

WORKSHEET –1

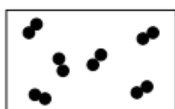
Unit : 1. Know your Elementum

Topic : Periodicity

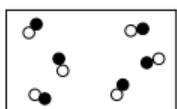
Grade: MYP 4

Question 1:

The boxes represent particles of different gases. One box shows the particles of elements in group 0 (group 8).



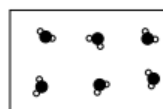
A



B



C



D

(a) (i) What name is given to group 0 (8) elements?

.....

(ii) Name two elements from group 0.

.....

(b) (i) Which box best represents particles from group 0 elements?

.....

(ii) Explain the reason for your answer.

.....

.....

....

(c) A lighted splint is put into a gas jar of helium. What would happen?

.....

(d) Some properties of elements change as you go down their group in the periodic table. For each property listed below, comment on if and how it changes as you go down group 0. (i) reactivity

.....

(ii) density

.....

Question 2:

Sarah is diving into a swimming pool. She can smell chlorine.

(a) (i) Explain why there is chlorine in the swimming pool.

.....

(ii) Iodine is the same group of the periodic table as chlorine. Give a use of iodine.

.....

(b) (i) Chlorine and iodine are in group 7 of the periodic table. What name is given to group 7 elements?

.....

(ii) Is chlorine a metal or non-metal?

.....

(iii) Is iodine a metal or non-metal?

.....

(c) (i) The atomic number of chlorine is 17. What does this tell you?

.....

Question 3:

(a) Identify Symbol, Group number and period of the following elements:

| Element | Symbol | Group Number | Period Number |
|---------|--------|--------------|---------------|
| Zinc | | | |
| Cobalt | | | |
| Lead | | | |
| Barium | | | |
| Silver | | | |
| Bromine | | | |
| Xenon | | | |
| Gallium | | | |

Question 4:

1. Define atomic radius.
2. Examine the trend in atomic radius from left to right across a period by clicking on all the elements in the 2nd period as well as the elements in Group 1A. List their atomic radii below in pm.

Li _____, Be _____, B _____, C _____, N _____, O _____, F _____, Ne _____

Li _____, Na _____, K _____, Rb _____, Cs _____, Fr _____

3. Based on both these trends, draw a single arrow toward the corner of the periodic table that would have the greatest atomic radius.

4. Based on your knowledge of the electronic structure of the atom, explain this trend.
5. Using the trend, arrange the following elements in order of **increasing** atomic radius (Ge, He, Sr, O, Ba). Check your answer using the ptable and compare.

Question 5:

Bromine is one of the halogens in Group VII.

(a) (i) Predict which halogen has the lightest color.

(ii) Predict which halogens are solids at room temperature.

(b) Halogens are obtained from the halides by displacement reactions. A student investigated the reaction of Potassium iodide with halogens (chlorine, fluorine, iodine, bromine, and Astatine) to predict their reactivity.

(i) Identify Independent, dependent and control variables of the reaction above.

(ii) What safety precautions must the student undertake while carrying out this investigation? Justify.

(iii) Using your knowledge on displacement reactions predict products of the following reactions.

Chlorine + Potassium Iodide →

Fluorine + Potassium Iodide →

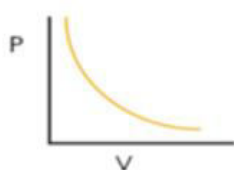
Iodine + Potassium Iodide →

Bromine + Potassium Iodide →

Astatine + Potassium Iodide →

1. State Charles' Law. **Volume is directly proportional to temperature when pressure is kept constant for a given amount of gas.**
2. Write the formula for Gay-Lussac's Law and name the 2 variables that must be constant. **$P_1/T_1 = P_2/T_2$**
3. Draw the graph of Boyle's Law.

Boyle-Marriott Law



P and V are inversely proportional at constant T and n.

$$P_1 V_1 = P_2 V_2$$



4. If the volume of a balloon is doubled then what will happen to its pressure? (at constant T and n) **It will half because there is twice as much space and the pressure is due to the collisions of the particles against the walls of the balloon.**

5. Eugenio had a metal box with an initial temperature of 10 °C and a pressure of 5 atm. He then heated it to 60 °C. What was the final pressure? (Hint: what units should T be in?)

$$T_1 = 10 + 273 = 283 \text{ K}$$

$$P_1 = 5 \text{ atm}$$

$$T_2 = 60 + 273 = 333 \text{ K}$$

.Gay-Lussac **$P_2 = P_1 T_2 / T_1$** **$P_2 = 5.88 \text{ atm}$**

6. María put 64 g of oxygen gas (O_2) into an empty 20 L container at 37 ° C. What is the pressure in her container? (Help: The molecular mass of O_2 is 32 g/mol)

$$PV = nRT; PV = (\text{mass}/\text{molec mass})RT;$$

$$T = 37 + 273 = 310 \text{ K}$$

$$P = (64/32) \times 0.082 \times 310 = \textbf{2.54 atm}$$

7. A 127 ° C and 3000 torr, David's gas occupies 2 m³. What volume will the same gas occupy if the temperature changes to 227 ° C and a pressure at 500 torr?

$$T_1 = 127 + 273 = 400 \text{ K}$$

$$T_2 = 227 + 273 = 500 \text{ K}$$

$$P_1 = 3000 \text{ torr} = 3.95 \text{ atm}$$

$$P_2 = 500 \text{ torr} = 0.66 \text{ atm}$$

$$V_1 = 2 \text{ m}^3$$

$$V_2 = ?$$

$$P_1 V_1 / T_1 = P_2 V_2 / T_2$$

$$V_2 = 3.95 \times 2 \times 500 / 400 \times 0.66 = 15 \text{ m}^3$$

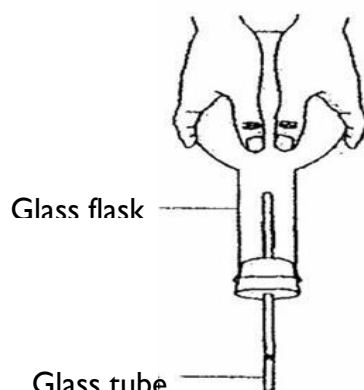
8. After his birthday party, Manolo put his balloon in the fridge. 5 minutes later, he noticed the balloon had shrunk. Explain why? Which gas law does it relate to?

Charles's Law. Decreasing T → decreasing V.

