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DUNMAN HIGH SCHOOL Preliminary Examination Year 6

H2 CHEMISTRY

Paper 1 Multiple Choice

9729/01

25 September 2023

1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your centre number, index number, name and class at the top of this page.

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the one you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **25** printed pages and **1** blank page.

1 Use of the Data Booklet is relevant to this question.

Sulfur and X are adjacent elements in Group 16 of the Periodic Table. X and Y are adjacent elements in the same period of the Periodic Table.

The table shows the atomic radius of these elements.

element	sulfur	X	Y
atomic radius / nm	0.088	0.103	0.114

What is the proton number of Y?

- | | | | |
|----------|----|----------|----|
| A | 7 | B | 9 |
| C | 33 | D | 35 |

2 *Use of the Data Booklet is relevant to this question.*

What is the order of increasing **seventh** ionisation energy for the elements shown?

Se Br Kr

- A** $\text{Br} < \text{Kr} < \text{Se}$
B $\text{Kr} < \text{Se} < \text{Br}$
C $\text{Kr} < \text{Br} < \text{Se}$
D $\text{Se} < \text{Kr} < \text{Br}$

3 Hexane is immiscible with water.

Which statements help to explain this observation?

- 1 There are stronger instantaneous dipole-induced dipole interactions in hexane than in water.
- 2 Hexane molecule is non-polar while water molecule has an overall dipole moment.
- 3 The O–H bonds in water molecules are stronger than the C–H bonds in hexane molecules.
- 4 The interactions formed between hexane and water molecules are weaker than the hydrogen bonds in water.

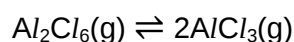
- A** 1, 2 and 4 only
B 2 and 4 only
C 1 and 2 only
D 1 and 3 only

4 Which row correctly describes the structure and bonding present in the solid lattice of the

given substance?

	substance	structure	bonding
A	ice	giant molecular	covalent and hydrogen bonding
B	iodine	simple molecular	covalent bonding and permanent dipoles
C	sodium sulfate	giant ionic	ionic and covalent bonding
D	copper	giant metallic	ionic bonding

- 5** The following equilibrium exists in a sample of aluminium chloride vapour.



When 1.50 g of aluminium chloride was introduced into an evacuated flask of 250 cm³ capacity and heated to 227 °C, the pressure inside the flask rose to 1.16×10^5 Pa.

Which row correctly describes the equilibrium gas mixture?

	average M_r	$\frac{\text{amount of Al}_2\text{Cl}_6(\text{g})}{\text{amount of AlCl}_3(\text{g})}$
A	97.6	< 1
B	97.6	> 1
C	214.9	< 1
D	214.9	> 1

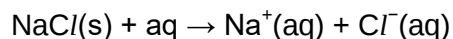
- 6** Which statements are correct?

- 1 $\Delta H^\ominus_{\text{formation}}(\text{H}_2\text{O}(\text{l})) = \Delta H^\ominus_{\text{combustion}}(\text{H}_2(\text{g}))$
- 2 $\Delta H^\ominus_{\text{formation}}(\text{H}_2\text{O}(\text{l})) = \text{BE}(\text{H}-\text{H}) + \frac{1}{2}\text{BE}(\text{O}=\text{O}) - 2\text{BE}(\text{O}-\text{H})$
- 3 $\Delta H^\ominus_{\text{formation}}(\text{H}_2\text{O}(\text{g})) = \Delta H^\ominus_{\text{formation}}(\text{H}_2\text{O}(\text{l})) - \Delta H^\ominus_{\text{vaporisation}}(\text{H}_2\text{O}(\text{l}))$

- | | | | |
|----------|--------------|----------|--------------|
| A | 1 and 2 only | B | 1 and 3 only |
| C | 1 only | D | 2 only |

- 7** Use of the Data Booklet is relevant to this question.

The standard enthalpy change of solution of sodium chloride is $+4 \text{ kJ mol}^{-1}$.



Values of the relevant enthalpy changes are given in the table.

	kJ mol^{-1}
lattice energy of sodium chloride	-786
standard enthalpy of hydration of chloride ion	-363

What is the value for the following enthalpy change?



