

The Morley Academy

1. Atomic Structure & Periodic Table Mastery Booklet

(Chemistry Paper 1)

Name : _____

Teacher : _____

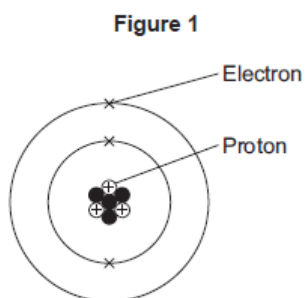
Date Given : _____

These booklets are a consolidation of your learning. They should be used in the following way - You should attempt the questions **WITHOUT** looking at the answers. Then mark your questions with **green pen** and add any missing marks you missed.

THESE BOOKLETS WILL IMPROVE YOUR GRADES...!!

Q1. There are eight elements in the second row (lithium to neon) of the periodic table.

(a) **Figure 1** shows a lithium atom.



(i) What is the mass number of the lithium atom in **Figure 1**?

Tick (✓) **one** box.

3

4

7

(1)

(ii) What is the charge of an electron?

Tick (✓) **one** box.

-1

0

+1

(1)

(iii) Protons are in the nucleus.

Which other sub-atomic particles are in the nucleus?

Tick (✓) **one** box.

ions

molecules

neutrons

(1)

(b) What is **always** different for atoms of different elements?

Tick (✓) **one** box.

number of neutrons

number of protons

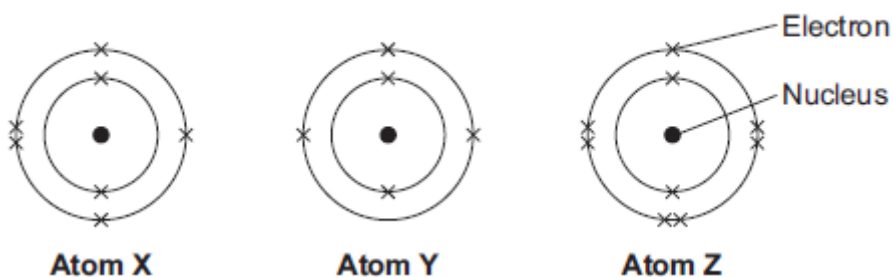
number of shells

(1)

(c) **Figure 2** shows the electron arrangements of three different atoms, **X**, **Y** and **Z**.

These atoms are from elements in the second row (lithium to neon) of the periodic table.

Figure 2



Which atom is from an element in Group 3 of the periodic table?

Tick (✓) **one** box.

Atom X

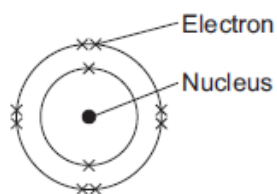
Atom Y

Atom Z

(1)

(d) **Figure 3** shows the electron arrangement of a different atom from an element in the second row of the periodic table.

Figure 3



- (i) Give the chemical symbol of this element.

(1)

- (ii) Why is this element unreactive?

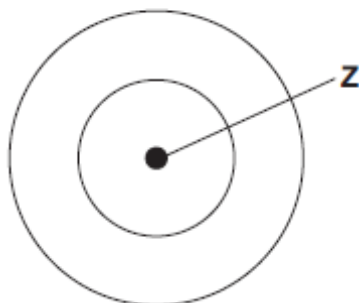
(1)

(Total 7 marks)

Q2. There are eight elements in the second row (lithium to neon) of the periodic table.

- (a) **Figure 1** shows an atom with two energy levels (shells).

Figure 1



- (i) Complete **Figure 1** to show the electronic structure of a boron atom.

(1)

- (ii) What does the central part labelled **Z** represent in **Figure 1**?

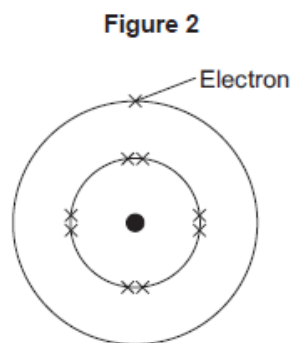
(1)

- (iii) Name the sub-atomic particles in part **Z** of a boron atom.