9. Mr Canning took the following apparatus and placed the end of the glass tube into a beaker of water. He then started to warm up the end of the flask with his hands. What might you have observed when he did this? Explain why? What would happen if he then cooled the glass flask? Bubbles would be produced as increasing T → increasing V so gas would be forced out of glass tube. When cooling, the opposite is true → water would be drawn up the tube.

10. We make 2 assumptions when dealing with Ideal Gases. State the 2 assumptions and explain why they are most valid at high temperatures and low pressure? 1. Particles have no volume. 2. There are no intermolecular forces between particles. High T and low P are most valid as particles will have more space and velocity and will therefore avoid any intermolecular forces.

1. State Charles' Law.
2. Write the formula for Gay-Lussac's Law and name the 2 variables that must be constant.
3. Draw the graph of Boyle's Law.
4. If the volume of a balloon is doubled then what will happen to its pressure? (at constant T and n)
5. Eugenio had a metal box with an initial temperature of 10°C and a pressure of 5 atm. He then heated it to 60°C . What was the final pressure? (*Hint: what units should T be in?*)
6. María put 64 g of oxygen gas (O_2) into an empty 20 L container at 37°C . What is the pressure in her container? (*Help: The molecular mass of O_2 is 32 g/mol*)
7. A 127°C and 3000 torr, David's gas occupies 2 m^3 . What volume will the same gas occupy if the temperature changes to 227°C and a pressure at 500 torr?
8. After his birthday party, Manolo put his balloon in the fridge. 5 minutes later, he noticed the balloon had shrunk. Explain why? Which gas law does it relate to?
9. Mr Canning took the following apparatus and placed the end of the glass tube into a beaker of water. He then started to warm up the end of the flask with his hands. What might you have observed when he did this? Explain why? What would happen if he then cooled the glass flask?



10. We make 3 assumptions when dealing with Ideal Gases. State the 3 assumptions and explain why they are most valid at high temperatures and low pressure.?

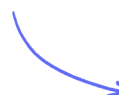
Theory Questions

Atomic Structure & the Periodic Table

Elements, Compounds & Mixtures / Atomic Structure / Electronic Configuration / Isotopes

| | |
|-----------------------|-------------|
| Easy (7 questions) | /47 |
| Medium (11 questions) | /91 |
| Hard (5 questions) | /47 |
| Total Marks | /185 |

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Easy Questions

1 (a) Cobalt is an element in Period 4 of the Periodic Table.

Use your copy of the Periodic Table to help you complete the table below.

| particle | number of protons | number of neutrons | number of electrons |
|------------------|-------------------|--------------------|---------------------|
| Co | | | |
| Co ²⁺ | | | |

(2 marks)

(b) Extended Only

⁶⁰Co is an isotope.

i) Explain the term isotope.

[2]

ii) Explain why two isotopes of the same element have identical chemical properties.

[1]

(3 marks)

2 (a) Substances can be classified as:

elements mixtures compounds

Elements can be divided into:

metals non-metals

Define each of the following terms.

i) element

[2]

ii) compound

[2]

iii) mixture

[1]

(5 marks)

(b) Classify each of the following as either an element, compound or mixture.

i) brass

[1]

ii) carbon dioxide

[1]

iii) copper

[1]

.....

.....

.....

(3 marks)

(c) Which physical property is used to distinguish between metals and non-metals?

It is possessed by all metals but by only one non-metal.

.....

(1 mark)

3 Complete the following table which gives the number of protons, electrons and neutrons in each of the five particles.

| particle | number of protons | number of electrons | number of neutrons |
|------------------------------|-------------------|---------------------|--------------------|
| | 19 | 19 | 20 |
| ${}^{56}_{26}\text{Fe}$ | | | |
| | 3 | 2 | |
| ${}^{70}_{31}\text{Ga}^{3+}$ | | | |
| | 34 | 36 | 45 |

(8 marks)

4 (a) Define the term *isotope*.

.....

.....

(2 marks)

(b) The table gives information about four particles, **A**, **B**, **C** and **D**.

Complete the table.

The first line has been done for you.

| particle | number of protons | number of electrons | number of neutrons | nucleon number | symbol or formula |
|----------|-------------------|---------------------|--------------------|----------------|-------------------|
| A | 6 | 6 | 6 | 12 | C |
| B | 11 | 10 | 12 | | |
| C | 8 | | 8 | | O ²⁻ |
| D | | 10 | | 28 | Al ³⁺ |

.....

.....

.....

.....

.....

.....

(7 marks)

5 (a) Magnesium, calcium and strontium are Group II elements.

Complete **Table 3.1** to show the electronic configuration of a calcium atom.

Table 3.1

| shell | 1st | 2nd | 3rd | 4th |
|---------------------|-----|-----|-----|-----|
| number of electrons | | | | |

.....
(1 mark)

(b) Describe how the electronic configuration of a strontium atom is similar to the electronic configuration of a calcium atom.

.....
(1 mark)

(c) Describe how the electronic configuration of a strontium atom is different from the electronic configuration of a calcium atom.

.....
(1 mark)

- 6 (a)** Complete the table to show the relative charge and approximate relative mass of a proton, a neutron and an electron.

| type of particle | relative charge | approximate relative mass |
|------------------|-----------------|---------------------------|
| proton | | 1 |
| neutron | | |
| electron | -1 | |

.....

.....

.....

.....

(4 marks)

- (b)** Deduce the number of electrons and neutrons in an atom of the isotope of potassium shown.



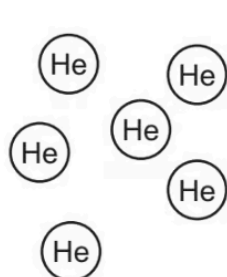
number of electrons: number of neutrons:

.....

.....

(2 marks)

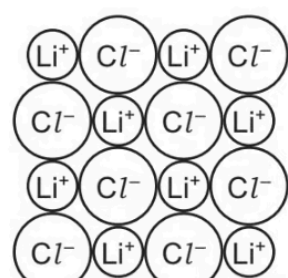
7 (a) The diagrams show part of the structures of five substances, A, B, C, D and E.



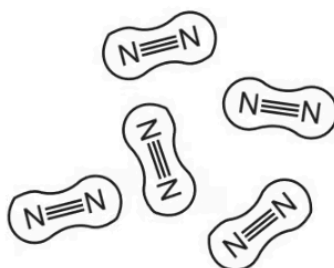
A



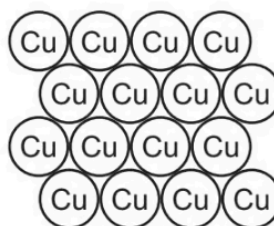
B



C



D



E

Answer the following questions about these structures.

