Pearson Edexcel International GCSE in Chemistry (9-1)

Exemplar student answers with examiner comments

Contents

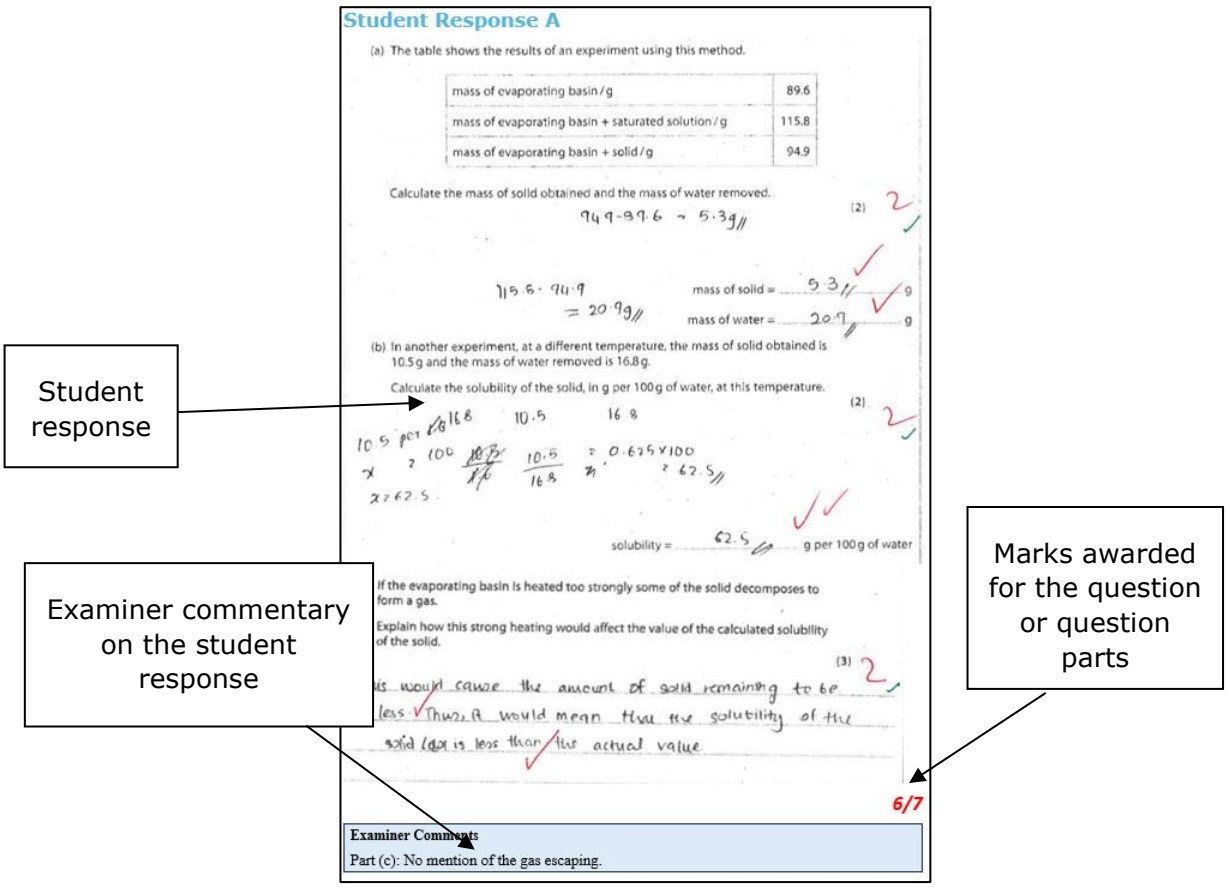
About this booklet

This booklet has been produced to support mathematics teachers delivering the new International GCSE in Chemistry.

The booklet looks at questions from the Sample Assessment Materials, and some relevant questions from past papers. It shows real student responses to these questions, and how the examining team follow the mark scheme to demonstrate how the students would be awarded marks on these questions.

How to use this booklet

Our examining team have selected student responses to 4 questions. Following each question you will find the mark scheme for that question and then a range of student responses with accompanying examiner comments on how the mark scheme has been applied and the marks awarded, and on common errors for this sort of question.



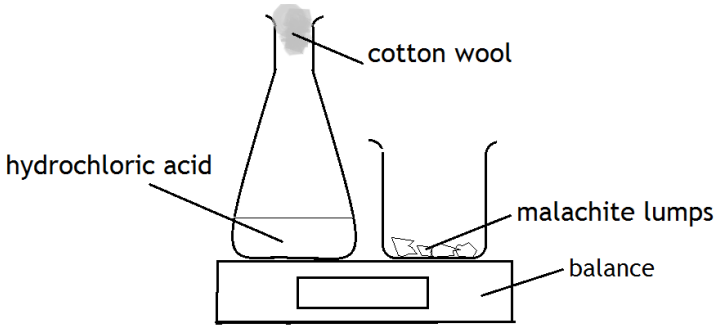
Paper 1

Exemplar Question 1

8. The copper(II) carbonate in the mineral, malachite, reacts with hydrochloric acid according to this equation.

$$CuCO_3(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(g) + CO_2(g)$$

Some students investigate the effect of changing the concentration of acid on the rate of this reaction. The diagram shows the apparatus they use.



This is the method they use:

- set the balance to zero
- add an excess of malachite lumps to the conical flask and replace the cotton wool
- start a timer and record the balance reading after one minute.

The experiment is repeated using different concentrations of hydrochloric acid. The mass and number of malachite lumps are kept the same in each experiment.

(a) The table shows the results obtained in one series of experiments.

Concentration of hydrochloric acid/ mol/dm^3	0.6	0.8	1.0	1.6	1.8	2.0
Balance reading/g	−0.20	−0.27	−0.44	−0.54	−0.60	−0.67

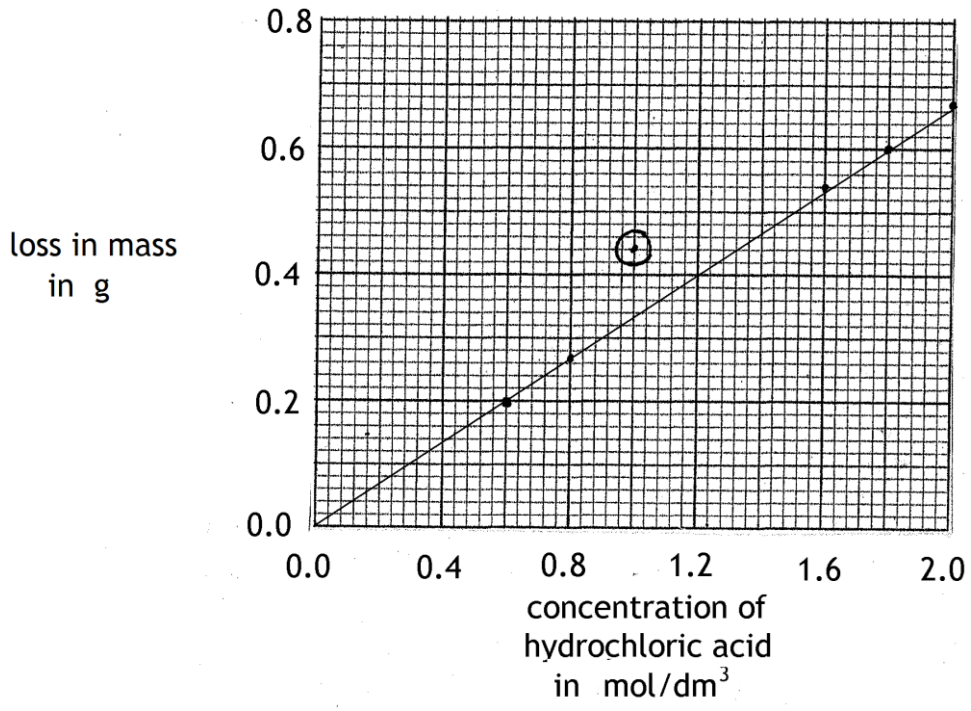
State why the balance readings have negative values.

(1)

.....

.....

(b) The graph shows the results of this series of experiments.



The circled point indicates an anomalous result.

(i) Suggest **one** mistake the students could have made to produce this result.

(1)

.....

(ii) State the relationship shown by the graph.

(1)

.....

.....

(c) Explain why an increase in the concentration of the acid causes an increase in the rate of the reaction. You should use the particle collision theory in your answer.

(2)

.....

.....

(Total for Question 8 = 5 marks)

Mark Scheme

Question number	Answer	Mark
8(a)	One reaction product is a gas and so escapes from the flask	**1**

Question number	Answer	Mark
8(b)(i)	Any one of: • balance reading recorded too late • acid concentration greater than recorded	**1**

Question number	Answer	Mark
8(b)(ii)	Loss in mass directly proportional to acid concentration	**1**

Question number	Answer	Additional guidance	Mark
8(c)	An explanation that makes reference to the following two points: • more particles in the same volume (1) • so collide more frequently (with malachite) (1)	accept particles closer together	**2**

Student Response A

(a) The table shows the results obtained in one series of experiments.

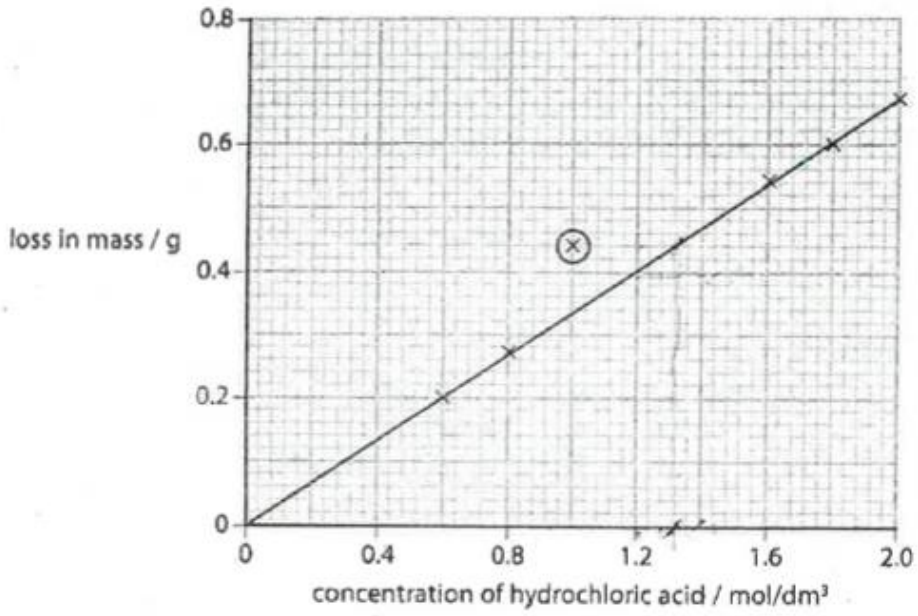
concentration of hydrochloric acid / mol/dm³	0.6	0.8	1.0	1.6	1.8	2.0
balance reading / g	−0.20	−0.27	−0.44	−0.54	−0.60	−0.67

State why the balance readings have negative values.

(1)

Carbon dioxide (CO_2) gas escaped from the conical flask and since the balance was set to zero, negative values were shown.

(b) The graph shows the results of this series of experiments.



10 = 0·0
0 3 = x
1·32

The circled point indicates an anomalous result.

(i) Suggest **one** mistake the students could have made to produce this result.

(1)

The concentration of HCl used may have been higher than 1·0, approximately 1·32 mol dm³ may have been used.

(ii) State the relationship shown by the graph.

(1)

As the concentration of HCl increases, the loss in mass increases. The concentration and loss in mass are directly proportional. A linear relationship is shown.

(c) Explain why an increase in the concentration of the acid causes an increase in the rate of the reaction. You should use the particle collision theory in your answer.

(2)

HCl molecules

More ~~we~~ ~~Effects~~ will be present if the concentration is high thus the chance that the malachite lumps collide with the molecules would be higher. Thus there would be more ~~collisions~~ successfull collisions per unit ~~time~~ time. Thus rate of reaction increases

(Total for Question 8 = 5 marks)

2 3

3/5

Examiner Comments

Part (c): In dilute solution HCl exists as ions, not molecules. It is also necessary to state that there are more particles/ions **in the same volume**. The second mark could not be awarded since the candidate did not state that there are **more** successful collisions per unit time.

Student Response B

(a) The table shows the results obtained in one series of experiments.

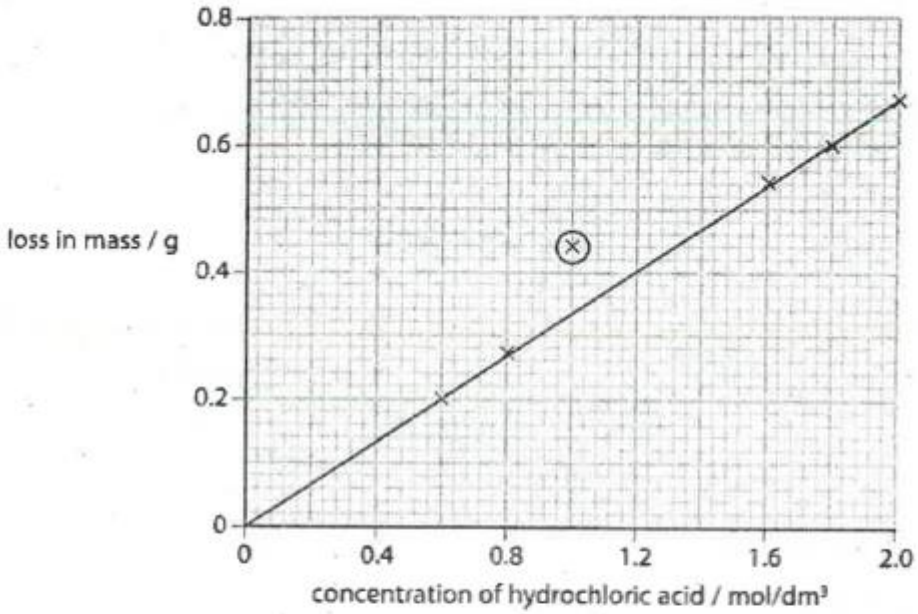
concentration of hydrochloric acid / mol/dm³	0.6	0.8	1.0	1.6	1.8	2.0
balance reading / g	−0.20	−0.27	−0.44	−0.54	−0.60	−0.67

State why the balance readings have negative values.

(1)

gas (CO_2) escapes / so the mass reduces. ✓ 1

(b) The graph shows the results of this series of experiments.



The circled point indicates an anomalous result.

(i) Suggest **one** mistake the students could have made to produce this result.

(1)

added hydrochloric acid which has higher concentration. NBOD — 0

(ii) State the relationship shown by the graph.