Give the relative charges of these sub-atomic particles.

(3)

- (b) The electronic structure of a neon atom shown in **Figure 2** is **not** correct.



Explain what is wrong with the electronic structure shown in **Figure 2**.

(3)

(Total 8 marks)

Q3. This question is about atoms.

- (a) What does the number 19 represent in ${}_{9}^{19}\text{F}$?

(1)

- (b) How many atoms are present in one mole of fluorine atoms?

Tick (✓) **one** box.

2.03×10^{26}

2.06×10^{23}

6.02×10^{23}

6.02×10^{26}

(1)

(c) The plum pudding model of the atom was replaced by the nuclear model.

The nuclear model was developed after the alpha particle scattering experiment.

Compare the plum pudding model with the nuclear model of the atom.

(4)

(d) An element has three isotopes.

The table shows the mass numbers and percentage of each isotope.

	Isotope 1	Isotope 2	Isotope 3
Mass number	24	25	26
Percentage (%)	78.6	10.1	11.3

Calculate the relative atomic mass (A_r) of the element.

Give your answer to 3 significant figures.

Relative atomic mass = _____

(2)

(Total 8 marks)

Q4. A student investigated the law of conservation of mass.

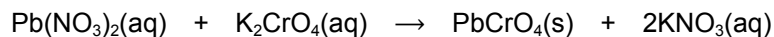
The law of conservation of mass states that the mass of the products is equal to the mass of the reactants.

This is the method used.

1. Pour lead nitrate solution into a beaker labelled **A**.
2. Pour potassium chromate solution into a beaker labelled **B**.
3. Measure the mass of both beakers and contents.
4. Pour the solution from beaker **B** into beaker **A**.
5. Measure the mass of both beakers and contents again.

When lead nitrate solution and potassium chromate solution are mixed, a reaction takes place.

This is the equation for the reaction:



(a) What would the student see when the reaction takes place?

(1)

(b) The table shows the student's results.

	Mass in g
Beaker A and contents before mixing	128.71
Beaker B and contents before mixing	128.97
Beaker A and contents after mixing	154.10
Beaker B after mixing	103.58

Show that the law of conservation of mass is true.

Use the data from the table above.

(2)

(c) What is the resolution of the balance used to obtain the results in the table?

Tick (✓) **one** box.

0.01 g 0.1 g 1 g 100 g

(1)

(d) Calculate the relative formula mass (M_r) of lead nitrate $\text{Pb}(\text{NO}_3)_2$

Relative atomic masses (A_r): N = 14 O = 16 Pb = 207

Relative formula mass = _____

(2)

(e) The formula of potassium chromate is K_2CrO_4

The charge on the potassium ion is +1

What is the formula of the chromate ion?

Tick (✓) **one** box.

CrO_4^+

CrO_4^{2+}

CrO_4^-

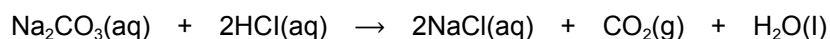
CrO_4^{2-}

(1)

- (f) Another student also tests the law of conservation of mass using the same method.

The student uses a different reaction.

This is the equation for the reaction.



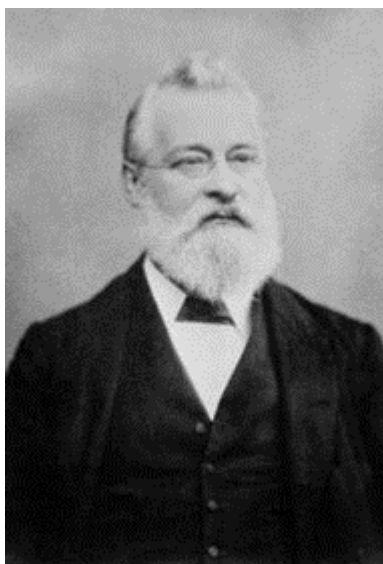
Explain why this student's results would **not** appear to support the law of conservation of mass.

(3)

(Total 10 marks)

Q5. The periodic table on the Data Sheet may help you answer these questions.

- (a) Many chemists have contributed to the development of the periodic table.



