National 5 Chemistry

Relevant Past Paper Questions from SQA Standard Grade Credit and Intermediate 2 papers

Unit 3: Chemistry in Society

March 2014

N5 Chemistry Past Paper Questions

This resource has been produced in response to the requests from practitioners who attended the National Qualifications Sciences events at Hampden Stadium in December 2013 which Education Scotland organised in partnership with the SQA.

The questions in this resource relate to the Chemistry in Society Unit for National 5 Chemistry and have been taken from the 2011, 2012 and 2013 Standard Grade and Intermediate 2 Past Papers.

For Chemistry in Society (Unit 3), the mandatory course key areas are as follows:

- Metals

- Properties of plastics

- Fertilisers

- Nuclear Chemistry

- Chemical Analysis

In cases where the questions relate to more than one of the National 5 Units, the constituent parts of the question have been separated into their respective key areas. The stem of the question has been retained to give the context of the question. If practitioners require the full integrated question, they should refer to the original past paper on the SQA website.

Past paper questions for the other two National 5 Units, Chemical Changes and Structure and Nature's Chemistry are also available from Education Scotland's National Qualifications Glow portal: http://www.educationscotland.gov.uk/nqcoursematerials/ (cut and paste link into your browser).

Education Scotland would like to acknowledge the support of the SQA in helping us produce this resource. We hope it proves helpful to practitioners across Scotland and assists with the implementation of the national qualifications.

Metals

St Gr
2011
Q18
a+b

A student set up the following experiment to electrolyse cobalt chloride solution.

power supply

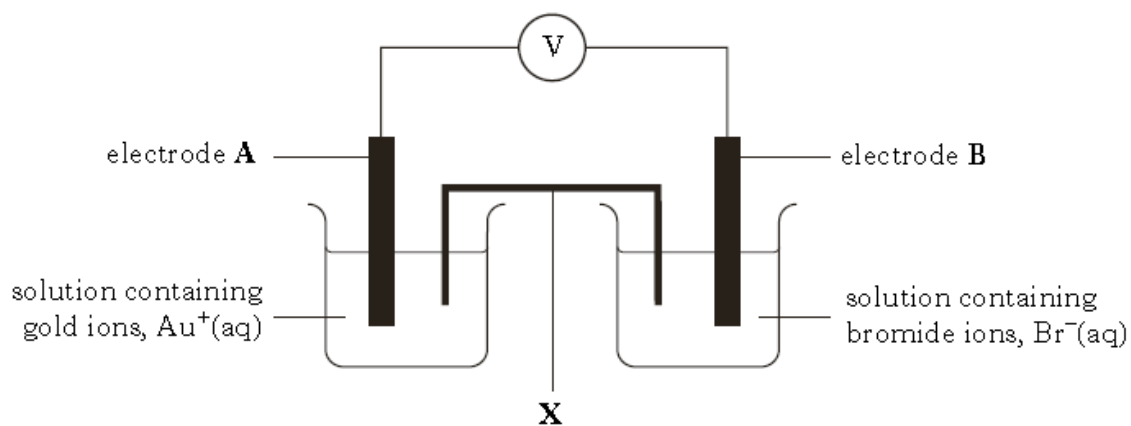electrodes

+   −

cobalt chloride
solution
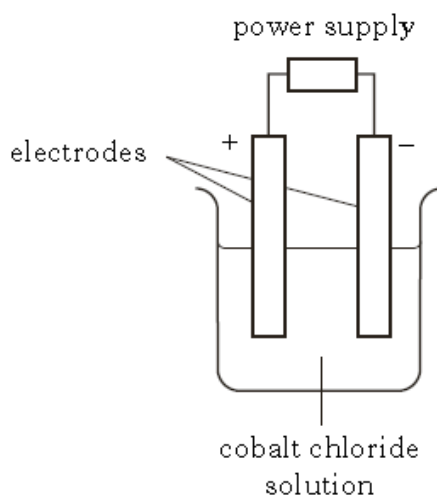
(a)   What **type** of power supply **must** be used to electrolyse cobalt chloride solution?   1

(b)   Describe what would be **seen** at the positive electrode.   1
         You may wish to use the data booklet to help you.
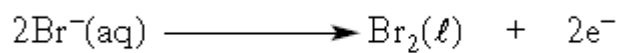

Answers	Sample Answers and Mark Allocation	Notes
(a)	d.c. or direct current 1	Not acceptable : Battery, lab pack
(b)	Chlorine gas	
	Bubbles of gas	
	Gas given off	
	Fizzing/effervescence	
	Green/yellow gas	
	$Cl_2(g)$ 1	

St
Gr
2011
Q21

A technician set up the following cell.

The reaction taking place at electrode **B** is:
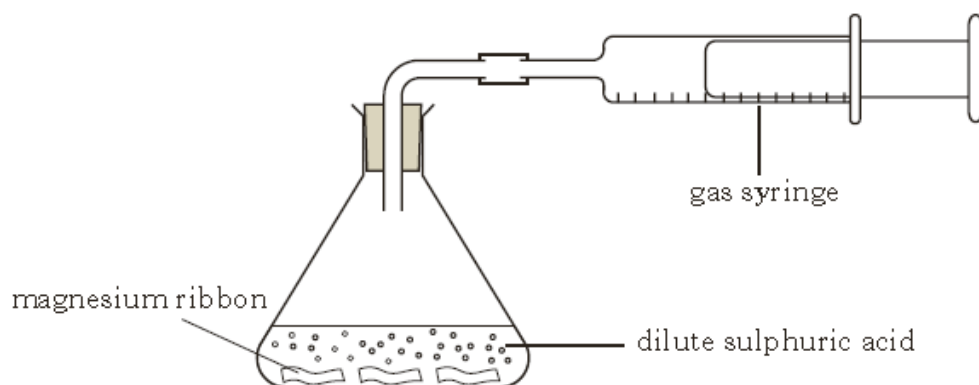
$$2Br^-(aq) \longrightarrow Br_2(\ell) \; + \; 2e^-$$

(a)   **On the diagram**, clearly mark the path and direction of electron flow.   1

(b)   Write the ion-electron equation for the reaction taking place at electrode **A**.   1
      You may wish to use the data booklet to help you.

(c)   Name the piece of apparatus labelled **X**.   1

Answers		Sample Answers and Mark Allocation	Notes
	(a)	A ⟵ B On or close to the wires **1**	Not acceptable : Arrow in solution or arrow continues into solution or ion bridge → Negates: Also negates if arrow also drawn on wire correctly.
	(b)	$Au^+(aq) + e^- \longrightarrow Au(s)$ State symbols not needed. Negative sign on electron not needed. **1**	
	(c)	Ion bridge/salt bridge Filter paper soaked in salt solution/electrolyte. **1**	Not acceptable: Ion-electron bridge Electrolyte or bridge on its own.

St
Gr
2012
Q13
(b)i.

Hydrogen gas is produced when magnesium reacts with dilute sulphuric acid.

