**1** When ammonium chloride dissolves in water, the temperature of the solution decreases.

What is the name for a reaction where the temperature of the solution decreases?

..... [1]

[Total: 1]

**2** The reaction of sodium with water is exothermic.

What is meant by the term *exothermic*?

.....

..... [1]

[Total: 1]

**3** Ammonia is used in the manufacture of nitric acid.

**(a)** Balance the chemical equation for the first step in the process.

$$4NH_3 + 5O_2 \rightarrow .....NO + 6H_2O$$

[1]

**(b)** The reaction is exothermic.

What is meant by the term *exothermic*?

.....

..... [1]

**(c)** The NO produced in the first step then reacts with oxygen to produce nitrogen dioxide, $NO_2$.

$$2NO + O_2 \rightarrow 2NO_2$$

How does this equation show that NO is oxidised?

.....

..... [1]

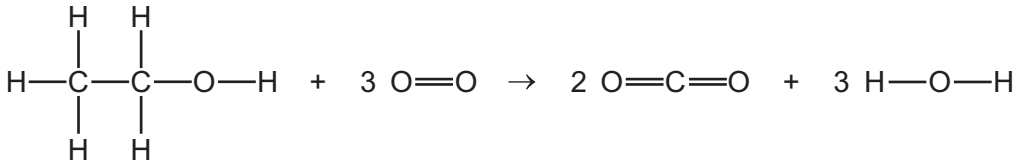
**(d)** Is nitrogen dioxide an acidic oxide or a basic oxide?
Give a reason for your answer.

.....

..... [1]

[Total: 4]

**4** The equation for the complete combustion of ethanol is shown.



Use the bond energies in the table to calculate the energy change, in kJ / mol, for the complete combustion of ethanol

| bond | bond energy in kJ / mol |
|---|---|
| C–C | 347 |
| C–H | 413 |
| C–O | 358 |
| C=O | 805 |
| O–H | 464 |
| O=O | 498 |

**(a)** Energy needed to break bonds.

..... kJ [1]

**(b)** Energy released when bonds are formed.

..... kJ [1]

**(c)** Energy change for the complete combustion of ethanol.

energy change = ..... kJ / mol [1]

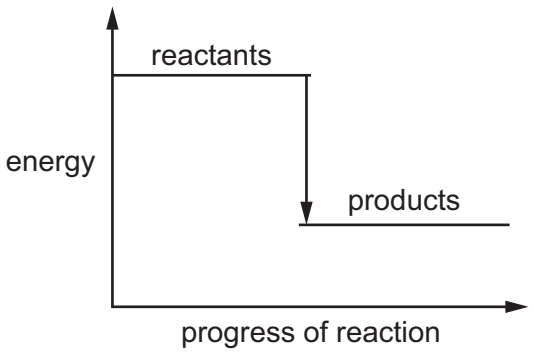
[Total: 3]

**5** Bromine reacts with hydrogen sulfide, $H_2S$.

**(a)** Complete the chemical equation for this reaction.

..... + $H_2S$ → .....HBr + S [2]

**(b)** The energy level diagram for this reaction is shown.




Explain how this diagram shows that the reaction is exothermic.

.....

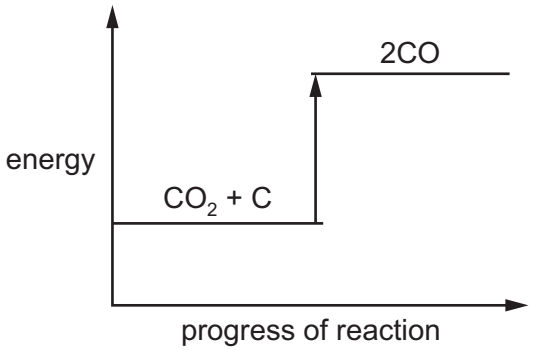
..... [1]

[Total: 3]

**6** Carbon dioxide can be reduced by carbon.

$$CO_2 + C \rightarrow 2CO$$

The energy level diagram for this reaction is shown.