(1)

directly proportional / linear relationship 0

(c) Explain why an increase in the concentration of the acid causes an increase in the rate of the reaction. You should use the particle collision theory in your answer.

(2)

2

When concentration increase, the number of particle per unit volume increase. Hence the number of colision per unit time increases causing the rate of reaction to increase.

(Total for Question 8 = 5 marks)

3

3/5

Examiner Comments

Part (b)(i): A **comparison** of the two concentrations of acid is required, so stating that the acid has a high concentration is not sufficient.

Part (b)(ii): To score here it is necessary to include the names of the two variables plotted on the graph in your answer.

Student Response C

(a) The table shows the results obtained in one series of experiments.

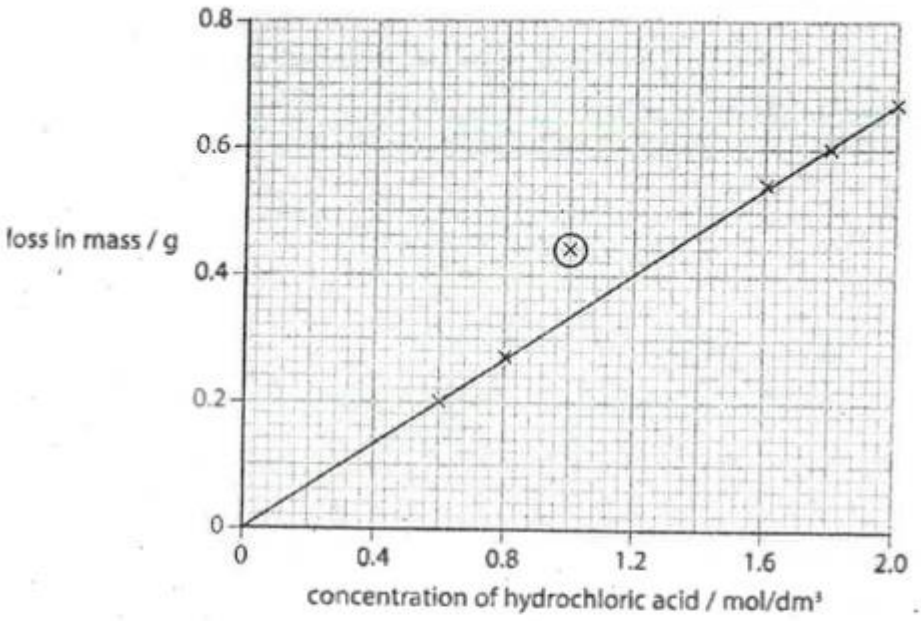
concentration of hydrochloric acid / mol/dm³	0.6	0.8	1.0	1.6	1.8	2.0
balance reading / g	−0.20	−0.27	−0.44	−0.54	−0.60	−0.67

State why the balance readings have negative values.

(1)

carbon dioxide gets evaporated so it has negative values

(b) The graph shows the results of this series of experiments.



The circled point indicates an anomalous result.

(i) Suggest **one** mistake the students could have made to produce this result.

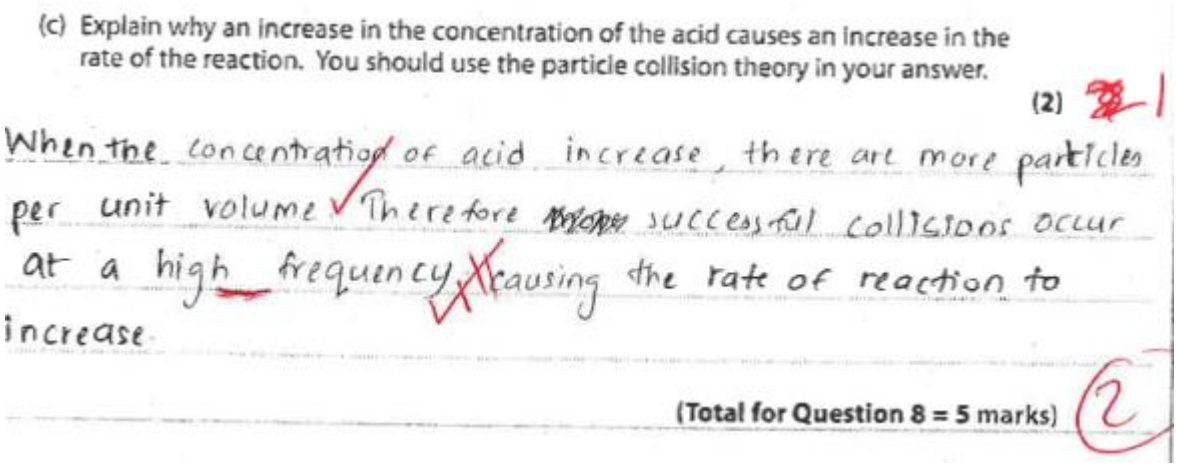
(1)

The students could have taken a higher concentration than 1.0 mol/dm³

(ii) State the relationship shown by the graph.

(1)

As the concentration of hydrochloric acid increase, the loss in mass also increase.



(c) Explain why an increase in the concentration of the acid causes an increase in the rate of the reaction. You should use the particle collision theory in your answer.

(2)

When the concentration of acid increase, there are more particles per unit volume. Therefore successful collisions occur at a high frequency causing the rate of reaction to increase.

(Total for Question 8 = 5 marks)

2/5

Examiner Comments

Part (a): Incorrect terminology used. The gas does not evaporate; it escapes.

Part (b)(ii): Since the graph line passes through the origin it is necessary to state that the two variables are directly proportional to one another, not just that as one increases so does the other.

Part (c): It is important to make a comparison between the frequencies of successful collisions. To state that there will now be a high frequency of collisions is not sufficient; it must be high**er**.

Student Response D

(a) The table shows the results obtained in one series of experiments.

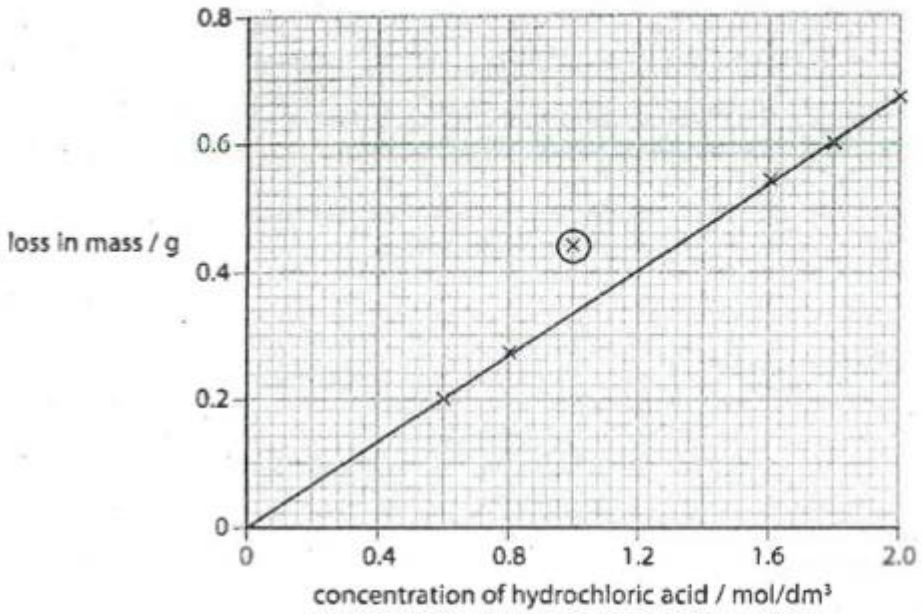
concentration of hydrochloric acid / mol/dm³	0.6	0.8	1.0	1.6	1.8	2.0
balance reading / g	−0.20	−0.27	−0.44	−0.54	−0.60	−0.67

State why the balance readings have negative values.

(1) 0

To show that the mass decreases.

(b) The graph shows the results of this series of experiments.



The circled point indicates an anomalous result.

(i) Suggest **one** mistake the students could have made to produce this result.

(1) 0

~~Concentration~~ Timer started quickly. X

(ii) State the relationship shown by the graph.

(1) 0

As the concentration of HCl increases the loss in mass also increases.

(c) Explain why an increase in the concentration of the acid causes an increase in the rate of the reaction. You should use the particle collision theory in your answer.

(2)

Increasing concentrations will increase the number of particles. These particles would now collide more frequently so the number of collisions increase and therefore increasing the rate of reaction.

(Total for Question 8 = 5 marks)

1/5

Examiner Comments

Part (a): The question required an answer that showed **why** the mass was decreasing, not just that the mass was decreasing.

Part (b)(ii): Since the graph line passes through the origin it is necessary to state that the two variables are directly proportional to one another.

Part (c): It is necessary to state that there are more particles/ions in **the same volume**.

Student Response E

(a) The table shows the results obtained in one series of experiments.

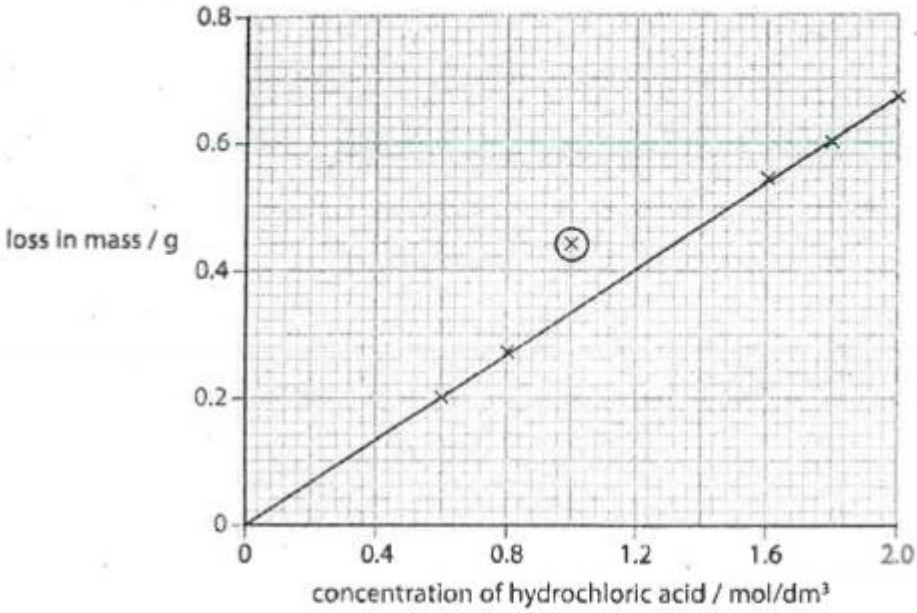
concentration of hydrochloric acid / mol/dm³	0.6	0.8	1.0	1.6	1.8	2.0
balance reading / g	−0.20	−0.27	−0.44	−0.54	−0.60	−0.67

State why the balance readings have negative values.

(1)

0

(b) The graph shows the results of this series of experiments.



The circled point indicates an anomalous result.

(i) Suggest **one** mistake the students could have made to produce this result.

(1)

0

The mass of the malachite lumps changed

(ii) State the relationship shown by the graph.

(1)

1

The loss in mass is ~~dif~~ directly proportional to the concentration of HCl

(c) Explain why an increase in the concentration of the acid causes an increase in the rate of the reaction. You should use the particle collision theory in your answer.

(2)

When the concentration increases more effective collisions take place between the HCl molecules and malachite lumps, thereby increasing the rate of reaction.

(Total for Question 8 = 5 marks)

1/5

Examiner Comments

Part (b)(i): The mass of the marble chips is irrelevant in this experiment since the chips are always in excess.

Part (c): In dilute solution HCl exists as ions, not molecules. It is also necessary to state that there are more particles/ions in **the same volume**. The second mark could not be awarded since the candidate did not state that there are **more** successful collisions per unit time.

Student Response F

(a) The table shows the results obtained in one series of experiments.

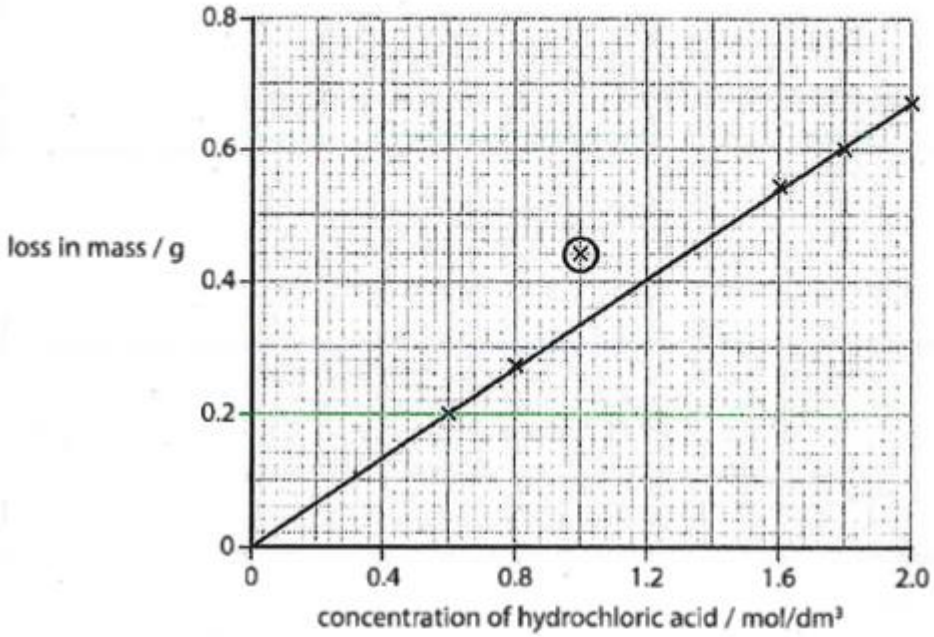
concentration of hydrochloric acid / mol/dm³	0.6	0.8	1.0	1.6	1.8	2.0
balance reading / g	−0.20	−0.27	−0.44	−0.54	−0.60	−0.67

State why the balance readings have negative values.

(1)

Waters + CO_2 will evaporate

(b) The graph shows the results of this series of experiments.



The circled point indicates an anomalous result.

(i) Suggest **one** mistake the students could have made to produce this result.

(1)

Not put the exact concentration.

(ii) State the relationship shown by the graph.

(1)

The loss in mass is proportional directly to hydrochloric acid conc.

(c) Explain why an increase in the concentration of the acid causes an increase in the rate of the reaction. You should use the particle collision theory in your answer.

(2)

With a higher concentration there are more collisions occuring. concentration affects rate of reaction, so the rate will increase as the collision frequency due to more particles

(Total for Question 8 = 5 marks)

2/5

Examiner Comments

Part (a): Incorrect terminology used. The gas does not evaporate; it escapes.

