AS SECTION 1 - PHYSICAL 1 - PRACTICE QUESTIONS

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

$$4Fe(NO_3)_3(s) \longrightarrow 2Fe_2O_3(s) + 12NO_2(g) + 3O_2(g)$$

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 mark]

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

[1 mark]

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(iii) Calculate the volume, in m^3, of **nitrogen dioxide** gas at 293 °C and 100 kPa produced from 2.16 g of iron(III) nitrate.
The gas constant is R = 8.31 $J K^{-1} mol^{-1}$.

(If you have been unable to obtain an answer to Question **2 (a) (i)**, you may assume the number of moles of iron(III) nitrate is 0.00642. This is **not** the correct answer.)

[4 marks]

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

[1 mark]

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

[1 mark]

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2 Antimony is a solid element that is used in industry. The method used for the extraction of antimony depends on the grade of the ore.

(a) Antimony can be extracted by reacting scrap iron with low-grade ores that contain antimony sulfide (Sb_2S_3).

(i) Write an equation for the reaction of iron with antimony sulfide to form antimony and iron(II) sulfide.

[1 mark]

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(ii) Write a half-equation to show what happens to the iron atoms in this reaction.

[1 mark]

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(b) In the first stage of the extraction of antimony from a high-grade ore, antimony sulfide is roasted in air to convert it into antimony(III) oxide (Sb_2O_3) and sulfur dioxide.

(i) Write an equation for this reaction.

[1 mark]

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(ii) Identify **one** substance that is manufactured directly from the sulfur dioxide formed in this reaction.

[1 mark]

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(c) In the second stage of the extraction of antimony from a high-grade ore, antimony(III) oxide is reacted with carbon monoxide at high temperature.

(i) Use the standard enthalpies of formation in **Table 1** and the equation given below **Table 1** to calculate a value for the standard enthalpy change for this reaction.

Table 1

	$Sb_2O_3(s)$	$CO(g)$	$Sb(l)$	$CO_2(g)$
$\Delta H_f^{\ominus}$ / kJ mol^{-1}	−705	−111	+20	−394

$$Sb_2O_3(s) + 3CO(g) \longrightarrow 2Sb(l) + 3CO_2(g)$$

[3 marks]

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(ii) Suggest why the value for the standard enthalpy of formation of liquid antimony, given in **Table 1**, is **not** zero.

[1 mark]

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(iii) State the type of reaction that antimony(III) oxide has undergone in this reaction.

[1 mark]

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(d) Deduce **one** reason why the method of extraction of antimony from a low-grade ore, described in part **3 (a)**, is a low-cost process. Do **not** include the cost of the ore.

[1 mark]

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3 (a) Complete the following table.

	Relative mass	Relative charge
Proton		
Electron		

(2 marks)

(b) An atom has twice as many protons and twice as many neutrons as an atom of ^{19}F
Deduce the symbol, including the mass number, of this atom.

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(2 marks)

(c) The Al^{3+} ion and the Na^{+} ion have the same electron arrangement.

(i) Give the electron arrangement of these ions.

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(ii) Explain why more energy is needed to remove an electron from the Al^{3+} ion than from the Na^{+} ion.

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(3 marks)

4 Molecules of NH_3, H_2O and HF contain covalent bonds. The bonds in these molecules are polar.

(a) (i) Explain why the H–F bond is polar.

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(ii) State which one of the molecules NH_3, H_2O or HF contains the least polar bond.

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(iii) Explain why the bond in your chosen molecule from part (a)(ii) is less polar than the bonds found in the other two molecules.

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(4 marks)

(iv) Explain why H_2O has a bond angle of 104.5°.

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(2 marks)

(b) The boiling points of NH_3, H_2O and HF are all high for molecules of their size. This is due to the type of intermolecular force present in each case.

(i) Identify the type of intermolecular force responsible.

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(ii) Draw a diagram to show how two molecules of ammonia are attracted to each other by this type of intermolecular force. Include partial charges and all lone pairs of electrons in your diagram.

(4 marks)

(c) When an H^+ ion reacts with an NH_3 molecule, an NH_4^+ ion is formed.

(i) Give the name of the type of bond formed when an H^+ ion reacts with an NH_3 molecule. Describe how this bond is formed in the NH_4^+ ion.

Type of bond .....

Description .....

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(ii) Draw the shape, including any lone pairs of electrons, of an NH_3 molecule and of an NH_4^+ ion.

NH_3 NH_4^+

(iii) Name the shape produced by the arrangement of the **atoms** in the NH_3 molecule.

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(iv) Give the bond angle in the NH_4^+ ion.

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(7 marks)