Forename	
Surname	
Candidate Signature	

Centre Number						Candidate Number				

GCSE

Combined Chemistry

Higher Tier 2H

Study Hack

Practice paper 2022

Time allowed: 1 hour 15 minutes

Materials

For this paper you must have:

- a ruler
- a calculator
- the periodic table

Instructions

- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outsidethe box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end ofthis book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information

- The maximum mark for this paper is 78.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.

You are reminded of the need for good English and clear presentation

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	

Q1.

Some students investigated the compounds in a green lettuce leaf and a red cabbage leaf.

The students placed each leaf in boiling ethanol and then tested each leaf for starch.

(a) The boiling point of ethanol is 78 °C

Ethanol is flammable so should not be directly heated with a Bunsen burner.

Give **one** way ethanol can be boiled safely.

Do **not** refer to wearing goggles in your answer.

_____

_____

(1)

(b) Describe how the students could test the leaves for starch.

Give the result if starch is present.

Test _____

_____

Result _____

(2)

(c) The students used paper chromatography to investigate the coloured pigments in both types of leaf.

Explain how paper chromatography causes the different pigments to separate.

_____

_____

_____

_____

_____

_____

(3)

Table 1 shows the students' results. The distance the solvent and each pigment moved was measured from the start line.

Table 1

Green lettuce		**Red cabbage**	
Distance moved in mm	R_f value	Distance moved in mm	R_f value

Solvent front	120	–	113	–
Yellow-green pigment	18	0.15	14	0.12
Bright green pigment	24	0.20	Not found	Not found
Yellow pigment	40	0.33	46	0.41
Orange pigment	120	1.00	113	1.00

Table 2 shows the known R_f value ranges of some pigments.

Table 2

Pigment	**R_f value**
Carotene	0.89 −0.98
Pheophytin a	0.42 −0.49
Pheophytin b	0.33 −0.40
Chlorophyll a	0.24 −0.30
Chlorophyll b	0.20 −0.26
Xanthophyll	0.04 −0.28

(d) One pigment was found in the green lettuce leaf, but was **not** found in the red cabbage leaf.

Describe why it is **not** possible to be certain what this pigment is.

Use the information in **Table 1** and **Table 2** to help you.

_____

_____

(1)

(e) The experiment was repeated and the solvent front travelled 140 mm from the start line.

Calculate the range of distances where the pigment carotene would be seen.

Use the equation for calculating R_f values and the information in **Table 2** to help you.

_____

_____

_____

_____

_____

From _____ mm to _____ mm

(5)

(f) Different coloured pigments absorb light at different wavelengths.

Explain how plants could have evolved to contain more than one pigment in their leaves.

(6)

(Total 18 marks)

Q2.

This question is about the hydrocarbons obtained from crude oil.

Octane is a hydrocarbon.

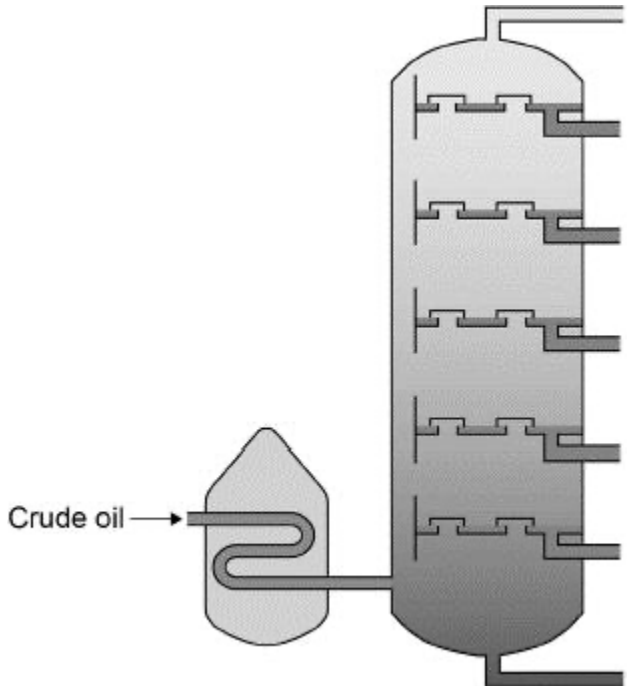
The formula of octane is C_8H_{18}

(a) How does the formula of octane show that octane is an alkane?