Part (c): In order to score the first mark it is necessary to state that there are more particles in **the same volume**.

Student Response G

(a) The table shows the results obtained in one series of experiments.

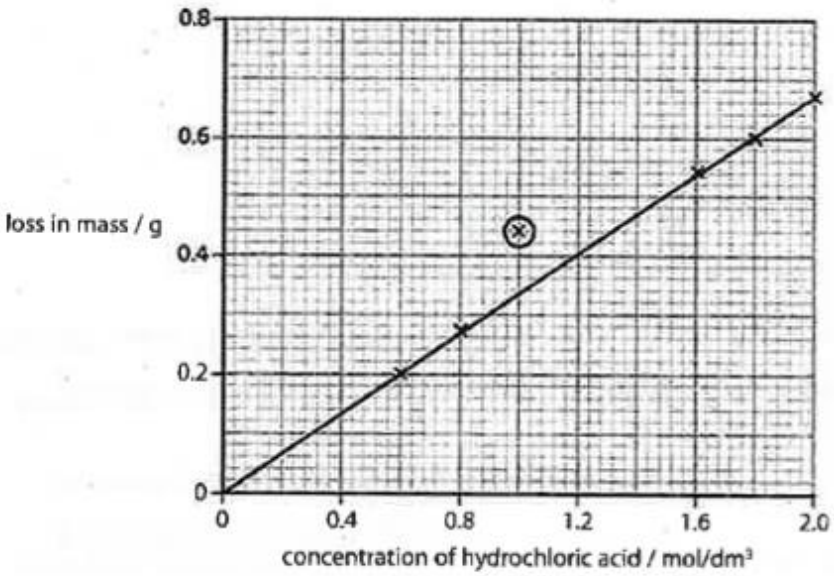
concentration of hydrochloric acid / mol/dm³	0.6	0.8	1.0	1.6	1.8	2.0
balance reading / g	−0.20	−0.27	−0.44	−0.54	−0.60	−0.67

State why the balance readings have negative values.

(1)

Some of the products escape, such as CO_2 ✓ BOD ✓

(b) The graph shows the results of this series of experiments.



The circled point indicates an anomalous result.

(i) Suggest **one** mistake the students could have made to produce this result.

(1)

0 not replaced the cotton wool fast enough meaning some product escape ✓

(ii) State the relationship shown by the graph.

(1)

with increasing concentration of hydrochloric acid, the loss in mass increases proportionally ✓ BOD

(c) Explain why an increase in the concentration of the acid causes an increase in the rate of the reaction. You should use the particle collision theory in your answer.

(2) 2

An increase in concentration of acid means there are more HCl particles in a given volume meaning that they are more likely to collide with the copper carbonate particles, and so react, in a set period of time.

(Total for Question 8 = 5 marks) 4

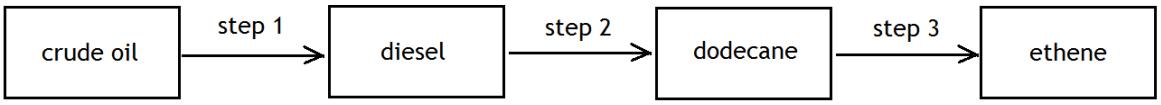
3/5

Examiner Comments

Part (c): 'More likely to collide' is not considered to be equivalent to 'collide more frequently', so the second mark is not awarded.

Exemplar Question 2

9 The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5)

.....

.....

.....

.....

.....

(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3)

.....

.....

.....

.....

.....

(c) Which of these formulae is that of an alkane?

(1)

[ ] **A** C_7H_{12}

[ ] **B** C_9H_{18}

[ ] **C** $C_{11}H_{24}$

[ ] **D** $C_{13}H_{30}$

(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon.

(1)

$$C_{12}H_{26} \rightarrow 2C_2H_4 + \text{.....}$$

(e) Alkanes and alkenes both react with halogens, but in different ways. The equations for two examples of these different reactions are shown.

equation 1 $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl +$ compound X

equation 2 $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

(i) State the condition needed for the reaction in equation 1 to occur.

(1)

.....

(ii) Deduce the formula of compound X.

(1)

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

Show only the outer electrons of each atom.

(2)

(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1.

(1)

.....

(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

(1)

[ ] **A** colourless to orange

[ ] **B** colourless to green

[ ] **C** green to colourless

[ ] **D** orange to colourless

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate its empirical formula.

(3)

empirical formula = ...

(Total for Question 9 = 19 marks)

Mark Scheme

Question number	Answer	Mark
9(a)	A description that makes reference to five of the following points: • crude oil is heated/vaporised (1) • the vapour enters the lower part of the column (1) • there is a temperature gradient up the column (1) • the vapour in the diesel fraction rises up the column until it condenses (1) • at a height where its boiling point is lower than the temperature in the column (1) • so the diesel fraction is removed (1)	**5**

Question number	Answer	Additional guidance	Mark
9(b)	An explanation that makes reference to the following three points: • dodecane contains hydrogen and carbon (1) • only/and no other elements (1) • and contains only single bonds (1)	accept does not contain double bonds/multiple bonds	**3**

Question number	Answer	Mark
9(c)	C	**1**

Question number	Answer	Mark
9(d)	C_8H_{18}	**1**

Question number	Answer	Additional guidance	Mark
9(e)(i)	Ultraviolet radiation	accept ultraviolet light	**1**

Question number	Answer	Mark
9(e)(ii)	HCl	**1**

Question number	Answer	Additional guidance	Mark
9(e)(iii)	• All 6 atoms with a dot and cross representing each bonding pair of electrons (1) • 3 lone pairs of electrons on Cl and none on any of the H atoms (1)	accept 2 dots or 2 crosses for each bond accept any combination of dots and crosses	**2**

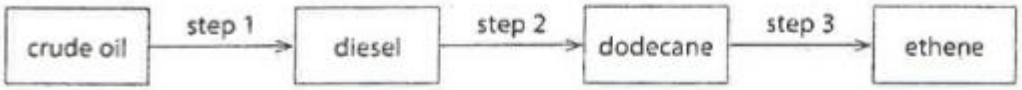
Question number	Answer	Mark
9(e)(iv)	Substitution	**1**

Question number	Answer	Mark
9(f)(i)	D	**1**

Question number	Answer	Mark
9(f)(ii)	• Dividing percentages by atomic masses (1) • Dividing results by smallest value OR obtaining ratio (1) • Writing empirical formula (1) Example calculation: C: 25.9 / 12 = 2.16 / 3 H: 5.0 / 1 = 5.0 / 7 Br: 57.6 / 80 = 0.72 / 1 O: 11.5 / 16 = 0.72 / 1 C_3H_7BrO accept symbols in any order	**3**

Student Response A

(9) The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5) 4 ✓

Crude oil is a mixture of hydrocarbons. A fractionating column is used. Diesel is a fraction of crude oil. Crude oil ~~is treated and~~ sent in to the fractionating column where it is heated ✓ Diesel and the other hydrocarbons have different boiling points, ~~when they~~ Crude oil is heated at the bottom of the chamber and ~~it~~ the gases ~~vapour~~ move up along the fractionating column ✓ which has been designed in a way where the temperature decreases as it goes up the column ✓ diesel has a unique boiling point in comparison to the others thus it condenses in a place where only it can return to its state as a liquid ✓ is then tapped off. ✓

(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3) 2 ✓

Dodecane belongs in the homologous series of Alkanes ~~which~~ in which hydrocarbons don't have a double bond ✓ This means that ~~it~~ the ~~last~~ carbon atom bond with the maximum amount of hydrogen ✓ atoms that it can bond with.

(c) Which of these formulae is that of an alkane?

(1)

- ☐ **A** C_7H_{12}
- ☐ **B** C_9H_{18}
- ☒ **C** $C_{11}H_{24}$
- ☐ **D** $C_{13}H_{30}$

(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon.

(1)

12 - (1 × 2)
26 - 8 = 18

$C_{12}H_{26} \rightarrow 2C_2H_4 + C_9H_{18}$

(e) Alkanes and alkenes both react with halogens, but in different ways.
The equations for two examples of these different reactions are shown.

equation 1 $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl$ + compound X

equation 2 $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

(i) State the condition needed for the reaction in equation 1 to occur.

(1)

UV light must be present.

(ii) Deduce the formula of compound X.

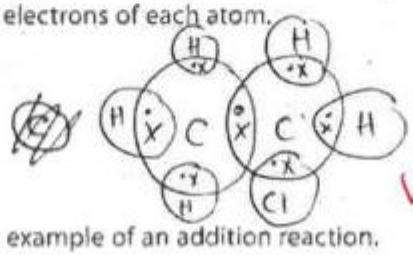
(1)

HCl

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

Show only the outer electrons of each atom.

(2)



(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1.

(1)

Substitution reaction

(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

(1)

- ☐ **A** colourless to orange
- ☐ **B** colourless to green
- ☐ **C** green to colourless
- ☒ **D** orange to colourless

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate the empirical formula of this compound.

(3)

C H Br O

25.9/12 5.0/1 57.6/80 11.5/16

2.16/0.72 5/0.72 0.72/0.72 0.72/0.72

3 : 7 : 1 : 1

C_3H_7BrO

C_3H_6BrOH

C_3H_6BrOH

empirical formula = C_3H_6BrO

(Total for Question 9 = 19 marks)

15

15/19

Examiner Comments

Part (a): Although the answer implied that the crude oil vapour is put into the column, there was no specific mention of this, so the mark for bullet point 2 cannot be awarded. Also, there was no mention of the diesel fraction condensing at a height where its boiling point is lower than the temperature in the column, so the mark for the fifth bullet point cannot be awarded.

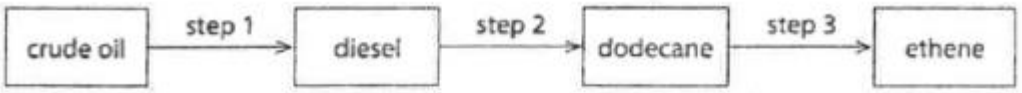
Part (b): One mark lost because the answer does not state that **only** carbon and hydrogen atoms are present in a hydrocarbon.

Part (e)(iii): Lone pairs on the chlorine atom missing.

Part (f)(ii): Although the correct empirical formula is given in the main text, the formula given on the answer line is not acceptable. An empirical formula should not show any functional groups that may be present.

Student Response B

(9) The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5)

Crude oil is heated ✓
At different levels of the column the heat reduces. ^
As the heat reduces the crude oil condenses
The diesel is obtained from where it condenses. ^

(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3)

It has no double bonds ✓ present in it so it is called saturated. Since it only ✓ contains hydrogen and carbon ✓ atoms it is called hydrocarbons.

(c) Which of these formulae is that of an alkane?

(1)

- ☐ A C_7H_{12}
- ☐ B C_9H_{18}
- ☒ C $C_{11}H_{24}$
- ☐ D $C_{13}H_{30}$

(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon.

(1)

$$C_{12}H_{26} \rightarrow 2C_2H_4 + C_8H_{18}$$

(e) Alkanes and alkenes both react with halogens, but in different ways.
The equations for two examples of these different reactions are shown.

equation 1 $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl$ + compound X

equation 2 $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

(i) State the condition needed for the reaction in equation 1 to occur.

(1)

UV light

(ii) Deduce the formula of compound X.

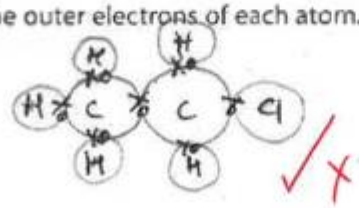
(1)

HCl

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

Show only the outer electrons of each atom.

(2)



(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1.

(1)

Substitution.

(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

(1)

- ☐ **A** colourless to orange
- ☐ **B** colourless to green
- ☐ **C** green to colourless
- ☒ **D** orange to colourless

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate the empirical formula of this compound.

(3)

C	H	Br	O
25.9 / 12	5.0 / 1	57.6 / 80	11.5 / 16
2.158	5	0.72	0.72
3	7	1	1

C_3H_7BrO

empirical formula = ...

(Total for Question 9 = 19 marks)

13

13/19

Examiner Comments

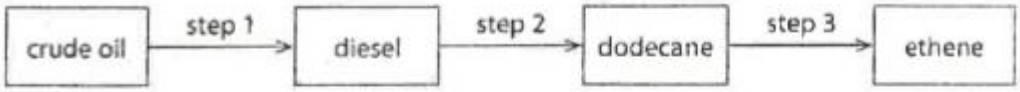
Part (a): Only the first bullet point scores here. The rest of the answer is too vague. For example, the statement 'At different levels of the column the heat reduces' is not sufficient. It is necessary to state that the temperature decreases as the column is ascended, or words to that effect.

Part (e)(iii): Lone pairs on the chlorine atom missing.

Part (f)(ii): The formula given is not acceptable. An empirical formula should not show any functional groups that may be present.

Student Response C

(9) The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5)

5

There are bubble caps in the fractionating column. The crude oil is heated and the particles evapourate from ~~the~~ bottom of the fractionating column and travels upwards. The particles gets trapped or passes through the bubble caps due to the ~~heat~~ density of the particle. Different fractions ~~of~~ are obtained by this method Diesel has a ~~lower~~ higher temperature than dodecane, therefore ~~the~~ diesel ~~can obtain~~ can be obtained by using a tap.

(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3)

3

Dodecane is a ~~unsaturated~~ hydrocarbon because it contains only hydrogen and carbon.

Dodecane is saturated because it contains the maximum number of bonds that it can have. There are no carbon-carbon double bonds in dodecane so it is a saturated hydrocarbon.

(c) Which of these formulae is that of an alkane?

(1)

- ☐ A C_7H_{12}
- ☐ B C_9H_{18}
- ☒ C $C_{11}H_{24}$
- ☐ D $C_{13}H_{30}$

(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon.

(1)

$C_{12}H_{26} \rightarrow 2C_2H_4 + C_8H_{18}$

(e) Alkanes and alkenes both react with halogens, but in different ways.
The equations for two examples of these different reactions are shown.

equation 1 $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl$ + compound X

equation 2 $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

(i) State the condition needed for the reaction in equation 1 to occur.

(1)

UV light

(ii) Deduce the formula of compound X.

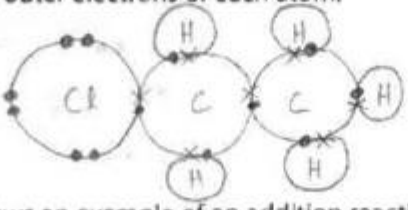
(1)

HCl

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

Show only the outer electrons of each atom.

(2)



(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1.

