

FREE SAMPLE: THE FIRST QUESTION

Question 1 (50 marks)

(a) A student has 500 cm^3 of a colourless solution that contains 2.0 g of sodium hydroxide (NaOH) dissolved in water.

- (i) Outline how the student could make the solution more dilute.
- (ii) What is a solute?
- (iii) Calculate the number of moles of NaOH in 2.0 g . (Ar: $\text{Na} = 23$, $\text{O} = 16$, $\text{H} = 1$)
- (iv) Calculate the concentration of the solution in moles per litre.

[10 marks]

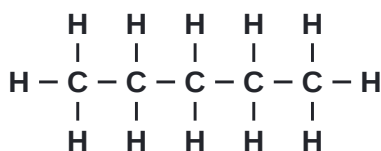
(b) The boiling point of an alkane depends on the size and shape of its molecules. The table gives the boiling points of some straight-chain alkanes. The diagrams show the structures of pentane and 2,2-dimethylpropane, which are isomers (both C_5H_{12}).

- Which alkane in the table has the highest boiling point?
- Describe the trend in boiling point as the number of carbon atoms increases.
- The boiling point of pentane is $36\text{ }^{\circ}\text{C}$ and the boiling point of 2,2-dimethylpropane is $10\text{ }^{\circ}\text{C}$. Which compound has weaker forces between its molecules? Give a reason for your answer.

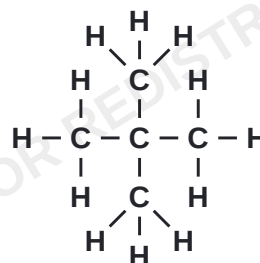
Alkane	Methane	Ethane	Propane	Butane	Pentane	Hexane
Boiling point ($^{\circ}\text{C}$)	-162	-89	-42	-1	36	69

[10 marks]

pentane



2,2-dimethylpropane



Pentane and 2,2-dimethylpropane.

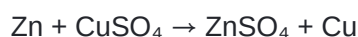
(c) Matter exists in three states: solid, liquid and gas.

- In the table, write solid, liquid or gas to name the state described.
- Gases can be compressed (squeezed into a smaller volume) but liquids cannot. Explain why.
- The ideal gas equation is $PV = nRT$. What quantity is represented by the letter n ?
- A gas is at a temperature of $27\text{ }^{\circ}\text{C}$. Convert this temperature to kelvin.

Description	Solid, liquid or gas?
particles are far apart and move quickly in all directions	
fixed volume, but takes the shape of its container	

[10 marks]

(d) A student places a piece of zinc into a beaker of blue copper(II) sulfate solution. After some time the blue colour fades and a brown solid forms on the zinc.



The table shows part of the reactivity series of metals, with the most reactive at the top.

- (i) Is zinc oxidised or reduced in this reaction? Justify your answer.
- (ii) Identify a metal in the table (other than zinc) that would react with copper(II) sulfate in a similar way.
- (iii) Identify a metal in the table that would not react with copper(II) sulfate.
- (iv) Name the brown solid that formed on the zinc.

Reactivity series (most reactive first)
magnesium (Mg)
aluminium (Al)
zinc (Zn)
iron (Fe)
copper (Cu)
silver (Ag)

[10 marks]

(e) Poly(ethene), also known as polythene, is made from many ethene molecules joined together in an addition polymerisation reaction.

(i) What is a polymer?

(ii) Name the monomer from which poly(ethene) is made.

(iii) State one everyday use of poly(ethene).

(iv) Why is it desirable to recycle plastics such as poly(ethene)?

(v) Poly(ethene) is made from a monomer with a carbon-carbon double bond. Name the family of hydrocarbons to which the monomer belongs.

[10 marks]

QUESTIONS 2 TO 7

50 marks each · in the real paper you answer any FIVE

This practice paper prints all six so you can choose your best five, or attempt more than the real paper allows.

THE WORKED ANSWER TO THAT QUESTION

Question 1 (50 marks) [Matter, solutions, reactivity and polymers]

(a) A student has 500 cm³ of a colourless solution that contains 2.0 g of sodium hydroxide (NaOH) dissolved in water. (i) Outline how the student could make the solution more dilute. (ii) What is a solute? (iii) Calculate the number of moles of NaOH in 2.0 g. (Ar: Na = 23, O = 16, H = 1) (iv) Calculate the concentration of the solution in moles per litre.