(1)

The fractions in crude oil are separated by fractional distillation.

The diagram below shows a fractionating column.



The table below gives some properties of different fractions separated from crude oil.

Fraction	**Range of number of carbon atoms per molecule**	**Boiling point range in °C**
Diesel	C_{15}–C_{20}	250–300
Heavy fuel oil	C_{20}–C_{25}	300–400
Kerosene	C_{10}–C_{15}	180–250
Petrol	C_5–C_{10}	40–180

(b) Which fraction in the table above is the most viscous?

Give **one** reason for your answer.

Tick (✓) **one** box.

Diesel ☐

Heavy fuel oil ☐

Kerosene ☐

Petrol ☐

Reason _____

_____

(2)

(c) Describe how the fraction containing octane is separated from crude oil.

Use data from the table above in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 7 marks)

Q3.

This question is about hydrocarbons.

(a) When a hydrocarbon $C_{10}H_{22}$ is cracked, two substances are produced.

Complete the equation for the reaction.

$$C_{10}H_{22} \rightarrow C_7H_{16} + \_\_\_\_\_$$

(1)

(b) Explain why the hydrocarbon C_7H_{16} has a lower boiling point than $C_{10}H_{22}$

_____

_____

_____

_____

(2)

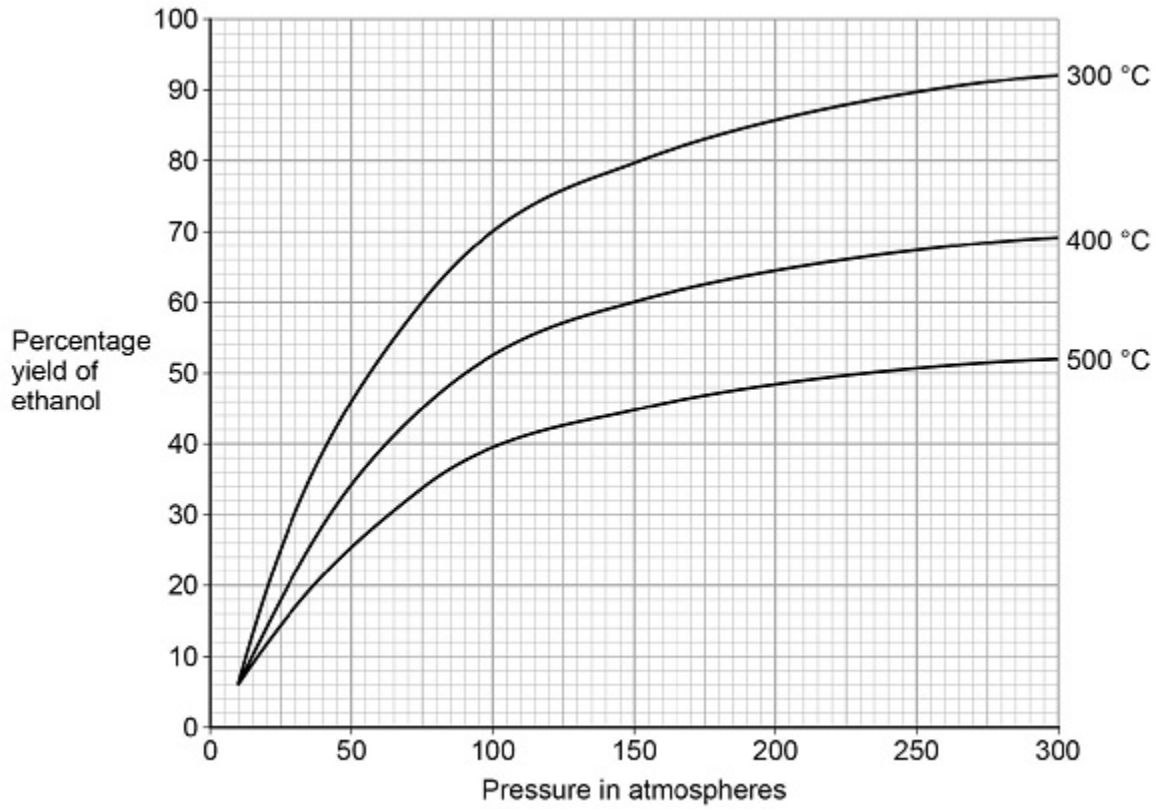
Ethanol is produced by reacting ethene with steam.

