$. Chlorine remains -1. Hydrogen stays $+1$. Sulfur holds $+6$. Oxygen stays -2. Because no values shift, the process functions strictly as an acid-base **proton-transfer** reaction.

Why the other answers are wrong

- **A)** $2Fe + 3Cl_2 \rightarrow 2FeCl_3$: Pure elements combine directly to form an ionic compound. Iron is oxidized from 0 to $+3$ and chlorine is reduced from 0 to -1. This direct bond formation relies entirely on electron transfer.
- **B) The electrolysis of sodium chloride solution**: Running electricity through aqueous sodium chloride forces non-spontaneous electron flow. At the anode: $2Cl^- \rightarrow Cl_2 + 2e^-$ ($-1 \rightarrow 0$, oxidation). At the cathode: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ ($+1 \rightarrow 0$, reduction). The mandatory separation of half-reactions proves it is an electrochemical redox process.
- **C)** $KClO_4 \rightarrow KCl + 2O_2$: The solid salt breaks down while moving electrons between elements. Chlorine decreases from $+7$ in $KClO_4$ to -1 in KCl. Oxygen increases from -2 to 0 in O_2, confirming it as a redox **decomposition**.
- **D)** $Cl_2 + H_2O \rightarrow HCl + HClO$: Chlorine begins at 0 in Cl_2 and splits into two distinct products. It is reduced to -1 in HCl and simultaneously oxidized to $+1$ in $HClO$. This internal electron shift defines a **disproportionation** reaction.

70 **Which one of the following is not an example of simple harmonic motion?**

A The motion of the Moon around the Earth as observed from Mars

B **The motion of a ball bouncing on the floor**

C A vibrating violin string

D The ripples produced when a stone is dropped into a tank of water

E A weight moving up and down at the end of a spring

Correct answer: B

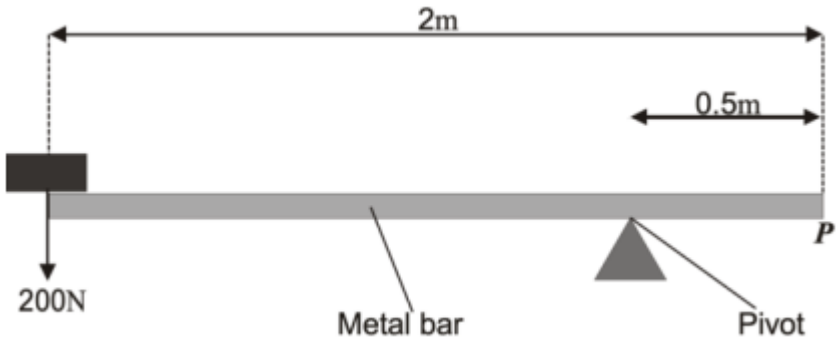
Simple harmonic motion requires a **linear restoring force** satisfying $F = -kx$ that generates **sinusoidal motion**. A bouncing ball follows vertical free-fall trajectories under constant gravity, interrupted by sudden floor impacts. These collisions are impulsive events that instantly reverse velocity rather than scaling with displacement. The resulting path consists of sharp parabolic segments instead of a smooth wave, violating harmonic conditions.

Why the other answers are wrong

- **A) The motion of the Moon around the Earth as observed from Mars**: The Moon travels in nearly uniform circular motion around Earth. Resolving this path into perpendicular components reveals that any single-axis view projects independent harmonic oscillations.
- **C) A vibrating violin string**: Plucked strings vibrate transversely where increased tension restores displaced segments proportionally. Every point oscillates at fundamental and overtone frequencies while preserving harmonic timing.
- **D) The ripples produced when a stone is dropped into a tank of water**: Small-amplitude water ripples allow gravity and surface tension to act approximately proportionally to displacement. Each fluid element oscillates vertically around equilibrium while the overall disturbance propagates outward.
- **E) A weight moving up and down at the end of a spring**: A mass on a spring directly obeys Hooke's law, providing a linear restoring force. This guarantees periodic displacement that perfectly matches sinusoidal functions over time.

71 **A uniform bar of length 2.0 m and weight 1000 N has its centre of gravity at its centre. The bar is pivoted in the position shown, and supports a weight of 200 N in the position shown in the diagram.**

What weight is needed at position P to balance the bar?



