

**Q1.** A sample of 2.18 g of oxygen gas has a volume of 1870 cm<sup>3</sup> at a pressure of 101 kPa.

What is the temperature of the gas?

The gas constant is  $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$ .

- A** 167 K
- B** 334 K
- C** 668 K
- D** 334 000 K

(Total 1 mark)

**Q2.** In an experiment to identify a Group 2 metal (X), 0.102 g of X reacts with an excess of aqueous hydrochloric acid according to the following equation.



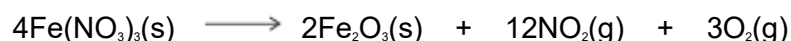
The volume of hydrogen gas given off is 65 cm<sup>3</sup> at 99 kPa pressure and 303 K.  
The gas constant is  $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$ .

Which is X?

- A** Barium
- B** Calcium
- C** Magnesium
- D** Strontium

(Total 1 mark)

**Q3.** When heated, iron(III) nitrate ( $M_r = 241.8$ ) is converted into iron(III) oxide, nitrogen dioxide and oxygen.



A 2.16 g sample of iron(III) nitrate was completely converted into the products shown.

- (a) (i) Calculate the amount, in moles, of iron(III) nitrate in the 2.16 g sample.

Give your answer to 3 significant figures.

.....  
.....

(1)

(ii) Calculate the amount, in moles, of oxygen gas produced in this reaction.

.....  
.....

(1)

(iii) Calculate the volume, in  $\text{m}^3$ , of **nitrogen dioxide** gas at  $293\text{ }^\circ\text{C}$  and  $100\text{ kPa}$  produced from  $2.16\text{ g}$  of iron(III) nitrate.

The gas constant is  $R = 8.31\text{ JK}^{-1}\text{ mol}^{-1}$ .

(If you have been unable to obtain an answer to part (i), you may assume the number of moles of iron(III) nitrate is  $0.00642$ . This is **not** the correct answer.)

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

(4)

(b) Suggest a name for this type of reaction that iron(III) nitrate undergoes.

.....

(1)

- (c) Suggest why the iron(III) oxide obtained is pure.  
Assume a complete reaction.

.....  
.....

(1)  
(Total 8 marks)

**Q4.** The metal lead reacts with warm dilute nitric acid to produce lead(II) nitrate, nitrogen monoxide and water according to the following equation.



- (a) In an experiment, an 8.14 g sample of lead reacted completely with a 2.00 mol dm<sup>-3</sup> solution of nitric acid.

Calculate the volume, in dm<sup>3</sup>, of nitric acid required for complete reaction.  
Give your answer to 3 significant figures

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
*(Extra space)* .....

(3)

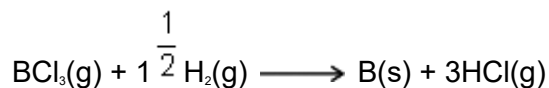
- (b) In a second experiment, the nitrogen monoxide gas produced in the reaction occupied 638 cm<sup>3</sup> at 101 kPa and 298 K.  
Calculate the amount, in moles, of NO gas produced.  
(The gas constant  $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$ )







- (d) Boron trichloride can be reduced by using hydrogen to form pure boron.



Calculate the percentage atom economy for the formation of boron in this reaction.

Apart from changing the reaction conditions, suggest **one** way a company producing pure boron could increase its profits from this reaction.

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

(Extra space) .....  
.....

(3)

- (e) A different compound of boron and chlorine has a relative molecular mass of 163.6 and contains 13.2% of boron by mass.

Calculate the molecular formula of this compound.  
Show your working.

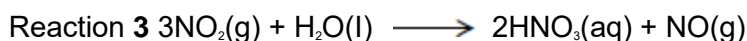
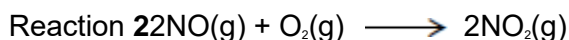
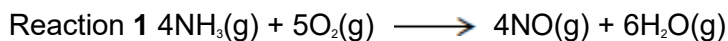
.....  
.....  
.....  
.....  
.....  
.....  
.....

(Extra space) .....  
.....

(4)

(Total 20 marks)

**Q6.** Ammonia is used to make nitric acid (HNO<sub>3</sub>) by the Ostwald Process. Three reactions occur in this process.



- (a) In one production run, the gases formed in Reaction 1 occupied a total volume of 4.31 m<sup>3</sup> at 25 °C and 100 kPa.

Calculate the amount, in moles, of NO produced.  
Give your answer to 3 significant figures.  
(The gas constant  $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$ )

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

(Extra space) .....  
.....  
.....

(4)

- (b) In another production run, 3.00 kg of ammonia gas were used in Reaction 1 and all of the NO gas produced was used to make NO<sub>2</sub> gas in Reaction 2.

- (i) Calculate the amount, in moles, of ammonia in 3.00 kg.

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

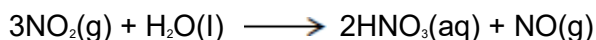


- (ii) Calculate the mass of NO<sub>2</sub> formed from 3.00 kg of ammonia in Reaction 2 assuming an 80.0% yield.  
Give your answer in kilograms.  
(If you have been unable to calculate an answer for part (b)(i), you may assume a value of 163 mol. This is **not** the correct answer.)

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

(Extra space) .....  
.....  
.....

- (c) Consider Reaction 3 in this process.



Calculate the concentration of nitric acid produced when 0.543 mol of NO<sub>2</sub> is reacted with water and the solution is made up to 250 cm<sup>3</sup>.

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

(Extra space) .....

.....

(2)

- (d) Suggest why a leak of NO<sub>2</sub> gas from the Ostwald Process will cause atmospheric pollution.

.....

.....

(1)

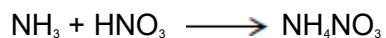
- (e) Give **one** reason why excess air is used in the Ostwald Process.

.....

.....

(1)

- (f) Ammonia reacts with nitric acid as shown in this equation.



Deduce the type of reaction occurring.

.....

(1)

(Total 14 marks)