

AQA GCSE CHEMISTRY (HIGHER) • 8462

CHEMISTRY



EXAM QUESTION PACK

4.1.1 ATOMIC STRUCTURE, SYMBOLS, RELATIVE ATOMIC MASS, CHARGE AND ISOTOPES (PACK 6)

SCORE

/114

PERCENTAGE

%

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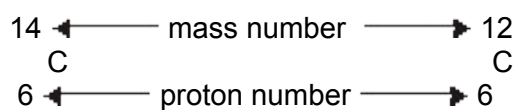
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Q1.

The two carbon atoms represented below are isotopes.

ISOTOPE 1

ISOTOPE 2



- (a) Describe **two** ways in which the isotopes are similar.

(2)

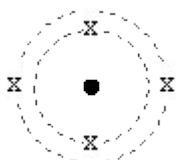
- (b) Describe as fully as you can **one** way in which they are different.

(2)

(Total 4 marks)

Q2.

- (a) The diagram shows the electronic structure of a particular element.



In a similar way, show the electronic structure of another element from the same group in the periodic table and name the element you select.

Name of element selected _____

(4)

- (b) The element lithium gives a moderate reaction with cold water, releasing hydrogen and forming a solution of lithium hydroxide.

Describe how sodium is similar to and how it is different from lithium in its chemical reaction with cold water.

Explain any similarity or difference in terms of their atomic structure.

Similarity. _____

Reason. _____

Difference. _____

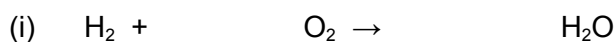
Reason. _____

(5)

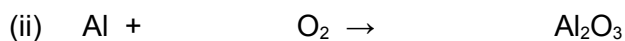
(Total 9 marks)

Q3.

- (a) Balance these chemical equations.



(1)



(1)

- (b) Briefly explain why an unbalanced chemical equation cannot fully describe a reaction.

(2)

(Total 4 marks)

Q4.

Sodium carbonate reacts with acids.

- (i) Complete the word equation.

sodium carbonate + hydrochloric acid $\rightarrow$ sodium chloride + _____ + water

(1)

- (ii) Name the salt produced if sodium carbonate reacts with dilute nitric acid.

(1)

(Total 2 marks)

Q5.

- (a) The formula for ammonia is NH_3 . What does the formula tell you about each molecule of ammonia?

(3)

- (b) Ammonia is used to make nitric acid (HNO_3). Calculate the formula mass (M_r) for nitric acid. (Show your working).

(3)

(Total 6 marks)

Q6.

- (a) Balance these chemical equations.



(1)

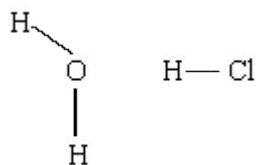


(1)

- (b) Briefly explain why an unbalanced chemical equation cannot fully describe a reaction.

(2)

- (c) Explain, as fully as you can, why a water molecule contains two hydrogen atoms but a hydrogen chloride molecule contains only one.



(You may use a diagram in your answer if you wish).

(3)

(Total 7 marks)

Q7.

You will find it helpful to use the information on the Data Sheet when answering this question.

In the nucleus of an aluminium atom are:

13 protons
and 14 neutrons.

- (a) Complete these sentences.

- (i) The mass number of the aluminium atom is _____ .
(ii) In an atom of aluminium there are _____ electrons.

(2)

- (b) Why is an aluminium atom electrically neutral?

(2)

- (c) Complete the table for the element fluorine.

PARTICLE	NUMBER OF PROTONS	NUMBER OF NEUTRONS	NUMBER OF ELECTRONS
Fluorine atom	9		9
Fluoride atom		10	

Q8.

