Year 8 science

Topic 8E Combustion

8E Combustion

Draw a ring around a number of stars for each statement. If you are very confident about a statement, draw your ring around all the stars. If you do not know anything about a statement do not draw a ring.

Topic	At the end of the unit:	
8Ea		
	State the meaning of fuel and combustion.	* * * * *
	Describe the reactants and products in the combustion of hydrocarbons.	* * * * *
	Name the fuel used in a fuel cell.	* * * * *
	Describe the tests for carbon dioxide and water.	* * * * *
	Write word equations to model reactions.	* * * * *
8Eb		
	State the meaning of oxidation.	* * * * *
	Describe the reactions of metals with oxygen.	* * * * *
	Identify reactants and products of oxidation using word equations.	* * * * *
	State what happens to mass in a chemical reaction.	* * * * *
	Explain changes in mass seen in reactions.	* * * * *
	Compare and contrast the oxygen and phlogiston theories.	* * * * *
8Ec		
	Name the three sides of a fire triangle and recognise hazard symbols.	* * * * *
	Describe what is meant by an exothermic change.	* * * * *
	Explain why different types of fire need to be put out in different ways.	* * * * *
	Evaluate data on burning fuels.	* * * * *
8Ec Working Scientifically		
	Identify variables that need to be controlled in an experiment.	* * * * *
	Plan ways in which to control variables in an experiment.	* * * * *
8Ed		
	Recall examples of pollutants formed by burning fossil fuels.	* * * * *
	Describe the reactions of non-metals with oxygen.	* * * * *
	Explain the products of complete and incomplete combustion of fossil fuels.	* * * * *
	Explain how sulfur dioxide and nitrogen can cause acid rain.	* * * * *
	Explain how pollution from fossil fuel combustion can be reduced.	* * * * *
	Evaluate measures for reducing pollution from fossil fuel combustion.	* * * * *
8Ee		
	State the meaning of greenhouse effect, global warming and climate change.	* * * * *
	Explain how human activities are affecting global warming.	* * * * *
	Explain how methods of controlling carbon dioxide emissions work.	* * * * *

Combustion and oxidation

Combustion is when a fuel burns. → Stored energy in the fuel is transferred to the surroundings. → This transfer causes the surroundings to get hotter. Some energy may also be transferred by light or sound. → The transfer can be useful for heating, or making engines move.

A **hydrocarbon** is made only of carbon and hydrogen. Many fuels are mainly hydrocarbons.

Hydrocarbon combustion:

hydrocarbon + oxygen → water + carbon dioxide

This is a word equation.

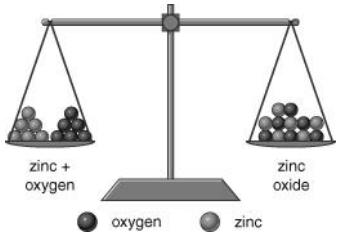
Combustion is also an **oxidation reaction** because the substances react with oxygen.

Carbon and hydrogen are **non-metals** but metals can also be oxidised:

metal + oxygen → metal oxide

Conservation of mass in reactions

In a reaction, the mass of the **reactants** is always the same as the mass of the **products**.



Metals can appear to gain mass when heated in air:

zinc + oxygen → zinc oxide

The difference in mass is the mass of oxygen that reacted.

When a hydrocarbon fuel combusts, it appears to lose mass because the products of the reaction (carbon dioxide, water vapour) are lost into the air.

Phlogiston

Before oxygen was discovered, scientists explained combustion by saying that, as a substance burnt, it gave out a substance called phlogiston to the air. For example:

wood → calx (ash) + phlogiston

However, the phlogiston theory could not explain why metals gained mass when they reacted with air.

The fire triangle and putting fires out

The fire triangle shows the three factors needed for a fire to burn. If any factor is removed, the fire will go out.

We use **fire extinguishers** to put out fires. Water extinguishers remove heat. Powder and carbon dioxide extinguishers exclude oxygen. Foam extinguishers can both remove heat and exclude oxygen.