1

gas syringe

magnesium ribbon

dilute sulphuric acid

The equation for the reaction is:

$$Mg(s) + H_2SO_4(aq) \longrightarrow MgSO_4(aq) + H_2(g)$$

Circle the formula for the salt in the above equation.

Answer	Sample Answers and Mark Allocation	Notes
	$MgSO_4$	SO_4
	1	

Marks
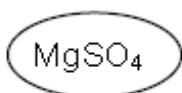
Q16 Titanium is an important metal used in aircraft manufacture.

   (a) Titanium can be produced from titanium chloride as shown.   1

$$2Mg(s) + TiCl_4(\ell) \longrightarrow 2MgCl_2(s) + Ti(s)$$

      Name the type of chemical reaction represented by the equation.

   (b) The magnesium chloride produced can be electrolysed as shown.
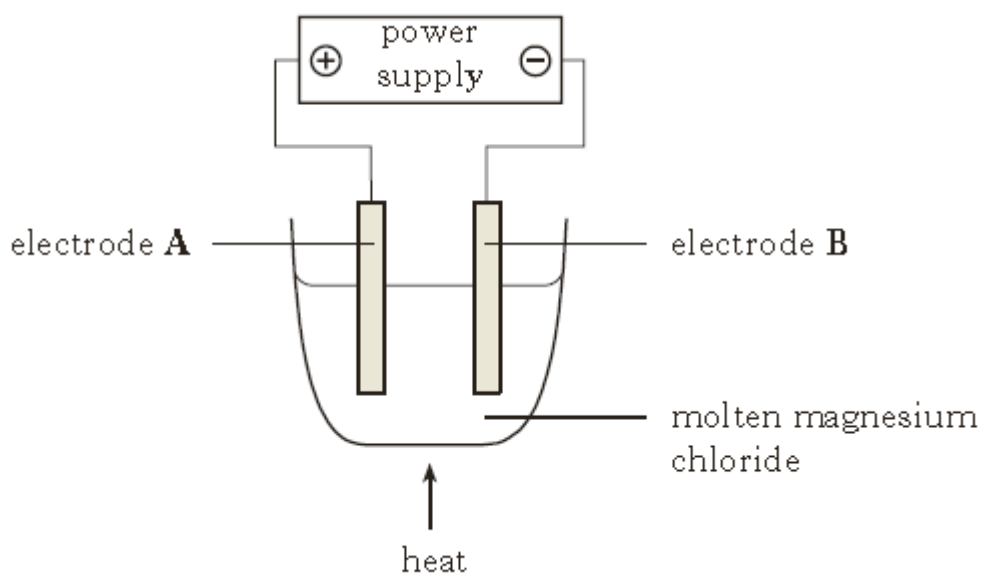
   (i) At which electrode would magnesium be produced, **A** or **B**?   1

     (ii) Write the ion-electron equation for the formation of chlorine.   1
         You may wish to use the data booklet to help you.

Answers	Sample Answers and Mark Allocation		Notes
(a)	displacement		Not acceptable:
	redox	**1**	Oxidation/reduction
(b) (i)	B/negative	**1**	

(b) (ii)

$2Cl^- \longrightarrow Cl_2 + 2e$ $Cl^- \longrightarrow Cl + e$

As per data booklet, ignore state symbols.

$2Cl^- - 2e \longrightarrow Cl_2$

$Cl^- \rightarrow \frac{1}{2} Cl_2 + e$ **1**

St
Gr
2012
Q 19

In Australia flow cells are used to store the energy from solar cells.
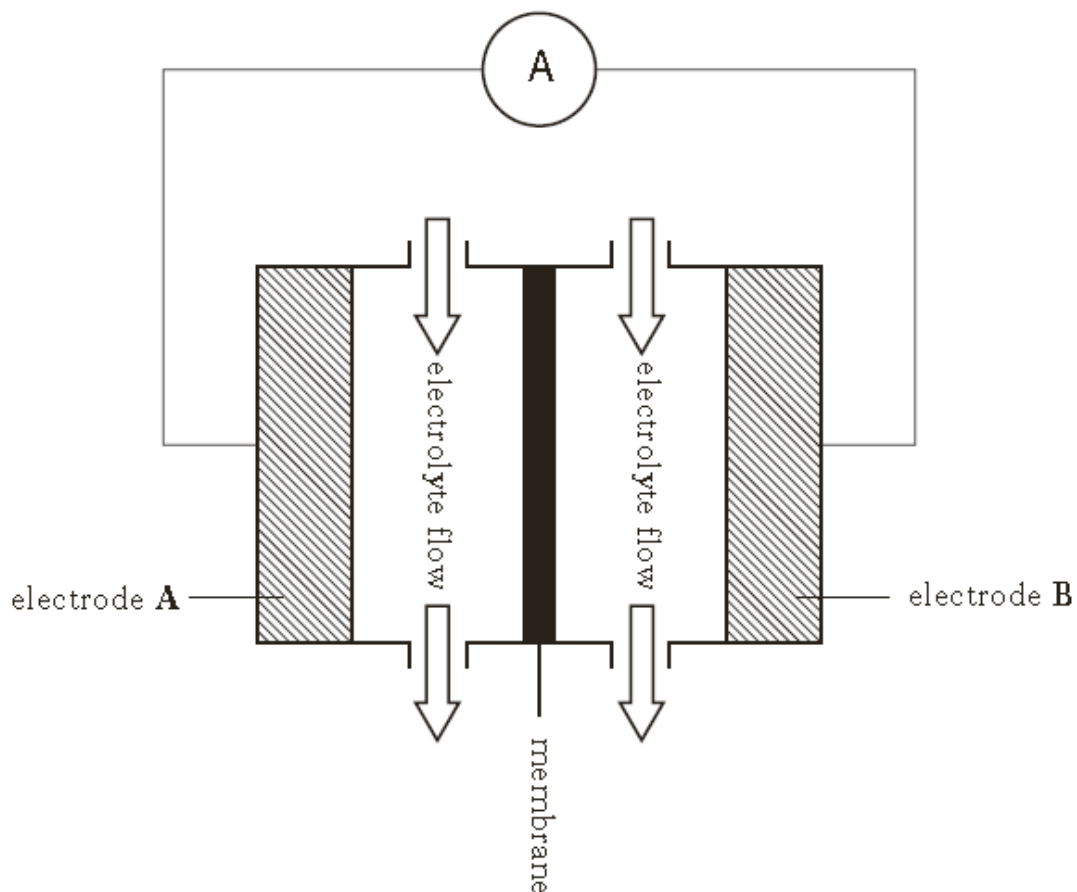
(a)   The reaction taking place at electrode **A** when the cell is providing electricity is: 1

$$Zn \longrightarrow Zn^{2+} + 2e^-$$

Name the type of chemical reaction taking place at electrode **A**.

1

(b)   **On the diagram**, clearly mark the path and direction of electron flow.