John Newlands was one of the first chemists who attempted to classify elements in a systematic way based on atomic weight. In 1866 he suggested that there was a repeating pattern of elements with similar properties every eighth element. Part of Newlands' periodic table is shown below.

H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co, Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce, La	Zr	Di, Mo	Ro, Ru

Many chemists in 1866 did not accept Newland's; periodic table.

By Conget at nl.wikipedia [Public domain], from Wikimedia Commons

- (i) Give **one** piece of evidence which supports Newlands' ideas.

(1)

- (ii) Suggest **two** reasons why many chemists in 1866 did not accept Newlands' ideas.

1. _____

2. _____

(b) Chlorine, bromine and iodine are Group 7 elements.

A student investigated the reactivity of these elements.
The student added:

- aqueous chlorine to potassium bromide and potassium iodide solutions
- aqueous bromine to potassium chloride and potassium iodide solutions
- aqueous iodine to potassium chloride and potassium bromide solutions.

The student's results are shown below.

Solution	Potassium chloride	Potassium bromide	Potassium iodide
Chlorine		Solution turned orange-brown	Solution turned brown
Bromine	No reaction		Solution turned brown
Iodine	No reaction	No reaction	

(i) Use these results to state **and** explain the trend in reactivity of these Group 7 elements.

(2)

(ii) Complete the equation below, which represents the reaction between chlorine and potassium bromide.



(1)

(iii) In terms of electronic structure, state why chlorine, bromine and iodine are in Group 7.

(1)

(c) Lithium, sodium and potassium are Group 1 elements.

Group 1 elements become **more** reactive down the group.

Explain why in terms of electronic structure.

(3)

(Total 10 marks)

Q6. In 1866 John Newlands produced an early version of the periodic table.

Part of Newlands' periodic table is shown below.

Column	1	2	3	4	5	6	7
	H	Li	Be	B	C	N	O
	F	Na	Mg	Al	Si	P	S
	Cl	K	Ca	Cr	Ti	Mn	Fe

Newlands' periodic table arranged all the known elements into columns in order of their atomic weight.

Newlands was trying to show a pattern by putting the elements into columns.

(a) Iron (Fe) does **not** fit the pattern in column 7.

Give a reason why.

(1)

(b) In 1869 Dmitri Mendeleev produced his version of the periodic table.

Why did Mendeleev leave gaps for undiscovered elements in his periodic table?

(1)

- (c) Newlands and Mendeleev placed the elements in order of atomic weight.

Complete the sentence.

The modern periodic table places the elements in order of

_____.

(1)

- (d) Lithium, sodium and potassium are all in Group 1 of the modern periodic table.

Explain why.

(2)

(Total 5 marks)

Q7. This question is about the halogens (Group 7).

- (a) How do the boiling points of the halogens change down the group from fluorine to iodine?

(1)

- (b) Sodium bromide is produced by reacting sodium with bromine.

Sodium bromide is an ionic compound.

- (i) Write down the symbols of the **two** ions in sodium bromide.

(1)

- (ii) Chlorine reacts with sodium bromide solution to produce bromine and one other product.

Complete the word equation for the reaction.

chlorine + sodium bromide \longrightarrow bromine + _____

(1)

- (iii) Why does chlorine displace bromine from sodium bromide?

(1)

- (iv) Use the Chemistry Data Sheet to help you to answer this question.

Suggest which halogen could react with sodium chloride solution to produce chlorine.

Q8. This question is about atomic structure and elements.

(a) Complete the sentences.

(i) The atomic number of an atom is the number of _____

(1)

(ii) The mass number of an atom is the number of _____

(1)

(b) Explain why an atom has no overall charge.

Use the relative electrical charges of sub-atomic particles in your explanation.

