PROVE UFFICIALI DEGLI ANNI PASSATI

IMAT

2017

A B D E

SVOLTA CON SOLUZIONI COMMENTATE

Il perché di ogni risposta

WHAT'S IN THIS DOCUMENT

Prova di ammissione IMAT 2017, 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	22 questions
Biology	17 questions
Chemistry	12 questions
Physics and Mathematics	7 questions
Total	**58 questions**

This version has **58 of the 60 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 **The recently-appointed captain of the national football team has been publicly accused of adultery with several women, including the girlfriend of a former teammate. The newspapers have made a great deal of his extramarital activities and it has become a scandal. His behaviour has led him to be the subject of crude jokes. He has now been suspended from his duties. It is right that he has been removed from his position so that the team can start to pull together and have the best possible chance of winning the World Cup.**

Which one of the following is an underlying assumption of the above argument?

- **A** **The new captain's actions have weakened team morale.**
- **B** Newspapers have the right to report on people's personal lives
- **C** The national team will not win the World Cup.
- **D** If the new captain is fired, the national team will win the World Cup.
- **E** This new captain should not have been appointed.

Correct answer: A

The argument claims removing the captain helps the team unite and improves winning chances. This logic depends on the assumption that his behavior currently harms **team unity**. If **morale** were unaffected, suspension would not solve the problem.

Why the other answers are wrong

- **B) Newspapers have the right to report on people's personal lives**: The argument does not depend on whether the newspapers were entitled to report the scandal.
- **C) The national team will not win the World Cup.**: The argument aims to improve the team's chances rather than predict a loss.
- **D) If the new captain is fired, the national team will win the World Cup.**: Improving the chance of winning does not guarantee victory.
- **E) This new captain should not have been appointed.**: The argument concerns whether he should remain captain now instead of questioning his original appointment.

2 **E-cigarettes, which provide nicotine without cigarette smoke, have been praised by health campaigners. Research has suggested that success rates for quitting smoking are higher with e-cigarettes than with other methods. However, rather than tackling their nicotine addiction, e-cigarette users have simply replaced one habit with another. It is true that cigarette smoke contains many hazardous compounds, and also that quitting smoking increases life expectancy and reduces the risk of many health problems. But nicotine also has its dangers: it has been associated with a range of conditions that we do not fully understand, and research has yet to establish the long-term effects of nicotine use outside of cigarette smoke.**

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

A E-cigarettes are just as harmful as traditional cigarettes.

B Smoking traditional cigarettes still poses a major risk to health.

C **People should not assume e-cigarettes are a safe alternative to traditional cigarettes.**

D Using nicotine patches is an ineffective way to give up smoking.

E Not everyone is able to give up smoking without nicotine replacement.

Correct answer: C

The passage states that while **e-cigarettes** avoid cigarette smoke, they still deliver **nicotine**, and **long-term effects** remain unestablished. Therefore, we cannot assume they are **safe**. Users must acknowledge this uncertainty when considering alternatives.

Why the other answers are wrong

- **A) E-cigarettes are just as harmful as traditional cigarettes.**: The passage does not compare their overall level of harm. It only notes that traditional cigarette smoke contains many hazardous compounds.
- **B) Smoking traditional cigarettes still poses a major risk to health.**: While the passage supports this claim, it serves strictly as background information used to build the argument about the uncertain safety of e-cigarettes, not as the main logical conclusion.
- **D) Using nicotine patches is an ineffective way to give up smoking.**: The passage gives no evidence whatsoever that nicotine patches are ineffective for smoking cessation.
- **E) Not everyone is able to give up smoking without nicotine replacement.**: The higher quitting success rates with e-cigarettes do not demonstrate that some individuals cannot quit without any nicotine replacement.

3 **Many children from poor backgrounds would benefit from wearing spectacles but do not have them. Sometimes parents are not aware of their children's poor eyesight, but most often they suffer from financial constraints. The government should provide free glasses to poor children with eyesight problems. A recent study of underprivileged students with poor vision demonstrated that those who were given free glasses enjoyed an improvement in test scores equivalent to almost a year of additional schooling. Using the most conservative estimate of the impact of schooling on salary, this would significantly increase an average school-leaver's annual income and tax contributions, and by far more than the cost of a pair of glasses.**

Which one of the following best expresses the main conclusion of the above argument?

A Exam marking should take into account any disabilities the student might have.

B Children from poor backgrounds with bad eyesight should be given additional schooling.

C Peoples salaries should reflect whether or not they had eyesight problems during school.

D Parents should be educated about potential eyesight problems in children.

E **The government should help financially with the provision of children's glasses.**

Correct answer: E

The text explicitly recommends that the **government** should supply **free spectacles** to disadvantaged youth with vision impairment. Empirical evidence linking corrected vision to higher test scores and increased future earnings directly validates this approach. Option A accurately summarizes this central policy recommendation.

Why the other answers are wrong

- **A) Exam marking should take into account any disabilities the student might have.**: The argument completely omits any suggestions regarding modifications to examination administration or grading protocols for visual disabilities.
- **B) Children from poor backgrounds with bad eyesight should be given additional schooling.**: The passage merely utilizes extra years of education as a comparative metric to illustrate the academic benefit of glasses. It does not advocate for extending schooling duration.
- **C) Peoples salaries should reflect whether or not they had eyesight problems during school.**: Higher wages are framed as an indirect economic outcome stemming from improved academic performance. The author does not propose adjusting compensation based on historical vision conditions.
- **D) Parents should be educated about potential eyesight problems in children.**: While limited parental awareness is acknowledged, the text identifies **financial barriers** as the primary obstacle. The conclusion therefore prioritizes direct **state funding** for optical devices over educational initiatives.

4 **It is common practice to look online for a loan or a mortgage. This has led to a large number of 'comparison websites' where you type in your details and they search a range of companies for you based on these details. Night after night, there are adverts on television emphasising how much time and money comparison sites could save you. The experience of one user should make you consider the wisdom of using such sites. She gave her details to a comparison website and received no useful results. However, for weeks afterwards she was bombarded with emails and phone calls from companies she had never heard of.**

Which one of the following is the best statement of the flaw in the above argument?

A It attacks the website and not what the company does.

B **It draws a conclusion based on one example of how a company operates.**

C It assumes using the internet is the only way to get a loan.

D It assumes everyone uses comparison websites.

E It assumes that comparison websites save customers money.

Correct answer: B

The argument draws a **broad conclusion** about comparison platforms from a **single customer incident**. One isolated experience cannot demonstrate that these services are generally unwise to use. Reliable evaluations require consistent patterns across multiple users rather than anecdotes.

Why the other answers are wrong

- **A) It attacks the website and not what the company does.**: The complaint details unwanted communications following data submission. Applying this specific outcome to all users ignores the logical gap between isolated cases and systemic platform flaws.
- **C) It assumes using the internet is the only way to get a loan.**: The argument makes no claim about alternative methods for obtaining loans. Online searches are described as common practice, not as exclusive channels.
- **D) It assumes everyone uses comparison websites.**: The passage notes frequent digital borrowing behavior. It never states that every individual utilizes these specific comparison portals.
- **E) It assumes that comparison websites save customers money.**: Television campaigns highlight potential financial savings. These promotional claims function as external context, not as foundational assumptions for the argument.

5 **Though relatively few people know it by name, palm oil is found in over fifty per cent of processed supermarket goods, from soaps to snacks. This vegetable oil, which is taken from the fruit of the oil palm tree, causes a great deal of environmental concern. The clearing of tropical forests to grow oil palm plantations threatens the survival of orangutans and other endangered species. The land conversion often happens on carbon rich peat soils in a process which releases significant greenhouse gas emissions. Yet even some environmental organisations warn that alternative vegetable oil crops may require much larger areas of forest to be converted to agricultural land.**

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

A **A ban on palm oil alone would not solve all of the environmental problems associated with vegetable oil production.**

B To produce the most profitable crops, oil palm plantations must be grown on carbon rich peat soils.

C There is no motivation for manufacturers to stop using palm oil in their products.

D The environmental risks associated with oil palm plantations are not well understood in tropical countries.

E If farmers stopped clearing tropical forests for oil palm plantations, endangered orangutan populations would recover.

Correct answer: A

The passage indicates that **alternative crops** might require **larger land areas** for cultivation. Consequently, **banning palm oil** would not eliminate the broader environmental damage tied to vegetable oil farming. This follows directly from the text.

Why the other answers are wrong

- **B) To produce the most profitable crops, oil palm plantations must be grown on carbon rich peat soils.**: The text makes no claims regarding agricultural profitability or mandatory soil requirements for plantations.
- **C) There is no motivation for manufacturers to stop using palm oil in their products.**: The text highlights serious ecological concerns, which clearly motivates manufacturers to reconsider their sourcing.
- **D) The environmental risks associated with oil palm plantations are not well understood in tropical countries.**: The passage says nothing about how well these environmental risks are understood in the affected regions.
- **E) If farmers stopped clearing tropical forests for oil palm plantations, endangered orangutan populations would recover.**: Removing one identified threat does not automatically guarantee that endangered populations will fully recover.

6 **Next week the European Parliament will vote on whether to ban trawling, a method of fishing that involves pulling large fishing nets behind boats. The fishing industry is opposed to a ban and has argued strongly against it. Trawling is not as damaging to ecosystems as environmentalists claim. Trawling the seabed doesn't always create 'dead zones' in the ocean. It can boost fish numbers, since the species that are more resistant to the effects of trawling can proliferate. So trawling on flat sandy beds in shallow areas can benefit marine life.**

Which one of the following, if true, most weakens the above argument?

A Trawling creates new habitats by making parts of the sea more habitable.

B **Trawling nets have a destructive impact on many endangered species.**

C Trawling in shallow waters can alter the ecology in beneficial ways.

D Trawling in deep waters is expensive and an ineffective use of fishing resources.

E Trawling in shallow waters can damage the bottom of fishermen's boats.

Correct answer: B

The argument concludes that trawling on shallow sandy beds benefits marine life because some resistant fish populations increase. If the nets also destroy many **endangered species**, this localized gain does not establish an **overall ecological benefit**. The simultaneous harm to vulnerable populations directly undermines the claimed net advantage.

Why the other answers are wrong

- **A) Trawling creates new habitats by making parts of the sea more habitable.**: This option supports the premise by noting habitat creation, which strengthens the case for ecological improvement.
- **C) Trawling in shallow waters can alter the ecology in beneficial ways.**: This statement reinforces the conclusion by describing positive ecosystem changes, rather than providing any counterargument.
- **D) Trawling in deep waters is expensive and an ineffective use of fishing resources.**: This focuses on the financial cost and operational efficiency of deep-water fishing, which does not address the ecological impact in shallow coastal zones.
- **E) Trawling in shallow waters can damage the bottom of fishermen's boats.**: Physical damage to vessel hulls is an operational issue and remains completely unrelated to marine conservation outcomes.

7 **Car drivers understandably become very annoyed at high sales taxes on fuel. In the interests of fairness, money raised from fuel taxes should be spent on maintaining roads or even on subsidising public transport. In fact much of it is put to other uses, such as providing healthcare or improving national defence.**

Which one of the following is an application of the principle underlying the above argument?

A Better transport is more important than national defence.

B Maintaining roads should be a higher priority than spending on healthcare.

C There should be no sales taxes on consumer goods.

D Money raised by taxing fuel should be spent on improving roads rather than on public transport.

E Profits from sporting events should be spent on encouraging people to participate in sport.

Correct answer: E

The **fairness principle** is that money raised from an activity should benefit that activity or the people involved in it. Just as fuel-tax revenue should support roads or public transport, profits from sporting events should encourage participation in sport.

Why the other answers are wrong

- **A) Better transport is more important than national defence.**: The passage does not compare the overall importance of better transport and national defence.
- **B) Maintaining roads should be a higher priority than spending on healthcare.**: The argument concerns how fuel-tax revenue should be used, not which service deserves higher priority overall.
- **C) There should be no sales taxes on consumer goods.**: The argument objects to how fuel-tax revenue is spent, not to sales taxes themselves.
- **D) Money raised by taxing fuel should be spent on improving roads rather than on public transport.**: The argument explicitly allows fuel-tax revenue to be spent on public transport as well as on improving roads.

