Candidate Name	Centre Number					Candidate Number				

GCSE COMBINED SCIENCE

COMPONENT 4

Applications in Science

HIGHER TIER

SAMPLE PAPER

(1 hour 45 minutes)

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1.**	**15**	
Section B	**2.**	**8**	
	3.	**15**	
	4.	**15**	
	5.	**9**	
	6.	**10**	
	7.	**8**	
	8.	**10**	
	Total	**90**	

ADDITIONAL MATERIALS

In addition to this examination paper you will need a calculator, a ruler and a resource booklet.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

This paper is in 2 sections, **A** and **B**.
Section **A**: 15 marks. Answer **all** questions. You are advised to spend about 25 minutes on this section.
Section **B**: 75 marks. Read the article in the resource booklet carefully then answer **all** questions. You are advised to spend about 1 hour 20 minutes on this section.
The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in question **8(a).**

EQUATION LIST

final velocity = initial velocity + acceleration × time	$v = u + at$
distance = ½ (initial velocity + final velocity) × time	$x = \frac{1}{2}(u + v)t$
(final velocity)^2 = (initial velocity)^2 + 2 × acceleration × distance	$v^2 = u^2 + 2ax$
distance = initial velocity × time + ½ × acceleration × time^2	$x = ut + \frac{1}{2}at^2$
change in thermal energy = mass × specific heat capacity× change in temperature	$\Delta Q = mc\Delta\theta$
thermal energy for a change of state = mass × specific latent heat	$Q = mL$
energy transferred in stretching = 0.5 × spring constant × (extension)^2	$E = \frac{1}{2}kx^2$
force on a conductor (at right angles to a magnetic field) carrying a current = magnetic field strength × current × length	$F = BIl$
potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in second coil	$V_1I_1 = V_2I_2$

SECTION A

Read the article in the resource booklet carefully and answer **all** *the questions that follow.*

1. (a) Methane has a larger GWP than carbon dioxide. It is claimed that methane should be burned rather than released into the atmosphere.

(i) Methane burns in air to produce carbon dioxide and water. Complete the balanced **symbol** equation for this reaction. [2]

$CH_4 + 2O_2 \rightarrow$ ..... + ...

(ii) Burning 100 kg of methane produces 275 kg of carbon dioxide. Use **Equation 1** and the information in **Table 1** to answer the following questions.

I Calculate the greenhouse contribution of 100 kg of methane. [2]

greenhouse contribution = ... kg CO_2eq

II Explain whether or not burning methane has less effect on global warming than just releasing it into the atmosphere. [2]

.....

.....

(b) Use the information in **Table 2** to answer the following questions.

(i) I Jack travels 100 km each day. He is concerned about his carbon footprint. Why would he choose a Voltec car rather than an Amptec car? [1]

.....

II Calculate the mass of CO_2 produced if the Amptec is driven 280 km. [2]

mass = …… g

(ii) Using a charger the Voltec can be charged fully by 32 kWh. When 1 kWh of electricity is used it produces 0.45 kg of carbon dioxide every hour.

Calculate how much carbon dioxide is produced to fully charge the Voltec. [2]

mass = ... kg

(iii) Explain why the data for the Voltec may be misleading. [2]

.....

.....

(c) Suggest **two** reasons why the government gives a grant to purchase electric vehicles. [2]

1. .....

2. .....

15

SECTION B

Answer **all** *questions.*

2. A group of students wanted to find the time taken to produce 100 cm^3 of gas when dilute hydrochloric acid reacts with marble chips.

(a) Describe a method that they could use in their experiment. You may include a diagram as part of your answer. [3]

……

……

……

(b) The students investigated the effect of temperature on the rate of the reaction. The results they obtained are below.

James used hydrochloric acid at 21°C and recorded a time of 2 minutes 33 seconds.

Syra heated her acid to 40 °C and the reaction took 39 seconds.

Abigail stopped her watch after 1 minute 17 seconds. Her acid had a starting temperature of 30 °C.

Draw a table with labelled columns. Record the students' results in your table with the times given in **seconds**. [3]

(c) Estimate how long the reaction will take at 50°C and explain how you came to this value. [2]

.....

.....

.....

.....

