Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3410U10-1

S24-3410U10-1

THURSDAY, 13 JUNE 2024 – MORNING

CHEMISTRY – Unit 1:
Chemical Substances, Reactions and Essential Resources
FOUNDATION TIER

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**7**	
3.	**7**	
4.	**6**	
5.	**6**	
6.	**7**	
7.	**6**	
8.	**10**	
9.	**6**	
10.	**7**	
11.	**6**	
12.	**7**	
Total	**80**	

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ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

Question **9** is a quality of extended response (QER) question where your writing skills will be assessed.

The Periodic Table is printed on the back cover of this paper and the formulae for some common ions on the inside of the back cover.

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Answer **all** questions.

1. This question is about mixtures and how to separate them.

(a) Draw **one** line from each mixture to the method used to separate the mixture. [4]

	Mixture	Method
A	ethanol and water	filtration
B	sand and water	evaporation
C	iron filings and sulfur powder	distillation
D	salt and water	using a magnet

(b) Which of the mixtures, **A**, **B**, **C** or **D**, contains a **solid** that has dissolved in water? [1]

.....

5

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2. (a) When lithium reacts with water in a large beaker hydrogen gas is released.

Lithium hydroxide solution is also formed. This turns universal indicator purple.

(i) Tick (✓) the box next to the description of what is seen when lithium reacts with water in a large beaker. [1]

lithium melts into a ball and sinks ☐

lithium fizzes and moves around the surface of the water ☐

lithium catches fire and burns with a blue flame ☐

(ii) Tick (✓) the box that describes lithium hydroxide solution. [1]

neutral ☐ acid ☐ alkali ☐

(iii) Lithium hydroxide contains Li^+ and OH^- ions.

Circle the correct formula for lithium hydroxide. [1]

liOH **LiOH** **$Li(OH)_2$** **Li_2OH**

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(b) Lithium reacts with chlorine to form lithium chloride.

(i) Tick (✓) the box next to the correct balanced equation for the reaction. [1]

$2Li + Cl_2 \longrightarrow 2LiCl_2$ ☐

$2Li + Cl_2 \longrightarrow 2Li_2Cl$ ☐

$2Li + Cl_2 \longrightarrow 2LiCl$ ☐

(ii) Anwen was asked to use a flame test and a silver nitrate test to identify lithium chloride.

Circle the expected observation for each test. [2]

Flame test	**Silver nitrate test**
green flame	yellow precipitate
red flame	blue precipitate
lilac flame	white precipitate

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(c) Lithium reacts with oxygen to form lithium oxide.

Tick (✓) the box next to the calculation used to find the relative formula mass (M_r) of lithium oxide, Li_2O. [1]

$A_r(Li) = 7$ $A_r(O) = 16$

7 + 7 + 16 ☐

7 + 16 ☐

7 + 7 + 16 + 16 ☐

7 + 16 + 16 ☐

7

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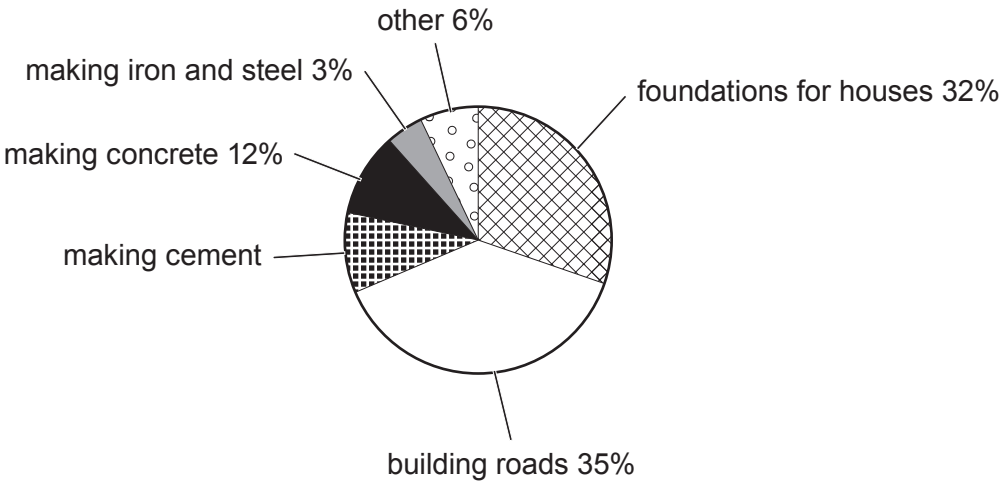
3. The pie chart shows some of the major uses of limestone.