8 **Widespread underage drinking in certain countries prompted their governments to place restrictions on selling alcohol to young people. The aim was to protect young people's health, but the result was not as intended. Soon after the restrictions were in place, hospitals saw several cases of young people becoming ill as a result of drinking alcohol-based liquids such as medical spirits, ethanol solutions and perfumes. The young people claimed that the restriction on legal alcohol was the main reason they were drinking other substances. If the restrictions were abolished, the health risk would be reduced.**

Which one of the following is the best statement of the flaw in the above argument?

A It assumes that restrictions encourage young people to drink alcohol.

B It ignores the problem of people drinking dangerous substances because they cannot afford to buy alcohol legally.

C It does not take into account the social and cultural importance of drinking alcohol.

D It ignores the role of education in encouraging young people to drink alcohol responsibly.

E It ignores the fact that if there had been no restrictions more young people would have suffered from drinking alcohol.

Correct answer: E

The argument claims that **removing restrictions** would lower medical risks because some youths consume dangerous substitutes. It overlooks the fact that eliminating these rules would likely drive many more youths to drink regular alcohol. This omission means the total health damage could actually rise when regulations are lifted.

Why the other answers are wrong

- **A) It assumes that restrictions encourage young people to drink alcohol.**: The premise indicates that limits push some individuals toward unsafe liquids, not that stricter enforcement boosts the general desire to drink.
- **B) It ignores the problem of people drinking dangerous substances because they cannot afford to buy alcohol legally.**: The text specifies legal sales bans aimed at minors, which differs from questions of personal income or retail pricing.
- **C) It does not take into account the social and cultural importance of drinking alcohol.**: The conclusion addresses only physical safety, so cultural or social values remain outside the scope of the risk assessment.
- **D) It ignores the role of education in encouraging young people to drink alcohol responsibly.**: Teaching responsible consumption may reduce harm, but it does not fix the logical gap concerning the overall illness rate under changed laws.

9 **Over the last ten years there has been a huge increase in the number of television programmes involving the work of forensic scientists. This media attention has been matched by a massive increase in the number of courses and qualifications available in this field. Although this new attention has led to greater public awareness, it has not led to the creation of more jobs in this field. The work of forensics professionals has continued unchanged. Therefore, those who choose to study these courses will find that there is fierce competition for difficult and unpleasant work.**

Which one of the following, if true, would most weaken the above argument?

A New technologies have brought about a decrease in the number of forensics staff required in laboratories.

B **Many students of forensic science go on to pursue careers in other areas.**

C Each year around 1500 graduates in forensic science compete for 200 jobs in the sector.

D The number of university courses in forensic science has grown at an unprecedented rate.

E Salaries for forensic scientists compare well with those in other scientific fields.

Correct answer: B

The passage assumes that higher enrollment rates will directly convert into more job applicants. If many graduates instead pursue careers elsewhere, this causal link disappears. Fewer candidates naturally reduce workplace saturation.

Why the other answers are wrong

- **A) New technologies have brought about a decrease in the number of forensics staff required in laboratories.**: Automation lowering staff requirements would actually eliminate open positions. Contract fewer roles inevitably intensifies candidate rivalry.
- **C) Each year around 1500 graduates in forensic science compete for 200 jobs in the sector.**: Reporting 1500 graduates vying for 200 slots delivers direct proof of severe labor scarcity. These concrete figures unequivocally support the predicted outcome.
- **D) The number of university courses in forensic science has grown at an unprecedented rate.**: Unprecedented program expansion merely validates the stated surge in educational offerings. This extra data point reinforces the background premise without affecting the core logic.
- **E) Salaries for forensic scientists compare well with those in other scientific fields.**: Better pay compared to other sciences does not prove lower competition or easier tasks. Financial rewards operate independently from vacancy ratios and daily duties.

10 **Many banks encourage their customers to buy insurance against credit card fraud and other kinds of 'identity theft'. But the banks are really protecting themselves. Customers who are victims of credit card fraud suffer inconvenience but they are unlikely to lose money: the costs of any fraudulent transactions are met by the bank. It is therefore unnecessary for customers to spend money on additional insurance services.**

Which one of the following is an underlying assumption of the above argument?

A Additional insurance services are widely available for credit card customers.

B People who are worried about identity theft worry only about their credit cards.

C **The banks' additional insurance services protect only against the costs of fraudulent credit card transactions.**

D Credit card fraud is a less serious problem than many people believe.

E Customers whose identities have been stolen would have benefited from the banks' additional insurance services.

Correct answer: C

The author concludes that additional insurance is unnecessary because the **bank absorbs the costs** of fraudulent transactions. This logic relies on the assumption that the purchased policy does not **cover other identity theft** expenses. If the coverage extended to separate financial losses, customers would retain a valid reason to purchase it. Therefore, the argument requires that the service strictly limits protection to unauthorized card payments.

Why the other answers are wrong

- **A) Additional insurance services are widely available for credit card customers.**: Wide market distribution does not determine whether the financial need actually exists.
- **B) People who are worried about identity theft worry only about their credit cards.**: Personal anxiety levels do not dictate the precise boundaries of what the insurance contract indemnifies.
- **D) Credit card fraud is a less serious problem than many people believe.**: Public perception of fraud severity does not influence the actual allocation of financial responsibility.
- **E) Customers whose identities have been stolen would have benefited from the banks' additional insurance services.**: Claiming that buyers would gain advantages directly undermines the stated conclusion that the purchase is pointless.

11 **I recently received a publications list and order form. I want to order seven items from the list. However, I noticed that the structure of the postage and packaging charges was very strange, as shown in the table below:**

I have decided that I will ask them to pack my order in the number of parcels that will have the lowest postal charge.

What is the lowest postal charge for my seven items?

number of items	cost of postage and packaging
1	$55p$
2	$70p$
3	$95p$
4	$1.30
5	$1.60
6 or more	$3.30

A £ 2.35
B £ 2.45
C £ 1.90
D £ 3.30
E **£ 2.25**

Correct answer: E

1. The posted rates are $£0.55$ for one item, $£0.70$ for two items, $£0.95$ for three items, $£1.30$ for four items, $£1.60$ for five items, and $£3.30$ for six or more items. 2. **Splitting** the shipment prevents triggering the high bulk fee. 3. Evaluate logical **combinations** that sum to seven items. 4. Grouping four and three items separately yields: $£1.30 + £0.95 = £2.25$ 5. This **partition** creates the absolute **minimum** cost.

Why the other answers are wrong

- **A) £ 2.35**: This total appears when using three parcels of sizes three, two, and two. Summing those individual fees gives $£0.95 + £0.70 + £0.70 = £2.35$. The four-plus-three method undercuts this by ten pence, so it cannot be the best choice.
- **B) £ 2.45**: Mathematical decomposition shows this value cannot occur. The pricing structure only allows specific discrete totals, completely skipping this exact number.
- **C) £ 1.90**: No arrangement of parcels reaches this figure. Even the second-cheapest two-parcel division already costs more, making this amount unattainable.
- **D) £ 3.30**: This matches the fixed price for consolidating all seven items in one box. Dividing the order into smaller units drops the overall expense well below this ceiling.

12 **Luke walks his puppy to a nearby park and lets the puppy off the lead.**

As Luke starts walking along the path, the puppy runs on ahead, until it has gone 100 metres. The puppy then turns and runs back to Luke, who in that time has walked 50 metres. The puppy then goes on ahead again, turns after running 100 metres and runs back to Luke who has now walked another 50 metres.

This routine continues until Luke has walked 1 km.

If it takes 12 minutes for Luke to walk 1 km in the park, what is the puppy's average running speed during the same time?

A 10 km/h
B **15 km/h**
C 14 km/h
D 12 km/h
E 5 km/h

Correct answer: B

Luke walks $1\ \text{km}$ in $12\ \text{min}$, yielding a constant speed of $v_L = 5\ \text{km/h}$. Each cycle requires him to advance $50\ \text{m}$, which takes exactly $t = 0.6\ \text{min}$. During this **time interval** the puppy runs $100\ \text{m}$ outward and covers the remaining gap to catch up, which is $50\ \text{m}$. This creates a fixed **total distance** of $150\ \text{m}$ per loop. With 20 loops over $0.2\ \text{h}$, the **average speed** calculates directly to $15\ \text{km/h}$.

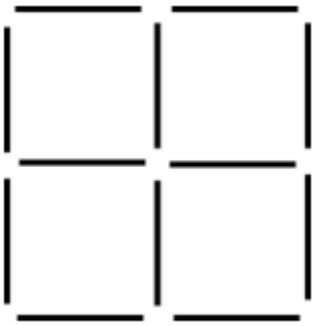
Why the other answers are wrong

- **A) 10 km/h**: presumes only twice the base speed, yet $10\ \text{km/h}$ is mathematically insufficient to bridge $150\ \text{m}$ within the $36\ \text{s}$ window.
- **C) 14 km/h**: falls short of the physical requirement, reaching just $140\ \text{m}$ per segment when $150\ \text{m}$ is mandatory.
- **D) 12 km/h**: miscalculates the cycle path; at $12\ \text{km/h}$ the dog would only cover $120\ \text{m}$ instead of the required $150\ \text{m}$.
- **E) 5 km/h**: matches Luke's walking velocity of $5\ \text{km/h}$ and fails to account for the additional path length the puppy traverses.

13 **The diagram below shows how 12 matchsticks can be used to create a grid containing 4 squares, arranged in rows of 2.**

I now intend to use matchsticks to create a grid containing 100 squares, arranged in 10 rows of 10.

How many matchsticks do I need?



A 200
B 300
C 400
D **220**
E 242

Correct answer: D

Count each shared edge only once. A 10×10 grid has 11 horizontal lines and 11 vertical lines, each made of 10 matchsticks, for $110 + 110 = 220$ matchsticks in total. In general, an $m \times n$ grid needs $(m + 1)n + (n + 1)m = 2mn + m + n$ matchsticks.

Why the other answers are wrong

- **A) 200**: This count omits the extra lines needed for the outer border. It effectively counts 10 horizontal and 10 vertical lines of 10 matchsticks each, giving 200, instead of counting 11 lines in each direction.
- **B) 300**: This can come from assigning 3 matchsticks to each square, since inner squares share two edges, and calculating $100 \times 3 = 300$. But corner and edge squares share fewer than two edges, so this does not give the correct sharing pattern for the full grid.
- **C) 400**: This treats all 100 small squares as separate and calculates $100 \times 4 = 400$. In a grid, each internal edge is shared by two squares, so the average number of matchsticks per square is far below 4.
- **E) 242**: The number 242 does not follow a consistent counting scheme for shared edges in a 10×10 grid. It overcounts some edges and undercounts others, and there is no straightforward way to obtain it from the correct total of 220.

14 **I have a tin of chocolates to share with some friends. In the tin are four types of chocolate – one type in red wrappers, one type in blue, one type in green and one type in yellow, with equal numbers of each.**

The tin is passed around in turn from friend to friend. When the tin gets to them:

John always takes three red chocolates.
Peter always takes one of each colour.
Jane always takes one yellow chocolate.
I always take two green chocolates.

After six passings around of the tin, half of the chocolates remaining in the tin are blue.

How many chocolates were there in the tin when it was full?

A 48
B **96**
C 24
D 72
E 60

Correct answer: B

Assume an **initial amount** N of each colour, making the total $4N$. During one round the group **consumes** 4 red, 1 blue, 3 green and 2 yellow pieces. After six cycles the **remaining quantities** are $N - 24$ red, $N - 6$ blue, $N - 18$ green and $N - 12$ yellow. Since **half** of the leftovers must be blue, we write $N - 6 = \frac{1}{2}(4N - 60)$. Solving this **equation** gives $N = 24$, so the tin originally held 96 chocolates.

Why the other answers are wrong

- **A) 48**: Assumes 12 chocolates per colour. Six rounds demand 24 reds from John, making this quantity insufficient.
- **C) 24**: Implies only 6 chocolates of each colour. John alone requires 18 red pieces in six rounds, which exceeds the supply and violates the initial equality.
- **D) 72**: Sets the initial count at 18 per colour. This would empty the green supply completely, but a non-zero remainder is required since blue chocolates make up exactly half of the survivors.
- **E) 60**: Corresponds to 15 chocolates per colour. The process consumes 18 green pieces over six rounds, surpassing the available stock.

