



Atomic structure, chemical reactions and the periodic table

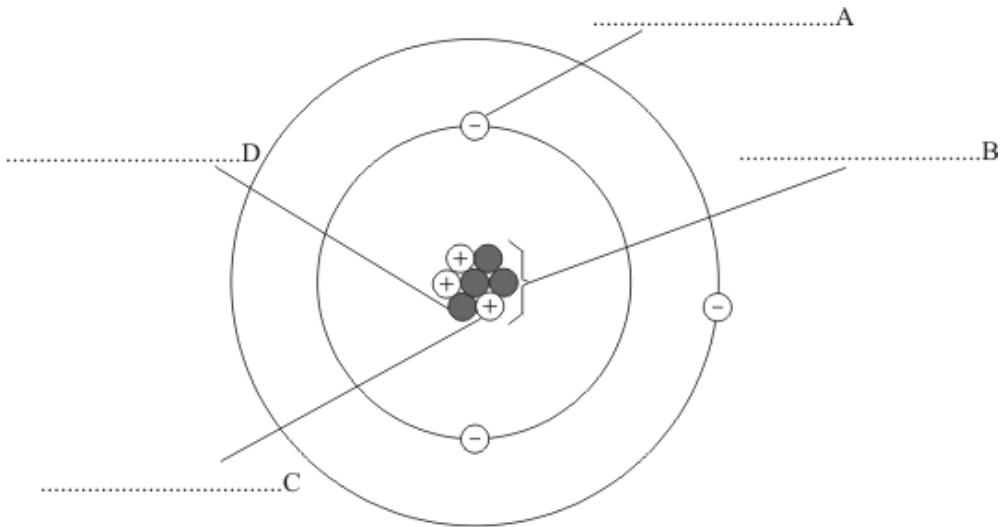


119 minutes



119 marks

Q1. The diagram shows an atom.



(a) On the diagram, write the names of structures **A**, **B**, **C** and **D**.

(4)

(b) To which Group of the periodic table does this atom belong?

.....

Give **one** reason for your answer.

.....

.....

(2)

(c) Name the element which is made up of this type of atom.

.....

(1)

(Total 7 marks)

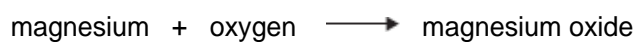
Q2. Magnesium burns in oxygen.



By Kingsway School [CC BY 2.0],
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(a) Use the Chemistry Data Sheet to help you to answer this question.

The word equation for magnesium burning is:

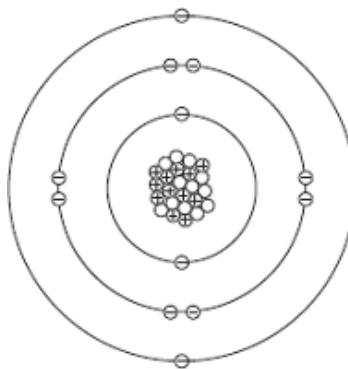


Draw **one** line from each substance to its correct description.

Substance	Description
magnesium	compound
magnesium oxide	metal
oxygen	mixture
	non-metal

(3)

(b) The diagram represents a magnesium atom.



Complete the table to show the name of each particle and the charge of each particle in the magnesium atom.

Name of particle	Charge
proton	+1
neutron
.....	-1

(2)

(c) Use the Chemistry Data Sheet to help you to answer these questions.

Draw a ring around the correct answer to complete each sentence.

(i) In a magnesium atom, the protons and neutrons are in the

core.
nucleus.
shell.

(1)

(ii) The number of protons in a magnesium atom is the

atomic number
mass number.
group number.

(1)

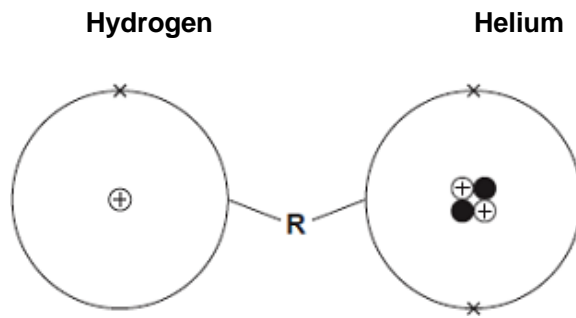
(iii) The sum of the protons and neutrons in a magnesium atom is the

atomic number.
mass number.
group number.

(1)

(Total 8 marks)

Q3. The Sun is mainly hydrogen and helium.
The diagrams show an atom of hydrogen and an atom of helium.



(a) Draw a ring around the correct answer to complete each sentence.

(i) The centre of each atom is called the

- molecule.
- nucleus.
- shell.

(1)

(ii) The circle (labelled **R**) around the centre of each atom is called

- a bond.
- an electrical charge.
- an energy level (shell).

(1)

(b) Use the diagrams in part (a) to help you to answer these questions.

Draw **one** line from each question to its correct answer.

Question	Answer
How many protons are there in the hydrogen atom?	1
How many electrons are there in the helium atom?	2
What is the mass number of the helium atom?	3
	4

(3)

(c) The Sun is 73% hydrogen and 25% helium. The rest is other elements.

What is the percentage of other elements in the Sun?

..... %

(1)

(d) One of the other elements in the Sun is neon.
Neon is in the same group of the periodic table as helium.

Use the Chemistry Data Sheet to help you to answer these questions.

(i) How many protons are there in a neon atom?

.....

(1)

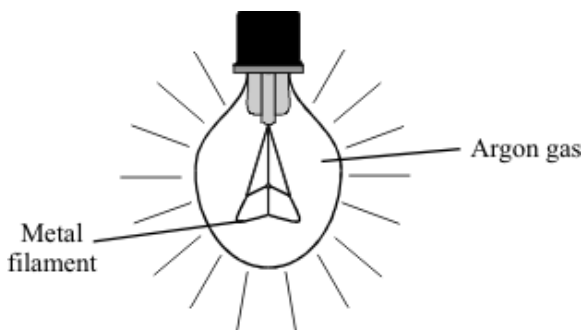
(ii) Which group of the periodic table are helium and neon in?

.....

