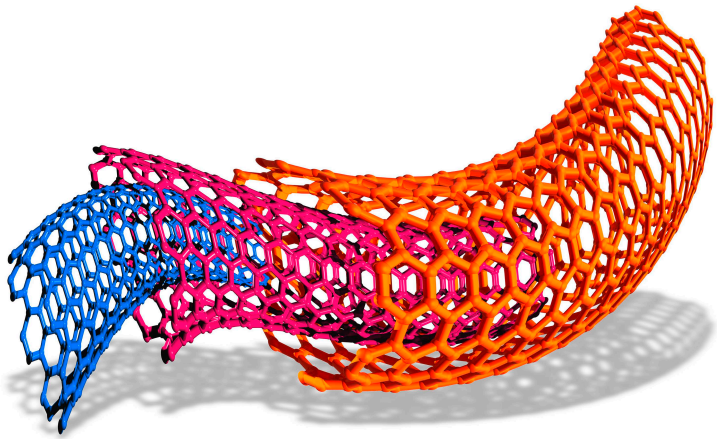
Cambridge Assessment International Education

Interactive

Interactive Example Candidate Responses

Paper 4 (May / June 2016), Question 2

Cambridge IGCSE™
Chemistry 0620



Version 2.0

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Select page

HIGH | MIDDLE | LOW

2 Period 3 contains the elements sodium to argon. This question asks about the chemistry of each of the Period 3 elements or their compounds.

(a) Sodium nitrate is a white crystalline solid. When heated it melts and the following reaction occurs.

$$2NaNO_3(l) \rightarrow 2NaNO_2(l) + O_2(g)$$

A 3.40 g sample of sodium nitrate is heated.

Calculate the

- number of moles of $NaNO_3$ used,

1 mol : 85g
n : 3.40
$= \frac{3.40}{85} = 0.04$ mols

0.04 mol

- number of moles of O_2 formed,

2 : 1
0.04 : n
$n = \frac{0.04}{2} = 0.02$

0.02 mol

- volume of O_2 formed, in dm^3 (measured at r.t.p.).

1 : 24
0.02 : n
$n = 24 \times 0.04 = 0.48$

0.48 dm^3 [3]

(b) Magnesium reacts slowly with warm water to form a base, magnesium hydroxide.

(i) Explain what is meant by the term *base*.

A compound that can react with an acid to give salt [1]

(ii) Write a chemical equation for the reaction between magnesium and warm water.

$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$ [2]

	Your Mark	Examiner marks and comments	
		Mark	Comment
2(a)		3/3	Correct.
2(b)(i)		0/1	The answer needed to include the idea of a proton acceptor.
2(b)(ii)		2/2	Correct.
2(c)		2/3	The candidate mentions reacting aluminium with named acids and bases but does not describe the dissolving of aluminium oxide in acids.
2(d)(i)		1/1	Correct.
2(d)(ii)		2/2	Correct.
2(e)(i)		1/2	The answer scores one mark for giving the oppositely charged ions involved but does not state that these particles attract one another.
2(e)(ii)		1/1	Correct.

EXAMINER COMMENTS | MARK SCHEME

(c) Aluminium oxide is amphoteric. It is insoluble in water.

$Al_2O_3 + HCl$

Describe experiments to show that aluminium oxide is amphoteric.

Add aluminium oxide to a few drops of aqueous sodium hydroxide, a white precipitate will form; add excess sodium hydroxide, solution will re dissolve to give a colorless solution. Aluminium oxide will react with an acid like HCl to form a salt, acting as base. It will redissolve in excess sodium hydroxide solution to form a colourless solution by forming salt of Sodium Alumminate while acting as a acid. [3]

(d) Silicon(IV) oxide has a giant structure.

(i) Name the type of bonding in silicon(IV) oxide.

Covalent [1]

(ii) Give two **physical** properties of silicon(IV) oxide.

High melting and boiling point

Insoluble in water. [2]

(e) Calcium phosphate is used in fertilisers. The bonding in calcium phosphate is ionic. Calcium phosphate contains the phosphate ion, PO_4^{3-}.

(i) What is ionic bonding?