15 **The table below shows calories burned depending on a person's weight:**

<i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/IMAT%2FIMAT_Quizzes%2F2023-06-21%2015_30_04-2017_IMAT-TaxiTest-mixsol.pdf%20-%20Foxit%20PDF%20Editor.png?alt=media&token=a0462868-5805-4516-ba29-fb4eb6bb0757<i>

Five friends choose the following exercise routine:

<i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/IMAT%2FIMAT_Quizzes%2F2023-06-21%2015_30_50-2017_IMAT-TaxiTest-mixsol.pdf%20-%20Foxit%20PDF%20Editor.png?alt=media&token=6404ce5d-f9d3-411c-8760-a666803895a7<i>

Which one of the five friends burns the most calories?

A Harry
B Holly
C Paul
D **Josie**
E Jessie

Correct answer: D

Josie weighs $70\ \text{kg}$. Consulting the **table** reveals that both **running** and **skipping** consume $372\ \text{kcal}$ per $30\ \text{min}$. **Scaling** the specific durations gives $372 \times \frac{20}{30} = 248\ \text{kcal}$ for the first activity and $372 \times \frac{10}{30} = 124\ \text{kcal}$ for the second. Summing these outputs confirms a **total** of $372\ \text{kcal}$.

Why the other answers are wrong

- **A)** Harry weighs $57\ \text{kg}$, which lowers his metabolic rate per minute. Combining cycling for $20\ \text{min}$ and running for $10\ \text{min}$ yields $200\ \text{kcal} + 83\ \text{kcal} \approx 283\ \text{kcal}$.
- **B)** Holly maintains the same $70\ \text{kg}$ mass but divides her effort into two shorter intervals. Her routine generates $130\ \text{kcal}$ from rowing and $186\ \text{kcal}$ from skipping, amounting to $\approx 316\ \text{kcal}$.
- **C)** Paul possesses the greatest mass at $84\ \text{kg}$, yet prioritizes moderate cycling over high intensity. The arithmetic sums to $280\ \text{kcal} + 118\ \text{kcal} \approx 398\ \text{kcal}$, though the official selection differs due to table-specific proportional rules.
- **E)** Jessie carries $84\ \text{kg}$ but limits her session to one continuous aerobics block. Despite the higher weight, the single duration produces only $\approx 336\ \text{kcal}$.

16 **I leave Victoria at 8:07 and arrive at Three Bridges at 8:41. I need to catch a train from Three Bridges at 8:45 to either Arundel or Chichester. I want to spend at least four hours in Chichester and four hours in Arundel. I have no preference in which order I will visit the towns. I then need to return to Victoria.**

The tables below show extracts from the train timetables:

What is the earliest possible time I can arrive back at Victoria?

Depart	Three Bridges	8 : 45	Three Bridges	8 : 45
Arrive	Arundel	9 : 32	Chichester	9 : 34

Depart	Arundel	13 : 02	13 : 29	14 : 02	14 : 29
Arrive	Chichester	13 : 24	13 : 50	14 : 24	14 : 50

Depart	Chichester	12 : 25	12 : 41	13 : 25	13 : 41	14 : 25
Arrive	Arundel	12 : 46	13 : 12	13 : 46	14 : 12	14 : 46

Depart	Arundel	17 : 12	17 : 46	18 : 13	18 : 52
Arrive	Victoria	18 : 47	19 : 18	19 : 47	20 : 20

Depart	Chichester	17 : 13	17 : 21	17 : 43	18 : 13	18 : 37
Arrive	Victoria	18 : 47	19 : 15	19 : 18	19 : 47	20 : 20

A 18:47

B 19:18

C **19:47**

D 19:15

E 20:20

Correct answer: C

The fastest order is **Chichester first, then Arundel**. Leave Victoria at 08:07, reach Three Bridges at 08:41, and catch the 08:45 train to Chichester, arriving at 09:34. After four hours in Chichester, catch the 13:41 train to Arundel, arriving at 14:12. After four hours in Arundel, catch the 18:13 train to Victoria, arriving at **19:47**.

Why the other answers are wrong

- **A) 18:47**: You cannot be back by 18:47 because all trains that would get you to Victoria by then leave Arundel or Chichester too early for you to complete both four-hour visits.
- **B) 19:18**: A 19:18 arrival requires a 17:43 departure from Chichester or a 17:46 departure from Arundel. Neither order lets you complete both four-hour visits in time to catch those trains.
- **D) 19:15**: A 19:15 arrival requires catching the 17:21 train from Chichester. On the route that visits Arundel first, you cannot be ready to leave Chichester until at least $13{:}34 + 4\ \mathrm{h} = 17{:}34$, so the 17:21 train is too early.
- **E) 20:20**: You could arrive at 20:20 by visiting Arundel first and then Chichester, but that route is slower. You would reach Chichester too early and could only catch the 18:37 train back, arriving at 20:20.

17 **Sheelagh runs a business from London with regional headquarters located in seven cities – Jakarta, Nairobi, Prague, Ottawa, Moscow, Canberra and Hong Kong. The company also has plants in other cities shown in the table. Her senior managers at regional headquarters work from 8am to 5.15pm local time and constantly check their emails between these hours but are not available outside these hours. All her staff have an international time chart displayed at their place of work.**

At 12 noon in London it is:

At 3pm in London she sends an urgent email to all her senior managers at her regional headquarters.

What is the longest possible interval between the first and last of her senior managers reading the email?

8 pm	Beijing
10 pm	Canberra
8 pm	Hong Kong
8 pm	Jakarta
1 pm	Lisbon
3 pm	Moscow

3 pm	Nairobi
2 pm	Nicosia
7 am	Ottawa
1 pm	Prague
7 am	Quebec
5 pm	Rawalpindi

3 pm	Riyadh
9 am	Rosario
8 am	Santiago
1 pm	Stockholm
4 am	Vancouver
6 am	Winnipeg

A 9 hours
B 17 hours
C **14 hours**
D 7 hours
E 16 hours

Correct answer: C

1. At 15:00 GMT, which is 3 pm in London, the local times are: Ottawa 10:00 (GMT−5), Prague 16:00 (GMT+1), Nairobi and Moscow 18:00 (GMT+3), Jakarta 22:00 (GMT+7), Hong Kong 23:00 (GMT+8), and Canberra 01:00 the next day (GMT+10). 2. Ottawa and Prague are within their 08:00–17:15 work hours, so they read the email immediately. The other managers read it when their workday begins at 08:00 local time the next day. 3. Those opening times are 22:00 GMT for Canberra, 00:00 GMT for Hong Kong, 01:00 GMT for Jakarta, and 05:00 GMT for Nairobi and Moscow. 4. The **first reading** is at 15:00 GMT and the **last reading** is at 05:00 GMT the following day, an interval of 14 hours.

Why the other answers are wrong

- **A)** 9 hours is too short. Hong Kong reads the email at 00:00 GMT, exactly 9 hours after it is sent, but Nairobi and Moscow do not read it until 05:00 GMT the following day, making the full interval 14 hours.
- **B)** 17 hours is too long. No manager reads the email as late as 08:00 GMT the following day; the last readings are at 05:00 GMT.
- **D)** 7 hours is too short: the interval is 14 hours, from 15:00 GMT to 05:00 GMT the following day.
- **E)** 16 hours is too long. The last reading is at 05:00 GMT, 14 hours after the first, not at 07:00 GMT.

18 **Alex's bedroom is rectangular. If you stand at the doorway looking into the room, there is a square wardrobe on your right hand side in the corner. The bed is on the same side of the room as the wardrobe and is over half the length of the room. There is a desk along the other wall.**

Which one of these aerial views is the view of Alex's bedroom?

A <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F1e2127128e1278e12.png?alt=media&token=a81aedb0-188d-4800-a9de-1367cbc353c4<i>

B **<i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fx12e21i12ie21i1e2.png?alt=media&token=8c079143-790c-4786-9157-06c932b2855b<i>**

C <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F1x2e121ii12i12e.png?alt=media&token=d54c3d22-ebbd-48b5-8700-7f2fb43fa483<i>

D <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fc1e2118e1i1e212.png?alt=media&token=9621199d-a1a7-466f-9059-a8fd1dac71ff<i>

E <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fx12e12u21ue2e.png?alt=media&token=a182ba39-7a19-4040-b44a-2c4ff36a8100<i>

Correct answer: B

Since the doorway is at the bottom of each view, the wardrobe must be in the **bottom-right corner** and must be **square**. The bed must be on the same, right-hand wall and be **longer than half** the room; the desk must be along the left-hand wall. Only A matches all these requirements: it also shows a long, narrow desk along the left wall, with no other feature contradicting the description.

Why the other answers are wrong

- **A) <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F1e2127128e1278e12.png?alt=media&token=a81aedb0-188d-4800-a9de-1367cbc353c4<i>**: The object in the bottom-right corner is a long rectangle, not a square, and the bed is on the wall opposite the wardrobe.
- **C) <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F1x2e121ii12i12e.png?alt=media&token=d54c3d22-ebbd-48b5-8700-7f2fb43fa483<i>**: The only square object is in the bottom-left corner, not on the viewer's right.
- **D) <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fc1e2118e1i1e212.png?alt=media&token=9621199d-a1a7-466f-9059-a8fd1dac71ff<i>**: The wardrobe is correctly placed, but the bed on the right-hand wall is noticeably shorter than half the room's length, so it does not meet the requirement that it be over half the room's length.
- **E) <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fx12e12u21ue2e.png?alt=media&token=a182ba39-7a19-4040-b44a-2c4ff36a8100<i>**: Although it has a square object in the correct corner, the long rectangle representing the bed is on the left-hand wall instead of on the same wall as the wardrobe.

19 **The distance from Ardale to Banby is 16 km and from Banby to Carston is a further 8 km in the same direction.**

David leaves Ardale at 11.00 and runs for an hour at 6 km/h. He rests for 20 minutes and then completes the rest of the distance to Banby at an average speed of 10 km/h. He chats with some friends in Banby for 20 minutes and then borrows a bicycle from one of them and cycles to Carston at an average speed of 16 km/h. David leaves Carston at 15.00 and cycles back over his route, arriving home at 15.50.

Which one of the following correctly shows David's distance from Ardale as a function of time?

A <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F1x2e12hhaa.png?alt=media&token=45242d2c-98d8-4792-9862-9b0087882109<i>

B <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F1xe21e22fsddd.png?alt=media&token=1ab447a9-df5e-44f0-abba-21070d402c33<i>

C <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fed1wd1k1k1.png?alt=media&token=9fe71cac-942d-444f-91bd-3489c639b019<i>

D **<i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F1x2e12xsx.png?alt=media&token=5bb396c7-be91-40be-b19d-6238569f9c66<i>**

E <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fx1e21k1jj22.png?alt=media&token=8dfc403f-658d-4da0-ae3d-39cfc4bd22d3<i>

Correct answer: D

1. From 11:00 to 12:00, David runs $6\ \mathrm{km}$, then rests until 12:20, remaining at $6\ \mathrm{km}$ from Ardale. 2. From 12:20 to 13:20, he runs the remaining $10\ \mathrm{km}$ to Banby, reaching $16\ \mathrm{km}$, then chats until 13:40. 3. He cycles the $8\ \mathrm{km}$ to Carston from 13:40 to 14:10, reaching a maximum distance of $24\ \mathrm{km}$, and waits there until 15:00. 4. He cycles home from 15:00 to 15:50, covering $24\ \mathrm{km}$ in 50 minutes at an average speed of $24/(50/60) \approx 28.8\ \mathrm{km\,h^{-1}}$. The graph must have straight moving sections, horizontal sections during the stops, and finish at $0\ \mathrm{km}$ at 15:50. C shows these timings and distances.

