

Surname	Centre Number	Candidate Number
First name(s)		0


GCSE – CONTINGENCY

3410U40-1



Z22-3410U40-1

THURSDAY, 23 JUNE 2022 – MORNING
**CHEMISTRY – Unit 2:
Chemical Bonding, Application of Chemical Reactions
and Organic Chemistry**
FOUNDATION TIER

1 hour 45 minutes

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

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 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 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 5(a) 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.



JUN223410U40101

Answer **all** questions.

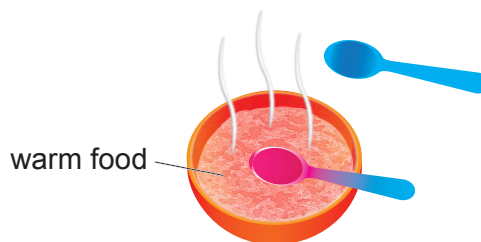
1. Smart materials are widely used in everyday life.

(a) The diagrams show some uses of smart materials which rely on their unusual properties.

nappies



baby-feeding spoon



summer T-shirts



cloudy

sunny

car bumper



dent

no dent

The box contains the names of four different types of smart material.

thermochromic pigment

shape memory polymer

hydrogel

photochromic pigment

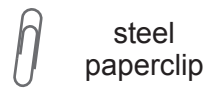
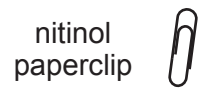


Use the information opposite to complete the table below.

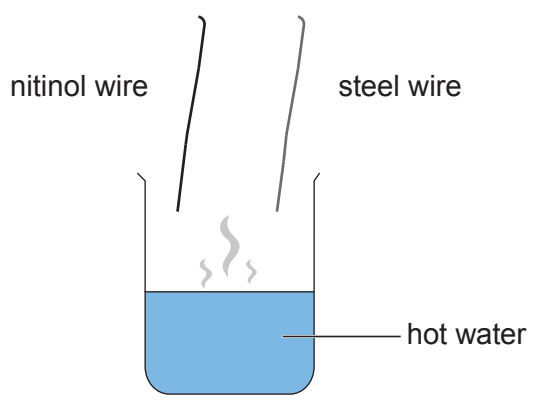
[4]

Unusual property	Use	Type of smart material
Able to absorb many times its own volume of water	nappies	hydrogel
Changes colour with changing temperature
Changes colour with changing light intensity

(b) Paperclips can be made from nitinol and from steel. Nitinol is a shape memory alloy but steel is not.



A student uncoiled both paperclips into straight wires and dropped them into hot water.



Put a **tick** (✓) in the box next to the statement that describes what happens.

[1]

- both wires reform into the shape of a paperclip
- only the nitinol wire reforms into the shape of a paperclip
- only the steel wire reforms into the shape of a paperclip
- neither wire reforms into the shape of a paperclip

5



2. (a) The diagram shows the colours of universal indicator at different pH values.

Colour	red	orange	yellow	green	blue	navy blue	purple
pH	1-2	3-4	5-6	7	8-9	10-11	12-13

- (i) Sodium hydroxide solution turns universal indicator purple.

Put a **tick** (✓) in the box next to the correct statement.

[1]

sodium hydroxide is a strong alkali

sodium hydroxide is a weak alkali

sodium hydroxide is a strong acid

sodium hydroxide is a weak acid

- (ii) Ethanol is neutral. State the **colour** universal indicator would turn in ethanol. [1]

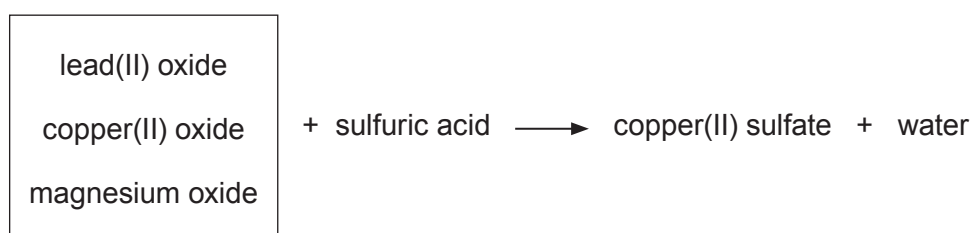
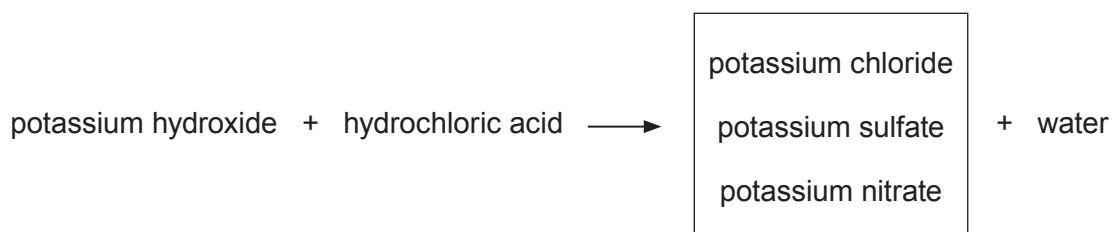
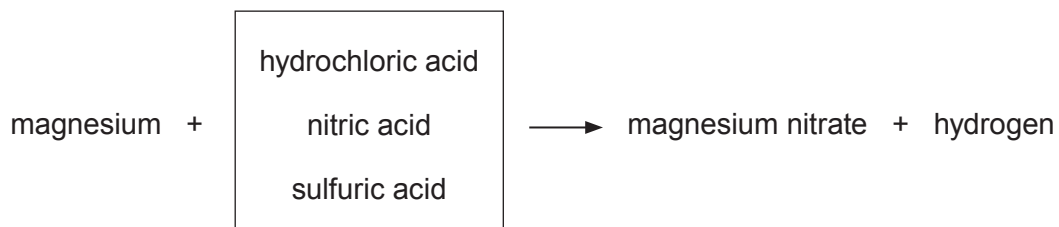
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(b) The word equations show reactions of acids with a metal, an alkali and a base.