Explain how this diagram shows that the reaction is endothermic.

.....

..... [1]

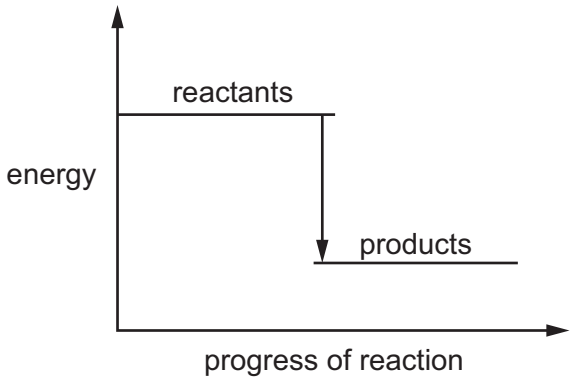
[Total: 1]

**7** Iodine reacts with aqueous sodium thiosulfate, $Na_2S_2O_3$.

**(a)** Balance the chemical equation for this reaction.

$$.....Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + .....NaI$$ [2]

**(b)** The energy level diagram for this reaction is shown.




Explain how this diagram shows that the reaction is exothermic.

.....

..... [1]

[Total: 3]

**8** Chromium can be manufactured by the reduction of chromium(III) oxide, $Cr_2O_3$, with aluminium.

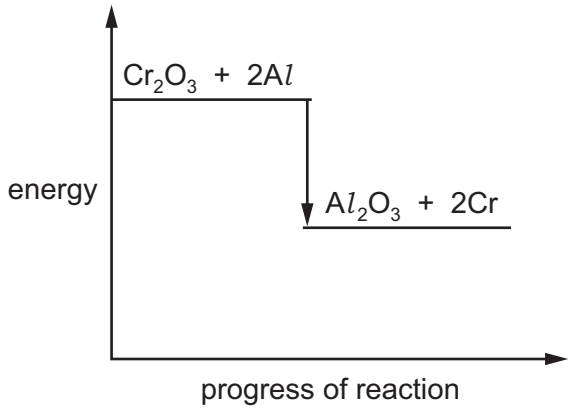
$$Cr_2O_3 + 2Al \rightarrow Al_2O_3 + 2Cr$$

**(a)** How does this equation show that chromium(III) oxide is reduced?

.....

..... [1]

**(b)** The energy level diagram for this reaction is shown.




Explain how this diagram shows that the reaction is exothermic.

.....

..... [1]

[Total: 2]

**9** Sodium carbonate can be manufactured by the reaction between limestone and sodium chloride. The reaction is endothermic.

What is meant by the term *endothermic*?

..... [1]

[Total: 1]

**10** Solid hydrated copper(II) sulfate decomposes to anhydrous copper(II) sulfate when it is continuously heated.

Is this an endothermic or an exothermic reaction?
Explain your answer.

.....

..... [1]

[Total: 1]

**11** Charcoal (carbon) can be burned in an excess of clean, dry air to provide the heat needed to make glass.

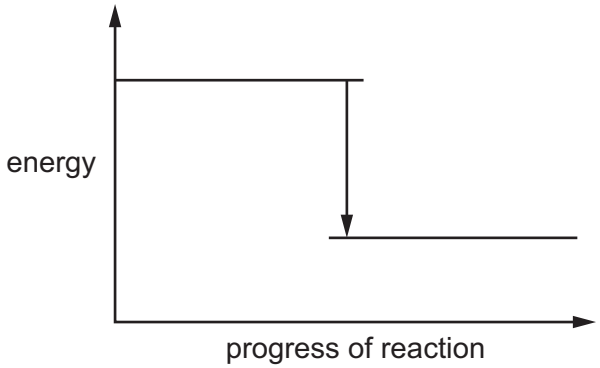
**(a)** Which gas is 21% of clean, dry air?

