

RADLEY

2026 Scholarship Examination Paper

CHEMISTRY

25th February – 26th February 2026

Time allowed – 30 min

Name:

Marks: / 34

Instructions

Write all your working on the examination paper

A calculator may be used

A diagram of a simple atomic model. At the center is a large black circle representing the nucleus. Two concentric circles represent electron orbits. Red dots, representing electrons, are placed on these orbits. A label 'Electron' with a leader line points to a red dot on the inner orbit. A label 'Nucleus' with a leader line points to the central black circle.

When elements react they lose or gain electrons from their outermost shell. The periodic table tells us how many electrons an atom loses or gains. Groups 1-3 have 1 to 3 electrons which can be lost. Groups 5-7 have 5 to 7 electrons and gain 3 to 1 electrons. The total number of electrons gained plus those already present adds up to eight (apart from hydrogen and helium). The last group (group 0) already has eight electrons in its outer shell and its elements are therefore not reactive. We cannot easily tell how many electrons are lost or gained by the elements in the middle of the periodic table (*Figure 2*). The groups correspond to the columns.

[illegible]

2

1. Barium has the symbol Ba and is listed as number 56 in the periodic table. Deduce if barium loses or gains electrons and state the number of electrons.

..... [2]

2. The reactivity of an atom may be judged by how easily it loses electrons. *Figure 3* shows the reactivity series of atoms of a select group of elements with the most reactive atoms at the top and the least reactive atoms at the bottom.

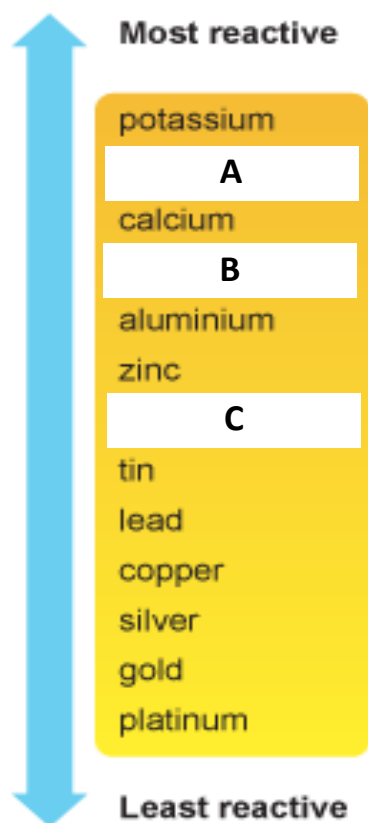


Figure 3. The reactivity series of some elements.

a. In *Figure 3* assign the correct letter to the following elements.

Magnesium

Sodium

Iron

[2]

b. Carbon is used to displace zinc from its oxide, it is more reactive than zinc, but cannot be used for aluminium, as carbon is less reactive than aluminium. Put an **arrow** on *Figure 3* to show where carbon should be in this series.

[1]

- c. Another element that we can add to the series in *Figure 3* above is hydrogen. Hydrogen gas is formed when some metals react with acids. The hydrogen gas is liberated from the acid during the reaction. Hydrogen can be treated like a metal. However, only reactive metal reacts with acids. Some students investigated the reaction of a few metals with acid. Here are their results.

Metal added to acid	Result
aluminium	strong fizzing
silver	no fizzing observed
tin	fizzing
lead	some fizzing
zinc	strong fizzing
copper	no fizzing observed

By reference to *Figure 3*, deduce the place between the two elements where hydrogen should be placed.

.....

[1]

- d. Hydrogen is a gas at room temperature whereas metals are usually solid. Using particle theory, explain in as much detail as you can the difference between a gas and solid.

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[4]

- e. One metal is a liquid at room temperature. Give the name and symbol of this metal.

.....

[1]

- f. What can you say about the forces of attraction between particles in the liquid water compared with those in the gas oxygen? What consequence does this have for the arrangement of the particles?

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[2]

- g. Going down group 1 (from lithium to caesium), predict and explain which of lithium or caesium loses its electron more easily.