A $+419 \text{ kJ mol}^{-1}$

B -419 kJ mol^{-1}

C $+75 \text{ kJ mol}^{-1}$

D -75 kJ mol^{-1}

8 Which row describes the properties of aluminium and phosphorus?

	aluminium	phosphorus
A	it conducts electricity only in the molten state	it does not conduct electricity in any state
B	its oxide is covalent with ionic character	its oxide is a solid at room temperature
C	its chloride dissolves slowly in cold water	its chloride reacts rapidly with water, producing acidic fumes
D	its chloride reacts rapidly with water, producing acidic fumes	when its chloride is added to water, the solution formed turns blue litmus red

9 Which statements are true about calcium carbonate and barium carbonate?

- 1 calcium carbonate forms a larger amount of gas when the same mass of each carbonate is completely decomposed on heating.
- 2 calcium carbonate has a larger magnitude of lattice energy than barium carbonate.
- 3 the metal cation in calcium carbonate has a larger polarising power than that in barium carbonate.
- 4 calcium carbonate decomposes at a higher temperature than barium carbonate.

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

- 10** An excess of an aqueous reagent Z is added to a solution containing chloride and iodide ions.

Which row describes the correct observations for the given identity of Z?

	aqueous reagent Z	observations
A	ammonia	white precipitate dissolved while yellow precipitate remained insoluble
B	iodine	colourless solution turned brown
C	bromine	colourless solution turned purple
D	silver nitrate	cream and yellow precipitates formed

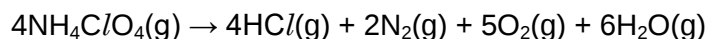
- 11** *Use of the Data Booklet is relevant to this question.*

Which statements are correct?

- 16.3 g of nitrogen contains 3.50×10^{23} molecules.
- 2.43 g of magnesium peroxide, MgO_2 , contains 0.0862 mol of ions.
- 1 mol of sodium carbonate contains 5 mol of atoms.

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

- 12** Ammonium perchlorate, NH_4ClO_4 , can be used as a rocket propellant. It is unstable and decomposes upon heating as shown below.



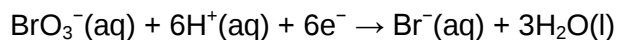
0.235 g of ammonium perchlorate undergoes complete decomposition. The gaseous product mixture was passed through water before being collected at room temperature and pressure.

What is the volume of gas collected?

- | | | | |
|----------|---------------------|----------|---------------------|
| A | 48 cm ³ | B | 84 cm ³ |
| C | 132 cm ³ | D | 204 cm ³ |

- 13** 20.0 cm³ of 0.02 mol dm⁻³ aqueous sodium bromate(V), NaBrO₃, was found to react completely with 80.0 cm³ of 0.01 mol dm⁻³ hydroxylamine, NH₂OH.

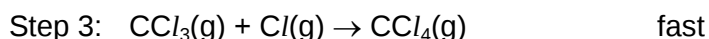
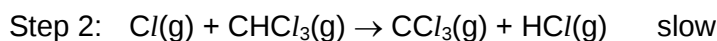
The half equation for the reduction of bromate(V) ion is shown.



What could be the nitrogen-containing product of this reaction?

- | | | | |
|----------|------------------|----------|------------------------------|
| A | NO | B | NO ₂ |
| C | N ₂ O | D | NO ₃ ⁻ |

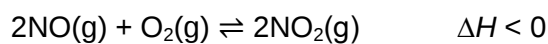
- 14** The mechanism below has been proposed for the reaction of CHCl₃ with Cl₂.



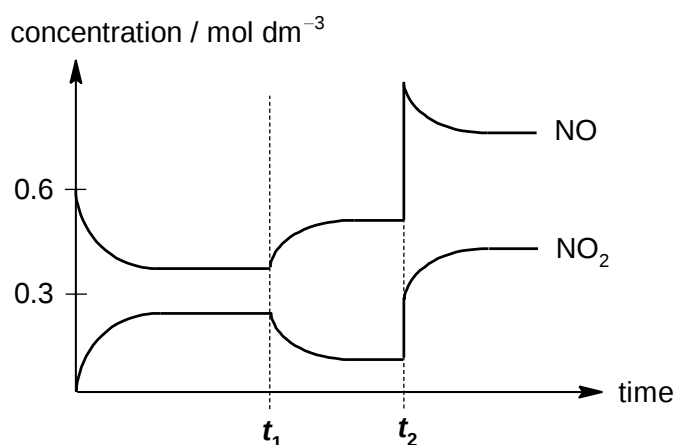
Which rate equation is consistent with this mechanism?

