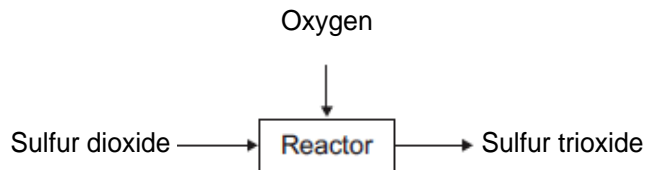
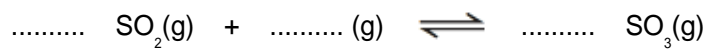


Q1. **Figure 1** represents a reaction in the production of sulfuric acid.

Figure 1



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



(2)

(b) The conditions can affect the rate of the reaction.

(i) The pressure of the reacting gases was increased.

State the effect of increasing the pressure on the rate of reaction.

Explain your answer in terms of particles.

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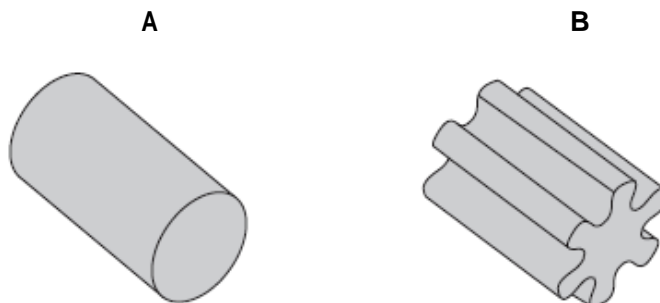
(3)

(ii) A catalyst is used for the reaction.

The gases pass through a layer containing pieces of the catalyst.

Figure 2 shows the shapes of pieces of catalyst.

Figure 2



Suggest and explain why shape **B** is more effective as a catalyst than shape **A**.

.....
.....
.....
.....

(2)

(c) The reaction is carried out at a high temperature to provide the reactants with the **activation energy**.

What is meant by the **activation energy**?

.....
.....
.....

(1)

(d) Sulfuric acid reacts with metals to produce salts.

(i) A student concluded that potassium would **not** be a suitable metal to react with sulfuric acid.

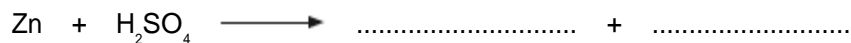
Explain why.

.....
.....
.....
.....

(2)

(ii) A student reacted zinc metal with sulfuric acid to produce a salt and another product.

Complete the equation for this reaction.



(2)

(iii) The student wanted to increase the rate of the reaction between the zinc and sulfuric acid.

State **one** way, other than using a catalyst, that the student could increase the rate of the reaction.

.....
.....

(1)

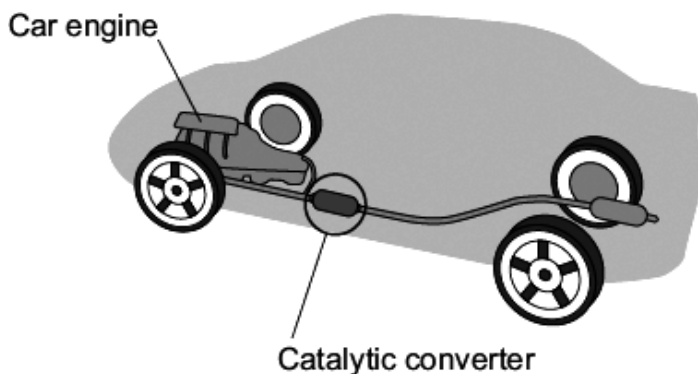
(Total 13 marks)

Q2. Read the information about car engines.

Burning petrol in air is an *exothermic* reaction. This reaction is used in car engines.

When petrol burns it produces harmful substances such as nitrogen oxides and carbon monoxide.

A catalytic converter stops these harmful substances being released into the air.

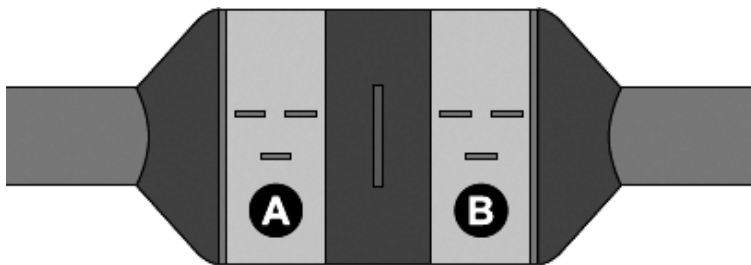


(a) The reaction is *exothermic*. What is the meaning of *exothermic*?