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[2]

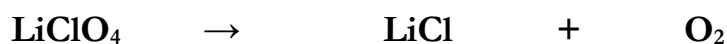
Question 1 total marks [15]

2. Oxygen candles are used in emergency situations to provide oxygen for people to breathe when other systems fail and are used in spacecraft. *Figure 4* shows an oxygen candle. Oxygen candles work by the thermal decomposition of an oxygen-rich substance to produce oxygen and another product. Lithium perchlorate, formula LiClO_4 , is often used as it gives a very high quantity of oxygen for its mass.



Figure 4. An oxygen candle

- a. Put numbers as appropriate to the left of each substance as appropriate to balance the equation for the thermal decomposition of lithium perchlorate. As a rule “What goes in comes out”.



[1]

- b. Circle the **one** word below that best describes lithium perchlorate.

Exothermic Atomic Compound Element
Mixture Liquid Molecular

[1]

- c. What is the test and result for oxygen gas?

.....
.....

[2]

- d. How many atoms of oxygen are there in LiClO_4 ?

.....[1]

- Lithium perchlorate has a density of $2.42\text{g} / \text{cm}^3$.
 - 60.2% of its mass is oxygen.
 - Liquid oxygen has density of $1.14\text{g} / \text{cm}^3$.
- e. Show by calculation whether lithium perchlorate has a greater mass of oxygen per cm^3 than liquid oxygen.

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[2]

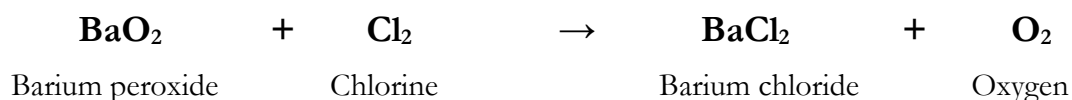
Chlorine gas can form as a by-product of the thermal decomposition in oxygen candles. Oxygen candles also contain a small amount of barium peroxide. Barium peroxide scavenges any chlorine gas that is made forming solid barium chloride and oxygen.

- f. Why is it essential that any chlorine gas made be scavenged?
Do not start the sentence with: “ It is ...”.

.....

[1]

- g. Chlorine gas is captured according to the following equation.



Calculate the mass of chlorine that could be captured by 1 g of barium peroxide.
The sum of the atomic masses of barium peroxide is 88 and the mass of chlorine is 71.

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[1]

The graph in *Figure 5* below shows the **rate of production** of oxygen by a commercially available sodium perchlorate oxygen candle over time.