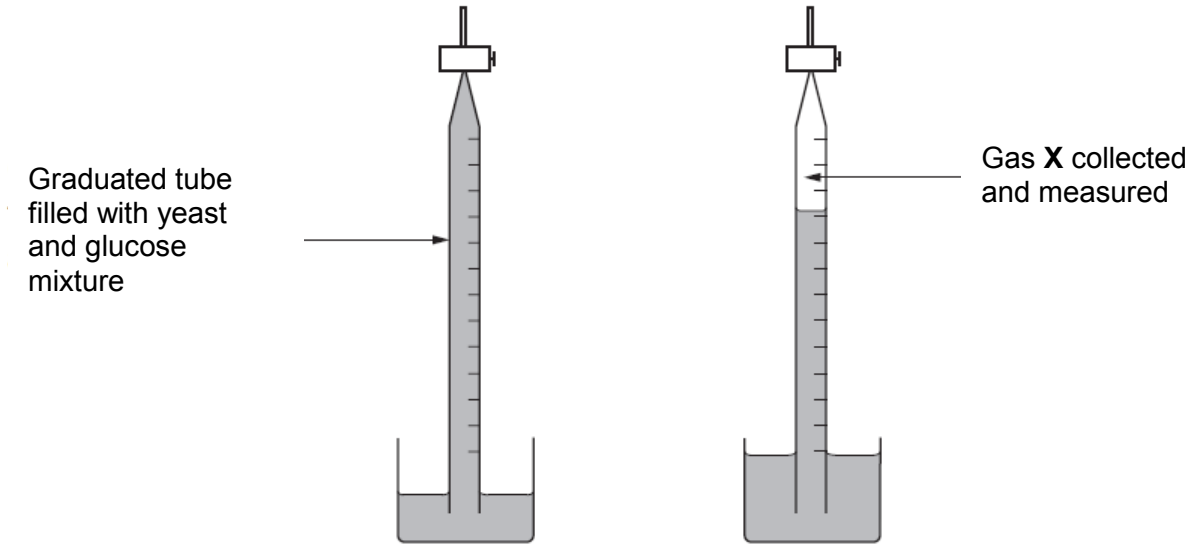
8

3. Scientists at a large brewery carried out an investigation into the effectiveness of three different strains of yeast which were fermenting glucose.

The basic outline of the investigative procedure is given below:

- boil and rapidly cool 2 litres of sterilized water to remove dissolved gases
- add 5 g of yeast to sterilized water
- dissolve glucose in the yeast-sterilized water mixture and pour into 3 sterilized graduating tubes until full
- measure the volume of gas given off every 15 minutes.

The apparatus is shown below.



Results table

		Volume of gas produced after 15 min (cm^3)	Volume of gas produced after 30 min (cm^3)	Volume of gas produced after 45 min (cm^3)	Volume of gas produced after 60 min (cm^3)	Volume of gas produced after 75 min (cm^3)
Strain of yeast	***Saccharomyces uvarum***	11.4	26.6	41.7	43.2	43.2
	Brettanomyces lambicus	6.1	14.8	22.1	23.9	23.9
	Saccharomyces cerevisiae	11.4	29.5	43.0	44.6	44.6

(a) (i) Name gas **X** shown in the diagram and explain its production. Include the relevant word equation in your answer. [4]

.....

.....

.....

.....

(ii) State which strain of yeast would be most effective at producing ethanol and explain your answer. [3]

Strain of yeast .....……

Explanation

.....

.....

.....

(iii) Why was it important to:

I completely fill the tubes at the start of the investigation [2]

.....

.....

II sterilize the water and graduated tubes? [1]

.....

(iv) The mean rate for the production of X in the first 45 minutes using Saccharomyces uvarum was 0.93 cm^3 of X/min.

I Calculate the mean rate of the production of gas X between 45 and 60 minutes for the same yeast. [2]

mean rate = …….. cm^3 of X/min

II Give **two** reasons why the rate of production of gas **X** may have slowed after 45 minutes. [2]

.....

.....