.....
.....

(1)

(b) The catalytic converter has two parts shown as **A** and **B** in the diagram.



Part **A** contains a catalyst made from platinum and rhodium.

Part **B** contains a catalyst made from platinum and palladium.

(i) Why are catalysts used in chemical reactions?

.....
.....

(1)

(ii) One reaction in part **A** is shown by this equation.



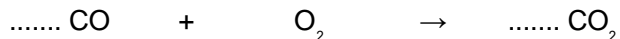
Suggest why this reaction helps the environment.

.....
.....

(1)

(iii) The equation for one of the reactions in part **B** is shown below.

Balance this equation.



(1)

(iv) The catalytic converter works for many years without replacing the catalyst.

Explain why the catalyst does not need to be replaced.

.....
.....

(1)

(v) Suggest why different catalysts are used in parts **A** and **B**.

.....
.....

(1)

- (c) Modern catalytic converters contain nanosized particles of catalyst. Using nanosized particles reduces the cost of the catalytic converter.

Suggest and explain why the use of nanosized catalyst particles reduces the cost of the catalytic converter.

Your answer should include information about the size and surface area of the particles.

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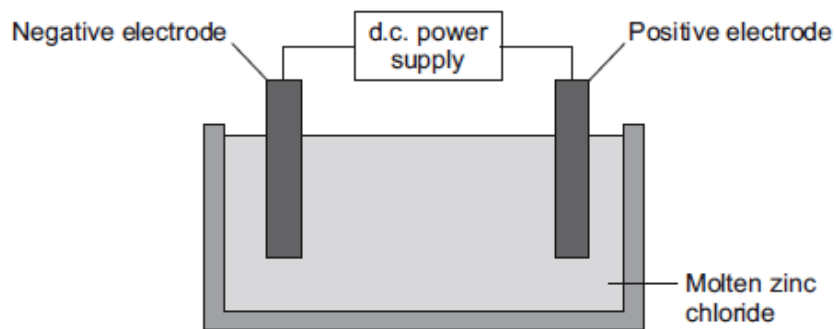
.....

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(3)
(Total 9 marks)

Q3. This question is about zinc and magnesium.

Zinc is produced by electrolysis of molten zinc chloride, as shown in the figure below.



- (a) (i) Why must the zinc chloride be molten for electrolysis?

.....

.....

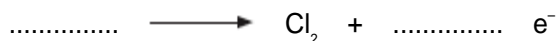
(1)

(ii) Describe what happens at the negative electrode.

.....
.....
.....
.....
.....
.....

(3)

(iii) Complete the half equation for the reaction at the positive electrode.



(1)

(b) Magnesium can be produced from magnesium oxide.

The equation for the reaction is:



(i) How can you tell from the equation that the reaction is done at a high temperature?

.....
.....

(1)

(ii) This reaction to produce magnesium from magnesium oxide is **endothermic**.

What is meant by an **endothermic** reaction?

.....
.....

(1)

(iii) A company made magnesium using this reaction.

Calculate the mass of magnesium oxide needed to produce 1.2 tonnes of magnesium.

Relative atomic masses (A_r): O = 16; Mg = 24

.....
.....
.....
.....

Mass of magnesium oxide needed = tonnes

(3)

- (iv) The company calculated that they would produce 1.2 tonnes of magnesium, but only 0.9 tonnes was produced.

Calculate the percentage yield.

.....

Percentage yield = %

(1)

- (v) Give **one** reason why the calculated yield of magnesium might not be obtained.

.....

(1)

(Total 12 marks)

Q4. Kelp is a seaweed.

Kelp can be used in foods and as a renewable energy source.



© Ethan Daniels/Shutterstock

- (a) Scientific experiments, on their own, **cannot** fully answer one of the following questions. Which one?

Tick (✓) **one** box.

Questions	Tick (✓)
How much carbon dioxide is produced when 100 g of kelp is burned?	
Does kelp give out more heat energy than coal?	
Will kelp last longer than coal as an energy source?	
Which fuel, kelp or coal, produces the most ash when burned?	

(1)

- (b) Scientists cannot answer the question 'should people use kelp instead of coal as an energy source?'

Give **two** reasons why.

.....
.....
.....
.....

(2)

- (c) Sodium iodide can be produced from kelp.

- (i) How many electrons are in the outer shell of an iodine atom?

(1)

- (ii) Sodium iodide contains sodium ions (Na^+) and iodide ions (I^-).