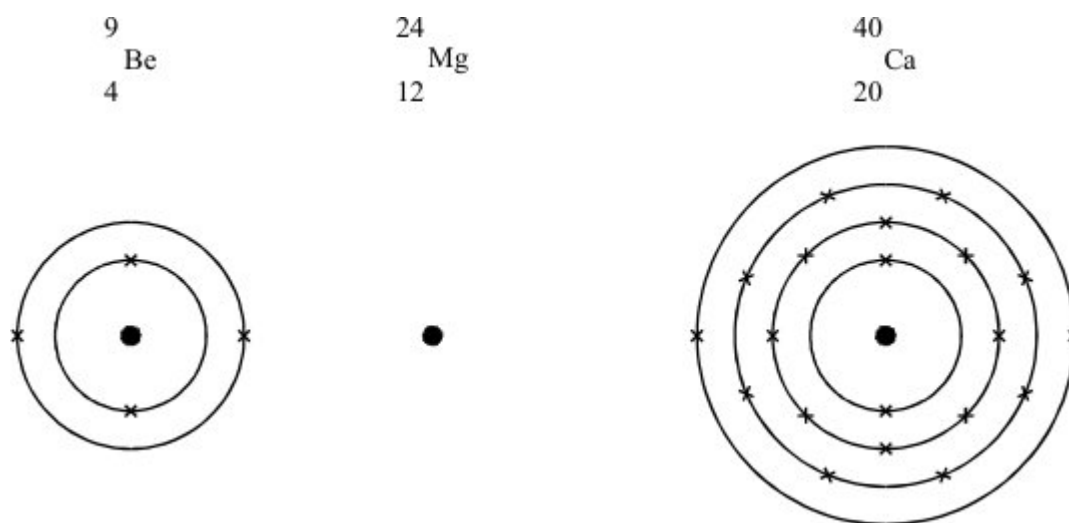
The formula for the compound hydrogen peroxide is H_2O_2 .

Write down everything that the formula tells you about each molecule of hydrogen peroxide.

(Total 4 marks)

Q9.

Three elements in Group 2 of the periodic table are beryllium (Be), magnesium (Mg) and calcium (Ca). Their mass numbers and proton numbers are shown below. The electronic structure is shown for beryllium and calcium.



(a) In a similar way, draw the electronic structure for magnesium.

(3)

- (b)
- The three elements have similar chemical properties
 - The reactivity of these elements with non-metals, increases from beryllium to magnesium to calcium.

Explain these two statements in terms of atomic structure.

(6)
(Total 9 marks)

Q10.

The information on the Data Sheet will be helpful in answering this question.

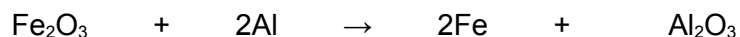
- (a) Calculate the formula mass (M_r) of the compound iron (III) oxide, Fe_2O_3 .

(Show your working.)

(3)

- (b) Calculate the mass of iron produced when 32g of iron (III) oxide is completely reduced by aluminium.

The reaction is shown in the symbol equation:



(Show your working.)

Answer = _____ grams

(3)
(Total 6 marks)

Q11.

Atoms of calcium, phosphorus and fluorine are represented below, each with its mass number and proton number.

40	31	19	← mass numbers
Ca	P	F	
20	15	9	← proton numbers

- (a) Use this information to complete the table.

	CALCIUM	PHOSPHORUS	FLUORINE
Number of protons in the nucleus	20		9
Number of neutrons in the nucleus	20	16	
Number of electrons		15	9

(3)

- (b) Calcium and fluorine atoms can combine to form the compound calcium fluoride, CaF_2 .

The fluoride ion is represented by F^- .

- (i) Explain how the fluorine atom forms a fluoride ion.

(2)

- (ii) How is the calcium ion represented?

(2)

- (c) Phosphorus and fluorine form a covalent compound, phosphorus trifluoride.

Complete the sentences below which are about this compound.

Phosphorus trifluoride is made up of phosphorus and fluorine _____

These are joined together by sharing pairs of _____ to form phosphorus trifluoride _____.

(3)

- (d) (i) Sodium chloride, an ionic compound, has a high melting point whereas paraffin wax, a molecular compound, melts easily.

Explain why.

(2)

- (ii) Molten ionic compounds conduct electricity but molecular compounds are non-conductors, even when liquid.

Explain why.

(2)

(Total 14 marks)

Q12.

Here is a symbol equation, with state symbols, for a chemical reaction between solutions of lead nitrate and potassium chloride.



The equation tells you the formulae of the two products of the reaction.

- (a) What are the names of the **two** products?

1. _____

2. _____

(2)

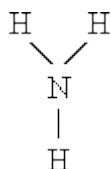
- (b) What else does the equation tell you about these products?

(2)

(Total 4 marks)

Q13.

The diagram shows one molecule of the compound ammonia.



Write down everything that the diagram tells you about each molecule of ammonia.