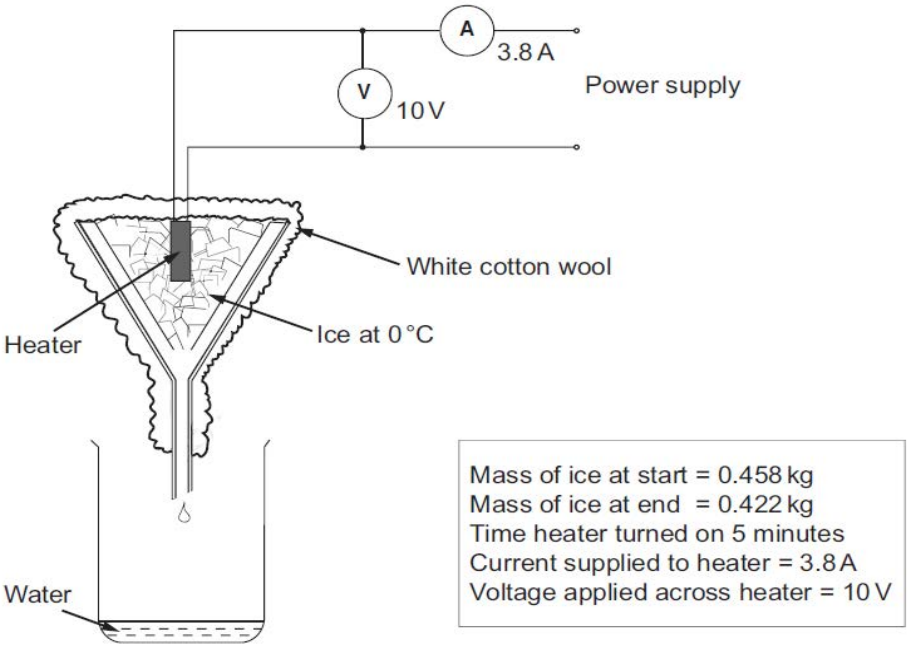
.....

(b) In the basic outline of the investigative procedure given above a number of the controlled variables have been omitted. Controlled variables are usually far more important than the dependent or independent variables. State why these must be controlled. [1]

.....

15

4. The following apparatus is used in an experiment to find the specific latent heat of fusion of ice.



(a) Explain what is meant by the phrase "the specific latent heat of fusion of ice". [3]

……

……

……

(b) The density of ice is 0.92 g/cm^3. Calculate the volume of ice (in cm^3) that has melted. [3]

volume = ... cm^3

(c) (i) Calculate the energy supplied by the heater in 5 minutes. [4]

energy supplied = ... J

(ii) Use an equation from **page 2** to calculate the specific latent heat of fusion of ice. [3]

specific latent heat of fusion = ... J/kg

(iii) If the insulation was to be removed and the experiment repeated, explain the effect on the calculated value of the specific latent heat of fusion. [2]

.....

.....

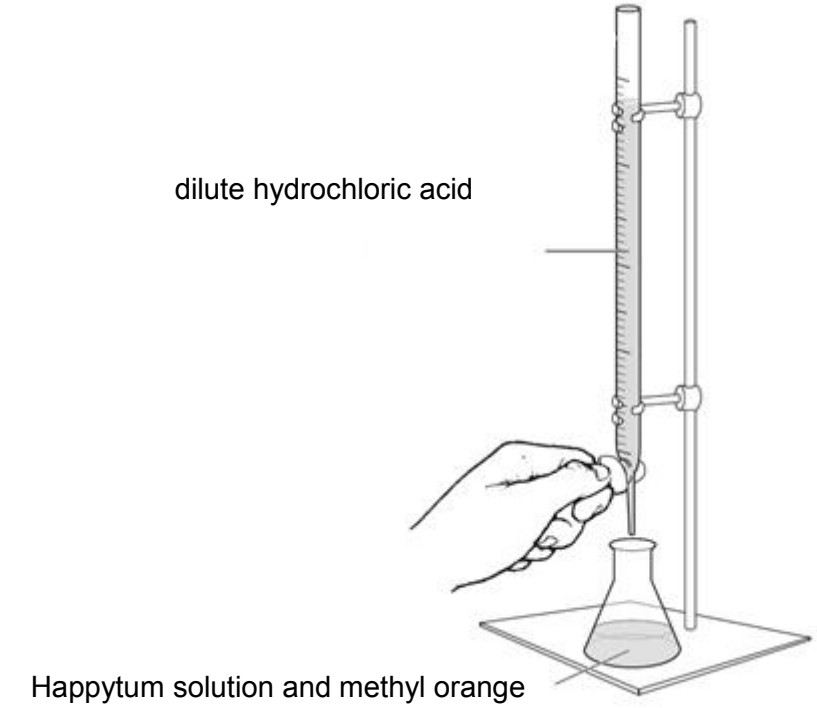
15

5. 'Happytum' is an antacid tablet used to treat indigestion which is caused by excess acid in the stomach. Antacids contain calcium carbonate.