(1)

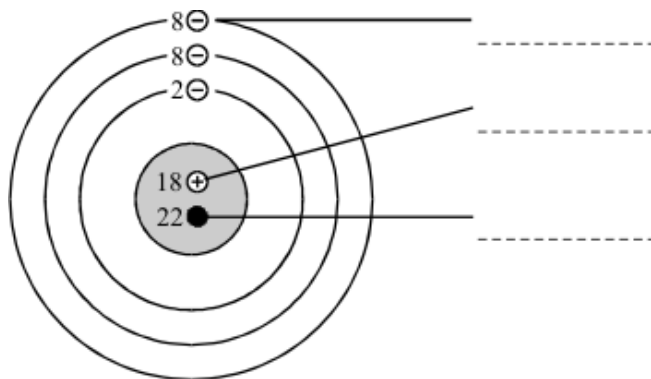
(Total 8 marks)

Q4. The diagram shows a light bulb.



(a) (i) An argon atom has the structure shown. Use the words in the box to label the particles in the atom. Each word should only be used **once**.

electron neutron proton



(2)

(ii) Argon is unreactive. Why?

.....
.....

(1)

(b) Oxygen would **not** be a suitable gas to use in a light bulb. Explain why.

.....
.....

(2)

(Total 5 marks)

Q5. Natural gas is mainly a hydrocarbon called methane.

(a) Use **one** word from the box to complete the sentence.

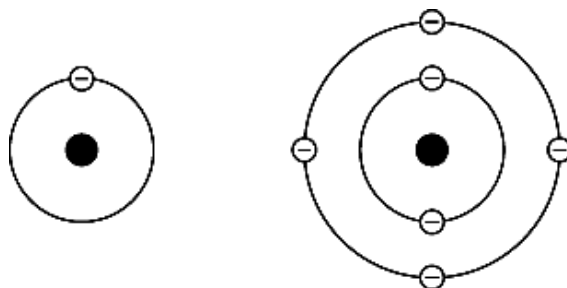
compounds	elements	molecules
------------------	-----------------	------------------

Hydrocarbons contain hydrogen and carbon only.

Hydrogen and carbon are

(1)

(b) The diagrams represent atoms of hydrogen and carbon.



Hydrogen

Carbon

Draw a ring around the correct answer to complete the sentences.

(i) The centre of each atom is called the

bond.
nucleus.
symbol.

(1)

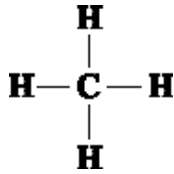
(ii) The hydrogen atom has one electron and the carbon atom has

three
four
six

 electrons.

(1)

(c) A molecule of methane can be represented as



Draw a ring around the correct answer to complete the sentences.

(i) The formula of methane is

CH
CH ₄
C ₄ H ₄

(1)

(ii) The line between C—H is called a

bond.
molecule.
nucleus.

(1)

(d) Methane burns to produce carbon dioxide (CO₂) and water (H₂O).

(i) Draw a ring around the correct answer to complete the sentence.

When methane burns it reacts with

carbon.
nitrogen.
oxygen.

(1)

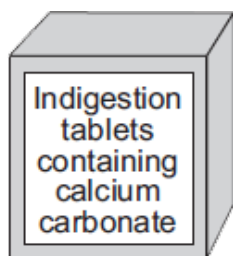
(ii) Hydrogen (H_2) can be used as a fuel.

Suggest why burning hydrogen would be less harmful to the environment than burning methane.

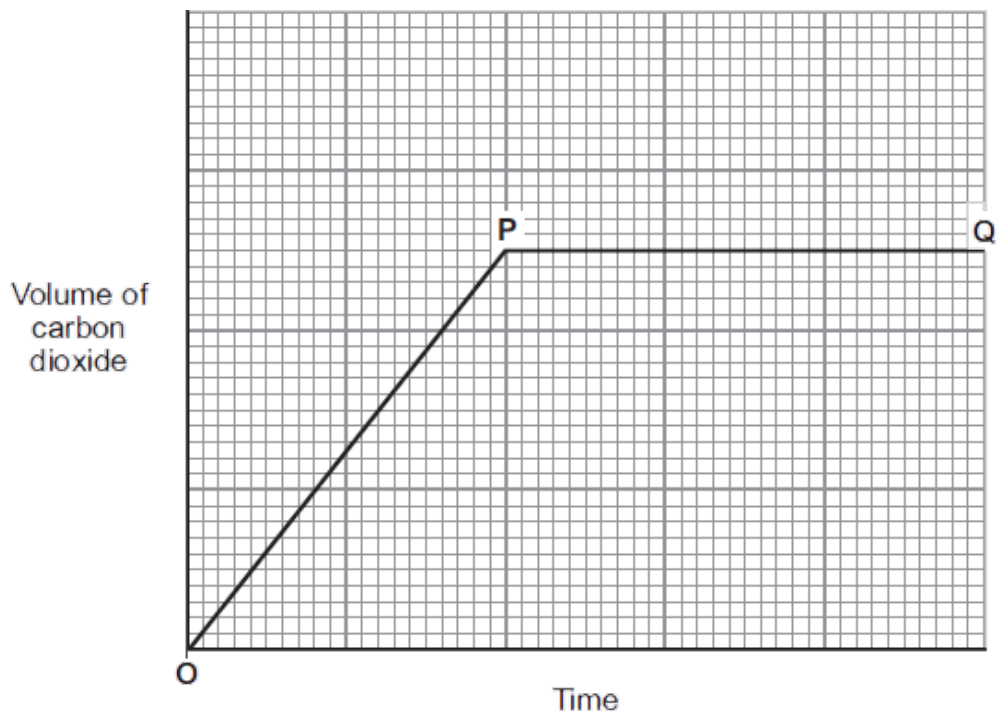
.....
.....

(1)
(Total 7 marks)

Q6. Human stomachs contain hydrochloric acid.
Stomach ache can be caused by too much acid in the stomach.
Indigestion tablets can be used to reduce the amount of acid in the stomach.



(a) The graph shows how the volume of carbon dioxide produced changes with time, after some calcium carbonate is added to hydrochloric acid.



(i) Complete the sentence to explain what happens between O and P.