Each structure may be used once, more than once or not at all.

Which one of these structures, A, B, C, D or E, is a compound?

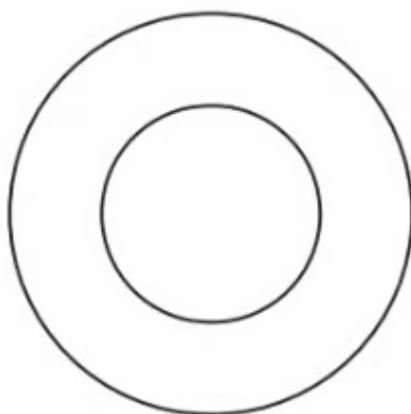
(1 mark)

(b) Substance B is an element.

What is meant by the term *element*?

(1 mark)

(c) Complete the diagram to show the electron arrangement in an oxygen atom.



(1 mark)

(d) Complete the table to show the number of electrons, protons and neutrons in the sulfur atom and copper ion shown.

| | number of electrons | number of neutrons | number of protons |
|----------------------------|---------------------|--------------------|-------------------|
| $^{34}_{16}\text{S}$ | | | |
| $^{63}_{29}\text{Cu}^{2+}$ | | | 29 |

(4 marks)

Medium Questions

1 (a) The table gives the composition of three particles.

| particle | number of protons | number of electrons | number of neutrons |
|----------|-------------------|---------------------|--------------------|
| A | 15 | 15 | 16 |
| B | 15 | 15 | 16 |
| C | 15 | 15 | 17 |

What is the evidence in the table for each of the following?

i) Particle **A** is an atom.

[1]

ii) **A**, **B** and **C** are all particles of the same element.

[1]

iii) Particles **A** and **C** are isotopes of the same element.

[2]

(4 marks)

(b) i) What is the electronic structure of particle **A**?

[1]

ii) Is element **A**, a metal or a non-metal? Give a reason for your choice.

[1]

(2 marks)

2 (a) Protons, neutrons and electrons are subatomic particles.

Complete the table to show the relative mass and relative charge of a proton, a neutron and an electron.

| particle | relative mass | relative charge |
|----------|------------------|-----------------|
| proton | | |
| neutron | | |
| electron | $\frac{1}{1840}$ | |

[3]

(3 marks)

(b) Extended Only

Bromine has two isotopes.

i) Define the term isotope.

[2]

ii) Explain why the two isotopes of bromine have the same chemical properties.

[2]

(4 marks)

(c) The table shows the number of protons, neutrons and electrons in some atoms and ions.

Complete the table.

| particle | number of protons | number of neutrons | number of electrons |
|-----------------------------|-------------------|--------------------|---------------------|
| ${}^7_3\text{Li}$ | | | |
| ${}^{34}_{16}\text{S}^{2-}$ | | | |
| | 19 | 22 | 18 |

(5 marks)

3 (a) i) Define the term atomic number.

[1]

ii) Define the term nucleon number.

[2]

(3 marks)

(b) The table shows the number of protons, neutrons and electrons in some atoms or ions.

Complete the table. The first line is given as an example.

| particle | number of protons | number of electrons | number of neutrons | symbol or formula |
|----------|-------------------|---------------------|--------------------|------------------------|
| A | 6 | 6 | 6 | $^{12}_6\text{C}$ |
| B | 12 | 12 | 12 | |
| C | 8 | | | $^{16}_8\text{O}^{2-}$ |
| D | 11 | 10 | 13 | |

(5 marks)

4 (a) The table below gives information about particles.

Complete the table. The first line has been done for you.

| particle | number of protons | number of electrons | electronic configuration | charge on particle |
|----------|-------------------|---------------------|--------------------------|--------------------|
| A | 12 | 10 | 2,8 | 2+ |
| B | | 18 | 2,8,8 | 1- |
| C | 18 | | 2,8,8 | 0 |
| D | 8 | 10 | | |

(4 marks)

(b) Gallium is a Group III element.

Define the term *element*.

(1 mark)

(c) The following are gallium atoms.



Complete the following table.

| atom | number of protons | number of neutrons | number of electrons |
|-----------------------|-------------------|--------------------|---------------------|
| $^{69}_{31}\text{Ga}$ | | | |
| $^{71}_{31}\text{Ga}$ | | | |

(3 marks)

5 (a) The table below gives the composition of six particles which are either atoms or ions.

| Particle | number of protons | number of neutrons | number of electrons |
|----------|-------------------|--------------------|---------------------|
| A | 33 | 40 | 33 |
| B | 19 | 20 | 18 |
| C | 34 | 45 | 36 |
| D | 33 | 42 | 33 |
| E | 13 | 14 | 13 |
| F | 24 | 28 | 21 |

Which particles are atoms? Explain your choice.

.....

.....

(2 marks)

(b) Which particle is a negative ion and why has this particle got a negative charge?

.....

.....

(2 marks)

(c) Which particles are positive ions?

.....

(1 mark)

(d) Explain why particle **A** and particle **D** are isotopes.

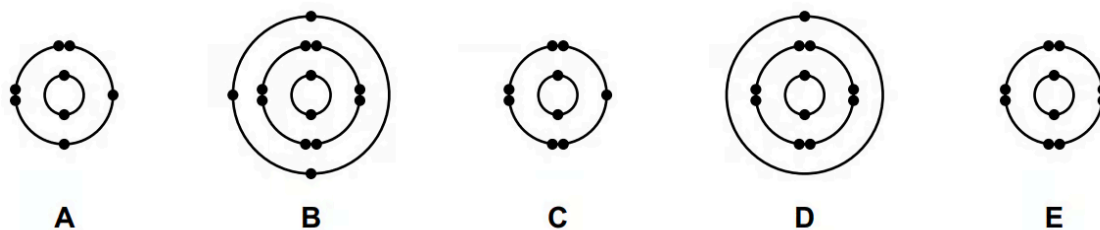
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.....

(2 marks)

6 (a) Figure 1.1 shows the electronic configurations of five atoms, A, B, C, D and E.

Figure 1.1



Each letter may be used once, more than once or not at all.

Give the letter of the atom, A, B, C, D or E, that is in Group III of the Periodic Table.

.....
(1 mark)

(b) Give the letter of the atom, A, B, C, D or E, that has 13 protons.