- | | |
|----------|---|
| A | rate = $k[\text{CHCl}_3][\text{Cl}]$ |
| B | rate = $k[\text{CHCl}_3][\text{Cl}_2]$ |
| C | rate = $k[\text{CHCl}_3][\text{Cl}_2]^{1/2}$ |
| D | rate = $\frac{k[\text{CHCl}_3]}{[\text{Cl}_2]}$ |

- 15** The half-life of the first-order gaseous reaction in which X₂ molecules become converted into X atoms is 25 minutes. 1 mol of X₂ is put into a sealed vessel at pressure p .



The graph below shows the changes in the concentrations of NO and NO₂ in the system with time. A change was made to the system at time t_1 and another change was made at time t_2 .

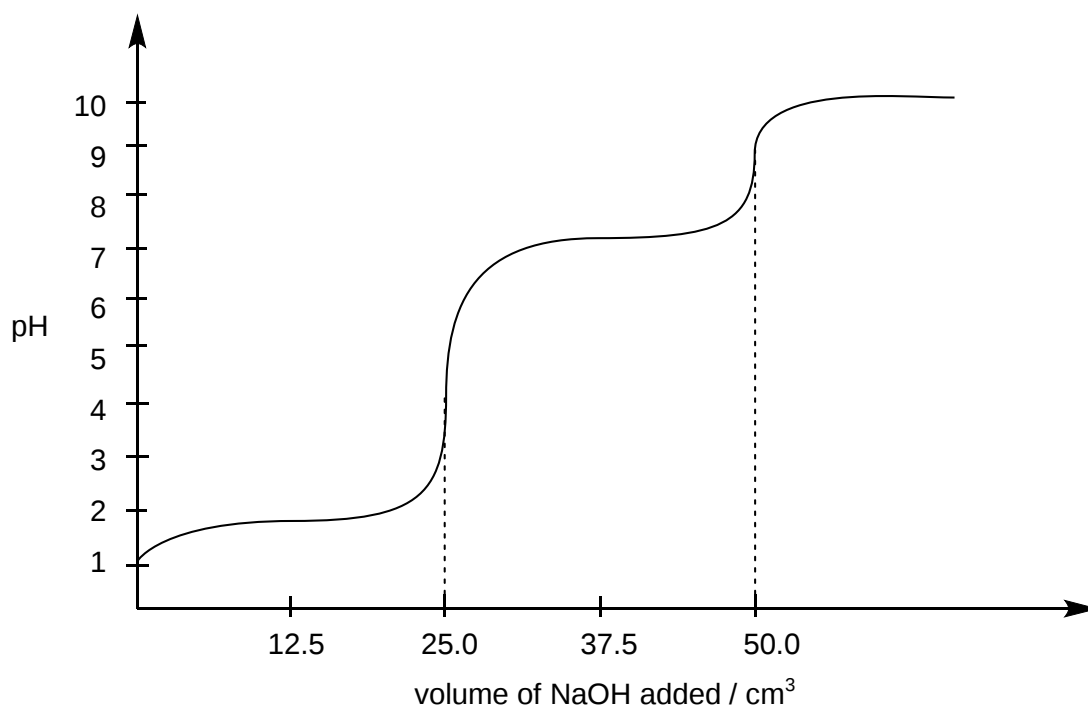


What were the changes made at t_1 and t_2 respectively?

	t_1	t_2
A	the temperature was increased	volume of the system was increased
B	the temperature was decreased	more O ₂ was added
C	the temperature was decreased	an inert gas was added at constant volume
D	the temperature was increased	volume of the system was decreased

18 Sulfurous acid, H₂SO₃, a dibasic acid, has pK_a values of 1.9 and 7.2.

The curve for the titration of a certain volume of 0.10 mol dm^{-3} sulfurous acid against a 0.10 mol dm^{-3} of sodium hydroxide, NaOH, is shown below.