..... [1]

**(b)** Write a word equation for carbon burning in an excess of air.

..... [1]

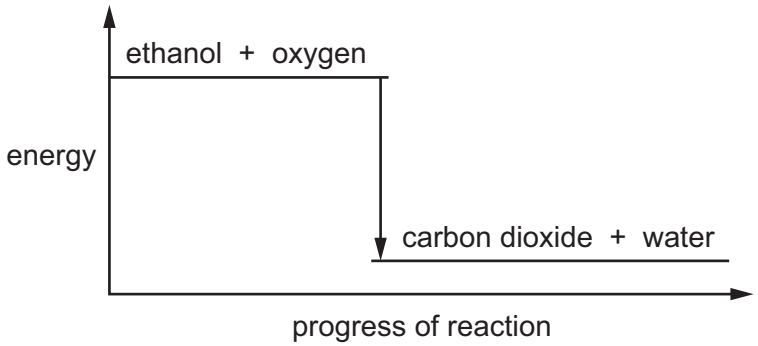
**(c)** Complete the energy level diagram for this reaction by adding these **two** words:
- reactants
- product.




[1]

[Total: 3]

**12** The energy level diagram for the complete combustion of ethanol is shown.




Explain how this diagram shows that the reaction is exothermic.

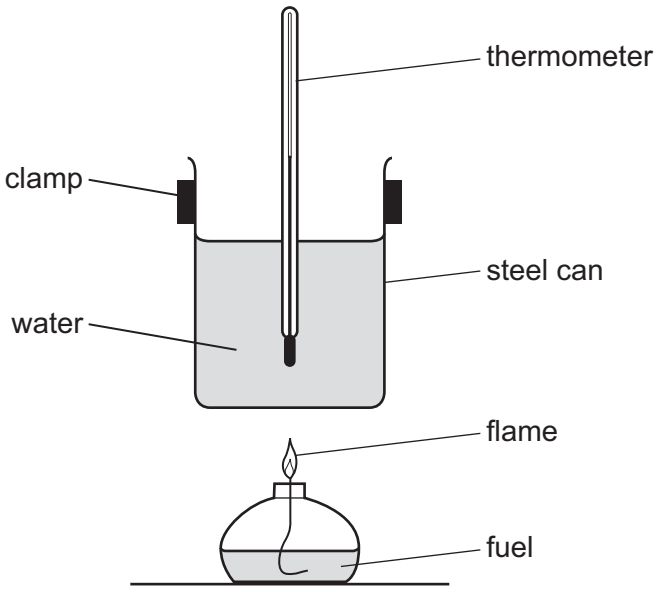
.....

..... [1]

[Total: 1]

**13** The energy released by burning four different fuels is compared using the apparatus shown.

A known mass of each fuel is burned and the temperature rise of the water is measured.




Suggest **two** factors that should be kept constant in this experiment.

1 .....

2 ..... [2]

[Total: 2]

**14** The reaction of ethanoic acid with sodium hydroxide is exothermic.

What is meant by the term *exothermic*?

..... [1]

[Total: 1]

**15** Refinery gas contains methane, ethane and propane.

**(a)** Draw the structure of a molecule of ethane showing all of the atoms and all of the bonds.

[1]

**(b)** Methane can be converted to hydrogen by reaction with steam.

Balance the chemical equation for this reaction.

