



## SAMPLE ASSESSMENT TASKS

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**CHEMISTRY**  
**GENERAL YEAR 12**

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## Sample assessment task

### Chemistry – General Year 12

#### Task 2 – Unit 3

**Assessment type:** Extended response

**Conditions**

Period allowed for completion of the task: three weeks; a combination of in-class and out-of-class work for the research component with a validation task at the end

**Task weighting**

10% of the school mark for this pair of units

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#### Comparing biofuels and hydrocarbon fuels

(40 marks)

Concerns over the contribution from combustion of fossil fuels to increased carbon dioxide levels in the atmosphere and dwindling supplies of crude oil have prompted research into, and use of, biofuels to replace hydrocarbons derived from crude oil.

In this task, you will research the:

- energy involved in the production and combustion of petrol, biodiesel and ethanol, and compare their use as fuels on the basis of energy
- carbon dioxide output from the combustion of petrol, biodiesel and ethanol
- industrial production of ethanol by fermentation
- issues surrounding the growing of crops for the production of ethanol for fuel.

#### What to do

1. Working in pairs, research the information detailed below and prepare a report on the information researched. Each person will need to prepare a report.
2. After carrying out your research, you will answer a set of in-class validation questions on the topic. This will be done on an individual basis. You may have a copy of your report to assist in answering the questions.

#### Energy from fuels

- Determine the amount of energy released by the burning of 1 kg of
  - petrol
  - ethanol
  - biodiesel.
- Comment on the value of each of these substances as fuel sources in terms of their energy output.

When considering the value of a substance as a fuel source, more than just its energy output needs to be considered. The amount of energy used to produce the fuel, often referred to as the **energy returned on energy invested (EROEI)**, also needs to be considered.

- Compare the energy returned on energy invested (EROEI) for petrol (gasoline), bioethanol and biodiesel (clearly indicate the source of the ethanol and source of biodiesel).
- Comment on the value of each of these substances as fuel sources in terms of the EROEI.

### **Carbon dioxide from fuels**

- Determine and compare the amount of carbon dioxide released by the burning of petrol, ethanol and biodiesel from vegetable oil. Indicate clearly the units you are using for your comparison; for example, you could compare the mass of carbon dioxide released for each kilogram of fuel combusted, or you could use the mass of carbon dioxide released per litre of fuel.
- Comment on the value of each of these substances as fuel sources in terms of their carbon dioxide output.
- Explain why the combustion of petrol, and other fossil fuels, adds to the amount of carbon dioxide in the atmosphere while burning of biofuels such as biodiesel and bioethanol does not add to the amount of carbon dioxide in the atmosphere over the long term.

### **Ethanol production by fermentation**

- Describe the steps in the industrial production of ethanol through fermentation. In your description
  - identify the raw material used and how it is treated
  - explain what happens at each step to eventually produce ethanol
  - name the substances used or produced in each step
  - explain and describe the type of respiration used in the fermentation.

### **Issues around growing crops for ethanol production**

- Identify and discuss the potential problems around the growing of crops for ethanol production.
- Describe any solutions that are being investigated to address these problems.

### **Referencing**

Give references for the sources you use to get your information (you must use at least **three** resources). For any websites, give the date you accessed it and, if possible, its author or the organisation responsible for its publication.

**Biofuels and Hydrocarbon fuels****(40 marks)****In-class validation questions**

Use the information you have researched about fuels to answer the following questions. You may use the report you have prepared to assist in answering the validation questions.

1. Complete the table below to show the energy and carbon dioxide outputs associated with the listed fuels. (12 marks)

Fuel	Source (raw material)	Energy produced per kg of fuel combusted (show energy units)	Energy returned on energy invested	CO <sub>2</sub> produced per unit of fuel combusted (show units)
Petrol				
Biodiesel				
Bioethanol				

2. Why does the combustion of petrol (and other fossil fuels) add to the amount of carbon dioxide in the atmosphere whilst burning of biofuels such as biodiesel and bioethanol does not add to the amount of carbon dioxide in the atmosphere over the long term? (3 marks)

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3. Draw a flow diagram showing the steps in the production of ethanol by fermentation. Include labels to clearly state the purpose of each step in the process. (6 marks)

4. Describe the raw material for your ethanol production process and describe how it is first treated. State the reason it is treated in this way in the process to produce ethanol. (4 marks)

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5. Give the name and chemical formula for the compound that the yeast directly ferments to produce ethanol. (2 marks)

Name \_\_\_\_\_

Chemical formula \_\_\_\_\_

6. What type of respiration does the yeast undergo in the fermentation process to produce the ethanol? What other compound is produced in this type of respiration? (2 marks)

Type of respiration \_\_\_\_\_

Compound produced (other than ethanol) \_\_\_\_\_

7. Describe **one** problem with using a crop food as a raw material in the fermentation process for the production of ethanol. (2 marks)

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8. Describe **one** way in which the problem you have described in question 7 may be solved. (2 marks)

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9. On the basis of your research, which of petrol, biodiesel and bioethanol would you recommend as a fuel? Explain your choice. (3 marks)

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10. Give the references for the sources you used to get your information. (4 marks)

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## Marking key for sample assessment task 2 – Unit 3

1. Complete the table below to show the energy and carbon dioxide outputs associated with the listed fuels.

Description				Marks
1 mark for each cell in the table				1–12
<b>Total</b>				<b>/12</b>
<b>Answer could include, but is not limited to:</b>				
Fuel	Source	Energy produced per kg of fuel combusted (show energy units)	Energy returned on energy invested	CO <sub>2</sub> produced per unit of fuel combusted (show units)
Petrol	Fossil fuel (crude oil)	About 40–45 MJ/kg	~5-30	3.3 kg CO <sub>2</sub> /kg of fuel
Biodiesel	Vegetable oil	About 40–45 MJ/kg	~1.3	2.5 kg CO <sub>2</sub> /kg of fuel
Bioethanol	Corn, grains, sugar cane, cellulosic biomass etc.	About 25–30 MJ/kg	~1.3 (corn) ~5 (sugar cane)	1.9 kg CO <sub>2</sub> /kg of fuel
<p><b>Note:</b> Values for the energy produced per kg of fuel, EROEI and CO<sub>2</sub> may vary to quite a degree depending on source of information. Note also the CO<sub>2</sub> given here is not a carbon intensity value (i.e. it is essentially a chemistry value based on the combustion equation).</p>				

2. Why does the combustion of petrol (and other fossil fuels) add to the amount of carbon dioxide in the atmosphere whilst burning of biofuels such as biodiesel and bioethanol does not add to the amount of carbon dioxide in the atmosphere over the long term?