(c)   Name the non-metal that conducts electricity, which could be used as an electrode.   1

Answers	Sample Answers and Mark Allocation	Notes
(a)	oxidation **1**	
(b)	Left to right indicated on or near the wire. **1**	Not acceptable: if line goes into cell 0 marks
(c)	C, graphite, carbon **1**	

St Gr 2012 Q21 (c)i The composition of a 250g magnet is shown. 1

Metal	aluminium	nickel	cobalt	copper	titanium	iron
% by mass	10	25	20	4	1	40

Calculate the mass, in grams, of aluminium in the magnet.
Show your working clearly.

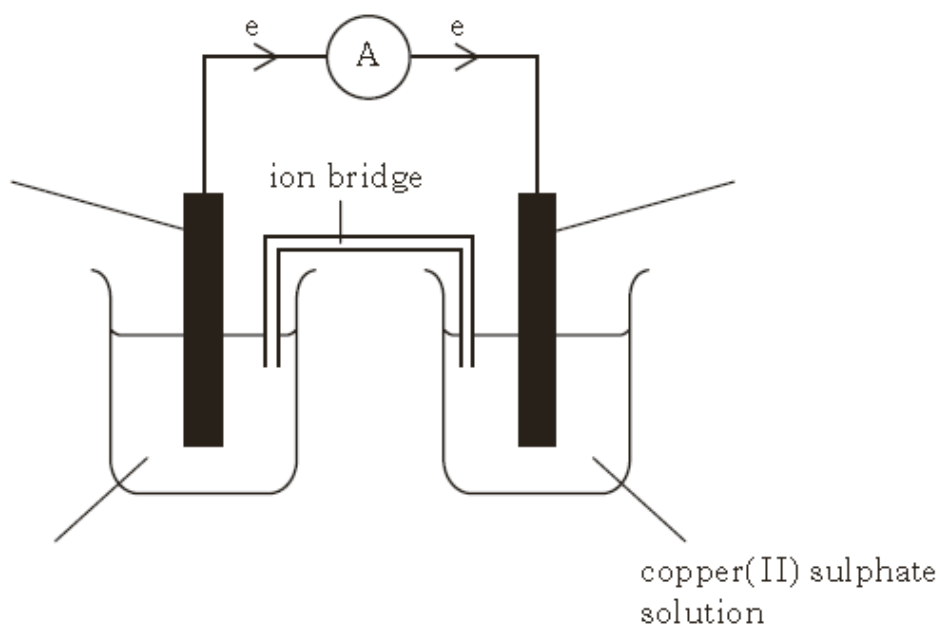Answer   Sample Answers and Mark Allocation   Notes

25g   **1**

StGr   Zinc displaces copper from copper(II) sulphate solution.
2013   The equation for the reaction is:
Q14

$$Zn(s) + Cu^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow Zn^{2+}(aq) + SO_4^{2-}(aq) + Cu(s)$$

(a)   Circle the spectator ion in the above equation.   1

(b)   Write the ion-electron equation for the **oxidation** step in this reaction.   1
      You may wish to use the data booklet to help you.

(c)   The reaction can also be carried out in a cell.

ion bridge

copper(II) sulphate
solution

(i)   Complete the **three labels** on the diagram.   1

(ii)   What is the purpose of the ion bridge?   1

Answers	Sample Answers and Mark Allocation	Notes
(a)	$SO_4{}^{2-}$	
	Can be circled on either side or both sides or identified in some other way	
	1	
(b)	$Zn \longrightarrow Zn^{2+} + 2e^-$	
	$Zn - 2e^- \longrightarrow Zn^{2+}$	
	Ignore state symbols (-ve sign not needed for e)	
	1	
(c) (i)	Zinc copper carbon or any metal below copper in ECS. Zinc sulphate solution/Zn^{2+}(aq) (or any other soluble zinc salt) or a solution containing ions of metals above zinc in ECS.	**Not acceptable:** Zn^{2+} on its own or with any other state symbol. Zinc sulphate without solution. Zinc solution.
	1	
(c) (ii)	To complete/finish the circuit/cell. To allow ions to flow/move/transfer (between the two beakers). To carry the ions (between the two beakers). To provide ions to complete the circuit.	**Not acceptable:** To transfer ions from zinc to copper To carry the current To conduct electricity To allow electrons to flow through the wire on its own Any mention of electrons on their own Allow electricity to pass through /flow To connect (the) electrolytes To keep (the) circuit flowing To connect the circuit **Negates:** Allow electrons to flow - unless specifically stated through the wire.

		Marks
St	Mercury can be extracted from the ore cinnabar, **HgS**.	2
Gr	Calculate the percentage by mass of mercury in cinnabar.	
2013		
Q16		
(b)i		

| Answer	Sample Answers and Mark Allocation	Notes
	FM = 232·5 (1) 200·5/232·5 x 100 = 86·2% or 86% (1) 86·2% or 86% on its own 2 marks Use of atomic numbers max 1 mark, must have working to gain the mark, 83·3% Metal other than Hg max 1 mark	

		Marks
Int 2	Metals can be extracted from metal compounds by heat alone, heating with carbon or by	1
2011	electrolysis.	
B	Name the type of chemical reaction which takes place when a metal is extracted from its	
Q12	compound.	
(a)		

Answer	Sample Answers and Mark Allocation	Notes
	reduction	Redox
	reduced 1	Redox and reduction
		0 marks
		(cancelling applies)

Int 2 The voltage obtained when different pairs of metal strips are connected in a cell varies and this
2011 leads to the electrochemical series.
B Using the apparatus below, a student investigated the electrochemical series. Copper and four
Q14. other metal strips were used in this investigation.
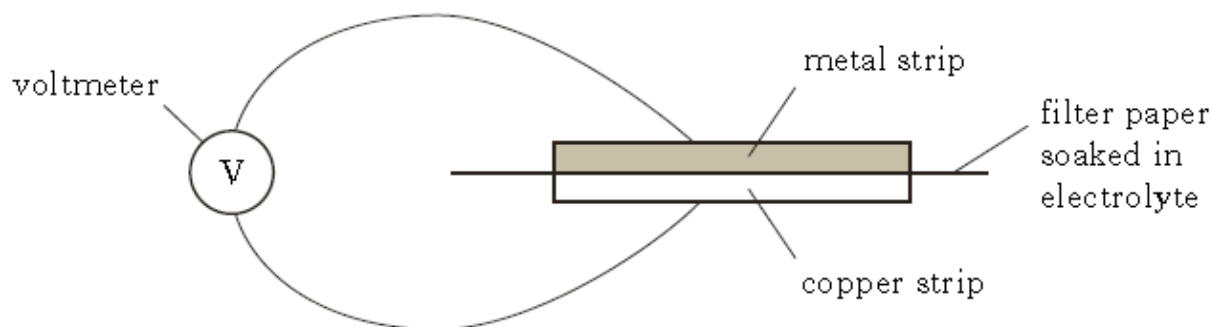
The results are shown.