$CH_4 + H_2O \rightarrow CO + .....H_2$ [1]

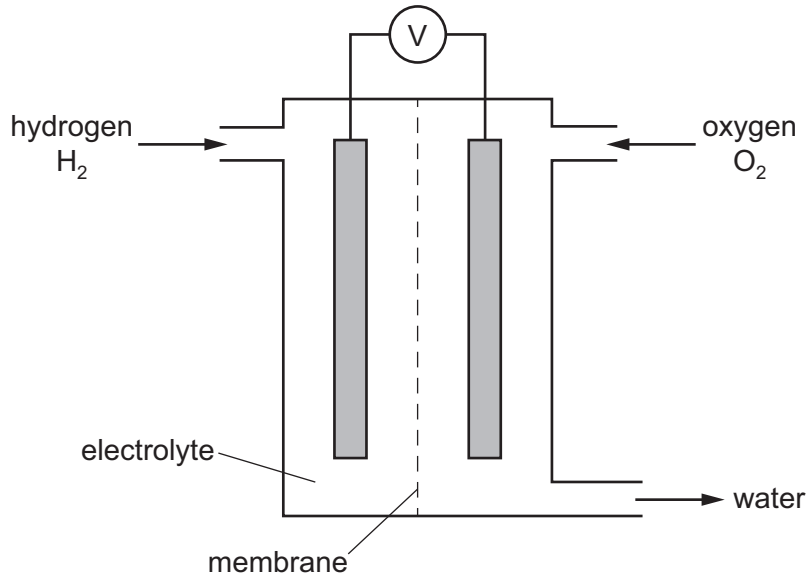
**(c)** This reaction is endothermic.

What is meant by the term *endothermic*?

..... [1]

[Total: 3]

**16** Hydrogen and oxygen react together in a hydrogen fuel cell. A hydrogen fuel cell is shown in the diagram.




In a hydrogen fuel cell, the hydrogen molecules are converted into hydrogen ions, $H^+$, according to the ionic half-equation shown.

$$H_2 \rightarrow 2H^+ + 2e^-$$

Write a chemical equation for the overall reaction that occurs in a hydrogen fuel cell.

..... [1]

[Total: 1]

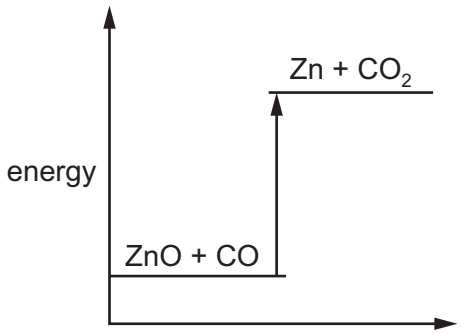
**17** Zinc is extracted from zinc oxide by heating zinc oxide with carbon monoxide.

$$ZnO + CO \rightarrow Zn + CO_2$$

**(a)** How does this equation show that zinc oxide is reduced?

..... [1]

**(b)** The energy level diagram for this reaction is shown.




Explain how this diagram shows that the reaction is endothermic.

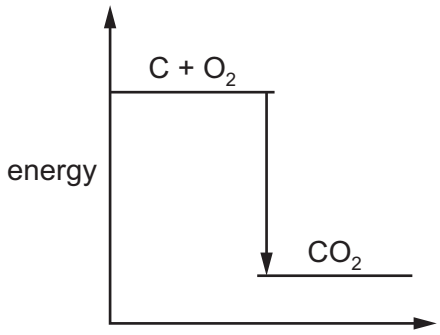
.....

..... [1]

[Total: 2]

**18** Carbon is an element in Group IV of the Periodic Table. It reacts with oxygen to form carbon dioxide.

The energy level diagram for this reaction is shown.



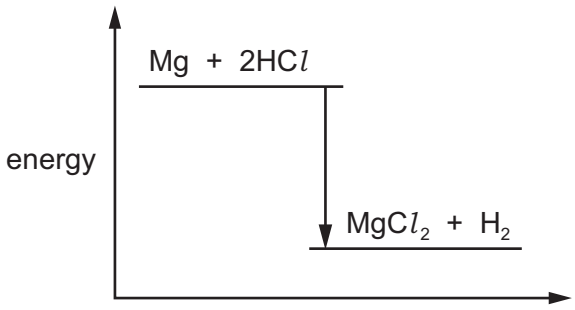

Explain how this diagram shows that the reaction is exothermic.