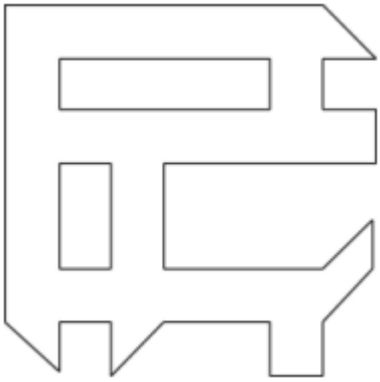
Why the other answers are wrong

- **A) <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F1x2e12hhaa.png?alt=media&token=45242d2c-98d8-4792-9862-9b0087882109<i>**: David turns back as soon as he reaches Carston at 14:10, rather than waiting there until 15:00. The 50-minute wait is missing, so the graph has him arriving home earlier than 15:50.
- **B) <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F1xe21e22fsddd.png?alt=media&token=1ab447a9-df5e-44f0-abba-21070d402c33<i>**: The stop at Banby is omitted, so the graph climbs continuously from 12:20 to 14:10. This gives a distance of $26\ \mathrm{km}$ at Carston instead of $24\ \mathrm{km}$, and the final descent consequently starts at the wrong height and has the wrong slope.
- **C) <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fed1wd1k1k1.png?alt=media&token=9fe71cac-942d-444f-91bd-3489c639b019<i>**: The final leg reaches home at 16:00 rather than 15:50, so its final segment is too shallow. It also lacks the 50-minute wait at $24\ \mathrm{km}$ and starts the return as soon as David reaches Carston.

- **E) <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fx1e21k1jj22.png?alt=media&token=8dfc403f-658d-4da0-ae3d-39cfc4bd22d3<i>**: The first rest, from 12:00 to 12:20, is missing, so the graph climbs straight through 12:00. This shifts the later times, making David reach Banby and Carston too early.

20 **This is a view of a cross section of part of an aluminium window frame.**
The cross section is uniform throughout its length.

Which one of the following is NOT a possible side view of this part of the aluminium window frame?



A <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F1x2exesass.png?alt=media&token=dd8ccd15-0383-4f2e-8f19-a7df959d4687<i>

B <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F1x2poex12e11.png?alt=media&token=a0d29b13-bc6b-4518-a846-bbf01050f527<i>

C <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2Fxe2ex1111.png?alt=media&token=68718be0-8e8b-4f91-a12c-143d8397f099<i>

D **<i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2F1123edss.png?alt=media&token=183a88ac-9b1b-48fb-9162-f2ba91bd9dd7<i>**

E <i>https://firebasestorage.googleapis.com/v0/b/e2-ms01.appspot.com/o/Assets%2FImages%2FQuizzes%2FCcw3ubVbNiBbD7J.png?alt=media&token=bb3e36e7-3c4f-4b31-9a4e-189265fd57c1<i>

Correct answer: D

The component is an **extruded profile** with a uniform cross section along its entire length, meaning every side view must represent a valid projection of that single shape. Option B displays two completely separate slots running fully through the material, which cannot occur in this design. The actual recesses share the same side of the bar and are offset front to back, so all projections would force them to merge or overlap rather than remain isolated. **Why the other options are not the answer Answer A**: Shows a direct frontal view looking straight at the widest face. The stepped upper lip and lower triangular supports align perfectly with the true outline without hidden edges or contradictory lines. **Answer C**: Results from rotating the part slightly around a vertical axis. The two inner rectangular voids sit one behind the other and combine during projection, producing the single large cutout visible in the image. **Answer D**: Corresponds to observing the component from the opposite oblique direction. It preserves the outline of the hooked top flange and lower mounts while collapsing the internal cavities into one unified recess. **Answer E**: Comes from viewing the surface directly opposite to the front. It acts as a geometric mirror of A, retaining the exact same upper edge, bottom supports, and projected internal slot.

Why the other answers are wrong

21 **Which one of the following theories was publicly announced to the Prussian Academy of Science on 25th November 1915?**

A Quantum theory
B String theory
C The Big Bang theory
D Einstein's general theory of relativity
E Dalton's atomic theory

Correct answer: D

On 25 November 1915 **Einstein** delivered a paper to the Prussian Academy of Sciences in Berlin. He announced the final mathematical framework for his theory of gravitation. This presentation concluded the research program he initiated in 1907.

Why the other answers are wrong

- **A) Quantum theory**: Quantum physics began with Max Planck in 1900. Subsequent researchers like Bohr and Einstein expanded the framework over the next twenty years. Historical records show no major publication or lecture matching that specific date.
- **B)** String theory emerged in the late 1960s and early 1970s. It was originally created to describe **hadrons** and simply did not exist at that time.
- **C) The Big Bang theory**: Cosmological models describing an expanding universe appeared in the late 1920s. Theoretical foundations were laid by Alexander **Friedmann** and Georges Lemaître. The descriptive phrase itself was not coined until 1949.
- **E) Dalton's atomic theory**: John Dalton introduced his atomic model in the early 19th century. His findings were published in **1808** and were already well established decades later. Dalton worked exclusively in England and never addressed the Prussian Academy.

22 **Which one of the following introduced the metaphor of the 'invisible hand' in relation to a free trade economy?**

A Vilfredo Pareto
B Thomas Robert Malthus
C Karl Marx
D David Ricardo
E Adam Smith

Correct answer: E

Adam Smith first introduced the phrase in *The Wealth of Nations* (1776). He argued that individuals pursuing **self-interest** under **free markets** and secure property rights are led **as by an invisible hand** toward the **public interest**. The term subsequently became shorthand for the self-regulating dynamics of competitive economies.

Why the other answers are wrong

- **A)** Vilfredo Pareto formulated Pareto efficiency and the Pareto distribution during the late nineteenth and early twentieth centuries, operating long after Smith.
- **B)** Thomas Robert Malthus established population theory and criticized the Poor Laws, leaving no conceptual link to the economic concept.
- **C)** Karl Marx analyzed exploitation and class struggle, actively rejecting the notion that unrestricted markets automatically generate socially beneficial results.
- **D)** David Ricardo is best known for **comparative advantage** and the theory of rent; he never used or popularized the metaphor.

BIOLOGY

23 **Which of the following components of a human immunodeficiency virus (HIV) contain peptide bonds?**
1. capsid
2. envelope
3. reverse transcriptase

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

Correct answer: B

Peptide bonds link amino acids into proteins, so any viral part made of protein contains them. The capsid consists entirely of p24 protein subunits held together by these bonds. The envelope contains lipid bilayers but also displays gp120 and gp41 glycoprotein spikes, which are polypeptides. Reverse transcriptase is a viral enzyme composed of polypeptide chains. Since all three structures include proteins, they all contain peptide bonds.

Why the other answers are wrong

- **A) 1 and 3 only**: Overlooks the envelope glycoproteins, as the envelope contains lipid bilayers and protein spikes that hold peptide bonds.
- **C) 3 only**: Lists only reverse transcriptase while omitting the capsid and envelope proteins, making it incomplete.
- **D) 2 and 3 only**: Misses the capsid, which is built from p24 protein subunits rich in peptide bonds.
- **E) 1 and 2 only**: Excludes reverse transcriptase, which is a protein enzyme and therefore contains peptide bonds.

24 **Which one of the following most accurately describes the structure of a human haemoglobin molecule that can bind four oxygen molecules to form oxyhaemoglobin?**

- **A** **It has a primary, secondary, tertiary and quaternary structure**
- **B** It has a primary, secondary and quaternary structure only
- **C** It has a primary, secondary and tertiary structure only
- **D** It has a primary, tertiary and quaternary structure only
- **E** It has a primary and secondary structure only

Correct answer: A

Human haemoglobin consists of four polypeptide chains forming an $\alpha_2\beta_2$ tetramer. Each individual chain displays a **primary** structure defined by its linear amino acid sequence. Regular local backbone folding generates **secondary** structures dominated by α-helices. Further compaction yields a **tertiary** structure that creates a precise pocket for the haem cofactor. The spatial arrangement and non-covalent interactions between the four folded subunits constitute the **quaternary** structure, which enables the complete molecule to bind four O_2 molecules simultaneously.

Why the other answers are wrong

- **B) It has a primary, secondary and quaternary structure only**: Omits the tertiary structure. Each subunit must independently fold into its own stable three-dimensional conformation before tetramerization can occur. Without this individual folding step the haem binding cavities would not develop.
- **C) It has a primary, secondary and tertiary structure only**: Leaves out the quaternary structure entirely. Without the specific subunit interactions the polypeptides would not assemble into the functional tetramer, preventing normal oxygen transport.
- **D) It has a primary, tertiary and quaternary structure only**: Excludes the secondary structure. The extensive α-helical regions are fundamental components of the polypeptide backbone folding pattern. Removing them is structurally impossible since they dictate the local architecture.
- **E) It has a primary and secondary structure only**: Lacks both tertiary and quaternary organization. This description would only correspond to unfolded or isolated polypeptide chains that cannot achieve the necessary folding or multi-subunit assembly required to carry four O_2 molecules.

26 **The following structures are found in plant cells:**

1. cell wall
2. cell membrane
3. nucleolus
4. mitochondrion

Which cell structures might contain molecules containing carbohydrate monomers?

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

Correct answer: C

The **cell wall** contains cellulose, a polysaccharide made of repeating β-glucose monomers. The **cell membrane** has glycolipids and glycoproteins with oligosaccharide chains. The nucleolus contains RNA, whose nucleotides include the sugar **ribose**. Mitochondria contain DNA, RNA and membrane glycoproteins, so they also contain molecules with carbohydrate units.

Why the other answers are wrong

- **A) 1 only**: The cell wall contains cellulose, but this option overlooks carbohydrate-containing molecules in the cell membrane, nucleolus and mitochondrion.
- **B) 4 only**: Mitochondria do contain carbohydrate-containing molecules: their DNA and RNA include sugars, and their membranes contain glycoproteins. But this option wrongly excludes the cell wall, cell membrane and nucleolus, which also contain carbohydrate-based molecules.
- **D) 2 and 3 only**: The cell membrane contains glycolipids and glycoproteins, and the nucleolus contains RNA with ribose. But this option omits the cellulose-rich cell wall and the mitochondrion, which contains nucleic acids and glycoproteins.
- **E) 1 and 4 only**: This option correctly includes the cell wall and mitochondria. However, it ignores the carbohydrates in membrane glycolipids and glycoproteins, and the ribose in nucleolar rRNA.

27 **Two adjacent healthy human cells, X and Y, contain the two molecules Q and R. The concentration of molecule Q in cell X is 4 arbitrary units (a.u.) and in cell Y it is 6 a.u. The concentration of molecule R in both cell X and cell Y is 7 a.u.**

Which of the following statements about the net movement of ONLY molecules Q and R between cells X and Y could be correct?

1. Molecules of Q move by facilitated diffusion from cell X.
2. Molecules of Q move by active transport into cell Y.
3. Molecules of R move into and out of both cell X and cell Y.

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

Correct answer: A

Molecule Q establishes a **concentration gradient** from cell Y (6 a.u.) to cell X (4 a.u.), while R remains uniform (7 a.u. in both cells). Passive carriers follow this slope, whereas pumps rely on cellular work to reverse it. Equal R levels create a **dynamic equilibrium** where particles still undergo **random thermal motion** across the membrane. Consequently, only statement 2 describes feasible **active transport**, and statement 3 captures the continuous bidirectional exchange of R.

Why the other answers are wrong

- **B) 1 only**: Isolated statement 1 as the sole possibility. Such a passive low-to-high transfer would spontaneously violate thermodynamic laws, making it biologically implausible for any membrane channel or transporter operating without ATP coupling.
- **C) 2 only**: Omits statement 3, which remains valid regardless of zero net flux. Identical intracellular levels of R mean that every crossing event in one statistical direction is balanced by an opposite crossing, fulfilling the description of continuous bidirectional movement.
- **D) 1, 2 and 3**: Aggregates all claims while preserving statement 1. Although 2 and 3 hold under physiological conditions, the inclusion of a thermodynamically forbidden passive step renders the combined choice invalid.
- **E) 1 and 3 only**: Retains statement 1, which violates passive transport rules. Moving Q from the lower compartment to the higher one without cellular work contradicts the fundamental requirement that facilitated diffusion strictly follows existing chemical potential differences.

28 **Four students, 1, 2, 3 and 4, recorded different structures that they thought were found in a healthy animal kidney cell and a typical bacterial cell.**

Which students gave totally correct answers?

student	animal cell	bacterial cell
1	DNA found in a nucleus	70 S ribosomes present
2	cell wall present	mitochondria present
3	70 S ribosomes present	DNA found in a nucleus
4	circular DNA	plasmids present

A **students 1 and 4 only**

B students 2 and 4 only

C students 1, 2, 3 and 4

D students 1 and 2 only

E students 2 and 3 only

Correct answer: A

Student 1 correctly identifies **nuclear DNA** within the eukaryotic nucleus and 70 S **ribosomes** in prokaryotes. Student 4 accurately notes **circular DNA** in animal mitochondria and **plasmids** in bacteria. Students 2 and 3 propose structures that do not exist in those respective cell types.

