

Atomic Structure and the periodic table H

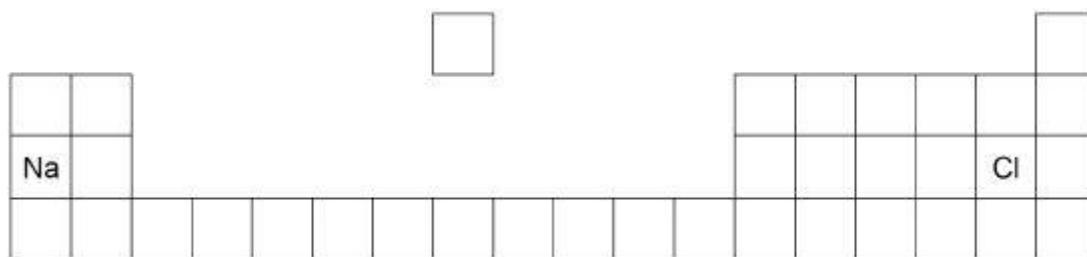
<https://SIYYOEX.exampro.net>

Q1.

This question is about sodium and chlorine.

Figure 1 shows the positions of sodium and chlorine in the periodic table.

Figure 1



- (a) State **one** difference and **one** similarity in the electronic structure of sodium and of chlorine.

Difference _____

Similarity _____

(2)

- (b) Sodium atoms react with chlorine atoms to produce sodium chloride (NaCl).

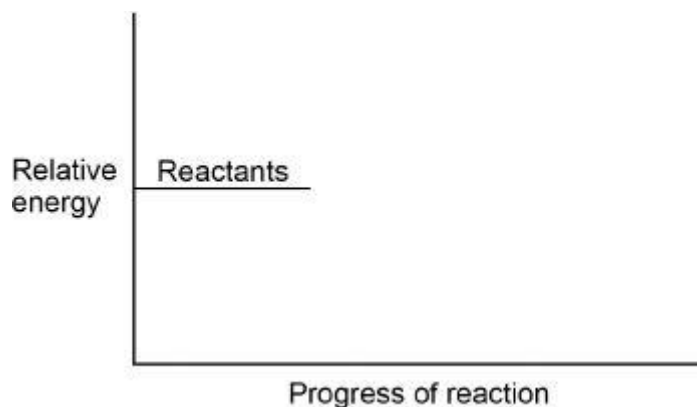
Describe what happens when a sodium atom reacts with a chlorine atom.

Write about electron transfer in your answer.

(4)

- (c) The reaction between sodium and chlorine is an exothermic reaction.
Complete the reaction profile for the reaction between sodium and chlorine.

Figure 2



(2)
(Total 8 marks)

Q2.

This question is about the periodic table.

In 1864 John Newlands suggested an arrangement of elements.

Figure 1 shows the arrangement Newlands suggested.

Figure 1

| 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 |

- (a) Give **two** differences between the groupings in **Figure 1** compared with the modern periodic table.

1. _____

2. _____

(2)

In 1869 Mendeleev produced his periodic table.

- (b) Why was Mendeleev's table called a periodic table?

| Statement | Letter representing element |
|---|-----------------------------|
| An alkali metal | A |
| An element consisting of molecules | D |
| An element that has atoms with the electronic structure 2.8.3 | E |
| | G |
| | J |

(3)
(Total 10 marks)