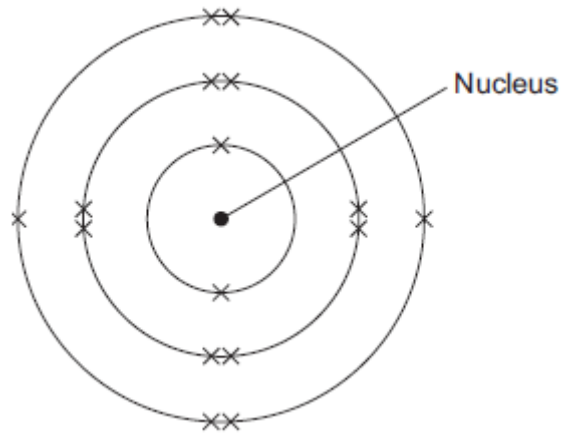
(2)

(c) Explain why fluorine and chlorine are in the same group of the periodic table.

Give the electronic structures of fluorine and chlorine in your explanation.

(2)

(d) The diagram shows the electronic structure of an atom of a non-metal.



What is the chemical symbol of this non-metal?

Tick (✓) **one** box.

Ar

O

S

Si

(1)

(e) When elements react, their atoms join with other atoms to form compounds.

Complete the sentences.

(i) Compounds formed when non-metals react with metals consist of particles called _____ .

(1)

(ii) Compounds formed from only non-metals consist of particles called _____ .

(1)

(Total 9 marks)

Q9.

Cells contain chemicals which react to produce electricity.

- (a) Why can a rechargeable cell be recharged?

(1)

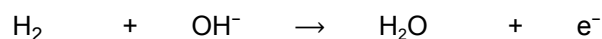
- (b) Give **two** factors that affect the voltage produced by a cell.

1.

2.

(2)

- (c) Balance the half-equation for the reaction occurring at an electrode in one type of hydrogen fuel cell.

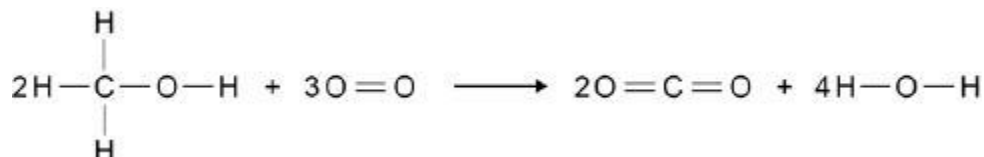
**(1)**

- (d) Why is the fuel cell in Question (c) described as an alkaline fuel cell?

(1)

- (e) Another type of fuel cell uses methanol instead of hydrogen.

The diagram represents the reaction in this fuel cell.



The table shows the bond energies for the reaction.

	C-H	C-O	O-H	O=O	C=O
Bond energy in kJ / mol	412	360	464	498	805

Calculate the overall energy change for the reaction.

Use the diagram and the table above.

Overall energy change = _____ kJ / mol

(3)

Q10. An atom of aluminium has the symbol ${}^{27}_{13}\text{Al}$

(a) Give the number of protons, neutrons and electrons in this atom of aluminium.

Number of protons _____

Number of neutrons _____

Number of electrons _____

(3)

(b) Why is aluminium positioned in Group 3 of the periodic table?

(1)

(c) In the periodic table, the transition elements and Group 1 elements are metals.

Some of the properties of two transition elements and two Group 1 elements are shown in the table below.

	Transition elements		Group 1 elements	
	Chromium	Iron	Sodium	Caesium
Melting point in °C	1857	1535	98	29
Formula of oxides	CrO Cr ₂ O ₃ CrO ₂ CrO ₃	FeO Fe ₂ O ₃ Fe ₃ O ₄	Na ₂ O	Cs ₂ O

Use your own knowledge **and** the data in the table above to compare the chemical and physical properties of transition elements and Group 1 elements.

(6)
(Total 10 marks)

Mark schemes

Q1.

- (a) (i) 7 1
- (ii) -1 1
- (iii) neutrons 1
- (b) number of protons 1
- (c) atom Y 1
- (d) (i) Ne 1
allow neon
- (ii) has a full outer shell
allow in Group 0
allow a noble gas
- or**
- full outer energy level
allow the shells are full
- or**
- has 8 electrons in its outer shell
ignore in Group 8 1
- [7]**

Q2.