Circle the correct substance in the box to complete each equation.

[3]

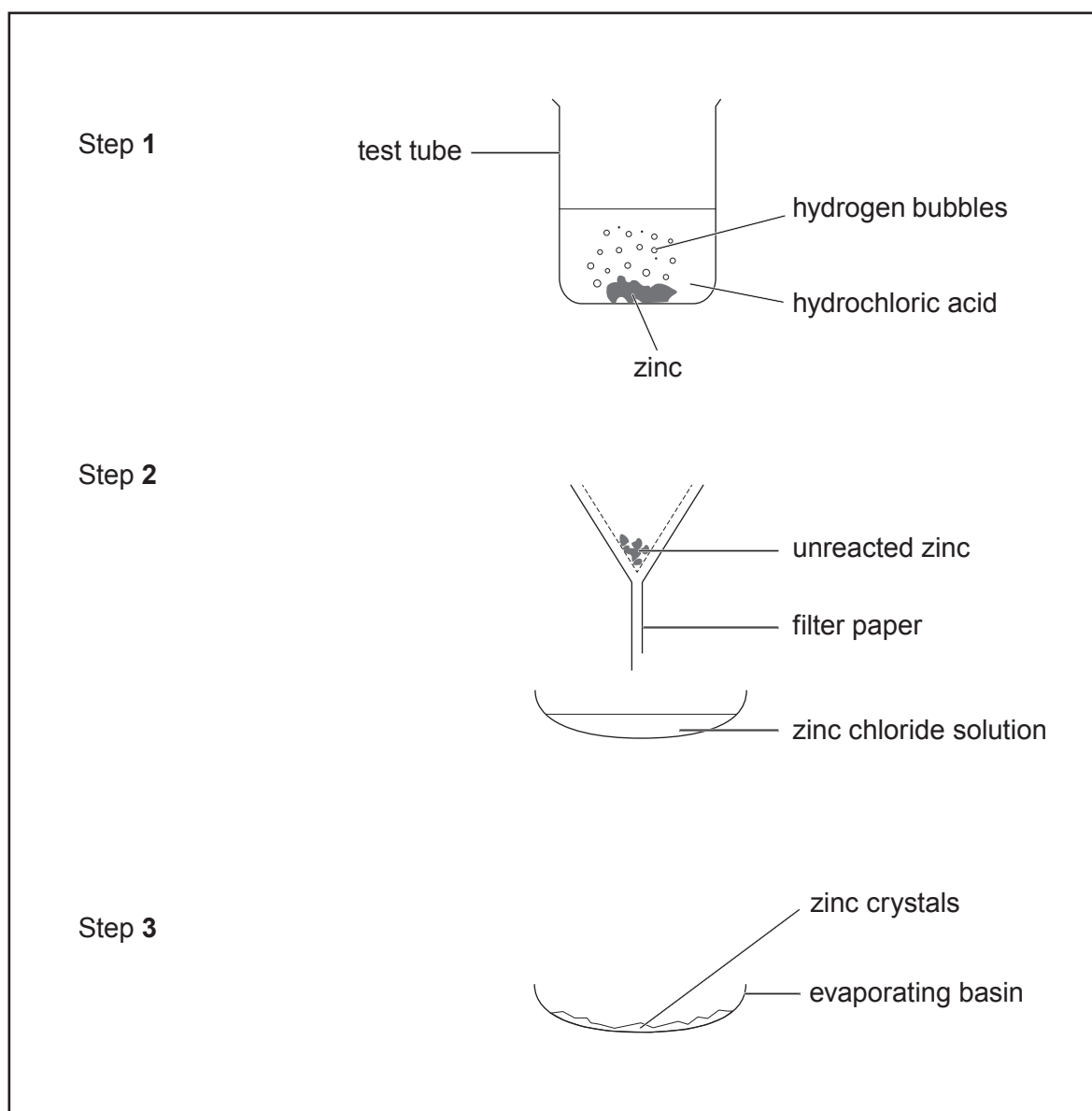


- (c) A student was asked how he would prepare a sample of zinc chloride crystals from zinc. The word equation for the reaction is



The diagrams below were taken from the student's work book.

There is **one** error in **each** of the student's diagrams.



(i) **Circle** the error in each diagram. [3]

(ii) Zinc chloride contains the ions Zn^{2+} and Cl^- .

Underline the correct formula of zinc chloride. [1]



(iii) Put a **tick** (✓) in the box next to the test to show that the gas given off is hydrogen. [1]