.....
(1 mark)

(c) Give the letter of the atom, A, B, C, D or E, that is a noble gas.

.....
(1 mark)

(d) Give the letter of the atom, A, B, C, D or E, that forms a stable ion with a single negative charge.

.....
(1 mark)

7 (a) Sulfuric acid is a compound.

Define the term compound.

(1 mark)

(b) Complete **Table 2.1** to show the number of electrons, neutrons and protons in the sulfur atom and oxide ion.

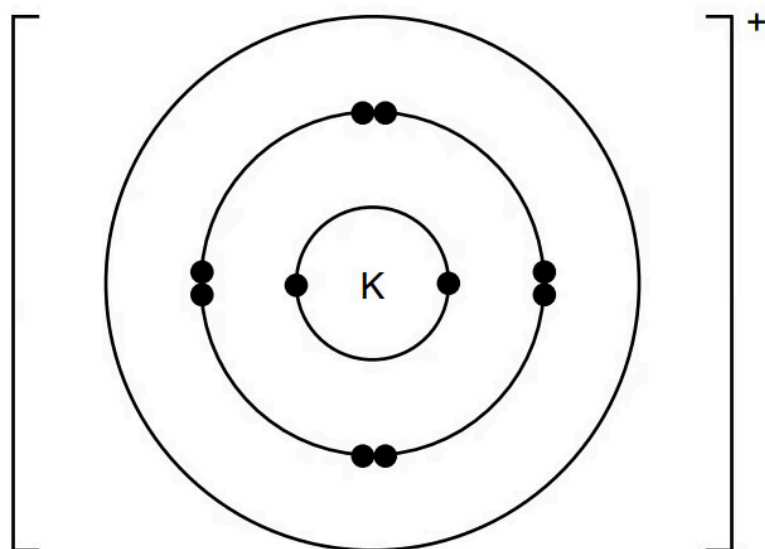
Table 2.1

| | number of electrons | number of neutrons | number of protons |
|--------------------------|---------------------|--------------------|-------------------|
| ${}^{34}_{16}\text{S}$ | 16 | | |
| ${}^{18}_8\text{O}^{2-}$ | | 10 | |

(3 marks)

(c) Complete **Figure 2.2** to show the electronic configuration of a potassium ion.

Figure 2.2



(1 mark)

8 (a) This question is about elements **X**, **Y** and **Z**.

An atom of element **X** is represented as ${}^{34}_{16}\text{X}$

Name the different types of particles found in the nucleus of this atom of **X**.

.....
.....
(2 marks)

(b) What is the term for the total number of particles in the nucleus of an atom?

.....
(1 mark)

(c) What is the total number of particles in the nucleus of an atom of ${}^{34}_{16}\text{X}$?

.....
(1 mark)

(d) What is the electronic structure of the ion X^{2-} ?

.....
(1 mark)

(e) What term is used to describe atoms of the same element with different numbers of particles in the nucleus?

.....
(1 mark)

(f) Separate: Chemistry and Extended Only

Part of the definition of relative atomic mass is 'the average mass of naturally occurring atoms of an element'. Some relative atomic masses are not whole numbers. Element Y has only two different types of atom, ^{69}Y and ^{71}Y . The ratio of atoms present in element Y is shown.

$$^{69}\text{Y} : ^{71}\text{Y} = 3 : 2$$

- Calculate the relative atomic mass of element Y to one decimal place.

relative atomic mass:

- Identify element Y.
- element Y:

.....
.....
.....
(3 marks)

(g) Element Z is in Period 3 and Group V.

Explain in terms of electron transfer why Z behaves chemically as a non-metal.

.....
.....
(2 marks)

9 (a) Extended Only

Chlorine is in Group VII of the Periodic Table. Two isotopes of chlorine are chlorine-35 and chlorine-37

State why these two isotopes of chlorine have the same chemical properties.

(2 marks)

- (b) Chlorine is in Group VII of the Periodic Table. Two isotopes of chlorine are chlorine-35 and chlorine-37.

Complete the table to show the number of electrons, neutrons and protons in each atom and ion.

| | number of electrons | number of neutrons | number of protons |
|---------------------------|---------------------|--------------------|-------------------|
| $^{35}_{17}\text{Cl}$ | | | |
| $^{37}_{17}\text{Cl}^{-}$ | | | |

(3 marks)

- (c) $^{22}_{11}\text{Na}$, $^{23}_{11}\text{Na}$ and $^{24}_{11}\text{Na}$ are isotopes of sodium.

Describe how these sodium isotopes are the same and how they are different in terms of the total number of protons, neutrons and electrons in each.

same:

different:

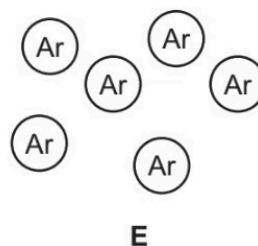
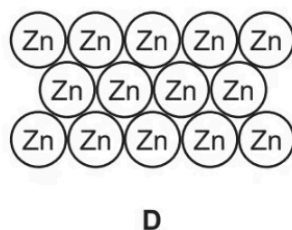
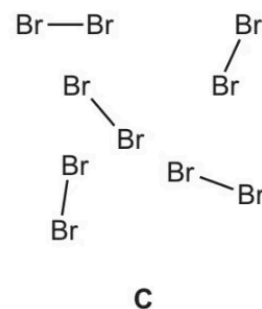
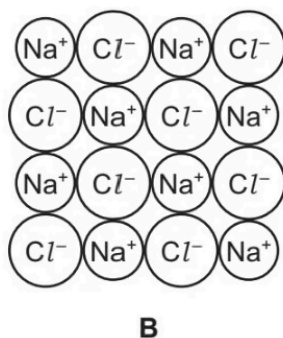
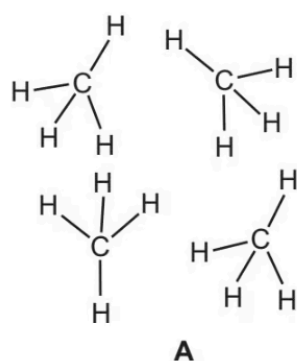
(3 marks)

- (d) ${}^{22}_{11}\text{Na}$, ${}^{23}_{11}\text{Na}$ and ${}^{24}_{11}\text{Na}$ are isotopes of sodium.

Why do all three isotopes have an overall charge of zero?

(1 mark)

10 (a) The diagram shows part of the structures of five substances, **A**, **B**, **C**, **D** and **E**.



