Write your name here

Surname	Other names

Pearson Edexcel
Level 1/Level 2 GCSE (9-1)

Centre Number	Candidate Number

Chemistry

Paper 2

Higher Tier

Sample Assessment Materials for first teaching September 2016
Time: 1 hour 45 minutes

Paper Reference
1CH0/2H

You must have:
a calculator
a ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an asterisk (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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S 5 0 0 4 8 A 0 1 2 8

PEARSON

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒.
If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 This question is about changes to the Earth's atmosphere.

(a) Which of the following is a correct statement about the relative amounts of carbon dioxide and oxygen in the Earth's early atmosphere?

(1)

☒ **A** large amount of carbon dioxide and large amount of oxygen

☒ **B** large amount of carbon dioxide and small amount of oxygen

☒ **C** small amount of carbon dioxide and large amount of oxygen

☒ **D** small amount of carbon dioxide and small amount of oxygen

(b) Several processes change the composition of the Earth's atmosphere.

Describe how the composition of the atmosphere is affected by burning fossil fuels.

(2)

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(c) The graphs in Figure 1 and Figure 2 show the concentration of carbon dioxide in the atmosphere and the mean global temperature between 1960 and 2000.

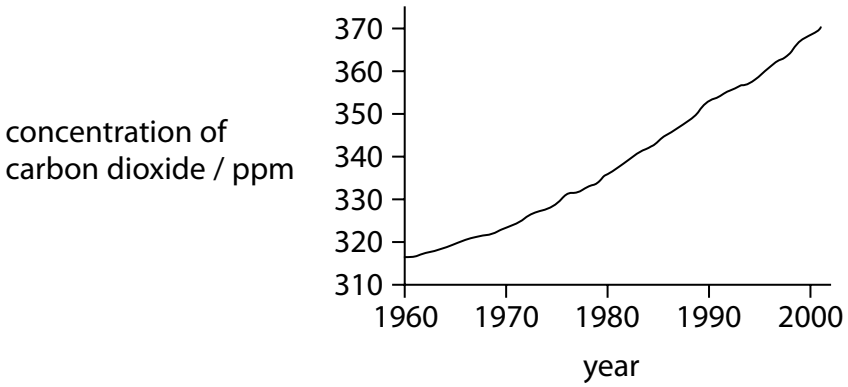

Figure 1

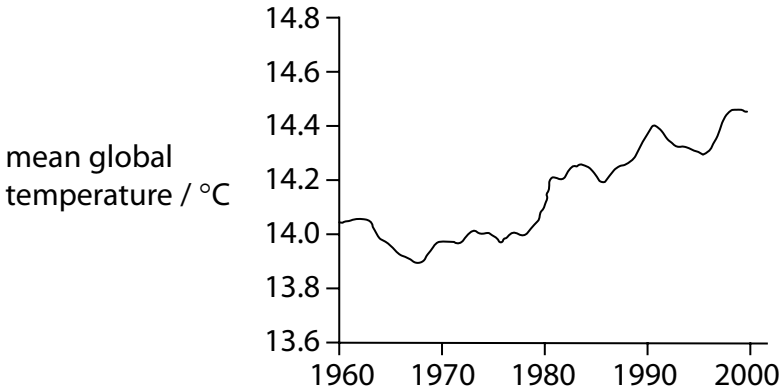

Figure 2

Explain whether these graphs provide evidence that an increase in carbon dioxide is causing the Earth's temperature to rise.

(2)

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.....

(d) Which of these pairs of gases are both greenhouse gases?

(1)

☒ **A** nitrogen and methane

☒ **B** nitrogen and oxygen

☒ **C** oxygen and water vapour

☒ **D** water vapour and methane

(Total for Question 1 = 6 marks)

2 Magnesium and calcium are in group 2 of the periodic table. They are less reactive than the metals in group 1.

(a) Calcium reacts with water to form calcium hydroxide, $Ca(OH)_2$, and hydrogen, H_2.

$$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(s) + H_2(g)$$

Describe what would be **seen** when a piece of calcium is dropped into a container of water.

(2)

.....

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(b) Magnesium reacts very slowly with cold water but it reacts faster with steam, H_2O, and forms magnesium oxide, MgO, and hydrogen.

Write the balanced equation for the reaction between magnesium and steam.

(2)

.....

(c) The electronic configurations of magnesium and calcium are

magnesium 2.8.2
calcium 2.8.8.2

When magnesium and calcium react with water they form positive ions.

Suggest an explanation, in terms of their electronic configurations, why calcium is more reactive than magnesium.

(2)

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(d) A sample of calcium bromide contains 0.2 g calcium and 0.8 g bromine by mass.

Calculate the empirical formula of calcium bromide.

(relative atomic masses: Ca = 40, Br = 80)

(3)

empirical formula = ...

(Total for Question 2 = 9 marks)

3 Crude oil is a mixture of hydrocarbons.

It can be separated into fractions.

(a) Which of these mixtures shows formulae of substances that could be in the gaseous fraction of crude oil?