(a) Use the pie chart to find the percentage of limestone used to make cement. [2]

Percentage = ... %

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(b) When limestone is heated, it produces calcium oxide and carbon dioxide.

(i) Complete the equation for this reaction by giving the formula of calcium oxide. [1]

$$CaCO_3 \longrightarrow \text{.....} + CO_2$$

(ii) Underline the name for this type of reaction. [1]

displacement **decomposition** **precipitation** **neutralisation**

(iii) When water is added to calcium oxide, an exothermic reaction occurs.

Tick (✓) the observation that shows that this reaction is exothermic. [1]

solid forms	☐
colour changes	☐
ice forms	☐
steam is given off	☐

(c) Give **two** benefits of limestone quarrying. [2]

.....

.....

7

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4. Atoms are made of protons, neutrons and electrons.

Some of the properties of protons, neutrons and electrons are shown in the table.

Particle	Mass	Charge
proton	.....	+1
neutron	1	0
electron	0	.....

(a) **Complete the table.** [2]

(b) Element **X** has 7 protons, 7 electrons and 7 neutrons.

Use this information to complete the following sentences. [4]

The atomic number of element **X** is ..... .

The mass number of element **X** is ..... .

The electronic structure of element **X** is ..... .

Element **X** is in Group ..... of the Periodic Table.

6

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5. Diagrams **A**, **B**, **C** and **D** represent argon (Ar), nitrogen (N_2), oxygen (O_2) and carbon dioxide (CO_2), but not in that order.

A **B** **C** **D**

(a) Give the **letter** of the diagram that represents argon. [1]

.....

(b) Give the **letter** of the diagram that represents a compound. Give a reason for your answer. [2]

Letter .....

Reason .....

.....

(c) (i) Use information from the diagrams above. Draw a diagram to represent a molecule of nitrogen dioxide, NO_2. [1]

(ii) Calculate the relative formula mass (M_r) of nitrogen dioxide, NO_2. [1]

$A_r(N) = 14$ $A_r(O) = 16$

M_r = ...

(iii) Balance the equation for the reaction between nitrogen and oxygen to produce nitrogen dioxide. [1]

N_2 + ☐ O_2 ⟶ ☐ NO_2

6

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09

6. Acid rain is formed by sulfur dioxide gas from industrial processes escaping into the atmosphere and reacting with water in clouds.

In recent years, scientists have developed sulfur scrubbers to stop sulfur dioxide gas escaping into the atmosphere from coal-fired power plants. The scrubbers are placed in the chimneys and trap the sulfur dioxide.

There are two types of scrubbers – wet scrubbers and dry scrubbers.

Wet scrubbers

Water is sprayed down the chimneys onto beds of crushed limestone. Sulfur dioxide is absorbed by the water forming an acidic solution which is neutralised by the limestone.

Wet scrubbing can be used in small and large power plants. During wet scrubbing 4% of sulfur dioxide escapes.

Dry scrubbers

A mixture of dry alkaline chemicals is sprayed into the chimneys. Some of the dry chemicals neutralise the sulfur dioxide.

Dry scrubbing is limited to small or medium sized power plants. No water is used so costs are lower. During dry scrubbing 10% of sulfur dioxide escapes.

Examiner only

(a) Tick (✓) the physical change happening to the sulfur dioxide in a wet scrubber. [1]

it freezes ☐

it dissolves ☐

it condenses ☐

it melts ☐

(b) Tick (✓) the pH change that happens as a solution of sulfur dioxide is neutralised in a wet scrubber. [1]

pH 11 to pH 7 ☐

pH 4 to pH 7 ☐

pH 7 to pH 11 ☐

pH 7 to pH 4 ☐

(c) The table shows some statements about wet and dry scrubbing.

Complete the table using a tick (✓) to show whether each statement applies to wet scrubbing only, to dry scrubbing only or to both wet and dry scrubbing. [3]

Statement	Wet scrubbing only	Dry scrubbing only	Both wet and dry scrubbing
Can be used in large power plants			
At least 90% efficient			
Neutralises sulfur dioxide			

Examiner only

(d) The table shows the mass of sulfur dioxide released into the atmosphere per year in the UK every five years between 1990 and 2015.