Metal strip	Voltage (V)	Direction of electron flow
1	0·6	metal 1 to copper
2	0·2	copper to metal 2
3	0·9	metal 3 to copper
4	0·1	copper to metal 4

(a) Which of the metals used is highest in the electrochemical series? 1

(b) Which **two** of the metals used would produce the highest voltage when connected in a 1
cell?

(c) What would be the reading on the voltmeter if both strips of metal were copper? 1

Answers   Sample Answers and Mark Allocation   Notes
(a)   (metal) 3   **Not acceptable:**
       0·9   **1**   (Metal) C

(b)   (metal) 2 and (metal) 3   **Not acceptable:**
       0·2 and 0·9   any other combination
       allow for follow through for incorrect answer in
       (a)
       (metal) 3 and students answer in (a)   **1**

(c)   0/ 0·0 / zero   **1**   **Not acceptable:**
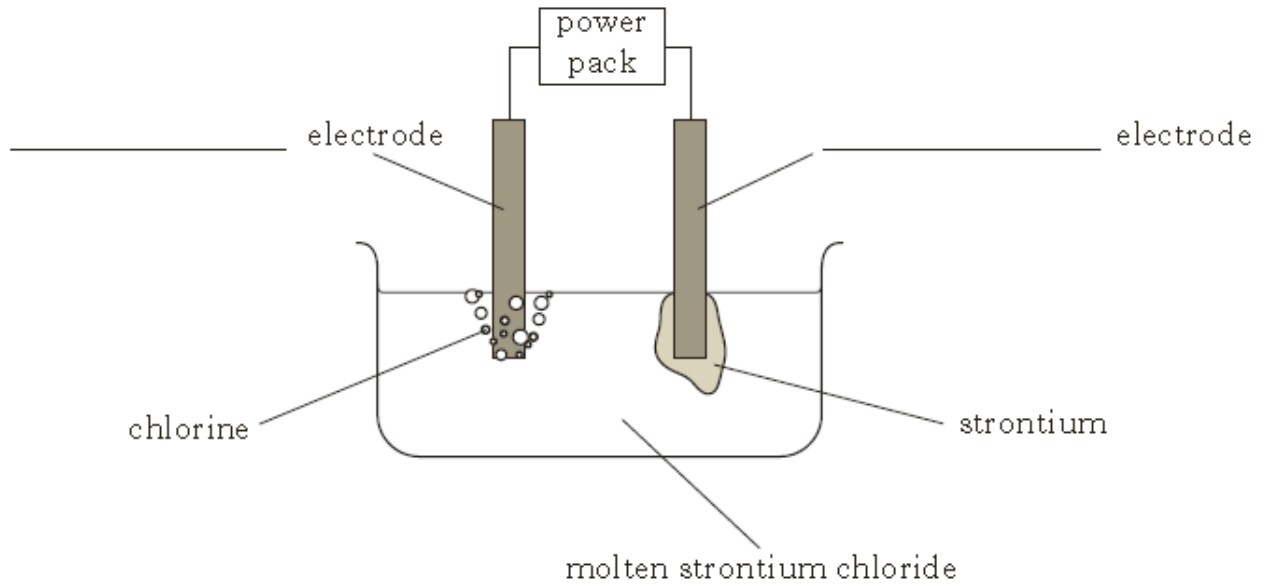   No voltage

Int 2   Strontium can be extracted from the compound strontium chloride using electrolysis.   1
B   Label the diagram to show the **charge** on each electrode.
Q1(b)

_____ electrode   electrode _____

power
pack

chlorine

strontium

molten strontium chloride

Answers   Sample Answers and Mark Allocation   Notes
           LH electrode = positive/+
           RH electrode = negative/-
           Both correct for **1 mark**

Int 2   Titanium metal is used to make dental braces.   1
2013
B
Q15
(b)

Titanium is extracted from its ore in the Kroll process. One step in this process involves the displacement of titanium chloride by sodium metal.
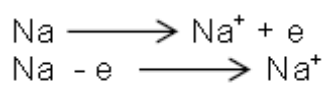The equation is shown.

$$4Na + TiCl_4 \longrightarrow 4NaCl + Ti$$

During the displacement, sodium atoms, Na, form sodium ions, Na^+.
Write the ion-electron equation for this change.

Answers   Sample Answers and Mark Allocation   Notes
                                                                       Not acceptable:
                 $Na \longrightarrow Na^+ + e$ Use of = sign
                 $Na - e \longrightarrow Na^+$

                 Ignore state symbols
                 Correct symbols to be used   **1**

		Marks
Int 2 2011 A Q7	Copper is a good conductor of electricity because	1

A the atoms are free to vibrate

B the atoms are in close contact

C the atoms have the electron arrangement 2, 8, 18, 1

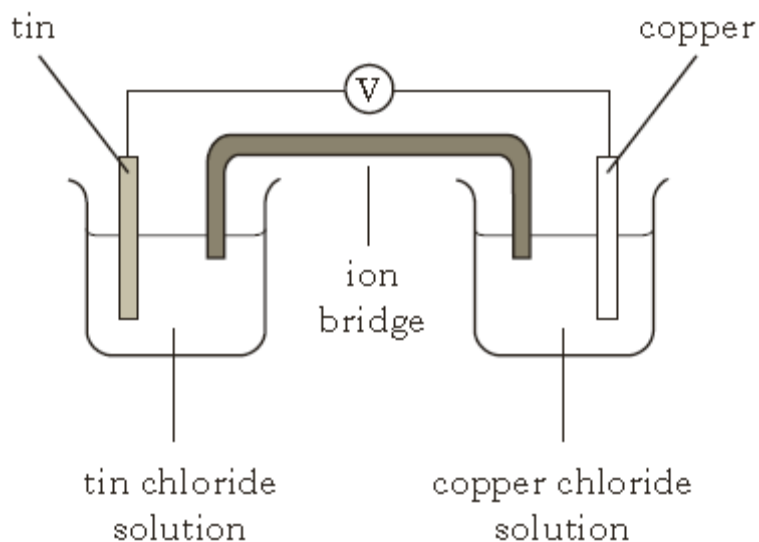D electrons can move readily from one atom to the next.

Answer	Sample Answers and Mark Allocation	Notes
D	**1**	

Int 2
2013
A
Q26

In the cell shown electrons flow through

A the solution from copper to tin

B the solution from tin to copper

C the wires from copper to tin

D the wires from tin to copper.

1

Q27
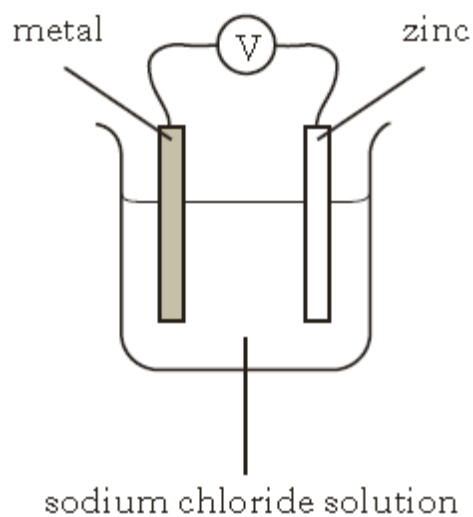
Which of the following metals, when linked to zinc, would give the highest cell voltage? (You may wish to use the data booklet to help you.)