(1)

Substitution reaction

(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

(1)

- ☐ **A** colourless to orange
- ☐ **B** colourless to green
- ☐ **C** green to colourless
- ☒ **D** orange to colourless

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate the empirical formula of this compound.

(3)

	C	H	Br	O
m =	25.9	5.0	57.6	11.5
n =	$\frac{25.9}{12}$	$\frac{5.0}{1}$	$\frac{57.6}{80}$	$\frac{11.5}{16}$
=	$\frac{2.16}{0.72}$	$\frac{5}{0.72}$	$\frac{0.72}{0.72}$	$\frac{0.72}{0.72}$
	3	7	1	1

C_3H_7BrO

empirical formula = C_3H_7BrO

(Total for Question 9 = 19 marks)

15

16

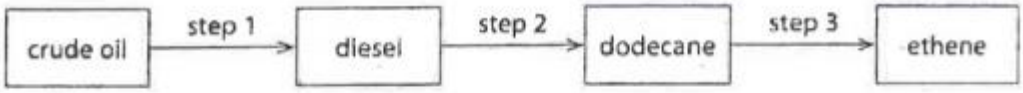
15/19

Examiner Comments

Part (a): First mark obtained for heating the crude oil. The candidate incorrectly states that the particles evaporate from the bottom of the column but nearly scores the mark for vapour travels upwards; however, the fourth bullet point in the mark scheme may only be awarded if there is a mention of the vapour condensing. There is no mention in the answer of any of the other points in the mark scheme, so only one mark awarded.

Student Response D

(9) The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5)

4

The crude oil is heated and passed into a fractionating column that is hotter at the bottom and cooler towards the top. The diesel fraction is obtained by making use of it's boiling point. The diesel vapour will move up as a gas until it's specific boiling point is reached and will then condense to form a liquid. This diesel fraction is then tapped off.

(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3)

3

dodecane is an alkane and so has no double bonds in it's structure. It also has the maximum possible number of hydrogen atoms for the given number of carbon atoms. Therefore dodecane is described as a saturated ~~hydrocarbon~~ due to this reason and also because it contains only carbon and hydrogen. it is considered a hydrocarbon.

(c) Which of these formulae is that of an alkane?

(1)

- ☐ A C_7H_{12}
- ☐ B C_9H_{18}
- ☒ C $C_{11}H_{24}$
- ☐ D $C_{13}H_{30}$

(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon.

(1)

$$C_{12}H_{26} \rightarrow 2C_2H_4 + C_8H_{18}$$

(e) Alkanes and alkenes both react with halogens, but in different ways.
The equations for two examples of these different reactions are shown.

equation 1 $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl$ + compound X

equation 2 $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

(i) State the condition needed for the reaction in equation 1 to occur.

(1)

Ultraviolet light

(ii) Deduce the formula of compound X.

(1)

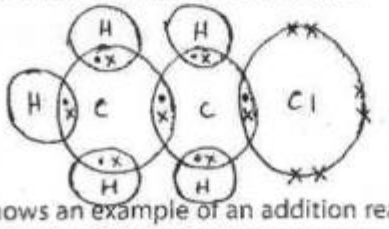
HCl

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

Show only the outer electrons of each atom.

(2)

C - 2,4
H - 1
Cl - 2, 8, 7



(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1.

(1)

Substitution reaction.

(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

(1)

☐ **A** colourless to orange

☐ **B** colourless to green

☐ **C** green to colourless

☒ **D** orange to colourless

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate the empirical formula of this compound.

(3)

C : H : Br : O

25.9/12 : 5.0/1 : 57.6/80 : 11.5/16

2.16/0.719 : 5.0/0.719 : 0.72/0.719 : 0.719/0.719

3 : 6.95 : 1 : 1

3 : 7 : 1 : 1

C_3H_7BrO //

empirical formula = C_3H_7BrO

(Total for Question 9 = 19 marks)

18

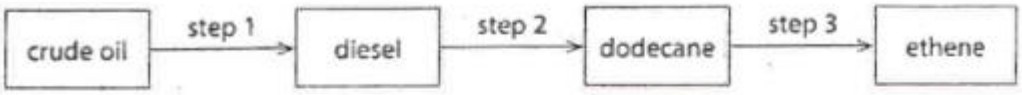
18/19

Examiner Comments

Part (a): The second mark is nearly scored, but it is important to state that the crude oil vapour enters the **lower part** of the column.

Student Response E

(9) The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5)

The crude oil is put into a fractionating column to be divided into fractions. A heat of 1500 °C is given to the crude oil. Under heat, the crude oil undergoes cracking to form the smaller diesel fraction. This fraction is piped out of the fractionating column afterwards.

(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3)

Dodecane is ~~an~~ a saturated hydrocarbon as it lacks a carbon - carbon double bond. Dodecane is an alkane and alkanes don't have a carbon - carbon double bonds, so they are saturated hydrocarbons.

(c) Which of these formulae is that of an alkane?

(1)

- ☐ **A** C_7H_{12}
- ☐ **B** C_9H_{18}
- ☒ **C** $C_{11}H_{24}$
- ☐ **D** $C_{13}H_{30}$

(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon.

(1)

$C_{12}H_{26} \rightarrow 2C_2H_4 +$ C_8H_{18}

(e) Alkanes and alkenes both react with halogens, but in different ways.
The equations for two examples of these different reactions are shown.

equation 1 $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl$ + compound X

equation 2 $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

(i) State the condition needed for the reaction in equation 1 to occur.

(1)

UV light

(ii) Deduce the formula of compound X.

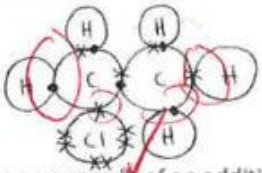
(1)

HCl

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

Show only the outer electrons of each atom.

(2)



(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1.

(1)

~~Halogin~~ Haloginaton

(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

(1)

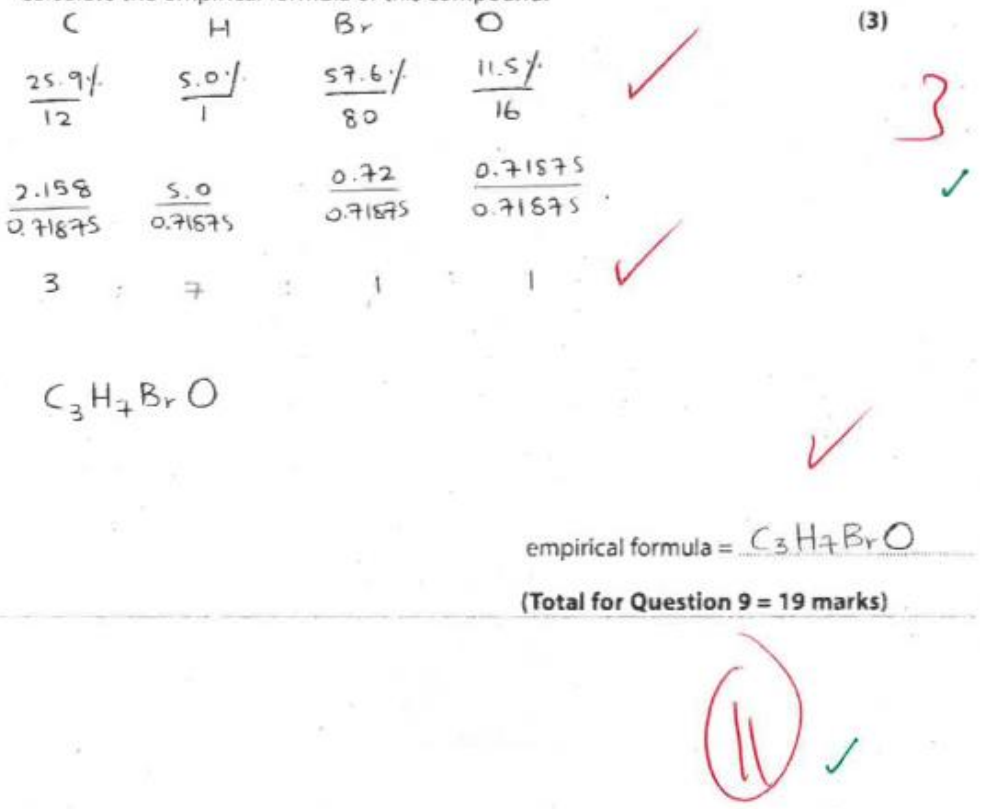
- ☐ **A** colourless to orange
- ☐ **B** colourless to green
- ☐ **C** green to colourless
- ☒ **D** orange to colourless

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate the empirical formula of this compound.

(3)



empirical formula = C_3H_7BrO

(Total for Question 9 = 19 marks)

11/19

Examiner Comments

Part (a): This candidate nearly scores the second mark, but fails to mention that the crude oil (vapour) enters the **lower part** of the column. The first mark is awarded for heating the crude oil, but the candidate now confuses the fractional distillation of the oil with cracking, so no further marks are awarded.

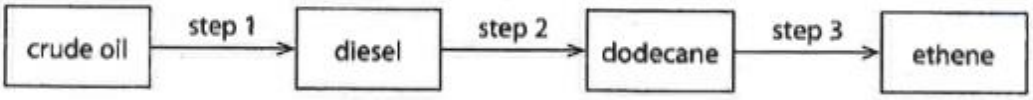
Part (b): The candidate has confined his/her answer to an explanation of the term 'saturated'. Since both 'saturated' and 'hydrocarbon' were in bold, an explanation of both is required to obtain full marks.

Part (e)(ii): Two of the C to H bonds contain only one electron, so the first mark is not awarded.

Part (e)(iv): Halogenation is not mentioned in the specification with reference to this type of reaction. It is always best to confine answers to the terms that are mentioned in the specification.

Student Response F

(9) The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5)

Cruel oil is burnt Fraction column then collects the condesed fraction which cools at different temperatures. Diesl is collected at its specific heat capacity and separated from refinery gas, kerosine and bitumen

(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3)

We know dodecane is saturated by the 'ane' extension to the name. Satured means that the molecule only contains sigle bonds. Hydrocarbons are only made from hydrogen & carbon and the extension of 'dodec' signifies that there are 10 carbons.

(c) Which of these formulae is that of an alkane?

(1)

☒ **A** C_7H_{12}

☐ **B** C_9H_{18}

☐ **C** $C_{11}H_{24}$

☐ **D** $C_{13}H_{30}$

(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon.

(1)

$$C_{12}H_{26} \rightarrow 2C_2H_4 + C_8H_{18}$$

(e) Alkanes and alkenes both react with halogens, but in different ways.
The equations for two examples of these different reactions are shown.

equation 1 $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl$ + compound X

equation 2 $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

(i) State the condition needed for the reaction in equation 1 to occur.

(1)

2- atmospheres of pressure 600°C temperature

(ii) Deduce the formula of compound X.

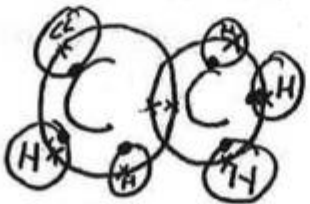
(1)

HCl

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

Show only the outer electrons of each atom.

(2)



(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1.

(1)

Subsitution

(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

(1)

- [x] **A** colourless to orange
- [ ] **B** colourless to green
- [ ] **C** green to colourless
- [ ] **D** orange to colourless

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate the empirical formula of this compound.

(3)

C	H	Br	O
12	1	80	16
25.9/12	5/1	57.6/80	11.5/16
2.16	5	0.72	0.718
3	7	1	1

C_3H_7BO

empirical formula = C_3H_7BO

(Total for Question 9 = 19 marks)

11/19

Examiner Comments

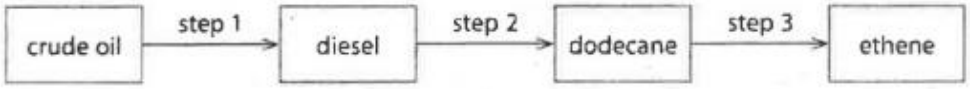
Part (a): The crude oil is only heated until it vaporises; it is not heated until it burns. A generous mark is awarded for 'collects the condensed fraction which cools at different temperatures'.

Part (e)(iii): Lone pairs on the chlorine atom missing.

Part (f)(iii): Benefit of the doubt is given for use of B instead of Br – treated as a 'slip of the pen'.

Student Response G

9 The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5)

3

Crude oil is heated to turn into vapour before entering the fractionating column from the bottom. The fractionating column is cooler at the top and hot at the bottom so as the vapour rises up the fractionating column, groups of hydrocarbons (fractions) with similar boiling point condense at different heights according to their bp. Some hydrocarbons are collected at the bottom as liquids because their bp is higher than the temperature in the fractionating column so they condense immediately. Diesel fraction is one of the fractions obtained

(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3)

3

Saturated is a compound with single bonds only between carbon atoms and a hydrocarbon is a compound with hydrogen and carbon atoms only. Dodecane is a saturated hydrocarbon as it contains hydrogen and carbon atoms only and all carbons are singly bonded with eachother.

(c) Which of these formulae is that of an alkane?

(1)

- ☐ **A** C_7H_{12}
- ☐ **B** C_9H_{18}
- ☒ **C** $C_{11}H_{24}$
- ☐ **D** $C_{13}H_{30}$

C_nH_{2n+2} ✓

(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon.

(1)

$C_{12}H_{26} \rightarrow 2C_2H_4 + C_8H_{18}$ ✓

(e) Alkanes and alkenes both react with halogens, but in different ways.
The equations for two examples of these different reactions are shown.

equation 1 $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl$ + compound X

equation 2 $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

(i) State the condition needed for the reaction in equation 1 to occur.

(1)

UV light ✓

(ii) Deduce the formula of compound X.

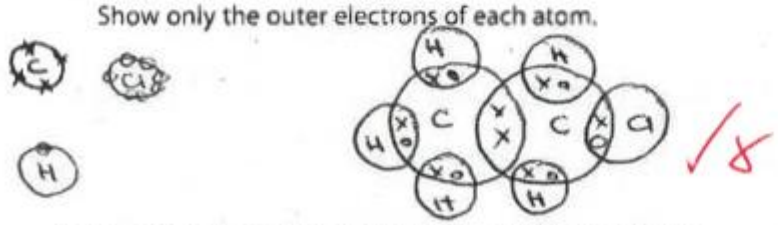
(1)

HCl ✓

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

Show only the outer electrons of each atom.

(2)



✓✓

(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1.

(1)

Substitution reaction ✓

(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

↳ unsaturated (1)

- ☐ **A** colourless to orange
- ☐ **B** colourless to green
- ☐ **C** green to colourless
- ☒ **D** orange to colourless

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate the empirical formula of this compound.

(3)

NOT COVERED YET

empirical formula = ...