Year	Mass of sulfur dioxide released (millions of tonnes)
1990	3.50
1995	0.60
2000	0.40
2005	0.35
2010	0.30
2015	0.20

Describe the trend in the mass of sulfur dioxide released into the atmosphere between 1990 and 2015. [2]

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7. (a) Three samples of water, **A**, **B** and **C**, were tested for hardness using soap solution.

The results are shown below.

- No lather formed in samples **A** and **B**
- Lather formed in sample **C**
- When sample **A** was boiled and soap solution added, lather formed
- When sample **B** was boiled and soap solution added, no lather formed

Tick (✓) **three** conclusions that can be drawn from these results. [3]

sample **C** is soft water	☐
all the samples are hard water	☐
samples **A** and **B** are hard water	☐
sample **B** contains temporary hardness	☐
sample **A** contains temporary hardness	☐
samples **A** and **B** contain permanent hardness	☐

(b) Give **one** method other than boiling that can be used to remove hardness from water. [1]

.....

Examiner only

(c) Tick (✓) the compound that causes hardness in water. [1]

sodium nitrate	
zinc chloride	
calcium sulfate	
potassium oxide	

(d) Give **one** health benefit of living in a hard water area. [1]

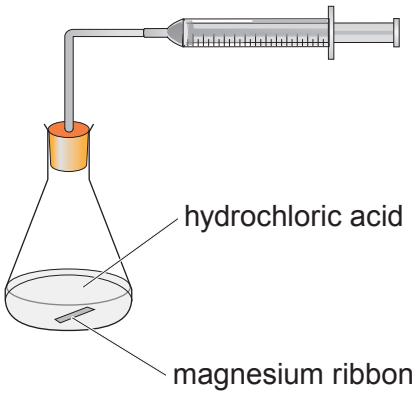
.....

6

8. A group of students investigated the rate of the reaction between magnesium and dilute hydrochloric acid.

The equation for the reaction is as follows.

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$



They carried out the reaction at 30 °C. The hydrogen gas was collected in a gas syringe and the volume recorded every minute for 6 minutes.

The results are shown in the table. The value at 1 minute has been left out.

Time (minutes)	0	1	2	3	4	5	6
Volume of hydrogen (cm^3)	0		29	39	46	50	50

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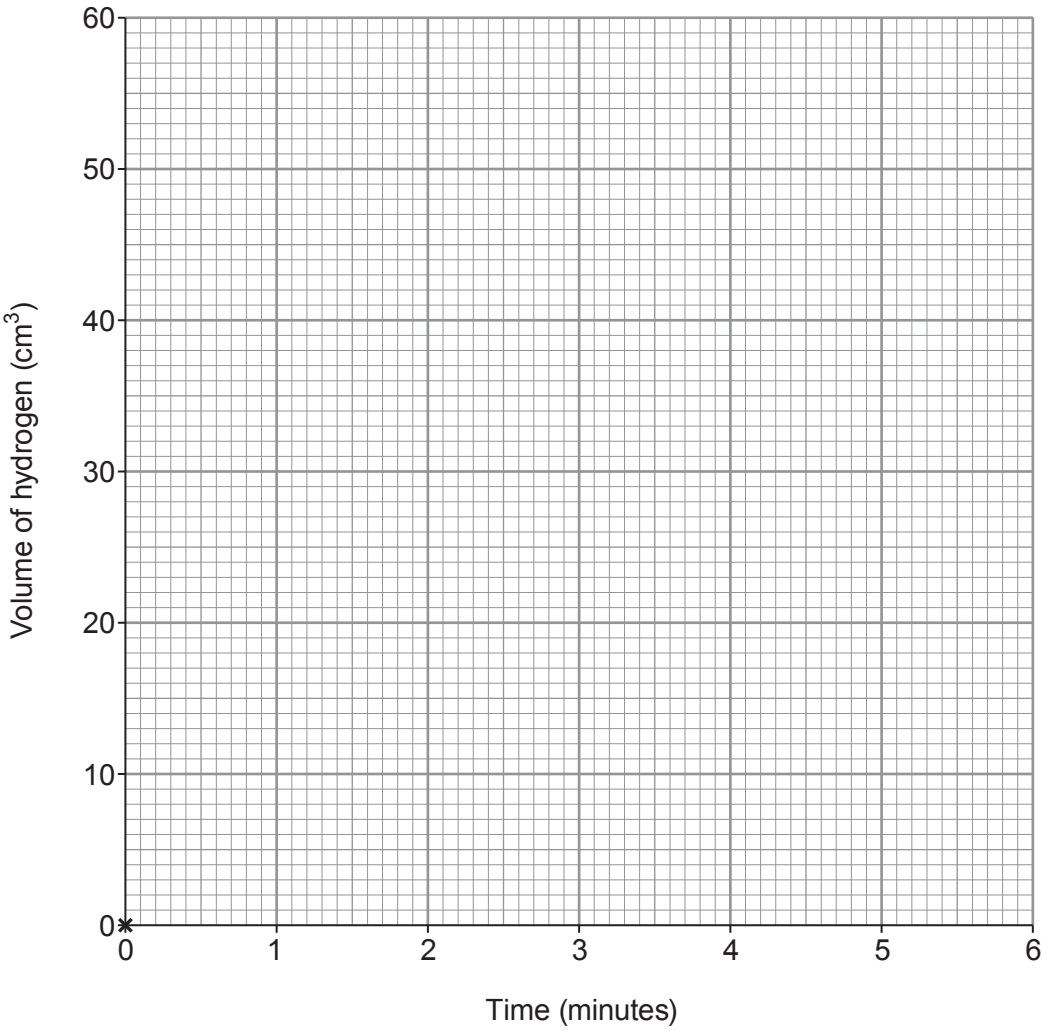
(a) (i) Plot the volume of hydrogen produced against time on the grid. The first point has been plotted for you. Draw a suitable line. [3]