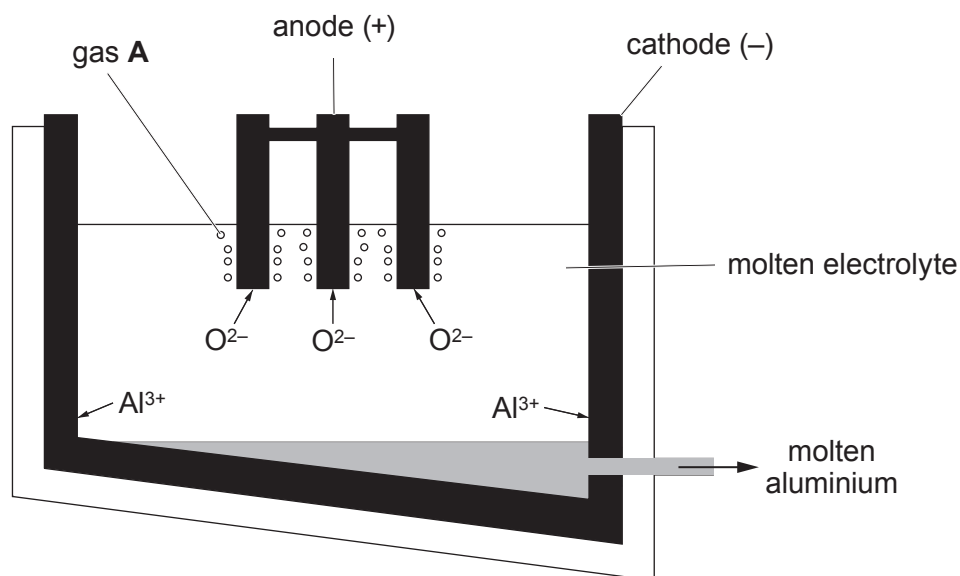
the gas pops with a lighted splint

the gas turns limewater milky

the gas relights a glowing splint



3. (a) The diagram shows a cell used in the extraction of aluminium from aluminium oxide.



positive	oxygen	cryolite	negative
aluminium	hydrogen	steel	graphite

- (i) Choose words from the box to complete each of the following sentences. [4]

The electrolyte is a mixture of molten aluminium oxide and

Aluminium ions, Al^{3+} , are attracted to the electrode with a charge.

Gas **A** is

The electrodes are made of

- (ii) Balance the equation for the overall reaction. [1]



- (b) Calculate the relative formula mass (M_r) of aluminium oxide, Al_2O_3 . [2]

$$A_r(\text{O}) = 16 \qquad A_r(\text{Al}) = 27$$

Relative formula mass =

- (c) The box below contains some properties of aluminium.

low density	non-magnetic	resists corrosion
good thermal conductor	good electrical conductor	

Window frames can be made from different materials.

Choose **two** properties from the box which make aluminium a **better** material than iron for making window frames. [2]

Property 1

Property 2



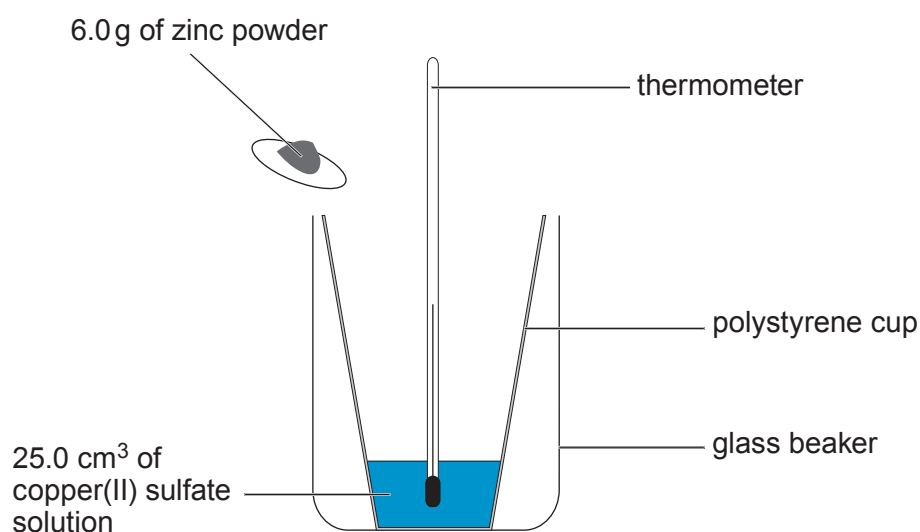
4. (a) The list shows part of the reactivity series.

magnesium
zinc
iron
copper

Underline the correct word(s) in the brackets to complete the following sentence. [1]

The reactivity of metals (**increases** / **stays the same** / **decreases**) down the list.

- (b) Aled investigated the reaction between zinc and excess copper(II) sulfate solution.



Aled put 25.0 cm³ of copper(II) sulfate solution into a polystyrene cup and recorded its temperature. He added 6.0 g of zinc powder to the solution and recorded the temperature every 10 s for 70 s. His results are shown in the table.