Oil fires should not be treated with water because the water sinks through the oil, which heats up and causes the water to evaporate. This causes the oil to 'spit' and can spread the fire.

Hazard symbols

Hazard symbols explain why a substance must be handled carefully.

Air pollution from burning fossil fuels

Complete combustion – the fuel reacts completely with oxygen, e.g.:

hydrocarbon + oxygen → carbon dioxide + water

Incomplete combustion – the fuel only partly reacts with oxygen, e.g.:

hydrocarbon + oxygen → carbon dioxide + water + carbon monoxide + carbon (soot)

Impurities in fossil fuels, such as substances that contain sulfur, also react with oxygen when heated:

sulfur + oxygen → sulfur dioxide

At the very high temperatures in vehicle engines, nitrogen gas from the air reacts with oxygen:

nitrogen + oxygen → nitrogen oxides

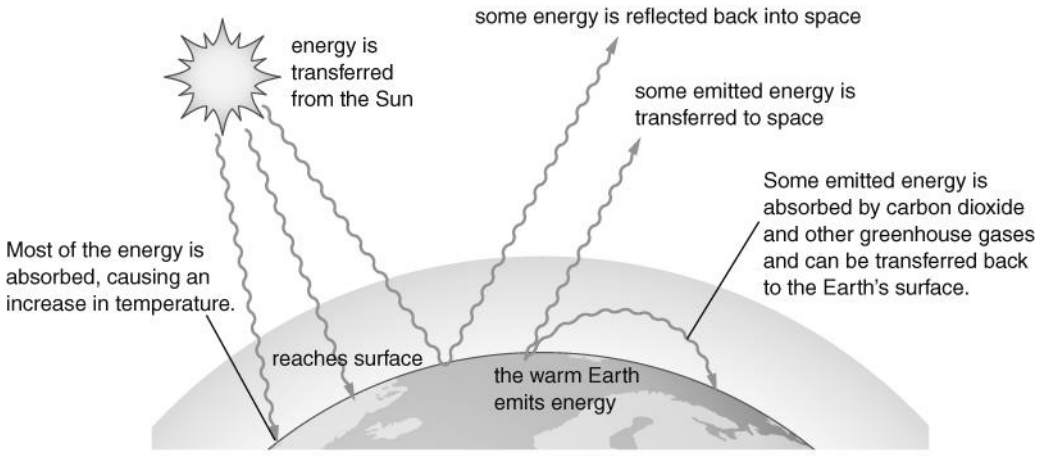
Many products from burning fossil fuels are **pollutants**; they harm the habitats and their organisms.

Acid rain

Acid rain is rain water that is made more acidic by dissolved sulfur dioxide and nitrogen oxides. Some of these gases are removed from power station chimneys by neutralisation, and by using **catalytic converters** on vehicle exhausts. Catalytic converters also remove carbon monoxide (another pollutant).

Greenhouse effect and global warming

Greenhouse gases in the Earth's atmosphere keep the Earth's surface warm. This is the **greenhouse effect**.



Carbon dioxide is a greenhouse gas. Most scientists think that the extra carbon dioxide released from burning fossil fuels has increased the temperature of the Earth's surface (**global warming**).

Scientists predict that global warming will cause **climate change**. The best way to control global warming is probably to reduce the amount of carbon dioxide we release into the air.

8Eb – Oxidation

Word	Pronunciation	Meaning
law of conservation of mass		The idea that mass is not lost or gained during a chemical reaction. The mass of all the reactants is equal to the mass of all the products.
metal		Any element that is shiny when polished, conducts heat and electricity well, is malleable and flexible and often has a high melting point.
metal oxide		A metal that has combined with oxygen in a chemical reaction, e.g. magnesium oxide. The general word equation for the reaction is: metal + oxygen → metal oxide
non-metal		Any element that is not shiny and does not conduct heat and electricity well.
oxidation	*ox-i-**day**-shun*	Reacting with oxygen. For example, when a fuel combusts or when a metal reacts with oxygen to form a metal oxide.
oxide		A compound of a metal or non-metal with oxygen, such as magnesium oxide or carbon dioxide.
oxidiser		A substance that supplies oxygen for a reaction.
phlogiston	*flo-**jist**-on*	A substance that scientists once thought explained why things burn; it has since been proved that it does not exist.