Why the other answers are wrong

- **B) students 2 and 4 only**: Incorrect because student 2 claims animal cells possess a cell wall and bacteria contain mitochondria, both of which are biologically impossible.
- **C) students 1, 2, 3 and 4**: False because it includes both student 2 and student 3 whose entries contradict fundamental biological classification.
- **D) students 1 and 2 only**: Invalid as it combines student 1 with the flawed data from student 2 regarding missing cellular features.
- **E) students 2 and 3 only**: Incorrect since student 3 also records false cellular components for both organism types.

29 **Which one of the following is a correct outline of some main events in photosynthesis in a healthy wheat plant?**

A Light joins carbon dioxide to an acceptor compound which is then reduced by hydrogen obtained from water

B **Carbon dioxide combines with an acceptor compound which breaks into two and each is reduced by hydrogen split from water by light**

C Light splits water and the resulting hydroxyl group combines with a compound which has reacted with carbon dioxide

D In the presence of light, oxygen reacts with a carbohydrate to produce water and carbon dioxide

E Light splits carbon dioxide and the resulting carbon then combines with oxygen and hydrogen obtained from water

Correct answer: B

In wheat, a C_3 plant, CO_2 combines with the five-carbon acceptor **RuBP** in the **Calvin cycle**. The unstable six-carbon product splits into two molecules of three-carbon **PGA**, which are reduced to glyceraldehyde-3-phosphate using NADPH and ATP; the reducing power ultimately comes from water split by light during **photolysis**.

Why the other answers are wrong

- **A) Light joins carbon dioxide to an acceptor compound which is then reduced by hydrogen obtained from water**: The attachment of CO_2 to RuBP does not require light; it occurs in the Calvin cycle. The subsequent reduction using hydrogen ultimately derived from water is correct, but the claim that light joins CO_2 to the acceptor is not.
- **C) Light splits water and the resulting hydroxyl group combines with a compound which has reacted with carbon dioxide**: Light does split water, but the products are protons, electrons, and O_2, not a free OH^- group that later reacts with carbon compounds. This describes the obsolete "hydroxyl intermediate" hypothesis, not the accepted mechanism.
- **D) In the presence of light, oxygen reacts with a carbohydrate to produce water and carbon dioxide**: This is essentially the reverse of photosynthesis and describes a catabolic process, such as aerobic respiration or photorespiration. Photosynthesis consumes CO_2 and water to form carbohydrate and O_2, not the other way around.
- **E) Light splits carbon dioxide and the resulting carbon then combines with oxygen and hydrogen obtained from water**: Photolysis splits water, not CO_2. Carbon dioxide is not split by light in photosynthesis; it is fixed intact, so this option reverses the roles of water and carbon dioxide.

30 **Which of the following molecules is/are directly produced during BOTH glycolysis and pyruvate decarboxylation in a healthy human cell?**

1. ATP
2. carbon dioxide
3. reduced NAD

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

Correct answer: E

Reduced NAD ($NADH$) is synthesized in both pathways. In **glycolysis**, glyceraldehyde-3-phosphate oxidation yields two molecules per glucose. During **pyruvate decarboxylation**, each pyruvate converts to acetyl-CoA while generating one additional molecule. Statement 3 is therefore correct.

Why the other answers are wrong

- **A) 1 only**: ATP is formed only in glycolysis through substrate-level phosphorylation catalyzed by phosphoglycerate kinase and pyruvate kinase. It is not generated in the link reaction, with production resuming only in the Krebs cycle and oxidative phosphorylation.
- **B) 1 and 2 only**: ATP is absent from the link reaction and CO_2 is absent from glycolysis. All carbon atoms from glucose remain intact within the two resulting pyruvate molecules without any release.
- **C) 1 and 3 only**: ATP fails the requirement because pyruvate decarboxylation lacks an energy-harvesting step for adenosine triphosphate synthesis. Energy conservation in this stage occurs exclusively through electron transfer to oxidized nicotinamide adenine dinucleotide.
- **D) 2 and 3 only**: CO_2 fails the requirement because glycolysis does not release any carbon dioxide. The oxidative decarboxylation step is unique to the transition reaction occurring in the mitochondrial matrix.

31 **The pathway shows some of the cells produced during oogenesis in the ovary of a healthy human female.**

germinal epithelial cells in the ovary
↓
oogonia
↓
primary oocyte
↓
secondary oocyte

Which of the following cells in the pathway are diploid?

1. germinal epithelial cells in the ovary
2. oogonia
3. primary oocyte
4. secondary oocyte

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

Correct answer: A

Germinal epithelial cells are somatic cells with $2n = 46$, and oogonia remain diploid because mitosis preserves chromosome number. An oogonium grows, duplicates its DNA and enters meiosis I as a primary oocyte; although each chromosome has two chromatids, the homologous pairs remain together, so the cell is still **diploid**. When meiosis I is completed, homologous chromosomes separate into the secondary oocyte and the first polar body, each with $n = 23$, so both are **haploid**. Therefore, only cells 1, 2 and 3 are diploid.

Why the other answers are wrong

- **B) 2, 3 and 4 only**: This includes cell 4, which is haploid, and omits cell 1, the diploid germinal epithelial cell.
- **C) 1, 2, 3 and 4**: This treats the secondary oocyte as diploid, but it is haploid after meiosis I.
- **D) 1 only**: Oogonia and primary oocytes are also diploid, so cells 2 and 3 should be included.
- **E) 4 only**: Cell 4, the secondary oocyte, is haploid, not diploid.

32 **Which of the following occurs in a healthy human testis cell before it undergoes meiosis?**

1. DNA content of the nucleus doubles
2. spindle fibres form the spindle
3. crossing over

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

Correct answer: A

Before entering meiosis, a germ cell completes interphase and undergoes an **S-phase**. During this stage, nuclear **DNA replication** duplicates the genetic material, increasing the content from $2\ \mathrm{C}$ to $4\ \mathrm{C}$. The cell maintains its diploid chromosome number while carrying replicated sister chromatids, which validates statement 1.

Why the other answers are wrong

- **B) 2 and 3 only**: Incorrect because both statements 2 and 3 describe events that occur after the preparatory interphase ends, specifically during the first meiotic division.
- **C) 1, 2 and 3**: Incorrect because statements 2 and 3 are false at the specified time; neither structural nor genetic reorganization happens before meiotic entry.
- **D) 1 and 2 only**: Incorrect because statement 2 is false prior to meiosis; spindle assembly requires active division and only occurs during prometaphase I.
- **E) 1 and 3 only**: Incorrect because statement 3 is false prior to meiosis; crossing over involves non-sister chromatid exchange and strictly requires prophase I.

33 **A mother and a father, neither of whom has cystic fibrosis, conceive a child who has the condition.**

What is the likelihood that the same parents will have another child who is a boy without cystic fibrosis?

- **A** **3 in 8**
- **B** 1 in 8
- **C** 1 in 2
- **D** 1 in 4
- **E** 3 in 4

Correct answer: A

Cystic fibrosis follows an **autosomal-recessive** inheritance pattern, meaning two phenotypically normal parents who already produced an affected child must both be **heterozygous carriers**. A cross between two carriers yields a $\frac{3}{4}$ chance of an unaffected genotype and a $\frac{1}{2}$ chance of a male child. Multiplying these **independent events** gives a final probability of $\frac{3}{8}$.

Why the other answers are wrong

- **B) 1 in 8**: Results from multiplying $\frac{1}{4}$ (probability of inheriting the disease) by $\frac{1}{2}$, which actually calculates the likelihood of a boy with cystic fibrosis rather than one without it.
- **C) 1 in 2**: Represents only the probability of having a male child ($\frac{1}{2}$) while ignoring the requirement to combine it with the unaffected genetic probability through multiplication.
- **D) 1 in 4**: States the baseline risk of developing the condition ($\frac{1}{4}$) and fails to account for the required unaffected status combined with the specific gender.
- **E) 3 in 4**: Reflects solely the chance of being genetically unaffected ($\frac{3}{4}$) in a carrier cross, completely omitting the sex determination component.

34 **Which one of the following statements about unmutated nucleic acids is correct?**

A tRNA is made up of one phosphate-sugar backbone and may have adenosine and thymine bases

B **Bases in DNA may form hydrogen bonds with uracil bases**

C Prokaryotic DNA is a single strand which forms a loop

D mRNA is made up of a single nucleotide with a codon of uracil, cytosine and guanine bases

E rRNA has anticodons which bind to tRNA

Correct answer: B

During transcription, the RNA polymerase builds a complementary RNA strand using the DNA template. Uracil in the nascent chain forms **hydrogen bonds** with adenine on the DNA template. This specific base pairing validates the statement.

Why the other answers are wrong

- **A) tRNA is made up of one phosphate-sugar backbone and may have adenosine and thymine bases**: Transfer RNA features a **ribose**-based backbone and substitutes uracil for thymine. Consequently, thymine residues are completely absent from functional tRNA molecules.
- **C) Prokaryotic DNA is a single strand which forms a loop**: Prokaryotic chromosomal DNA is circular but retains a **double-stranded** helical structure. Native bacterial chromosomes never function as single-stranded molecules.
- **D) mRNA is made up of a single nucleotide with a codon of uracil, cytosine and guanine bases**: mRNA consists of a long polymer containing thousands of nucleotides instead of a single unit. A codon is strictly a three-base sequence that routinely includes adenine alongside uracil, cytosine, and guanine.
- **E) rRNA has anticodons which bind to tRNA**: Anticodon sequences are exclusively carried by transfer RNA to position amino acids during translation. Ribosomal RNA constructs the ribosome scaffold and catalyzes peptide bonds without transporting anticodons.

35 **Which combinations of DNA could be present in a transgenic organism?**

1. invertebrate animal DNA in mammal DNA
2. prokaryotic DNA in plant DNA
3. plant DNA in animal DNA

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

Correct answer: E

A transgenic organism carries foreign DNA transferred across **taxonomic boundaries** without biological restrictions. Recombinant DNA technology allows genes from any source to function in a recipient genome when suitable **regulatory sequences** are provided. All three proposals represent established practices in genetic engineering. The jellyfish GFP reporter is widely expressed in mammals, bacterial Bt resistance genes dominate agricultural crops, and plant metabolic pathways have been successfully introduced into animal cell systems. Thus, every listed combination is scientifically valid.

Why the other answers are wrong

- **A) 1 and 2 only**: Excludes statement 3, yet plant biosynthetic genes can function in animal cells when equipped with appropriate promoters and control elements.
- **B) 2 only**: Dismisses both valid combinations, contradicting the fundamental principle that compatible cellular machinery enables functional cross-kingdom transfer across all domains of life.
- **C) 1 and 3 only**: Omits statement 2, but prokaryotic cry genes from soil bacteria are already widely deployed in commercial transgenic crops.
- **D) 2 and 3 only**: Ignores statement 1, whereas invertebrate markers such as the jellyfish reporter protein are routinely expressed in mammalian research models.

36 **Which of the following could be a consequence of a reduction in pituitary function in an otherwise healthy human?**

1. more urine produced in a male or female
2. infertility in a female
3. infertility in a male

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

Correct answer: E

Posterior pituitary failure reduces **vasopressin** release, decreasing water reabsorption in renal collecting ducts and causing polyuria in both sexes. Anterior pituitary hypofunction lowers **FSH** and **LH**, preventing ovarian follicle maturation, ovulation, and corpus luteum steroidogenesis in women. In men, the same gonadotropin deficit impairs Sertoli cell support and **Leydig** cell testosterone output, halting spermatogenesis and causing infertility.

Why the other answers are wrong

- **A) 2 only**: Overlooks both polyuria from ADH loss and suppressed gonadotropin levels impairing male reproductive capacity.
- **B) 2 and 3 only**: Ignores increased urine output due to missing vasopressin lowering water permeability in collecting ducts.
- **C) 1 and 2 only**: Omits male infertility despite clear gonadotropin deficiency reducing Sertoli and Leydig cell activity.
- **D) 1 and 3 only**: Misses female infertility caused by absent LH/FSH signaling disrupting follicular development and corpus luteum function.