The equation for the reaction is:

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

Figure 1 shows the percentage yield of ethanol using different reaction conditions.

Figure 1



(c) Explain why changing the pressure affects the percentage yield of ethanol.

(3)

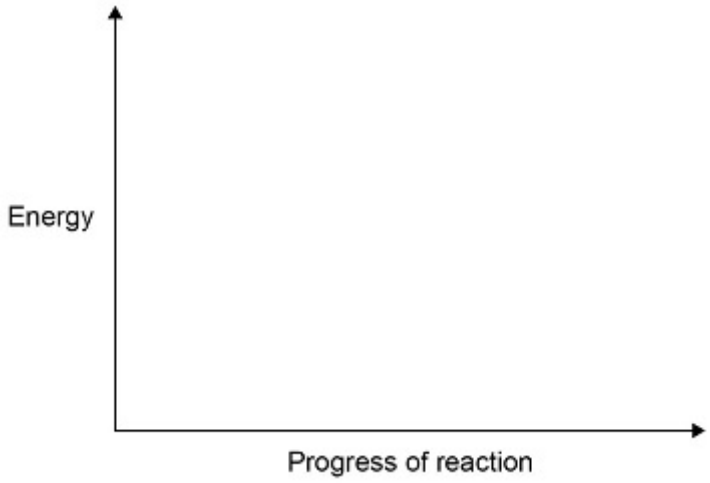
The forward reaction is exothermic.

(d) How does **Figure 1** provide evidence for this?

(1)

(e) **Figure 2** shows part of a reaction profile diagram.

Figure 2



A catalyst is used in the reaction to produce ethanol.

Complete **Figure 2** to show how the catalyst increases the rate of this reaction.

You should label the reaction profile diagram.

(4)

(f) Suggest why the catalyst does not affect the yield of ethanol at equilibrium.

_____

_____

_____

_____

(2)

(Total 13 marks)

Q4.

This question is about copper and fuels.

(a) Copper is extracted from low-grade ores by phytomining.

Describe how copper metal is produced by phytomining.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) Another method of extracting copper from low-grade ores is bioleaching.

A solution of copper sulfate ($CuSO_4$) produced by bioleaching has a concentration of 0.319 g/dm^3

Relative atomic masses (A_r): Cu = 63.5 O = 16 S = 32

Calculate the number of moles of copper that can be produced from 1 dm^3 of this solution.

_____

_____

_____

_____

_____

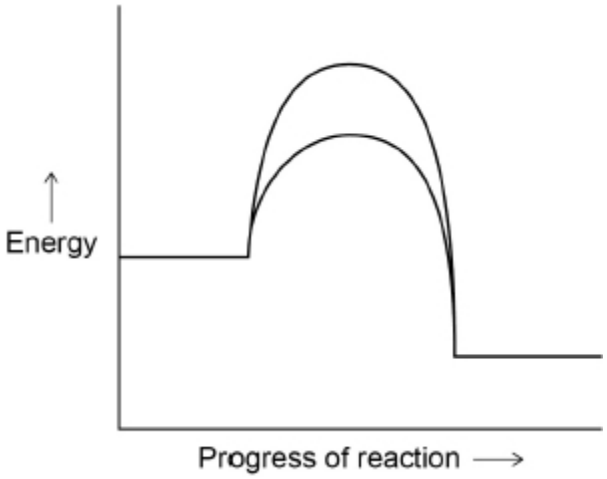
_____

Number of moles of copper = _____ mol

(3)

Copper is used as a catalyst.

The diagram shows reaction profiles for a reaction with and without a catalyst.



(c) How do the reaction profiles show that using a catalyst does not affect the overall energy change for the reaction?

Tick (✓) **one** box.