8Ec – Fire safety

Word	Pronunciation	Meaning
exothermic	*ex-O-**therm**-ic*	A reaction that gives out energy that can be felt as it heats the surroundings, such as combustion.
fire extinguisher		Something that is used to put out a fire, such as a canister of carbon dioxide, powder, water or foam.
fire triangle		A way of showing in a diagram that heat, fuel and oxygen are needed for fire.
hazard symbol		A warning symbol that shows why something is dangerous.

8Ec WS – Fair testing

Word	Pronunciation	Meaning
control variable	***vair**-ee-ab-el*	A variable other than the independent variable that could affect the dependent variable and so needs to be controlled.
dependent variable	*dee-**pend**-ent* ***vair**-ee-ab-el*	The variable that is measured in an investigation. The values of the dependent variable depend on those of the independent variable.

Word	Pronunciation	Meaning
fair test		An experiment in which all the control variables are controlled and only changes in the independent variable cause changes in the dependent variable.
independent variable	***vair***-*ee-ab-el*	The variable that you chose the values of in an investigation.
variable	***vair***-*ee-ab-el*	Anything that can change and be measured.

8Ed – Air pollution

Word	Pronunciation	Meaning
acid rain		Rainwater that is more acidic than usual due to air pollution, usually caused by sulfur dioxide and nitrogen oxides dissolved in it.
asthma		A condition in which the tiny tubes leading to the alveoli become narrow and start to fill with mucus.
catalytic converter	*cat-a-**lit**-ick*	A device fitted to the exhaust pipe of a vehicle to change harmful pollutant gases into less harmful gases.
complete combustion		When a substance reacts fully with oxygen, such as: carbon + oxygen → carbon dioxide
incomplete combustion		When a substance reacts only partially with oxygen, such as when carbon burns in air producing carbon dioxide, carbon monoxide and soot (unburnt carbon).
filter (chemistry)		Anything, such as cloth, paper or a layer of sand, through which a fluid is passed to remove suspended pieces of solid.
filter (physics)		Something that only lets certain colours through and absorbs the rest.
nitrogen oxide		Acidic gas formed when nitrogen reacts with oxygen at high temperatures, such as in a car engine. There are different types of nitrogen oxide.
pollutant		A substance that can harm the environment or the organisms that live there.
soot		A form of carbon, which is produced as very fine particles when hydrocarbon fuels undergo incomplete combustion.
sulfur dioxide		An acidic gas released from burning fossil fuels, which contributes to acid rain.

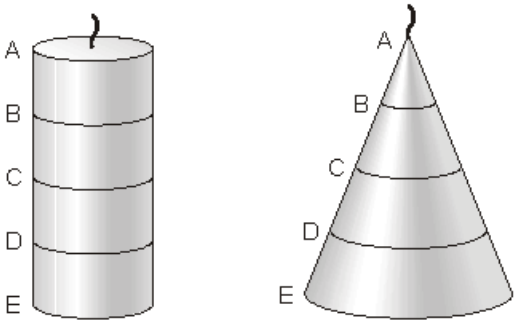
8Ee – Global warming

Word	Pronunciation	Meaning
climate change		Changes that will happen to the weather as a result of global warming.
global warming		Increased warming of the Earth's surface as a result of increased amounts of carbon dioxide and other greenhouse gases in the air.