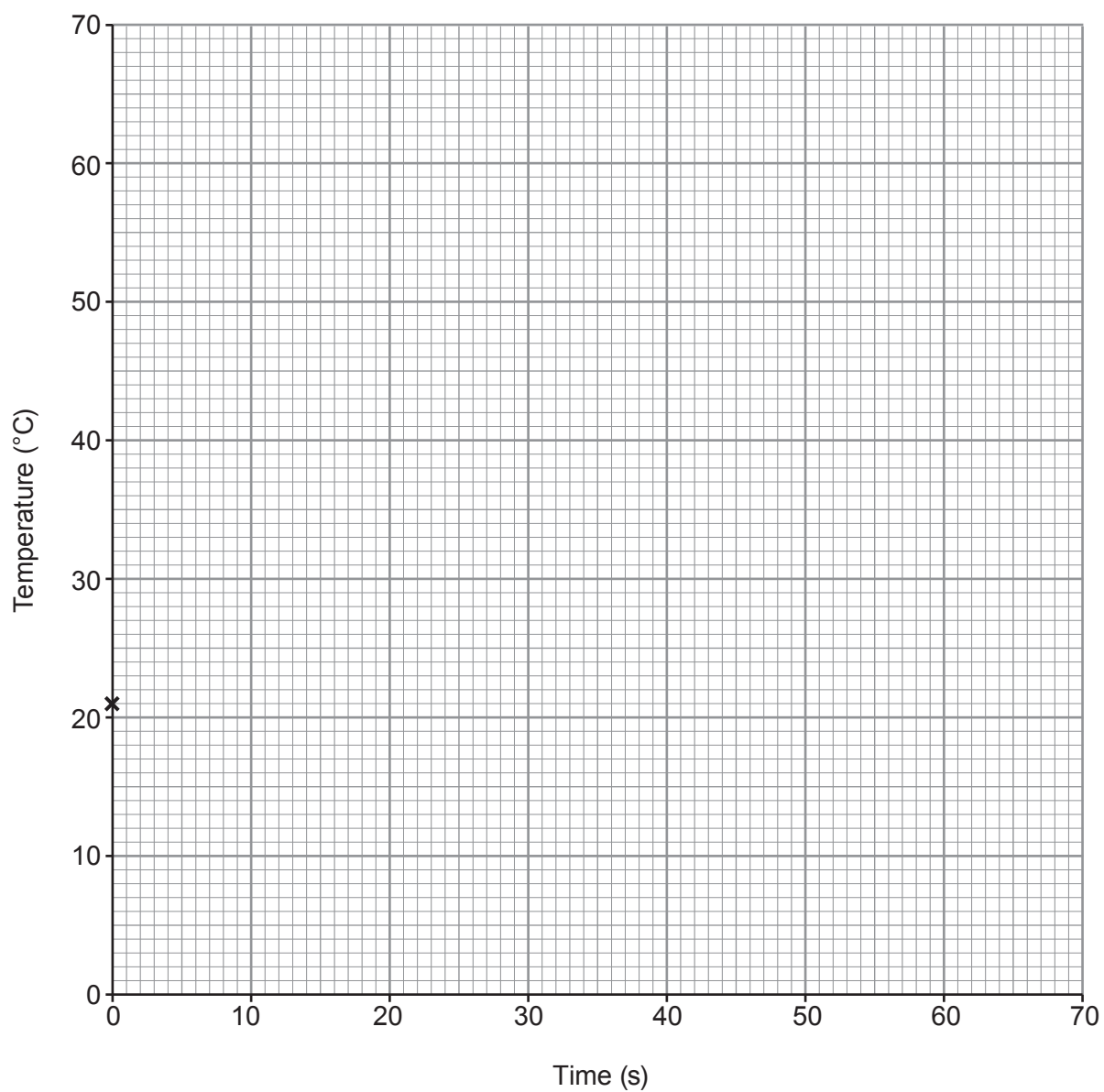
Time (s)	0	10	20	30	40	50	60	70
Temperature (°C)	21	38	50	58	60	59	56	52

- (i) Plot these results on the grid opposite. Draw a suitable line.

The first point has been plotted for you.

[3]





(ii) **Circle** the time it took for **all** the zinc powder to be used up.

[1]

30 s

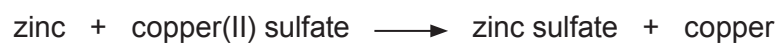
40 s

50 s

70 s

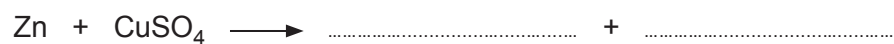


- (iii) The word equation for the reaction between zinc and copper(II) sulfate solution is as follows.



- I. Complete the symbol equation for the reaction.

[2]



- II. Underline the type of reaction taking place.

[1]

combustion**displacement****neutralisation****addition**Examiner
only

8



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5. (a) The table shows some properties of three plastics.

Plastic	Properties		
polycarbonate	high impact strength	good heat resistance	transparent
bakelite	rigid	good chemical resistance	good thermal insulator
coated nylon	good electrical insulator	flexible	waterproof

Use only the information in the table to answer this part-question.

State which plastic is used for making each of the following items.

Choose the **two** main properties that make the plastic suitable.

Give the reasons why these properties are important.

[6 QER]

motorbike helmet visor



tent fabric





Examiner
only

Area with horizontal dotted lines for writing.








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15



(b)

Recycling Plastics

Of all the materials we recycle, plastic is the most complex. The problem is that some plastic packaging is made from several different types of plastic. Different types of plastic are identified by different symbols.

Type of plastic	Symbol	Ease of recycling	Uses
PET		easy	soft drink bottles, rigid food packaging
HDPE		easy	milk cartons, cleaning product bottles, yoghurt pots
PVC		difficult	window frames, guttering
LDPE		difficult	food bags, shopping bags
PP		easy	margarine tubs, microwave meal trays
PS		difficult	some yoghurt pots, takeaway meal trays
other		cannot be recycled	mixed plastic products e.g. salad bags, crisp bags

Waste plastic is collected in different ways.

- Some local authorities collect all their recycling in one bin
- Others ask households to separate their plastics from the rest of their recycling

Sometimes plastic waste cannot be recycled and has to be sent to landfill or incinerated instead. This happens for several reasons.

- People are confused about which plastics can and cannot be recycled
- The plastic packaging is contaminated with food waste
- In areas where recycling materials are collected in one bin, one type of waste can contaminate another

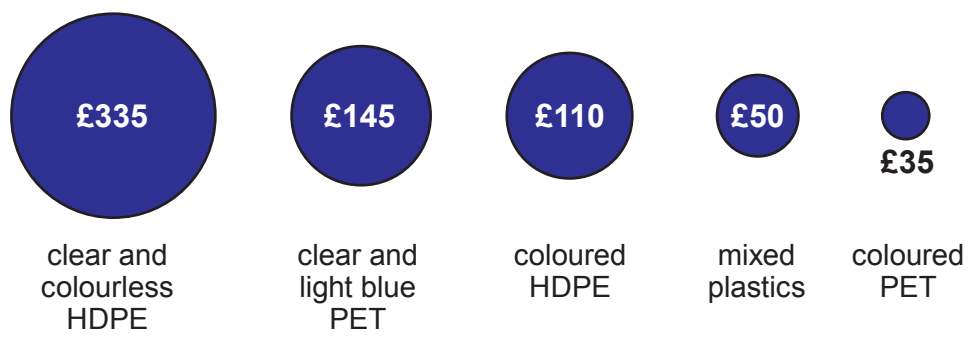
Most plastic can be recycled – but it is not always economical to do so.