Both reaction profiles show exothermic reactions. ☐

Both reaction profiles start at the same energy level and end at the same energy level. ☐

Both reaction profiles show the activation energy. ☐

The activation energy for the uncatalysed reaction is much lower than for the catalysed reaction. ☐

(1)

(d) Copper is a catalyst in a reaction to produce ethanol from carbon dioxide.

Ethanol (C_2H_5OH) is used as a fuel.

Suggest why producing ethanol from carbon dioxide is sustainable.

_____

_____

_____

_____

(2)

(e) Chemistry plays an important role in sustainable development.

What is sustainable development?

_____

_____

_____

_____

(2)

(Total 12 marks)

Q5.

There is less carbon dioxide in the Earth's atmosphere now than there was in the Earth's early atmosphere.

(a) The amount of carbon dioxide in the Earth's early atmosphere decreased because it was used by plants and algae for photosynthesis, dissolved in the oceans and formed fossil fuels.

Give **one** other way that the amount of carbon dioxide in the Earth's early atmosphere decreased.

_____

_____

(1)

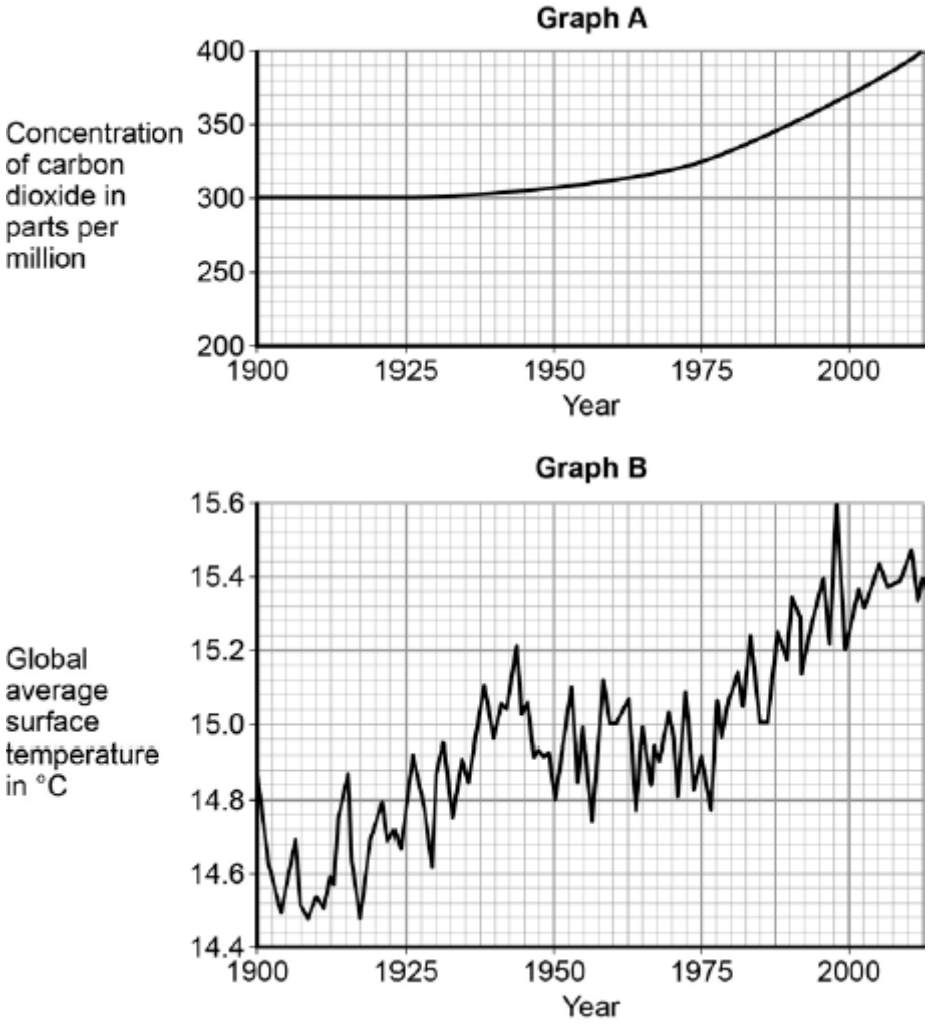
(b) Carbon dioxide is a greenhouse gas.