Description	Marks
For petrol: <ul style="list-style-type: none"> <li>combustion of petrol, a fossil fuel, releases carbon (in the form of CO<sub>2</sub>) that has been out of the carbon cycle for millions of years</li> </ul>	1
For biofuels: <ul style="list-style-type: none"> <li>the carbon in biofuels has been a part of the carbon cycle i.e. the C in biofuels comes from CO<sub>2</sub> that has been taken from the atmosphere</li> <li>when burnt, it is returning the CO<sub>2</sub> to the atmosphere but not adding additional CO<sub>2</sub></li> </ul>	1 1
<b>Total</b>	<b>/3</b>

3. Draw a flow diagram showing the steps in the production of ethanol by fermentation. Include labels to clearly state the purpose of each step in the process.

Description	Marks
Initial steps in process are appropriate to the raw material	1
Step for formation of simple (fermentable) sugars included	1
Fermentation indicates use of yeast	1
Distillation step included	1
Labelling makes it clear what each step involves	1–2
<b>Total</b>	<b>/6</b>
<b>Answer could include, but is not limited to:</b>	
<p><b>Note:</b> Steps in flow chart may vary depending on the raw material students have chosen for their research</p> <p>For cellulosic starting material, possible steps may include: Pre-treatment to break down cellulosic material → enzyme hydrolysis to convert cellulose (and hemicellulose) to simple sugars → fermentation by yeast to convert sugars to ethanol → distillation to remove ethanol from fermentation broth</p> <p>For corn, starting material possible steps may include: Milling to grind the corn to powder → liquefaction with enzyme to liquefy the starch → saccharification with further enzymes to convert starch to fermentable sugars → fermentation by yeast to convert sugars to ethanol → distillation to remove ethanol from fermentation broth</p>	

4. Describe the raw material for your ethanol production process and describe how it is first treated. State the reason it is treated in this way in the process to produce ethanol.

Description	Marks
Description of raw material	1
Description of initial treatment of raw material	1–2
Reason for treatment of raw material	1
<b>Total</b>	<b>/4</b>
<b>Answer could include, but is not limited to:</b>	
<p><b>Note:</b> there are a variety of raw materials that may be used to produce ethanol through fermentation and initial treatment will vary according to the raw material</p> <p>For cellulosic starting material:</p> <ul style="list-style-type: none"> <li>raw material can be structural portions from a range of plants that are not typically used directly for food or are not directly fermentable</li> <li>initial treatment may involve steps to remove some of the lignin in the biomass and reduce the particle size. This may involve treatment with acid, alkali, organic solvent, heat treatment, steam explosion</li> <li>treatment is required primarily to release cellulose so that it can be hydrolysed to simple sugars</li> </ul> <p>For corn:</p> <ul style="list-style-type: none"> <li>the initial step may be dry milling to grind the corn to small particle size</li> <li>treatment is required primarily to release starches so that it can be hydrolysed to simple sugars</li> </ul> <p>For wet milled corn, the initial step is to soak the whole corn kernel in water and dilute sulfuric acid for 24–48 hours. This is done to allow separation of the corn into its components.</p>	

5. Give the name and chemical formula for the compound that the yeast directly ferments to produce ethanol.

Description	Marks
Name of fermentable sugar	1
Chemical formula	1
<b>Total</b>	<b>/2</b>
<b>Answer could include, but is not limited to:</b>	
fermentable sugar may include sucrose (C <sub>12</sub> H <sub>22</sub> O <sub>11</sub> ), glucose (C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> ), fructose (C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> )	

6. What type of respiration does the yeast undergo in the fermentation process to produce the ethanol? What other compound is produced in this type of respiration?

Description	Marks
Anaerobic respiration	1
Carbon dioxide	1
<b>Total</b>	<b>/2</b>

7. Describe **one** problem with using a crop food as a raw material in the fermentation process for the production of ethanol.

Description	Marks
Description of problem – states problem and expands on how it is problematic	1–2
<b>Total</b>	<b>/2</b>
<b>Answer could include, but is not limited to:</b>	
<ul style="list-style-type: none"> <li>the food may otherwise be used to feed people so diverting it from this purpose may contribute to under-nourishment</li> <li>this may be particularly important in developing countries that may divert crop foods to ethanol production for supply to developed countries to try to get export revenue</li> <li>the use of farm land to produce fuel crops that could otherwise be used to grow food crops may also contribute to food shortages</li> <li>potential for deforestation to provide additional land to grow crops for ethanol production or to use the woody material for cellulosic biomass</li> </ul>	

8. Describe **one** way in which the problem you have described in question 7 may be solved.

Description	Marks
Description of solution	1–2
<b>Total</b>	<b>/2</b>
<b>Answer could include, but is not limited to:</b>	
<ul style="list-style-type: none"> <li>• replacement with a cellulosic biomass source from plant material not otherwise used as food may address the problem of diverting food crops to fuel production</li> <li>• using algae as source of liquid hydrocarbon biofuel instead of ethanol. There is research going into the use of algae on a commercial scale to produce hydrocarbons. Algal ponds can be used on land that would otherwise not be suitable for crop farming so not affecting food production. Algae can also use farm run-off water that may have fertiliser in it</li> </ul>	

9. On the basis of your research, which of petrol, biodiesel and bioethanol would you recommend as a fuel? Explain your choice.