- Bottles attract the best prices, especially clear ones
- Coloured plastic is less desirable; the colour cannot be removed so its use is limited
- Polystyrene is almost never recycled because there is no market for it



Examiner only

Maximum price per tonne of used bottles (2018)



(i) Put a **tick** (✓) next to the correct statement. [1]

- all plastics are easy to recycle
- PET, HDPE and PP are easy to recycle
- PET, HDPE and PVC are difficult to recycle
- PVC, LDPE and PS cannot be recycled

(ii) Put a **tick** (✓) in **two** boxes which explain why some plastic items have to go to landfill. [2]

- the plastic items still contain food waste
- not enough plastic items have been collected to make recycling worthwhile
- the plastic item is made up of more than one type of plastic
- too many plastic items have been collected for recycling
- the plastic items are too large to fit in the incinerator

(iii) **Circle** the type of plastic for which there is the greatest demand for recycling. [1]

- coloured PET
- clear and light blue PET
- clear and colourless HDPE
- coloured HDPE

10



6. (a) The table shows the names, molecular formulae and structural formulae of some alkanes.

(i) Complete the table.

[3]

Name	Molecular formula	Structural formula
.....	CH ₄	$ \begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array} $
ethane	C ₂ H ₆	
propane	$ \begin{array}{cccc} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{H} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & \\ & \text{H} & \text{H} & \text{H} \end{array} $
butane	C ₄ H ₁₀	$ \begin{array}{cccc} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & \\ \text{H} & -\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & & \\ & \text{H} & \text{H} & \text{H} & \text{H} \end{array} $

- (ii) Give the **names** of the **two** elements present in all alkanes.

[1]

..... and

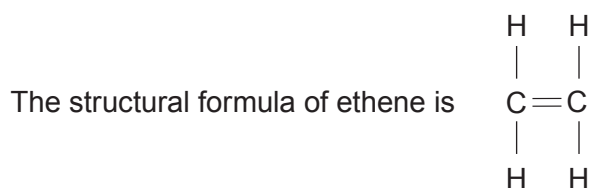
- (iii) The general formula for the alkanes is C_nH_{2n+2}.

Circle the molecular formula for the alkane containing 6 carbon atoms.

[1]

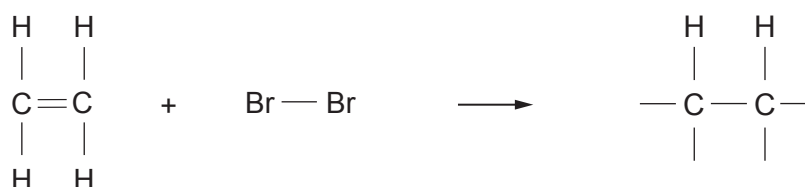


- (b) Ethene belongs to a different family of hydrocarbons called the alkenes.



The presence of the double bond in alkenes can be identified using bromine water.

- (i) Complete the structural formula for the product of the reaction between ethene and bromine. [1]



- (ii) Complete the sentence below by underlining the correct words in the brackets. [2]

Ethene turns (**purple / orange / green / colourless**) bromine water
(**green / milky / colourless / blue**).

- (c) Underline the name given to the type of reaction taking place when ethene reacts with bromine. [1]

addition

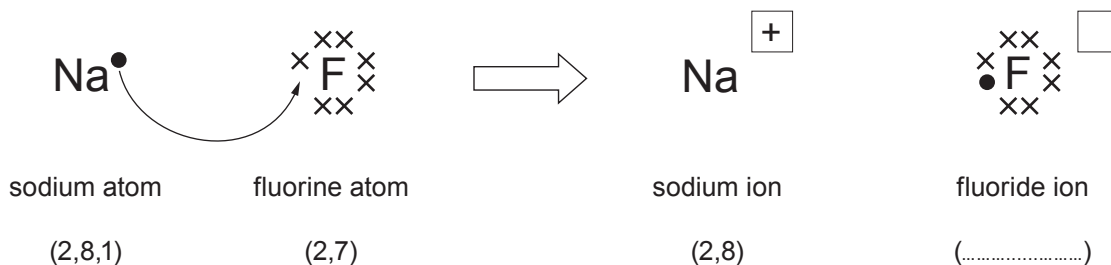
polymerisation

oxidation

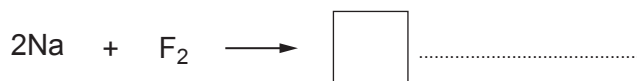
neutralisation



7. (a) The diagram shows the electronic changes that occur when sodium reacts with fluorine to form sodium fluoride. The ● and × symbols represent outer shell electrons.