Describe the greenhouse effect.

(4)

(c) The graphs in **Figure 1** show the concentration of carbon dioxide in the atmosphere and global average surface temperature since 1900.

Figure 1



Calculate the percentage increase in the concentration of carbon dioxide from 1975 to 2000.

_____ %

(1)

(d) What was the global average surface temperature in 1980?

Global average surface temperature = _____ °C

(1)

(e) A student stated: 'The graphs show that increasing the concentration of carbon dioxide in the atmosphere causes global temperature increases.'

Discuss why this statement is only partially true.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 11 marks)

Q6.

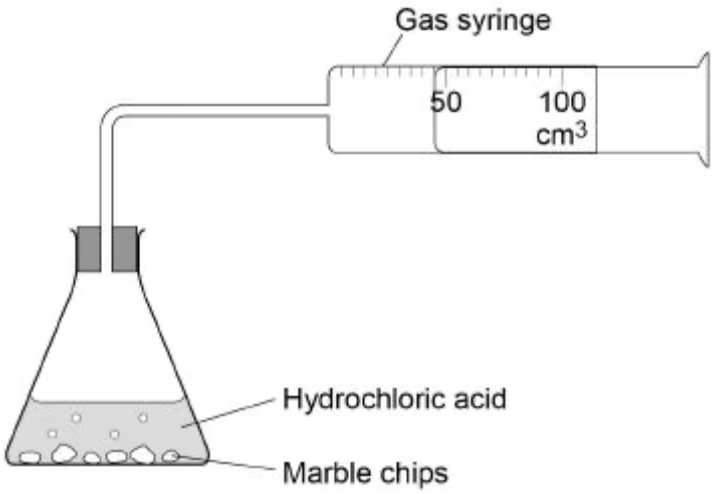
A student investigated the effect of the size of marble chips on the rate of the reaction between marble chips and hydrochloric acid.

This is the method used.

1. Add 10 g of marble chips into the flask.
2. Add 50 cm^3 of hydrochloric acid, connect the gas syringe and start a timer.
3. Record the volume of gas produced every 10 seconds.

Figure 1 shows the apparatus.

Figure 1



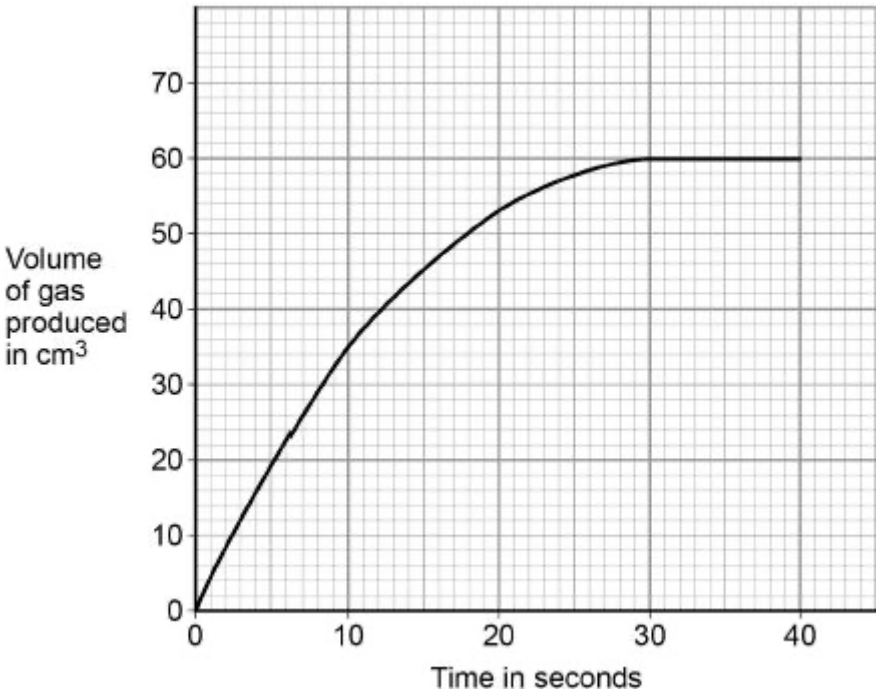
(a) Complete the equation for the reaction.