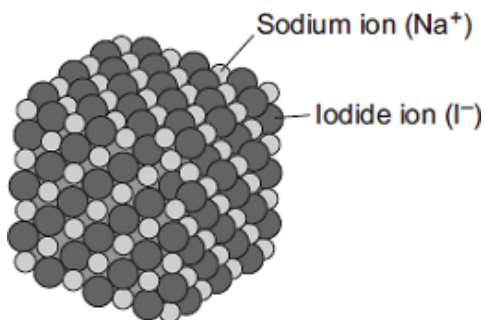
Describe, as fully as you can, what happens when sodium atoms react with iodine atoms to produce sodium iodide.

You may use a diagram in your answer

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(3)

(iii) The diagram shows the structure of sodium iodide.



Solid sodium iodide does not conduct electricity.

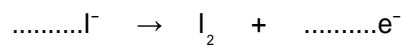
Why does sodium iodide solution conduct electricity?

.....
.....

(1)

(iv) When sodium iodide solution is electrolysed, iodine is formed at the positive electrode.

Complete and balance the half equation for the formation of iodine.



(1)

(v) What is formed at the negative electrode when sodium iodide solution is electrolysed?

Explain why.

.....
.....
.....
.....

(2)

(Total 11 marks)

Q5. This question is about calcium hydroxide.

Ancient artworks and monuments can be protected from acid rain if the surface is sprayed with calcium hydroxide nanoparticles.



By Svilen Enev (Own work) [GFDL or CC-BY-SA-3.0], via Wikimedia Commons

(a) Calcium hydroxide has the formula $\text{Ca}(\text{OH})_2$

Why are there two hydroxide ions for each calcium ion in the formula?

.....
.....
.....

(1)

(b) The calcium hydroxide is used in the form of *nanoparticles*.

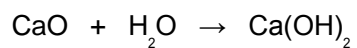
What are *nanoparticles*?

.....
.....

(1)

(c) A student added water to calcium oxide to make calcium hydroxide.

The equation for the reaction is shown below.



Calculate the maximum mass of calcium hydroxide which could be made from 2.00 g of calcium oxide.

Relative atomic masses (A_r): H = 1; O = 16; Ca = 40.

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.....

Maximum mass of calcium hydroxide = g

(3)
(Total 5 marks)

Q6. Read the article.

Problem food colourings

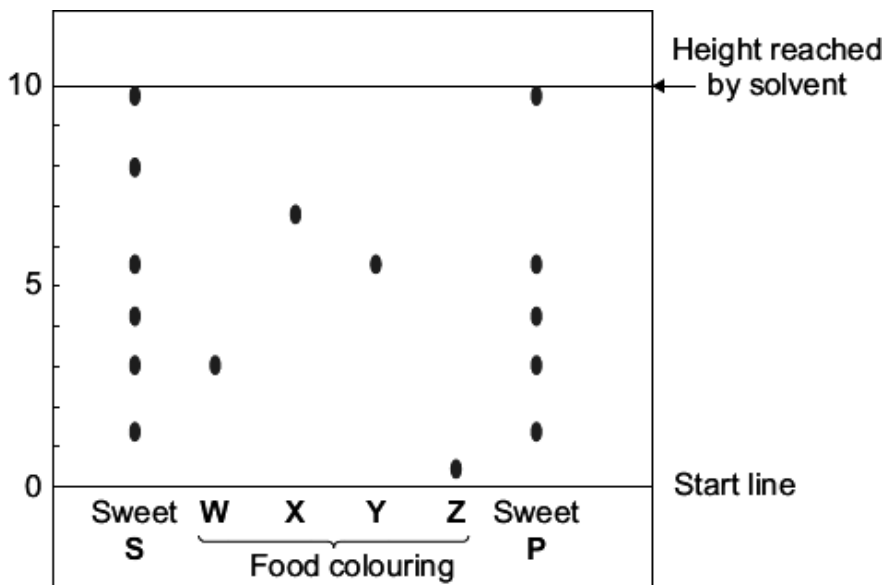
Scientists say they have evidence that some food colourings cause hyperactive behaviour in young children.

These food colourings are added to some sweets.

W, X, Y and Z are food colourings that may cause hyperactive behaviour in young children.

A scientist used chromatography to see if these food colourings were used in two sweets, S and P.

The results are shown on the chromatogram.



(a) Food colourings, such as W, X, Y and Z, are added to some sweets.

Suggest **one** reason why.

.....
.....

(1)

(b) In chromatography, the R_f value = $\frac{\text{distance moved by the colouring}}{\text{distance moved by the solvent}}$

Use the scale on the chromatogram to help you to answer this question.

Which food colouring, W, X, Y or Z, has an R_f value of 0.7?