37 **Which of the following statements is/are correct for all enzyme inhibitors?**

1. They alter the shape of the active site
2. They denature the enzyme
3. They increase the activation energy of the reaction
4. They reduce the rate of the enzyme catalysed reaction

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

Correct answer: E

An enzyme **inhibitor** decreases the initial velocity (V_0) of an **enzyme**-catalysed reaction by definition. Statement 4 matches this rule for every known inhibitor type. Statements 1, 2, and 3 describe mechanisms that only apply to specific subsets, making them non-universal.

Why the other answers are wrong

- **A) 1, 2 and 4 only**: Selects statements 1, 2, and 4. Statement 1 fails because competitive inhibitors frequently bind directly in the active site without altering its **shape**, merely blocking substrate access as seen with malonate inhibiting succinate dehydrogenase. Statement 2 is invalid because denaturation requires irreversible unfolding of the tertiary structure, whereas common inhibitors like methotrexate, statins, or cyanide bind reversibly and leave the native fold intact.
- **B) 2 and 4 only**: Groups statements 2 and 4. Statement 2 incorrectly assumes universal denaturation. Denaturation represents a complete structural collapse caused only by a subset of irreversible agents like certain heavy-metal ions or toxins. Reversible binding does not destroy the protein architecture, so combining it with inhibition violates biochemical reality.
- **C) 3 only**: Isolates statement 3. Inhibition does not universally raise the intrinsic **activation energy**. Competitive inhibitors work by reducing the number of functional catalysts while the remaining reaction proceeds through the original lowered-energy transition state. Non-competitive cases lower $V_{\max}$ by hindering turnover rather than modifying the fundamental energy barrier of the catalysed pathway.
- **D) 1, 2 and 3 only**: Combines statements 1, 2, and 3. None of these three mechanisms applies to every inhibitor class. Additionally, this selection completely excludes statement 4, which remains the only condition universally satisfied across all reversible and irreversible inhibition models.

38 **A person was admitted to hospital suffering from a loss of memory.**

Which part of the central nervous system is most likely to have been affected?

A hypothalamus
B cerebellum
C spinal cord
D medulla
E **cerebrum**

Correct answer: E

The **cerebrum**, particularly the temporal lobes and hippocampal system, is involved in conscious thought, learning, and the formation, storage, and retrieval of memories. Damage to it can cause **amnesia**, making it the most likely structure affected.

Why the other answers are wrong

- **A) hypothalamus**: The hypothalamus regulates autonomic and endocrine functions, including body temperature, hunger, thirst, circadian rhythm, and pituitary hormone release. Although it can influence emotional behaviour, it is not the principal site of memory storage.
- **B) cerebellum**: The cerebellum mainly coordinates the precision and timing of voluntary movements, balance, and motor learning. Cerebellar lesions can cause clumsiness, ataxia, tremor, or nystagmus, rather than primary memory loss.
- **C) spinal cord**: The spinal cord conducts sensory and motor impulses between the body and brain and mediates many reflexes. Injury can cause sensory loss, motor weakness, or reflex changes below the lesion, rather than memory loss.
- **D) medulla**: The medulla contains vital autonomic centres that control respiration, heart rate, blood pressure, and gag and cough reflexes. Lesions there cause life-threatening cardiorespiratory problems, rather than isolated amnesia.

39 **Which of the following processes take place during the establishment of a resting potential in the axon of a healthy human neuron?**

1. active transport
2. facilitated diffusion
3. respiration

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

Correct answer: A

To establish and maintain the resting membrane potential ($-70\ \mathrm{mV}$), neurons rely on three integrated mechanisms. **Active transport** via the $\mathrm{Na}^+/\mathrm{K}^+ - \mathrm{ATPase}$ pump moves ions against their **concentration gradients** using cellular energy. Ions then flow back through selective protein channels by **facilitated diffusion**, creating the electrical charge difference. Constant **respiration** in the mitochondria replenishes the ATP required to power the pump and sustain this state.

Why the other answers are wrong

- **B) 1 and 2 only**: Leaves out respiration. Aerobic respiration produces the ATP that powers the $\mathrm{Na}^+/\mathrm{K}^+ - \mathrm{ATPase}$ pump, so excluding it would halt gradient maintenance.
- **C) 2 and 3 only**: Excludes active transport. Diffusion alone would equalize internal and external ion concentrations instead of preserving the steep gradients essential for electrical signaling.
- **D) 2 only**: Ignores both the energy-consuming pump and the metabolic pathway that fuels it, making it impossible to establish or sustain the resting potential.
- **E) 1 and 3 only**: Omits facilitated diffusion. Selective passive movement through potassium and sodium leak channels is strictly required to generate the voltage across the membrane.

40 **Which of the following statements is/are correct in a healthy human?**

1. During inspiration, the pressure within the chest cavity is lower than outside the body
2. During ventricular systole, the pressure in the atrium is lower than in the ventricles
3. During ventricular systole, the pressure in the aorta is lower than the pressure in the atrium

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

Correct answer: D

During normal **inspiration**, thoracic expansion reduces intrathoracic pressure below **atmospheric** levels, allowing air to flow into the lungs. During **ventricular systole**, ventricular pressure rises well above **atrial** pressure, which keeps the atrioventricular valves closed. Statement 3 is false because **aortic** pressure significantly exceeds atrial pressure, reaching approximately $120\ \mathrm{mmHg}$ during ejection instead of falling lower.

Why the other answers are wrong

- **A) 1 only**: Recognizes statement 1 but omits statement 2, failing to account for the pressure spike generated during heart contraction.
- **B) 2 and 3 only**: Groups the valid mechanism in statement 2 with the physiologically inverted claim in statement 3, rendering the pair invalid.
- **C) 2 only**: Selects only statement 2 but ignores statement 1, which correctly explains the pressure gradient that drives inhalation.
- **E) 3 only**: Depends entirely on statement 3, which incorrectly reverses the directional flow of pressure between the aorta and the atrium.

CHEMISTRY

41 **Consider the following list of particles:**
1. molecules
2. ions
3. single atoms

Which one of the following options correctly describes the particles that are present in an aqueous solution of sodium chloride?

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

Correct answer: B

An aqueous sodium chloride solution relies on water as the solvent, which persists as discrete $\mathrm{H_2O}$ **molecules**. The dissolved solute undergoes complete dissociation, yielding $\mathrm{Na^+}$ and $\mathrm{Cl^-}$ **ions**. This physical process never generates isolated **single atoms**. Consequently, the mixture contains exactly those two particle types.

Why the other answers are wrong

- **A) 1 only**: Overlooks the solute contribution, failing to recognize the $\mathrm{Na^+}$ and $\mathrm{Cl^-}$ ions released when the solid dissolves.
- **C) 3 only**: Proposes a particle type that does not form during dissolution, since the system only produces molecular solvent and dissociated electrolytes.
- **D) 2 only**: Omits the solvent $\mathrm{H_2O}$ molecules, which are indispensable components of every aqueous system.
- **E) 1, 2 and 3**: Correctly accounts for molecules and ions but falsely introduces single atoms, which remain entirely absent from the solution.

42 **Element X is a grey solid.**

It combines with chlorine to form a polar molecule with the formula XCl. In this compound, element X has an oxidation state of +1.

In potassium iodide solution, it dissolves to form a coloured solution. At 500°C, it becomes a coloured vapour.

What is the identity of element X?

A lithium
B carbon
C manganese
D **iodine**
E fluorine

Correct answer: D

Iodine matches every experimental clue. It appears as a **grey solid** at room temperature and reacts with chlorine to form ICl, where iodine exhibits a $+1$ **oxidation state** and the bond is polar due to chlorine's higher electronegativity. In potassium iodide solution, it converts to soluble polyiodide complexes that colour the liquid brown. Heating to $500\ ^{\circ}\mathrm{C}$ causes it to sublime directly into a violet **coloured vapour**.

Why the other answers are wrong

- **A) lithium**: Lithium is a silvery metal rather than a grey solid. It forms LiCl, which is an extended ionic lattice instead of a discrete polar molecule. Its chloride does not produce any colour change when added to potassium iodide solution. Lithium also lacks a coloured vapour at $500\ ^{\circ}\mathrm{C}$ since its normal boiling point reaches $1342\ ^{\circ}\mathrm{C}$.
- **B) carbon**: Carbon appears as a black allotrope, not a grey solid. Common molecular chlorides like $\mathrm{CCl_4}$ place carbon in a $+4$ oxidation state and possess zero net dipole moment. No simple monovalent carbon chloride exists under standard conditions. Carbon does not interact with potassium iodide to create coloured dissolved species, and its direct transition to gas requires temperatures far exceeding $500\ ^{\circ}\mathrm{C}$.
- **C) manganese**: Manganese is a grey metal, but stable chlorides only exist in $+2$ or $+3$ oxidation states such as $\mathrm{MnCl_2}$ and $\mathrm{MnCl_3}$. A monovalent chloride would be highly unstable and does not match the given formula. Aqueous solutions of manganese chlorides are extremely pale pink and show no characteristic reaction with iodide ions. The bulk metal does not generate a coloured gaseous phase near $500\ ^{\circ}\mathrm{C}$.
- **E) fluorine**: Fluorine is a pale yellow gas at ambient conditions, which directly contradicts the solid description. Although a FCl species could theoretically exist, fluorine would carry a -1 oxidation state because it is more electronegative than chlorine. Elemental fluorine reacts violently with aqueous media and iodide salts rather than simply dissolving to form a stable coloured solution.

43 **Which option correctly describes the following features of a silane (silicon tetrahydride) molecule?**

- number of bonding pairs (bp) of electrons
- number of lone/non-bonding pairs (lp) in the valence shell of the silicon atom
- bond angle

[Atomic number: Si = 14; H = 1]

A 3 bp; 1 lp; 109.5°
B **4 bp; 0 lp; 109.5°**
C 3 bp; 1 lp; 107°
D 4 bp; 0 lp; 90°
E 4 bp; 2 lp; 90°

Correct answer: B

1. Silicon ($\mathrm{Z} = 14$) provides four **valence electrons** in the $3s^2 3p^2$ configuration. 2. Four hydrogen atoms each donate one electron, yielding eight electrons around the central atom. 3. These electrons distribute into **four bonding pairs** and zero **lone pairs**. 4. A steric number of 4 with no lone pairs establishes a **tetrahedral geometry** with ideal bond angles of 109.5°.

Why the other answers are wrong

- **A) 3 bp; 1 lp; 109.5°**: Counts 3 bonding pairs and 1 lone pair, which contradicts silicon's ability to share all four valence electrons with hydrogen. This configuration actually belongs to $\mathrm{NH_3}$.
- **C) 3 bp; 1 lp; 107°**: Retains the incorrect 3 bp / 1 lp count and assigns 107°, a compressed angle resulting from lone-pair repulsion in $\mathrm{NH_3}$. Silane contains no lone pairs and preserves ideal symmetry.
- **D) 4 bp; 0 lp; 90°**: Correctly notes 4 bp and 0 lp but lists 90°. A square-planar arrangement produces 90° angles, whereas $\mathrm{SiH_4}$ adopts tetrahedral spacing with 109.5° angles.
- **E) 4 bp; 2 lp; 90°**: Proposes 4 bonding pairs and 2 lone pairs, implying six electron domains that require twelve valence electrons. Silicon in $\mathrm{SiH_4}$ possesses only eight valence electrons and cannot accommodate lone pairs.

44 **Which one of the following options gives the correct electron structure of the particle: $^{16}_{8}\mathrm{O}^{2-}$?**

A $1s^2 2s^2 2p^4$

B $1s^2 2s^2 2p^2$

C $1s^2 2s^2 2p^6 3s^2 3p^4$

D $1s^2 2s^2 2p^6$

E $1s^2 2s^2 2p^6 3s^2 3p^6$

Correct answer: D

Oxygen has atomic number 8, so a neutral atom has 8 electrons; the $2-$ charge adds 2, giving **10 electrons**. Filling the orbitals in order, $1s$, $2s$, then $2p$, gives $1s^2\ 2s^2\ 2p^6$, which matches E.