A 600 N
B 1800 N
C 800 N
D 1000 N
E **1600 N**

Correct answer: E

To maintain **rotational equilibrium**, the total torques around the support must cancel out. 1. The **leverage arms** extend $1.5\ \mathrm{m}$ for the $200\ \mathrm{N}$ mass, $0.5\ \mathrm{m}$ for the $1000\ \mathrm{N}$ bar weight, and $0.5\ \mathrm{m}$ for the unknown force W at P. 2. The combined **anticlockwise moments** calculate to $(200\ \mathrm{N} \times 1.5\ \mathrm{m}) + (1000\ \mathrm{N} \times 0.5\ \mathrm{m}) = 800\ \mathrm{Nm}$. 3. Equating this to the **clockwise moment** $W \times 0.5\ \mathrm{m}$ solves directly to **1600 N**.

Why the other answers are wrong

- **A) 600 N**: Substituting $600\ \mathrm{N}$ yields a rotational effect of $600\ \mathrm{N} \times 0.5\ \mathrm{m} = 300\ \mathrm{Nm}$, drastically underestimating the counterbalancing effort needed.
- **B) 1800 N**: Choosing $1800\ \mathrm{N}$ creates an excessive downward influence of $1800\ \mathrm{N} \times 0.5\ \mathrm{m} = 900\ \mathrm{Nm}$, pushing the system past the static balance point and causing rotation.
- **C) 800 N**: Applying $800\ \mathrm{N}$ produces a torque of $800\ \mathrm{N} \times 0.5\ \mathrm{m} = 400\ \mathrm{Nm}$, which accounts for only half of the opposing $800\ \mathrm{Nm}$ required to stabilize the structure.
- **D) 1000 N**: A magnitude of $1000\ \mathrm{N}$ generates a turning force of $1000\ \mathrm{N} \times 0.5\ \mathrm{m} = 500\ \mathrm{Nm}$, remaining insufficient against the heavier anticlockwise loads.

72 **Which of the following systems has an overall entropy closest to zero?**

A The evaporation of ether at room temperature

B An object in free fall when it has reached terminal velocity

C **A satellite in orbit 25 000 km above the Earth**

D A weight moving up and down on a spring

E A metal object being rapidly electroplated

Correct answer: C

A satellite at that altitude follows a nearly circular orbit where **mechanical energy** remains effectively constant. The absence of atmospheric drag ensures **negligible friction**, preventing irreversible conversions to heat. Because the motion is periodic and reversible, the number of accessible **microstates** is extremely small. Consequently, the system behaves like an isolated body with **entropy production** $dS_{\text{prod}} \approx 0$, making its total entropy closest to zero among the choices.

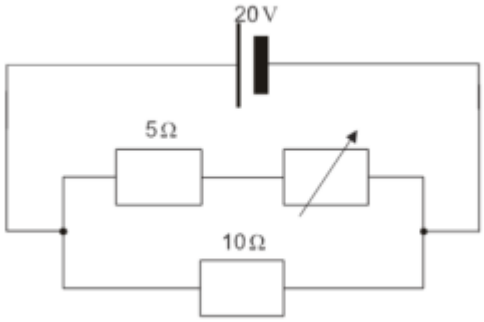
Why the other answers are wrong

- **A) The evaporation of ether at room temperature**: Vaporization represents a phase transition accompanied by a large positive entropy change described by $\Delta S \approx \Delta H_{\text{vap}}/T$. Since ether boils at low temperatures, it readily transforms from liquid to gas under room conditions. The resulting expansion creates significant molecular **disorder**, substantially raising the system's entropy.
- **B) An object in free fall when it has reached terminal velocity**: At terminal velocity, gravitational pull is exactly counterbalanced by fluid drag. The drag force transforms potential energy into **turbulent flow**, which eventually dissipates as thermal energy. This continuous conversion constitutes an irreversible process that generates entropy without bound.
- **D) A weight moving up and down on a spring**: Real mechanical systems experience **internal friction** and air resistance that dampen the oscillation. These forces convert ordered motion into disordered heat, which spreads through the mass and surrounding medium. This continuous conversion drastically increases the number of accessible **microstates**, generating entropy until the movement ceases.
- **E) A metal object being rapidly electroplated**: Rapid electroplating drives spontaneous **redox reactions** powered by an external voltage source. Resistive heating from the current produces substantial **Joule heat** within the electrolytic cell. Simultaneously, dissolved ions migrate to establish uniform **concentration gradients**, both mechanisms creating irreversible entropy.

73 **Three resistors are connected to a 20 V battery with a constant supply.**
One of the resistors is a variable resistor.

The resistance of the variable resistor is gradually increased from zero to 5 Ω.