Between O and P the calcium carbonate and hydrochloric acid

(1)

(ii) Complete the sentence to explain what happens at **P**.

At **P** the calcium carbonate and hydrochloric acid

because

(2)

(iii) Describe the test for carbon dioxide gas.

Test

Result of the test

(2)

- (b) Calcium carbonate is found in limestone.
Limestone is removed from the ground by quarrying.



Photograph supplied by Stockbyte/Thinkstock

Tick (✓) **one** advantage and tick (✓) **one** disadvantage of quarrying limestone.

Statement	Advantage Tick (✓)	Disadvantage Tick (✓)
Quarrying limestone destroys the shells and skeletons of marine organisms that formed the limestone.		
Quarrying limestone releases dust, and lorries release carbon dioxide from burning diesel fuel.		
Quarrying limestone provides building materials, employment and new road links.		
Quarrying limestone removes ores from the ground.		

Q7. Atoms are made up of three main particles called protons, neutrons and electrons.

Use the periodic table on the data sheet to help you to answer these questions.

(a) Sodium is in Group 1 of the periodic table.

(i) Why are potassium and sodium in the same Group of the periodic table?

.....
.....

(1)

(ii) How many protons are in an atom of sodium?

(1)

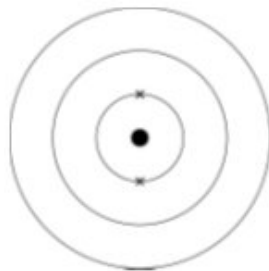
(iii) The atomic number of sodium is 11.

How many neutrons are in an atom of sodium with mass number 23?

.....

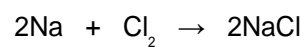
(1)

(iv) Each sodium atom has 11 electrons. Complete the electronic structure of sodium.



(2)

(b) The chemical equation for a reaction of sodium is shown below.



Describe this reaction of sodium in terms of the names of the substances and the numbers of the atoms involved.

.....

.....

.....

.....

.....

.....

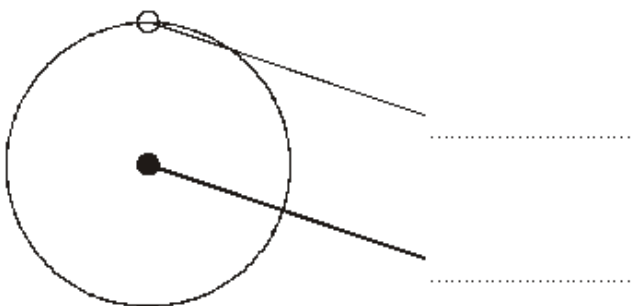
(3)
(Total 8 marks)

Q8. Hydrogen is an element.

(a) The diagram shows the parts of a hydrogen atom.

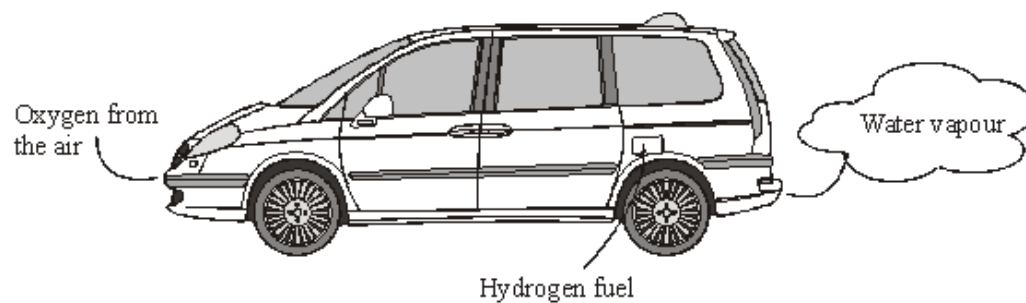
Use words from the box to label the diagram.

electron	group	nucleus	symbol
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(2)

(b) Hydrogen can be used as a *clean fuel* for cars.



(i) When hydrogen burns in air, it reacts with another element.

Complete the word equation for this reaction.



(1)

(ii) Suggest **one** reason why hydrogen is called a *clean fuel*.

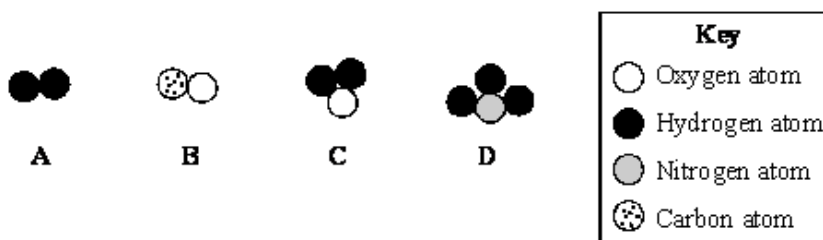
.....
.....

(1)

(Total 4 marks)

Q9. The periodic table on the Data Sheet might help you to answer this question.

Diagrams **A – D** show models of four different molecules.



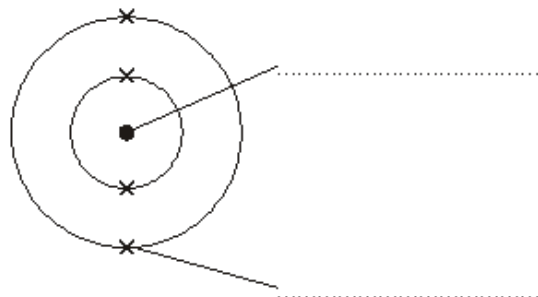
Complete the table to give the name and the formula of each of the molecules A – D.

The first one has been done for you.

Molecule	Name	Formula
A	Hydrogen	H ₂
B		
C		
D		

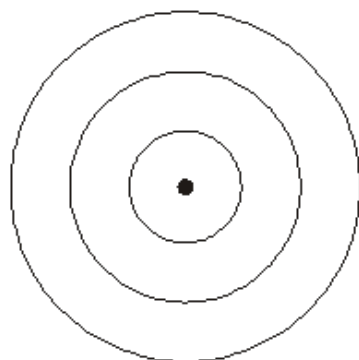
(Total 6 marks)

- Q10.** (a) The diagram represents an atom of beryllium. Use words from the box to label the diagram.