- (a) (i) electronic structure 2,3 drawn 1
allow any representation of electrons, such as, dots, crosses, or numbers (2,3)
- (ii) nucleus 1
- (iii) protons and neutrons 1
do not allow electrons in nucleus
- (relative charge of proton) +1 1
allow positive
- (relative charge of neutron) 0 1

allow no charge/neutral

1

ignore number of particles

- (b) too many electrons in the first energy level or inner shell

allow inner shell can only have a maximum of 2 electrons

1

too few electrons in the second energy level or outer shell

allow neon has 8 electrons in its outer shell or neon does not have 1 electron in its outer shell

allow neon has a stable arrangement of electrons or a full outer shell

1

neon does not have 9 electrons or neon has 10 electrons

allow one electron missing

allow fluorine has 9 electrons

1

ignore second shell can hold (maximum) 8 electrons or 2,8,8 rule or is a noble gas or in Group 0

max 2 marks if the wrong particle, such as atoms instead of electrons

if no other mark awarded allow 1 mark for the electronic structure of neon is 2,8

[8]

Q3.

- (a) mass number

allow the number of protons + neutrons

1

- (b) 6.02×10^{23}

1

- (c) **Level 2 (3-4 marks):**

Scientifically relevant features are identified; the ways in which they are similar / different is made clear.

Level 1 (1-2 marks):

Relevant features are identified and differences noted.

Level 0

No relevant content.

Indicative content

similarities

- both have positive charges
- both have (negative) electrons
- neither has neutrons

differences

plum pudding model	nuclear model
--------------------	---------------

ball of positive charge (spread throughout)	positive charge concentrated at the centre
electrons spread throughout (embedded in the ball of positive charge)	electrons outside the nucleus
no empty space in the atom	most of the atom is empty space
mass spread throughout	mass concentrated at the centre

4

$$\frac{(24 \times 78.6) + (25 \times 0.1) + (26 \times 11.3)}{100}$$

(d)

100

or

$$(24 \times 0.786) + (25 \times 0.101) + (26 \times 0.113)$$

$$= 24.3$$

1

1

an answer of 24.3 scores 2 marks

[8]

Q4.

(a) precipitate / solid formed
allow colour change

1

(b) total mass before = 257.68 g
total mass after = 257.68 g

1

so the mass of products equals
the mass of the reactants

1

(c) 0.01 g

1

(d) $207 + (2 \times 14) + (6 \times 16)$

or

$$207 + 2 \times [14 + (3 \times 16)]$$

1

$$= 331$$

1

an answer of 331 scores 2 marks

(e) CrO_4^{2-}

1

(f) carbon dioxide is a gas
allow a gas is produced

1

the gas escapes during the reaction

(so) the mass at the end is less than expected

1

1

[10]

Q5.

- (a) (i) a correct link between any two named elements eg same group / column
same properties / number of outer electrons

allow some link between any two elements in the same group (in both Newlands and or the modern periodic table)

1

- (ii) any **two** from:

ignore statements about lack of evidence / proof

- elements still being discovered

or

no gaps for undiscovered elements

- some boxes have 2 elements in them
- metals and non-metals in same column / mixed up
accept some elements in same column have different properties.
allow any sensible suggestion about misplaced elements eg
copper in group 1 elements

- pattern for first 16 or so elements only
allow did not work for all elements

2

- (b) (i) $\text{Cl} > \text{Br} > \text{I}$

accept reactivity / it decreases down the group

or

$\text{I} < \text{Br} < \text{Cl}$

1

Cl has 2 reactions, Br has 1 reaction, I doesn't react
owtte

allow Cl has most / more reactions and I has least / less reactions (must be clear about where Br fits in)

1

- (ii) Br_2

allow multiples / fractions if correctly completed and balanced

1

- (iii) (they) have 7 outer electrons

allow (they) have 7 electrons in highest occupied (energy) level / shells / rings

1

- (c) *outer / last / final must be mentioned once in correct context, otherwise max 2 marks comparative required on all three points accept converse ie less reactive up group*

down group (atom / elements) bigger

or

outer electrons (level / shell / ring) further from nucleus / centre
ignore more electrons

or

more shells / level / rings

do not accept more outer shells for this mark

1

force(s) / attraction(s) are weaker

allow electron(s) attracted less easily

allow electron(s) less under influence (of nucleus)

or

more shielding

or

1

attracts less

do not accept magnetic / gravitational / intermolecular forces

electron(s) lost more easily

allow electron(s) more likely to be lost

allow easier to give away

1

[10]

Q6.