(1)

☒ **A** C_2H_4, C_3H_8, $C_4H_{10}O$

☒ **B** C_2H_4, C_3H_7Br, C_4H_{10}

☒ **C** C_2H_6, C_3H_8, C_4H_{10}

☒ **D** C_2H_6, C_3H_7Br, $C_4H_{10}O$

(b) Figure 3 shows the percentages of the fractions in crude oil from three different oil wells.

	percentage of fraction in crude oil from		
fraction	**oil well A**	**oil well B**	**oil well C**
gases	1	6	9
petrol	2	15	24
kerosene	6	14	20
diesel oil	7	10	16
fuel oil	26	28	30
bitumen	58	27	1

Figure 3

(i) State which oil well contains the greatest combined total of diesel oil and fuel oil.

(1)

.....

(ii) State which oil well produces a crude oil containing the highest percentage of the high boiling point fractions.

(1)

.....

(c) Fractions of crude oil contain alkanes.

A sample of decane, $C_{10}H_{22}$, cracked using the apparatus in Figure 4.

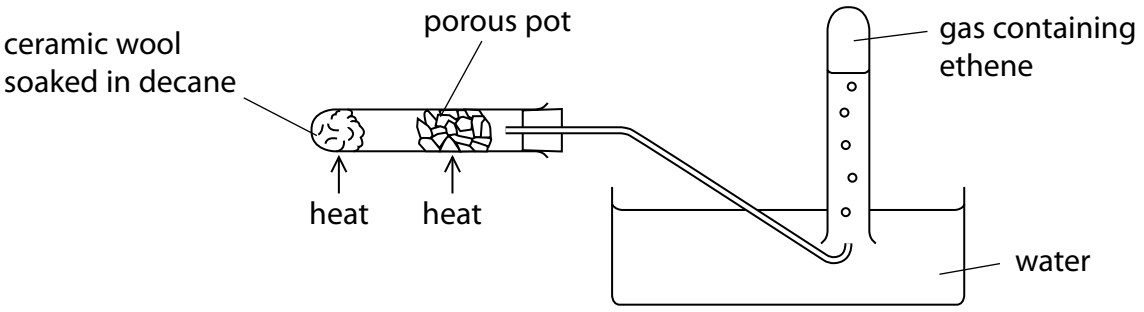


Figure 4

(i) Explain how ethene is produced using the apparatus in Figure 4.

(3)

(ii) One molecule of decane produced two molecules of propene, C_3H_6, and one molecule of product **Z**.

$C_{10}H_{22} \rightarrow 2C_3H_6$ + product **Z**

What is the formula of product **Z**?

(1)

- ☒ **A** C_4H_8
- ☒ **B** C_4H_{10}
- ☒ **C** C_7H_{14}
- ☒ **D** C_7H_{16}

(iii) When decane undergoes complete combustion, a mixture of carbon dioxide and water is formed.

Complete the balanced equation for this reaction.

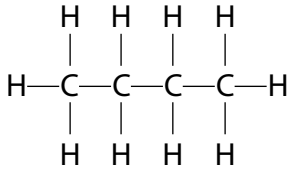
(2)

$2C_{10}H_{22}$ + ... $O_2 \rightarrow$ ..... CO_2 + ... H_2O

(Total for Question 3 = 9 marks)

4 Alkanes and alkenes are hydrocarbons.

The structure of a molecule of butane is shown.



(a) Which of the following is the empirical formula for butane?

(1)

☒ **A** CH

☒ **B** CH_2

☒ **C** C_2H_5

☒ **D** C_4H_{10}

(b) Figure 5 shows some information about the alkenes, ethene and propene.

Complete the table. The structure of propene must show all covalent bonds.

(2)

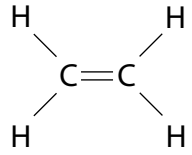
name of alkene	molecular formula	structure
ethene		
propene	C_3H_6	

Figure 5

(c) Butene reacts with steam to produce butanol.

$$C_4H_8 + H_2O \rightarrow C_4H_9OH$$

(i) Calculate the maximum mass of butanol, C_4H_9OH, that can be produced when 1.4 kg of butene, C_4H_8, reacts with excess steam.

(relative atomic masses: H = 1, C = 12, O = 16
relative molecular mass of butene, C_4H_8 = 56)

(3)

mass of butanol = ... kg

(ii) What type of reaction takes place between butene and steam?

(1)

☒ **A** addition

☒ **B** dehydration

☒ **C** neutralisation

☒ **D** substitution

(d) A sample of each of three hydrocarbons, **X**, **Y** and **Z**, was shaken with bromine water. Bromine water is orange coloured.

The results are:

X orange mixture becomes colourless

Y orange mixture becomes colourless

Z mixture remains orange

Using the results, comment on the structures of the hydrocarbons **X**, **Y** and **Z**.

(2)

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.....

(Total for Question 4 = 9 marks)

5 Qualitative tests are used to identify ions.

(a) A student carries out a flame test on an unknown solid.
A red flame is seen.
The student concludes that the solid is lithium carbonate.

Explain why this conclusion is **not** justified.

(2)

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(b) The following tests were carried out on a substance containing two ions.

1. A flame test on the solid substance produced a yellow colour.

2. Dilute hydrochloric acid was added to a solution of the substance followed by a few drops of barium chloride solution.
A white precipitate formed.

Give the name and formula of the substance.

(2)

Name of substance .....

Formula of substance .....

(c) The test for chloride ions was carried out on a solution.
Dilute nitric acid was added to the solution, followed by a few drops of silver nitrate solution.
A white precipitate formed.