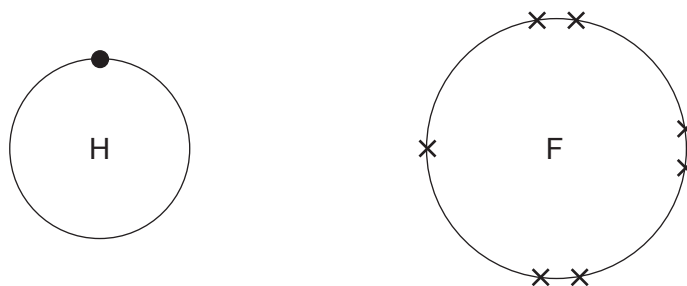


- (i) **Complete the diagram** by writing the electronic structure of the fluoride ion in the brackets and its charge in the box. [2]
- (ii) Complete and balance the equation for the reaction between sodium and fluorine to form sodium fluoride. [2]

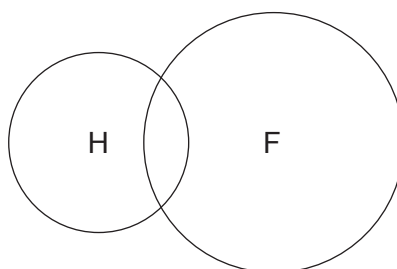


- (b) Hydrogen reacts with fluorine to form hydrogen fluoride, HF.

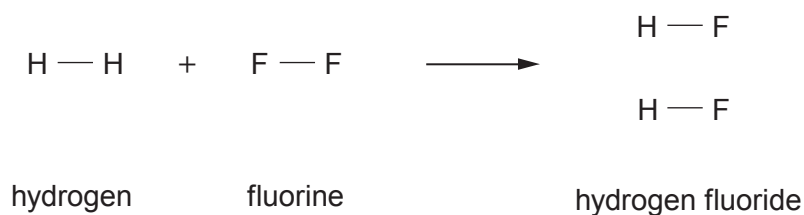
The diagrams show the outer shell electrons in an atom of hydrogen and an atom of fluorine.



Complete the diagram below to show the outer shell electrons in a molecule of hydrogen fluoride. [2]



- (c) The equation shows the bonds which are broken and the bonds which are formed when hydrogen reacts with fluorine to form hydrogen fluoride.



The relevant bond energies are shown in the table.

Bond	Bond energy (kJ)
H — H	436
F — F	154
H — F	565

- (i) The total energy needed to break the bonds in the H—H and F—F molecules is 590 kJ. Use the information in the table to show how this value is obtained. [1]
- (ii) Use the information in the table to calculate the total energy released when the bonds in the **two** H—F molecules are formed. [1]

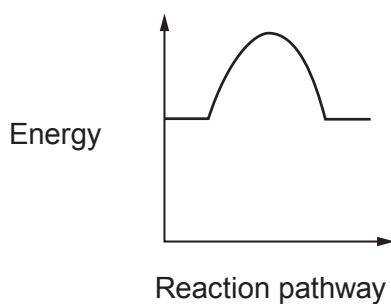
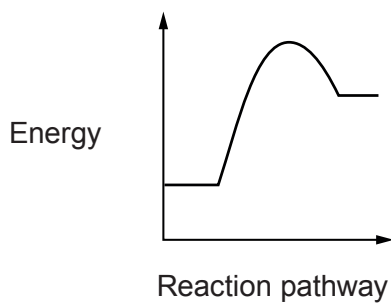
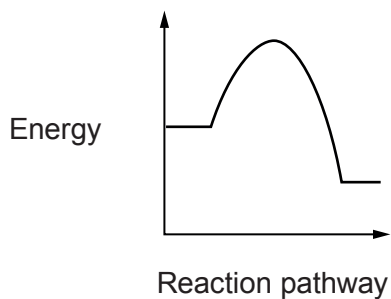
Energy = kJ



(iii) The formation of hydrogen fluoride is an exothermic reaction.

Put a **tick** (✓) in the box next to the energy profile diagram that shows an exothermic reaction.

[1]



8. (a) Crude oil can be separated into simpler mixtures called fractions. The table shows information about some of the main fractions obtained from crude oil by fractional distillation.

Fraction	Boiling point range ($^{\circ}\text{C}$)	Number of carbon atoms present in the alkanes
petroleum gases	< 20	$\text{C}_1\text{--C}_4$
petrol	30–75	$\text{C}_5\text{--C}_8$
naphtha	70–180	$\text{C}_9\text{--C}_{12}$
kerosene	180–250	$\text{C}_{13}\text{--C}_{16}$
diesel oil	250–340	$\text{C}_{17}\text{--C}_{20}$
lubricating oil	340–500	$\text{C}_{20}\text{--C}_{24}$
fuel oil	490–580	$\text{C}_{25}\text{--C}_{28}$

- (i) Decane has a boiling point of 174°C . Give the name of the fraction which contains decane. [1]