Answer the following questions about these structures. Each structure may be used once, more than once or not at all.

Which two of these structures, **A**, **B**, **C**, **D** or **E**, are compounds?

.....

.....

(2 marks)

(b) Substance **E** is present in air. Air is a mixture of different gases. Describe **two** characteristics of a mixture.

.....

.....

(2 marks)

(c) Complete the table to show the number of electrons, protons and neutrons in the sulfur atom and zinc ion shown.

| | number of electrons | number of neutrons | number of protons |
|----------------------------|---------------------|--------------------|-------------------|
| $^{36}_{16}\text{S}$ | | | |
| $^{67}_{30}\text{Zn}^{2+}$ | | | 30 |

(4 marks)

11 (a) This question is about the structures of atoms and ions.

Define the term *proton number*.

(2 marks)

(b) Complete the table to show the number of protons, neutrons and electrons present in atoms of ${}^{24}_{12}\text{Mg}$ and ${}^{26}_{12}\text{Mg}$.

| | number of protons | number of neutrons | number of electrons |
|-------------------------|-------------------|--------------------|---------------------|
| ${}^{24}_{12}\text{Mg}$ | | | |
| ${}^{26}_{12}\text{Mg}$ | | | |

(2 marks)

(c) What term is used to describe atoms of the same element, such as ${}^{24}_{12}\text{Mg}$ and ${}^{26}_{12}\text{Mg}$?

(1 mark)

(d) Extended Only

Explain why the chemical properties of ${}^{24}_{12}\text{Mg}$ and ${}^{26}_{12}\text{Mg}$ are the same.

(2 marks)

- (e) Complete the table to identify the atoms and ions which have the following numbers of protons, neutrons and electrons.

| | number of protons | number of neutrons | number of electrons |
|---------------------------|-------------------|--------------------|---------------------|
| ${}^{23}_{11}\text{Na}^+$ | 11 | 12 | 10 |
| | 4 | 5 | 4 |
| | 17 | 20 | 18 |

.....

.....

.....

.....

(4 marks)

- (f) State the electronic structure of the following atom and ion.

Al:

S^{2-} :

.....

.....

(2 marks)

Hard Questions

1 (a) The symbols of six particles are shown below.

| | | | | | |
|-----------------|------------------|----|---|----|-----------------|
| Na ⁺ | Ca ²⁺ | Kr | P | Si | O ²⁻ |
|-----------------|------------------|----|---|----|-----------------|

Select from the list of particles to answer the following questions. A particle may be selected once, more than once or not at all.

i) Which **two** ions have the same electronic structure?

[1]

ii) Which ion has the same electronic structure as an atom of argon?

[1]

iii) Which atom can form an ion of the type X³⁻?

[1]

iv) Which atom can form a hydride which has a formula of the type XH₄?

[1]

.....

.....

.....

.....

(4 marks)

(b) i) How many protons, neutrons and electrons are there in one copper(II) ion ${}^{64}_{29}\text{Cu}^{2+}$

[2]

ii) ${}^{45}_{21}\text{Sc}$ represents an atom of scandium. How many nucleons and how many charged particles are there in one atom of scandium?

[2]

(4 marks)

(c) Two different atoms of sodium are ${}^{23}_{11}\text{Na}$ and ${}^{24}_{11}\text{Na}$.

i) Explain why these two atoms are isotopes.

[2]

ii) ${}^{24}_{11}\text{Na}$ is radioactive. It changes into an atom of a different element which has one more proton. Identify this element.

[1]

(3 marks)

2 (a) The table gives the composition of three particles.

| particle | number of protons | number of electrons | number of neutrons |
|----------|-------------------|---------------------|--------------------|
| A | 15 | 15 | 16 |
| B | 15 | 18 | 16 |
| C | 15 | 15 | 17 |

What is the evidence in the table for each of the following?

i) Particle **A** is an atom.

[1]

ii) They are all particles of the same element.

[1]

iii) Particle **B** is a negative ion.

[2]

iv) Particles **A** and **C** are isotopes.

[2]

(6 marks)

(b) i) What is the electronic structure of particle **A**?

[1]

ii) What is the valency of the element?

[1]

iii) Is the element a metal or a non-metal? Give a reason for your choice.

[1]

(3 marks)

- 3 (a)** Complete the table which gives the names, symbols, relative masses and relative charges of the three subatomic particles.

| name | symbol | relative mass | relative charge |
|----------|--------|---------------|-----------------|
| electron | | | |
| proton | | 1 | |
| | n | | 0 |

(3 marks)

(b) Use the information in the table to explain the following.

i) Atoms contain charged particles but they are electrically neutral because they have no overall charge.

[2]

ii) Atoms can form positive ions.

[2]

iii) Atoms of the same element can have different masses.

[2]

iv) Scientists are certain that there are no undiscovered elements missing from the Periodic Table from hydrogen to lawrencium.

[1]

(7 marks)

4 (a) The table below gives the number of protons, neutrons and electrons in atoms or ions.

| particle | number of protons | number of electrons | number of neutrons | symbol or formula |
|----------|-------------------|---------------------|--------------------|---------------------------|
| A | 9 | 10 | 10 | ${}^{19}_{9}\text{F}^{-}$ |
| B | 11 | 11 | 12 | |
| C | 18 | 18 | 22 | |
| D | 15 | 18 | 16 | |
| E | 13 | 10 | 14 | |

Complete the table. The first line is given as an example.

(6 marks)

(b) Which atom in the table is an isotope of the atom which has the composition 11p, 11e and 14n?

Give a reason for your choice.

(2 marks)

5 (a) This question is concerned with the elements in Period 5, Rb to Xe.

The electron distributions of some of these elements are given in the following list.

- element A $2 + 8 + 18 + 10$
- element B $2 + 8 + 18 + 18 + 8$
- element C $2 + 8 + 18 + 18 + 5$
- element D $2 + 8 + 18 + 18 + 6$
- element E $2 + 8 + 18 + 18 + 4$
- element F $2 + 8 + 18 + 18 + 7$

i) Identify element C.

[1]

ii) Which element in the list does not form any compounds?

[1]

iii) Which element in the list forms a chloride of the type XCl_2 ?

[1]

iv) Which two elements would react together to form a compound of the type XY_4 ?

[1]

v) Which element in the list would react with cold water to form an alkaline solution and hydrogen?