(a) Answer: (i) Add more water (solvent). (ii) The substance that dissolves in the solvent to make a solution (here NaOH). (iii) $M_r(\text{NaOH}) = 40$; moles = $2.0 \div 40 = 0.050$ mol. (iv) $500 \text{ cm}^3 = 0.500 \text{ L}$; concentration = $0.050 \div 0.500 = 0.10$ mol per litre (0.10 M).

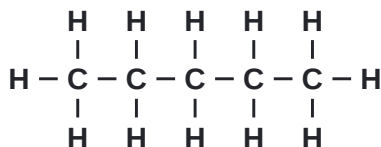
- Approach: dilute means more solvent; moles = mass $\div$ molar mass; concentration = moles $\div$ volume in litres.
- (i) Adding more water spreads the same amount of solute through a larger volume, so the solution is more dilute. 2 marks. (ii) A solute is the substance that dissolves; the water is the solvent. 2 marks.
- (iii) $M_r(\text{NaOH}) = 23 + 16 + 1 = 40$. Moles = mass $\div$ $M_r = 2.0 \div 40 = 0.050$ mol. 3 marks.
- (iv) Convert the volume: $500 \text{ cm}^3 \div 1000 = 0.500 \text{ L}$. Concentration = moles $\div$ litres = $0.050 \div 0.500 = 0.10$ mol per litre. 3 marks.

KEY TAKEAWAY

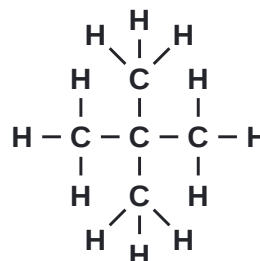
Moles = mass $\div$ molar mass, and concentration (mol per litre) = moles $\div$ volume in litres, so always convert cm³ to litres first.

(b) The boiling point of an alkane depends on the size and shape of its molecules. The table gives the boiling points of some straight-chain alkanes. The diagrams show the structures of pentane and 2,2-dimethylpropane, which are isomers (both C₅H₁₂). (i) Which alkane in the table has the highest boiling point? (ii) Describe the trend in boiling point as the number of carbon atoms increases. (iii) The boiling point of pentane is 36 °C and the boiling point of 2,2-dimethylpropane is 10 °C. Which compound has weaker forces between its molecules? Give a reason for your answer.

pentane



2,2-dimethylpropane



Pentane and 2,2-dimethylpropane.

(b) Answer: (i) Hexane (69 °C). (ii) The boiling point increases as the number of carbon atoms (the chain length) increases. (iii) 2,2-dimethylpropane has the lower boiling point, so its forces are weaker: its molecules are more compact and branched, so they have less surface contact with each other.

- Approach: read the table, describe the pattern, then link boiling point to the strength of the forces between molecules.
- (i) The boiling points are methane -162 , ethane -89 , propane -42 , butane -1 , pentane 36 and hexane 69 °C. The highest is hexane. 2 marks.
- (ii) Each extra carbon atom raises the boiling point, so longer chains boil at higher temperatures: the bigger the molecule, the stronger the forces between molecules. 3 marks.
- (iii) A lower boiling point means weaker forces between molecules. Pentane is a long straight chain that touches its neighbours along its whole length, while the compact branched 2,2-dimethylpropane touches them less, so it has weaker forces and boils at 10 °C. 5 marks.

KEY TAKEAWAY

For isomers, the more branched molecule has less surface contact, weaker forces between molecules and a lower boiling point.

(c) Matter exists in three states: solid, liquid and gas. (i) In the table, write solid, liquid or gas to name the state described. (ii) Gases can be compressed (squeezed into a smaller volume) but liquids cannot. Explain why. (iii) The ideal gas equation is $PV = nRT$. What quantity is represented by the letter n ? (iv) A gas is at a temperature of 27 °C. Convert this temperature to kelvin.