(Total for Question 9 = 19 marks)

13/19

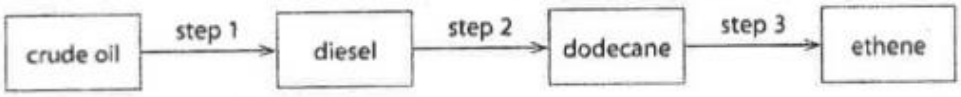
Examiner Comments

Part (a): First two marks only awarded. The candidate talks generally about fractional distillation and not specifically about the diesel fraction.

Part (e)(iii): Lone pairs on the chlorine atom missing.

Student Response H

9 The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5)

3

It is obtained by the process called fractional distillation. Crude oil is heated at 350 - 400 °C in a fractionating column where it separates into different fractions. Fractions are groups of organic compounds with similar boiling points. The different compounds that diesel contains in tubes will rise up the fractionating column and will condense high up the column where the temperature reaches their boiling points (The fractionating column is colder as you go up) ~~and hence diesel will be collected~~

(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3)

3

Dodecane is a hydrocarbon because it is made up of the elements hydrogen and carbon only. It is saturated because it ~~has~~ contains only single covalent bonds between its carbon atoms.

(c) Which of these formulae is that of an alkane?

C_nH_{2n+2}

(1)

- ☐ **A** C_7H_{12}
- ☐ **B** C_5H_{10}
- ☑ **C** $C_{11}H_{24}$
- ☐ **D** $C_{13}H_{30}$

(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon.

(1)

$C_{12}H_{26} \rightarrow 2C_2H_4 + C_8H_{18}$

(e) Alkanes and alkenes both react with halogens, but in different ways.
The equations for two examples of these different reactions are shown.

equation 1 $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl$ + compound X

equation 2 $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

(i) State the condition needed for the reaction in equation 1 to occur.

(1)

Presence of UV light

(ii) Deduce the formula of compound X.

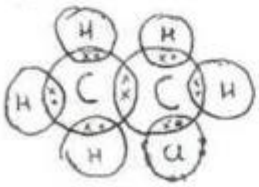
(1)

HCl

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

Show only the outer electrons of each atom.

(2)



(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1.

(1)

Substitution reaction

(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

(1)

- ☐ **A** colourless to orange
- ☐ **B** colourless to green
- ☐ **C** green to colourless
- ☑ **D** orange to colourless

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate the empirical formula of this compound.

(3)

NOT COVERED YET

empirical formula = ...

(Total for Question 9 = 19 marks)

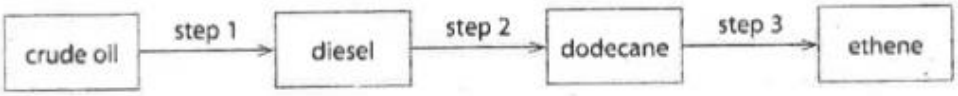
14/19

Examiner Comments

Part (a): First mark awarded even though the candidate states that the crude oil is heated in the column, and not before it enters the column. Third mark awarded for 'the fractionating column gets colder as you go up' – this is equivalent to marking point 3. Fourth mark awarded for 'compounds in diesel condense high up'. Fifth mark cannot be awarded since the compounds will condense at a temperature **lower** than their boiling points, not where it reaches their boiling points.

Student Response I

9 The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5)

3 ✓

Using fractional distillation, crude oil is first heated at very high temperatures ~~[illegible]~~ 350-400°C and enters the fractionating tower as a vapour, diesel condenses somewhere in the middle of the ~~diesel to the top of the~~ column ~~[illegible]~~ (the top of the column is cooler than the bottom, the compounds with the lower boiling point condense higher up on the fractionating tower. After it is condensed diesel is obtained as a liquid ✓ and used for heating ~~[illegible]~~ and pour fuel)

Bm

(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3)

2 ✓

because dodecane is an alkane (which is a saturated hydrocarbon) as the carbon contains the maximum number of single bonds. ✓ Furthermore the compound contains only hydrogen and carbon ✓ therefore it is called a hydrocarbon

(c) Which of these formulae is that of an alkane?

(1)

C_nH_{n+2}

- ☐ A C_7H_{12}
- ☐ B C_9H_{18}
- ☒ C $C_{11}H_{24}$
- ☐ D $C_{13}H_{30}$

(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon.

(1)

$26 - 8 = 18$

$12 - 4 = 8$

$C_{12}H_{26} \rightarrow 2C_2H_4 + C_8H_{18}$

(e) Alkanes and alkenes both react with halogens, but in different ways.
The equations for two examples of these different reactions are shown.

equation 1 $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl$ + compound X

equation 2 $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

(i) State the condition needed for the reaction in equation 1 to occur.

(1)

UV light

(ii) Deduce the formula of compound X.

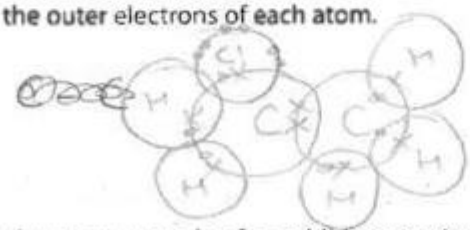
(1)

HCl

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

Show only the outer electrons of each atom.

(2)



(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1.

(1)

Substitution

(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

(1)

- ☐ **A** colourless to orange
- ☐ **B** colourless to green
- ☐ **C** green to colourless
- ☐ **D** orange to colourless

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate the empirical formula of this compound.

(3)

NOT COVERED YET

empirical formula = ...

(Total for Question 9 = 19 marks)

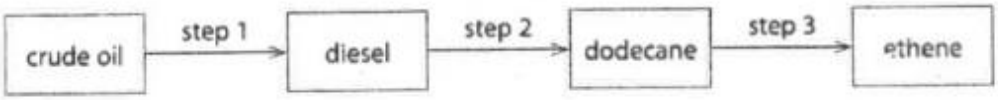
12/19

Examiner Comments

Part (a): First mark scored for crude oil is heated, but second mark not awarded since the candidate did not state that the vapour enters the **lower** part of the column. 'The top is cooler than the bottom' is accepted as equivalent to 'temperature gradient' and 'obtained as a liquid' is accepted as equivalent to 'diesel fraction is removed'. There is no mention of either the vapour rising up the column (third marking point) or of the vapour condensing at a height where it boiling point is lower than the temperature in the column, so only three marks are awarded.

Student Response J

9 The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5)

The crude oil is heated in a high temperature. The ~~foet~~ carbon chains with different lengths have different boiling points so the small carbon chains will rise over diesel. So you will collect the carbon chains with the highest boiling point.

(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3)

Dodecane is described as a saturated hydrocarbons because it ~~doesn't~~ have double carbon to carbon bonds, it only has single carbon to carbon bonds.

(c) Which of these formulae is that of an alkane?

(1)

- ☐ A C_7H_{12}
- ☐ B C_9H_{18}
- ☒ C $C_{11}H_{24}$
- ☐ D $C_{13}H_{30}$

(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon.

(1)

$$C_{12}H_{26} \rightarrow 2C_2H_4 + C_8H_{18}$$

(e) Alkanes and alkenes both react with halogens, but in different ways.
The equations for two examples of these different reactions are shown.

equation 1 $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl$ + compound X

equation 2 $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

(i) State the condition needed for the reaction in equation 1 to occur.

(1)

You need UV light to provide energy for the reaction

~~You need an aluminium oxide catalyst~~

(ii) Deduce the formula of compound X.

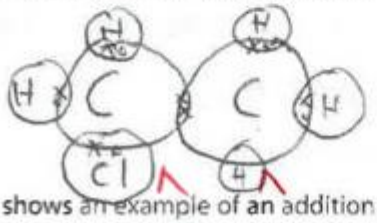
(1)

HCl

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

Show only the outer electrons of each atom.

(2)



(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1.

(1)

condensation

(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

(1)

0 ✓

☐ **A** colourless to orange

☐ **B** colourless to green

☐ **C** green to colourless ^

☐ **D** orange to colourless

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate the empirical formula of this compound.

(3)

0 ✓

NOT COVERED YET

empirical formula = ...

(Total for Question **9 = 19** marks)

6 ✓

6/19

Examiner Comments

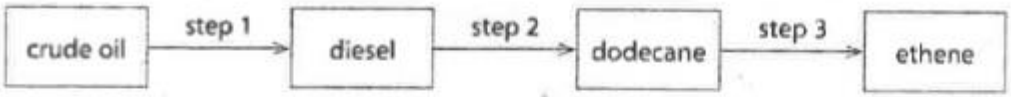
Part (a): First mark awarded for crude oil is heated, but nothing credit worthy after that. Candidate gives vague information rather than focusing on the diesel fraction as demanded by the question.

Part (b): Part(b): The candidate has confined his/her answer to an explanation of the term ‘saturated’. Since both ‘saturated’ and ‘hydrocarbon’ were in bold, an explanation of both is required to obtain full marks.

Part (e)(iii): One bonding pair of electrons missing, so first mark not awarded. No lone pairs shown on the chlorine atom, so second mark not awarded.

Student Response K

(9) The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5) 2

To obtain diesel from crude oil, the crude oil would have to undergo fractional distillation. A fractionating column is heated, with higher temperature at the bottom and lower at the top. At different heights of the column there are collection tubes. Diesel is a mixture of hydrocarbons, all with similar boiling points and so, as the crude oil rises as a gas, the group of hydrocarbons that make up diesel, once they reach a specific temperature will condense and be collected.

BOD

(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3) 3

Dodecane contains 12 carbon atoms all bonded by single carbon to carbon bonds. This single bond is what makes a compound saturated. It is then described as a hydrocarbon because the only elements present in the compound are hydrogen and carbon.

(c) Which of these formulae is that of an alkane? C_nH_{2n} (1)

- ☐ **A** C_7H_{12}
- ☑ **B** C_9H_{18} C_nH_{2n}
- ☐ **C** $C_{11}H_{24}$
- ☐ **D** $C_{13}H_{30}$

(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon. (1)

$$C_{12}H_{26} \rightarrow 2C_2H_4 + C_8H_{18}$$

(e) Alkanes and alkenes both react with halogens, but in different ways.
The equations for two examples of these different reactions are shown.

equation 1 $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl$ + compound X

equation 2 $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

(i) State the condition needed for the reaction in equation 1 to occur. (1)

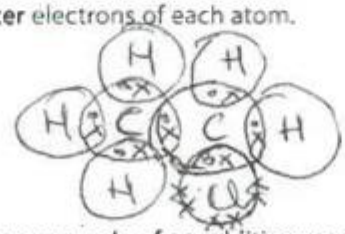
UV light

(ii) Deduce the formula of compound X. (1)

$C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$ (compound X = HCl)

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

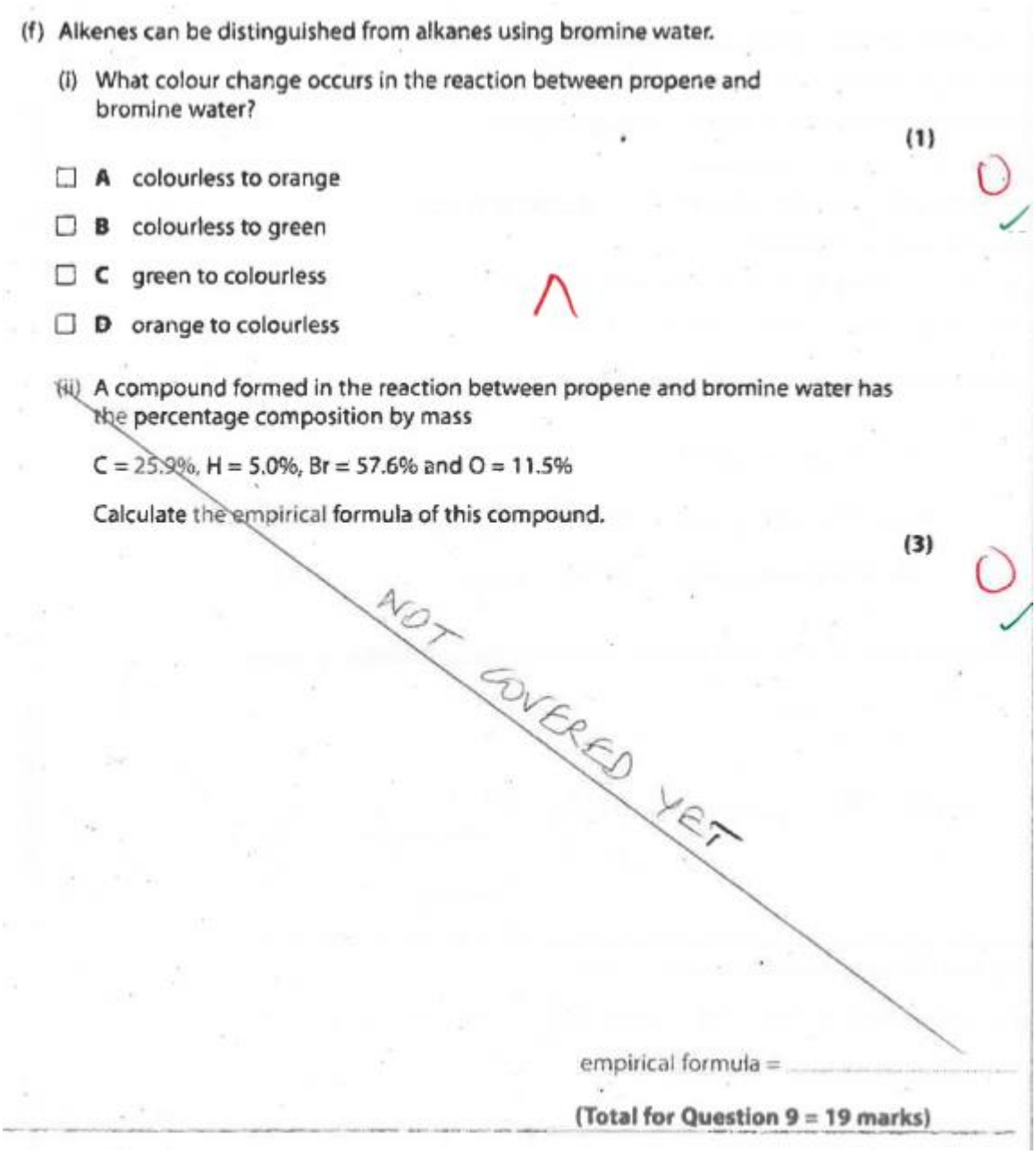
Show only the outer electrons of each atom. (2)



(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1. (1)

Substitution



(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

(1)

- ☐ **A** colourless to orange
- ☐ **B** colourless to green
- ☐ **C** green to colourless
- ☐ **D** orange to colourless

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate the empirical formula of this compound.

(3)

NOT COVERED YET

empirical formula = ...