A group of students was asked to carry out an investigation to find the percentage of calcium carbonate in a Happytum tablet. They followed the procedure below:

1. A tablet weighing 0.54 g was crushed and added to 50 cm^3 of water in a conical flask.
2. Five drops of methyl orange were added.
3. The mixture was titrated with dilute hydrochloric acid of concentration 0.25 mol/dm^3 until the methyl orange turned red.
4. This procedure was repeated using an identical tablet.

Diagram of apparatus



(a) Describe the chemical reaction that occurs between a Happytum tablet and an acid. [2]

……...

……...

……...

The results collected were as follows.

	Run 1	**Run 2**
Final volume (cm^3)	12.30	23.90
Initial volume (cm^3)	0.65	12.30
Volume added (cm^3)	.....	.....

(b) Calculate the mean volume added. [1]

mean volume added = …… cm^3

(c) In this reaction,1 mol of calcium carbonate reacts with 2 mol of hydrochloric acid.
Calculate the amount in moles of calcium carbonate in one tablet. [2]

amount of calcium carbonate = …… mol

(d) Calculate the percentage by mass of calcium carbonate in each tablet. [2]

percentage by mass = …… %

(e) Explain why the two titres above are not the same. [2]
Assume no weighing errors or spillages were made.

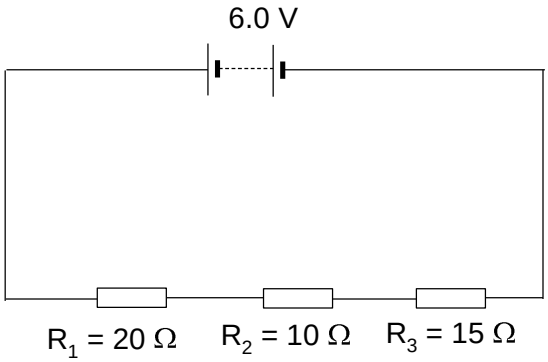
……

……

……

6. A group of pupils study electrical circuits in a physics lesson. They are given a 20 Ω resistor, a 15 Ω resistor and a 10 Ω resistor.

(a) They set up the following circuit with the aim to use it to make various measurements.



(i) Calculate the current in the circuit. [4]
Record your answer to two decimal places.

current = ...

(ii) **Add** to the circuit diagram the symbol for a voltmeter to measure the potential difference across the ends of the 15 Ω resistor. [1]

(iii) **Modify** the circuit diagram to add the symbol of an ammeter which measures the current through the 15 Ω resistor. [1]

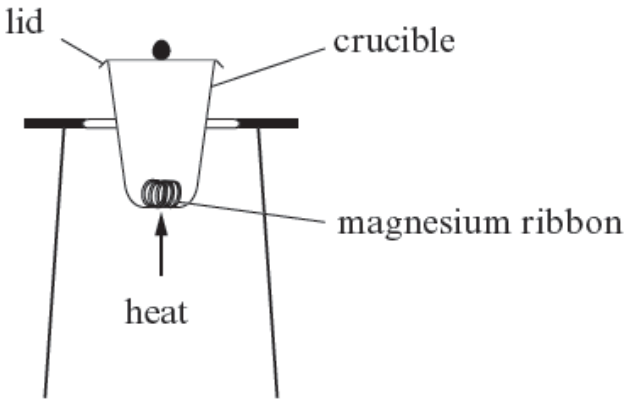
(iv) Calculate the potential difference across the 20 Ω resistor. [1]

potential difference = ... V

(b) Draw a circuit diagram below that uses the same components as the one above with a **higher** total current. Explain why your circuit has a higher current. [3]

10

7. Magnesium burns in air with a bright white flame to give a white powder called magnesium oxide. In order to work out the formula of magnesium oxide, Emily and Dwayne carried out an experiment using the apparatus shown below.



The results of their experiment are shown in the table.

Mass of crucible and lid (g)	19.80
Mass of crucible, lid and magnesium (g)	20.28
Mass of crucible, lid and product after heating (g)	20.44

(a) State what is meant by the term 'empirical formula'. [2]

……...

……...

(b) Calculate the empirical formula for magnesium oxide using Emily and Dwayne's results.
You must show your workings. [4]

A_r (Mg) = 24 A_r (O) = 16

empirical formula ……

(c) The correct empirical formula of magnesium oxide is MgO. Explain why Emily and Dwayne's results give a different value.