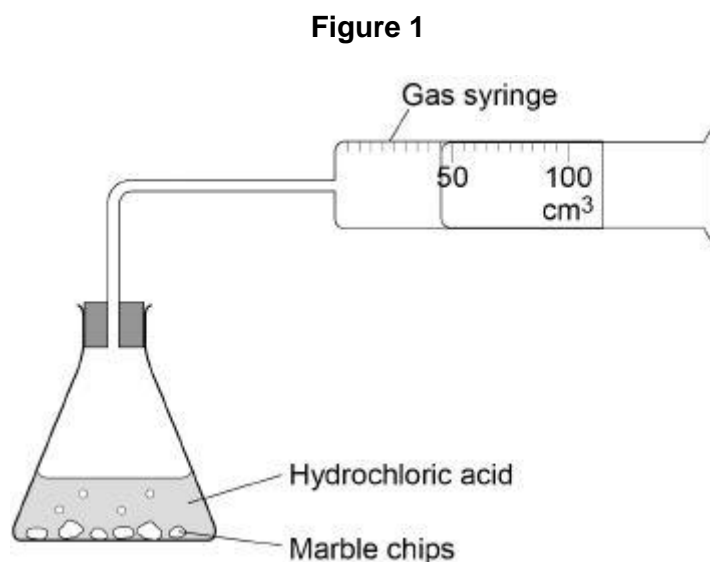
Q3.

A student investigated the effect of the size of marble chips on the rate of the reaction between marble chips and hydrochloric acid.

This is the method used.

1. Add 10 g of marble chips into the flask.
2. Add 50 cm³ of hydrochloric acid, connect the gas syringe and start a timer.
3. Record the volume of gas produced every 10 seconds.

Figure 1 shows the apparatus.



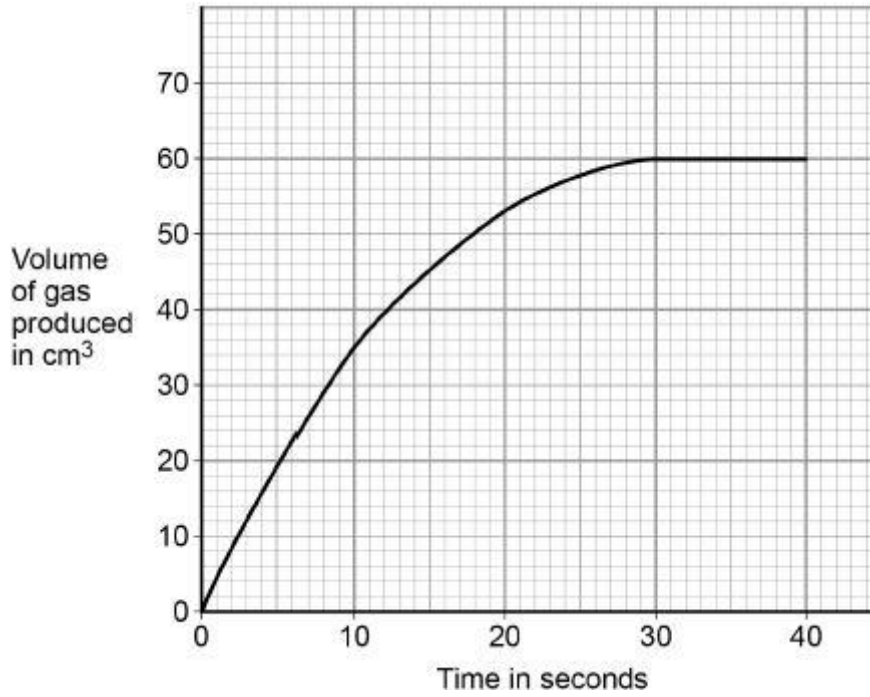
(a) Complete the equation for the reaction.



(2)

Figure 2 shows the student's results.

Figure 2



(b) Describe the trend shown in **Figure 2**

Use values in your answer.

(3)

(c) Describe how you would use **Figure 2** to find the rate of the reaction at 15 seconds.

You do **not** need to do a calculation.

(2)

(d) Give the units for the rate of this reaction.

(1)

The table below shows the results of the investigation.

| Relative size of marble chips | Volume of gas produced in cm ³ after given time in seconds | | | | | |
|-------------------------------|---|------|------|------|------|------|
| | 10 s | 20 s | 30 s | 40 s | 50 s | 60 s |
| Small | 35 | 53 | 60 | 60 | 60 | 60 |
| Medium | 21 | 39 | 51 | 58 | 60 | 60 |
| Large | 14 | 29 | 39 | 48 | 58 | 60 |

(e) Give **one** conclusion about how the size of the marble chips affects the rate of the reaction.