.....

..... [1]

[Total: 1]

**19** The energy level diagram for the reaction between magnesium and hydrochloric acid is shown.




Which statement about the reaction is **not** correct?

**A** Energy is given out during the reaction.

**B** The products are at a lower energy level than the reactants.

**C** The reaction is endothermic.

**D** The temperature increases during the reaction.

[1]

[Total: 1]

**20** Which reaction is endothermic?

**A** acid neutralising alkali causing a temperature increase

**B** adding magnesium to hydrochloric acid

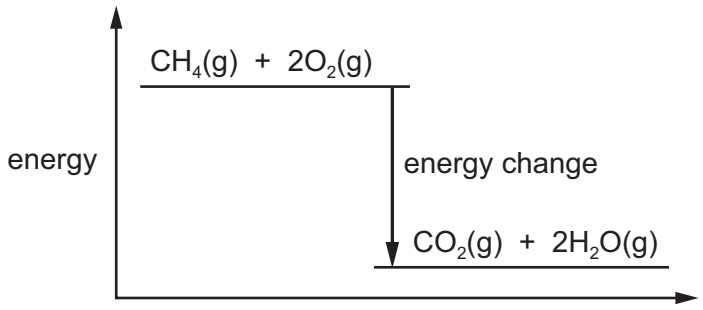
**C** calcium carbonate decomposing when heated

**D** combustion of fossil fuels

[1]

[Total: 1]

**21** The energy level diagram for the combustion of methane is shown.




Which row gives the equation and energy change for this reaction?

| | equation | energy change in kJ / mol |
|---|---|---|
| **A** | $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ | +891 |
| **B** | $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ | –891 |
| **C** | $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ | +891 |
| **D** | $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ | –891 |

[1]

[Total: 1]

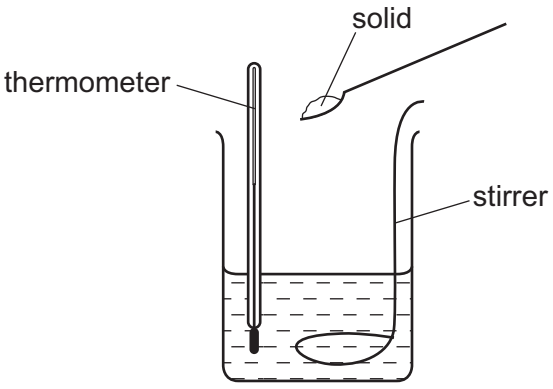
**22** Which row correctly describes whether the reaction is exothermic or endothermic?

| | reaction | exothermic | endothermic |
|---|---|---|---|
| **A** | calcium carbonate → calcium oxide + carbon dioxide | ✓ | ✗ |
| **B** | carbon + oxygen → carbon dioxide | ✓ | ✗ |
| **C** | methane + oxygen → carbon dioxide + water | ✗ | ✓ |
| **D** | sodium + water → sodium hydroxide + hydrogen | ✗ | ✓ |

[1]

[Total: 1]

**23** A student measures the maximum temperature changes when five different solids, **P**, **Q**, **R**, **S** and **T**, are dissolved separately in water. She uses the apparatus shown below.




The table of results is shown below.

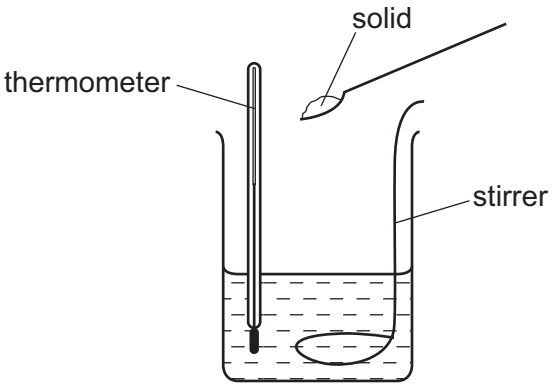
| solid added | initial temperature of the water / °C | highest temperature of the solution / °C |
|---|---|---|
| **P** | 20 | 24 |
| **Q** | 18 | 23 |
| **R** | 19 | 16 |
| **S** | 22 | 23 |
| **T** | 20 | 18 |

Which solid gave the greatest temperature change when dissolved in water?