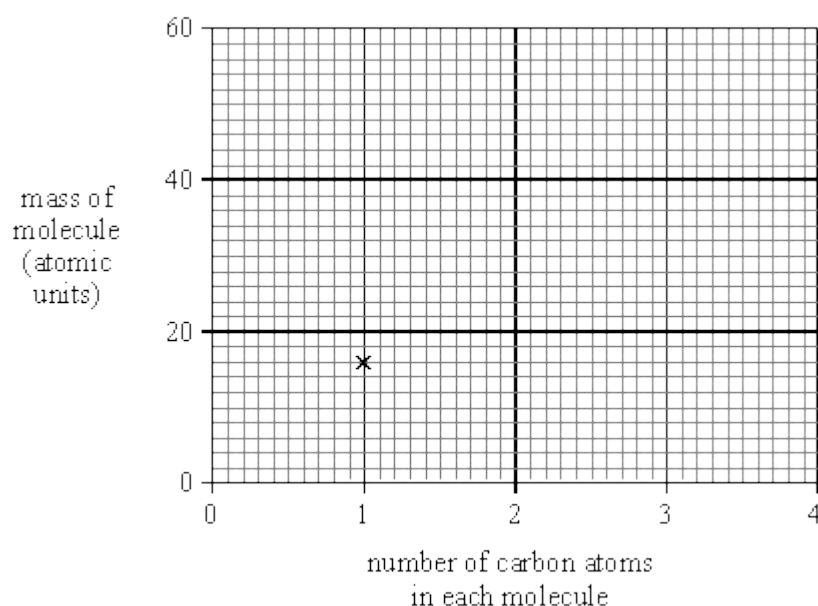
(Total 4 marks)

Q14.

The table gives some information about a family of molecules in crude oil.

NUMBER OF CARBON ATOMS IN MOLECULE	MASS OF MOLECULE (atomic units)
1	16
2	30
4	58

- (a) Show information from the table in the most appropriate way on the grid.



(3)

- (b) What is the mass of a molecule with three carbon atoms?

(1)

- (c) The other atoms in each molecule are all hydrogen atoms.
What family of substances do all the molecules belong to?

(1)

- (d) The mass of a carbon atom is 12 atomic units.
The mass of a hydrogen atom is 1 atomic unit.

So the molecule with one carbon atom has four hydrogen atoms.
Its formula is CH₄.

Write down the formula:

- (i) of the molecule with two carbon atoms _____
- (ii) of a molecule from the same family with five carbon atoms _____

(2)

(Total 7 marks)

Q15.

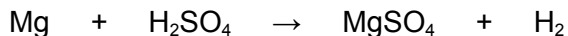
- (a) The formula for the chemical compound magnesium sulphate is MgSO₄.

Calculate the relative formula mass (M_r) of this compound. (Show your working.)

(2)

- (b) Magnesium sulphate can be made from magnesium and dilute sulphuric acid.

This is the equation for the reaction.



Calculate the mass of magnesium sulphate that would be obtained from 4g of magnesium.
(Show your working.)

Answer _____ g

(2)

(Total 4 marks)

Q16.

These are the electronic structures of the atoms of three different elements.

2.8.1
element A

2.8.8
element B

2.8.8.1
element C

- (a) Identify elements A and B.

Element A is _____

Element B is _____

(2)

- (b) (i) Why is element C more reactive than element A?

(2)

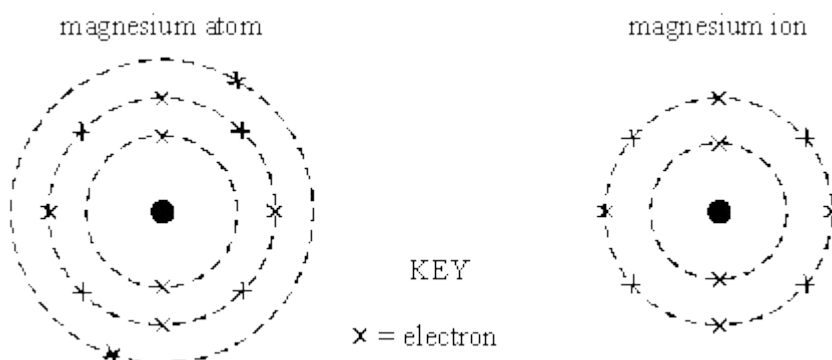
- (ii) Why is element B unreactive?

(2)

(Total 6 marks)

Q17.

- (a) The diagrams below show the electronic structure of a magnesium atom and a magnesium ion.