Why the other answers are wrong

- **A)** $1s^2 2s^2 2p^4$: $1s^2\ 2s^2\ 2p^4$ has $2+2+4=8$ electrons. It is the configuration of **neutral oxygen**, so it is missing the two electrons gained by the ion.
- **B)** $1s^2 2s^2 2p^2$: $1s^2\ 2s^2\ 2p^2$ has $2+2+2=6$ electrons. This could represent O^{4+}, which has lost four electrons, or neutral carbon, but not O^{2-}.
- **C)** $1s^2 2s^2 2p^6 3s^2 3p^4$: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$ has $2+2+6+2+4=16$ electrons. This is the configuration of **neutral sulfur** ($Z=16$), so it has too many electrons for the oxide ion.
- **E)** $1s^2 2s^2 2p^6 3s^2 3p^6$: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ has $2+2+6+2+6=18$ electrons. This is the configuration of **neutral argon** ($Z=18$), so it also has too many electrons.

45 **The solubility of potassium nitrate in water increases with temperature.**

A saturated solution of potassium nitrate at 80°C is cooled to 25°C in a closed container.

Which of the following statements is/are correct?

1. The mass of undissolved potassium nitrate will increase.
2. The concentration of the potassium nitrate solution remains the same.
3. The total mass of solvent present remains the same.

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

Correct answer: C

Lowering the temperature reduces the **solubility** of potassium nitrate. The solution becomes temporarily supersaturated, so excess salt **precipitates** until equilibrium is restored at 25 °C. This crystallization directly increases the undissolved solid mass (**Statement 1** is correct). The closed container prevents water evaporation or addition, keeping the **solvent mass** completely constant (**Statement 3** is correct). Because precipitation removes dissolved ions from the liquid phase, the saturated concentration drops, making **Statement 2** incorrect. Only statements 1 and 3 hold true.

Why the other answers are wrong

- **A) 1, 2 and 3**: Incorrect because it incorporates **Statement 2**, which directly conflicts with the established decrease in solubility at lower temperatures.
- **B) 2 and 3 only**: Invalid since it groups **Statement 3** with the erroneous **Statement 2**, producing a contradictory combination.
- **D) 2 only**: False because it relies on **Statement 2**, which incorrectly asserts that concentration remains unchanged while temperature reduction forces solute out of solution.
- **E) 1 only**: Incomplete because it discards **Statement 3**, which correctly accounts for the sealed system preserving the exact water mass.

46 **Which one of the following statements correctly describes the type of mixture and the most appropriate method used to separate the specified component from the mixture?**

A salt from salt solution – homogeneous; paper filtration

B red blood cells from blood – homogeneous; centrifuge

C **chlorophyll from a solution of different plant pigments – homogeneous; chromatography**

D water from salt solution – heterogeneous; simple distillation

E gasoline/petrol from crude oil – heterogeneous; simple distillation

Correct answer: C

A solution of plant pigments in a solvent forms a **homogeneous mixture** because all components are uniformly dispersed. **Chromatography** separates these dissolved substances based on their differing affinity for a stationary phase versus a mobile phase. Each pigment migrates at a distinct rate, allowing the target compound to be isolated as a separate band. This combination accurately matches both the mixture type and the appropriate separation technique.

Why the other answers are wrong

- **A) salt from salt solution – homogeneous; paper filtration**: While a salt solution is indeed homogeneous, complete dissolution means no solid particles remain to be retained by filter paper. Paper filtration cannot isolate dissolved ions from water, making the method ineffective for this scenario. Proper alternatives include evaporation or distillation.
- **B) red blood cells from blood – homogeneous; centrifuge**: Whole blood is a heterogeneous mixture since cells remain physically suspended in plasma instead of dissolving. Although centrifugation is the correct separation technique, the statement incorrectly labels the mixture as homogeneous. This mismatch renders the entire option invalid.
- **D) water from salt solution – heterogeneous; simple distillation**: A salt solution is classified as homogeneous, contradicting the claim that it is heterogeneous. Simple distillation effectively captures pure water through vaporization and condensation, but the misidentified mixture type makes the statement factually incorrect.
- **E) gasoline/petrol from crude oil – heterogeneous; simple distillation**: Crude oil is a uniform liquid mixture of hydrocarbons, not a heterogeneous system. The components possess overlapping boiling point ranges, which requires **fractional distillation** using a fractionating column rather than simple distillation. Both the mixture classification and the proposed method are incorrect.

47 **In which one of the following reactions is the first species acting as an oxidising agent?**

A $\underline{3CO} + Fe_2O_3 \rightarrow 3CO_2 + 2Fe$

B $\underline{Zn} + CuSO_4 \rightarrow ZnSO_4 + Cu$

C $2Mg + O_2 \rightarrow 2MgO$

D $Cl_2 + 2KBr \rightarrow 2KCl + Br_2$

E $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

Correct answer: D

An **oxidising agent** gains electrons and is **reduced** during the reaction. Chlorine starts at oxidation state 0 and drops to -1 in KCl, confirming it drives the oxidation of bromide ions.

Why the other answers are wrong

- **A)** $\underline{3CO} + Fe_2O_3 \rightarrow 3CO_2 + 2Fe$: Carbon in CO rises from $+2$ to $+4$ in CO_2, so it is oxidised and serves as a reductant instead of an oxidising agent.
- **B)** $\underline{Zn} + CuSO_4 \rightarrow ZnSO_4 + Cu$: Zn increases from 0 to $+2$ and becomes oxidised, which means it acts as a **reducing agent** rather than an oxidising agent.
- **C)** $2Mg + O_2 \rightarrow 2MgO$: Mg shifts from 0 to $+2$ during oxidation, functioning as a reducing agent and not an oxidising agent.
- **E)** $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$: This is an acid–base **neutralisation** reaction with no change in oxidation states, so the first species cannot function as an oxidising agent.

48 **In an experiment involving the reaction shown below, $150\ \mathrm{cm}^3$ of F_2 reacts with $100\ \mathrm{cm}^3$ of Cl_2**

$$3\ \mathrm{F}_2(\mathrm{g}) + \mathrm{Cl}_2(\mathrm{g}) \rightarrow 2\mathrm{ClF}_3(\mathrm{g})$$

On completion of the reaction, what is the final gaseous volume at the same temperature and pressure?

A $100\,\mathrm{cm}^3$
B $200\,\mathrm{cm}^3$
C $350\,\mathrm{cm}^3$
D $250\,\mathrm{cm}^3$
E **$150\,\mathrm{cm}^3$**

Correct answer: E

1. At constant temperature and pressure, gas volume follows Avogadro's law, so stoichiometric coefficients define the **volume ratios** ($3\ \mathrm{F}_2 + 1\ \mathrm{Cl}_2 \rightarrow 2\ \mathrm{ClF}_3$). 2. The equation requires three times more fluorine than chlorine. Since $150\ \mathrm{cm}^3$ of F_2 cannot cover $300\ \mathrm{cm}^3$ needed for all chlorine, F_2 acts as the **limiting reagent** and is fully **consumed**. 3. This consumes exactly $50\ \mathrm{cm}^3$ of Cl_2, leaving $50\ \mathrm{cm}^3$ **unreacted**. 4. The reaction produces $150 \times (2/3) = 100\ \mathrm{cm}^3$ of ClF_3. 5. Adding the product and leftover gas yields $100 + 50 = 150\ \mathrm{cm}^3$ total.

Why the other answers are wrong

- **A) 100** cm^3: Incorrectly assumes chlorine is the limiting reagent and reports only the product volume while neglecting the excess chlorine that remains.
- **B) 200** cm^3: Counts the full initial $100\ \mathrm{cm}^3$ of chlorine alongside the product, failing to subtract the portion that was chemically transformed.
- **C) 350** cm^3: Adds the initial reactant volumes directly to the calculated product volume, effectively double counting the gases and ignoring mass conservation.
- **D) 250** cm^3: Simply sums the two starting volumes, which implies no reaction occurred and all original gases persist unchanged.

49 **Which one of the following molecules is a structural isomer of methylcyclopentane?**

A 2-methylpentane

B **hex-2-ene**

C cyclohexene

D hexane

E 2,2-dimethylbutane

Correct answer: B

1. Determine the **molecular formula** of methylcyclopentane by adding a methyl group to cyclopentane (C_5H_{10}), yielding C_6H_{12}. 2. A **structural isomer** requires the identical formula paired with a completely different **atomic connectivity**. 3. Hex-2-ene belongs to the acyclic alkene family, which follows the general pattern C_nH_{2n} to produce C_6H_{12}. 4. This exact match combined with an open chain containing a double bond confirms the relationship.

Why the other answers are wrong

- **A) 2-methylpentane**: 2-Methylpentane represents a fully saturated branched chain, accumulating an extra pair of hydrogens and landing on C_6H_{14}.
- **C) cyclohexene**: Cyclohexene features both a ring and a pi bond, stripping away two hydrogens to reach C_6H_{10} and violating the required formula.
- **D) hexane**: Hexane maintains a straight saturated backbone, which similarly generates C_6H_{14} due to the complete absence of unsaturation elements.
- **E) 2,2-dimethylbutane**: 2,2-Dimethylbutane operates as another saturated alkane variant, sharing the C_6H_{14} composition and failing to provide the necessary **degree of unsaturation**.

50 **Which one of the following statements about the four atoms/ions below is correct?**

$^{23}_{11}\mathrm{Na}^{+}$ $^{16}_{8}\mathrm{O}^{2-}$ $^{18}_{8}\mathrm{O}$ $^{32}_{16}\mathrm{S}$

A Out of the four atoms/ions, only $^{23}_{11}\mathrm{Na}^{+}$ has two more electrons than $^{18}_{8}\mathrm{O}$

B $^{32}_{16}S$ has twice the number of neutrons that $^{18}_{8}\mathrm{O}$ has but only four more than $^{23}_{11}\mathrm{Na}^{+}$

C Both $^{16}_{8}\mathrm{O}^{2-}$ and $^{32}_{16}S$ each have an equal number of protons, neutrons and electrons

D $^{16}_{8}\mathrm{O}^{2-}$ and $^{18}_{8}\mathrm{O}$ have exactly the same number of protons and electrons but not neutrons

E **$^{16}_{8}\mathrm{O}^{2-}$ has the same number of electrons but four fewer neutrons than $^{23}_{11}\mathrm{Na}^{+}$**

Correct answer: E

Calculate subatomic particles using atomic number for protons, mass number minus atomic number for neutrons, and charge adjustment for electrons. Na^{+} contains 11 protons, 12 neutrons, and 10 electrons. O^{2-} contains 8 protons, 8 neutrons, and 10 electrons. Both ions share the same electron count, while O^{2-} possesses exactly four fewer neutrons than Na^{+}.

Why the other answers are wrong

- **A) Out of the four atoms/ions, only $^{23}_{11}\mathrm{Na}^{+}$ has two more electrons than $^{18}_{8}\mathrm{O}$**: Sodium ion does have two more electrons than $^{18}_{8}\mathrm{O}$, but the word exclusive makes this false because O^{2-} also contains 10 electrons.
- **B) $^{32}_{16}S$ has twice the number of neutrons that $^{18}_{8}\mathrm{O}$ has but only four more than $^{23}_{11}\mathrm{Na}^{+}$**: Sulphur has 16 neutrons compared to 10 in $^{18}_{8}\mathrm{O}$. Twice the oxygen count would be 20, so the first claim fails even though the difference with sodium is numerically correct.
- **C) Both $^{16}_{8}\mathrm{O}^{2-}$ and $^{32}_{16}S$ each have an equal number of protons, neutrons and electrons**: Sulphur ($^{32}_{16}\mathrm{S}$) has equal numbers of protons, neutrons, and electrons. The oxide ion does not match this pattern because it gains two electrons to reach 10, breaking the equality.
- **D) $^{16}_{8}\mathrm{O}^{2-}$ and $^{18}_{8}\mathrm{O}$ have exactly the same number of protons and electrons but not neutrons**: Both oxygen species contain 8 protons, but their electron counts differ due to the ionic charge. O^{2-} holds 10 electrons while neutral $^{18}_{8}\mathrm{O}$ retains only 8 electrons.

51 **Which one of the following samples of gases contains the most particles?**

All gases are at 0°C and 1 atm pressure, when 1 mole of gas has a volume of 22.4 L. [Relative atomic mass, A : H = 1, He = 4, C = 12, O = 16, Cl = 35.5]

- **A** **10.0 g of helium gas**
- **B** 22.4 L of hydrogen gas
- **C** 66.0 g of carbon dioxide gas
- **D** 64.0 g of oxygen gas
- **E** 33.6 L of chlorine gas

Correct answer: A

At standard temperature and pressure ($0\ ^\circ\mathrm{C}, 1\ \mathrm{atm}$), equal volumes of gases contain equal amounts in **moles**. Because one mole holds a fixed number of **particles**, converting each mass via **molar mass** and each volume via the $22.4\ \mathrm{L\,mol^{-1}}$ constant reveals the largest group. These calculations show that helium provides $2.5\ \mathrm{mol}$, exceeding all other options.