(Total for Question 9 = 19 marks)

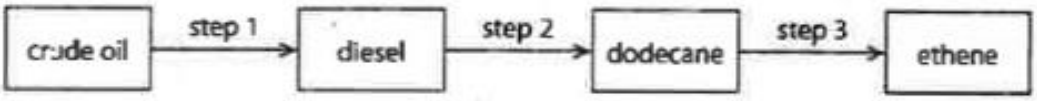
11/19

Examiner Comments

Part (a): The candidate's description is generally too vague. The question demanded that the answer be focused on obtaining the diesel fraction. The statement 'higher temperatures at the bottom and lower at the top' is accepted as being equivalent to 'temperature gradient', so the third mark in the mark scheme is awarded. A second mark is awarded for 'condenses'.

Student Response L

9 The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5)

The crude oil is fed into the bottom of the tall column and is heated. It then vaporises. As it goes up the column it becomes cooler. When the vapors become cool enough they condense on a platform and are fed back out of the the column. All of the vapors with boiling points at the height range of the diesel fraction condense here and are collected as a fraction.

(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3)

3

dodecane is a salured hydrocarbon because it is made up of Hydrogen and Carbon only and does not have a double bond.

(c) Which of these formulae is that of an alkane?

(1)

- ☐ A C_7H_{12}
- ☐ B C_9H_{18}
- ☒ C $C_{11}H_{24}$
- ☐ D $C_{13}H_{30}$

(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon.

(1)

$$C_{12}H_{26} \rightarrow 2C_2H_4 + C_8H_{18}$$

(e) Alkanes and alkenes both react with halogens, but in different ways.
The equations for two examples of these different reactions are shown.

equation 1 $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl$ + compound X

equation 2 $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

(i) State the condition needed for the reaction in equation 1 to occur.

(1)

High temperature

(ii) Deduce the formula of compound X.

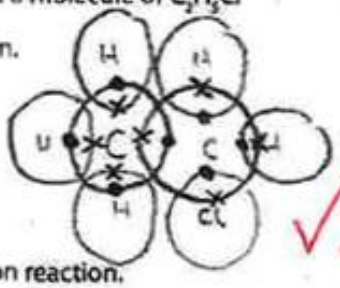
(1)

CH

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

Show only the outer electrons of each atom.

(2)



(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1.

(1)

Displacement reaction

(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

(1)

- ☐ **A** colourless to orange
- ☐ **B** colourless to green
- ☐ **C** green to colourless
- ☒ **D** orange to colourless

$C_3H_8 + Br_2 \rightarrow C_3H_8Br_2$ M=1 E=2 P=3 B=4

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate the empirical formula of this compound.

(3)

in 100g.

C	H	Br	O	
25.9g	5	57.6	11.5	mass (g)

11/19

Examiner Comments

Part (a): The implication from the first sentence is that the crude oil is heated **after** being fed into the column. This is not the case; it is heated **prior** to being fed into the column. However, a mark is still given for the crude oil being heated. 'As it goes up the column it becomes cooler' it acceptable for 'temperature gradient', so the third marking point in the mark scheme is awarded. The fourth marking point is also reached by mentioning that the vapours of the diesel fraction condense. However, there is no mention of why they condense, nor any mention of the liquid being removed.

Part (e)(i): 'High temperature' is always ignored as a condition for this reaction. UV radiation is the required condition.

Part (e)(iii): The lone pairs on the chlorine atom are missing.

Paper 2

Exemplar Question 3

2 This is a method used to measure the solubility of a solid in water:

- add an excess of solid to some water in a boiling tube and stir
- measure the temperature of the saturated solution formed
- weigh an empty evaporating basin
- pour some of the saturated solution into the evaporating basin
- weigh the basin and contents
- heat the evaporating basin to remove all of the water
- weigh the evaporating basin and remaining solid.

(a) The table shows the results of an experiment using this method.

Mass of empty evaporating basin/g	89.6
Mass of evaporating basin + saturated solution/g	115.8
Mass of evaporating basin + solid/g	94.9

Calculate the mass of solid obtained and the mass of water removed.

(2)

mass of solid = ...g

mass of water = ...g

(b) In another experiment, at a different temperature, the mass of solid obtained is 10.5 g and the mass of water removed is 16.8 g.

Calculate the solubility of the solid, in g per 100 g of water, at this temperature.

(2)

solubility = ...g per 100 g of water

(c) If the evaporating basin is heated too strongly some of the solid decomposes to form a gas.

Explain how this would affect the value of the calculated solubility of the solid.

(3)

.....

.....

.....

.....

(Total for Question 2 = 7 marks)

Mark Scheme

Question number	Answer	Mark
2(a)	• (mass of solid) 5.3 (g) (1) • (mass of water) 20.9 (g) (1)	**2**

Question number	Answer	Mark
2(b)	• (10.5 ÷ 16.8) × 100 (1) • 62.5 (grams of solid per 100 g of water) (1)	**2**

Question number	Answer	Mark
2(c)	An explanation that links together the following three points: • the gas will escape (1) • the mass of solid remaining will be less (than it should be) (1) • the value of the calculated solubility will be lower (than it should be) (1)	**3**

Student Response A

(a) The table shows the results of an experiment using this method.

mass of evaporating basin / g	89.6
mass of evaporating basin + saturated solution / g	115.8
mass of evaporating basin + solid / g	94.9

Calculate the mass of solid obtained and the mass of water removed.

(2)

94.9 - 89.6 = 5.3g //

115.6 - 94.9 = 20.9g //

mass of solid = 5.3 // g

mass of water = 20.9 // g

(b) In another experiment, at a different temperature, the mass of solid obtained is 10.5 g and the mass of water removed is 16.8 g.

Calculate the solubility of the solid, in g per 100 g of water, at this temperature.

(2)

10.5 per 16.8 10.5 16.8

10.5 per 16.8 = 100

x = 100 / 16.8

x = 62.5

10.5 / 16.8 = 0.625 x 100

= 62.5 //

solubility = 62.5 // g per 100 g of water

(c) If the evaporating basin is heated too strongly some of the solid decomposes to form a gas.

Explain how this strong heating would affect the value of the calculated solubility of the solid.

(3)

This would cause the amount of solid remaining to be less. Thus, it would mean that the solubility of the solid (g) is less than the actual value.

6/7

Examiner Comments

Part (c): No mention of the gas escaping.

Student Response B

(a) The table shows the results of an experiment using this method.

mass of evaporating basin / g	89.6
mass of evaporating basin + saturated solution / g	115.8
mass of evaporating basin + solid / g	94.9

Calculate the mass of solid obtained and the mass of water removed.

(2)

2 ✓

water – 115.8 – 94.9 = 20.9

94.9 – 89.6 = 5.3

mass of solid = 5.3 ✓ g

mass of water = 20.9 ✓ g

(b) In another experiment, at a different temperature, the mass of solid obtained is 10.5 g and the mass of water removed is 16.8 g.

Calculate the solubility of the solid, in g per 100 g of water, at this temperature.

(2)

2 ✓

$\frac{10.5}{16.8} \times 100$

= 62.5 ✓✓

solubility = 62.5 g per 100 g of water

(c) If the evaporating basin is heated too strongly some of the solid decomposes to form a gas.

Explain how this strong heating would affect the value of the calculated solubility of the solid.

(3)

The solid will form a gas and ✓ evaporate

The final ~~mass~~ amount of solid will reduce ✓ BOD

The results will be inaccurate. ^

5/7

Examiner Comments

Part (c): Incorrect terminology used; the gas does not evaporate, it escapes. The third mark could not be awarded since the final sentence is too vague; it is necessary to state in what way the results will be inaccurate.

Student Response C

(a) The table shows the results of an experiment using this method.

mass of evaporating basin / g	89.6
mass of evaporating basin + saturated solution / g	115.8
mass of evaporating basin + solid / g	94.9

Calculate the mass of solid obtained and the mass of water removed.

(2)

m_{solid} = 94.9 − 89.6

= 5.3 g

m_{water} = (115.8 − 89.6)

= 26.2 g

mass of solid = 5.3 g

mass of water = 26.2 g

(b) In another experiment, at a different temperature, the mass of solid obtained is 10.5 g and the mass of water removed is 16.8 g.

Calculate the solubility of the solid, in g per 100 g of water, at this temperature.

(2)

$\frac{10.5\text{ g} + 16.8\text{ g}}{100\text{ g}}$

= 0.273 g per 100 g of water

solubility = 0.273 g per 100 g of water

(c) If the evaporating basin is heated too strongly some of the solid decomposes to form a gas.

Explain how this strong heating would affect the value of the calculated solubility of the solid.

(3)

When the solid ~~is evaporated~~ decomposes and form a gas the mass of the solid decrease. Then the calculated solubility of the solid would be lesser than the theoritical value as a lesser mass is calculated when weighing the evapourating basin after removing the water.

3/7

Examiner Comments

Part (a): Incorrect subtraction to calculate mass of water; should be (115.8 – 94.9).

Part (b): Incorrect calculation performed. The experiment showed that 10.5 g of solid dissolved in 16.8 g of water. To find the solubility in g/100 g of water, one needs to use ratios to calculate the mass of solid that would dissolve in 100 g of water.

Part (c): No mention of the gas escaping, so first mark cannot be awarded.

Student Response D

(a) The table shows the results of an experiment using this method.

mass of evaporating basin / g	89.6
mass of evaporating basin + saturated solution / g	115.8
mass of evaporating basin + solid / g	94.9

Calculate the mass of solid obtained and the mass of water removed.

(2) 2

mass of water removed = 115.8 g − 94.9
= 20.9 g //

mass of solid = 94.9 g − 89.6 g
= 5.3 g //

mass of solid = 5.3 g ✓

mass of water = 20.9 g ✓

(b) In another experiment, at a different temperature, the mass of solid obtained is 10.5 g and the mass of water removed is 16.8 g.

Calculate the solubility of the solid, in g per 100 g of water, at this temperature.

(2) 1

Solubility = 52 g per 100 g of water //

10.5 g → 16.8 g

x g → 100 g

x = (100 g × 10.5 g) / 16.8 g ✓
= 62.5 g

solid dissolved = 62.5 g − 10.5 g ✗
= 52 g

solubility = 52 g per 100 g of water

(c) If the evaporating basin is heated too strongly some of the solid decomposes to form a gas.

Explain how this strong heating would affect the value of the calculated solubility of the solid.

(3)

The strong heating would increase the value of the calculated solubility of the solid because as some of the solid is decomposed to form a gas the mass of solid that dissolves in 100g of water would now increase as the water also boils to form a gas.

3/7

Examiner Comments

Part (b): Incorrect calculation performed. The experiment showed that 10.5 g of solid dissolved in 16.8 g of water. To find the solubility in g/100 g of water, one needs to use ratios to calculate the mass of solid that would dissolve in 100 g of water.

Part (c): This candidate has failed to appreciate that the formation, and subsequent escape, of a gas will decrease the mass of solid obtained, and hence that this results in the calculated solubility being lower than it should be.

Student Response E

(a) The table shows the results of an experiment using this method.

mass of evaporating basin / g	89.6
mass of evaporating basin + saturated solution / g	115.8
mass of evaporating basin + solid / g	94.9

Calculate the mass of solid obtained and the mass of water removed.

(2) 2 ✓

mass of solid = 5.3 ✓ g

mass of water = 20.9 ✓ g

(b) In another experiment, at a different temperature, the mass of solid obtained is 10.5 g and the mass of water removed is 16.8 g.

Calculate the solubility of the solid, in g per 100 g of water, at this temperature.

(2) 2 ✓

~~1g~~ / 100g

1g ⟶ 100g

10.5g ⟶ 16.8g

16.8 = 1050

g = 62.5

solubility = 62.5 ✓✓ g per 100 g of water

(c) If the evaporating basin is heated too strongly some of the solid decomposes to form a gas.

Explain how this strong heating would affect the value of the calculated solubility of the solid.

(3)

If some of the solid decomposes, the final mass of solid obtained would not be accurate, therefore, ~~the~~ solubility value calculated would be less. ✓

5/7

Examiner Comments

Part (c): No mention of the gas escaping and the statement that the mass of solid obtained would be inaccurate is too vague.

Student Response F

(a) The table shows the results of an experiment using this method.

mass of evaporating basin / g	89.6
mass of evaporating basin + saturated solution / g	115.8
mass of evaporating basin + solid / g	94.9

Calculate the mass of solid obtained and the mass of water removed.

(2)

115.8 - 89.6 = 26.2

94.9 - 89.6 = 5.3

mass of solid = 5.3 g

mass of water = 26.2 g

(b) In another experiment, at a different temperature, the mass of solid obtained is 10.5 g and the mass of water removed is 16.8 g.

Calculate the solubility of the solid, in g per 100 g of water, at this temperature.

(2)

solubility = _____ g per 100 g of water

(c) If the evaporating basin is heated too strongly some of the solid decomposes to form a gas.

Explain how this strong heating would affect the value of the calculated solubility of the solid.

(3)

1/7

Examiner Comments

Part (a): Incorrect subtraction to calculate mass of water. Should be (115.8 – 94.9).

Part (b): No calculation attempted. The result of the experiment showed that 10.5 g of solid dissolved in 16.8 g of water. To find the solubility in g/100 g of water, one needs to use ratios to calculate the mass of solid that would dissolve in 100 g of water.

Student Response G

(a) The table shows the results of an experiment using this method.

mass of evaporating basin / g	89.6
mass of evaporating basin + saturated solution / g	115.8
mass of evaporating basin + solid / g	94.9

Calculate the mass of solid obtained and the mass of water removed.

(2) 2 ✓

mass of solid: 94.6 − 89.6 = 5.3g.

mass of water: 115.8 − 89.6 − 5.3 = 20.9g.

mass of solid = 5.3 ✓ g

mass of water = 20.9 ✓ g

(b) In another experiment, at a different temperature, the mass of solid obtained is 10.5 g and the mass of water removed is 16.8 g.

Calculate the solubility of the solid, in g per 100 g of water, at this temperature.

(2) 2 ✓

10.5g 16.8g

x 100g

$x = \frac{10.5 \times 100}{16.8}$

= 62.5g.

solubility = 62.5 ✓✓ g per 100 g of water

(c) If the evaporating basin is heated too strongly some of the solid decomposes to form a gas.

Explain how this strong heating would affect the value of the calculated solubility of the solid.

(3) 1 ✓

Since some of the solid would decompose with strong heating, the value we would calculate would be understated (and the value would be less). The solubility calculation would not be accurate, since our results would imply that less solid can be dissolved at that temperature and volume

(Total for Question 2 = 7 marks)

5/7

Examiner Comments

Part (c): No mention of the gas escaping leading to a decrease in the mass of solid.