The pH ranges of colour changes for thymol blue indicator are 1.2 – 2.8 and 8.0 – 9.6.

Which statements are correct?

- 1 The volume of 0.10 mol dm^{-3} sulfurous acid used is 25.0 cm^3 .
- 2 Thymol blue is a suitable indicator to detect the first and second equivalence points.
- 3 HSO_3^- has $\text{p}K_a$ value of 7.2 and $\text{p}K_b$ value of 12.1.

A 1 and 2 only

B 1 and 3 only

C 3 only

D 1 only

19 Values of the solubility products at 20°C are given.

$$K_{sp}(\text{ZnF}_2) = 8.7 \times 10^{-2} \text{ mol}^3 \text{ dm}^{-9}$$

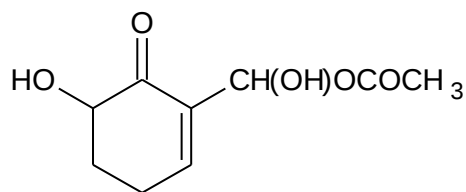
$$K_{sp}(\text{BaF}_2) = 1.8 \times 10^{-7} \text{ mol}^3 \text{ dm}^{-9}$$

Solid zinc fluoride is shaken with water at 20 °C. The remaining solid is filtered off, leaving a saturated solution **X**. Solid BaF₂ is then added to solution **X**.

Which row of the table is correct?

	[F ⁻ (aq)] in X /mol dm ⁻³	Solubility of BaF ₂ in X /mol dm ⁻³
A	2.8×10^{-1}	2.3×10^{-6}
B	2.8×10^{-1}	6.4×10^{-7}
C	5.6×10^{-1}	3.2×10^{-7}
D	5.6×10^{-1}	5.7×10^{-7}

20 The structure of compound P is shown.



compound P

Which statements about compound P are correct?

- 1 It has cis-trans isomers.
- 2 It has three sp² carbon atoms.
- 3 It has two chiral centres.
- 4 The C=C π bond is formed via a 2sp²-2sp² overlap.

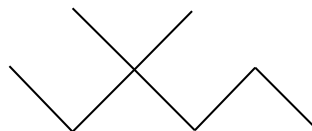
A 3 only

B 1 and 4 only

C 2 and 3 only

D 1, 2 and 4 only

- 21 3,3-dimethylhexane was reacted with limited chlorine in the presence of UV light.

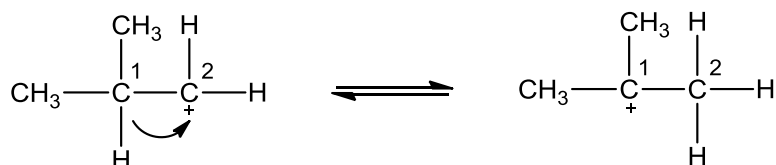


3,3-dimethylhexane

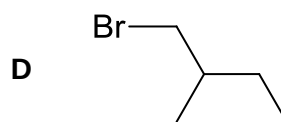
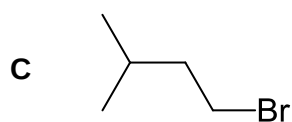
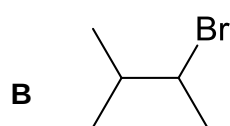
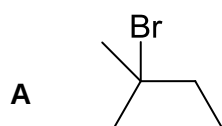
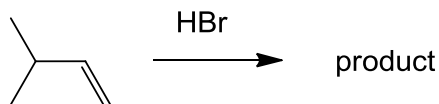
Given that a hydrogen on a secondary carbon is substituted 4.5 times as quickly as that on a primary carbon, what is the ratio of the two mono-substituted products shown below?