Word	Pronunciation	Meaning
greenhouse effect		The warming effect on the Earth's surface caused by greenhouse gases absorbing energy emitted from the warm Earth's surface and re-emitting it back to the surface.
greenhouse gas		A gas, such as carbon dioxide, water vapour or methane, in the Earth's atmosphere, which absorbs energy emitted from the Earth's surface and then emits it back to the surface.

Q1.

Simon made two candles from the same amount of wax.
He drew lines on both candles.

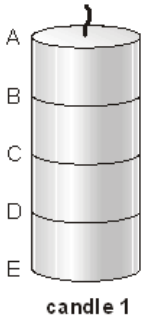


(a) What would Simon use to measure the **distance** between the lines?

.....

1 mark

(b) He timed how long **candle 1** took to burn.
His results are shown below.

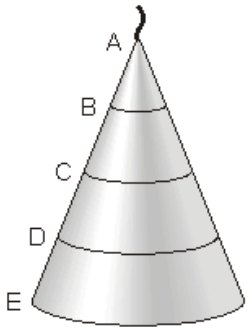


(i) How long would it take for **candle 1** to burn from C to D?
Write your answer in the table.

part that burned	time for candle 1 to burn (minutes)
A to B	30
B to C	30
C to D	
D to E	30

1 mark

(ii) Simon timed how long **candle 2** took to burn.



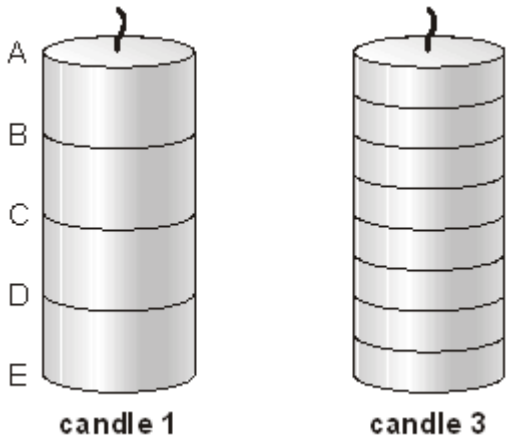
candle 2

How long would it take for **candle 2** to burn from A to B **and** from D to E?
Write your answers in the table.

part that burned	time for candle 2 to burn (minutes)
A to B	
B to C	20
C to D	40
D to E	

2 marks

(c) Simon wanted to use a candle to measure time.
He made **candle 3** the same size as **candle 1**.



candle 1 candle 3

Why is **candle 3** more useful than **candle 1** for measuring time?

.....

.....

1 mark

maximum 5 marks

Q2.

The table below gives information about three fuels that can be used in cars.

✓ shows a substance is produced when the fuel burns.
X shows a substance is **not** produced when the fuel burns.

fuel	physical state	energy released, in kJ/kg	some of the substances produced when the fuel burns		
			carbon monoxide	sulphur dioxide	water
petrol	liquid	48 000	✓	✓	✓
hydrogen	gas	121 000	**X**	**X**	✓
ethanol (alcohol)	liquid	30 000	✓	**X**	✓

(a) Which fuel, in the table, releases the **least** energy per kilogram (kg)?

.....

1 mark

(b) Some scientists say that if hydrogen is burned as a fuel there will be less pollution.
From the information in the table, give **one** reason why there will be less pollution.

.....

.....

1 mark

(c) Which of the three **fuels** in the table can be compressed into a small container?

.....

1 mark

(d) Which gas in the air is needed for fuels to burn?
Tick the correct box.

carbon dioxide ☐

nitrogen ☐

oxygen ☐

water vapour ☐

1 mark

(e) Petrol and ethanol are both fuels. Petrol is made from oil.
Scientists say that oil could run out in 100 years.
In some countries people plant sugar cane and use it to make ethanol.

Sugar cane will **not** run out. Explain why.