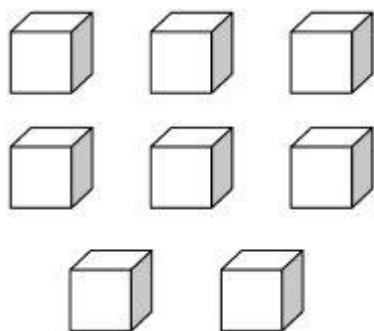
(1)

(f) Suggest why all three sizes of marble chips produce a maximum volume of 60 cm³ of gas.

(1)

(g) **Figure 3** shows eight small cubes, each 1 cm × 1 cm × 1 cm, and one large cube, 2 cm × 2 cm × 2 cm

Figure 3



Total volume of small cubes = 8 cm³

Volume of large cube = 8 cm³

Total surface area of small cubes = 48 cm²

Calculate the surface area of the large cube.

Surface area of the large cube = _____ cm²

(2)

(h) Explain why the size of the marble chips affects the rate of the reaction.

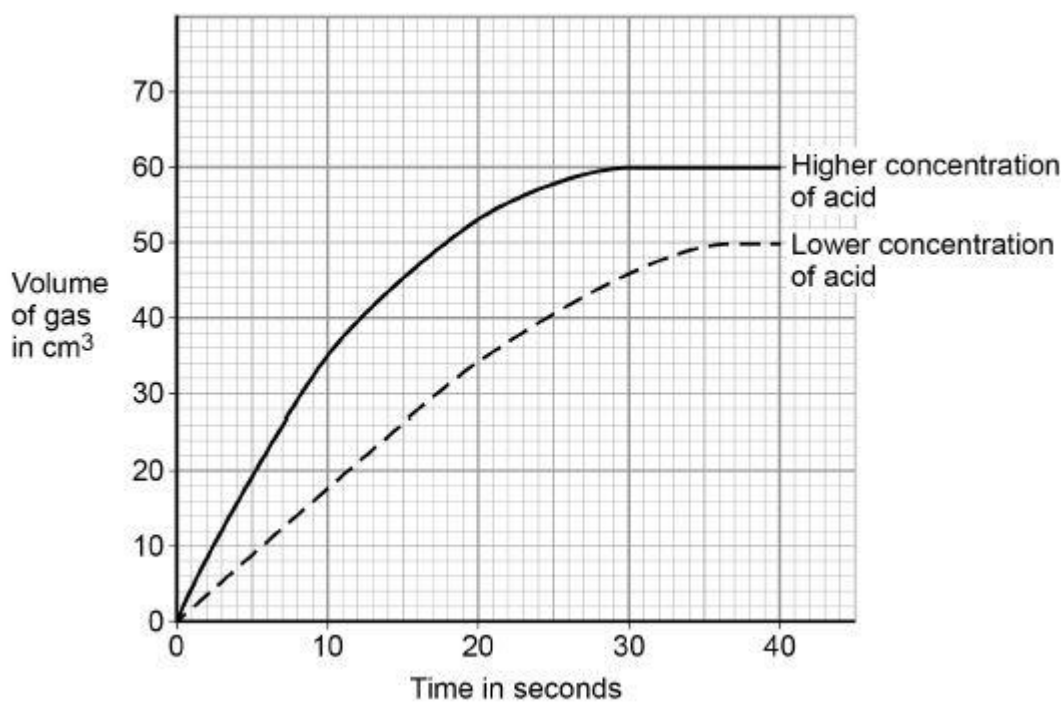
Give your answer in terms of 'collision theory'.

(2)

(i) The student repeated the investigation with small marble chips using hydrochloric acid with a lower concentration.

Figure 4 shows the volume of gas produced during the first 40 seconds.