Bonding between a cation and anion through complete transfer of electrons. Electrostatic forces hold the bonds. [2]

(ii) Deduce the formula of calcium phosphate.

$Ca_3(PO_4)_2$ [1]

	Your Mark
2(a)	
2(b)(i)	
2(b)(ii)	
2(c)	
2(d)(i)	
2(d)(ii)	
2(e)(i)	
2(e)(ii)	

Examiner marks and comments

	Mark	Comment
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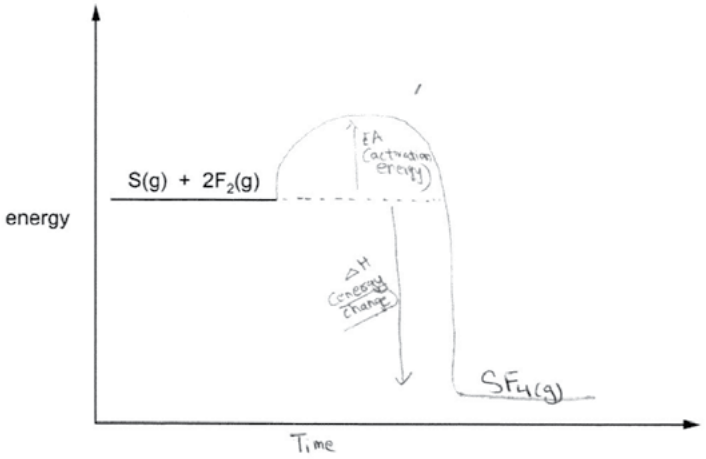
2(e)(ii)	1/1	Correct.

(f) Sulfur tetrafluoride, SF_4, can be made by combining gaseous sulfur with fluorine.

$$S(g) + 2F_2(g) \rightarrow SF_4(g)$$

The reaction is exothermic.

(i) Complete the energy level diagram for this reaction. Include an arrow which clearly shows the energy change during the reaction.

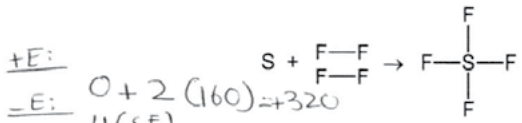


[3]

(ii) During the reaction the amount of energy given out is -780 kJ/mol.

The F–F bond energy is 160 kJ/mol.

Use this information to determine the bond energy, in kJ/mol, of one S–F bond in SF_4.

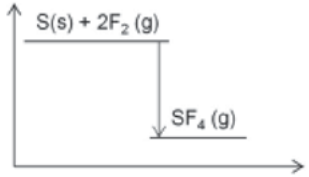


275 kJ/mol [3]

Select page

HIGH | MIDDLE | LOW

	Your Mark
2(f)(i)	
2(f)(ii)	
2(g)(i)	
2(g)(ii)	
2(h)(i)	
2(h)(ii)	

Q2	Mark scheme
(f)(i)	 **M1** *exothermic mark*: horizontal product energy line at lower energy than that of reactant energy line; **M2** *label of product mark*: SF_4; **M3** *correct direction of vertical heat arrow*: arrow must start level with reactant energy and finish level with product energy **and** must have only **one** (correct) arrow-head.
(f)(ii)	**M1** *bond energy of* $2F_2$: 2 × F–F = 2 × 160 = 320 (kJ/mol) **M2** *bond energy of all bonds in* SF_4: 780 + 320 = 1100 (kJ/mol) **M3** *calculated bond energy of* SF_4 *divided by 4*: 1100/4 = 275 (kJ/mol)
(g)(i)	kills bacteria;
(g)(ii)	name of compound: cobalt(II) chloride; from: blue; to: pink;
(h)(i)	it has a complete outer shell/a full outer shell/8 electrons in the outer shell;
(h)(ii)	(in) lamps;

EXAMINER COMMENTS | MARK SCHEME

(g) Chlorine and compounds of chlorine are important in water treatment and in laboratory testing for water.

(i) Chlorine is added to water to make the water safe to drink.

Explain why adding chlorine makes water safe to drink.

It kills bacteria in water. [1]

(ii) A compound of chlorine is used in the laboratory to test for the presence of water.