Why is it necessary to add dilute nitric acid in this test?

(1)

☒ **A** To neutralise the solution

☒ **B** Nitrate ions are needed for the test to work

☒ **C** To make sure that no carbonate ions are present

☒ **D** The test only works in alkaline conditions

(d) Sodium hydroxide solution is used to identify some cations present in compounds.

(i) Sodium hydroxide solution is warmed with a solution of ammonium ions. Ammonia gas is given off.

Describe the test to show the gas is ammonia.

(2)

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(ii) Sodium hydroxide solution is also used to distinguish between iron(II) ions, Fe^{2+} and iron(III) ions, Fe^{3+}, in solution.

You are given a solution containing iron(II) ions and another solution containing iron(III) ions.

Describe what is seen when sodium hydroxide solution is added to each of these solutions.

(2)

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(iii) Iron(III) ions, Fe^{3+}, react with hydroxide ions in solution to form iron(III) hydroxide.

Complete the ionic equation for this reaction.

(1)

$Fe^{3+} + 3OH^- \rightarrow$ .....

(Total for Question 5 = 10 marks)

6 This question is about properties of materials.

(a) Figure 6 shows some properties of steel and Kevlar®.

property	steel	Kevlar®
density / g cm^{-3}	7.85	1.44
relative strength	1	5
flexibility	low	high
resistance to corrosion	low	high

Figure 6

Body armour, such as a bullet-proof vest, could be manufactured using either of these materials.

Explain **two** reasons why Kevlar® is preferred to steel as the material for body armour.

(4)

(b) The use of nanoparticles has increased in recent years.

(i) The length of one side of a cube of silver is 2 cm as shown in Figure 7.

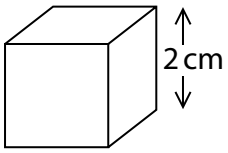

Figure 7

Calculate the surface area to volume ratio of this cube of silver.

(3)

surface area to volume ratio = ...

(ii) Suggest an explanation of why a given mass of silver is more effective as a catalyst when used as nanoparticles rather than in a powder form.

(3)

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(Total for Question 6 = 10 marks)

7 A student investigated the rate of reaction between dilute hydrochloric acid and marble chips (calcium carbonate).

Calcium chloride, carbon dioxide and water are formed.

(a) Complete and balance the equation for the reaction.

(2)

$CaCO_3 + HCl \rightarrow$ ..... + ... + ...

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(b) The student investigated the rate by using different sizes of marble chips. In their investigation, the same mass of marble chips was used in each experiment.

The volume of gas given off was measured.

The graph in Figure 8 shows the results.

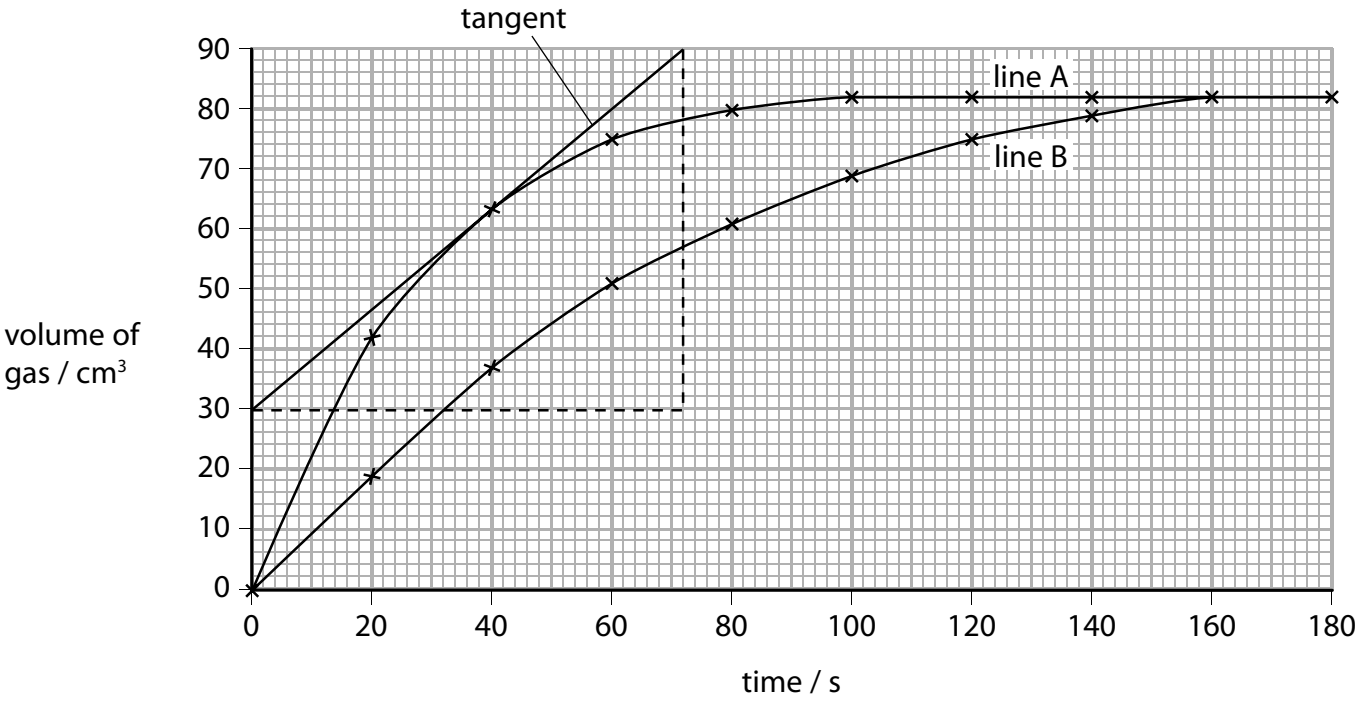

Figure 8

(i) State how the graph shows that line B gives the results for the larger marble chips.