Figure 4



Explain why the results for the lower concentration of acid are different from the results for the higher concentration of acid.

(3)
(Total 17 marks)

Q4.

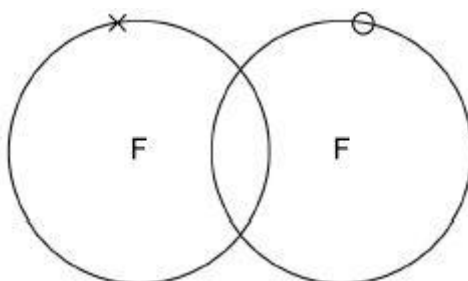
This question is about the halogens.

- (a) Write the state symbol for chlorine at room temperature.

Cl₂ (_____)

(1)

- (b) The diagram below represents one molecule of fluorine.
Complete the dot and cross diagram on the diagram above.
You should show only the electrons in the outer shells.



(2)

- (c) A fluorine atom can be represented as ${}^{19}_{9}\text{F}$

What is the total number of electrons in a fluorine molecule (F₂)?

Tick **one** box.

9 14 18 38

(1)

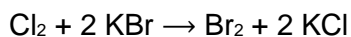
- (d) Aluminium reacts with bromine to produce aluminium bromide.

Complete the balanced chemical equation for this reaction.



(2)

- (e) When chlorine reacts with potassium bromide, chlorine displaces bromine.



Explain why chlorine is more reactive than bromine.

(3)

(Total 9 marks)

Mark schemes

Q1.

- (a) (difference)
sodium has one and chlorine has seven electrons in outer level / shell

or

number of electrons

number of electrons must be correct if quoted

1

(similarity)

both have three / same number of levels / shells

or

have electrons in third level / shell

or

both have incomplete (outer) levels / shells

allow both have 2 electrons in inner shell

or

both have 8 electrons in second shell

or

both are one electron away from full outer level / shell

1

- (b) sodium (atom) loses

allow moves / transfers for loses

*do **not** accept sodium ion loses*

1

one (outer shell electron)

1

chlorine (atom) gains

*do **not** accept chloride*

1

one (electron)

1

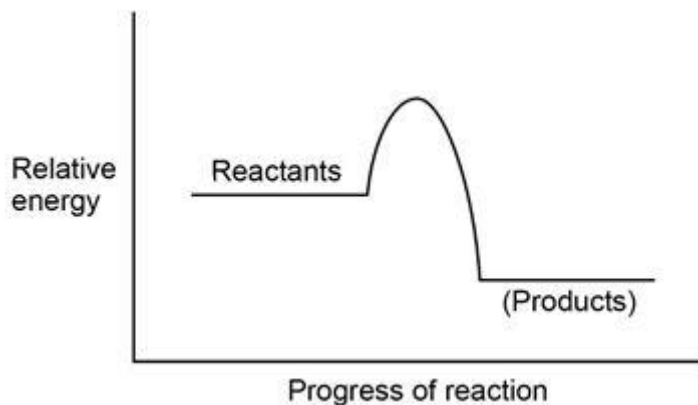
transfer of 1 electron from chlorine to sodium

max 2 marks

*reference to sharing or covalent bonding **max 3 marks***

allow marks from suitable diagram(s)

- (c)



ignore labels

any curve / line going up and then down

products line below reactants

allow curve to start / finish anywhere along

reactant / product lines

1
1

[8]

Q2.