What is the charge on the magnesium ion? _____

(2)

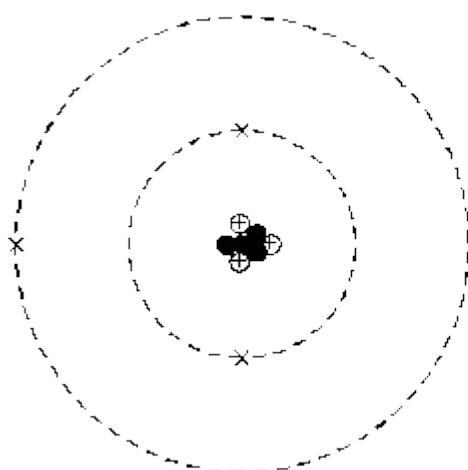
- (b) Calcium bromide has the formula CaBr_2 .

What does this tell you about the ions in this compound?

(2)
(Total 4 marks)

Q18.

The diagram shows the structure of a lithium atom.



KEY

$\oplus$ = proton

$\times$ = electron

(a) (i) What is represented by  _____

(ii) What is represented by  _____

(2)

(b) What is the symbol for lithium? _____

(1)

(Total 3 marks)

Q19.

This question is about the structure of atoms.

(a) Choose words from the list to complete the sentences below.

electrons ions neutrons protons

In an atom, the particles with a negative charge are called _____

Particles in the nucleus with no charge are called _____

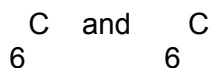
An atom has no overall charge because it has the same number of electrons and _____

(3)

(b) Two isotopes of the element carbon are:

12

14



Complete the table of information for these two isotopes.

	ATOMIC NUMBER	MASS NUMBER	NUMBER OF PROTONS	NUMBER OF NEUTRONS
${}^{12}_6\text{C}$ Isotope	6	12	6	6
${}^6_6\text{C}$ Isotope	6		6	

(2)

(Total 5 marks)

Q20.

- (a) Write down the symbols for

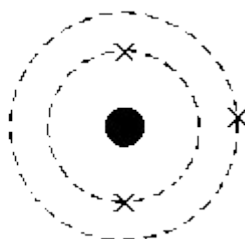
lithium _____

fluorine _____

(2)

- (b) The electronic structure of a lithium atom can be shown like this:

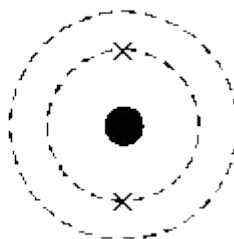
2,1 or



where **x** is an electron.

In a similar way, complete this diagram to show the electronic structure of a fluorine atom.

2,7 or



(1)

- (c) A lithium atom can lose one electron to form a lithium ion which can be written **(2)⁺**
A fluorine atom can gain one electron to form a fluoride ion.

Choose from the list the correct way to write the fluoride ion.

(2,6)⁺ **(2,7)⁺** **(2,7)⁻** **(2,8)⁺** **(2,8)⁻**

Answer _____

(2)

(Total 5 marks)

Mark schemes

Q1.

- (a) same number/six electrons;
same number/six protons;
react in same way **not** same element or both carbon
any two for 1 mark each

2

- (b) different number of neutrons
gains 1 mark

but

or

$^{14}_6\text{C}$ has two more neutrons
gains 1 mark

different mass number

or

but two mass units bigger

gains 2 marks

$^{14}_6\text{C}$ has 8 neutrons while
gains 2 marks

$^{12}_6\text{C}$ has 6 neutrons

2

[4]

Q2.

- (a) 2.8.2. magnesium or 2.8.8.2. calcium
inner shell (2)
outer shell (2)
intermediate shell/s correct
element named to match structure
each for 1 mark
(Structure correct for element name but not in group 2, award 2 marks)

4

- (b) Similar hydrogen and/or an alkali/hydroxide produced
for 1 mark

Reasons:

chemical reaction involves loss of an electron
Na + Li have the same number of electrons in the

outer shell

(do not allow same group of p.table)

each for 1 mark

Different

rate of reaction faster for sodium*

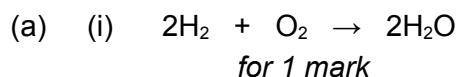
for 1 mark

Reason: outer electron more easily lost from the sodium atom
 [* allow sodium hydroxide produced]
for 1 mark

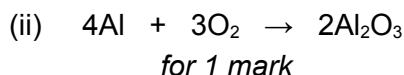
5

[9]

Q3.