[1]

(5 marks)

- (b) Predict two differences in physical properties and two differences in chemical properties between rubidium and the transition metal niobium.

physical

chemical

(4 marks)

CHEM1001 Worksheet 6: Concentration

Model 1: Concentration

Most chemical reactions occur in solution, including almost all of those occurring in our bodies. When dealing with solutions, we measure out volumes instead of weighing out quantities. Volume is related to the number of moles present using the *concentration* or *molarity*. Concentration (symbol c) is defined as the number of moles of a substance dissolved in one litre of solution:

$$c = \frac{n}{V} \quad \frac{(\text{mol})}{(\text{L})}$$

Critical thinking questions

1. The units of concentration are often written as M. Use the equation above to work out the units of concentration in terms of mol and L.
2. What is the concentration of the solution obtained when 0.50 mol of NaCl is dissolved into 0.20 L of water?
3. The concentration of carbon dioxide in the oceans around Australia is about 0.05×10^{-3} M. How many moles of CO₂ are present in 3.2 L of seawater?
4. What mass of CO₂ does this correspond to?
5. A 500. mL solution of HCl with a concentration of 0.10 M is diluted to 1500. mL. What is the new concentration? (*Hint*: work out the number of moles present.)
6. A 500. mL solution of HCl with a concentration of 0.10 M is diluted to 750. mL. What is the new concentration?

Heating and Cooling Curves

Heating Curves

If the temperature of a pure solid is measured at intervals as it is heated and changes state to a liquid and then a gas, and the temperature is plotted against time, a HEATING curve is obtained. A heating curve is shown for Figure 1 below. The curve below shows that as heating occurs the temperature of the substance increases. The graph shows two horizontal sections where the temperature remains constant over a period of time even though heating continues. This happens when there is a change in state.

Activity #1: Heating Curves

1. Use the graph in figure 1 below to answer the following questions.

At **point A**, the beginning of observations, the substance exists in a _____ state. Material in this phase has a _____ volume and shape. With each passing minute, _____ is added to the substance. This causes the molecules of the substance to gain more _____ energy and hence _____ faster which we detect by a temperature rise in the substance.

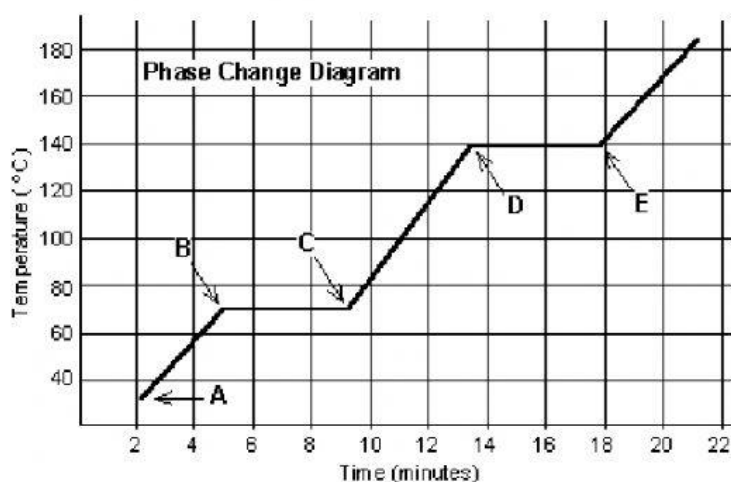


Figure SEQ Figure 1* ARABIC 1: Heating Curve

At **point B**, the temperature of the substance is _____ °C and at Point C the temperature is _____ °C. This first change in state is where _____ occurs as the temperature remains constant at the _____ point of the substance. The substance is now in the _____ phase. Material in this phase has _____ volume and _____ shape. The energy put to the substance between minutes 5 and 9 was used to convert the substance from a _____ to a _____.

- c) Between 9 and 13 minutes, the added energy increases the temperature of the substance. During the time from **point D to point E**, the liquid is _____. By **point E**, the substance is completely in the _____ phase and has reached the _____ point. Material in this phase has _____ volume and _____ shape. The energy put to the substance between minutes 13 and 18 converted the substance from a _____ to a _____ state. Beyond **point E**, the substance is still in the _____ phase, but the molecules are moving faster as indicated by the increasing temperature.

In summary:

From A to B, the material is in the _____ state of matter

From B to C, the process of _____ is taking place

From C to D, the material is in the _____ state of matter

From D to E, the process of _____ is taking place

Anything after E is in the _____ state of matter.

Activity # 2: Heating Curves

2. Based on the information above label the Heating curve below in the spaces provided below using the following words:

Solid, melting point, gas, liquid, boiling point

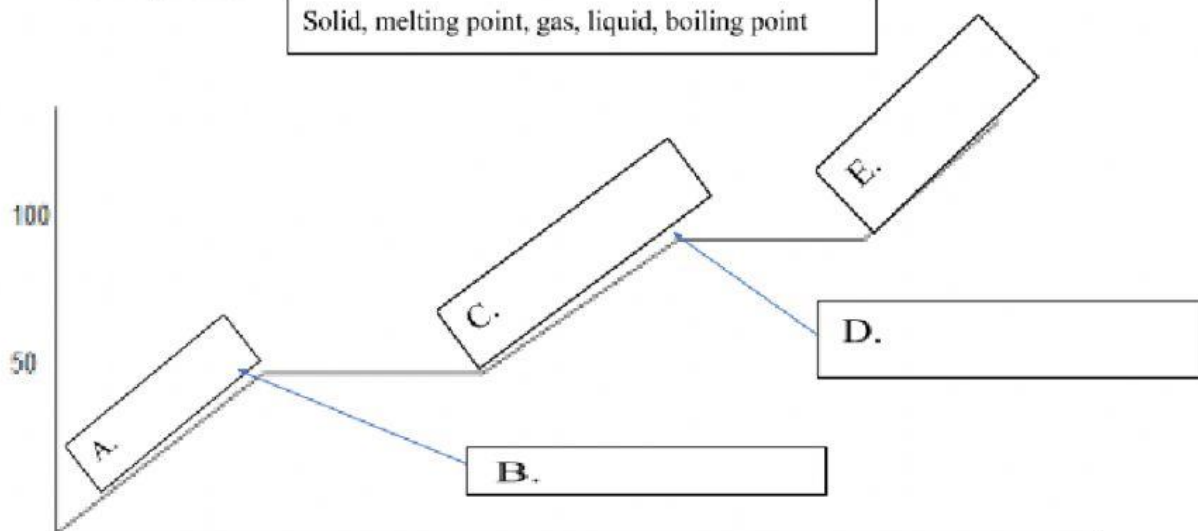


Figure 2:Blank Heating Curve

Activity #3: Interpreting Cooling Curves

Cooling Curves

If the temperature of a gas is measured at intervals as it is cooled and changes state to a liquid and then to a solid, and the temperature is plotted on a graph against time a cooling curve is obtained. Figure 3 shows the cooling curve of a water.