Description	Marks
States a fuel	1
Explanation of choice	1–2
<b>Total</b>	<b>/3</b>
<b>Answer could include, but is not limited to:</b>	
<p>Choice of petrol may be for reasons such as:</p> <ul style="list-style-type: none"> <li>• more energy produced on its combustion</li> <li>• energy returned on energy invested the best of the three fuels examined</li> <li>• currently difficult to supply enough liquid hydrocarbon fuels from sustainable sources to meet demand</li> </ul> <p>Choice of biofuel may be for reasons such as:</p> <ul style="list-style-type: none"> <li>• CO<sub>2</sub> output is less than for petrol so reduced contribution to greenhouse effect</li> <li>• does not add new carbon to the carbon cycle (i.e. there is no net increase in atmospheric CO<sub>2</sub>)</li> <li>• (where EROEI is greater than 1) can be sustainably produced</li> </ul>	

10. Give the references for the sources you used to get your information.

Description	Marks
At least three references provided	1–3
Referencing is clear, enabling sources to be checked	1
<b>Total</b>	<b>/4</b>

## Sample assessment task

### Chemistry – General Year 12

#### Task 9 – Unit 4

Assessment type: Test

**Conditions**

Time for the task: 50 minutes

**Task weighting**

5% of the school mark for this pair of units

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## Test

**Metal properties and structure and Alloys****(45 marks)****Recommended time: 50 minutes**

Where needed, use the periodic table provided.

Write your answers in the space provided on the paper.

1. Draw a diagram to represent the way atoms and their outer electrons are arranged in metals.  
Label the diagram appropriately. (3 marks)

2. Explain what it is about the way in which metals bond that makes them generally good conductors of electricity. (2 marks)

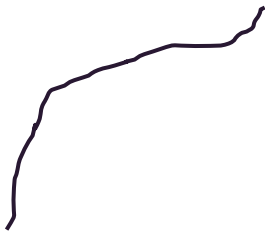
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3. Examine the set of electrical equipment below to answer the questions that follow.



Electrical wires



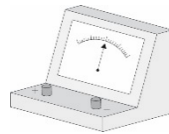
Battery



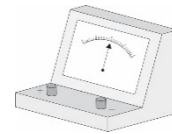
Metal samples



Light globe



Ammeter



Voltmeter



- (a) Select the equipment needed to compare the electrical conductivity of the metal samples and draw a diagram to show how the equipment should be connected to form a circuit to measure their electrical conductivity. (2 marks)

- (b) Explain why the metal samples represented in the diagram are not appropriate for this experiment? (2 marks)

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4. Classify the following elements as metal, non-metal or metalloid by placing the name or symbol of the element in the appropriate cell of the table below. (8 marks)

Oxygen (O)                      Boron (B)                      Potassium (K)                      Polonium (Po)  
Helium (He)                      Hydrogen (H)                      Strontium (Sr)                      Thallium (Tl)

Metal	Non-metal	Metalloid

5. The ways in which metals (or alloys) are used is related to their properties.

(a) For the metals listed in the table below, give a use and its related property. (8 marks)

Metal	Use	Property related to use
Copper		
Iron		
Zinc		
Aluminium		

- (b) For the uses listed in the table below, give a metal and its related property. You need to choose different metals than those given in question 5 (a). (6 marks)

Use	Metal	Related property
Kitchen washing sink		
Jewellery		
Food cans		

6. The ability of metals to produce coloured flames allows them to be used in fireworks. For the metal salts used in fireworks in the table below, give the colour produced when the metal salt is heated in a flame. (4 marks)

Metal salt	Colour
Barium chloride	
Sodium nitrate	
Calcium chloride	
Lithium carbonate	



7. Oxides and other compounds of the first row transition metals often provide the colour in the glazing of pottery. For the transition metal ions in the table below (compounds typically used in glazing are indicated in brackets), give their typical colours. (4 marks)

Transition metal ion	Colour
Copper(II), $\text{Cu}^{2+}$ (in $\text{CuO}$ , $\text{CuCO}_3$ )	
Cobalt (II), $\text{Co}^{2+}$ (in $\text{CoAl}_2\text{O}_4$ )	
Iron(III), $\text{Fe}^{3+}$ (in $\text{Fe}_2\text{O}_3$ )	
Iron(II), $\text{Fe}^{2+}$ (in $\text{FeF}_2$ )	

8. Iron can be mixed with carbon to form steel alloys. Steels can be classified as low carbon or high carbon. Low-carbon steels have approximately 0.05%–0.3% carbon and are generally ductile (can be drawn into wires) and malleable (easily bent) but not very strong and hard. High-carbon steels have approximately 0.9%–2.5% carbon and are strong and hard.

Identify the type of steel that would be most suitable for making:

- (a) a pruning saw for cutting tree branches in the garden. Explain your choice of steel type. (2 marks)

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- (b) railings for stairs. Explain your choice of steel type. (2 marks)

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9. The main metals in the alloy bronze are copper and tin. When bronze was first developed, bronze objects became more popular than copper objects because it is more durable and harder. The durability of bronze is because it does not readily oxidise (rust).

Explain why bronze is slow to oxidise.

(2 marks)

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## Marking key for sample assessment task 9 – Unit 4

1. Draw a diagram to represent the way atoms and their outer electrons are arranged in metals. Label the diagram appropriately.

Description	Marks
Cations in layered rows	1
Valence electrons represented, scattered between cations and layers	1
Clear labels	1
<b>Total</b>	<b>/3</b>
<b>Answer could include, but is not limited to:</b>	

2. Explain what it is about the way in which metals bond that makes them generally good conductors of electricity.

Description	Marks
Their valence electrons are delocalised	1
Valence electrons are free to move through the solid lattice of cations, carrying their negative charge	1
<b>Total</b>	<b>/2</b>

3. Examine the set of electrical equipment below to answer the questions that follow.
- (a) Select the equipment needed to compare the electrical conductivity of the metal samples and draw a diagram to show how the equipment should be connected to form a circuit to measure their electrical conductivity.