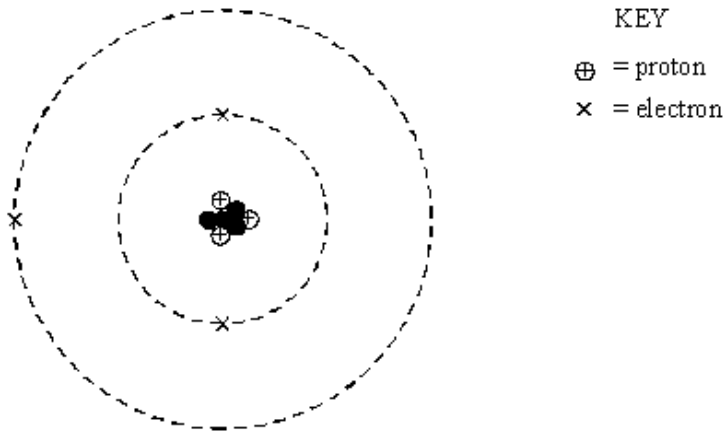
(2)

- (b) Use crosses (x) to complete the diagram to show the electronic structure of a magnesium atom. The atomic (proton) number of magnesium is 12.



(2)
(Total 4 marks)

Q11. The diagram shows the structure of a lithium atom.



(a) (i) What is represented by \bullet

(ii) What is represented by \oplus

(2)

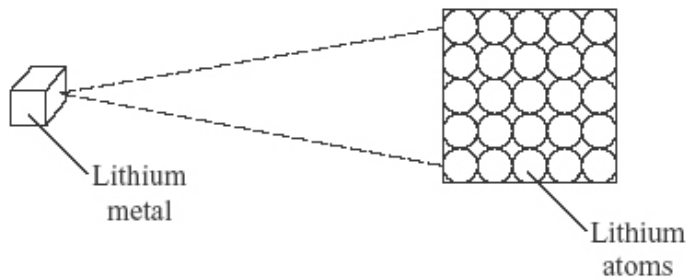
(b) What is the symbol for lithium?

(1)

(Total 3 marks)

Q12. Lithium metal is used in alkaline batteries.

(a) The diagram shows the atoms in lithium metal.



Why is lithium metal described as an element?

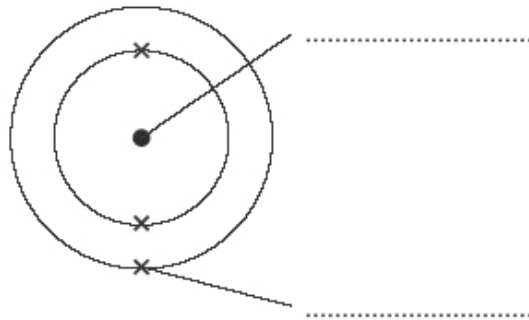
.....

(1)

(b) The diagram below represents a lithium atom.

Choose words from the box to label parts of the atom.

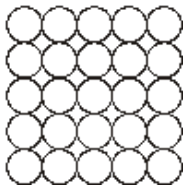
bond	electron	molecule	nucleus
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(2)
(Total 3 marks)

Q13. Iron is the main structural metal used in the world.

(a) The diagram represents the particles in iron, Fe.



Draw a ring around the correct word in the box to complete the sentence.

Iron is described as an element because all the

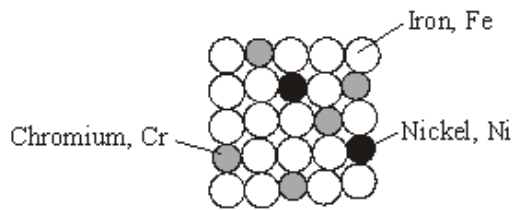
atoms
compounds
metals

are the same.

(1)

(b) Stainless steel is mostly iron.

The diagram represents the particles in stainless steel.



Use the correct words from the box to complete the sentences about alloys.

metal	mixture	molecule	polymer	smart	structure
-------	---------	----------	---------	-------	-----------

Stainless steel is an alloy because it is a of iron, chromium and nickel.

An alloy is made up of more than one type of

Stainless steel alloys are harder than iron because the different sized atoms added change

the

An alloy that can return to its original shape after being deformed is called a

..... alloy.

(4)

(c) In the UK, we use about 1.8 billion steel cans every year but only 25% are recycled. Used steel cans are worth about £100 per tonne.

Recycling saves raw materials and reduces waste that would end up in landfill. Producing steel by recycling used cans saves 75% of the energy that would be needed to produce steel from iron ore. This also reduces carbon dioxide emissions.

(i) Give **two** reasons, from the information above, to explain why recycling used steel cans is a good idea.

1

.....

2

.....

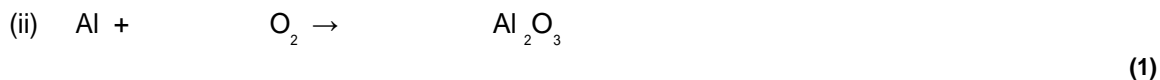
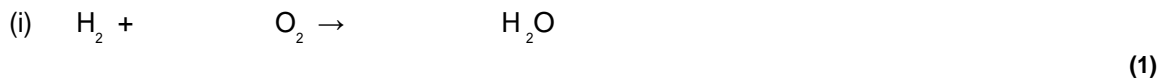
(2)

- (ii) Suggest how the local council could increase the percentage of used steel cans that are recycled.

.....
.....

(1)
(Total 8 marks)

Q14. (a) Balance these chemical equations.