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(ii) I. Use your graph to estimate the volume of hydrogen that would have been produced after 1 minute. [1]

..... cm^3

II. Calculate the mean rate of the reaction over the **first** minute. Give your answer in **cm^3/s**. [2]

Use the formula

$$\text{mean rate} = \frac{\text{volume of hydrogen } (cm^3)}{\text{time (s)}}$$

Mean rate = ... cm^3/s

(b) There is no catalyst for this reaction.

Give **two** ways the students could increase the rate of this reaction. [2]

.....

.....

(c) The students calculated that if they used 0.5 g of magnesium in this reaction, they would make 2.0 g of magnesium chloride. However, when they used 0.5 g of magnesium only 1.7 g of magnesium chloride was made.

Calculate the percentage yield for this reaction. [2]

Percentage yield = ... %

10

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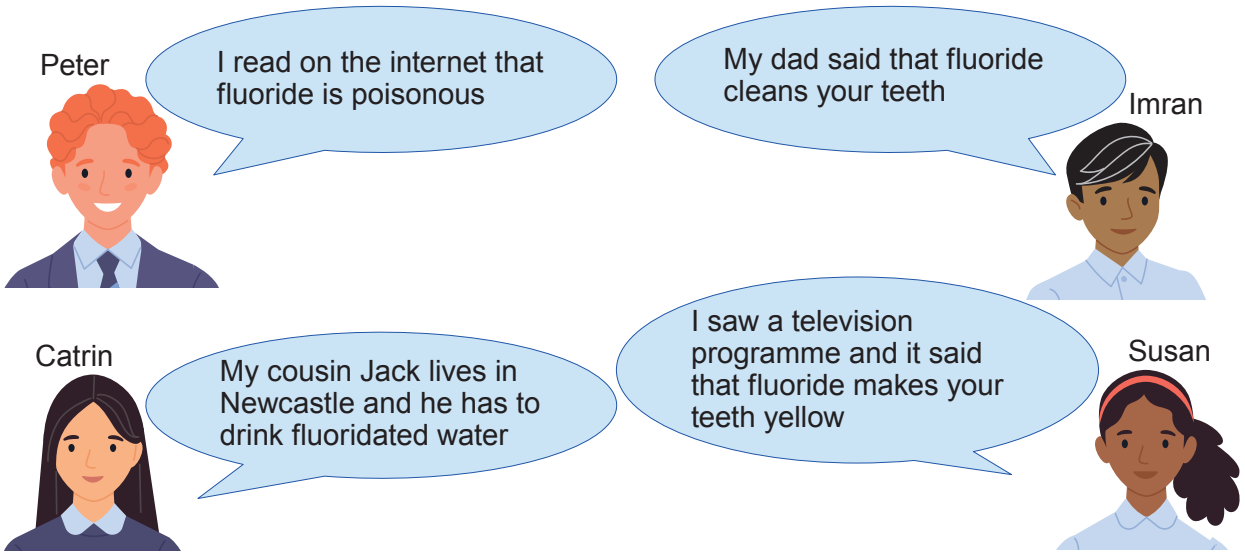
9. Mrs Ennion asked her Year 10 class what they knew about fluoride in drinking water.