Which graph shows how the current from the battery varies with the resistance (R) of the variable resistor?



A **<i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fdw1818d1ju8d.png?alt=media&token=71d7b9e1-69a4-4fce-b9cf-0af8d97b3d9c<i>**

B <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F3d19ccvcvc.png?alt=media&token=6a4a425e-1ea9-4af9-920d-021dee90eb1a<i>

C <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fw81uc1jdc.png?alt=media&token=9a79c306-ca8a-4d48-bd34-90e660ad458b<i>

D <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F1w9iwsc19ic91.png?alt=media&token=75f2c95a-9d20-485c-a871-99ad6a896614<i>

E <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fs81yc818c1.png?alt=media&token=464de176-6f29-4e33-a119-a0e7771da45d<i>

Correct answer: A

1. The circuit contains two parallel branches: one with a fixed $10\ \Omega$ resistor and another with a $5\ \Omega$ resistor in series with the variable resistor R. 2. The **equivalent resistance** follows $\frac{1}{R_{eq}} = \frac{1}{5+R} + \frac{1}{10}$. 3. The **total current** supplied by the battery is $I(R) = 20\left(\frac{1}{5+R} + 0.1\right)$. 4. When R equals $0\ \Omega$, the current starts at $6.0\ \text{A}$. When R reaches $5\ \Omega$, it falls to $4.0\ \text{A}$. 5. The mathematical behavior produces a **hyperbolic decay** that starts at $6.0\ \text{A}$ and flattens toward $4.0\ \text{A}$, matching graph A.

Why the other answers are wrong

- **B) <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F3d19ccvcvc.png?alt=media&token=6a4a425e-1ea9-4af9-920d-021dee90eb1a<i>**: Exhibits an incorrect curvature that does not match the predicted flattening decrease defined by $I(R) = 20\left(\frac{1}{5+R} + 0.1\right)$.
- **C) <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fw81uc1jdc.png?alt=media&token=9a79c306-ca8a-4d48-bd34-90e660ad458b<i>**: Displays a rising curve, which contradicts Ohm's law because adding resistance to any branch must reduce the total current drawn from the battery.

- **D) <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F1w9iwsc19ic91.png?alt=media&token=75f2c95a-9d20-485c-a871-99ad6a896614<i>**: Plots a straight line or marks incorrect endpoints, failing to capture the required smooth transition from $6.0\ \mathrm{A}$ to $4.0\ \mathrm{A}$.
- **E) <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fs81yc818c1.png?alt=media&token=464de176-6f29-4e33-a119-a0e7771da45d<i>**: Shows a steep linear decrease, but the actual dependence follows a reciprocal function rather than a straight line.

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74 **An object of mass 50 g just floats in a liquid of density 2.5 g/ml.**

When the object is placed in a liquid of density 2.0 g/ml, it sinks to the bottom of the container.

What is the force that the object exerts on the bottom of the container?

$\left[g = 10\ \mathrm{m/s^2} = 10\ \mathrm{N/kg}\right]$

A **0.1 N**
B 10 N
C 0.4 N
D 400 N
E 40 N

Correct answer: A

The object **just floats** in the first liquid, establishing its **volume** via displacement: $V = m/\rho_1 = 0.050\ \mathrm{kg}/2500\ \mathrm{kg\,m^{-3}} = 2.0 \times 10^{-5}\ \mathrm{m^3}$. In the second liquid, the **buoyant force** calculates to $F_b = \rho_2 V g = 2000 \times 2.0 \times 10^{-5} \times 10 = 0.40\ \mathrm{N}$. Since the **weight** $W = mg = 0.50\ \mathrm{N}$ exceeds this upward push, the object rests on the container floor. The downward contact force equals the net unbalanced load: $F_{\mathrm{bottom}} = W - F_b = 0.50\ \mathrm{N} - 0.40\ \mathrm{N} = 0.10\ \mathrm{N}$.

Why the other answers are wrong

- **B) 10 N**: Derived by approximating the 50 g mass as 1 kg. Computing $1\ \mathrm{kg} \times 10\ \mathrm{N\,kg^{-1}}$ produces 10 N, which completely disregards the stated mass value.
- **C)** 0.4 N represents only the buoyant force generated by the second liquid. It ignores the object's full gravitational weight and confuses partial upward support with total contact pressure.
- **D) 400 N**: Two orders of magnitude too large, equivalent to the weight of a 40 kg body. It directly contradicts the given 50 g mass and violates static equilibrium requirements.
- **E) 40 N**: Likely obtained by mixing cgs and MKS unit systems or misplacing decimal factors (e.g. scaling $4\ \mathrm{N}$ by ten). The magnitude far exceeds both the actual weight and the theoretical buoyant limit.