A	1	3
B	2	3
C	3	2
D	3	1

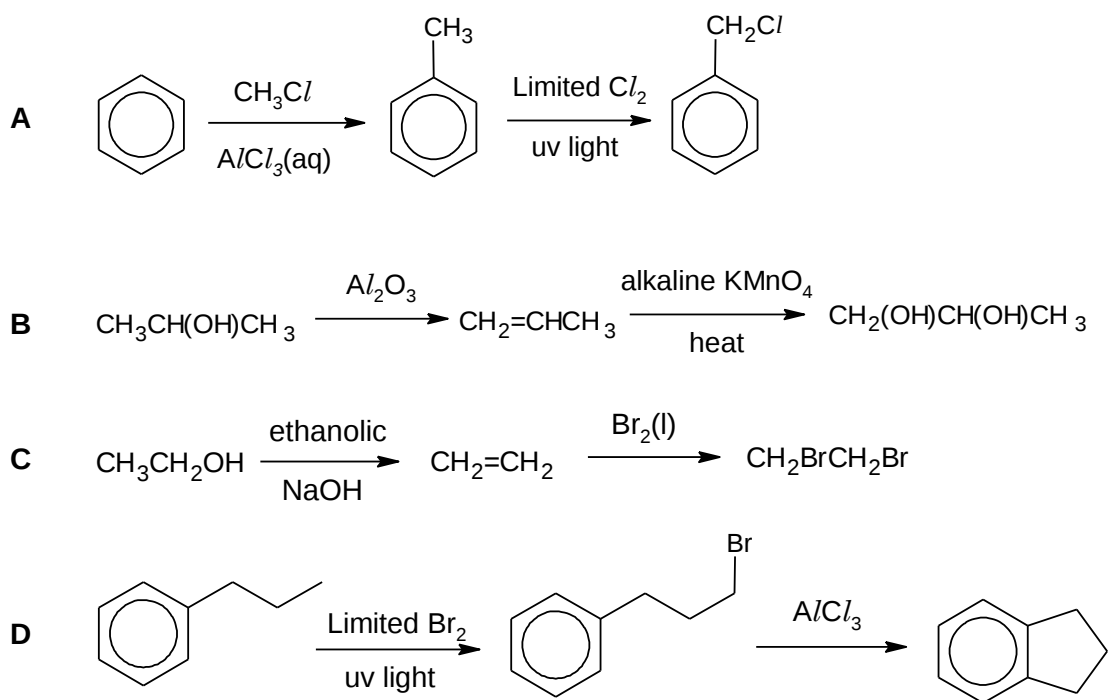
- 22 A 1,2-hydride shift is a carbocation rearrangement in which a hydrogen atom in a carbocation migrates to an adjacent carbon atom to form a more stable carbocation.



Using the information above, which compound is the **major** product of the following reaction?



23 Which reaction scheme is able to produce the intended final product?



24 Which mechanism involves a carbocationic intermediate **and** could lead to the formation of a racemic product mixture?

- 1 Electrophilic addition
- 2 Nucleophilic addition
- 3 Bimolecular nucleophilic substitution
- 4 Unimolecular nucleophilic substitution

A 1 and 3 only

B 2 and 4 only

C 1 and 4 only

D 2 and 3 only

- 25 When $\text{CH}_3\text{CHBrCH}_3$ was heated with alcoholic silver nitrate, a precipitate was observed after 5 minutes.

Two other halogen derivatives, R and S, were separately warmed with alcoholic silver nitrate, and the observations were recorded below.

compound	observations
R	A precipitate was formed after 7 minutes. The precipitate remained when dilute ammonia was added.
S	No precipitate was formed after prolonged heating.

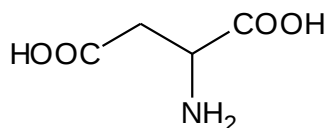
What is the structure of R and S?

	R	S
A	$\text{CH}_3\text{CHI}\text{CH}_3$	$\text{C}_6\text{H}_5\text{Br}$
B	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$	$\text{CH}_2=\text{CHCl}$
C	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$	$\text{CH}_3\text{CHFCH}_3$
D	$\text{C}_6\text{H}_5\text{Cl}$	$\text{CH}_2=\text{CHI}$

- 26 Which molecule can be oxidised to $(\text{CH}_3)_2\text{CHCOOH}$?

- | | | | |
|---|--|---|----------------------------------|
| A | $(\text{CH}_3)_2\text{CHCH}(\text{OH})\text{CH}_3$ | B | $(\text{CH}_3)_2\text{CHCONH}_2$ |
| C | $(\text{CH}_3)_2\text{CH}(\text{OH})$ | D | $(\text{CH}_3)_2\text{CHCN}$ |

- 27 Aspartic acid is used in the production of biodegradable superabsorbent polymers.