Student Response H

(a) The table shows the results of an experiment using this method.

mass of evaporating basin / g	89.6
mass of evaporating basin + saturated solution / g	115.8
mass of evaporating basin + solid / g	94.9

Calculate the mass of solid obtained and the mass of water removed.

(2)

115.9 − 89.6 = 26.2 [saturated solution]

94.9 − 89.6 = 5.3 [solid]

26.2 − 5.3 = 20.9 [water]

mass of solid = 5.3 g

mass of water = 20.9 g

(b) In another experiment, at a different temperature, the mass of solid obtained is 10.5 g and the mass of water removed is 16.8 g.

Calculate the solubility of the solid, in g per 100 g of water, at this temperature.

(2)

$\frac{10.5}{16.8} = \frac{x}{100}$

$16.8x = 10.5 \times 100$

$x = \frac{10.5 \times 100}{16.8} = 62.5$

solubility = 62.5 g per 100 g of water

(c) If the evaporating basin is heated too strongly some of the solid decomposes to form a gas.

Explain how this strong heating would affect the value of the calculated solubility of the solid.

(3)

Since solubility is the volume of solid dissolved in 100 g of water in a given temperature, then if you reduce the volume of solid left in the evaporating basin (due to strong heat) then the calculation for the solubility won't be accurate and won't be reliable. The result you would obtain would show in this case that the solubility of this solid is less than what it actually is.

5/7

Examiner Comments

Part (c): Unfortunate error made by referring to less **volume** of solid and not less **mass**. Also, there is no mention of the gas escaping, so first mark not awarded.

Student Response I

(a) The table shows the results of an experiment using this method.

mass of evaporating basin / g	89.6
mass of evaporating basin + saturated solution / g	115.8
mass of evaporating basin + solid / g	94.9

Calculate the mass of solid obtained and the mass of water removed.

94.9 - 89.6 = 5.3

115.8 - 94.9 = 20.9

20.9 - 5.3 = 15.6

mass of solid = 5.3 g

mass of water = 15.6 g

(2) 1 ✓ ✓ X

(b) In another experiment, at a different temperature, the mass of solid obtained is 10.5 g and the mass of water removed is 16.8 g.

Calculate the solubility of the solid, in g per 100 g of water, at this temperature.

100 : 12.6

832 : 10.5

(2) 0 ✓ XX

solubility = 12.6 % g per 100 g of water

(c) If the evaporating basin is heated too strongly some of the solid decomposes to form a gas.

Explain how this strong heating would affect the value of the calculated solubility of the solid.

(3)

(Because then the ~~gas with evaporated and leaving~~ less a solution would start bubbling vigirously and some of it may be lost, effecting the result.) Also it will start evaporating ~~so there will be less liquid~~ so the ~~gg~~ solid will form a gas so you will have less of the solid than you should have, so therefore it effects the value of solubility (Total for Question 2 = 7 marks) (since now you have decomposed the solid) so you have less solid then what you have started with ~~which with has~~ ~~neither has~~ which will not be dissolved or saturated on the bottom, so you will be unaware that it has been decomposed and you will assume it is dissolved therefore effecting your results.

2

2/7

Examiner Comments

Part (a): Incorrect subtraction to calculate mass of water. Should be (115.8 – 94.9).

Part (b): Incorrect calculation. The result of the experiment showed that 10.5 g of solid dissolved in 16.8 g of water. To find the solubility in g/100 g of water, one needs to use ratios to calculate the mass of solid that would dissolve in 100 g of water.

Part (c):

There is no mention of the gas escaping, so first mark not awarded. The second mark is awarded for stating that there would be less solid than before, but the candidate merely states that this will affect the value calculated for the solubility without stating **how** it will be affected.

Student Response J

(a) The table shows the results of an experiment using this method.

mass of evaporating basin / g	89.6
mass of evaporating basin + saturated solution / g	115.8
mass of evaporating basin + solid / g	94.9

Calculate the mass of solid obtained and the mass of water removed.

94.9 − 89.6 = 5.3

115.8 − 5.3 = 110.5

105 − 89.6 = 20.9

(2) 2

mass of solid = 5.3 g

mass of water = ~~110.5~~ 20.9 g

(b) In another experiment, at a different temperature, the mass of solid obtained is 10.5 g and the mass of water removed is 16.8 g.

Calculate the solubility of the solid, in g per 100 g of water, at this temperature.

(2) 2

100 / 16.8

100 ÷ 16.8 = 125/21

125/21 × 105 = 62.5

solubility = 62.5 g per 100 g of water

(c) If the evaporating basin is heated too strongly some of the solid decomposes to form a gas.

Explain how this strong heating would affect the value of the calculated solubility of the solid.

(3) 1

The solid obtained would be less so the results of the experiment would be inaccurate. because when you try to calculate the solubility the answer will not be accurate

5/7

Examiner Comments

Part(c): Second mark awarded even though the candidate does not specify that it is the **mass** of the solid that will be less. No mention of gas escaping for first mark, and no mention of the effect that less solid has on the calculated solubility.

Student Response K

(a) The table shows the results of an experiment using this method.

mass of evaporating basin / g	89.6
mass of evaporating basin + saturated solution / g	115.8
mass of evaporating basin + solid / g	94.9

Calculate the mass of solid obtained and the mass of water removed.

(2)

mass of solid: 94.9 - 89.6 = 5.3

mass of water: 115.8 - 94.9 = 20.9

mass of solid = 5.3 g

mass of water = 20.9 g

(b) In another experiment, at a different temperature, the mass of solid obtained is 10.5 g and the mass of water removed is 16.8 g.

Calculate the solubility of the solid, in g per 100 g of water, at this temperature.

(2)

solubility = _____ g per 100 g of water

(c) If the evaporating basin is heated too strongly some of the solid decomposes to form a gas.

Explain how this strong heating would affect the value of the calculated solubility of the solid.

(3)

if some of the solid decomposed to form a gas then its mass would be lost to the surroundings as it dissipates.

3/7

Examiner Comments

Part (b): Calculation not attempted. The experiment showed that 10.5 g of solid dissolved in 16.8 g of water. To find the solubility in g/100 g of water, one needs to use ratios to calculate the mass of solid that would dissolve in 100 g of water.

Part (c): First mark awarded for gas is lost, but no mention of the effect of this on the mass of solid obtained and the subsequent calculated value for the solubility.

Exemplar Question 4

8 Polymers can be classified as addition polymers or condensation polymers.

(a) An addition polymer can be formed from the monomer $CH_2=CHCl$

(i) Name this monomer.

(1)

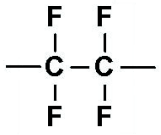
.....

Name the addition polymer formed from this monomer.

(1)

.....

(b) The diagram shows the repeat unit of a different addition polymer.

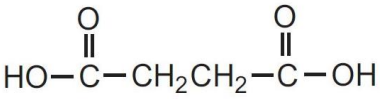


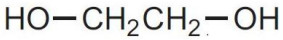
Draw the displayed formula of the monomer used to make this polymer.

(1)

(c) Polyesters are condensation polymers.

The structures of two monomers that are used to make a polyester are:





(i) Draw the structure of the repeat unit of the polyester formed from these two monomers.

(2)

(ii) Identify the small molecule formed when these two monomers form the polyester.

(1)

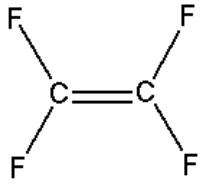
.....

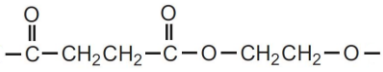
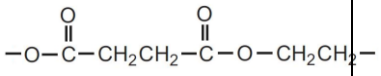
(Total for Question 8 = 6 marks)

Mark Scheme

Question number	Answer	Additional guidance	Mark
8(a)(i)	Chloroethene	accept vinyl chloride	**1**

Question number	Answer	Additional guidance	Mark
8(a)(ii)	Poly(chloroethene)	accept polyvinyl chloride ignore PVC	**1**

Question number	Answer	Additional guidance	Mark
8(b)		ignore bond angles	**1**

Question number	Answer	Additional guidance	Mark
8(c)(i)	• Correct ester link (1) • Rest of unit correct (1) Example: 	accept: 	**2**

Question number	Answer	Additional guidance	Mark
8(c)(ii)	Water/H_2O	if both name and formula given, both must be correct	**1**

Student Response A

8 Polymers can be classified as addition polymers or condensation polymers.

(a) An addition polymer can be formed from the monomer $CH_2=CHCl$

(i) Name this monomer.

(1)

chloroethene 1-chloroethene ✓

(ii) Name the addition polymer formed from this monomer.

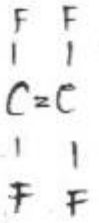
(1)

~~chloro polyethene~~ poly-1-chloroethene ✓

(b) The diagram shows the repeat unit of a different addition polymer.

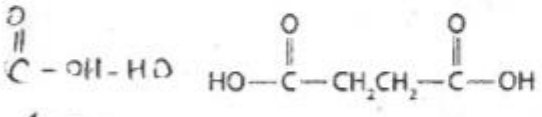
Draw the displayed formula of the monomer used to make this polymer.

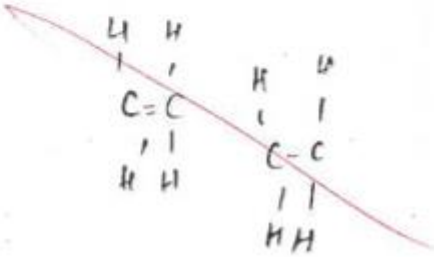
(1)



(c) Polyesters are condensation polymers.

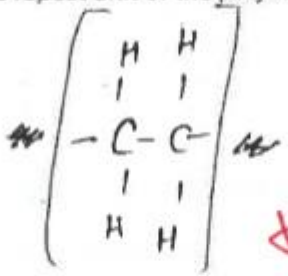
The structures of two monomers that are used to make a polyester are:





b Hydrogen carbonate

(i) Draw the structure of the repeat unit of the polyester formed from these two monomers.



(2)

(ii) Identify the small molecule formed when these two monomers form the polyester.

Hydrogen carbonate $CH_2(O_3)$

(1)

(Total for Question 8 = 6 marks)

3/6

Examiner Comments

Part(a): The locator '1' is not required in either answer, but its inclusion is ignored.

Student Response B

8 Polymers can be classified as addition polymers or condensation polymers.

(a) An addition polymer can be formed from the monomer $CH_2=CHCl$

(i) Name this monomer.

(1)

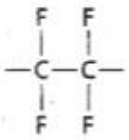
Chloroethene ✓

(ii) Name the addition polymer formed from this monomer.

(1)

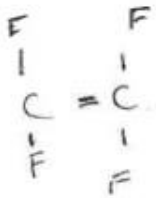
poly(chloroethene) MBD

(b) The diagram shows the repeat unit of a different addition polymer.



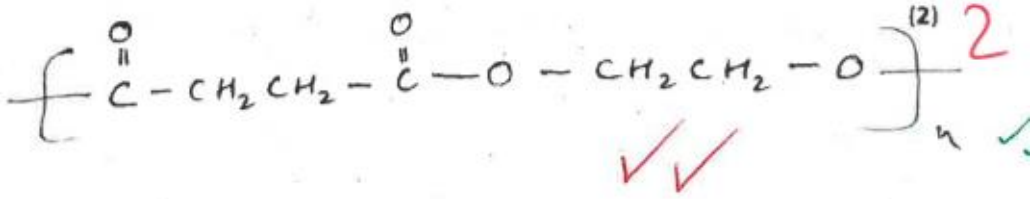
Draw the displayed formula of the monomer used to make this polymer.

(1)



(i) Draw the structure of the repeat unit of the polyester formed from these two monomers.

(2)



(ii) Identify the small molecule formed when these two monomers form the polyester.

(1)

H_2O (water) ✓

5/6

Examiner Comments

Part (a)(ii): It is a common mistake to name an addition polymer as a saturated compound.

Student Response C

8 Polymers can be classified as addition polymers or condensation polymers.

(a) An addition polymer can be formed from the monomer $CH_2{=}CHCl$

(i) Name this monomer.

(1)

Chloroethene ✓ 1 ✓

(ii) Name the addition polymer formed from this monomer.

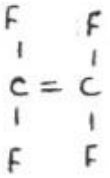
(1)

poly(chloroethane) 0 ✓

(b) The diagram shows the repeat unit of a different addition polymer.

Draw the displayed formula of the monomer used to make this polymer.

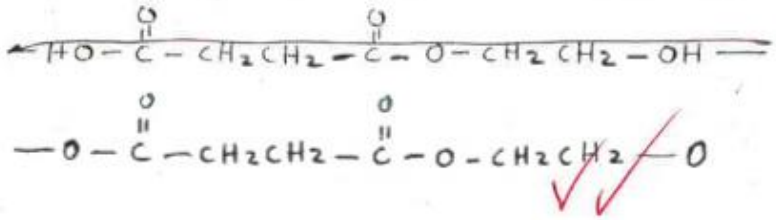
(1)



✓ 1 ✓

(i) Draw the structure of the repeat unit of the polyester formed from these two monomers.

(2)



2 ✓

(ii) Identify the small molecule formed when these two monomers form the polyester.

(1)

H_2O ✓ 1 ✓

6/6

Examiner Comments

Part (a)(ii): It is a common mistake to name an addition polymer as a saturated compound.

Student Response D

8 Polymers can be classified as addition polymers or condensation polymers.

(a) An addition polymer can be formed from the monomer $CH_2=CHCl$

(i) Name this monomer. **(1)** 1

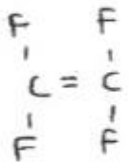
Chloroethene ✓

(ii) Name the addition polymer formed from this monomer. **(1)** 0

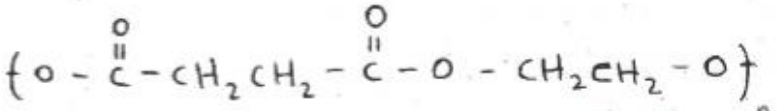
poly chloroethane

(b) The diagram shows the repeat unit of a different addition polymer.

Draw the displayed formula of the monomer used to make this polymer. **(1)** 1



(i) Draw the structure of the repeat unit of the polyester formed from these two monomers. **(2)** 2



(ii) Identify the small molecule formed when these two monomers form the polyester. **(1)** 1

Water (H_2O) ✓

5/6

Examiner Comments

Part (a)(ii): It is a common mistake to name an addition polymer as a saturated compound.

Student Response E

8 Polymers can be classified as addition polymers or condensation polymers.

(a) An addition polymer can be formed from the monomer $CH_2{=}CHCl$

(i) Name this monomer.

(1)

chloroethene ✓ ✓

(ii) Name the addition polymer formed from this monomer.