Name the compound of chlorine used in this test and describe the colour change seen in a positive result of this test.

name of compound Cobalt chloride

colour change from blue to pink

[3]

(h) Argon is an unreactive noble gas.

(i) Explain why argon is unreactive.

It outer shells are complete with electrons. [1]

(ii) Give **one** use of argon.

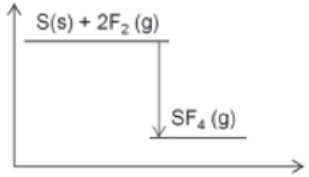
Filled in filament lamps [1]

[Total: 27]

Select page

HIGH MIDDLE LOW

	Your Mark
2(f)(i)	
2(f)(ii)	
2(g)(i)	
2(g)(ii)	
2(h)(i)	
2(h)(ii)	

Q2	Mark scheme
(f)(i)	 **M1** *exothermic mark*: horizontal product energy line at lower energy than that of reactant energy line; **M2** *label of product mark*: SF_4; **M3** *correct direction of vertical heat arrow*: arrow must start level with reactant energy and finish level with product energy **and** must have only **one** (correct) arrow-head.
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EXAMINER COMMENTS

MARK SCHEME

Select page

HIGH | MIDDLE | LOW

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(a) Sodium nitrate is a white crystalline solid. When heated it melts and the following reaction occurs.

$$2NaNO_3(l) \rightarrow 2NaNO_2(l) + O_2(g)$$

A 3.40 g sample of sodium nitrate is heated.

Calculate the

- number of moles of $NaNO_3$ used,

$\frac{3.4}{85} \neq \frac{0.04}{2}$ ~~x2~~.

0.042 mol

- number of moles of O_2 formed,

0.02 ÷ 2.

0.01 mol

- volume of O_2 formed, in dm^3 (measured at r.t.p.).

1 mole = 24

0.01 = x.

0.24 dm^3

[3]

(b) Magnesium reacts slowly with warm water to form a base, magnesium hydroxide.

(i) Explain what is meant by the term *base*.

Proton acceptor. Has OH^- ions. [1]

(ii) Write a chemical equation for the reaction between magnesium and warm water.

$2Mg + 2H_2O \rightarrow 2Mg(OH)_2$ [2]

~~Mg + H2O → MgOH2~~.

	Your Mark
2(a)	
2(b)(i)	
2(b)(ii)	
2(c)	
2(d)(i)	
2(d)(ii)	
2(e)(i)	
2(e)(ii)	

Q2	Mark scheme
(a)	number of moles of $NaNO_3$ used: 3.40/85 = 0.04(00) (mol) **OR** 4.(00) × 10^{-2} (mol); number of moles of O_2 formed: 0.04/2 = 0.02(00) (mol) **OR** 2.(00) × 10^{-2} (mol); volume of O_2 formed: 0.02 × 24 = 0.48 (dm^3);
(b)(i)	(a substance which is) a proton/H+/hydrogen ion acceptor;
(b)(ii)	$Mg(s) + 2H2O(l) \rightarrow Mg(OH)_2(aq) + H_2(g)$ $Mg(OH)_2$; rest of equation;
(c)	**M1** add a named acid, e.g. HCl and a named alkali, e.g. NaOH; **M2** Al_2O_3 will react with/neutralise both reagents; **M3** and so it will dissolve into the reagent/form a solution;
(d)(i)	covalent;
(d)(ii)	any 2 from: high melting point/high boiling point; poor conductor (of electricity); hard; insoluble;
(e)(i)	**M1** (electrostatic) attraction; **M2** between oppositely charged ions;
(e)(ii)	$Ca_3(PO_4)_2$;

EXAMINER COMMENTS

MARK SCHEME

Select page

HIGH | MIDDLE | LOW

(c) Aluminium oxide is amphoteric. It is insoluble in water.

Describe experiments to show that aluminium oxide is amphoteric.

React aluminum oxide with an acid. You will get an aluminum salt and water. React aluminum oxide and base you will get water and salt. [3]

Eg: $Al_2O_3 + H_2SO_4 \rightarrow Al(SO_4)_3 + H_2O$.

② $Al_2O_3 + NO_3 \rightarrow Al(NO_3)_3 + H_2O$

(d) Silicon(IV) oxide has a giant structure.