Peter, Imran, Catrin and Susan's responses are shown.



Use your own knowledge of fluoridation to comment on each of these responses. [6 QER]

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Examiner only

10. The table below gives information about seven elements, **A-G**.

Element	Melting point (°C)	Boiling point (°C)	Electrical conductivity	Malleability
A	839	1484	good	good
B	−23	115	poor	
C	1414	3265	poor	poor
D	−102	−34	poor	
E	10	112	poor	poor
F	−188	−42	poor	
G	660	2470	good	good

(a) Use information from the table to answer parts (i)-(iii).

(i) Give the **letter** of the element that has the greatest difference between its melting point and boiling point. [1]

.....

(ii) Give the **letters** of the **two** elements that are gases at room temperature, 20 °C.

Give a reason for your choice. [2]

Letters ..... and .....

Reason .....

.....

Examiner only

(iii) Give the **letter** of the element that is a metalloid.

Explain your choice. [2]

Letter .....

Explanation .....

.....

.....

(b) One of the elements is aluminium. It reacts spectacularly with iron(III) oxide in the thermit reaction.

Complete and balance the equation for the reaction between aluminium and iron(III) oxide to produce aluminium oxide and iron. [2]

$\square$ Al + Fe_2O_3 ⟶ ..... + 2 Fe

7

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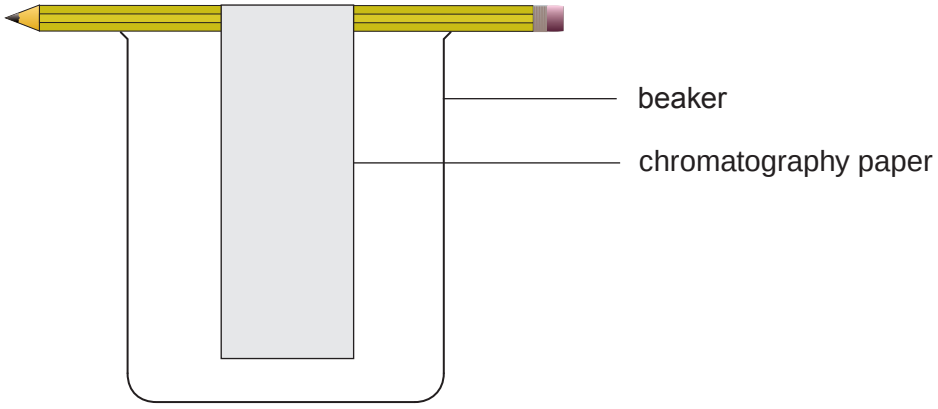
11. (a) Amanda wanted to determine what coloured dyes were present in a sample of orange ink.

The diagram shows a piece of chromatography paper, supported by a pencil, placed in a beaker at the start of her experiment.

Complete the diagram by showing

- the position of the ink sample at the start
- the water level in the beaker [2]



(b) The table shows the R_f values for some coloured dyes that are found in inks.

Dye colour	R_f value
blue	0.40
yellow	0.25
red	0.70
green	0.15

(i) Explain why coloured dyes have different R_f values. [2]

.....

.....

.....