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

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

(2)
(Total 4 marks)

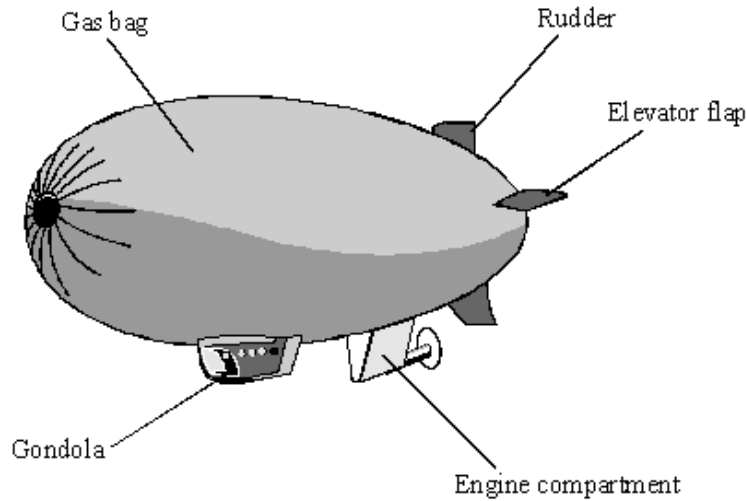
Q15. Sodium reacts with water to produce hydrogen gas and a solution of sodium hydroxide.

Complete the **word** equation for this reaction (do **not** use symbols or formulae).

..... + +

(Total 3 marks)

Q16. The drawing shows an airship that was used about 80 years ago.



(a) The gas bag was filled with hydrogen. A leak from the gas bag could be very dangerous. Use your knowledge of the reactions of hydrogen to explain why.

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

(2)

(b) Modern airships are filled with helium.

(i) What property makes both hydrogen and helium suitable for use in airships?

.....
.....

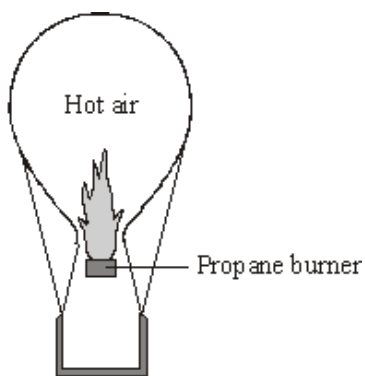
(1)

(ii) Helium is safer than hydrogen for use in airships. Explain why. You should use the position of helium in the periodic table in your answer.

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

(2)
(Total 5 marks)

Q17. Hot air balloons burn hydrocarbons to heat the air.



- (a) The hot air contains these gases:
- nitrogen, N_2
 - oxygen, O_2
 - argon, Ar
 - carbon dioxide, CO_2
 - water vapour, H_2O

(i) Argon is an *element*.

What is an *element*?

.....

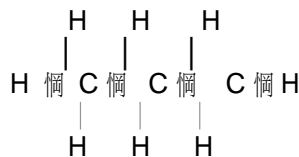
(1)

(ii) Name **one** other gas in the hot air that is also an element.

.....

(1)

(b) Propane, C_3H_8 , can be represented as:



Use the correct words from the box to complete the sentences.

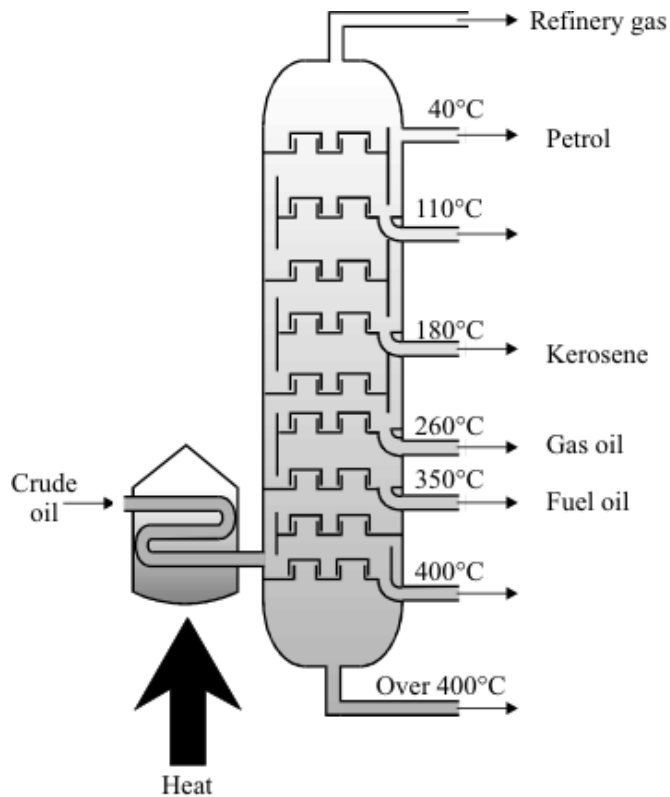
bond	carbon	compound	element	mixture
-------------	---------------	-----------------	----------------	----------------

(i) Propane is a and is made up of atoms of hydrogen and

(2)

- (ii) Each line between the atoms in propane represents a chemical (1)
 (Total 5 marks)

Q18. To make crude oil more useful it is separated into different fractions.



(a) Complete the gaps in the following sentences.

Crude oil is separated into different fractions by a process called
 Each fraction has a different

(2)

(b) Each fraction is a mixture of compounds. Most of these compounds are hydrocarbons, made up of the elements hydrogen and carbon.

(i) Explain the difference between a mixture and a compound.

.....