(1)

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.....

(ii) A tangent has been drawn on line A.

Calculate the rate of reaction at this point.

(2)

rate of reaction = ... $cm^3 s^{-1}$

(c) During any reaction, reactants are used up and the rate of reaction decreases.

Explain, in terms of particles, why the rate of reaction decreases.

(2)

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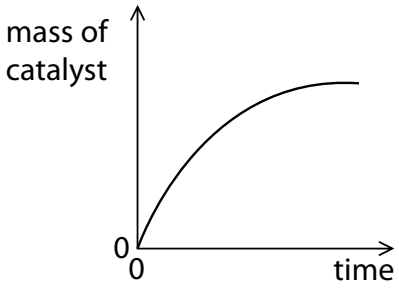
(d) The decomposition of hydrogen peroxide is catalysed by adding a small amount of manganese(IV) oxide.

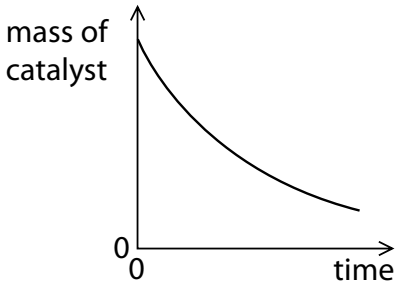
Which of these graphs shows the mass of the catalyst as the reaction takes place?

(1)

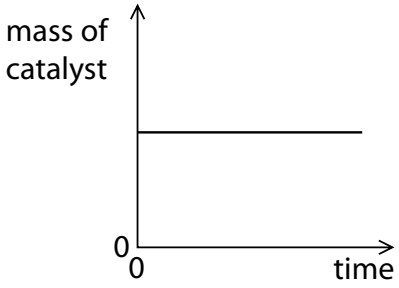
☒ **A**



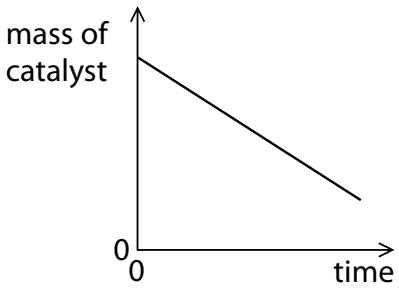
☒ **B**



☒ **C**



☒ **D**



(e) Two gases, **X** and **Y**, react to give a gaseous product **Z**.

The reaction is carried out under two different sets of conditions in experiments 1 and 2 as shown in Figure 9.

condition	experiment 1	experiment 2
temperature / °C	30	20
pressure / atm	1	2

Figure 9

Explain why it is not possible to predict what the rate of Experiment 2 will be compared with Experiment 1.

(3)

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(Total for Question 7 = 11 marks)

8 The elements chlorine, bromine and iodine are part of group 7 in the periodic table.

(a) The appearances of chlorine, bromine and iodine at room temperature are shown in Figure 10.

halogen	appearance
chlorine	green gas
bromine	red-brown liquid
iodine	grey solid

Figure 10

Astatine is the element below iodine in group 7.

Predict the appearance of astatine.

(1)

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*(b) The order of reactivity of chlorine, bromine and iodine can be determined by carrying out displacement reactions.

Explain how displacement reactions can be used to show the reactivity of these three elements.

(6)

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(c) When iron wool is heated in bromine vapour, it reacts to form iron bromide.

(i) In an experiment, 5.60 g of iron reacted exactly with 24.0 g of bromine, Br_2.

[relative atomic masses: Fe = 56.0, Br = 80.0]

Determine, using this information, the balanced equation for the reaction between iron and bromine.
You must show your working.

(4)

(ii) When iron reacts with bromine, bromide ions are formed.

Explain the type of reaction bromine atoms undergo when they are converted to bromide ions.

(2)

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(Total for Question 8 = 13 marks)

9 (a) A student carried out an experiment to prove that candle wax, a hydrocarbon, produces carbon dioxide and water vapour when it burns.

The equipment used is shown in Figure 11.