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76 **David has two boxes containing shapes.**

In box A there are 4 stars and 2 hearts
In box B there are 2 stars and 1 heart

David takes, at random, a shape from box A and puts it into box B. He then takes a shape from box B.

What is the probability that this shape is a star?

A $\frac{3}{4}$
B $\frac{4}{3}$
C $\frac{4}{9}$
D $\frac{2}{3}$
E $\frac{1}{12}$

Correct answer: D

1. Box A contains 4 stars and 2 hearts, establishing a $\frac{2}{3}$ likelihood of **transferring** a star and a $\frac{1}{3}$ likelihood of transferring a heart. 2. If a star is moved, Box B holds 3 stars and 1 heart, resulting in a success chance of $\frac{3}{4}$. 3. If a heart is moved, Box B holds 2 stars and 2 hearts, creating a chance of **drawing** a star equal to $\frac{1}{2}$. 4. Calculate the overall outcome by multiplying each path and summing them: $(\frac{2}{3} \times \frac{3}{4}) + (\frac{1}{3} \times \frac{1}{2}) = \frac{1}{2} + \frac{1}{6} = \frac{2}{3}$.

Why the other answers are wrong

- **A)** $\frac{3}{4}$: This figure matches the success rate of drawing a star after successfully moving a star into Box B, specifically $\frac{3}{4}$, yet it wrongly assumes that single condition determines the final result without applying initial weights.
- **B)** $\frac{4}{3}$: Any legitimate probability must fall between 0 and 1, making this fraction **impossible**, and choosing it typically signals a conceptual error where independent stages are added instead of properly weighted.
- **C)** $\frac{4}{9}$: This value results from calculating only the first branch $\frac{2}{3} \times \frac{3}{4} = \frac{1}{2}$, but it ignores the alternative path where a heart moves and accounts for merely half of the initial scenarios.
- **E)** $\frac{1}{12}$: This option traces the product $\frac{2}{6} \times \frac{2}{4}$, which targets a specific combined sequence, applies incorrect denominators for the intended path, and excludes all other valid movements.

77 **Which of the expressions below has the largest value for 0 < x < 1? 1**

A $\frac{1}{\sqrt{x}}$

B $\sqrt{x}$

C $\frac{1}{(1+x)}$

D $\frac{1}{x}$

E x^2

Correct answer: D

For $0 < x < 1$, the **reciprocal** $1/x$ produces a value strictly greater than 1. The variable x is the smallest positive component among all options. Its reciprocal therefore becomes the largest value.

Why the other answers are wrong

- **A)** $\frac{1}{\sqrt{x}}$: Although $\sqrt{x} < 1$ gives a quotient greater than 1, the term $\sqrt{x}$ remains larger than x. This keeps the fraction smaller than $1/x$.
- **B)** $\sqrt{x}$: Extracting a square root from a fraction between 0 and 1 preserves the value within that same interval. Any number below 1 is automatically outperformed by $1/x$.
- **C)** $\frac{1}{(1+x)}$: Adding x to 1 makes the denominator strictly greater than 1. This confines the result between $1/2$ and 1. It cannot exceed values that are always above 1.
- **E)** x^2: **Squaring** a proper fraction yields an even smaller result, satisfying $0 < x^2 < x < 1$. This places it at the bottom of all five expressions.

78 **How many different integers, n, are there such that the difference between $2\sqrt{n}$ and 7 is less than 1?**

A 4

B 2

C 0

D **6**

E 8

Correct answer: D

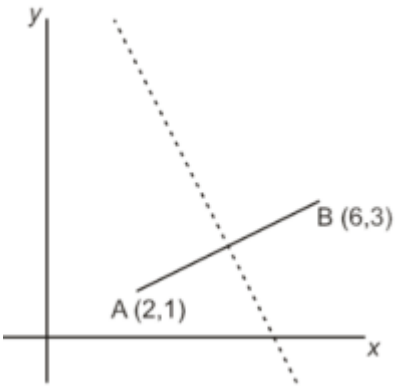
We evaluate the condition $|2\sqrt{n} - 7| < 1$. Removing the absolute value produces $-1 < 2\sqrt{n} - 7 < 1$. Adding 7 gives $6 < 2\sqrt{n} < 8$. Dividing by 2 yields $3 < \sqrt{n} < 4$. Squaring the positive terms results in $9 < n < 16$. The valid integers are $10, 11, 12, 13, 14, 15$, which totals six.