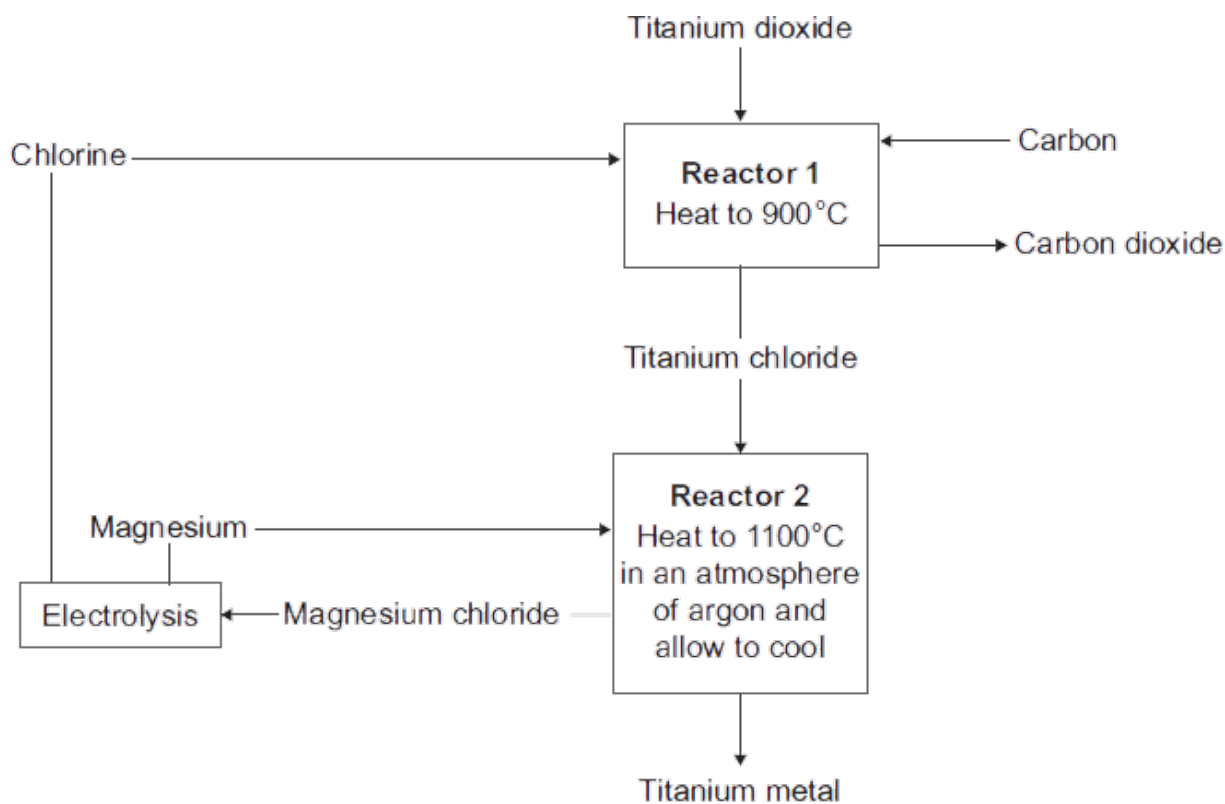
(2)

(ii) Explain the difference between a compound and an element.

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

(2)
(Total 6 marks)

Q19. Rutile is an ore of titanium. Rutile contains titanium dioxide.
The flow chart shows how titanium metal is extracted from titanium dioxide.



(a) Titanium is much more expensive than iron.

Give **one** reason why.

.....
.....

(1)

(b) Name the only waste product shown on the flow chart.

.....

(1)

(c) Describe the example of recycling shown on the flow chart.

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

(2)

(d) The air is removed from **Reactor 2**. An atmosphere of argon is used for the reaction between titanium chloride and magnesium metal.

Explain why.

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

(2)

(e) Titanium metal is produced by reacting titanium chloride with magnesium.

950 kg of titanium chloride was mixed with 240 kg of magnesium metal. The mixture was heated and produced 950 kg of magnesium chloride.

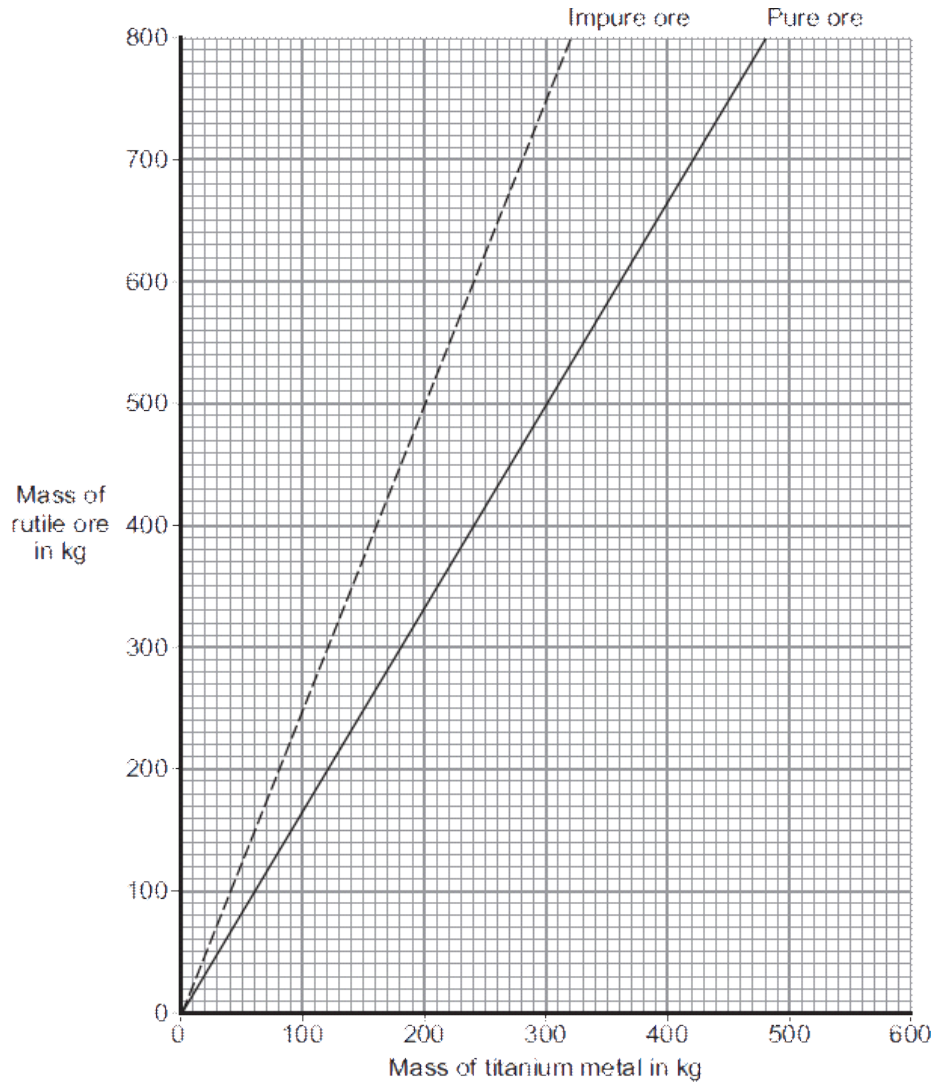
Calculate the mass of titanium metal produced.

.....