A Copper

B Iron

C Magnesium

D Tin

1

Q29   When a metal element reacts to form a compound the metal is
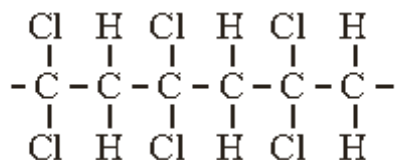
A displaced

B oxidised

C precipitated

1

D   reduced.

Question	Sample answers and mark allocation		Notes
26.	D	**1**	
27.	A	**1**	
29.	B	**1**	

Properties of Plastics

St Gr
2011
Q13
(a).

Polyvinyldichloride (PVDC) is a plastic used in food packaging.
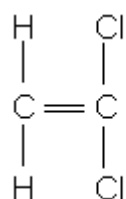The structure of part of a PVDC molecule is shown.

```
   Cl  H  Cl  H  Cl  H
   |   |  |   |  |   |
 - C - C - C - C - C - C -
   |   |  |   |  |   |
   Cl  H  Cl  H  Cl  H
```

Draw the **full** structural formula for the monomer used to make PVDC.

Answer   Sample Answers and Mark Allocation   Notes
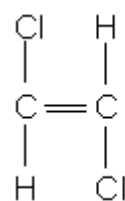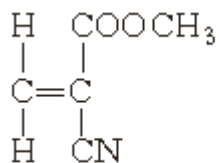   **Not acceptable:**

```
   H     Cl              Cl    H              Cl    H
   |     |               |     |              |     |
   C  =  C      or       C  =  C              C  =  C
   |     |               |     |              |     |
   H     Cl              Cl    H              H     Cl
```

1
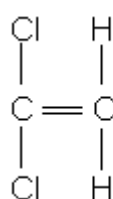
		Marks
St Gr. 2012 Q20 (a)+ (b)	(a) The monomer in superglue has the following structure.	1

$$\begin{array}{ccc} H & COOCH_3 \\ | & | \\ C & = & C \\ | & | \\ H & CN \end{array}$$

Draw a section of the polymer, showing **three** monomer units joined together.

(*b*) The polymer does **not** change shape on heating.

What term is used to describe this type of polymer?   1

Answers	Sample Answers and Mark Allocation	Notes
(a)	Diagram must show three monomer units linked together One end bond missing no penalty **1**	**Not acceptable:** If molecule closed at both ends zero marks.
(b)	thermosetting thermosetting **1** thermoset thermoset thermal setting thermal setting 1	

Int 2   Polyethene terephthalate (PET) is used to make plastic bottles which can easily be recycled by   1
2012   heating and reshaping.
A   A section of the PET structure is shown.
Q16
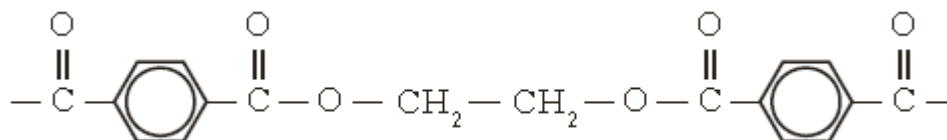
Which line in the table best describes PET?

	Type of polymer	Property
A	addition	thermoplastic
B	condensation	thermosetting
C	addition	thermosetting
D	condensation	thermoplastic

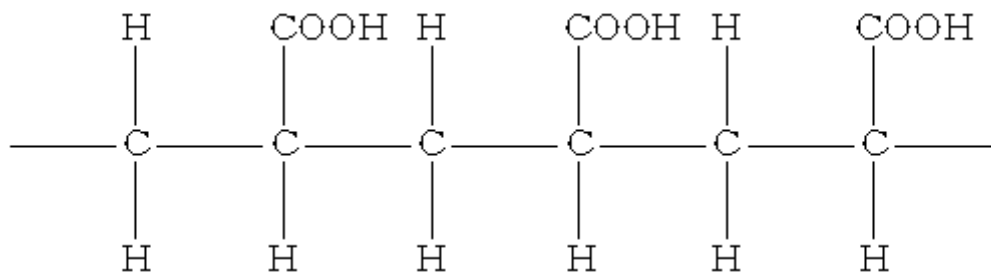Question   Sample Answers and Mark Allocation   Notes
            D   **1**

2011   Synthetic nappies contain hydrogel polymers which attract and absorb water molecules.
B   The following is part of the structure of a hydrogel polymer.
Q10
(a) i
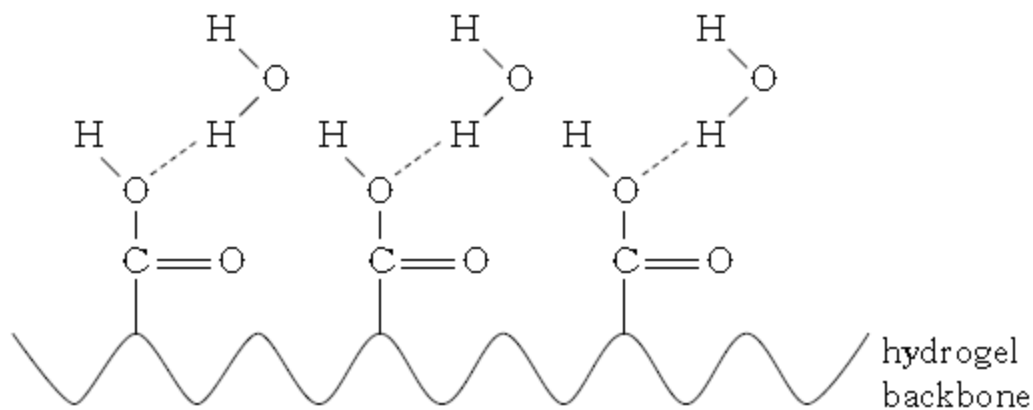

(a)   Draw the monomer from which this polymer is made.   1

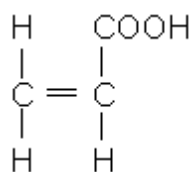(b)   The diagram below shows how water molecules are attracted to the hydrogel.   1

What type of bonding must be present **in the water molecules**, which allows them to be
attracted to the hydrogel?

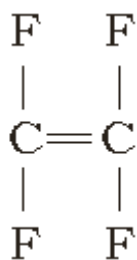| Answers	Sample Answers and Mark Allocation	Notes
(a)		**Not acceptable:** COOH if expanded must be correct. Repeating unit and monomer shown with no indication of steps involved (professional judgement).
	allow one slip – missing H atom OR missing C – H bond but not C=O or – O – H ignore brackets around correct monomer. **1**	
(b)	Polar covalent **1**	**Not acceptable:** Covalent Any reference to networks Hydrogen bonding

Int 2
2013
B
Q10
(b)
i&ii

Some waterproof clothing contains a thin layer of the plastic PTFE.