Why the other answers are wrong

- **A) 4**: Results from evaluating one endpoint incorrectly and stopping the enumeration early. It records only a **partial** sequence of valid numbers instead of the complete range.
- **B) 2**: Identifies only the boundary squares 9 and 16. These points are excluded because the original inequality uses **strict** comparison symbols rather than inclusive ones.
- **C) 0**: Concludes that no integer satisfies the condition. This error stems from squaring terms prematurely or mishandling the algebraic steps, which distorts the inequality signs and falsely suggests an **empty** interval.
- **E) 8**: Retains both boundary values 9 and 16 alongside all intermediate numbers. This happens when the strict boundaries are mistakenly treated as non-strict limits.

79 **The graph below shows the line joining A (2,1) and B (6,3), and its perpendicular bisector (shown dashed ----------).**

Which of the following is the equation of the dashed line?



- **A** **y = 10 – 2x**
- **B** y = 2x – 10
- **C** y = 2x – 6
- **D** y = 4 – 2x
- **E** $y = 4 - \frac{x}{2}$

Correct answer: A

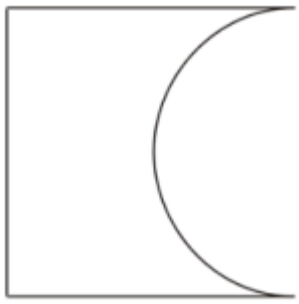
1. Compute the **midpoint** of AB: $M\left(\frac{2+6}{2}, \frac{1+3}{2}\right) = (4, 2)$. 2. Determine the **slope** of AB: $m = \frac{3-1}{6-2} = \frac{1}{2}$. 3. The **perpendicular bisector** requires a **negative reciprocal** slope of -2. 4. Apply the **point–slope form** with $(4, 2)$ to obtain $y - 2 = -2(x - 4)$, which simplifies to $y = -2x + 10$.

Why the other answers are wrong

- **B) y = 2x – 10**: Also features an incorrect slope of +2 rather than –2.
- **C) y = 2x – 6**: Uses a positive slope of 2 instead of the required –2.
- **D) y = 4 – 2x**: Maintains the correct slope of –2 but assumes a wrong y-intercept of 4. Evaluating at x = 4 gives y = 4 – 8 = –4, proving it does not pass through the midpoint (4, 2).
- **E)** $y = 4 - \frac{x}{2}$: Presents a slope of –½, which changes the sign but does not provide the necessary –2 value for perpendicularity.

80 **A square piece of metal has a semicircular piece cut out of it as shown.**
The area of the remaining metal is 100 cm^2.

Which of the following is a correct expression of the length of the side of the square in cm?



A $10\sqrt{\frac{2}{4-\pi}}$

B $10\sqrt{\frac{1}{8-\pi}}$

C $20\sqrt{\frac{2}{8-\pi}}$

D $20\sqrt{\frac{2}{8+\pi}}$

E $20\sqrt{\frac{1}{4-\pi}}$

Correct answer: C

Let s denote the **side** of the square. The removed shape is a **semicircle** with diameter s, giving a **radius** of $r = \frac{s}{2}$. Its area equals $\frac{1}{2}\pi r^2 = \frac{\pi s^2}{8}$. Removing this from the square leaves a **remaining** area of $s^2 - \frac{\pi s^2}{8} = s^2\frac{8-\pi}{8}$. Equating this to 100 and taking the **square root** yields $s = 20\sqrt{\frac{2}{8-\pi}}$.

Why the other answers are wrong

- **A)** $10\sqrt{\frac{2}{4-\pi}}$: Uses $4-\pi$ in the denominator instead of $8-\pi$ and multiplies by 10 instead of 20.
- **B)** $10\sqrt{\frac{1}{8-\pi}}$: Starts with 10 instead of 20 and omits the required factor of $\sqrt{2}$ in the numerator.
- **D)** $20\sqrt{\frac{2}{8+\pi}}$: Switches to a plus sign inside the radical ($8+\pi$), which incorrectly adds the semicircle area rather than subtracting it.
- **E)** $20\sqrt{\frac{1}{4-\pi}}$: Contains two mistakes by using $4-\pi$ instead of $8-\pi$ and dropping the $\sqrt{2}$ factor from the numerator.

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