$CaCO_3$ + _____HCl ⟶ _____

(2)

Figure 2 shows the student's results.

Figure 2



(b) Describe the trend shown in **Figure 2**

Use values in your answer.

_____

_____

_____

_____

_____

_____

(3)

(c) Describe how you would use **Figure 2** to find the rate of the reaction at 15 seconds.

You do **not** need to do a calculation.

_____

_____

_____

_____

(2)

(d) Give the units for the rate of this reaction.

_____

(1)

The table below shows the results of the investigation.

Relative size of marble chips	**Volume of gas produced in cm^3 after given time in seconds**					
	10 s	**20 s**	**30 s**	**40 s**	**50 s**	**60 s**
Small	35	53	60	60	60	60
Medium	21	39	51	58	60	60
Large	14	29	39	48	58	60

(e) Give **one** conclusion about how the size of the marble chips affects the rate of the reaction.

_____

_____

(1)

(f) Suggest why all three sizes of marble chips produce a maximum volume of 60 cm^3 of gas.

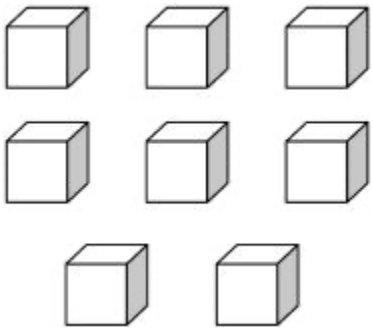
_____

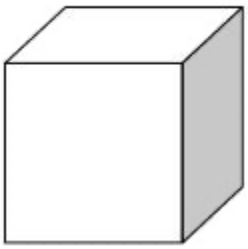
_____

(1)

(g) **Figure 3** shows eight small cubes, each 1 cm × 1 cm × 1 cm, and one large cube, 2 cm × 2 cm × 2 cm

Figure 3





Total volume of small cubes = 8 cm^3

Volume of large cube = 8 cm^3

Total surface area of small cubes = 48 cm^2

Calculate the surface area of the large cube.

_____

_____

Surface area of the large cube = _____ cm^2

(2)

(h) Explain why the size of the marble chips affects the rate of the reaction.

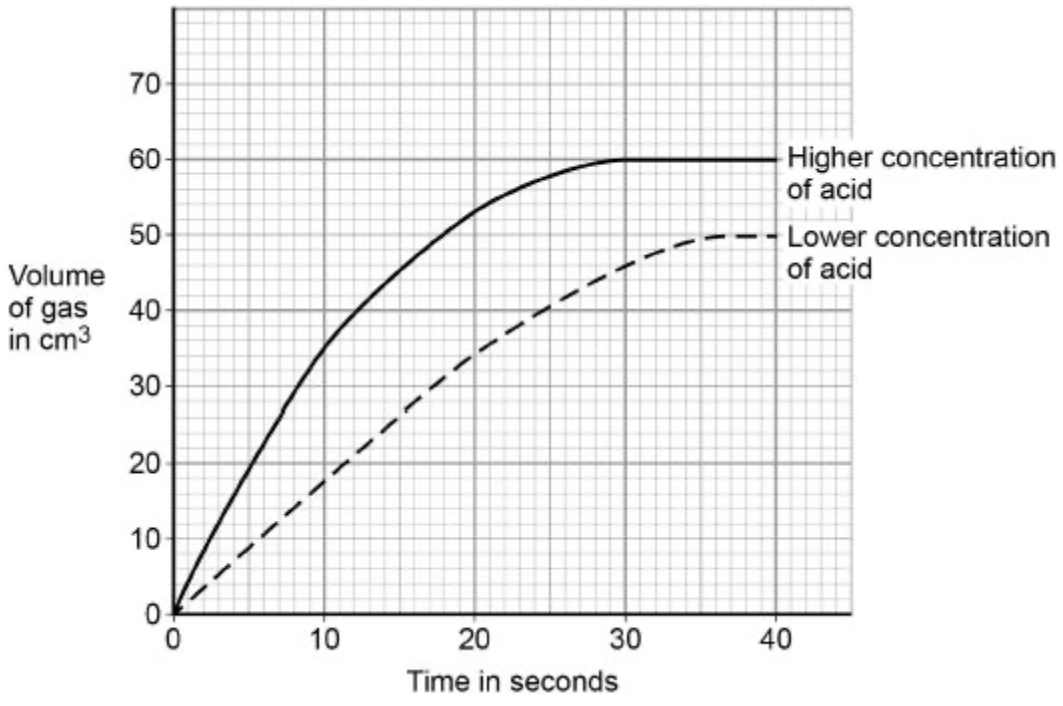
Give your answer in terms of 'collision theory'.