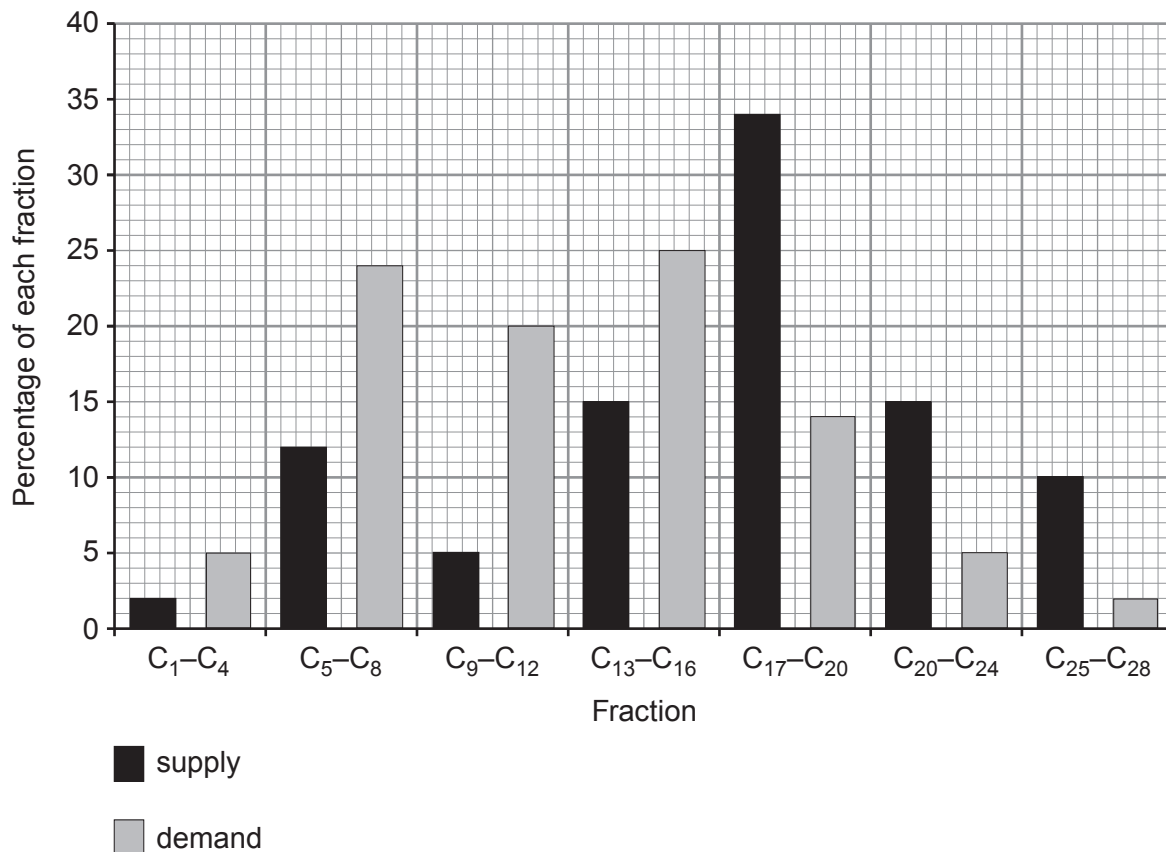
.....

- (ii) One alkane is found in both diesel oil and lubricating oil. Give the number of carbon atoms in this alkane. [1]

.....



(b) The bar chart shows the supply and demand for some of the fractions obtained from crude oil.



(i) Give the fraction where the demand is 100% greater than the supply. [1]

.....

(ii) Put a **tick** (✓) in the box next to the statement that best describes how the supply and demand of the fractions change as the chain length increases. [1]

supply is greater than demand for all fractions

supply is greater than demand up to C₁₆ after which demand is greater than supply

demand is greater than supply up to C₁₆ after which supply is greater than demand

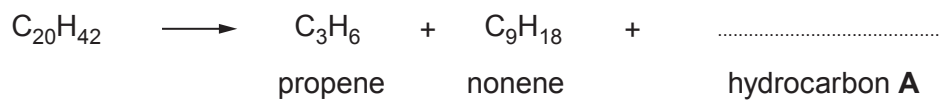
the difference between supply and demand increases up to C₁₆ after which it decreases



- (iii) Oil companies have solved the problem of over-supply of some fractions using a process called cracking.

The alkane $C_{20}H_{42}$ can be cracked forming propene, nonene and **one molecule** of hydrocarbon **A**.

- I. Complete the equation for the cracking of $C_{20}H_{42}$. [1]



- II. Propene is an important raw material in the production of polypropene.
Give the name of the process used to make polypropene from propene. [1]

.....



(c) Every year thousands of acres of forests are destroyed by wildfires. Fire-fighters use several different methods to put out this type of fire.



State **three** methods that are used to put out forest fires.

Give the part of the fire triangle being removed in each method.

Each method should refer to a different part of the fire triangle.

[3]

Method 1

Part of the fire triangle being removed

Method 2

Part of the fire triangle being removed

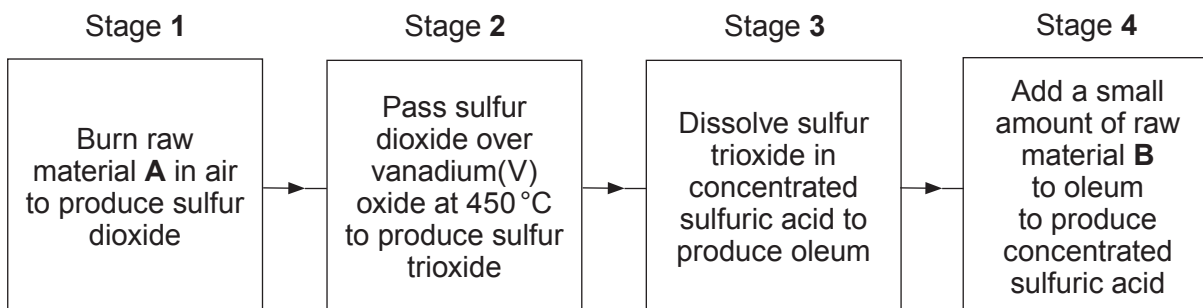
Method 3

Part of the fire triangle being removed

9



9. (a) Sulfuric acid is produced by the contact process. The flow diagram shows the main stages in the process.