Description	Marks
Selects correct equipment – wires, battery, ammeter, metal samples	1
Diagram shows components correctly connected in series	1
<b>Total</b>	<b>/2</b>

- (b) Explain why the metal samples represented in the diagram are not appropriate for this experiment?

Description	Marks
Metal samples differ in size so it is not a fair test	1
For results to be valid, size of samples must be the same so that any differences in conductivity of the tested metals are due only to the types of metal (and not differences in size) (i.e. size of metal should be a controlled variable)	1
<b>Total</b>	<b>/2</b>

4. Classify the following elements as metal, non-metal or metalloid by placing the name or symbol of the element in the appropriate cell of the table below.

Oxygen (O)                      Boron (B)                      Potassium (K)                      Polonium (Po)  
Helium (He)                      Hydrogen (H)                      Strontium (Sr)                      Thallium (Tl)

Metal	Non-metal	Metalloid
Potassium Strontium Thallium	Oxygen Boron Helium Hydrogen	Polonium

Description	Marks
One mark for each element as in the table above	1-8
<b>Total</b>	<b>/8</b>

5. The ways in which metals (or alloys) are used is related to their properties.

- (a) For the metals listed in the table below, give a use and its related property.

Description	Marks															
One mark for each appropriate use	1-4															
One mark for each property related to use	1-4															
<b>Total</b>	<b>/8</b>															
<b>Answer could include, but is not limited to:</b>																
<table border="1"> <thead> <tr> <th>Metal</th> <th>Use</th> <th>Property related to use</th> </tr> </thead> <tbody> <tr> <td>Copper</td> <td>Electrical wiring</td> <td>Good conductor electricity</td> </tr> <tr> <td>Iron</td> <td>Construction material</td> <td>Hard (when alloyed)</td> </tr> <tr> <td>Zinc</td> <td>Galvanising steel</td> <td>Provides protective layer to slow corrosion of underlying iron</td> </tr> <tr> <td>Aluminium</td> <td>Window frames</td> <td>Forms protective oxide layer so does not corrode (or light weight)</td> </tr> </tbody> </table>	Metal	Use	Property related to use	Copper	Electrical wiring	Good conductor electricity	Iron	Construction material	Hard (when alloyed)	Zinc	Galvanising steel	Provides protective layer to slow corrosion of underlying iron	Aluminium	Window frames	Forms protective oxide layer so does not corrode (or light weight)	
Metal	Use	Property related to use														
Copper	Electrical wiring	Good conductor electricity														
Iron	Construction material	Hard (when alloyed)														
Zinc	Galvanising steel	Provides protective layer to slow corrosion of underlying iron														
Aluminium	Window frames	Forms protective oxide layer so does not corrode (or light weight)														

- (b) For the uses listed in the table below, give a metal and its related property. You need to choose different metals than those given in question 5 (a) above.

Description	Marks												
One mark for each appropriate metal	1-3												
One mark for each reason related to use	1-3												
<b>Total</b>	<b>/6</b>												
<b>Answer could include, but is not limited to:</b>													
<table border="1"> <thead> <tr> <th>Use</th> <th>Metal</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>Kitchen washing sink</td> <td>Stainless steel</td> <td>Does not corrode</td> </tr> <tr> <td>Jewellery</td> <td>Gold</td> <td>Malleable, ductile, shiny (only one answer needed)</td> </tr> <tr> <td>Food cans</td> <td>Tin (steel)</td> <td>Reduces corrosion of underlying steel (malleable)</td> </tr> </tbody> </table>	Use	Metal	Reason	Kitchen washing sink	Stainless steel	Does not corrode	Jewellery	Gold	Malleable, ductile, shiny (only one answer needed)	Food cans	Tin (steel)	Reduces corrosion of underlying steel (malleable)	
Use	Metal	Reason											
Kitchen washing sink	Stainless steel	Does not corrode											
Jewellery	Gold	Malleable, ductile, shiny (only one answer needed)											
Food cans	Tin (steel)	Reduces corrosion of underlying steel (malleable)											

6. The ability of metals to produce coloured flames allows them to be used in fireworks. For the metal salts used in fireworks in the table below, give the colour produced when the metal salt is heated in a flame.

Description		Marks
One mark for each colour		1–4
<b>Total</b>		<b>/4</b>
<b>Answer could include, but is not limited to:</b>		
Metal salt	Colour	
Barium chloride	green	
Sodium nitrate	yellow	
Calcium chloride	orange	
Lithium carbonate	red	

7. Oxides and other compounds of the first row transition metals often provide the colour in the glazing of pottery. For the transition metal ions in the table below (compounds typically used in glazing are indicated in brackets), give their typical colours.

Description		Marks
One mark for each colour		1–4
<b>Total</b>		<b>/4</b>
<b>Answer could include, but is not limited to:</b>		
Transition metal ion	Colour	
Copper(II), $\text{Cu}^{2+}$ (in $\text{CuO}$ , $\text{CuCO}_3$ )	green/blue	
Cobalt (II), $\text{Co}^{2+}$ (in $\text{CoAl}_2\text{O}_4$ )	blue	
Iron(III), $\text{Fe}^{3+}$ (in $\text{Fe}_2\text{O}_3$ )	red/browns/ shades of yellow	
Iron(II), $\text{Fe}^{2+}$ (in $\text{FeF}_2$ )	green	

8. Iron can be mixed with carbon to form steel alloys. Steels can be classified as low carbon or high carbon. Low-carbon steels have approximately 0.05%–0.3% carbon and are generally ductile (can be drawn into wires) and malleable (easily bent) but not very strong and hard. High-carbon steels have approximately 0.9%–2.5% carbon and are strong and hard.

Identify the type of steel that would be most suitable for making:

- (a) a pruning saw for cutting tree branches in the garden. Explain your choice of steel type

Description		Marks
High-carbon steel		1
The blade needs to be hard to cut through the wood		1
<b>Total</b>		<b>/2</b>

(b) railings for stairs. Explain your choice of steel type.