(1)

- (c) From the chromatogram, what conclusions can the scientist make about the colourings in sweets **S** and **P**?

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.....

.....

(3)
(Total 5 marks)

Q7. The article gives some information about maple syrup.

Maple Syrup – New Superfood!



© Picsfive/iStock

Scientists analysed the syrup from maple trees. They have identified some new compounds. These compounds could be used to treat diabetes and bacterial infections.

- (a) One new compound identified in maple syrup is Quebecol.

Some scientists tried to produce Quebecol in their laboratory. The scientists produced a mixture containing two compounds, **A** and **B**.

The table shows the percentage by mass of carbon in the two compounds the scientists produced.

Compound	Percentage by mass of carbon (%)
A	74.2
B	67.6

Quebecol has the formula $C_{24}H_{26}O_7$

The relative formula mass (M_r) of Quebecol is 426.

Relative atomic mass (A_r): C = 12.

Use the data to show that compound **B** is Quebecol.

You must show your working.

.....
.....
.....

(1)

- (b) Scientists separated another compound from the maple syrup.

The compound contained:

5.65 g carbon (C); 2.20 g nitrogen (N); 0.629 g hydrogen (H).

Calculate the empirical formula of the compound.

To gain full marks you must show your working.

Relative atomic masses (A_r): H = 1; C = 12; N = 14.

.....
.....
.....
.....
.....
.....
.....

Empirical formula =

(4)
(Total 5 marks)

M1.	(a)	O_2 in correct space	1
		correct balancing	
		<i>accept multiples</i>	1
	(b)	(i) rate increases	
		<i>incorrect reference to energy = max 2</i>	
		<i>ignore references to equilibrium</i>	1
		because particles are closer together	
		<i>accept because there are more particles (per unit volume)</i>	
		<i>allow particles have less space / room to move around</i>	1
		so frequency of collisions increases	
		<i>accept particles are more likely to collide</i>	
		<i>ignore more collisions</i>	
		<i>ignore more successful collisions</i>	1
		(ii) has a greater surface area	
		<i>so the reaction is faster</i>	
		<i>accept so more frequent collisions</i>	1
	(c)	the (minimum) amount of energy (particles must have) to react or to start a reaction	
		<i>accept the energy needed to break bonds</i>	
		<i>ignore references to heat</i>	1
	(d)	(i) (potassium is) too / very reactive	
		<i>ignore potassium is a Group 1 / alkali metal</i>	1
		so dangerous / violent reaction	
		<i>accept hydrogen produced rapidly</i>	1
		(ii) $ZnSO_4$	
		<i>accept products in either order</i>	
		<i>ignore names of substances</i>	1
		H_2	
		<i>do not accept brackets or charges in the formulae</i>	1
		(iii) any one from:	
		• increase concentration (of sulfuric acid)	
		• increase temperature or heat it	
		• increase surface area of zinc	1

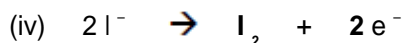
- M2.** (a) gives out heat / energy
allow release / loses
allow the products have less energy
- or**
- energy / heat transferred to the surroundings
ignore temperature rises
allow more energy given out in forming bonds than taken in to break bonds
- 1
- (b) (i) speed up the reaction (owtte)
accept changes the rate
accept lowers activation energy
accept increases successful collisions
accept allows reaction to take place at a lower temperature
- 1
- (ii) nitrogen (N₂) / oxygen (O₂) / products are safe **or** not harmful / pollutant / toxic / dangerous / damaging
ignore releases nitrogen / oxygen unless qualified
- or**
- (harmful) nitrogen monoxide / NO is not released into the air.
accept prevents / less acid rain
ignore greenhouse gas / ozone layer
- 1
- (iii) 2 and 2
accept correct multiples or fractions
- 1
- (iv) idea of catalyst not being used up
allow not changed by reaction
ignore catalyst does not take part
ignore catalyst not used in the reaction
- 1
- (v) idea of different reactions (require different catalysts)
accept catalysts work for specific reactions
allow different gases
- 1
- (c) • smaller / very small / or any indication of very small / 1–100 nanometres / a few (hundred) atoms
ignore just small
ignore size of the converter
- 1

- big(ger) surface area 1
- less (catalyst) needed / small amount of catalyst needed 1

[9]