(i) Name the type of bonding in silicon(IV) oxide.

Covalent bonding [1]

(ii) Give two **physical** properties of silicon(IV) oxide.

Very hard. and high density. [2]

(e) Calcium phosphate is used in fertilisers. The bonding in calcium phosphate is ionic. Calcium phosphate contains the phosphate ion, PO_4^{3-}.

(i) What is ionic bonding?

Bonding between a metal and non-metal. Cation bonded to anion. [2]

(ii) Deduce the formula of calcium phosphate.

$Ca_3(PO_4)_2$ [1]

	Your Mark
2(a)	
2(b)(i)	
2(b)(ii)	
2(c)	
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2(d)(ii)	
2(e)(i)	
2(e)(ii)	

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EXAMINER COMMENTS

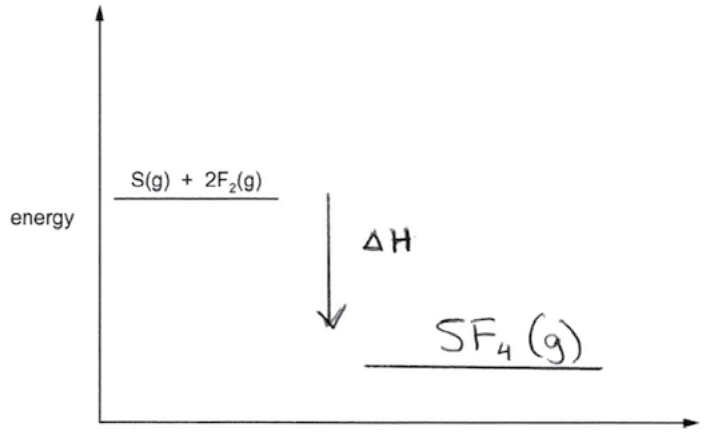
MARK SCHEME

(f) Sulfur tetrafluoride, SF_4, can be made by combining gaseous sulfur with fluorine.

$$S(g) + 2F_2(g) \rightarrow SF_4(g)$$

The reaction is exothermic.

(i) Complete the energy level diagram for this reaction. Include an arrow which clearly shows the energy change during the reaction.

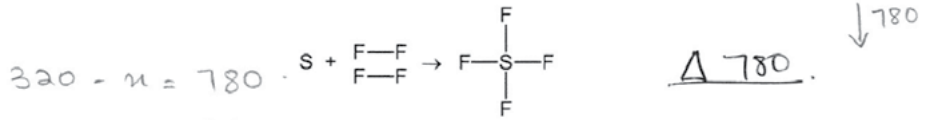


[3]

(ii) During the reaction the amount of energy given out is 780 kJ/mol.

The F–F bond energy is 160 kJ/mol.

Use this information to determine the bond energy, in kJ/mol, of one S–F bond in SF_4.



F-F x 2 = 320.

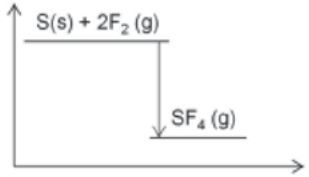
$\frac{-460}{4} = -115$

320 − x = 780

x = −460

-115 kJ/mol [3]

	Your Mark
2(f)(i)	
2(f)(ii)	
2(g)(i)	
2(g)(ii)	
2(h)(i)	
2(h)(ii)	

Q2	Mark scheme
(f)(i)	 **M1** *exothermic mark*: horizontal product energy line at lower energy than that of reactant energy line; **M2** *label of product mark*: SF_4; **M3** *correct direction of vertical heat arrow*: arrow must start level with reactant energy and finish level with product energy **and** must have only **one** (correct) arrow-head.
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(h)(ii)	(in) lamps;

EXAMINER COMMENTS

MARK SCHEME

(g) Chlorine and compounds of chlorine are important in water treatment and in laboratory testing for water.

(i) Chlorine is added to water to make the water safe to drink.

Explain why adding chlorine makes water safe to drink.

To kill microbes and bacteria. [1]

(ii) A compound of chlorine is used in the laboratory to test for the presence of water.