(a) any **two** from:

- hydrogen is in a group
allow converse arguments
allow hydrogen is with the halogens
- only seven groups
- no group 0
allow no noble gases
- halogens are in Group 1
allow fluorine and / or chlorine are in Group 1
- other elements are in one group higher
allow one example of this
- transition metals included in groups
allow one example, eg, iron in same group as aluminium

2

(b) similar properties occur at regular intervals

1

(c) some elements appeared to be in the wrong group

1

(when) the elements were arranged in order of relative atomic mass

allow (so) he placed them into groups with similar properties

1

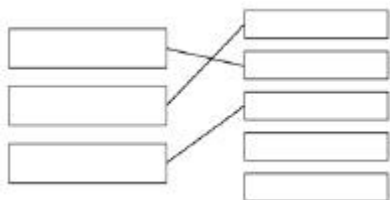
(d) most elements are mixtures of isotopes

1

(so) should be arranged in order of atomic number

1

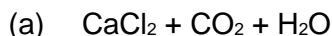
(e)



1
1
1

[10]

Q3.



products in any order

1

balancing: **2** (HCl)

dependent on correct formulae for products

1

(b) value from graph used to show volume increase

must include a time or volume value

1

values from graph used to show the volume increases less rapidly

must include time interval or volume increment

1

volume **or** time stated when graph line levels off

*allow levels off at 60 (cm³) **or** 28 to 30 s*

allow descriptions in terms of rate of reaction

1

values must be approximately correct

(c) draw tangent at 15 s

allow draw a straight line on the curve at 15 s

1

calculate gradient

allow correct description of gradient calculation

ignore calculations if given

1

(d) centimetres cubed per second

*allow cm³/s **or** cm³ s⁻¹ (all lower case)*

allow mixture of abbreviations and words, e.g.

centimetres cubed/s

*do **not** accept non-SI abbreviations (e.g. sec for s)*

1

(e) (rate) increases as chips get smaller

allow converse

1

(f) same amount of acid
or
same number of moles of acid
allow same volume of acid
allow same concentration of acid
allow same mass of CaCO₃ / marble chips
allow one reactant is the limiting factor 1

(g) (surface area of each face = 2 × 2 =) 4 1

(6 × 4 =) 24 (cm²)
allow 6 × student's value from step 1 1
an answer of 24 (cm²) scores 2 marks

(h) small(er) chips have large(r) surface area (for the same volume)
allow converse 1

so more frequent collisions
allow more chance of collisions
allow more likely to collide
*do **not** accept reference to speed of particles or energy of collisions*
ignore more collisions
ignore more successful collisions 1

(i) (sloping part is less steep because) reaction is slower 1

due to less frequent collisions
*do **not** accept reference to speed of particles or energy of collisions*
ignore fewer collisions 1

fewer acid particles (in same volume)
ignore weaker acid 1

or
(sloping part is less steep because) reaction is slower (1)

there are fewer acid particles (in same volume) (1)

(graph levels off lower) so less gas is produced (1)

allow converse for more concentrated acid

[17]

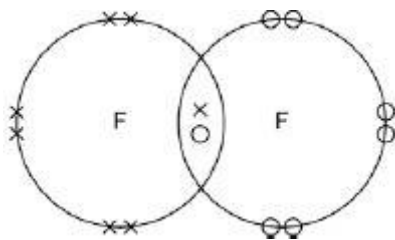
Q4.

(a) g
*do **not** accept upper case (G)*

do **not** accept gas

1

(b)



one shared pair anywhere in overlap between two circles **or** on intersection

1

6 other electrons on each atom

1

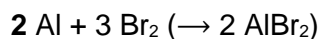
allow dots **or** crosses **or** mixture for all marks
ignore any inner shell electrons

(c) 18

1

(d) AlBr_3

1



1

allow 1 mark for balancing their equation with an incorrect product

(e) chlorine is a smaller atom
or has fewer energy levels
or outer shell closer to nucleus

ignore chlorine has fewer electrons

1

chlorine has less shielding

or

has the greater attraction between the nucleus and the outer shell **or** incoming electron

1

therefore chlorine can gain an electron (into the outer shell) more easily

1

if no other marks awarded allow 1 mark for correct trend in reactivity in Group 7

do **not** accept reference to incorrect particles e.g. chloride atom

max 2 if outer shell / level not mentioned

'it' refers to chlorine

allow converse reasons for bromine being less reactive

[9]