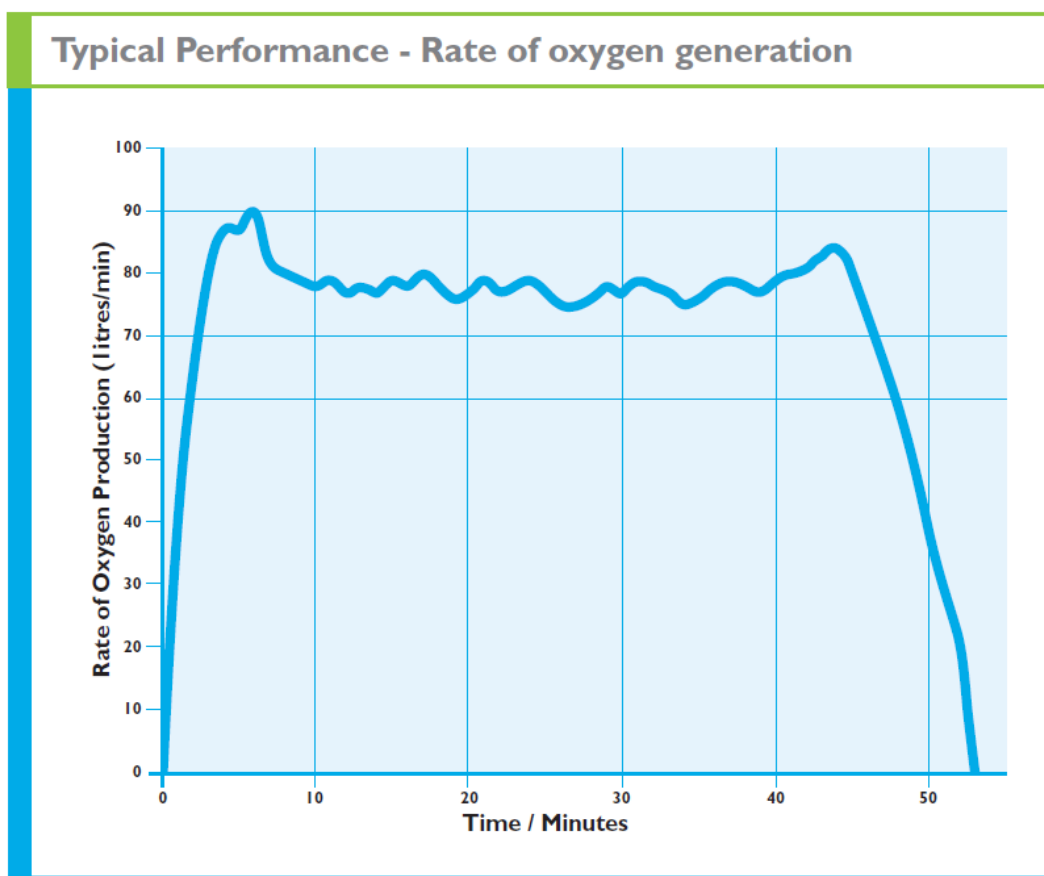


Figure 5. Rate of production of oxygen over time

- h. After ten minutes the rate of production has stabilised. Approximately how many litres of oxygen are being produced per minute once the rate has stabilised?

..... [1]

- i. At what time is the **rate** of oxygen production the greatest?

..... [1]

- j. Describe what happens to the rate of production of oxygen after 44 minutes.

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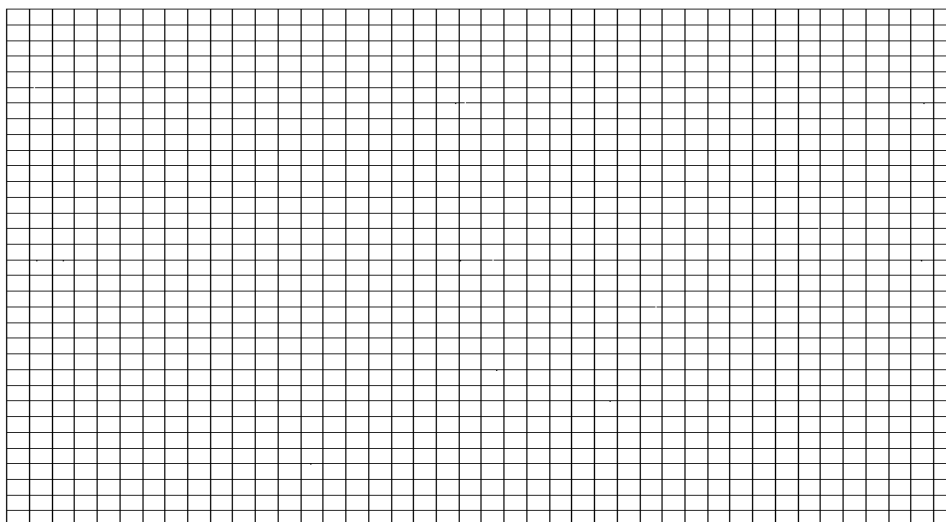
 [2]

- k. Circle the value in litres that best approximates the **total** volume of oxygen produced by the candle after an hour.

53 91 0 60
370 7200 3700

[1]

- l. With reference to *Figure 5* sketch a properly labelled graph below to show how the mass changes with time for a 3 kg sodium perchlorate oxygen candle. Approximately 50 % of the starting mass is oxygen.



[2]

- m. Roughly what percentage of the air is oxygen? %
[1]

- n. When liquid oxygen is heated the temperature of the liquid oxygen increases until the boiling point is reached.

Explain why the temperature does not rise at the boiling point of liquid oxygen but increases again when all oxygen has turned into a gas.

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[2]

Question 2 total marks [19]

END