(2)

(i) The student repeated the investigation with small marble chips using hydrochloric acid with a lower concentration.

Figure 4 shows the volume of gas produced during the first 40 seconds.

Figure 4



Explain why the results for the lower concentration of acid are different from the results for the higher concentration of acid.

(3)
(Total 17 marks)

Q1.

(a) (boil ethanol) in a water bath

1

(b) (test) add iodine (solution)

1

(result) blue-black

allow black
allow blue / black
allow dark blue
ignore purple unqualified

1

(c) solvent moves through paper

1

different pigments have different solubilities in solvent
or
different pigments have different attractions for the paper

1

(and so) are carried different distances

1

allow references to solvent as the mobile phase and paper as the stationary phase

(d) any **one** from:

- R_f values overlap
  or
  0.20 is within range for two pigments
- R_f ranges overlap
- could be chlorophyll b or xanthophyll
- there may be other pigments (that are not in table 2)

1

(e) $$(R_f \text{ value}) = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$$

1

$$0.89 = \frac{\text{distance moved by substance}}{140}$$

or

$$0.98 = \frac{\text{distance moved by substance}}{140}$$

1

(distance moved by substance)
= 0.89 × 140

or
= 0.98 × 140

1

= 125 / 124.6 **or** 137 / 137.2

1

(from) 125 / 124.6 (mm to) 137 / 137.2 (mm)

1

*an answer of (from) 125 / 124.6 (mm to) 137 / 137.2 (mm) scores **5** marks*

*calculation using an incorrect distance moved by solvent scores a maximum of **4** marks*

(f) **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

- variation arising from mutations
- mutations occurring randomly
- produce a different protein / pigment / enzyme responsible for pigment production
- produce if more likely to survive
- will pass on favourable genes
- idea of timescale
- if more light captured, faster rate of photosynthesis
- increased photosynthesis causes faster growth
- outcompete neighbouring plants
- different colours of light have different wavelengths
- absorbing wider range of wavelengths means more light is absorbed
- more likely to survive in changing conditions

[18]

Q2.

(a) (alkane) has the (general) formula C_nH_{2n+2}

1

(b) heavy fuel oil

*do **not** award any marks if incorrect fraction given*

1

contains largest molecules (which have greatest viscosity)

allow has most carbon atoms (per molecule)

ignore reference to highest boiling point

1

(c) crude oil is heated to vaporise hydrocarbons

1

there is a temperature gradient in the column

allow the column gets cooler going up

1

as gases rise up the column the gases condense

1

fraction (containing octane / petrol) condenses between 40 °C and 180 °C

1

[7]

Q3.

(a) C_3H_6

1

(b) smaller molecule

allow shorter (hydrocarbon) chain

allow smaller hydrocarbon if MP2 obtained

1

(so) fewer intermolecular forces

*do **not** accept fewer covalent bonds*

1

(c)

allow converse argument

yield increases as pressure increases

1

(because) fewer (gas) molecules as products

1

(so) equilibrium moves to right / products

1

(d) the yield increases when temperature is decreased

allow converse statements

1

(e) reaction profile showing exothermic reaction

1

labelling of activation energy

allow correct labelling of activation energy if endothermic reaction shown

1

second profile drawn with different activation energy

in each profile reactants level and products level must be the same

1

correct distinction between catalyst and no catalyst

1

(f) increases the rate of the forward and reverse reaction

allow changes the rate of the forward and reverse reaction

1

by the same amount

1

[13]

Q4.