Mass = kg

(1)

- (f) The graph shows the mass of titanium metal produced from a pure rutile ore and from an impure rutile ore.



The difference between the two lines represents the amount of waste rock in the impure ore.

300 kg of titanium metal was produced from the impure ore.

Calculate the mass of waste rock in the impure ore.

.....

Mass = kg

(1)
(Total 8 marks)

Q20. (a) Sulphur is a yellow element. It is a non-metal.

(i) Complete the sentence.

In an element, all the atoms

.....

(1)

(ii) Give **two** properties you would expect sulphur to have because it is a non-metal.

1.

.....

2.

.....

(2)

(b) Use the names of metals from the box to complete the table.

copper iron magnesium manganese zinc

Use	Name of metal
for electric wiring in a house
for manhole covers
to galvanise iron

(3)

(c) Copper is used to make hot water pipes. Both iron and steel are cheaper.

Suggest **two** reasons why copper is used rather than iron or steel.

1.

.....

2.

.....

(2)

- (d) The drawing shows a container of a compound called sodium chloride.



- (i) Which other element has combined with sodium to form this compound?

.....

(1)

- (ii) For every atom of sodium, how many atoms of the other element have combined with it?

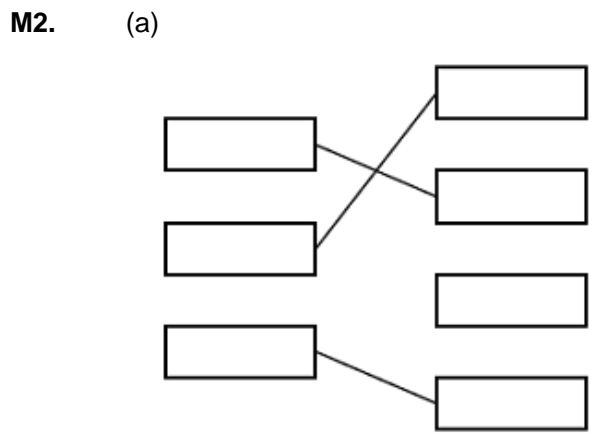
.....

(1)

(Total 10 marks)

- M1.** (a) **A** – electron 1
- B** – nucleus 1
- C** – proton 1
- D** – neutron 1
- (b) Group 1 / alkali metals 1
- has one electron in outer shell
*accept 3 protons / 3 electrons / atomic number 3
 therefore lithium (so Group 1 / alkali metals)* 1
- (c) lithium 1
accept Li

[7]



*one mark for each substance linked correctly to its description
 do **not** accept more than one line from each substance*

- 3
- (b) 0 / zero / none / no charge 1
- electron 1
- (c) (i) nucleus 1
- (ii) atomic number 1

(iii) mass number

1

[8]

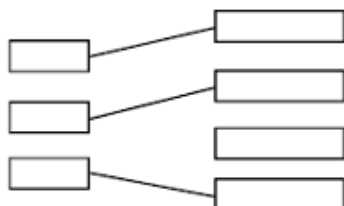
M3. (a) (i) nucleus

1

(ii) an energy level (shell)

1

(b)



3

(c) 2 / two(%)

1

(d) (i) 10 / ten

1

(ii) (group) 0

accept noble gases
ignore (group) 8

1

[8]

M4. (a) (i) **all correct two marks one or two correct one mark**

electron
proton
neutron

2

(ii) (argon has) a full outer shell (of electrons)

accept energy level for shell
accept does not lose or gain electrons
*do **not** accept does not form bonds*
***or** react **or** is a noble **or** inert gas*

1

(b) oxygen would react (with metal)

accept oxygen is reactive
*do **not** accept metal would react (neutral)*

1

metal would burn

*accept metal would be 'destroyed'
or metal oxide formed or metal is oxidised
do not accept it would explode or
would not last long
accept filament for metal*

1

[5]

M5. (a) elements

1

(b) (i) nucleus

1

(ii) six

1

(c) (i) CH₄

1

(ii) bond

1

(d) (i) oxygen

1

(ii) any **one** from:

- (water) does not pollute
*accept no harmful gas(es)
allow less pollution*
- (only) water is produced
- no carbon dioxide / monoxide (is produced)
accept no greenhouse gas(es) / effect or no global warming

1

[7]

M6. (a) (i) react

*allow neutralise
allow bubbles / fizzes
accept produces gas / CO₂
ignore rises*

1

(ii) stop reacting / producing

stops on its own is insufficient allow stop working / bubbling / fizzing

1

the (hydrochloric) acid / (calcium) carbonate is used up
accept because the (calcium) carbonate has neutralised the (hydrochloric) acid

OR

have been used up (1)

the graph line becomes horizontal / levels out (1)

OR

stays the same / no change (1)

ignore reference to graph line

no further reaction (1)

1

- (iii) bubble the gas through limewater / calcium hydroxide solution
allow (add) limewater
test must be correct to gain result mark

1

(the solution) goes cloudy
allow milky

1

- (b) advantage > Quarrying limestone provides building materials, employment and new road links

1

disadvantage > Quarrying limestone releases dust, and lorries release carbon dioxide from burning diesel fuel

1

[7]

- M7.** (a) (i) both have one / 1 electron in the outer energy level / shell
allow both react in a similar way

1

- (ii) eleven / 11

1

- (iii) twelve / 12

1

- (iv) (2x)

max 1 if candidate changes the number of electrons in the first energy level / shell

8x (in second energy level / shell)

1

1x (in outer energy level / shell)

1

- (b) two sodium atoms (react) 1
- two (bonded) chlorine atoms (react)
allow one chlorine molecule (reacts) 1
- two sodium ions and two chloride ions (are produced)
allow two molecules of sodium chloride (are produced) or two sodium chloride particles (are produced) 1
- [8]**

M8. (a) electron 1
words must be in correct position

nucleus 1

(b) (i) oxygen / O₂ 1
ignore air

- (ii) any **one** from:
- (water) does not pollute
accept no harmful gas(es)
 - (only) water is produced
 - no carbon dioxide (is produced)
accept no greenhouse gas(es) / effect
 - no sulfur dioxide (is produced)
accept no acid rain
 - no nitrogen oxides (are produced)
 - no carbon / no particles (are produced) 1