- M3.**
- (a) (i) so ions can move (and carry charge) 1
accept so current can flow
allow so it can conduct (electricity)
allow so charged particles can move
*do **not** accept so electrons can move*
- (ii) because zinc ions gain electrons 1
accept because zinc ions are reduced
- 2 (electrons) 1
- zinc is formed 1
accept correct half equation for 3 marks
if no mark gained allow
*positive ions go to negative electrode **or***
*opposites attract **or***
*reduction (of zinc) **or***
(zinc) gains electrons for 1 mark
- (iii) $2 \text{Cl}^- \longrightarrow \text{Cl}_2 + 2 \text{e}^-$ 1
must be completely correct
- (b) (i) because the magnesium is a gas 1
allow magnesium goes from solid to gas
- (ii) (a reaction which) takes in energy (from the surroundings) 1
accept more energy needed to break bonds than released by forming bonds
accept correct reference to energy level diagram
allow (a reaction which) takes in heat (from the surroundings)
- (iii) ($M_r \text{MgO} =$) 40 1
accept ($2 M_r \text{MgO} =$) 80
- 1.2 / 24 (x40) **or** 0.05 (x40)
- or**
- 40 / 24 (x1.2) **or** 1.67 (x1.2)

	<i>allow ecf from step 1</i>	1
	2(.0)	
	<i>allow ecf carried through from step 1</i>	
	<i>correct answer with or without working gains 3 marks</i>	1
(iv)	75(%)	1
(v)	any one from:	
	• the reaction is reversible	
	<i>accept incomplete reaction</i>	
	<i>ignore equilibrium not reached</i>	
	• <i>some lost / escaped / released (when separated)</i>	
	• some of the reactant may react in different ways from the expected reaction	
	• <i>impure reactant(s)</i>	
	<i>ignore measurement and calculation errors</i>	1
		[12]
M4.	(a) Will kelp last longer than coal as an energy source?	1
	(b) any two from:	
	• cannot be determined by experiment	
	<i>allow can't predict how long kelp / coal will last</i>	
	<i>allow more testing needed</i>	
	• based on opinion	
	• ethical or environmental or economic reason	
	<i>allow could damage ecosystem allow reference to cost</i>	2
(c)	(i) 7	1
	(ii) sodium (atom) loses (electron) and iodine (atom) gains (an electron)	
	<i>reference to incorrect bonding or incorrectly named particle</i>	
	<i>= max 2</i>	
	<i>any or all marks can be obtained from a labelled diagram</i>	
	<i>ignore inner shell electrons if shown</i>	1
	1 electron	1
	(electrostatic) attraction or forms ionic bond(s)	1
	(iii) <u>ions</u> can move (in the solution)	1



1

(v) hydrogen is formed

1

because sodium is more reactive (than hydrogen)

1

[11]

M5. (a) because calcium is +2 and hydroxide is -1
accept to balance the charges

or

to make the compound neutral (in terms of charges)

allow calcium needs to lose 2 electrons and hydroxide needs to gain one electron

1

(b) particles of size 1-100 nm
allow clear comparison to 'normal' size particles

or particles with a few hundred atoms / ions

or particles with a high surface area (to volume ratio)

or as different properties to 'normal' size particles of the same substance

1

(c) $M_r \text{CaO} = 56$
and

$M_r \text{Ca(OH)}_2 = 74$

1

$2/56$ (x74) **or** 0.036 (x74)

or

allow ecf from step 1

$74/56$ (x2) **or** $1.3(214\dots)$ (x2)

1

$2.6(428\dots)$ in range 2.6 to 2.96

correct answer with or without working gains 3 marks

allow ecf carried through from step 1

ignore final rounding to 3

1

[5]

M6. (a) (improve) appearance
allow add colour
allow these food colourings have not been proven to cause hyperactive behaviour in young children
*do **not** accept taste / flavour / preservatives*
ignore reference to E-numbers 1

(b) X 1

(c) any **three** from:

- S contains six / 6 colourings
- P contains five / 5 colourings
if neither of first 2 bullet points given allow 1 mark for S contains more colours than P or converse
- both S and P contain the same
 five / 5 colourings
- both contain W **and** Y
- both sweets (may) cause hyperactivity
ignore unsafe
- neither contain X **and** Z

3

[5]

M7. (a) $\frac{(24 \times 12)}{426} \times 100 = 67.6$

or

$426 \times (67.6 / 100) = 288$
 $288 / 12 = 24$ 1

(b) 5.65 / 12 2.2 / 14 0.629 / 1
correct answer of C₃NH₄ with no working scores 2 marks 1

0.471 0.157 0.629
allow ecf from mp2 onwards 1

3

1

4

if the ratios are not shown but the correct working is shown for mp1 and mp2 , the ratio mark can be scored from C_3NH_4

1



if the initial fractions are inverted and the candidate gets an answer of $C_4N_{12}H_3$ award 2 marks

1

[5]