..... [1]

[Total: 1]

**24** A student measures the maximum temperature changes when five different solids, **P**, **Q**, **R**, **S** and **T**, are dissolved separately in water. She uses the apparatus shown below.




The student stirs the mixture as each solid is added.

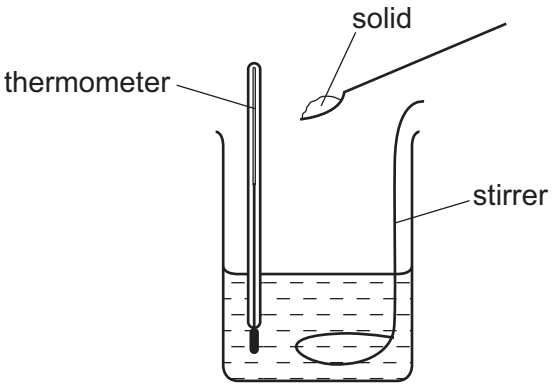
Suggest why she does this.

.....

..... [1]

[Total: 1]

**25** A student measures the maximum temperature changes when five different solids, **P**, **Q**, **R**, **S** and **T**, are dissolved separately in water. She uses the apparatus shown below.




Suggest **two** factors which should be kept the same to make the experiment a fair test.

1. .....

2. ..... [2]

[Total: 2]

**26** Radioactive isotopes can be used as a source of energy.

Which **one** of the following isotopes is a radioactive isotope?
Put a ring around the correct answer.

$^{12}_{6}C$ $^{235}_{92}U$ $^{1}_{1}H$ $^{65}_{30}Zn$

[1]

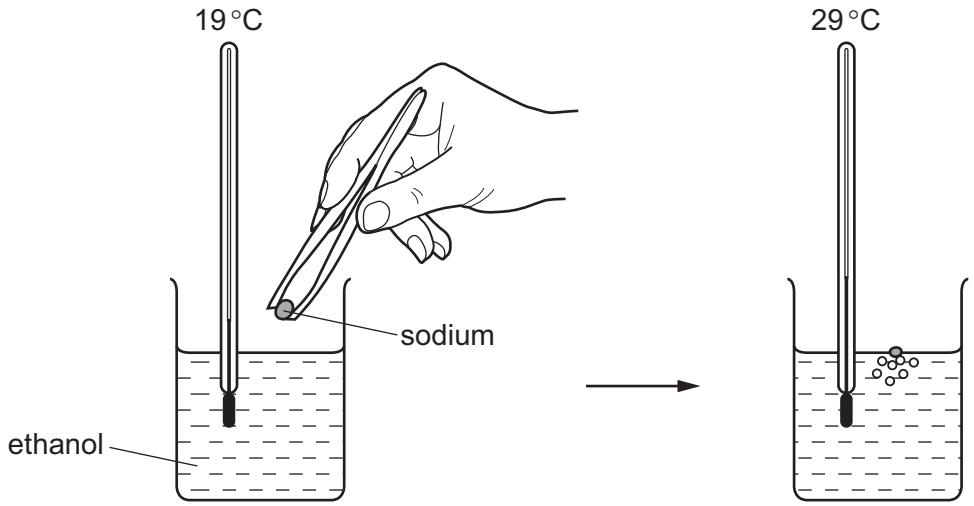
[Total: 1]

**27** Is burning an exothermic or an endothermic reaction?
Give a reason for your answer.

..... [1]

[Total: 1]

**28** A small piece of sodium is added to some ethanol. The temperature was measured before and after the sodium was added.