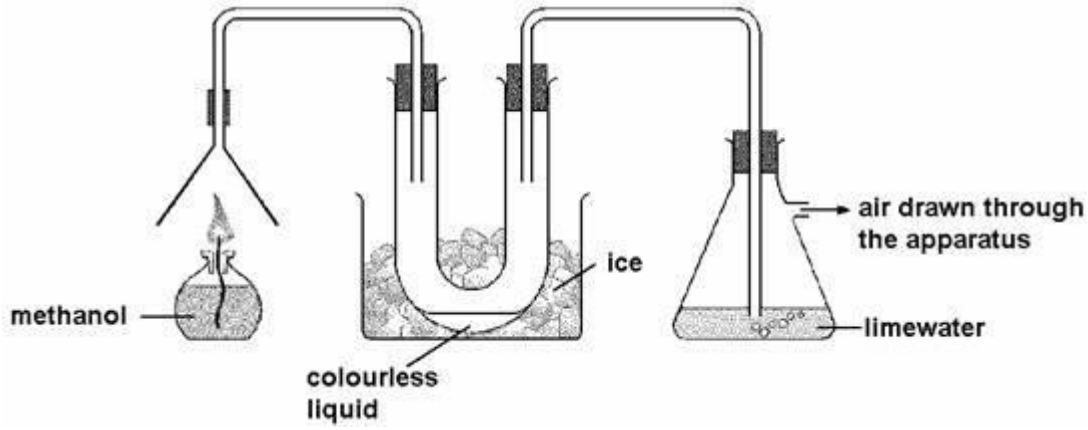
.....

.....

1 mark
Maximum 5 marks

Q3.

(a) George used the apparatus below to find out what substances are produced when methanol burns.



As the methanol burned, two different gases were produced.

(i) One of these gases condensed in the U-tube to give a colourless liquid. Give the name of this liquid.

.....

1 mark

(ii) The other gas turned the lime water cloudy.
Give the name of this gas.

.....

1 mark

(b) Methanol is sometimes used in antifreeze. It can be added to water in car windscreen wash-bottles to prevent the water from freezing in cold conditions.

(i) The label on the bottle of antifreeze has two hazard warning symbols. What **two** precautions would you need to take when using this antifreeze?

1. .....

.....

2. .....

.....

1 mark

(ii) Water freezes at 0°C. The label on the bottle shows how the freezing point changes when different amounts of antifreeze are added to water.

Terry put a mixture containing 10% antifreeze into the wash-bottle of his car.
During the night the temperature dropped to –14°C.
The wash-bottle burst.
Explain why the wash-bottle burst.

.....

.....

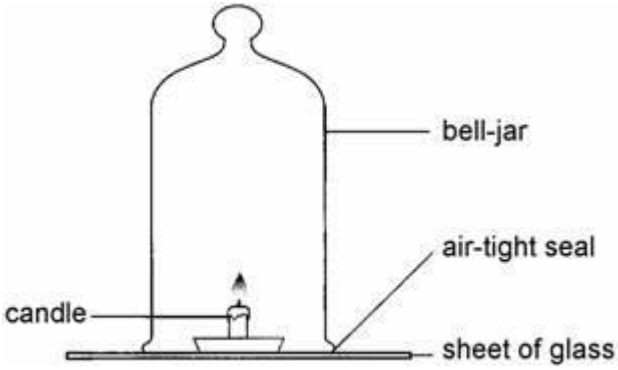
.....

.....

2 marks
Maximum 5 marks

Q4.

The diagram below shows a candle burning in air under a bell-jar.



(a) (i) When the candle burns, there is a reaction. Give the chemical formulae of the products of this reaction.

1. .....

2. .....

2 marks

(ii) As the candle burns, some of the candle wax is used up. Give two other observations which would show that a chemical reaction is taking place.

1. .....