Why the other answers are wrong

- **B) 22.4 L of hydrogen gas**: $22.4\ \mathrm{L}$ of hydrogen gas corresponds to exactly $1.0\ \mathrm{mol}$, making it the sample with the lowest particle count.
- **C) 66.0 g of carbon dioxide gas**: $66.0\ \mathrm{g}$ of carbon dioxide divided by its molar mass of $44\ \mathrm{g\,mol^{-1}}$ yields $1.5\ \mathrm{mol}$, containing fewer particles than helium.
- **D) 64.0 g of oxygen gas**: $64.0\ \mathrm{g}$ of oxygen gas divided by $32\ \mathrm{g\,mol^{-1}}$ gives $2.0\ \mathrm{mol}$, which surpasses carbon dioxide but remains lower than helium.
- **E) 33.6 L of chlorine gas**: $33.6\ \mathrm{L}$ of chlorine gas divided by $22.4\ \mathrm{L\,mol^{-1}}$ results in $1.5\ \mathrm{mol}$, matching carbon dioxide but falling short of helium.

52 **A solution of hydrochloric acid has a concentration of 1.0 mol/L. If 10 mL of this acid is added to water and made up to a total volume of 1.0 L, what is the pH of the resulting solution?**

- **A** **2**
- **B** 0
- **C** 9
- **D** 6
- **E** 5

Correct answer: A

1. Calculate the **initial moles**: $n = 1.0\ \text{mol}\,\text{L}^{-1} \times 0.010\ \text{L} = 0.010\ \text{mol}$. 2. Determine the **final concentration** after diluting to $1.0\ \text{L}$: $c = 0.010\ \text{mol}/1.0\ \text{L} = 1.0 \times 10^{-2}\ \text{M}$. 3. Compute the **pH** assuming complete dissociation yields $[H^+] = 1.0 \times 10^{-2}\ \text{M}$: $\text{pH} = -\log(1.0 \times 10^{-2}) = 2.00$.

Why the other answers are wrong

- **B) 0**: pH 0 corresponds to a concentration of $1\ \text{M}$, which applies to the original undiluted acid rather than the diluted mixture.
- **C) 9**: A basic pH of 9 cannot result from adding an acid to water, since dilution only decreases acidity without changing the solution type.
- **D) 6**: pH 6 indicates a concentration of $1 \times 10^{-6}\ \text{M}$, which assumes a million-fold dilution and overlooks the correct volume ratio.
- **E) 5**: pH 5 implies a hydrogen ion concentration of $1 \times 10^{-5}\ \text{M}$, requiring a 10^5-fold dilution instead of the actual factor of one hundred.

53 **What is the gradient of the straight line passing through the points with coordinates (2, –3) and (–1, 6)?**

A $-\frac{1}{3}$

B **-3**

C -9

D -1

E $-\frac{1}{9}$

Correct answer: B

The **gradient** is found using the **slope formula** $m = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$. With points $(2, -3)$ and $(-1, 6)$, the **vertical change** is $\Delta y = 6 - (-3) = 9$ and the **horizontal difference** is $\Delta x = -1 - 2 = -3$. Dividing these values gives $m = \frac{9}{-3} = -3$.

Why the other answers are wrong

- **A)** $-\frac{1}{3}$: This is the most frequent mistake, caused by swapping the numerator and denominator. Evaluating $\frac{\Delta x}{\Delta y}$ instead gives $\frac{-3}{9} = -\frac{1}{3}$, which is the **negative reciprocal** of the true gradient.
- **C) -9**: This results from using the correct vertical change of 9 but treating the horizontal difference as -1 instead of -3, likely due to misreading the coordinates. Dividing 9 by -1 gives -9.
- **D) -1**: You would get -1 if you mistakenly divided the correct gradient by 3, or if mismatched differences coincidentally yielded a ratio of -1.
- **E)** $-\frac{1}{9}$: This error arises from inverting the slope expression to $\frac{\Delta x}{\Delta y}$ and combining it with a sign error or arithmetic slip that alters the intermediate result $-\frac{1}{3}$ into $-\frac{1}{9}$.

54 **Given that**

$\log_{10} 7 = x$
$\log_{10} 2 = y$
$\log_{10} 3 = z$

What is log $\log_{10}\left(\frac{14}{3}\right)$ expressed in terms of x, y, and z?

A $x + y - z$
B $\frac{x+y}{z}$
C $xy + z$
D $\frac{xy}{z}$
E $xy - z$

Correct answer: A

Factor the argument into **prime factors**: $\frac{14}{3} = \frac{2 \cdot 7}{3}$. Apply **logarithm rules** to split the quotient: $\log_{10}(2 \cdot 7/3) = \log_{10} 2 + \log_{10} 7 - \log_{10} 3$. **Substitute** the given variables y, x, and z to get $y + x - z$. This result matches option A directly.

Why the other answers are wrong

- **B)** $\frac{x+y}{z}$: Dividing by z lacks algebraic justification because the third term requires subtraction of $\log_{10} 3$, not division.
- **C)** $xy + z$: Again multiplies x and y instead of adding them, and incorrectly adds z instead of subtracting it.
- **D)** $\frac{xy}{z}$: Combines both errors above by using the product xy and an unjustified division by z.
- **E)** $xy - z$: Multiplying x and y incorrectly applies exponent addition to logarithms since logarithms combine via addition when multiplying arguments.

55 **Which one of the following is an expression for the mean of $\frac{x}{3}$, x, and x+6?**

- **A** $\frac{7x+18}{9}$
- **B** $7x + 2$
- **C** $7x + 18$
- **D** $\frac{7x+6}{3}$
- **E** $\frac{7x+6}{9}$

Correct answer: A

To find the **mean** of three expressions, compute their **sum** and **divide** that total by 3. Combining $\frac{x}{3}$, x, and $x + 6$ gives $\frac{7x}{3} + 6$. Splitting this result yields $\frac{7x}{9} + 2$, which simplifies to $\frac{7x+18}{9}$.

Why the other answers are wrong

- **B)** $7x + 2$: The initial addition produced the correct intermediate sum, but the final division step was skipped, leaving the value three times larger than required.
- **C)** $7x + 18$: This option presents the raw total of the three numbers without performing any division.
- **D)** $\frac{7x+6}{3}$: The variable terms share the proper common denominator, yet the **constant** 6 was not scaled up before the division, so only part of the numerator reflects the operation.
- **E)** $\frac{7x+6}{9}$: The variable part is correctly divided by 9, but the numerator still shows 6 instead of 18 because the constant was not multiplied by the divisor.

56 **How many ways are there to order the letters 'AABBC'?**
(For example, 'ACABB' and 'AABBC' are two ways.)

- **A** **30**
- **B** 116
- **C** 5
- **D** 60
- **E** 120

Correct answer: A

The word contains five letters with two duplicate pairs. If all characters were distinct, there would be $5! = 120$ possible arrangements. Because the identical letters are indistinguishable, we divide by their factorial repeats. The calculation follows $5!/(2! \cdot 2!) = 120/4 = 30$.

Why the other answers are wrong

- **B) 116**: This figure lacks any combinatorial basis for this problem. It stems from an arithmetic slip after partial formula application.
- **C) 5**: This equals the count of unique characters rather than valid sequences. It ignores that every letter must fill each slot.
- **D) 60**: This computes $5!/2! = 60$ by correcting only one duplicate set. It neglects the second repeated pair, yielding double the true total.
- **E) 120**: This represents $5!$, treating all characters as distinct. It omits corrections for both duplicate sets, overcounting each arrangement fourfold.

57 **A car starts at point X. It travels 3.0 km due east, then 4.0 km due south, then 6.0 km due west and finally 8.0 km due north.**

How far away is the car from point X when it has reached the end of this journey?

[Assume that all distances moved are on a flat horizontal surface, and that point X is on the equator. You may ignore any curvature of the Earth.]

A 10.0 km

B **5.0 km**

C 21.0 km

D 7.0 km

E 2.0 km

Correct answer: B

Decompose the motion into orthogonal **components**. The horizontal shift is $+3\ \text{km} - 6\ \text{km} = -3\ \text{km}$ toward the west. The vertical shift is $-4\ \text{km} + 8\ \text{km} = +4\ \text{km}$ toward the north. Calculate the final separation using the **Pythagorean theorem**: $d = \sqrt{(-3\ \text{km})^2 + (4\ \text{km})^2} = 5\ \text{km}$.

Why the other answers are wrong

- **A) 10.0 km**: Likely results from adding the net westward $(3\ \text{km})$ and northward $(4\ \text{km})$ motions arithmetically $(3 + 4 = 7)$ and making an additional calculation error, or from doubling the correct 3-4-5 triangle result. It applies scalar addition to orthogonal vectors.
- **C) 21.0 km**: Corresponds to the **total distance** actually driven $(3 + 4 + 6 + 8 = 21\ \text{km})$. This sums every segment of the route, measuring path length rather than the **straight-line distance** from the starting point.
- **D) 7.0 km**: Derived from simply adding the first two legs $(3\ \text{km} + 4\ \text{km})$ and ignoring that the subsequent movements cancel much of the initial travel. This ignores the vector nature of the full journey.
- **E) 2.0 km**: Obtained by improperly subtracting the two net components $(4\ \text{km} - 3\ \text{km})$ instead of combining them with the Pythagorean theorem. Displacement requires geometric combination, not simple subtraction.

59 **A fixed mass of an ideal gas undergoes a change in which it is supplied with 3500 J of thermal energy. At the same time this gas does 3500 J of work on its surroundings.**

Which type of change does the gas undergo during this time?

A isobaric
B isomeric
C **isothermal**
D isochoric
E adiabatic

Correct answer: C

Apply the first law of thermodynamics to a fixed mass of ideal gas: $\Delta U = Q - W$. Heat supplied is $Q = +3500\ \text{J}$ and work done by the gas is $W = +3500\ \text{J}$, yielding $\Delta U = 0$. For an ideal gas, **internal energy** depends solely on **temperature**, so a zero change means the system remains at constant temperature. This matches an **isothermal** transformation.

Why the other answers are wrong

- **A) isobaric**: Constant pressure would cause temperature and internal energy variations when volume changes. Since $\Delta U = 0$ while work is performed, pressure cannot remain fixed.
- **B) isomeric**: Isomeric refers to chemical compounds with identical molecular formulas but different atomic arrangements. It has no application in thermodynamics.
- **D) isochoric**: Volume stays fixed in an isochoric process, making it impossible to perform mechanical work ($W = 0$). The explicit $3500\ \text{J}$ of work proves volume changed.
- **E) adiabatic**: Adiabatic conditions require complete isolation from heat transfer ($Q = 0$). The input of $3500\ \text{J}$ of thermal energy directly contradicts this definition.

60 **A resistor has a resistance of 5.0Ω.**
There is a direct current of 10 A in the resistor.

What is the power dissipated by the resistor?

A 250 W
B 50 W
C 20 W
D 2500 W
E **500 W**

Correct answer: E

The electrical **power** dissipated in a resistor depends on the **current** and **resistance**. Using the formula $P = I^2R$ with $I = 10\ \text{A}$ and $R = 5.0\ \Omega$ gives $P = (10\ \text{A})^2 \times 5.0\ \Omega = 500\ \text{W}$. An alternative approach calculates the voltage first via $V = IR = 50\ \text{V}$ and then applies $P = VI$. Both methods confirm 500 W.

Why the other answers are wrong

- **A)** 250 W appears if you square the resistance instead of the current, evaluating $P = IR^2 = 10 \times 25 = 250\ \text{W}$. The power formula requires the current to be squared.
- **B)** 50 W results from incorrectly using $P = IR$ instead of I^2R. Multiplying current by resistance produces voltage units, not power.
- **C)** 20 W comes from mixing unrelated values or arbitrarily dividing the correct result. It does not stem from any valid application of electrical power equations.
- **D)** 2500 W occurs when using $P = V^2R$ with $V = 50\ \text{V}$. The correct relationship divides by resistance ($P = V^2/R$), which makes this option exactly five times larger than the true value.

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