[Assume that they did not spill any product and correctly weighed the material in each case.] [2]

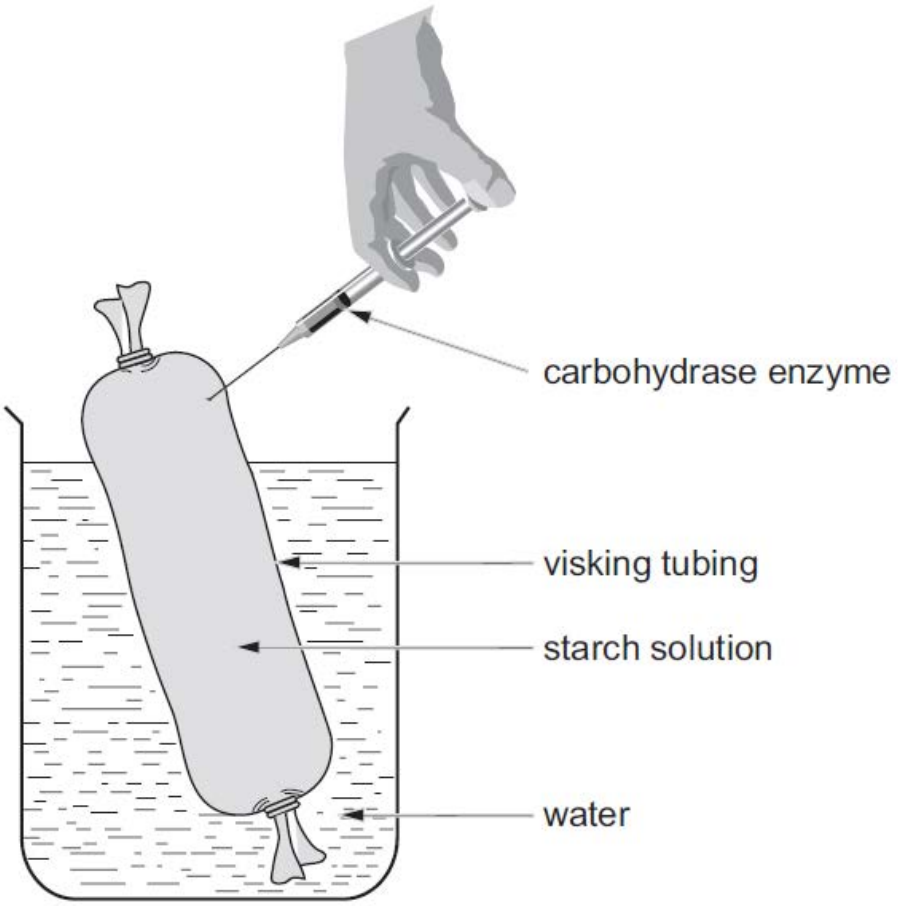
.....

.....

.....

8

8. An experiment was carried out to investigate some of the properties of visking tubing. A piece of tubing was knotted at the bottom end and then filled with starch solution. A knot was then tied at the top end. The filled visking tubing was then suspended in a beaker of water.



For the next 15 minutes the water in the beaker was sampled, at 5 minute intervals, for the presence of both starch and glucose. After 15 minutes a carbohydrase enzyme was injected into the visking tubing and further samples of water were tested.

The results are shown below:

	Time (minutes)						
	0	5	10	15	20	25	30
starch	-	-	-	-	-	-	-
glucose	-	-	-	-	+	++	+++

Key - = negative result
\+ = positive result
+++ = increasing concentration

(a) Account for the observations made in this experiment. [6 QER]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) State how the water in the beaker was tested for both glucose and starch and how the tests confirmed the results in the table above. [4]

.....

.....

.....

.....

.....

.....

.....

.....