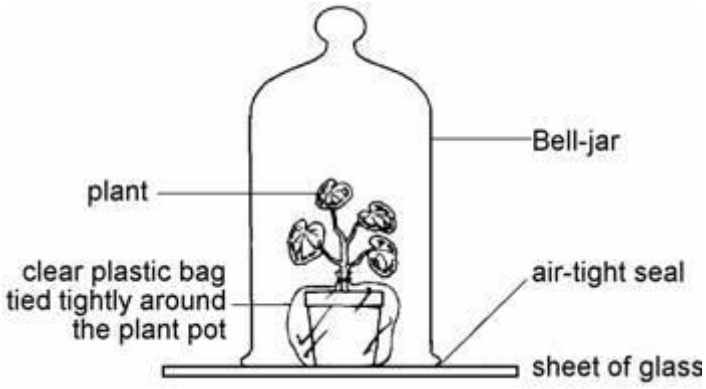
.....

2. .....

.....

2 marks

(b) A potted plant is placed under a bell-jar as shown below.



Photosynthesis in the leaves causes changes in the proportion of the gases in the bell-jar.

(i) In bright sunlight, what are **two** of these changes?

1. .....

2. .....

2 marks

(ii) Explain why the changes will be different if the plant is kept in the dark.

.....

.....

.....

2 marks

(c) Chlorophyll is the green substance present in cells in the leaves.

(i) Give the name of the part of the cell which contains chlorophyll.

.....

1 mark

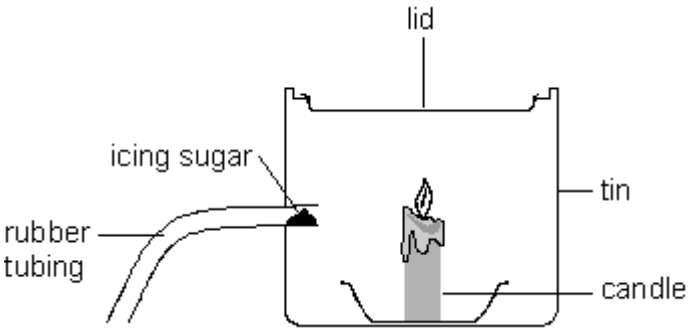
(ii) Which part of the cell controls the production of chlorophyll?

.....

1 mark
Maximum 10 marks

Q5.

A teacher set up the following apparatus behind a safety screen.
She placed 1 g of icing sugar in the end of the rubber tubing inside the tin, as shown below.



The teacher blew through the other end of the rubber tubing.
The icing sugar came into contact with the flame.
There was a loud explosion and the lid was blown off the tin.

(a) Complete the following sentence describing the energy changes which took place.

..... energy in the icing sugar changed to

..... energy and ..... energy.

3 marks

(b) As a result of the explosion, the lid of the tin was pushed off.
Explain what had happened to the gas molecules inside the tin to make this happen.

.....

.....

.....

.....

2 marks

(c) When icing sugar is burned in this experiment, the gas **used** and the gas **produced** are the same as when energy is released from sugar in the cells of the body.

(i) Which gas, in the air, is **used** when the icing sugar burns?

.....

1 mark

(ii) Give the name of the gas **produced** when the icing sugar burns.

.....

1 mark

(d) The table below shows the energy values of four food substances.

food substance	**energy value, in kJ per 100 g**
icing sugar	1680
curry powder	979
flour	1450
custard powder	630

The teacher repeated the experiment with 1 g of custard powder.
What difference would this make to the experiment?

.....

.....

1 mark
Maximum 8 marks

Mark schemes

Q1.

(a) • a ruler

accept 'a metre rule'
accept 'a tape measure'
'cm' is insufficient 'a measuring stick' is insufficient

1 (L3)

(b) (i) • 30

*do **not** accept '30 seconds'*

1 (L3)

(ii) • *A to B*: any number from 5 to 15

accept a range such as '5 to 10'

1 (L4)

• *D to E*: any number from 45 to 80

accept a range such as '50 to 60'

1 (L4)

(c) any **one** from

• you can measure smaller intervals of time

accept 'each section burns for a shorter time'
*accept 'it is more precise **or** accurate'*
'it is easier to read' is insufficient

• the lines are closer

accept 'the lines are close'
accept 'the lines are further apart on candle 1'
accept 'the lines are 1 cm apart on candle 1 and 0.5 cm apart on candle 3'
*accept 'there are more lines **or** smaller spaces **or** smaller segments'*
*accept 'more sections **or** rings'*
'the lines are smaller' is insufficient

1 (L4)

[5]

Q2.