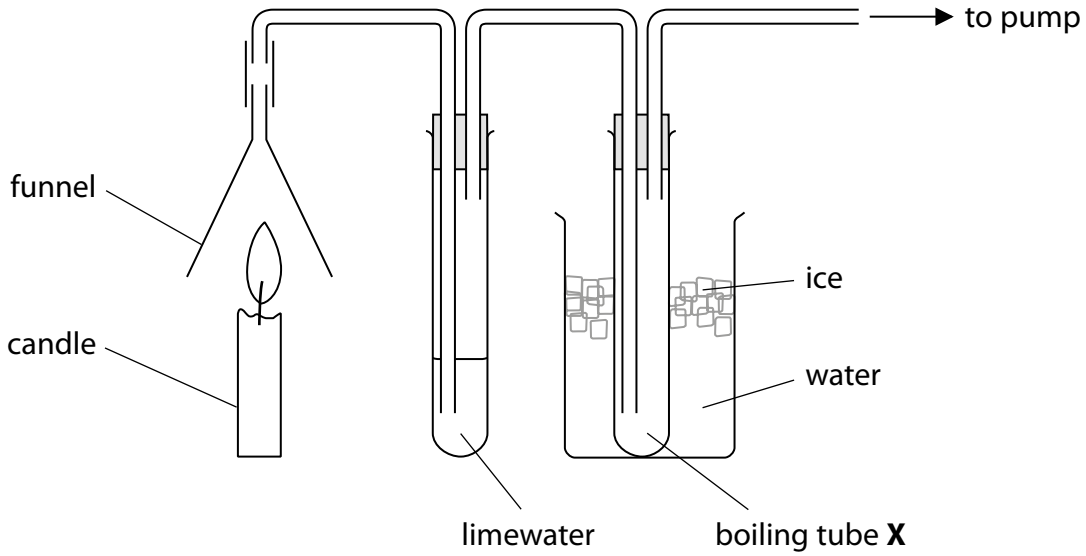

Figure 11

The gas produced from the burning candle is drawn through the apparatus.
The limewater turned milky showing that carbon dioxide had been formed.

A small amount of a colourless liquid condensed in boiling tube **X**.
The student claimed that this proved that burning candle wax produced water.
The teacher said the apparatus had been set up incorrectly and therefore this conclusion about water was not valid.

Explain how the student could modify the equipment to prove that water is produced by burning candle wax.

(2)

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*(b) Polymers are addition or condensation polymers.

Polymers can be formed by using the monomers shown in Figure 12.

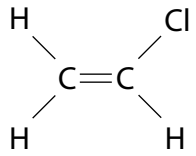
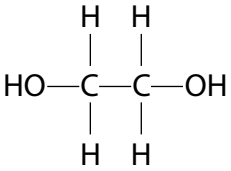
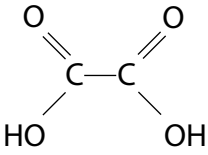
monomer	structure
chloroethene	
ethane-1,2-diol	
ethanedioic acid	

Figure 12

Explain, using appropriate monomers from Figure 12, how different polymers can be formed.

(6)

(c) An alcohol **A**, with molecular formula C_2H_5OH is oxidised to a compound **B** with molecular formula $C_2H_4O_2$.

(i) Compound **B** is not an alcohol and is a member of another homologous series.

State the name of this homologous series.

(1)

.....

(ii) Draw the structure of a molecule of compound **A** and a molecule of compound **B**, showing all covalent bonds.

(2)

Compound **A**

Compound **B**

(Total for Question 9 = 11 marks)

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10 (a) Each of these substances forms ions in solution.

One mole of the following substances is dissolved in 1 dm^3 of water.

Which solution contains the greatest number of ions?

(1)

☒ **A** ammonium sulfate, $(NH_4)_2SO_4$

☒ **B** iron(III) chloride, $FeCl_3$

☒ **C** magnesium nitrate, $Mg(NO_3)_2$

☒ **D** potassium bromide, KBr

(b) When sodium hydroxide solution is neutralised with an acid there is a temperature change.

A student is given dilute hydrochloric acid and dilute ethanoic acid of the same concentration in mol dm^{-3}.

Devise a plan to compare the temperature changes produced when sodium hydroxide solution is neutralised with each of these two acids.

(4)

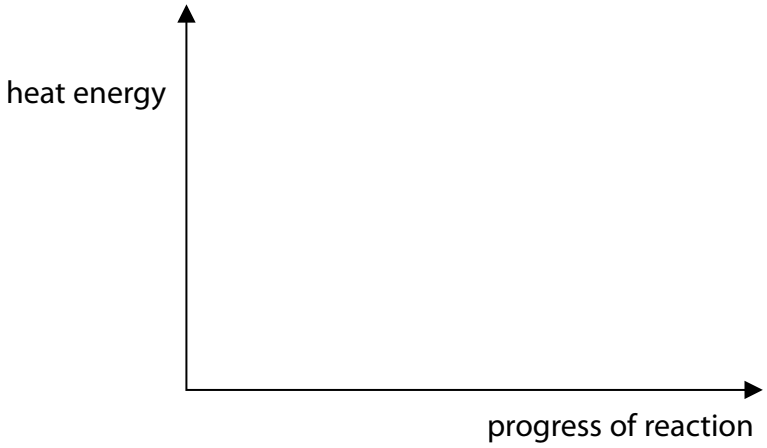
(c) Hydrogen reacts with chlorine to form hydrogen chloride.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

The reaction is exothermic.

Draw and label the reaction profile diagram for this reaction, identifying the activation energy.

(3)



(d) The energies of some bonds are shown in Figure 13.

bond	energy of bond / kJ mol^{-1}
H—H	436
Cl—Cl	243
H—Cl	432

Figure 13

Hydrogen reacts with chlorine to form hydrogen chloride.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

Calculate the energy change, in kJ mol^{-1}, for the reaction of 1 mol of hydrogen gas, H_2, with 1 mol of chlorine gas, Cl_2, to form 2 mol of hydrogen chloride gas, HCl.