10

GCSE COMBINED SCIENCE

COMPONENT 4

Applications in Science

HIGHER TIER

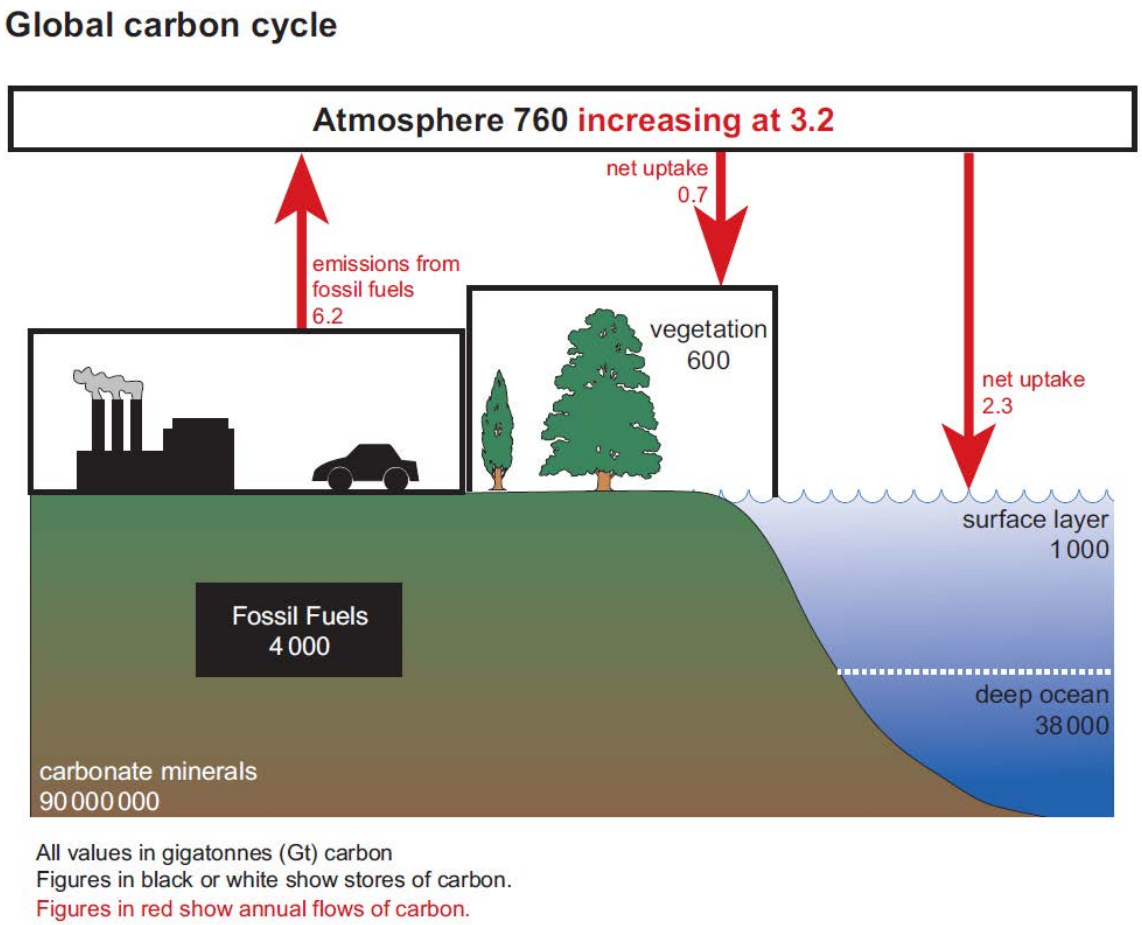
SAMPLE ASSESSMENT MATERIALS

RESOURCE BOOKLET
for use in Section A

EXPLORING THE GREENHOUSE EFFECT

On Earth, carbon is recycled as shown in **Diagram 1** below.

Diagram 1



It is claimed that global warming is caused by humans adding greenhouse gases (GHG) to the atmosphere. Two GHG are carbon dioxide (CO_2) and methane (CH_4).

Greenhouse gases can be compared using their Global Warming Potential (GWP). GWP is the ability of a GHG to trap heat in the atmosphere relative to an equal amount of carbon dioxide. **Table 1** gives the GWP of four GHG.

Table 1

Greenhouse gas	GWP
CO_2	1
CH_4	21

Equation 1

$$\text{greenhouse contribution in kg } CO_2\text{eq} = \text{mass of gas (kg)} \times \text{GWP}$$

The Government gives a grant to buyers of electric vehicles. This is intended to reduce the amount of GHG we produce.

Two such electric vehicles are the Amptec and the Voltec. The Voltec car has an electric motor only. The Amptec car has both an electric motor and a petrol engine. **Table 2** gives information about these electric vehicles and of a petrol engine car.

Table 2

	Typical petrol engine car	Amptec	Voltec
Range per charge (km)	not applicable	80	200
Range on one tank of fuel (km)	700	660	not applicable
Mean fuel used (litres per 100 km)	6.0	1.2	0
Official CO_2 produced (g/km) (Tested over 100 km)	100	27	0