Aspartic acid

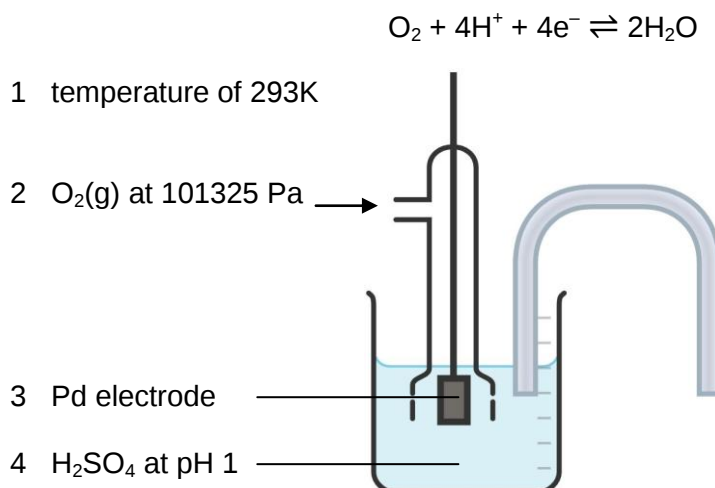
It has pK_a values of 2.0, 3.9 and 9.9.

At which pH will the zwitterionic form of aspartic acid be the major species in solution?

- | | | | |
|---|---|---|----|
| A | 3 | B | 5 |
| C | 7 | D | 11 |

- 28 In the diagram of a half-cell shown below, which conditions will allow $E^\ominus$ for the following

electrode system to be measured?



- | | | | |
|----------|-----------------|----------|-------------------|
| A | 1 and 2 only | B | 2 and 3 only |
| C | 1, 3 and 4 only | D | none of the above |

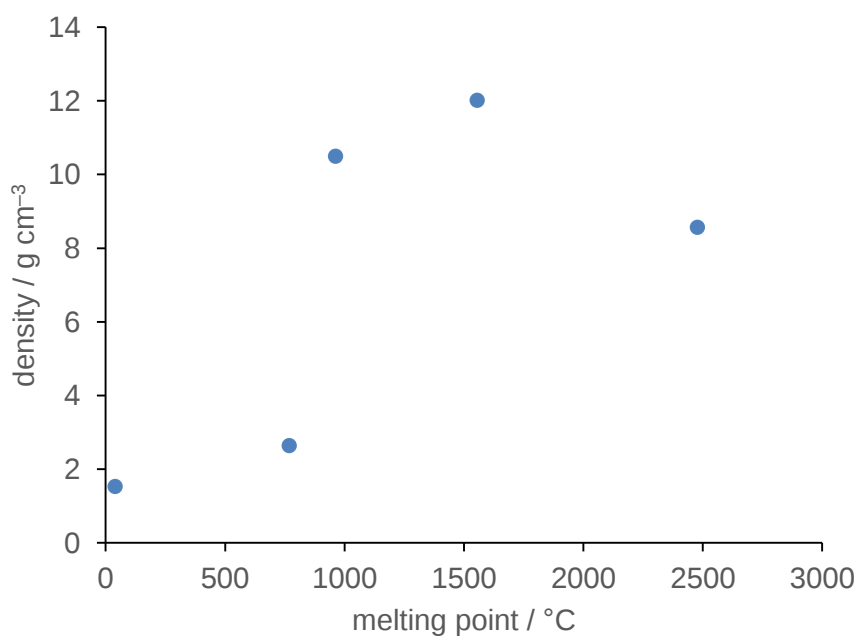
29 *Use of the Data Booklet is relevant to this question.*

In the electrolysis of aqueous magnesium nitrate using graphite electrodes, V and W were produced at the negative and positive electrodes respectively.

After some time, what is the ratio of mass of V : mass of W obtained?

- | | | | |
|----------|--------|----------|--------|
| A | 2 : 1 | B | 1 : 8 |
| C | 1 : 16 | D | 1 : 46 |

- 30 The melting points and densities of some Period 5 metals are plotted on the same graph.



How many transition elements are shown?

- | | |
|----------------|---------------|
| A one | B two |
| C three | D four |

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