(4)

energy change = ... kJ mol^{-1}

(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 100 MARKS

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

Paper 2 Higher

Question number	Answer	Mark
1(a)	B	(1)

Question number	Answer	Mark
1(b)	An answer that provides a description by making reference to: • adds carbon dioxide/adds water vapour (1) • removes oxygen (1)	(2)

Question number	Answer	Additional guidance	Mark
1(c)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • as concentration of carbon dioxide increases the (mean global) temperature increases (overall) (1) • {but there is no evidence that the increase in (mean global) temperature is caused by the increase in concentration of carbon dioxide/other factors may cause the increase in (mean global) temperature} (1) OR • as concentration of carbon dioxide increases the (mean global) temperature increases (1) • so this does provide evidence that an increase in carbon dioxide is causing the Earth's temperature to rise (1) OR • as concentration of carbon dioxide increases the (mean global) temperature overall increases but {fluctuates/increases and decreases} (1) • so this does not provide evidence that an increase in carbon dioxide is causing the Earth's temperature to rise (1)	Award for conclusion (second mark) only given if reason given	(2)

Question number	Answer	Mark
1(d)	D	(1)

Question number	Answer	Additional guidance	Mark
2(a)	An answer that combines the following points of understanding to provide a logical description: • (hydrogen produced as a gas so) there would be {effervescence/fizzing/ bubbles} (1) • and (calcium hydroxide produced as a solid so) the water would go {cloudy/a white precipitate would form} (1)	Allow: calcium moves (around) (1) calcium decreases in size/disappears/dissolves (1)	(2)

Question number	Answer	Mark
2(b)	$Mg + H_2O \rightarrow MgO + H_2$ • LHS (1) • RHS (1)	(2)

Question number	Answer	Additional guidance	Mark
2(c)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • In calcium the outermost electron(s) {are further away from nucleus /experience(s) greater shielding} (from the nucleus) (as shown by the electronic configuration) (1) • Therefore less attraction between nucleus and electron(s)/ the electron(s) is/are easier to remove (1)	Allow answers in terms of why reactivity of magnesium is less than that of calcium	(2)

Question number	Answer	Additional guidance	Mark
2(d)	• divides mass by relative atomic mass (1) • calculates simplest ratio (1) • expresses ratio correctly as empirical formula (1)	Example of calculation Ca : Br $\frac{0.2}{40}$: $\frac{0.8}{80}$ 0.005 : 0.01 1 : 2 empirical formula $CaBr_2$ Formula alone scores max 1	**(3)**

Question number	Answer	Mark
3(a)	C	**(1)**

Question number	Answer	Mark
3(b)(i)	(oil well) C	**(1)**

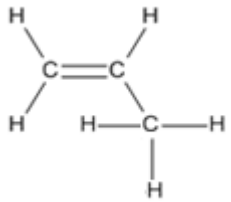
Question number	Answer	Mark
3(b)(ii)	(oil well) A	**(1)**

Question number	Answer	Additional guidance	Mark
3(c)(i)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (2 marks): • when the decane is heated it vaporises/turns to a gas (1) • decane vapour/gas breaks down as it comes in contact with hot porous pot (1) • large molecules of decane produce smaller molecules, including ethene (1)	Do not allow this point if ethane passes over hot porous pot	**(3)**

Question number	Answer	Mark
3(c)(ii)	B	**(1)**

Question number	Answer	Mark
3(c)(iii)	$2C_{10}H_{22}$ + **31**O_2 → **20**CO_2 + **22**H_2O • LHS (1) • RHS both numbers correct (1)	**(2)**

Question number	Answer	Mark
4(a)	C	(1)

Question number	Answer	Additional guidance	Mark
4(b)	• molecular formula – C_5H_{10} (1) • structure (1) 		(2)

Question number	Answer	Additional guidance	Mark
4(c)(i)	• calculates relative molecular mass of C_4H_9OH (1) • calculates mass of C_4H_9OH produced (1) • final answer = 1.9 (kg) (1)	<u>Example of calculation</u> Relative molecular mass of C_4H_9OH = (4 × 12) + (9 × 1) + 16 + 1 = 74 Mass of C_4H_9OH produced = (74 ÷ 56) × 1.4 Accept 1.85 (kg) Award full marks for use of moles/correct numerical answer without working	(3)

Question number	Answer	Mark
4(c)(ii)	A	(1)

Question number	Answer	Mark
4(d)	• X and Y are both unsaturated/contain {multiple/double} bonds/alkenes (1) • Z is saturated/contains no {multiple/double} bonds/alkane (1)	(2)

Question number	Answer	Mark
5(a)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • the flame test only confirms the presence of lithium ions/Li^+ (1) • but another test is needed to confirm the identity of the anion/negative ion/CO_3^{2-} (1) OR • the red flame test shows the presence of calcium ions Ca^{2+} and not lithium ions/Li^+ (1) • the student did not test for carbonate ions (1)	**(2)**

Question number	Answer		Mark
5(b)	• name: sodium sulfate (1) • formula: Na_2SO_4 (1)	Allow formula consequential on incorrect name	**(2)**

