1.   0.0200 mol of calcium oxide is reacted completely with 2.00 mol dm^{-3} HCl.

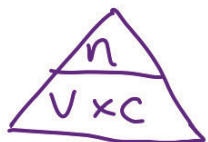What is the volume, in cm^3, of 2.00 mol dm^{-3} HCl required for this reaction?
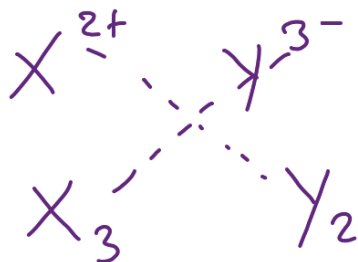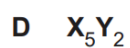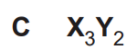
A   15

B   20
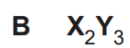
C   30

D   60

Your answer   B

$$CaO + 2HCl \longrightarrow CaCl_2 + H_2O$$
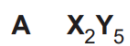
$$0.02 \times 2 = 0.04 \, mol$$

$$\frac{0.04}{2} = 0.02 \, dm^3$$
$$= 20 \, cm^3$$

[1]

2. In the Periodic Table, element **X** is in Group 2 and element **Y** is in Group 15 (5).

   What is the likely formula of an ionic compound of **X** and **Y**?

    A X_2Y_5

    B X_2Y_3

    C X_3Y_2

    D X_5Y_2

    answer C   [1]

3. This question is about elements and compounds in Group 14 (Group 4) of the periodic table.

(a) There are four oxides of lead: PbO, PbO_2, Pb_2O_3 and Pb_3O_4.

A student carries out an experiment to identify an unknown lead oxide, which is one of the four oxides of lead shown above.

The student plans to reduce the unknown lead oxide to lead by heating the lead oxide in a stream of methane gas, CH_4. The apparatus is shown below.
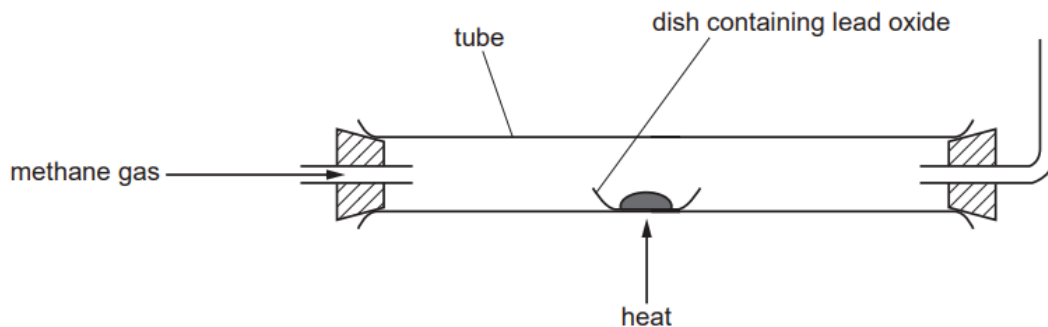
Student's method

- Weigh an empty dish.
  Add the lead oxide to the dish and reweigh.

- Set up the apparatus and pass methane gas through the tube as shown.
  Heat the dish for 10 minutes.

- Pass cold air through the tube to cool the dish and contents.

- Weigh the dish and contents.

(i) Write the equation for the reduction of Pb_2O_3 with CH_4.

$$4Pb_2O_3 + 3CH_4 \rightarrow 8Pb + 3CO_2 + 6H_2O$$ [1]
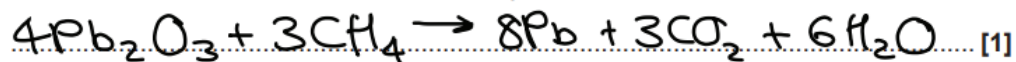
(ii) The student uses safety glasses and a lab coat.

State, with a reason, **one** other important safety precaution the student should take when carrying out this experiment.

Compounds may be toxic/poisonous/
flammable so use a fume cupboard.
Lead is toxic/poisonous so wear [1]
gloves.
Methane is flammable so keep away
from flame.

(iii) The student was not sure that all the oxygen had been removed from the lead oxide.

Suggest **two** modifications that the student could make to their method to be confident that all the oxygen had been removed. Explain your reasoning.

1 Heat to a constant mass
pass methane through tube as it cools

2 Spread/break up lead oxide
use excess methane
Bubble gas through lime water. [2]

(iv) The student makes suitable modifications to the method and repeats the experiment to obtain the accurate results shown below.

Mass of dish/g	8.364
Mass of dish + lead oxide/g	11.818
Mass of dish + lead at end of experiment/g	11.496

Calculate the empirical formula of the lead oxide.

Pb : O

3.132 : 0.322

$$\frac{3.132}{207.2} : \frac{0.322}{16}$$

0.0151 : 0.020125

3 : 4

11.818 − 11.496
= 0.322
11.496 − 8.364
= 3.132

empirical formula = ...Pb_3O_4........... [2]

(b) SiO_2 and CO_2 are oxides of other Group 14 (Group 4) elements.

Solid SiO_2 melts at 2156 °C. Solid CO_2 melts at −56 °C.

Suggest the type of lattice structure in solid SiO_2 and in solid CO_2 and explain the difference in melting points in terms of the types of force within each lattice structure.

Structure in SiO_2(s) ...giant...

Structure in CO_2(s) ...Simple molecular...

Explanation ...london forces in CO_2. Covalent bonds in SiO_2 stronger than intermolecular forces in CO_2...

.... [4]

4.   Phosphoric acid is a tribasic acid.
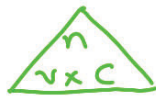
What is the mass of $Ca(OH)_2$ that completely neutralises 100 cm³ of 0.100 mol dm⁻³ phosphoric acid?

A   0.49 g

B   0.74 g

C   1.11 g

D   2.22 g

$100 \times 10^{-3} \times 0.1 = 0.01$ mol

$40 + ((16+1) \times 2) = 74$

$\dfrac{0.01}{2} \times 3 = 0.015$ mol $Ca(OH)_2$

$0.015 \times 74 = 1.11$ g

Your answer   C   [1]