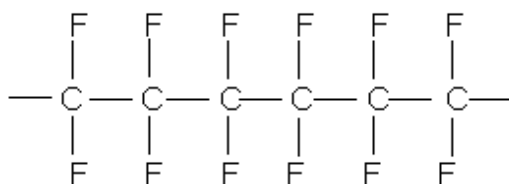(a)   PTFE is a polymer made from the monomer shown.   1

$$F \quad F$$
$$| \quad\quad |$$
$$C=C$$
$$| \quad\quad |$$
$$F \quad F$$

Draw a section of the PTFE polymer, showing three monomer units joined together.

(b)   Name this type of polymerisation reaction.   1

Question	Sample Answers and Mark Allocation	Notes
(a)		**Not acceptable:** missing C to C bond/ no end bonds Fl Carbon to carbon double bond F at end

both end bonds must be present, dotted lines, squiggles /
allow one missing C to F bond/
allow one missing F
don't penalise for size/shape of F
must have 6 carbons
ignore brackets   **1**

(b)

Addition/ additional   **1**

Fertilisers

St
Gr
2011
Q19
(a)
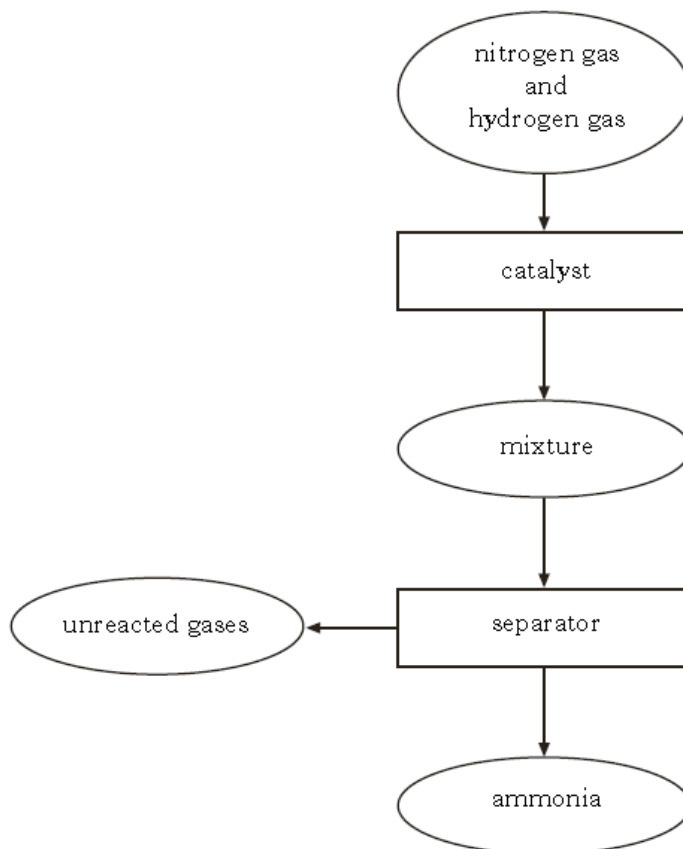
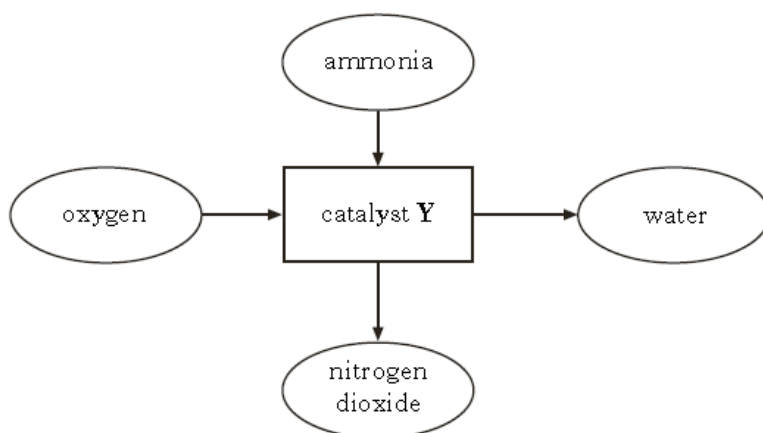Catalysts can be used in different processes.

(a)   The flow diagram shows the steps involved in the Haber process.   1

On the flow diagram above draw an arrow to show how the process is made more economical.

(b)   Ammonia can be used to produce nitrogen dioxide as shown.

(i)   Name catalyst **Y**.   1

(ii) Why is it **not** necessary to continue to supply heat once the reaction has started?   1

Answers	Sample Answers and Mark Allocation	Notes
(a)	Arrows drawn from unreacted gases to hydrogen and nitrogen box or catalyst box or between these two **1**	
(b) (i)	Platinum, Pt **1**	
(b) (ii)	It is an exothermic reaction The reaction produces heat **1**	

St Gr   Ammonia is produced in the Haber process.   1
2012   Temperature is another factor which affects the percentage yield of ammonia.
Q12 (c)

Temperature/°C	Percentage yield of ammonia
200	88
300	67
400	49
500	18

Suggest a reason why 500 °C is the temperature chosen to operate an industrial ammonia plant rather than 200 °C.

Answer   Sample Answers and Mark Allocation   Notes
           Speed up reaction, too slow at 200⁰C   **Not acceptable:**
           1   Any mention of
                                                     decomposition
                                                     Cost
                                                     Negates:
                                                     Faster & produces more
                                                     ammonia

Marks

St Gr   Potassium hydroxide reacts with sulphuric acid to form potassium sulphate, which can be used   1
2012   as a fertiliser.
Q 15
(c)   Calculate the percentage, by mass, of potassium in potassium sulphate, K_2SO_4.
   Show your working clearly.

Answer	Sample Answers and Mark Allocation	Notes
	FM = 174g (1 mark)	**Not acceptable:**
	$78/174 \times 100 = 44.8$ (1 mark)	44 on its own zero
	44.8 or 45 on its own 2 marks	If use element not in potassium
	Using atomic numbers 44% (max 1 mark)	
	44 must have working	
	If use mass of one potassium max 1 mark	
	If use S or O max 1 mark	

.

Nuclear Chemistry

H
2011
A
Q40

Some smoke detectors make use of radiation which is very easily stopped by tiny smoke particles moving between the radioactive source and the detector.