Name the compound of chlorine used in this test and describe the colour change seen in a positive result of this test.

name of compound Ea' Cobalt (II) chloride

colour change from blue to pink. [3]

(h) Argon is an unreactive noble gas.

(i) Explain why argon is unreactive.

Has a complete outter electron shell. (8 electrons). [1]

(ii) Give **one** use of argon.

Used in tungsten light bulbs. [1]

[Total: 27]

Select page

HIGH | MIDDLE | LOW

	Your Mark
2(f)(i)	
2(f)(ii)	
2(g)(i)	
2(g)(ii)	
2(h)(i)	
2(h)(ii)	

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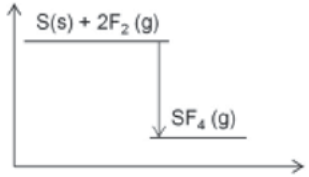
(f)(i)	 **M1** *exothermic mark*: horizontal product energy line at lower energy than that of reactant energy line; **M2** *label of product mark*: SF_4; **M3** *correct direction of vertical heat arrow*: arrow must start level with reactant energy and finish level with product energy **and** must have only **one** (correct) arrow-head.
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EXAMINER COMMENTS | MARK SCHEME

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(a) Sodium nitrate is a white crystalline solid. When heated it melts and the following reaction occurs..

$$2NaNO_3(l) \rightarrow 2NaNO_2(l) + O_2(g)$$

A 3.40 g sample of sodium nitrate is heated.

Calculate the

- number of moles of $NaNO_3$ used,

10 mol

- number of moles of O_2 formed,

6 Ab mol

- volume of O_2 formed, in dm^3 (measured at r.t.p.).

48 dm^3 [3]

(b) Magnesium reacts slowly with warm water to form a base, magnesium hydroxide.

(i) Explain what is meant by the term *base*.

It doesn't react [1]

(ii) Write a chemical equation for the reaction between magnesium and warm water.

$2Mg + 2H_2O \rightarrow 2MgH_2O$ [2]

Your Mark

2(a)

2(b)(i)

2(b)(ii)

2(c)

2(d)(i)

2(d)(ii)

2(e)(i)

2(e)(ii)

Q2	Mark scheme
(a)	number of moles of $NaNO_3$ used: 3.40/85 = 0.04(00) (mol) **OR** 4.(00) × 10^{-2} (mol); number of moles of O_2 formed: 0.04/2 = 0.02(00) (mol) **OR** 2.(00) × 10^{-2} (mol); volume of O_2 formed: 0.02 × 24 = 0.48 (dm^3);
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(d)(i)	covalent;
(d)(ii)	any 2 from: high melting point/high boiling point; poor conductor (of electricity); hard; insoluble;
(e)(i)	**M1** (electrostatic) attraction; **M2** between oppositely charged ions;
(e)(ii)	$Ca_3(PO_4)_2$;

EXAMINER COMMENTS

MARK SCHEME

(c) Aluminium oxide is amphoteric. It is insoluble in water.

Describe experiments to show that aluminium oxide is amphoteric.

-try to dissolve it in water

[3]

(d) Silicon(IV) oxide has a giant structure.

(i) Name the type of bonding in silicon(IV) oxide.

covalent ionic [1]

(ii) Give two **physical** properties of silicon(IV) oxide.

-shiny

-malubal [2]

(e) Calcium phosphate is used in fertilisers. The bonding in calcium phosphate is ionic. Calcium phosphate contains the phosphate ion, PO_4^{3-}.

(i) What is ionic bonding?

When two ionic compounds bond

[2]

(ii) Deduce the formula of calcium phosphate.

$2Ca_3PO_4^{-3}$ [1]

Select page

HIGH MIDDLE LOW

	Your Mark
2(a)	
2(b)(i)	
2(b)(ii)	
2(c)	
2(d)(i)	
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EXAMINER COMMENTS