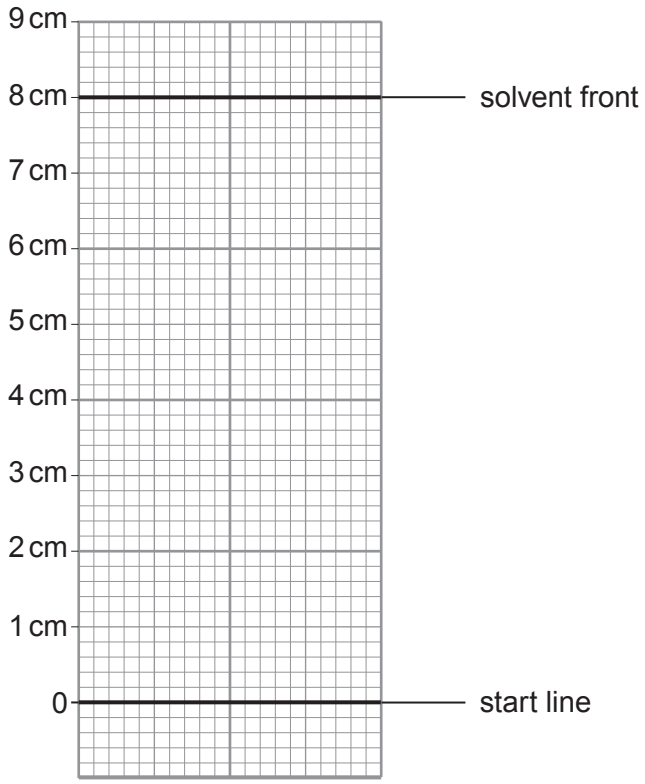
Examiner only

(ii) Orange ink separates into red and yellow dyes.

On the chromatogram, draw the positions of the spots you would expect to see after a sample of orange ink has been analysed by chromatography. [2]

Use the formula

distance travelled by dye = R_f value × distance travelled by solvent



6

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12. (a) Wegener's theory of continental drift was not accepted by other scientists during his lifetime because he had no explanation of how the continents moved.

We now know that the continents sit on tectonic plates which move very slowly.

State why these plates move. [1]

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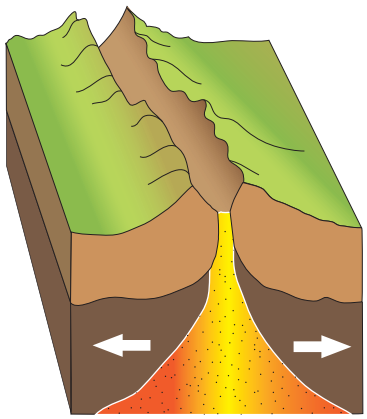
.....

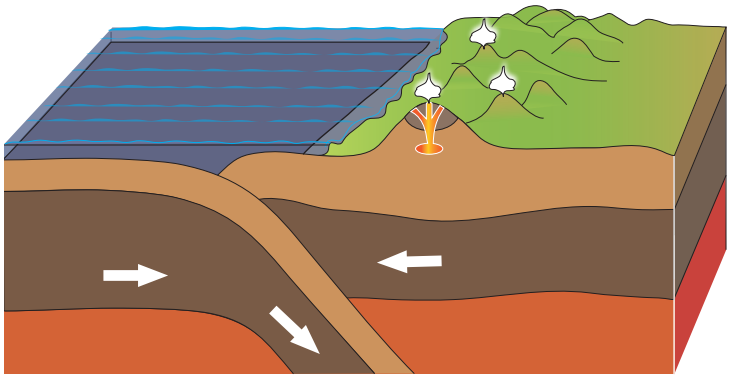
(b) The diagrams below show two different types of plate boundary.

At a constructive plate boundary, the plates move away from each other.

At a destructive plate boundary, the plates move towards each other.



Constructive



Destructive

Describe what happens at each type of boundary. [4]

Constructive

.....

.....

.....

Destructive

.....

.....

.....

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(c) The cities of Los Angeles and San Francisco are on opposite sides of a conservative plate boundary at a distance of 600 km apart.

They are moving closer together as the plates slide past one another at a relative speed of about 40 mm per year.

Use the formula below to calculate the amount of time before the cities are next to one another. [2]

$$\text{time} = \frac{\text{distance}}{\text{speed}}$$

1 km = 1 000 m 1 m = 1 000 mm

Time = ... years

7

END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	**Formula**	**Name**	**Formula**
aluminium	Al^{3+}	bromide	Br^{-}
ammonium	NH_4^{+}	carbonate	CO_3^{2-}
barium	Ba^{2+}	chloride	Cl^{-}
calcium	Ca^{2+}	fluoride	F^{-}
copper(II)	Cu^{2+}	hydroxide	OH^{-}
hydrogen	H^{+}	iodide	I^{-}
iron(II)	Fe^{2+}	nitrate	NO_3^{-}
iron(III)	Fe^{3+}	oxide	O^{2-}
lithium	Li^{+}	sulfate	SO_4^{2-}
magnesium	Mg^{2+}		
nickel	Ni^{2+}		
potassium	K^{+}		
silver	Ag^{+}		
sodium	Na^{+}		
zinc	Zn^{2+}		

THE PERIODIC TABLE

Group	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
	86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 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	179 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	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
	223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key