3. Answer the questions below based on the cooling curve in Figure 3 below.

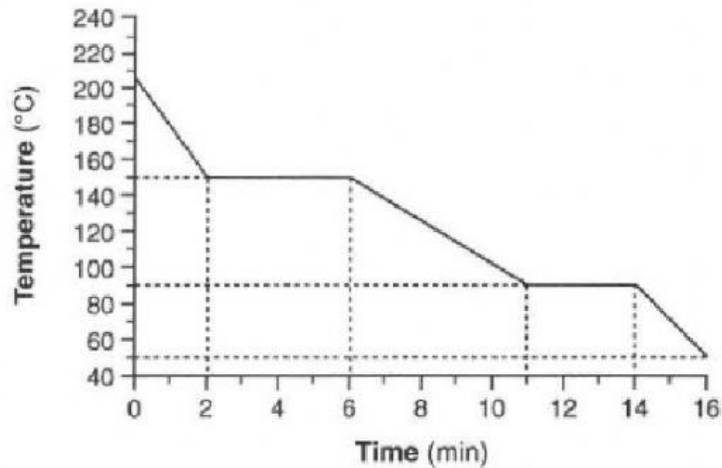


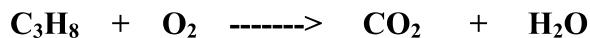
Figure 3: Cooling Curve

- a) What is the freezing point temperature of the substance? _____
- b) What is the boiling point temperature of the substance? _____
- c) What is the melting point temperature of the substance? _____
- d) On the graph above, Label the gas, liquid and Solid.
- e) State the time period where the substance is a solid. _____
- f) State the time period where the substance is a liquid. _____
- g) During which time period would the substance possess kinetic energy? _____

Limiting Reagent Worksheet #1

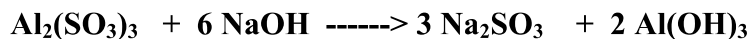
Name: _____

1. Given the following reaction: (Balance the equation first!)



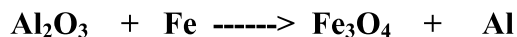
- a) If you start with 14.8 g of C_3H_8 and 3.44 g of O_2 , determine the limiting reagent
- b) determine the number of moles of carbon dioxide produced
- c) determine the number of grams of H_2O produced
- d) determine the number of grams of excess reagent left

2. Given the following equation:



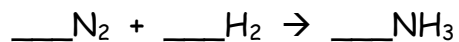
- a) If 10.0 g of $\text{Al}_2(\text{SO}_3)_3$ is reacted with 10.0 g of NaOH , determine the limiting reagent
- b) Determine the number of moles of $\text{Al}(\text{OH})_3$ produced
- c) Determine the number of grams of Na_2SO_3 produced
- d) Determine the number of grams of excess reagent left over in the reaction

3. Given the following equation:

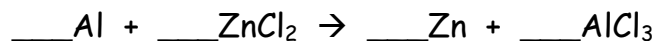


- a) If 25.4 g of Al_2O_3 is reacted with 10.2 g of Fe , determine the limiting reagent
- b) Determine the number of moles of Al produced
- c) Determine the number of grams of Fe_3O_4 produced
- d) Determine the number of grams of excess reagent left over in the reaction

1. Nitrogen and hydrogen react to form ammonia gas according to the following equation.

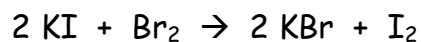


- a. If 56.0 grams of nitrogen are used up by the reaction, how many grams of ammonia will be produced?
- b. How many grams of hydrogen must react if the reaction needs to produce 63.5 grams of ammonia?
2. Aluminum metal reacts with zinc chloride to produce zinc metal and aluminum chloride.

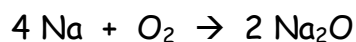


- a. A mass of 45.0 grams of aluminum will react with how many grams of zinc chloride?
- b. What mass of aluminum chloride will be produced if 22.6 grams of zinc chloride are used up in the reaction?

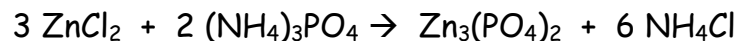
3. For the reaction whose balanced equation is as follows, find the number of grams of I_2 that will be formed when 300.0 g of bromine react.



4. For the reaction whose balanced equation is as follows, find the number of grams of sodium that must react to produce 42.0 grams of sodium oxide.



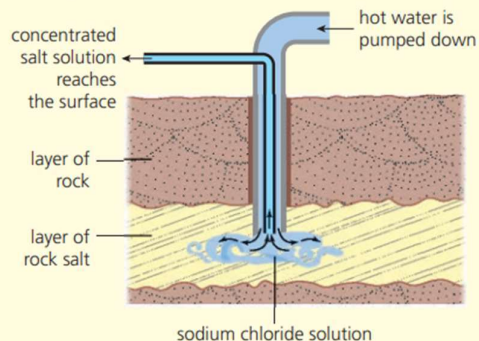
5. For the reaction whose balanced equation is as follows, find how many grams of zinc phosphate will be produced by the reaction of 5.00 grams of ammonium phosphate.



Practical

Rock salt

Common salt is sodium chloride and is found naturally in large amounts in seawater or in underground deposits. Sodium chloride can be extracted from underground by the process of solution mining.



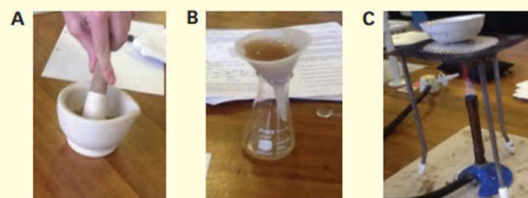
▲ Figure 9.32

- 1 a) On what physical property of sodium chloride does this process depend?
- b) Suggest one reason why solution mining uses a lot of energy.
- c) Suggest one negative effect which solution mining has on the environment.
- d) Suggest how sodium chloride is obtained from the concentrated salt solution.
- 2 Rock salt is a mixture of salt, sand and clay. To separate pure salt from rock salt, the method listed below can be used in the laboratory.

Method:

- i Place 8 spatulas of rock salt into a mortar and grind using a pestle.