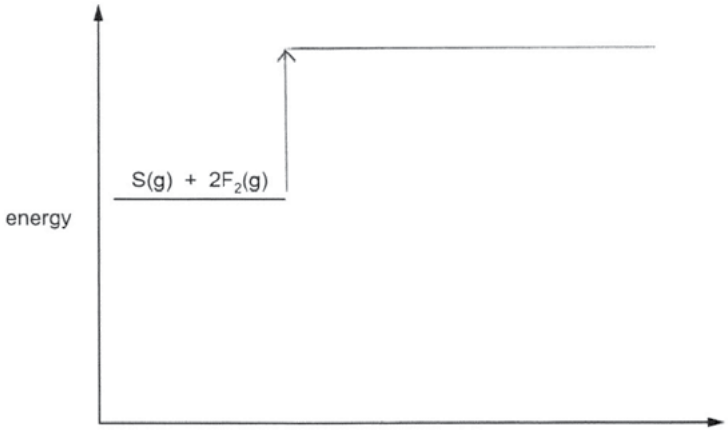
MARK SCHEME

(f) Sulfur tetrafluoride, SF_4, can be made by combining gaseous sulfur with fluorine.

$$S(g) + 2F_2(g) \rightarrow SF_4(g)$$

The reaction is exothermic.

(i) Complete the energy level diagram for this reaction. Include an arrow which clearly shows the energy change during the reaction.



[3]

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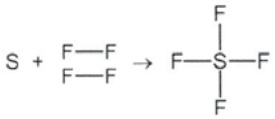
Use this information to determine the bond energy, in kJ/mol, of one S–F bond in SF_4.

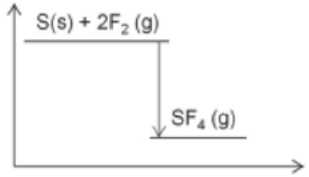


780 - 160 - 160 = 460

460 ÷ 4 = 115

~~195~~ 115 kJ/mol [3]

Your Mark	
2(f)(i)	
2(f)(ii)	
2(g)(i)	
2(g)(ii)	
2(h)(i)	
2(h)(ii)	

Q2	Mark scheme
(f)(i)	 **M1** *exothermic mark*: horizontal product energy line at lower energy than that of reactant energy line; **M2** *label of product mark*: SF_4; **M3** *correct direction of vertical heat arrow*: arrow must start level with reactant energy and finish level with product energy **and** must have only **one** (correct) arrow-head.
(f)(ii)	**M1** *bond energy of* $2F_2$: $2 \times F–F = 2 \times 160 = 320$ (kJ/mol) **M2** *bond energy of all bonds in* SF_4: 780 + 320 = 1100 (kJ/mol) **M3** *calculated bond energy of* SF_4 *divided by 4*: 1100/4 = 275 (kJ/mol)
(g)(i)	kills bacteria;
(g)(ii)	name of compound: cobalt(II) chloride; from: blue; to: pink;
(h)(i)	it has a complete outer shell/a full outer shell/8 electrons in the outer shell;
(h)(ii)	(in) lamps;

(g) Chlorine and compounds of chlorine are important in water treatment and in laboratory testing for water.

(i) Chlorine is added to water to make the water safe to drink.

Explain why adding chlorine makes water safe to drink.

It kills germs ..... [1]

(ii) A compound of chlorine is used in the laboratory to test for the presence of water.

Name the compound of chlorine used in this test and describe the colour change seen in a positive result of this test.

name of compound ..... Cl_2 .....

colour change from ..... Green ..... to ..... colourless .....

[3]

(h) Argon is an unreactive noble gas.

(i) Explain why argon is unreactive.

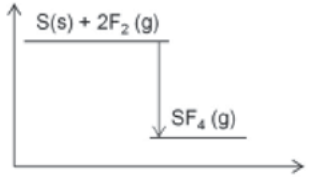
because it has a complete outer shell ..... [1]

(ii) Give **one** use of argon.

used it lights ..... [1]

[Total: 27]

	Your Mark
2(f)(i)	
2(f)(ii)	
2(g)(i)	
2(g)(ii)	
2(h)(i)	
2(h)(ii)	

Q2	Mark scheme
(f)(i)	 **M1** *exothermic mark*: horizontal product energy line at lower energy than that of reactant energy line; **M2** *label of product mark*: SF_4; **M3** *correct direction of vertical heat arrow*: arrow must start level with reactant energy and finish level with product energy **and** must have only **one** (correct) arrow-head.
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EXAMINER COMMENTS

MARK SCHEME

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