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

Question number	Answer	Additional guidance	Mark
5(d)(i)	An answer that provides a description by making reference to: • test gas with moist (red) litmus paper (1) • turns blue (1)	Allow universal indicator paper/pH paper and yellow to blue/purple	**(2)**

Question number	Answer	Additional guidance	Mark
5(d)(ii)	An answer that provides a description by making reference to: • iron(II) – green/pale green/grey-green **and** precipitate /solid (1) • iron(III) – red-brown/brown **and** precipitate /solid (1)	Allow two correct colours (1)	**(2)**

Question number	Answer	Mark
5(d)(iii)	$(Fe^{3+} + 3OH^-) \rightarrow Fe(OH)_3$	**(1)**

Question number	Answer	Mark
6(a)	An explanation that combines identification via a judgement (maximum 2 marks) to reach a conclusion via justification/reasoning, which must be linked to the judgement (maximum 2 marks): • it is lighter/has a lower density/than steel (1) • so it is easier/more comfortable to wear (1) OR • it is stronger (1) • so it is less likely to be penetrated (1) OR • it is more flexible (1) • so it is easier/more comfortable to wear (1) OR • does not (corrode/rust) (1) • so it will last longer (1)	**(4)**

Question number	Answer	Additional guidance	Mark
6(b)(i)	• calculates total surface area (1) • calculates volume (1) • calculates surface area to volume ratio (1)	<u>Example of calculation</u> Surface area = 6 × 2 × 2 = 24 (cm^2) Volume = 2 × 2 × 2 = 8 (cm^3) Surface area to volume ratio = 24/8 = 3 : 1 Award full marks for correct numerical answer without working	**(3)**

Question number	Answer	Mark
6(b)(ii)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (2 marks): • silver nanoparticles have a much greater surface area to volume ratio than powder (1) OR • silver nanoparticles have a much greater surface area than the same volume of a powder (1) Plus • because chemical reactions take place on the surface of the solid silver catalyst (1) • so there will be more frequent collisions/the rate of reaction will be faster (1) OR • So in a given time, more molecules can come together to react (1)	**(3)**

Question number	Answer	Additional guidance	Mark
7(a)	$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$ • LHS (1) • RHS (1)	Allow products in any order	**(2)**

Question number	Answer	Mark
7(b)(i)	(line B) less steep/(line B) flattens later (1)	**(1)**

Question number	Answer	Mark
7(b)(ii)	• Slope = 60 ÷ 72 (1) • = 0.83(3) ($cm^3\ s^{-1}$) (1)	**(2)**

Question number	Answer	Mark
7(c)	An explanation that makes reference to: identification – knowledge (1 mark) and reasoning/justification – knowledge (1 mark): • fewer particles/as the reactants are used up there will be fewer particles to react/lower concentration of particles (1) • this will result in a lower frequency of collisions so fewer particles reacting in a given time (1)	**(2)**

Question number	Answer	Mark
7(d)	C	**(1)**

Question number	Answer	Mark
7(e)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks): • the decrease in temperature will cause a decrease in rate of reaction (1) • and the increase in pressure will cause an increase in rate of reaction (1) • because the changes have opposite effects on the rate it is not possible which has the greater effect (1)	**(3)**

Question number	Answer	Mark
8(a)	Candidates relate information given to order of elements in the periodic table to predict: dark grey/black **and** solid/crystals	**(1)**

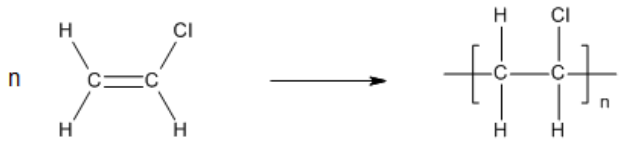
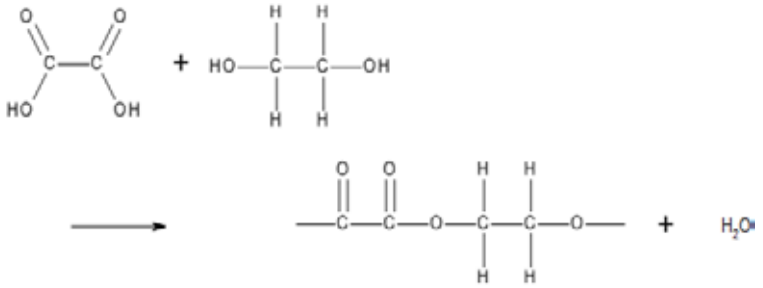
Question number	Indicative content	Mark
*8(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (6 marks)** • order of reactivity: chlorine > bromine > iodine The order of reactivity supported by suitable experiments from: • add (aqueous) chlorine to a solution of potassium bromide • the solution turns orange/yellow • bromine is produced / $Cl_2 + 2KBr \rightarrow Br_2 + 2KCl$ / $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ • (so) chlorine is more reactive than/displaces bromine /oxidises bromide ions • add (aqueous) bromine to a solution of potassium iodide • the solution turns yellow/red/ brown • iodine is produced / $Br_2 + 2KI \rightarrow I_2 + 2KBr$ / $Br_2 + 2I^- \rightarrow I_2 + 2Br^-$ • (so) bromine is more reactive than/displaces iodine/ oxidises iodide ions • add (aqueous) chlorine to a solution of potassium iodide • the solution turns yellow/red/ brown • iodine is produced / $Cl_2 + 2KI \rightarrow I_2 + 2KCl$ / $Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$ • (so) chlorine is more reactive than/displaces iodine/oxidises iodide ions Allow use of suggested reactions which do not produce a displacement reaction, e.g. add (aqueous) bromine to a solution of a potassium chloride with suitable conclusion/explanation	**(6)**