(c) Answer: (i) Particles are far apart and move at random in all directions: gas. Particles are close together and slide past each other, so it has a fixed volume but takes the shape of its container: liquid. (ii) In a gas the particles are far apart with lots of empty space between them; in a liquid they are already touching. (iii) The amount of gas in moles (the number of moles). (iv) $27 + 273 = 300$ K.

- Approach: describe the particle arrangement for each state; use the idea of empty space for compression; know the symbols in $PV = nRT$.
- (i) Gas: far apart, moving quickly in all directions. Liquid: close together but able to slide past one another, fixed volume but no fixed shape. 4 marks.
- (ii) Gas particles are far apart, so the space between them can be squeezed out. Liquid particles are already touching, so there is almost no space to remove. 2 marks.
- (iii) In $PV = nRT$: P is pressure, V is volume, n is the number of moles of gas, R is the gas constant and T is the temperature in kelvin. 1 mark. (iv) $K = ^\circ\text{C} + 273 = 27 + 273 = 300$ K. 3 marks.

KEY TAKEAWAY

In a gas the particles are far apart, which is why gases compress; in $PV = nRT$ the temperature must always be in kelvin ($^\circ\text{C} + 273$).

(d) A student places a piece of zinc into a beaker of blue copper(II) sulfate solution. After some time the blue colour fades and a brown solid forms on the zinc. $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$ The table shows part of the reactivity series of metals, with the most reactive at the top. (i) Is zinc oxidised or reduced in this reaction? Justify your answer. (ii) Identify a metal in the table (other than zinc) that would react with copper(II) sulfate in a similar way. (iii) Identify a metal in the table that would not react with copper(II) sulfate. (iv) Name the brown solid that formed on the zinc.

(d) Answer: (i) Oxidised: zinc atoms lose electrons to become Zn^{2+} ions. (ii) Magnesium, aluminium or iron (any metal above copper). (iii) Silver (or gold). (iv) Copper.

- Approach: oxidation is loss of electrons; a metal displaces another only if it is higher in the series.
- (i) $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$. The zinc atoms lose electrons, so zinc is oxidised. 4 marks.
- (ii) Metals above copper in the series are more reactive and displace it: magnesium, aluminium or

iron all work. 2 marks. (iii) Silver is below copper, so it cannot displace copper from its salt. 2 marks.

- (iv) The copper(II) ions gain electrons and form copper metal, a brown solid. 2 marks.

KEY TAKEAWAY

A more reactive metal displaces a less reactive one from solution; the metal that displaces is oxidised because it loses electrons.

(e) Poly(ethene), also known as polythene, is made from many ethene molecules joined together in an addition polymerisation reaction. (i) What is a polymer? (ii) Name the monomer from which poly(ethene) is made. (iii) State one everyday use of poly(ethene). (iv) Why is it desirable to recycle plastics such as poly(ethene)? (v) Poly(ethene) is made from a monomer with a carbon-carbon double bond. Name the family of hydrocarbons to which the monomer belongs.

(e) Answer: (i) A very large molecule made by joining many small molecules (monomers) together. (ii) Ethene. (iii) Plastic bags, bottles, food wrap, pipes (any one). (iv) It saves raw materials (crude oil), reduces waste in landfill and pollution, and saves energy. (v) Alkenes.

- Approach: a polymer is built from repeating monomer units; the monomer for poly(ethene) has a C=C double bond.
- (i) A polymer is a long chain molecule made of many repeating units; the small molecules joined together are monomers. 2 marks. (ii) The monomer is ethene, $\text{CH}_2=\text{CH}_2$. 2 marks.
- (iii) Any one: plastic bags, food wrap, bottles, pipes, toys. 2 marks.
- (iv) Recycling saves crude oil (the raw material), reduces litter and landfill, and uses less energy than making new plastic. 2 marks. (v) Ethene has a C=C double bond, so it is an alkene (an unsaturated hydrocarbon). 2 marks.

KEY TAKEAWAY

Polymers are built from monomers with a C=C double bond by addition polymerisation, and recycling them saves raw materials and reduces waste.

LOS: Matter, solutions, reactivity and polymers (Leaving Certificate Chemistry, Ordinary Level written paper, Strands 1 to 4)

QUESTIONS 2 TO 7

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