1



1

(b) *idea that:*
 must end up with the same number of atoms as at the start
any 2 each

otherwise matter is shown to be lost/gained
for 1 mark

won't show correct amount of each element/compound

2

[4]

Q4.

(i) carbon dioxide (*allow* CO_2)
for 1 mark

1

(ii) sodium nitrate (accept correct formula)
for 1 mark

1

[2]

Q5.

(a) *reference to*
 hydrogen (atoms))
 nitrogen (atoms)) but **not** molecules
each for 1 mark

ratio of 1N to 3H **atoms**
for 1 further mark

or 1 nitrogen atom and 3 hydrogen atoms
 (ignore any incorrect statements about nature of bonding)

3

(b) *evidence of*
 H = 1

N = 14

O = 16

gains 1 mark

but

H = 1

N = 14

O = 16 × 3 or 48

gains 2 marks

but 63

gains 3 marks

3

[6]

Q6.

- (a) (i) $2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O}$ (allow $\text{H}_2 + \frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{O}$)

both circled for 1 mark

1

- (ii) $4 \text{Al} + 3 \text{O}_2 \rightarrow 2 \text{Al}_2\text{O}_3$

all circled for 1 mark

1

- (b) *idea that:*

must end up with the same number of atoms

otherwise matter is shown to be lost/gained

doesn't show correct amount of each element/compared

each for 1 mark

2

- (c) *idea that:*

oxygen has 2 electrons short in outer shell) in words or

chlorine has 1 electron short in outer shell) indicated on diagram

(shared pair/covalent bond with) hydrogen

atom supplies **one** further electron*

*(but do not allow hydrogen **gives away** electron or **ionic bond**)

for 1 mark each

3

[7]

Q7.

- (a) (i) 27

- (ii) 13

each for 1 mark

2

- (b) each proton has a/1 positive charge and each electron has a/1 negative charge OR electrons and protons have (equal but) opposite charges there are equal numbers of protons and electrons in the atom/ so charges cancel or balance (each other)

each for 1 mark

2

(c)

PARTICLE	NUMBER OF PROTONS	NUMBER OF NEUTRONS	NUMBER OF ELECTRONS
Fluorine atom		10	
Fluoride atom	9		10

each for 1 mark

3

[7]

Q8.

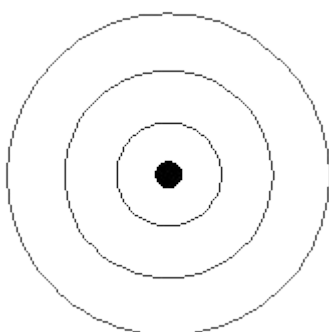
contains oxygen atoms
contains hydrogen atoms
atoms are [chemically] bonded
ratio of two hydrogen to two oxygen atoms

each for 1 mark

[4]

Q9.

(a)



each shell completed correctly
[for written 2.8.2 award 1 mark]

for 1 mark each

3

(b) idea that

- chemical reactions of metals, involves losing electrons
for 1 mark
- these three elements have the same number of electrons in the outer shell/highest energy level
gains 1 mark

but

- these three elements all have two electrons in the outer shell/highest energy level
gains 2 marks

All form ions with a 2+ charge gains all 3 of these marks

- reactivity depends on how easily the electrons are lost
for 1 mark
- the further the electrons are from the nucleus/the higher the energy level they are in, the more shells the atom has*
then the more easily they are lost
for 1 mark
- in calcium the electrons are further from the nucleus than in magnesium than in beryllium
for 1 mark

or as you go down the group
(*not just "the more electrons"....)

6

[9]

Q10.

- (a) Fe_2 [56×2] **or** 112
 O_3 [16×3] **or** 48
each gain 1 mark

but $M_r = 160$
gains 3 marks

3

- (b) [$\text{Fe}_2 \text{O}_3 + 2\text{Al} \rightarrow 2\text{Fe} + \text{Al}_2 \text{O}_3$]

160 $\rightarrow$ 112 (NB Credit if unworked
(or value (or value but should be totalled)
from (a)) from (a))
gains 1 mark

but
32 g. of $\text{Fe}_2 \text{O}_3 \rightarrow 32/160 \times 112$
gains 2 marks

but = 22.4
gains 3 marks

3

[6]

Q11.