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas, enquiry, techniques and procedures lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure, which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Question number	Answer	Additional guidance	Mark
8(c)(i)	• calculates mol of Fe (1) • calculates mol of Br^2 (1) • determines simplest ratio/LHS of equation (1) • deduces formula of iron bromide produced/RHS of equation (1) OR • divides mass by relative atomic mass (1) • simplest ratio (1) • empirical formula (1) • deduces LHS to obtain balanced equation (1)	<u>Example of calculation</u> mol Fe = $\frac{5.6}{56}$ = 0.1 mol Br_2 = $\frac{24}{(2\times80)}$ = 0.15 ratio Fe:Br_2 = 2 : 3/ 2Fe + 3Br_2 2$FeBr_3$/Fe_2Br_6 Fe : Br $\frac{5.6}{56}$: $\frac{24}{80}$ 0.1 : 0.3 1 : 3 $FeBr_3$ 2Fe + 3Br_2 → 2$FeBr_3$	**(4)**

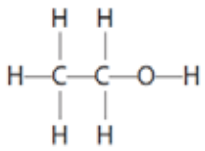
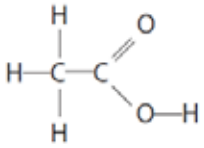
Question number	Answer	Mark
8(c)(ii)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • bromine atoms are reduced (1) • because electrons are gained to form bromide ions (1)	**(2)**

Question number	Answer	Mark
9(a)	An explanation that combines identification – improvement of the experimental procedure (1 mark) and justification/reasoning which must be linked to the improvement (1 mark): • reverse the boiling tubes/pass gas through the tube in ice water first (1) • so that if any liquid condenses in the tube it must have come from the burning wax (and not from the limewater) (1)	**(2)**

Question number	Indicative content	Mark
*9(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Candidates choose appropriate monomers to illustrate the formation of different polymers. • polymer molecules are long chains • made up of simple repeating units • use chloroethene (only) • to form poly(chloroethene) • which is addition polymerisation • use ethane-1,2-diol and ethanedioic acid • to form a polyester • which is condensation polymerisation • one of the bonds in the double bond in chloroethene molecule breaks • and chloroethene molecules join together to form a long chain molecule • equation  • identification of repeat unit • alcohol group combines with a carboxylic acid group • and an ester (link) formed • with a water (molecule) eliminated • equation  • ester link shown • identification of repeat unit	**(6)**

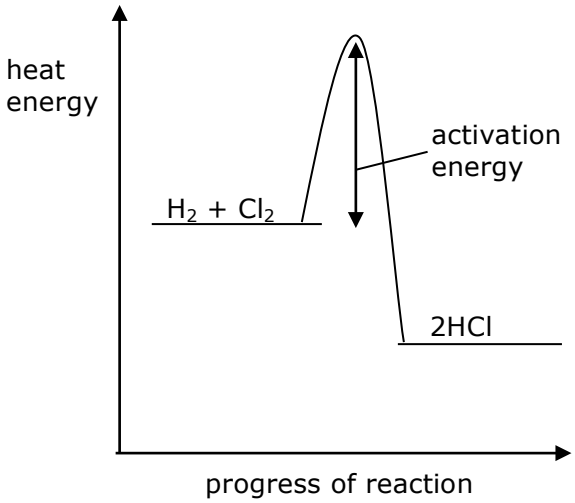
Level	Mark	Descriptor
	0	No awardable content.
Level 1	1–2	• The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2) • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3–4	• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2) • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5–6	• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2) • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Question number	Answer	Marks
9(c)(i)	carboxylic acids	**(1)**

Question number	Answer	Marks
9(c)(ii)	A is  (1) B is  (1)	**(2)**

Question number	Answer	Mark
10(a)	B	**(1)**

Question number	Answer	Marks
10(b)	An answer that combines the following points to provide a plan: • measure known volume of sodium hydroxide solution (1) • add same volume of each of the acids (1) • stir the mixture (1) • record the initial and final temperatures/temperature change (1)	**(4)**

Question number	Answer	Mark
10(c)	 • product line, labelled (2)HCl/product(s), to right of and lower than reactant line, labelled $H^2 + Cl^2$/reactants (1) • curve drawn on diagram (1) • activation energy labelled (1)	**(3)**

Question number	Answer	Additional guidance	Mark
10(d)	• calculates energy needed to break bonds (1) • calculates energy released in forming bonds (1) • calculates energy change (1) • evaluation of final answer with negative sign (1)	<u>Example of calculation</u> Bonds broken = 436 + 243 = 679 ($kJ\ mol^{-1}$) Bonds formed = 2 × 432 = 864 ($kJ\ mol^{-1}$) Energy change = 679 – 864 = −185 ($kJ\ mol^{-1}$) Award full marks for correct numerical answer without working	**(4)**