(a) growing plants (on low-grade ore)

allow named plant

1

plants are burnt (to produce ash)

1

(ash dissolved in acid to produce) solution of a copper compound

allow named copper compound

1

electrolysis (of solution of a copper compound)
or
displacement (by adding scrap iron to a solution of a copper compound)

allow addition of scrap iron (to a solution of a copper compound)

1

(b)

*an answer of 0.002 or 2 × 10^{-3} (mol) scores **3** marks*

M_r $CuSO_4$ = 159.5

1

$$\frac{0.319}{159.5}$$

allow correct use of incorrectly calculated value for M_r

1

= 0.002 (mol)

allow 2 × 10^{-3} (mol)

1

(c) both reaction profiles start at the same energy level and end at the same energy level.

1

(d) the amount of carbon dioxide used to produce the ethanol

1

is the same as the amount of carbon dioxide given off when the ethanol is burned

1

alternative approach

there is sufficient carbon dioxide (in the atmosphere) (1)

because carbon dioxide is constantly produced from burning fossil fuels (1)

if no other mark awarded allow for 1 mark burning ethanol produces carbon dioxide

(e) meets needs of current generation

1

without compromising needs of future generations

allow so there are enough resources for future generations

ignore references to harming / damaging planet / environment

1

[12]

Q5.

(a) sediment / limestone formation from carbonates

1

(b) short wavelength radiation

1

passes through atmosphere to Earth's surface

1

Earth's surface radiates different wavelengths

1

which are absorbed by greenhouse gases to produce temperature increase

allow CH_4 H_2O or CO_2

1

(c) 13.8 %

allow values in the range 13.0 to 15.0

1

(d) 15.08 (°C)

allow values in the range 15.05 – 15.10

1

(e) correlation between CO_2 levels and temperature

1

despite short-term variations of temperature

1

supported by values from graph which show correlation

1

cannot determine causality from this data or possible causality as increasing use of fossil fuels since 1900 has caused accelerated temperature increase

1

[11]

Q6.

(a) $CaCl_2 + CO_2 + H_2O$

products in any order

1

balancing: **2** (HCl)

dependent on correct formulae for products

1

(b) value from graph used to show volume increase

must include a time or volume value

1

values from graph used to show the volume increases less rapidly

must include time interval or volume increment

1

volume **or** time stated when graph line levels off

*allow levels off at 60 (cm^3) **or** 28 to 30 s*
allow descriptions in terms of rate of reaction

1

values must be approximately correct

(c) draw tangent at <u>15 s</u>

allow draw a straight line on the curve at <u>15 s</u>

1

calculate gradient

allow correct description of gradient calculation
ignore calculations if given

1

(d) centimetres cubed per second

*allow cm^3/s **or** $cm^3\ s^{-1}$ (all lower case)*
allow mixture of abbreviations and words, e.g. centimetres cubed/s
*do **not** accept non-SI abbreviations (e.g. sec for s)*

1

(e) (rate) increases as chips get smaller

allow converse

1

(f) same amount of acid
or
same number of moles of acid

allow same volume of acid
allow same concentration of acid
allow same mass of $CaCO_3$ / marble chips
allow one reactant is the limiting factor

1

(g) (surface area of each face = 2 × 2 =) 4

1

(6 × 4 =) 24 (cm^2)

allow 6 × student's value from step 1

1

*an answer of 24 (cm^2) scores **2** marks*

(h) small(er) chips have large(r) surface area (for the same volume)

allow converse

1

so more frequent collisions

allow more chance of collisions
allow more likely to collide

*do **not** accept reference to speed of particles or energy of collisions*

ignore more collisions
ignore more successful collisions

1

(i) (sloping part is less steep because) reaction is slower

1

due to less frequent collisions

*do **not** accept reference to speed of particles or energy of collisions*
ignore fewer collisions

1

fewer acid particles (in same volume)

ignore weaker acid

1

or
(sloping part is less steep because) reaction is slower (1)

there are fewer acid particles (in same volume) (1)

(graph levels off lower) so less gas is produced (1)

allow converse for more concentrated acid

[17]