- (a) (iron) is a metal

accept transition element

allow (iron) had different properties (to oxygen and sulfur)

ignore electrons

1

- (b) so that elements with similar properties could be placed together

allow to make the pattern fit

ignore undiscovered elements

1

- (c) atomic number(s)
allow proton number(s) 1
- (d) all have one electron in the outer shell (highest energy level)
allow same number of electrons in the outer shell (highest energy level) 1
- (so they) have similar properties
or
react in the same way
allow specific reactions e.g. with water 1
- [5]**

Q7.

- (a) increase 1
- (b) (i) Na^+ and Br^-
both required 1
- (ii) sodium chloride
allow NaCl
do not allow sodium chlorine 1
- (iii) chlorine is more reactive than bromine
allow converse argument
allow symbols Cl, Cl₂, Br and Br₂
allow chlorine / it is more reactive
do not allow chloride or bromide 1
- (iv) fluorine
allow F / F₂
do not allow fluoride. 1
- [5]**

Q8.

- (a) (i) protons
allow "protons or electrons", but do not allow "protons and electrons" 1
- (ii) protons plus / and neutrons 1
- (b) (because the relative electrical charges are) $- (1)$ for an electron and $+ (1)$ for a proton

allow electrons are negative and protons are positive

1

and the number of electrons is equal to the number of protons

if no other mark awarded, allow 1 mark for the charges cancel out

1

(c) (the electronic structure of) fluorine is 2,7 and chlorine is 2,8,7

allow diagrams for the first marking point

1

(so fluorine and chlorine are in the same group) because they have the same number of or 7 electrons in their highest energy level or outer shell

if no other mark awarded, allow 1 mark for have the same / similar properties

1

(d) S

1

(e) (i) ions

1

(ii) molecules

1

[9]

Q9.

(a) the chemical reaction is reversible

1

(b) any **two** from:

- type of electrode
- electrolyte
- concentration of electrolyte
- temperature

2

(c) $\text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2\text{e}^-$

allow multiples

1

(d) contains OH^- ions

1

(e) (bonds broken)

$$((6 \times 412) + (2 \times 360) + (2 \times 464) + (3 \times 498)) = 5614$$

1

(bonds made)

$$((4 \times 805) + (8 \times 464)) = 6932$$

1

(overall energy change)

$$(6932 - 5614) = -1318 \text{ (kJ / mol)}$$

allow ecf from marking point 1 and / or marking point 2

1

an answer of 1318 (kJ / mol) scores 3 marks

[8]

Q10.

(a) 13 (protons)

The answers must be in the correct order.

if no other marks awarded, award 1 mark if number of protons and electrons are equal

1

14 (neutrons)

1

13 (electrons)

1

(b) has three electrons in outer energy level / shell

allow electronic structure is 2.8.3

1

(c) **Level 3 (5–6 marks):**

A detailed and coherent comparison is given, which demonstrates a broad knowledge and understanding of the key scientific ideas. The response makes logical links between the points raised and uses sufficient examples to support these links.

Level 2 (3–4 marks):

A description is given which demonstrates a reasonable knowledge and understanding of the key scientific ideas. Comparisons are made but may not be fully articulated and / or precise.

Level 1 (1–2 marks):

Simple statements are made which demonstrate a basic knowledge of some of the relevant ideas. The response may fail to make comparisons between the points raised.

0 marks:

No relevant content.

Indicative content

Physical

Transition elements

- high melting points
- high densities
- strong
- hard

Group 1

- low melting points
- low densities
- soft

Chemical

Transition elements

- low reactivity / react slowly (with water or oxygen)

- used as catalysts
- ions with different charges
- coloured compounds

Group 1

- very reactive / react (quickly) with water / non-metals
- not used as catalysts
- white / colourless compounds
- only forms a +1 ion

6

[10]