Description	Marks
Low-carbon steel	1
This type of steel is malleable, allowing it to be shaped	1
<b>Total</b>	<b>/2</b>

9. The main metals in the alloy bronze are copper and tin. When bronze was first developed, bronze objects became more popular than copper objects because it is more durable and harder. The durability of bronze is because it does not readily oxidise (rust).

Explain why bronze is slow to oxidise.

Description	Marks
The copper in the bronze initially oxidises to form a layer of copper oxide	1
The oxide then protects the underlying metal from further corrosion	1
<b>Total</b>	<b>/2</b>

## Sample assessment task

### Chemistry – General Year 12

#### Task 10 – Unit 4

**Assessment type:** Science inquiry/Investigation

**Conditions**

Time for the task: 120 minutes

**Task weighting**

7.5% of the school mark for this pair of units

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#### Metal/Metal ion reactions

(92 marks)

##### Introduction

In a metal/ metal ion displacement reaction, a more reactive metal will displace (take the place of) the ions of a less reactive metal in a compound. The reaction usually takes place in aqueous (water) solution; for example, if an iron nail is placed in a solution containing copper(II) ions, the copper(II) ions will form metallic copper and the iron will form iron(II) ions.

Displacement reactions can allow the placement of metals in a series in order of reactivity. A metal activity series is a series of metals arranged from the most reactive to the least reactive.

In this investigation, you will be mixing a range of metals with metal ion solutions to develop a metal activity series.

##### What to do

1. Working with your partner, complete Part A of the Experimental procedure.
2. Working individually, complete the Data analysis questions for Part A.
3. Working with your partner, complete Part B of the Experimental procedure.
4. Working individually, complete the Data analysis questions for Part B.
5. Working with your partner, complete Part C of the Experimental procedure.
6. Working individually, complete the Data analysis questions for Part C.

**Note:** The total allocation of marks for the experimental procedure for Parts A, B and C will be based on the following

- appropriate handling of equipment and chemicals (2 marks)
- safety (2 marks)
- cleaning up of equipment and chemicals (2 marks)

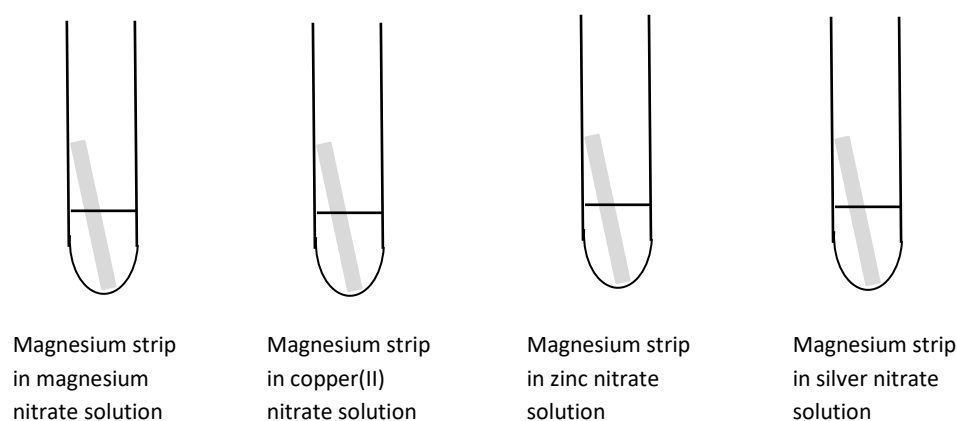
### Equipment and chemicals

- 4 test tubes and a test tube rack
- 4 strips (~4 cm × 0.5 cm) of the following metals – magnesium, copper, zinc, iron (or iron nail), lead, tin, nickel
- 0.1 mol L<sup>-1</sup> solutions of the following
  - magnesium nitrate, Mg(NO<sub>3</sub>)<sub>2</sub>
  - copper(II) nitrate, Cu(NO<sub>3</sub>)<sub>2</sub>
  - zinc nitrate, Zn(NO<sub>3</sub>)<sub>2</sub>
  - iron(II) nitrate, Fe(NO<sub>3</sub>)<sub>2</sub>
  - lead(II) nitrate, Pb(NO<sub>3</sub>)<sub>2</sub>
  - tin(II) nitrate, Sn(NO<sub>3</sub>)<sub>2</sub>
  - silver nitrate, AgNO<sub>3</sub>
  - nickel(II) nitrate, Ni(NO<sub>3</sub>)<sub>2</sub>

### Part A

#### Experimental procedure

1. Place approximately a 2 cm depth of magnesium nitrate, copper(II) nitrate, zinc nitrate and silver nitrate solutions in separate test tubes (see Figure 1).
2. Carefully, lower a strip of magnesium metal into each test tube (see Figure 1). Leave for about 10 minutes and then record your observations. Observations should include any changes to the metal strip and the solution. You may like to take a photograph of your test tubes which you may print and attach to your report.
3. Place the metal strips in the waste container as directed by your teacher, and the silver wastes in the silver residues container. Other solutions can be rinsed down the sink. Wash your test tubes and rinse them with deionised water.
4. Repeat steps 1, 2 and 3 with copper metal, then zinc metal.



**Figure 1:** Test tubes with metal solutions and metal strips.



**Results****(12 marks)**

Record your observations in the table below.