1

radioisotope   detector
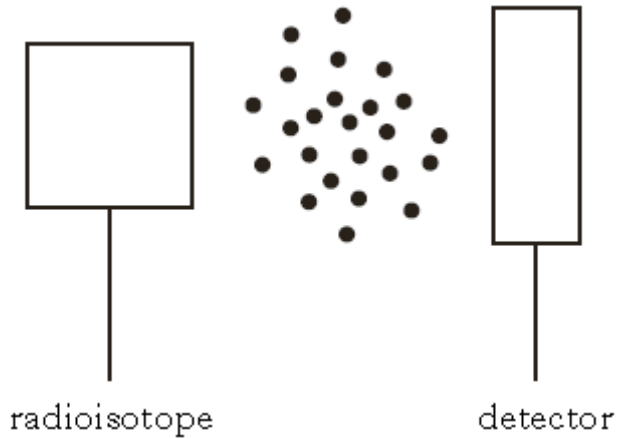
The most suitable type of radioisotope for a smoke detector would be

A an alpha-emitter with a long half-life

B a gamma-emitter with a short half-life

C an alpha-emitter with a short half-life

D a gamma-emitter with a long half-life.

Answer	Sample Answers and Mark Allocation	Notes
	A	

H
2011 B
Q12(b)
& (c) i

The element iodine has only one isotope that is stable. Several of the radioactive isotopes of iodine have medical uses. Iodine-131, for example, is used in the study of the thyroid gland and it decays by beta emission.
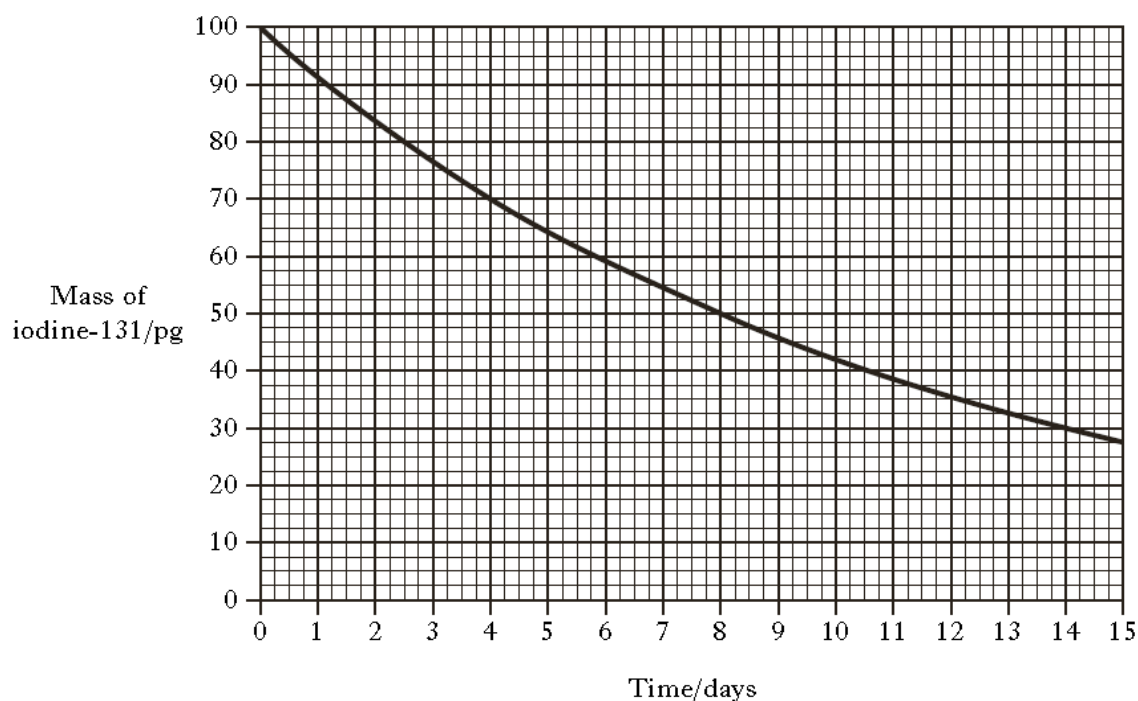
(a) Complete the balanced nuclear equation for the beta decay of iodine-131.   1

$$^{131}_{53}\text{I} \qquad \rightarrow$$

(b) The graph shows how the mass of iodine-131 in a sample changes over a period of time.   1

What is the half-life of this isotope?

Answers	Sample Answers and Mark Allocation	Notes
(a)		

$$^{131}_{53}I \rightarrow \ ^{131}_{54}Xe + \ ^{0}_{-1}e \qquad (1)$$

$$^{131}_{53}I \rightarrow \ ^{131}_{54}Xe + \ ^{0}_{-1}e^{-} \qquad (1)$$

$$^{131}I \rightarrow \ ^{131}Xe + e^{-} \qquad (1)$$

$$^{131}I \rightarrow \ ^{131}Xe + e \qquad (1) \qquad \textbf{1 or 0}$$

$$^{131}I \rightarrow \ ^{131}Xe + \beta \qquad (1)$$

(b)   8 days   **1**

Marks
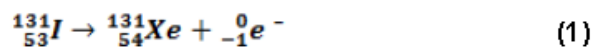
H 2012 B Q4 (a), (b) i & (c)	Phosphorus-32 and strontium-89 are two radioisotopes used to study how far mosquitoes travel.

(a) Strontium-89 decays by emission of a beta particle.   1
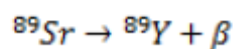Complete the nuclear equation for the decay of strontium-89.

$$^{89}Sr \rightarrow$$

(b) In an experiment, 10 g of strontium‑89 chloride was added to a sugar solution used to   1
feed mosquitoes.
The strontium‑89 chloride solution was fed to the mosquitoes in a laboratory at 20 °C.
When the mosquitoes were released, the outdoor temperature was found to be 35 °C.
What effect would the increase in temperature have on the half-life of the strontium-89?

(c) A mosquito fed on a solution containing phosphorus-32 is released.   1
Phosphorus-32 has a half-life of 14 days.
When the mosquito is recaptured 28 days later, what fraction of the phosphorus-32 will
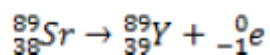remain?

Question	Sample Answers and Mark Allocation	Notes
(a)	$$^{89}Sr \rightarrow {}^{89}Y + \beta$$ or $$^{89}_{38}Sr \rightarrow {}^{89}_{39}Y + {}^{0}_{-1}e$$ **1** Atomic numbers not required- if shown, they must be correct Mass numbers shown top left as in question paper	
(b)	No effect/no change **1**	