Explain how this experiment shows that the reaction is exothermic.

..... [1]

[Total: 1]

**29** Limestone can be changed into slaked lime in two chemical reactions.

**1.** When limestone, $CaCO_3$, is heated it decomposes into lime, CaO.

**2.** Water is slowly dripped into the cooled lime. The lime appears to expand and steam is produced. Slaked lime, $Ca(OH)_2$, is formed.

Which row shows the correct description of each of the chemical reactions?

| | reaction 1 | reaction 2 |
|---|---|---|
| **A** | endothermic | endothermic |
| **B** | endothermic | exothermic |
| **C** | exothermic | endothermic |
| **D** | exothermic | exothermic |

[1]

[Total: 1]

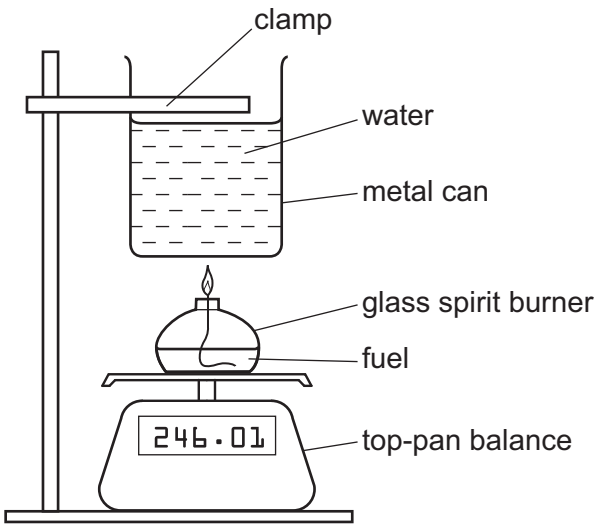
**30** When metals react with hydrochloric acid, the temperature of the reaction mixture increases.
Which **one** of the following words best describes this reaction?
Draw a ring around the correct answer.

**endothermic** **exothermic** **isotopic** **radioactive**

[1]

[Total: 1]

**31** A student wants to compare the energy released when different fuels are burned.
He measures the increase in temperature of the water in a metal can when the fuels are burned.



**(a)** What piece of apparatus is missing from the diagram above?

..... [1]

**(b)** State **two** things the student should keep the same when burning each fuel.

.....

.....

..... [2]

**(c)** Suggest why the water in the can should be stirred.

.....

..... [1]

**(d)** What happens to the reading on the top-pan balance as the fuel burns?
Give a reason for your answer.

.....

..... [2]

**(e)** The results of burning four fuels, **D**, **E**, **F** and **G**, are shown in the table below.

| fuel | temperature of water at start of experiment / °C | temperature of water at end of experiment / °C |
|---|---|---|
| **D** | 20 | 45 |
| **E** | 19 | 43 |
| **F** | 16 | 44 |
| **G** | 21 | 46 |

Which fuel produced the greatest temperature rise in the water?

..... [1]

[Total: 7]

**32** Some reactions are endothermic.

How does the temperature and energy change in an endothermic reaction?

| | temperature change | energy change |
|---|---|---|
| **A** | decreases | energy taken in |
| **B** | decreases | energy given out |
| **C** | increases | energy taken in |
| **D** | increases | energy given out |

[1]

[Total: 1]

**33** Natural gas, which is mainly methane, is a fossil fuel.

**(a)** What is meant by the term *fuel*?

.....

..... [1]

**(b)** Name **two** other fossil fuels.

..... [2]

**(c)** Name a **solid** fuel which is not a fossil fuel.

..... [1]

[Total: 4]

**34** Some white anhydrous copper(II) sulfate powder is put into a beaker of water and stirred.

What would show that the process was exothermic?

**A** A blue solution is formed.

**B** The beaker feels cooler.

**C** The beaker feels warmer.

**D** The powder dissolves in the water.

[1]

[Total: 1]