Metal	Metal ion in solution			
	Magnesium ion, Mg <sup>2+</sup>	Copper(II) ion, Cu <sup>2+</sup>	Zinc ion, Zn <sup>2+</sup>	Silver ion, Ag <sup>+</sup>
Mg				
Cu				
Zn				

**Data analysis**

1. For each combination where reaction occurred, describe the evidence to support the conclusion that there was a reaction. (9 marks)

2. For each combination where reaction occurred, write a balanced equation for the reaction. (6 marks)

3. Rank the metals in order from most reactive to least reactive in the appropriate table below. Also rank the metal ions from least reactive to most reactive in the appropriate table below. Explain how you decided on your rankings. (5 marks)

	Metal table	Metal ion table									
Most reactive	<table border="1"><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr></table>					<table border="1"><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr></table>					Least reactive
↓			↑								
Least reactive			Most reactive								

**Part B****Experimental procedure**

1. Place approximately a 2 cm depth of iron(II) nitrate, lead(II) nitrate, nickel(II) nitrate and tin(II) nitrate solutions in separate test tubes.
2. Carefully, lower a strip of iron metal into each test tube. Leave for about 10 minutes and then record your observations. Observations should include any changes to the metal strip and the solution. You may like to take a photograph of your test tubes.
3. Place the metal strips in the waste container as directed by your teacher. Solutions can be rinsed down the sink. Wash your test tubes and rinse them with deionised water.
4. Repeat steps 1, 2 and 3 with lead metal, tin metal and then nickel.

**Results****(16 marks)**

Record your observations in the table below.

Metal	Metal ion in solution			
	Iron(II) ion, Fe <sup>2+</sup>	Lead(II) ion, Pb <sup>2+</sup>	Tin(II) ion, Sn <sup>2+</sup>	Nickel(II) ion, Ni <sup>2+</sup>
Fe				
Pb				
Sn				
Ni				

**Data analysis**

4. For each combination where reaction occurred, write a balanced equation for the reaction. (6 marks)

4. Rank the metals in order from most reactive to least reactive in the appropriate table below. Also rank the metal ions from least reactive to most reactive in the appropriate table below. (2 marks)

	Metal table	Metal ion table	
Most reactive			Least reactive
↓			↑
↓			↑
↓			↑
↓			↑
Least reactive			Most reactive

**Part C****Experimental procedure**

1. Using zinc, copper, iron and lead metals and zinc nitrate, copper(II) nitrate, iron(II) nitrate and lead(II) nitrate solutions, mix the metals and solutions in the same way as was done for Parts A and B. There is no need to repeat combinations done in Parts A and B.
2. Record your observations in the Results table.
3. Place the metal strips in the waste container as directed by your teacher. Solutions can be rinsed down the sink. Wash your test tubes and rinse them with deionised water.

**Results****(12 marks)**

Record your results in the table below.

Metal	Metal ion in solution			
	Zinc ion, Zn <sup>2+</sup>	Copper(II) ion, Cu <sup>2+</sup>	Iron(II) ion, Fe <sup>2+</sup>	Lead(II) ion, Pb <sup>2+</sup>
Zn		Done in Part A		
Cu	Done in Part A			
Fe				Done in Part B
Pb			Done in Part B	

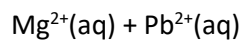
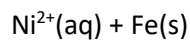
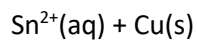
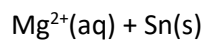
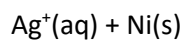
**Data analysis and interpretation**

6. For each combination where reaction occurred, write a balanced equation for the reaction. (4 marks)

7. Rank the eight metals in order from most reactive to least reactive in the appropriate table below. Also rank the eight metal ions from least reactive to most reactive in the appropriate table below. (2 marks)

	Metal table	Metal ion table																	
Most reactive	<table border="1"><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr></table>									<table border="1"><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr><tr><td> </td></tr></table>									Least reactive
↓			↑																
Least reactive			Most reactive																

8. Use the information in the tables in question 7 to predict if a reaction will occur when the following metals and ions are combined. Where there is a reaction, write a balanced equation. (7 marks)



9. An unknown metal, M, is found to react with  $\text{Cu}^{2+}$  ions,  $\text{Pb}^{2+}$  ions and  $\text{Sn}^{2+}$  ions but not  $\text{Mg}^{2+}$  ions or  $\text{Fe}^{2+}$  ions. Where should the unknown metal, M, be located on your activity series? Explain your decision. (2 marks)
10. Unlike most metals, gold and platinum can be found in their pure form in nature. Where are they best placed in the metal activity series for the eight metals you have tested? (1 mark)
11. The history of the use of metals is thought to begin with gold for jewellery (possibly as long ago as 6000 BC). Use of gold was followed by the Copper Age (~4200 BC) which, in turn, is followed by the Bronze Age (~3300 BC) (bronze is an alloy of copper and tin) and then the Iron Age (~1200 BC) but there is no aluminium age described. Suggest a reason for the development of this timeline in the use of metals and why aluminium was not used in ancient civilisations. (2 marks)

## Marking key for sample assessment task 10 – Unit 4

## Experimental procedure

Description	Marks
Uses equipment appropriately	1–2
Safely conducts the experiment	1–2
Cleans up equipment and work area appropriately	1–2
<b>Total</b>	<b>/6</b>

## Part A

## Results

Description	Marks
1 mark for each observation	1–12
<b>Total</b>	<b>/12</b>

Answer could include, but is not limited to:

Metal	Metal ion in solution			
	Magnesium ion, Mg <sup>2+</sup>	Copper(II) ion, Cu <sup>2+</sup>	Zinc ion, Zn <sup>2+</sup>	Silver ion, Ag <sup>+</sup>
Mg	No change observed	Solid forms on the surface of the Mg strip and the blue colour in the solution fades	Solid forms on the surface of the Mg strip; no colour change in the solution	Solid forms on the surface of the Mg strip; no colour change in the solution
Cu	No change observed	No change observed	No change observed	Solid forms on the surface of the Mg strip and the colourless solution becomes bluish-green
Zn	No change observed	Solid forms on the surface of the Zn strip and the blue colour in the solution fades	No change observed	Solid forms on the surface of the Zn strip; no colour change in the solution



### Data analysis

1. For each combination where reaction occurred, describe the evidence to support the conclusion that there was a reaction.