(a) ethanol **or** alcohol

if more than one box is ticked, award no mark

1 (L3)

(b) any **one** from

• burning hydrogen does not produce carbon monoxide

*accept 'petrol **or** ethanol **or** alcohol produces carbon monoxide'*

• burning hydrogen does not produce sulphur dioxide

accept 'petrol produces sulphur dioxide'

- burning hydrogen only produces water
- burning petrol causes acid rain

*accept 'hydrogen **or** ethanol **or** alcohol does not cause acid rain'*

1 (L4)

(c) hydrogen

accept 'H_2''
accept 'gas'

1 (L4)

(d) oxygen ✓

if more than one box is ticked, award no mark

1 (L4)

(e) any **one** from

- it can be grown

accept 'it does not take long to grow'

- it can be replanted

accept 'it can be replaced'

- it is renewable
- it can be reproduced

accept 'it produces seeds'

1 (L4)

[5]

Q3.

(a) (i) water

accept 'H_2O'

1 (L5)

(ii) carbon dioxide

accept 'CO_2'

1 (L5)

(b) (i) do not use antifreeze **or** methanol near a naked flame and do not swallow

accept 'it catches fire easily and it is poisonous'
accept 'wash hands after use' for do not swallow
*accept 'it is flammable **or** inflammable and it is poisonous'*
***both** answers are required for the mark*

1 (L5)

(ii) any **one** from

- water froze

- the mixture froze
- the contents froze

  accept '10% antifreeze is not enough to stop the water freezing'

  'not enough antifreeze used' is insufficient

  *do **not** accept 'it froze'*

1 (L6)

and expanded

1 (L6)

[5]

Q4.

(a) (i) any **two** from

- CO_2

  *do **not** accept 'carbon dioxide'*

- H_2O

  *do **not** accept 'water'*

- CO

  *do **not** accept 'carbon monoxide'*

- C

  *do **not** accept 'carbon'*

2 (L7)

(ii) any **two** from

- water droplets form on the inside of the bell-jar

  accept 'condensation'

- thermal energy is released

  *accept 'heat **or** energy is given off'*

- light is released

  accept 'there is a flame'

- soot is produced
- smoke is produced

  accept 'the wick is used up'

  *do **not** accept 'carbon dioxide is formed' **or** 'carbon monoxide is given off'*

2 (L7)

(b) (i) answers may be in either order

- oxygen increases

1 (L7)

- carbon dioxide decreases

1 (L7)

(ii) photosynthesis stops

1 (L7)

respiration continues to take place

*do **not** accept 'respiration takes place'*

1 (L7)

(c) (i) chloroplast

1 (L7)

(ii) nucleus

1 (L7)

[10]

Q5.

(a) chemical

*accept 'potential' **or** 'stored'*

1 (L6)

any **two** from

- sound
- thermal

  accept 'heat'
- kinetic

  accept 'movement'
- light

2 (L6)

(b) any **two** from

- they gained energy

  accept 'they move more quickly'
- they hit the lid with greater force

  accept 'they hit the lid harder'
- they hit the lid more often

  accept 'the pressure inside the tin increased'

  accept 'the molecules are closer together'

  accept 'more molecules are present'

2 (L6)

(c) (i) oxygen

accept 'O_2'

1 (L6)

(ii) any **one** from

- carbon dioxide

accept 'CO_2'

- water vapour
  accept 'H_2O'
  accept 'carbon monoxide'

1 (L6)

(d) any **one** from

- it was quieter
- the lid didn't move as high
  accept 'the lid was not pushed off'
- less energy released
  accept 'it does not work'

1 (L5)