(a)

	Calcium	Phosphorus	Fluorine
No of protons		15	
No of neutrons			10

No of electrons	20		
-----------------	----	--	--

for 1 mark each

3

- (b) (i) gain of electron(s)
from (atoms) (of) calcium
for 1 mark

2

- (ii) Ca^+
gains 1 mark
but superscript only Ca^{2+} / Ca^{++}
gains 2 marks

2

- (c) atoms
electrons
molecule(s) not compound
each for 1 mark

3

- (d) (i) *ideas that*
- ionic – strong forces between ions
 - molecular – weak forces between molecules
each for 1 mark

2

- (ii) *ideas that*
- ionic – ions/charged particles are free to move
 - molecular -molecules do not carry a charge
each for 1 mark

2

[14]

Q12.

- (a) lead chloride } *in any order*
potassium nitrate }
for 1 mark each
- (b) lead chloride is solid / a precipitate
potassium nitrate is aqueous / in solution / dissolves in water
NOT liquid
for 1 mark each

2

2

(Accept ratio of molecular KNO_3 : PbCl_2 is 2:1 for 2 marks)
(do not accept relative number of atoms in each compound)

One is a solid, one is a solution – worth 1 mark

[4]

Q13.

idea that

- contains nitrogen atoms
- contains hydrogen atoms
- atoms are chemically bonded NOT linked/joined
- ratio of one nitrogen to three hydrogen (atoms) formula of ammonia is NH_3
for 1 mark each

[4]

Q14.

- (a) • vertical axis appropriately scaled
[i.e. using more than half the grid]
- all three points correctly plotted* (to $< \frac{1}{2}$ a square)
 - reasonably straight line drawn through points (to $< \frac{1}{2}$ a square)*
[*credit both these marks for bars correctly drawn since discontinuous variable]
each • for 1 mark

x [If points incorrectly plotted credit 1 mark for the best fit straight line or curve but not point-to-point]

3

- (b) 44 (atomic units)
for 1 mark
(e.c.f. i.e. credit consistent with candidate's graph)

1

- (c) hydrocarbons / alkanes
for 1 mark

1

- (d) C_2H_6
 C_5H_{12}
each for 1 mark

[NB figures must be subscripted]

2

[7]

Q15.

- (a) $\text{Mg} \quad \text{S} \quad \text{O}_4$
 $24 + 32 + 16 (\times 4)$ or 64 / evidence of all A_r 's
gains 1 mark

but $(M_r) = 120$
gains 2 marks

2

- (b) evidence that 24(g) magnesium would produce 120(g) magnesium sulphate
gains 1 mark

or correct scaling by 1/6

but 20(g) magnesium sulphate
gains 2 marks
[credit error carried forward from (a) with full marks in (b)]

2

[4]

Q16.

- (a) A is sodium/ Na^*
 B is argon/ Ar^*
each for 1 mark
*(*case of letters must be correct)*

2

- (b) (i) *ideas that*

- outer electron (in element C / 2.8.8.1 / potassium) is at a higher energy level / in a more outer shell/further away from nucleus / shielded by more full electron shells
- electron is more easily lost/less strongly held / attracted
each for 1 mark

2

- (ii) *ideas that*

- (element B / 2.8.8 / argon) has an outer shell that is complete/has 8 electrons
- no tendency to gain or lose electrons / has a stable configuration
- (not 'is stable' / 'in group O' / 'a noble gas')
each for 1 mark

2

[6]

Q17.

- (a) positive / + / 2
gains 1 mark

but $2^+ / ++ / +2$
gains 2 marks

- (b) *Ideas that: 2*
 Ca^{2+}
 Br [Do not disqualify for "bromine" ions]
 Ions / They are in the ratio 1:2
any two for 1 mark each

2

[4]

Q18.

- (a) (i) neutron (*name only*)
- (ii) nucleus / protons and neutrons
each for 1 mark
(do not allow mass number)
- (b) Li (*correct cases of letters required*)
for 1 mark

2

1

[3]

Q19.

- (a) electrons
 neutrons
 protons
- for 1 mark each*
- (b) mass number no. of neutrons
- 14 8
- for 1 mark each*

3

2

[5]

Q20.

- (a) lithium = Li
(ignore mass / atomic numbers)
fluorine = F (do not allow if case is incorrect)
for 1 mark each
- (b) (allow • or O for electrons)
(allow any positions for the seven electrons added provided they are on the outer ring)
for 1 mark
- (c) (2,8)⁺ or (2,7)⁻
(brackets not required) gains 1 mark

2

1

but (2,8)-

gains 2 marks

2

[5]