Description	Marks
For Mg + Cu <sup>2+</sup> , 1 mark for change to Mg strip and 1 mark for change in solution colour	1–2
For Mg + Zn <sup>2+</sup> , change to Mg strip	1
For Mg + Ag <sup>+</sup> , change to Mg strip	1
For Cu + Ag <sup>+</sup> , 1 mark for change to Cu strip and 1 mark for change in solution colour	1–2
For Zn + Cu <sup>2+</sup> , 1 mark for change to Zn strip and 1 mark for change in solution colour	1–2
For Zn + Ag <sup>+</sup> , 1 mark for change to Zn strip and 1 mark for change in solution colour	1
<b>Total</b>	<b>/9</b>
<b>Answer could include, but is not limited to:</b>	
<ul style="list-style-type: none"> <li>• For Mg + Cu<sup>2+</sup>, the Mg strip showed solid forming on it and the solution colour faded. This suggests changes were occurring, therefore reaction was occurring</li> <li>• For Mg + Zn<sup>2+</sup>, the Mg strip showed solid forming on it which suggests reaction was occurring</li> <li>• For Mg + Ag<sup>+</sup>, the Mg strip showed solid forming on it which suggests reaction was occurring</li> <li>• For Cu + Ag<sup>+</sup>, the Cu strip showed solid forming on it and the solution colour changed. This suggests changes were occurring, therefore reaction was occurring</li> <li>• For Zn + Cu<sup>2+</sup>, the Zn strip showed solid forming on it and the solution colour faded. This suggests changes were occurring, therefore reaction was occurring</li> <li>• For Zn + Ag<sup>+</sup>, the Zn strip showed solid forming on it which suggests reaction was occurring</li> </ul>	

2. For each combination where reaction occurred, write a balanced equation for the reaction.

Description	Marks
1 mark for each balanced equation	1–6
<b>Total</b>	<b>/6</b>
<b>Answer could include, but is not limited to:</b>	
$\text{Mg(s)} + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{aq}) + \text{Cu(s)}$ $\text{Mg(s)} + \text{Zn}^{2+}(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{aq}) + \text{Zn(s)}$ $\text{Mg(s)} + 2 \text{Ag}^{+}(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{aq}) + 2 \text{Ag(s)}$ $\text{Cu(s)} + 2 \text{Ag}^{+}(\text{aq}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2 \text{Ag(s)}$ $\text{Zn(s)} + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Cu(s)}$ $\text{Zn(s)} + 2 \text{Ag}^{+}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + 2 \text{Ag(s)}$ <p><b>Note:</b> state symbols not required and full molecular equations are acceptable</p>	

3. Rank the metals in order from most reactive to least reactive in the appropriate table below. Also rank the metal ions from least reactive to most reactive in the appropriate table below. Explain how you decided on your rankings.

Description	Marks
Metal ranking (most reactive to least reactive) Mg, Zn, Cu, Ag	1
Metal ion ranking (least reactive to most reactive) Mg <sup>2+</sup> , Zn <sup>2+</sup> , Cu <sup>2+</sup> , Ag <sup>+</sup>	1
Recognition that metal reactivity can be based on number of solutions the metal reacted with	1
Recognition that ion reactivity can be based on number of metals the ion reacted with	1
Recognition that it follows from the high reactivity of the Ag <sup>+</sup> that Ag will be the least reactive metal	1
<b>Total</b>	<b>/5</b>
<b>Answer could include, but is not limited to:</b>	
<ul style="list-style-type: none"> <li>• Metal rankings are based on the reactivity demonstrated by the metal strips when they were placed in the solutions of metal ions. Mg reacted with three of the solutions, zinc with two of the solutions and copper with only one solution</li> <li>• Metal ion rankings are based on the reactivity demonstrated by ions when the metal strips were placed in the solutions. Mg<sup>2+</sup> reacted with none of the metals, Zn<sup>2+</sup> reacted with one of the metals, Cu<sup>2+</sup> reacted with two of the metals and Ag<sup>+</sup> reacted with three of the metals</li> <li>• It follows from the high reactivity of the Ag<sup>+</sup> that Ag will be the least reactive metal</li> </ul>	

## Part B

## Results

Description					Marks
1 mark for each observation					1–16
<b>Total</b>					<b>/16</b>
<b>Answer could include, but is not limited to:</b>					
Metal	Metal ion in solution				
	Iron(II) ion, Fe <sup>2+</sup>	Lead(II) ion, Pb <sup>2+</sup>	Tin(II) ion, Sn <sup>2+</sup>	Nickel(II) ion, Ni <sup>2+</sup>	
Fe	No reaction	Solid forms on the surface of the Fe strip and the colourless solution becomes (very) pale green	Solid forms on the surface of the Fe strip and the colourless solution becomes (very) pale green	Solid forms on the surface of the Fe strip and the green solution becomes paler (but this may be difficult to see)	
Pb	No reaction	No reaction	No reaction	No reaction	
Sn	No reaction	Solid forms on the surface of the Sn strip; no colour change in the solution	No reaction	No reaction	
Ni	No reaction	Solid forms on the surface of the Ni strip and the colourless solution becomes green	Solid forms on the surface of the Ni strip and the colourless solution becomes green	No reaction	

## Data analysis

4. For each combination where reaction occurred, write a balanced equation for the reaction.

Description		Marks
1 mark for each balanced equation		1–6
<b>Total</b>		<b>/6</b>
<b>Answer could include, but is not limited to:</b>		
$\text{Fe(s)} + \text{Pb}^{2+}(\text{aq}) \rightarrow \text{Fe}^{2+}(\text{aq}) + \text{Pb(s)}$ $\text{Fe(s)} + \text{Ni}^{2+}(\text{aq}) \rightarrow \text{Fe}^{2+}(\text{aq}) + \text{Ni(s)}$ $\text{Fe(s)} + \text{Sn}^{2+}(\text{aq}) \rightarrow \text{Fe}^{2+}(\text{aq}) + \text{Sn(s)}$ $\text{Sn(s)} + \text{Pb}^{2+}(\text{aq}) \rightarrow \text{Sn}^{2+}(\text{aq}) + \text{Pb(s)}$ $\text{Ni(s)} + \text{Pb}^{2+}(\text{aq}) \rightarrow \text{Ni}^{2+}(\text{aq}) + \text{Ni(s)}$ $\text{Ni(s)} + \text{Sn}^{2+}(\text{aq}) \rightarrow \text{Ni}^{2+}(\text{aq}) + \text{Sn(s)}$		
<b>Note:</b> state symbols not required and full molecular equations are acceptable		

5. Rank the metals in order from most reactive to least reactive in the appropriate table below. Also rank the metal ions from least reactive to most reactive in the appropriate table below.