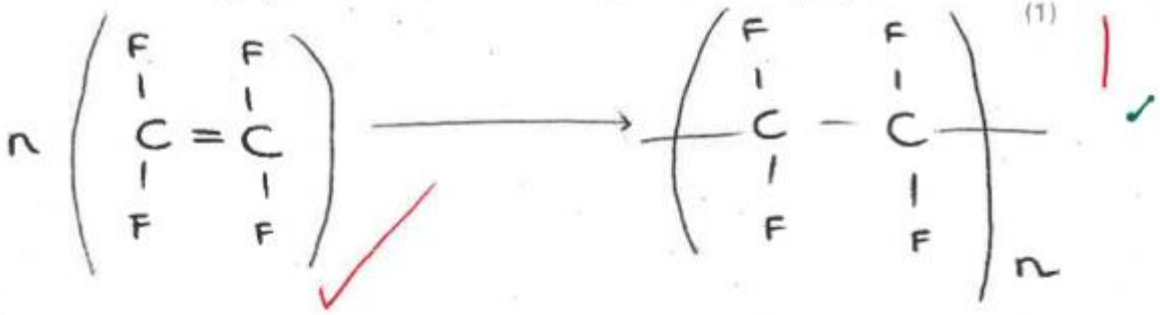
(1)

poly(chloroethene) ✓ ✓

(b) The diagram shows the repeat unit of a different addition polymer.

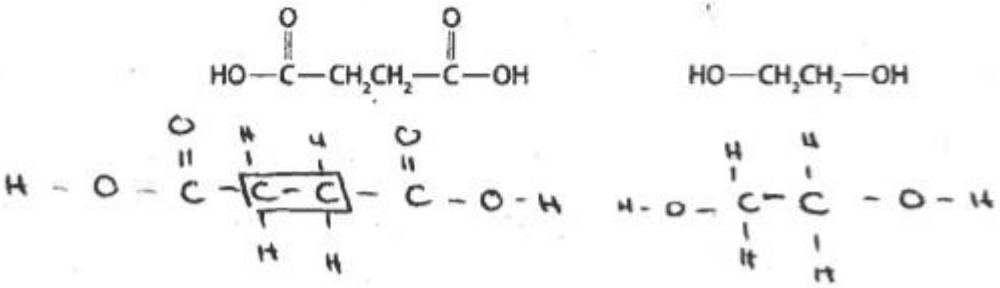
Draw the displayed formula of the monomer used to make this polymer.

(1)



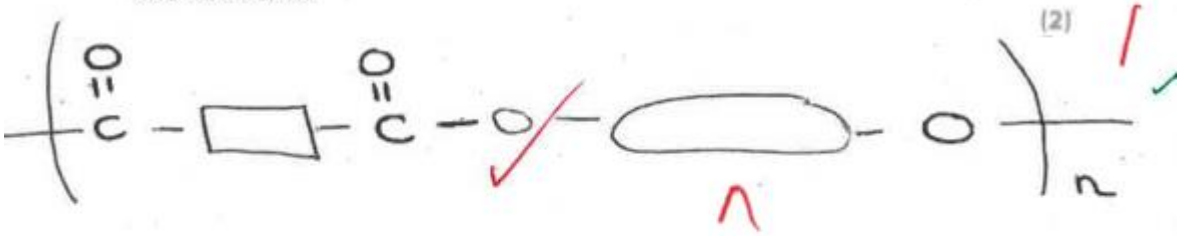
(c) Polyesters are condensation polymers.

The structures of two monomers that are used to make a polyester are:



(i) Draw the structure of the repeat unit of the polyester formed from these two monomers.

(2)



(ii) Identify the small molecule formed when these two monomers form the polyester.

(1)

water

5/6

Examiner Comments

Part (c)(i): Correct ester link shown, but rest on molecule is incorrect as blocks are used to represent the hydrocarbon chains.

Student Response F

8 Polymers can be classified as addition polymers or condensation polymers.

(a) An addition polymer can be formed from the monomer $CH_2=CHCl$

(i) Name this monomer. (1)

Chloroethene ✓

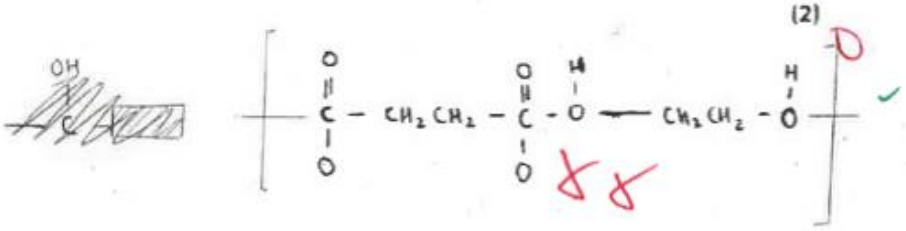
(ii) Name the addition polymer formed from this monomer. (1)

Polychloro ethene ✓ ✗ Bod

(b) The diagram shows the repeat unit of a different addition polymer.

Draw the displayed formula of the monomer used to make this polymer. (1)

(i) Draw the structure of the repeat unit of the polyester formed from these two monomers. (2)



(ii) Identify the small molecule formed when these two monomers form the polyester. (1)

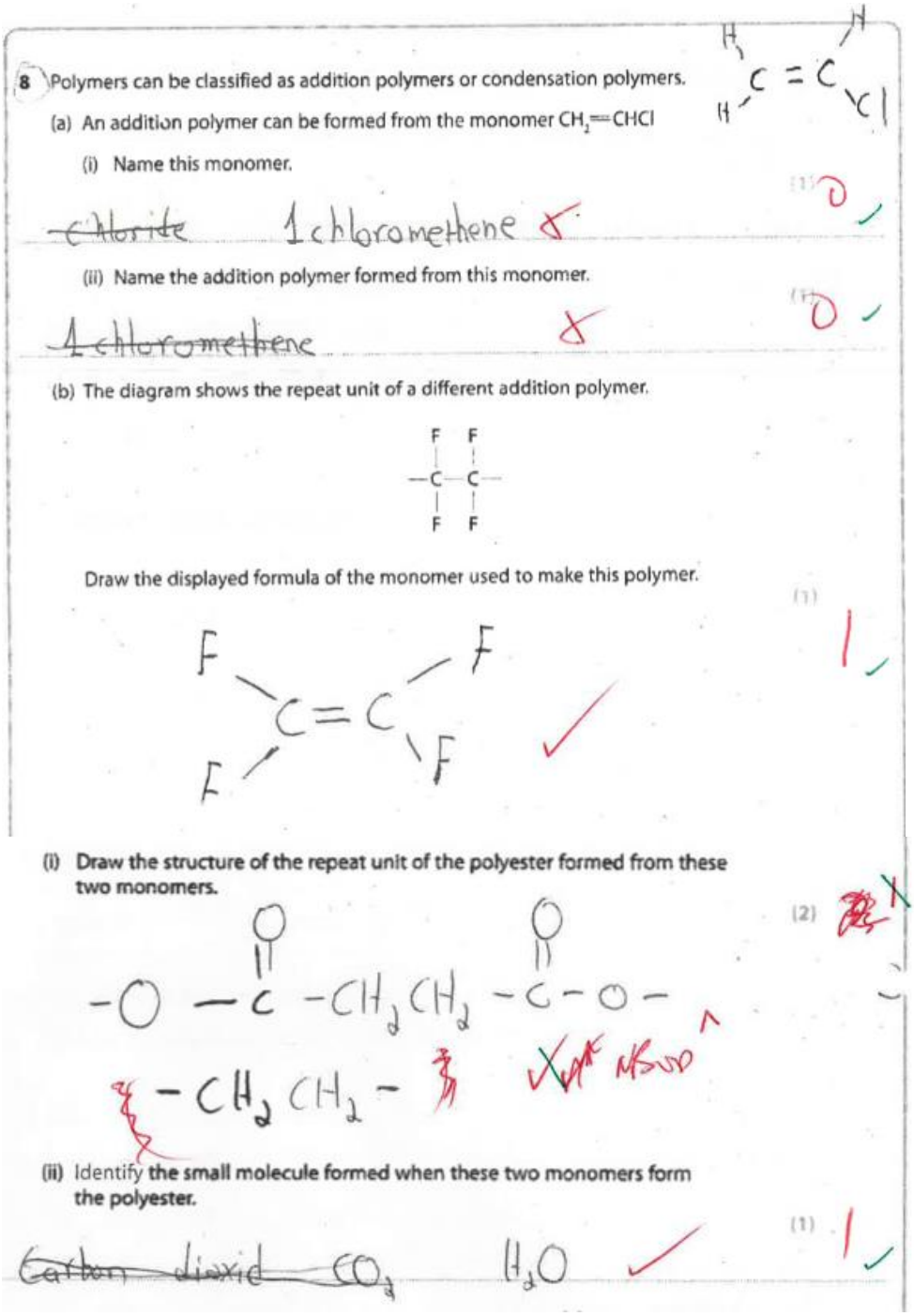
Water (H_2O) ✓

4/6

Examiner Comments

Part (a)(ii): Close call! Could be an ‘a’ or an ‘e’ before the ‘n’. Candidates need to be aware that clearer writing is required to be certain of scoring the mark.

Student Response G



8 Polymers can be classified as addition polymers or condensation polymers.

(a) An addition polymer can be formed from the monomer $CH_2=CHCl$

(i) Name this monomer.

~~chloride~~ 1chloromethene ✗ (1) 0 ✓

(ii) Name the addition polymer formed from this monomer.

~~1chloromethene~~ ✗ (1) 0 ✓

(b) The diagram shows the repeat unit of a different addition polymer.

Draw the displayed formula of the monomer used to make this polymer.

(1)

1 ✓

(i) Draw the structure of the repeat unit of the polyester formed from these two monomers.

(2)

(ii) Identify the small molecule formed when these two monomers form the polyester.

(1)

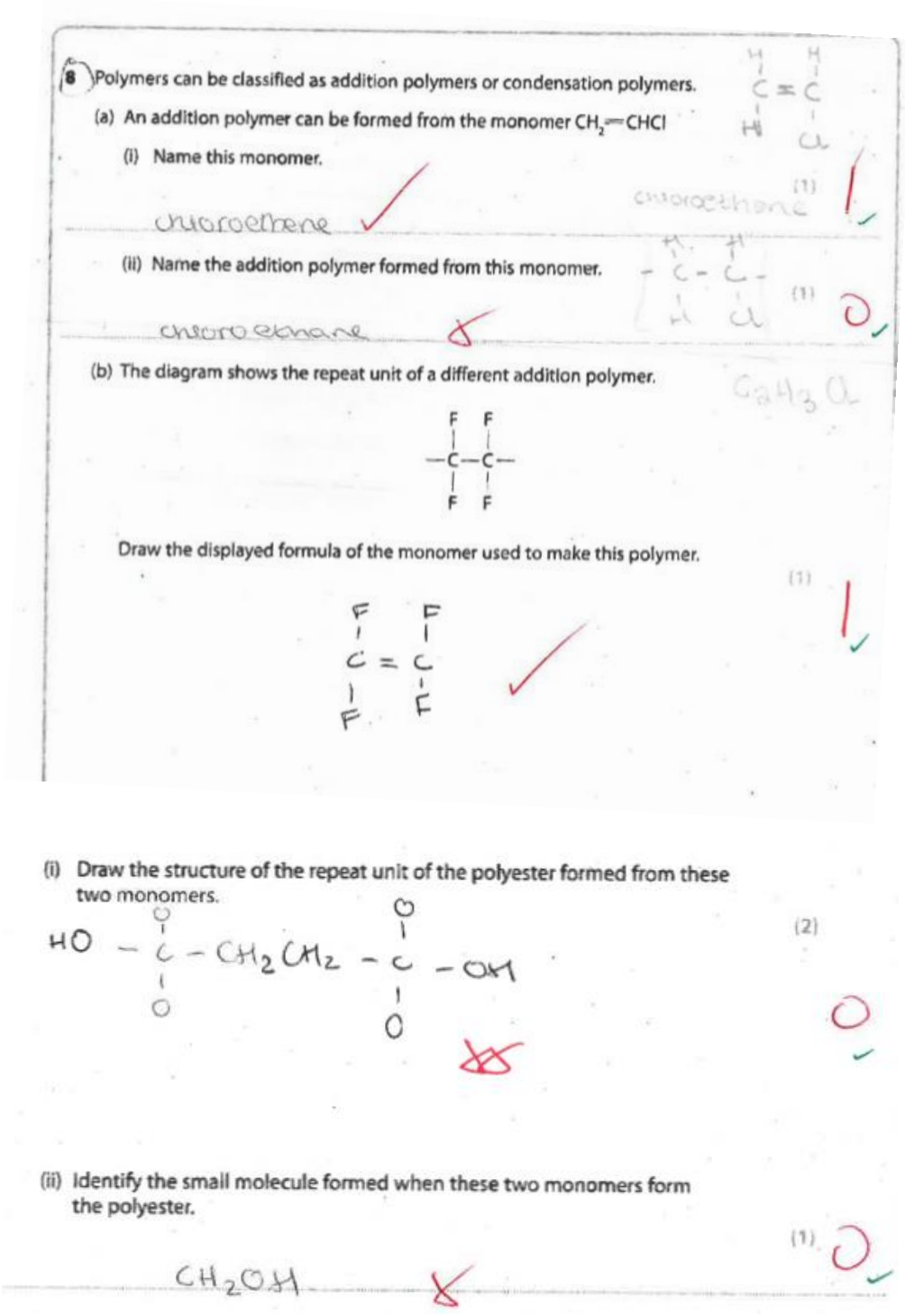
~~Carbon dioxid~~ CO_2 H_2O ✓ 1 ✓

2/6

Examiner Comments

Part (c): Second mark awarded even though the candidate does not specify that it is the **mas**s of the solid that will be less. No mention of gas escaping for first mark, and no mention of the effect that less solid has on the calculated solubility.

Student Response H



8 Polymers can be classified as addition polymers or condensation polymers.

(a) An addition polymer can be formed from the monomer $CH_2=CHCl$

(i) Name this monomer.

chloroethene ✓ (1) chloroethene ✓

(ii) Name the addition polymer formed from this monomer.

chloroethane ✗ (1) ✓

(b) The diagram shows the repeat unit of a different addition polymer.

Draw the displayed formula of the monomer used to make this polymer.

(1) ✓

(i) Draw the structure of the repeat unit of the polyester formed from these two monomers.

(2)

(ii) Identify the small molecule formed when these two monomers form the polyester.

(1) ✓

CH_2OH ✗

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Examiner Comments

Part (a)(ii): The candidate rather strangely does not correctly name the polymer, despite having correctly named the monomer.