- (i) Give the name of raw materials **A** and **B**. [2]

A

B

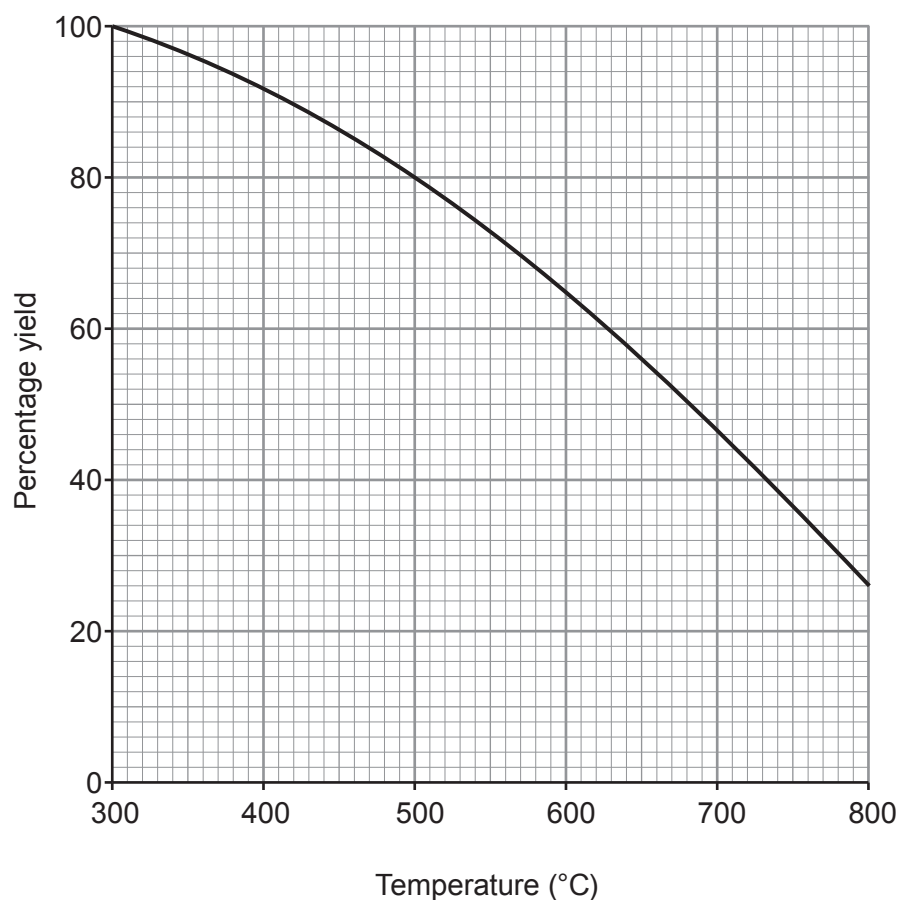
- (ii) State the purpose of vanadium(V) oxide in stage 2. [1]

.....

- (iii) Complete and balance the equation for the reaction in stage 2. [2]



- (iv) The graph shows how the percentage yield of sulfur trioxide changes with temperature between 300 °C and 800 °C.



Use the graph to answer parts I and II.

- I. State the trend in the percentage yield of sulfur trioxide as the temperature increases. [1]

- II. Give the temperature **range** to be used to obtain a yield of sulfur trioxide greater than 80%. [1]

..... to °C

- (v) One molecule of sulfur trioxide reacts with one molecule of sulfuric acid to form one molecule of oleum as the **only product**.

Complete the equation for this reaction by giving the formula of oleum. [1]



- (b) The photograph shows the exothermic reaction between concentrated sulfuric acid and sugar, $C_{12}H_{22}O_{11}$.



- (i) Name the **two** products formed. [2]
..... and
- (ii) State the type of reaction taking place. [1]
.....

END OF PAPER



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**

<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹ H Hydrogen 1 </div>												<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁴ He Helium 2 </div>																							
<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁹ Be Beryllium 4 </div>												<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹⁹ F Fluorine 9 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ²⁰ Ne Neon 10 </div>																					
<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ²³ Na Sodium 11 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ²⁴ Mg Magnesium 12 </div>										<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ³² S Sulfur 16 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ^{35.5} Cl Chlorine 17 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁴⁰ Ar Argon 18 </div>																			
<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ³⁹ K Potassium 19 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁴⁰ Ca Calcium 20 </div>										<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁷³ Ge Germanium 32 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁷⁵ As Arsenic 33 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁷⁹ Se Selenium 34 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁸⁰ Br Bromine 35 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁸⁴ Kr Krypton 36 </div>															
<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁸⁶ Rb Rubidium 37 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁸⁸ Sr Strontium 38 </div>										<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹¹⁵ In Indium 49 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹¹² Cd Cadmium 48 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹⁰⁸ Ag Silver 47 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹⁰⁶ Pd Palladium 46 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹⁰³ Rh Rhodium 45 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹⁰¹ Ru Ruthenium 44 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁹⁹ Tc Technetium 43 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁹⁶ Mo Molybdenum 42 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁹³ Nb Niobium 41 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁹¹ Zr Zirconium 40 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁸⁹ Y Yttrium 39 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ⁸⁷ Fr Francium 87 </div>	
<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹³³ Cs Caesium 55 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹³⁷ Ba Barium 56 </div>										<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ²⁰⁴ Tl Thallium 81 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ²⁰¹ Hg Mercury 80 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹⁹⁷ Au Gold 79 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹⁹⁵ Pt Platinum 78 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹⁹² Ir Iridium 77 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹⁸⁶ Os Osmium 76 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹⁸⁴ W Tungsten 74 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹⁸¹ Ta Tantalum 73 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹⁷⁹ Hf Hafnium 72 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹⁷⁵ Re Rhenium 75 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ¹⁷⁹ La Lanthanum 57 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ²²³ Fr Francium 87 </div>	
<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ²²⁷ Ac Actinium 89 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ²²⁶ Ra Radium 88 </div>										<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ²⁰⁷ Pb Lead 82 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ²⁰⁹ Bi Bismuth 83 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ²¹⁰ Po Polonium 84 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ²¹⁰ At Astatine 85 </div>		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ²²² Rn Radon 86 </div>															

Key