Description		Marks
Metal ranking (most reactive to least reactive) Fe, Ni, Sn, Pb		1
Metal ion ranking (least reactive to most reactive) Fe <sup>2+</sup> , Ni <sup>2+</sup> , Sn <sup>2+</sup> , Pb <sup>2+</sup>		1
<b>Total</b>		<b>/2</b>

## Part C

## Results

Description		Marks		
1 mark for each observation		1–12		
<b>Total</b>		<b>/12</b>		
<b>Answer could include, but is not limited to:</b>				
Metal	Metal ion in solution			
	Zinc ion, Zn <sup>2+</sup>	Copper(II) ion, Cu <sup>2+</sup>	Iron(II) ion, Fe <sup>2+</sup>	Lead(II) ion, Pb <sup>2+</sup>
Zn	No reaction	Done in Part A	Solid forms on the surface of the Zn strip and the pale green solution becomes paler	Solid forms on the surface of the Zn strip and the colourless solution remains colourless
Cu	Done in Part A	No reaction	No reaction	No reaction
Fe	No reaction	Solid forms on the surface of the Fe strip and the blue colour of the solution fades (may become very pale green if left long enough)	No reaction	Done in Part B
Pb	No reaction	Solid forms on the surface of the Pb strip and the blue colour of the solution fades	Done in Part B	No reaction

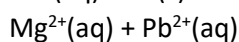
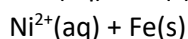
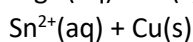
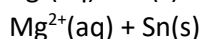
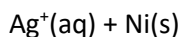
6. For each combination where reaction occurred, write a balanced equation for the reaction.

Description		Marks	
1 mark for each balanced equation		1–4	
<b>Total</b>		<b>/4</b>	
<b>Answer could include, but is not limited to:</b>			
$\text{Zn(s)} + \text{Fe}^{2+}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Fe(s)}$ $\text{Zn(s)} + \text{Pb}^{2+}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Pb(s)}$ $\text{Fe(s)} + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Fe}^{2+}(\text{aq}) + \text{Cu(s)}$ $\text{Pb(s)} + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Pb}^{2+}(\text{aq}) + \text{Cu(s)}$			
<b>Note:</b> state symbols not required and full molecular equations are acceptable			

7. Rank the eight metals in order from most reactive to least reactive in the appropriate table below. Also rank the eight metal ions from least reactive to most reactive in the appropriate table below.

Description		Marks	
Metal ranking (most reactive to least reactive) Mg, Zn, Fe, Ni, Sn, Pb, Cu, Ag		1	
Metal ion ranking (least reactive to most reactive) Mg <sup>2+</sup> , Zn <sup>2+</sup> , Fe <sup>2+</sup> , Ni <sup>2+</sup> , Pb <sup>2+</sup> , Sn <sup>2+</sup> , Cu <sup>2+</sup> , Ag <sup>+</sup>		1	
<b>Total</b>		<b>/2</b>	

- 8 Use the information in the tables in question 8 to predict if a reaction will occur when the following metals and ions are combined. Where there is a reaction, write a balanced equation.



Description	Marks
1 mark for recognising there is a reaction; 1 mark for balanced equation $2 \text{Ag}^+(\text{aq}) + \text{Ni}(\text{s}) \rightarrow 2 \text{Ag}(\text{s}) + \text{Ni}^{2+}(\text{aq})$	1–2
No reaction for $\text{Mg}^{2+}(\text{aq}) + \text{Sn}(\text{s})$	1
No reaction for $\text{Sn}^{2+}(\text{aq}) + \text{Cu}(\text{s})$	1
1 mark for recognising there is a reaction; 1 mark for balanced equation $\text{Ni}^{2+}(\text{aq}) + \text{Fe}(\text{s}) \rightarrow \text{Ni}(\text{s}) + \text{Fe}^{2+}(\text{aq})$	1–2
No reaction for $\text{Mg}^{2+}(\text{aq}) + \text{Pb}^{2+}(\text{aq})$	1
<b>Total</b>	<b>/7</b>

**Note:** Full molecular equations acceptable and state symbols not needed

9. An unknown metal, M, is found to react with  $\text{Cu}^{2+}$  ions,  $\text{Pb}^{2+}$  ions and  $\text{Sn}^{2+}$  ions but not  $\text{Mg}^{2+}$  ions or  $\text{Fe}^{2+}$  ions. Where should the unknown metal, M, be located on your activity series? Explain your decision.

Description	Marks
M should be between Fe and Sn	1
There is not sufficient information to determine if M is more or less reactive than Ni	1
<b>Total</b>	<b>/2</b>

10. Unlike most metals, gold and platinum can be found in their pure form in nature. Where are they best placed in the metal activity series for the eight metals you have tested?

Description	Marks
Recognition that they should go toward the less reactive end with silver	1
<b>Total</b>	<b>/1</b>

11. The history of the use of metals is thought to begin with gold for jewellery (possibly as long ago as 6000 BC). Use of gold was followed by the Copper Age (~4200 BC) which, in turn, is followed by the Bronze Age (~3300 BC) (bronze is an alloy of copper and tin) and then the Iron Age (~1200 BC) but there is no aluminium age described. Suggest a reason for the development of this timeline in the use of metals and why aluminium was not used in ancient civilisations.

Description	Marks
Recognition that the order of use of metals is related to their reactivity – the least reactive are used earliest	1
Recognition that aluminium is too reactive for ancient civilisations to have the technology to extract it from its ore	1
<b>Total</b>	<b>/2</b>