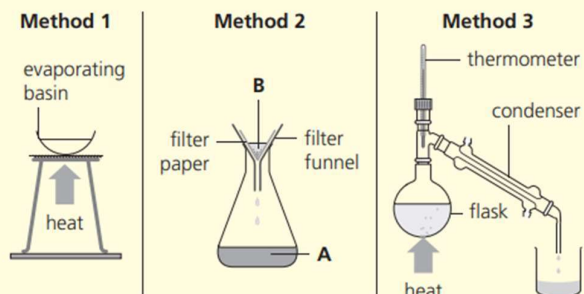
- ii Place the rock salt into a beaker and quarter fill with water.
- iii Place on a gauze and tripod and heat, stirring with a glass rod. Stop heating when the salt has dissolved – the sand and clay will be left undissolved.
- iv Allow to cool and then filter.
- v Heat until half the volume of liquid is left.
- vi Place the evaporating basin on the windowsill to evaporate off the rest of the water slowly. Pure salt crystals should be left.



Choose one step of the method (i to vi) which is best represented in each photograph A–C.

- 3 a) Why is rock salt considered to be a mixture?
- b) What was the purpose of grinding the rock salt?
- c) Why was the mixture heated and stirred?
- d) State what the filtrate contains.
- e) State what the residue contains.
- f) Explain why the salt obtained may still be contaminated with sand and suggest how you would improve your experiment to obtain a purer sample of salt.

5 Mixtures may be separated in the laboratory in many different ways. Three different methods of separating mixtures are shown below.

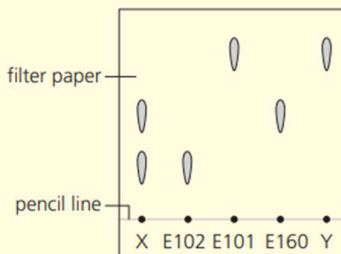


▲ Figure 9.34

- Name each method of separation. [3 marks]
- Which method (1, 2 or 3) would be most suitable for obtaining water from potassium chloride solution? [1 mark]
- Which method would be most suitable for removing sand from a mixture of sand and water? [1 mark]
- What general term is used for liquid **A** and solid **B** in method 2? [2 marks]
- State why method 2 would **not** be suitable to separate copper(II) chloride from copper(II) chloride solution. [1 mark]

To determine if two different orange drinks X and Y contained the food colourings E102, E101 or E160 a student put a drop of each orange drink and a drop of each food colouring along a pencil line on filter paper.

The filter paper was placed in a tank containing 1 cm depth of solvent. The solvent soaked up the paper and carried different components with it. After 5 minutes, the filter paper was removed and allowed to dry. The results are shown.



▲ Figure 9.35

- a) What is the name of the process used by the student to analyse the two orange drinks? [1 mark]
- b) i) Orange drink X contains the food colouring E102. How do the results show this? [1 mark]
- ii) What other food colouring does orange drink X contain? [1 mark]
- iii) Re-draw the diagram and add a spot to show that orange drink Y also contained food colouring E160. [1 mark]
- iv) The line across the bottom of the filter paper was drawn with a pencil not with ink. Why should the line not be drawn with ink? [1 mark]

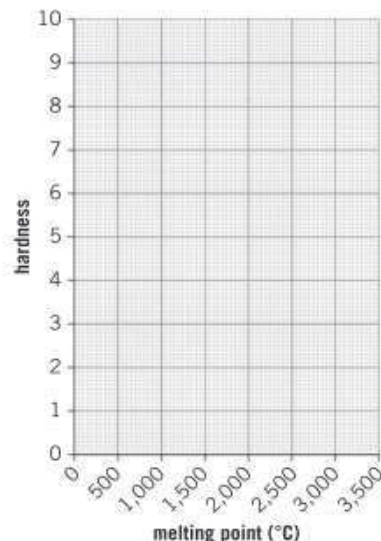
A pupil is investigating air pollution. She acquires a portable gas monitor that can measure the concentration of pollutant gases in the air. She decides to use the gas monitor to measure air pollution in five different places:

- Inside her home
 - At school
 - By the nearest busy road
 - In the center of her nearest town
 - In the countryside.
- a)** Identify the independent and dependent variables for this experiment. [2]
- b)** Suggest how she might present her results. [1]
- c)** She decides that her experiment would be improved by measuring the air in the morning, the afternoon and the evening and taking an average of her values. Explain why this is an improvement to her method. [2]
- d)** She now tries to decide whether to take all the readings for all the different places on one day, or to measure each place on a different day. Discuss the advantages and disadvantages of each method. [3]

It is suggested that the hardness of metals might be related to their melting point. The hypothesis is that metals with a low melting point are softer because they are closer to the liquid state than metals with high melting points:

The table shows the hardness of ten metals based on the Mohs scale and their melting points.

| Metal | Hardness (Mohs scale) | Melting point (°C) |
|-----------|-----------------------|--------------------|
| aluminium | 2.8 | 660 |
| boron | 9.3 | 2,075 |
| calcium | 1.8 | 842 |
| copper | 3.0 | 1,085 |
| gold | 2.5 | 1,064 |
| iron | 4.0 | 1,538 |
| lead | 1.5 | 328 |
| sodium | 0.5 | 98 |
| titanium | 6.0 | 1,668 |
| tungsten | 7.5 | 3,422 |



1. Plot a graph of the data with hardness on the y-axis and melting point on the x-axis. Add a line of best fit. You might want to use a copy of the axes shown above.
2. Does your graph support the hypothesis that metals with higher melting points are harder?
3. Cobalt is a metal that has a melting point of 1,495°C. Use your graph to predict the hardness of cobalt on the Mohs scale.

A pupil is researching whether there is a link between the hardness of metals and their melting points. She researches six metals that all have the same crystal structure and finds their approximate hardness on the Mohs scale and their melting points.

She finds the following data: aluminium has a hardness of 2.8 and a melting point of 660°C; copper has a hardness of 3 and a melting point of 1,085°C; gold has a hardness of 2.5 and a melting point of 1,064°C; lead has a hardness of 1.5 and a melting point of 327°C; nickel has a hardness of 4.0 and a melting point of 1,455°C; and platinum has a hardness of 3.5 and a melting point of 1,768°C.

8. Explain why it was important that all six metals had the same crystal structure. [2]
9. Put the data into a suitable table. [2]
10. Plot a graph of melting point (y-axis) against hardness (x-axis). [4]
11. Does your graph suggest that there is a relationship between these quantities? [2]