[4]

M9.	B	carbon monoxide	1	
		CO		
		<i>accept carbon oxide</i>		
		<i>do not credit carbon dioxide</i>		
		<i>do not credit if any superscripts or</i>		
		<i>subscripts used but accept C₁O₁,</i>		
		<i>accept OC</i>		
		<i>do not credit if obviously lower case</i>	1	
	C	water	1	
		H ₂ O		
		<i>accept hydrogen oxide</i>		
		<i>do not accept hydrogen hydroxide</i>		
		<i>do not credit if obviously lower case or</i>		
		<i>if 2 not subscript</i>		
		<i>do not accept HOH</i>		
		<i>accept OH₂</i>	1	
	D	ammonia	1	
		NH ₃		
		<i>do not accept ammonium</i>		
		<i>do not credit if obviously lower case,</i>		
		<i>or if 3 not subscript</i>		
		<i>accept nitrogen hydride or hydrogen</i>		
		<i>nitride</i>		
		<i>do not accept hydrogen nitrate or</i>		
		<i>nitrite</i>		
		<i>allow H₃N</i>	1	
				[6]
M10.	(a)	nucleus	1	
		electron	1	
	(b)	correct number of electrons (12)		
		<i>accept dots and circles</i>	1	
		2.8.2	1	
				[4]

M11.	(a) (i) neutron (<i>name only</i>)	2	
	(ii) nucleus / protons and neutrons <i>each for 1 mark</i> <i>(do not allow mass number)</i>		
	(b) Li (<i>correct cases of letters required</i>) <i>for 1 mark</i>	1	[3]

M12.	(a) made of one sort of atom <i>accept it is in the periodic table</i> <i>accept it only has lithium atoms</i>	1	
	(b) nucleus labelled correctly	1	
	electron labelled correctly	1	[3]

M13.	(a) atoms	1	
	(b) mixture	1	
	metal	1	
	structure	1	
	smart	1	

(c) (i) any **two** from:

- saves raw materials / iron ore
- saves energy / fuels
accept cheaper / saves money
- make new / useful items
- make money / it is economic
- reduces pollution
allow less harmful for the environment
- decreases cost of steel cans
- reduces carbon dioxide emissions
- decreases waste materials / use of landfill

2

(ii) any **one** from:

- provide information / education of the need to recycle
- legislate against / charge for waste
- reward / pay people to recycle
accept fine people for not recycling
- put labels on the cans
- provide recycling bags / bins / areas

1

[8]

M14. (a) (i) $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$ *both circled correct
for 1 mark

1

(ii) $\text{A}_1 + \text{O}_2 \rightarrow \text{A}_1\text{O}_3$ all circled correct
for 1 mark

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]

- M15.**
- correct reactants (i.e. sodium + water either way round)
 - correct products (i.e. sodium hydroxide + hydrogen, either way round)
 - arrow \rightarrow / = [do not allow produce/makes or similar]

[do not allow symbols or formulae]
each for 1 mark

[3]

- M16.** (a) any **two** from:

could explode (owtte)
accept 'pop'

reacts with oxygen (air)

ignites easily **or** flammable **or** fire risk (owtte)

2

- (b) (i) lighter / less dense than air
accept each has a very low density

1

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

noble gas
*accept group 0, 8 or 18 **or** has full shells*

so (very) unreactive **or** inert
accept 'not reactive'

will not burn / explode / react

2

[5]

- M17.** (a) (i) made up of one sort of atom
accept it is in the periodic table
or
has its own symbol 1
- (ii) nitrogen / N / N₂ **or** oxygen / O / O₂
do not accept argon or helium
do not accept oxide 1
- (b) (i) compound 1
- carbon 1
- (ii) bond 1
- [5]**

- M18.** (a) fractional distillation 1
- boiling point or use 1
- (b) (i) mixture: compounds **or** elements **or** substances together but not chemically combined
ignore references to separation 1
- compound: (different) elements **or** different atoms together and chemically combined
ignore references to separation 1
- (ii) element: contains only one type of atom
accept made of atoms which contain the same number of protons 1
- compound: contains different types of atom chemically combined
'chemically combined' not needed here if already stated in (b)(i) 1
- [6]**

- M19.** (a) any **one** from:
ignore references to cost / mining / availability
- there are many stages needed (to extract titanium)
allow longer / slower / more complicated process / batch process
 - more energy / materials are needed (to extract titanium)
ignore higher temperature ignore reference to electrolysis
 - titanium cannot be extracted by using carbon
*do **not** accept titanium extracted by electrolysis*
- 1
- (b) carbon dioxide
allow CO₂
- 1
- (c) magnesium chloride is electrolysed / used / decomposed
- 1
- magnesium and / or chlorine are recycled / reused
allow the products of electrolysis are recycled
word / symbol equation = 1 mark
- 1
- (d) *accept titanium for magnesium*
- because oxygen / nitrogen (in air) would react with the magnesium
or
 would produce magnesium oxide / nitride
- 1
- whereas argon is inert / unreactive **or** argon does not react with magnesium
ignore argon is in Group 0 / noble gas
- 1
- (e) 240
- 1
- (f) 250
allow range 245 to 250
- 1

[8]

- M20.** (a) (i) are identical / the same
or have the same number of protons /
 the same proton number / electrons
 not similar
- 1

(ii) any **two** of

low melting point

low boiling point

brittle (solid)

do not credit just solid

poor conductor of heat

or *heat insulator*

poor conductor of electricity

or *electrical insulator*

accept just poor / low conductor or just insulator once only

dull surface

or *not shiny*

cannot be hammered / bent (into shape)

or *not malleable*

cannot be stretched (into shape)

or *not ductile*

does not make a clanging

sound (when struck)

or *not sonorous*

acidic oxides

low density

2

(b) copper

1

iron

correct symbols

1

zinc

1

(c) can be bent (easily)

or *malleable*

or *can be joined easily*

do not credit just can be joined

not reactive

or *does not corrode*

or *does not react (with hot water)*

accept does not rust

2

- (d) (i) chlorine
do not credit chloride
- (ii) one / 1
same number / amount

1

1

[10]