(c)   ¼ or 0.25 or 25%   **1**
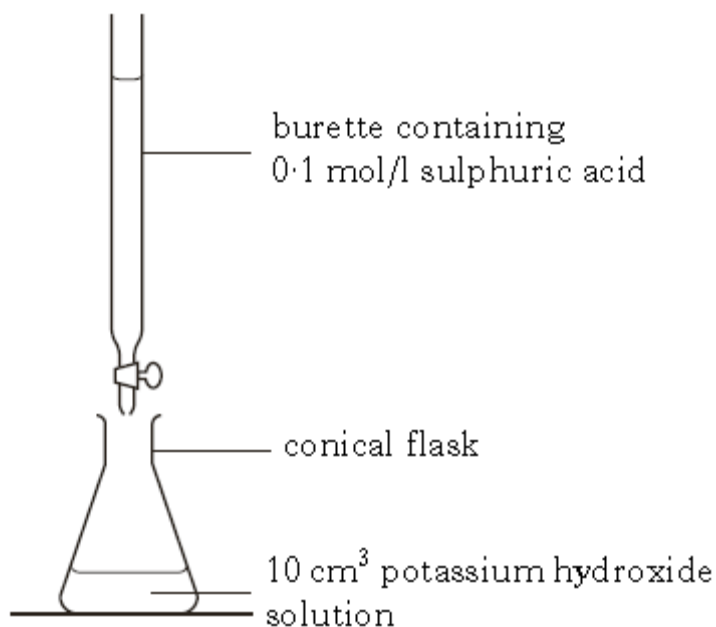

Chemical Analysis

St   Potassium sulphate can be produced by titrating potassium hydroxide solution with dilute
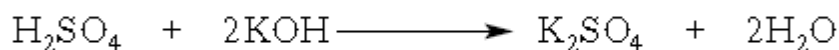Gr   sulphuric acid.
2011
Q20
(c) i
&(d)

burette containing
0·1 mol/l sulphuric acid

conical flask

10 cm³ potassium hydroxide
solution

(c)i   What must be added to the conical flask to show the end-point of the titration?   1

(d)   The equation for the reaction is: 2

$$H_2SO_4 \ + \ 2KOH \longrightarrow K_2SO_4 \ + \ 2H_2O$$

The number of moles of sulphuric acid used was 0.002 moles. Using this, calculate the
number of moles of potassium hydroxide in the 10cm³ sample of potassium hydroxide
solution.

Answers	Sample Answers and Mark Allocation		Notes
(c)i			**Not acceptable:**
	Indicator/named acid/base indicator		Ferroxyl indicator
	pH/universal indicator	**1**	Bicarbonate indicator

Marks

St Gr   Another experiment involved determining the concentration of sodium carbonate solution by
2013   titration.
Q 18
(b) ii
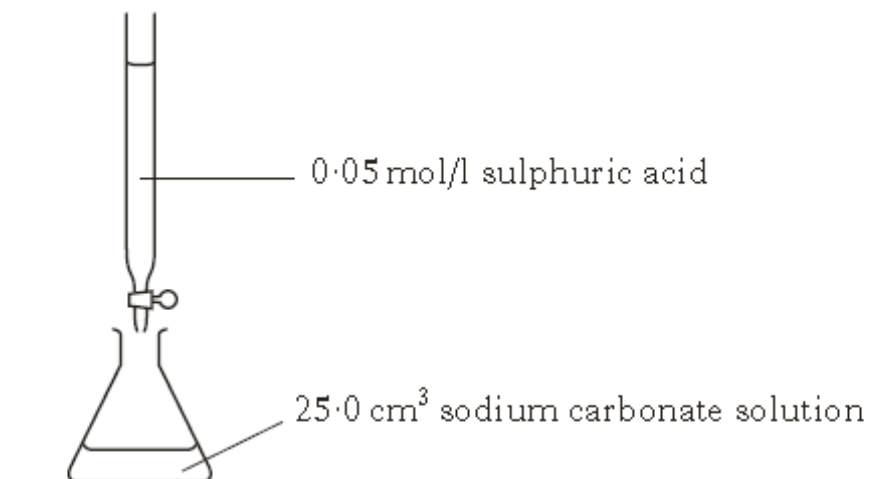
The results showed that 20 cm^3 of sulphuric acid was required to neutralise the sodium
carbonate solution.

One mole of sulphuric acid reacts with one mole of sodium carbonate.

0.001 moles of sulphuric acid reacted, calculate the concentration, in mol/l, of the sodium
carbonate solution.

Question   Sample Answers and Mark Allocation   Notes

                Apply mole ratio 1:1
                0·001: 0·001   **1** mark
                0·001 = c x 0·025
                c = 0·04   **1** mark

Int 2
2011
B
Q11
(c)ii
& iii

Some household cleaners contain the chemical limonene which gives them a lemon smell. The structure of limonene is shown below.

$$CH_3$$
$$C$$
$$H_2C \qquad CH$$
$$H_2C \qquad CH_2$$
$$C$$
$$H \qquad C-CH_3$$
$$CH_2$$
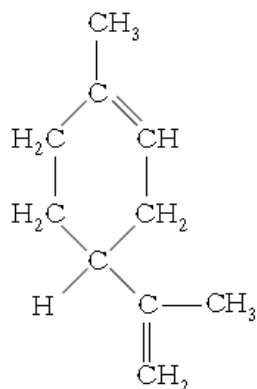
Using bromine solution, a student carried out titrations to determine the concentration of limonene in a household cleaner.

0·50 mol l⁻¹ bromine solution
(orange/red)

Flask

20·0 cm³ household cleaner
(colourless)
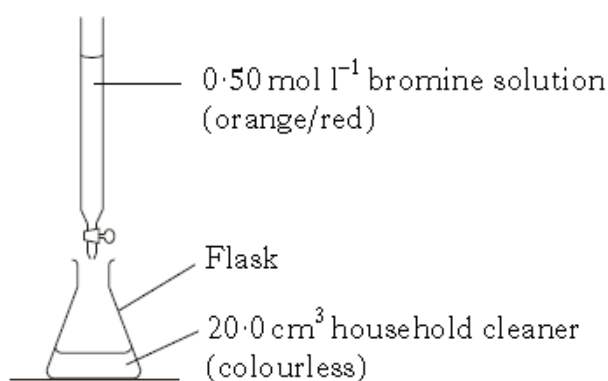
Titration	Initial burette reading (cm³)	Final burette reading (cm³)	Titre (cm³)
1	0·5	17·1	16·6
2	0·2	16·3	16·1
3	0·1	16·0	15·9

(c)i   What average volume should be used in calculating the concentration of limonene?   1

(c)i
i   The equation for the reaction between limonene and bromine solution is shown.   3

$$C_{10}H_{16}(aq) \; + \; 2Br_2(aq) \longrightarrow C_{10}H_{16}Br_4(aq)$$
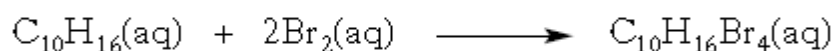
Calculate the concentration of limonene in the household cleaner in mol l⁻¹.

Question	Sample Answers and Mark Allocation	Notes
(c)i	$16·0/16$ **1**	

(c)ii

moles of Br_2 $= 0·5 \times 0·016$
$\qquad\qquad = 0·008$ **1 mark**

moles of $C_{10}H_{16} = \dfrac{0·008}{2} = 0·004$

1 mark

concentration of $C_{10}H_{16} = \dfrac{0·004}{0·02}$

$= 0·2$ **1 mark**

Or $0·2025$ (if $16·2$ used)
$= 0·20/0·203$ if rounded
Allow follow through for incorrect answer above.

$\dfrac{20 \times c_1}{1} = \dfrac{16 \times 0·5}{2}$
$40 \times c_1 = 8$
$\qquad c_1 = 0·2$