0 1 Ammonia is manufactured from nitrogen and hydrogen by the Haber process:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2\ NH_3(g)$$

The forward reaction is exothermic.

Nitrogen and hydrogen are needed to make ammonia.

0 1 . 1 What are the sources of these two materials?

[2 marks]

Nitrogen .....

Hydrogen .....

Not all the hydrogen and nitrogen reacts.

0 1 . 2 Explain what happens to the unreacted nitrogen and hydrogen, and why?

[2 marks]

.....

.....

0 2 In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

The conditions used in the Haber process are:

200 atmospheres pressure 450°C iron

0 2 . 1 Use the equation and your knowledge of reversible reactions to explain why these conditions are used in the Haber process.

To get full marks you must consider both yield and rate of reaction in your answer.

[6 marks]

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0 3 Ammonia is a very useful chemical. It is produced from nitrogen and hydrogen. The equation for the reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2\ NH_3(g)$$

A company wants to make 13.6 tonnes of ammonia.

0 3 . 1 Calculate the mass of nitrogen needed.

[3 marks]

Relative atomic masses (Ar): H = 1; N = 14

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Mass of nitrogen = ... tonnes

0 3 . 2 The company expected to make 13.6 tonnes of ammonia. The yield of ammonia was only 8.4 tonnes.

Calculate the percentage yield of ammonia.

[2 marks]

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Percentage yield of ammonia = ... %

0 3 . 3 Use the equation above to explain why the percentage yield of ammonia was less than expected.

[1 marks]

……

……

(Total 16 marks)

End of Question

See next page for Data Sheet

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KEY
relative atomic mass **atomic symbol** name atomic number

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorous 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac** actinium 89	[261] **Rf** ruthfordium 104	[262] **Db** dubium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111							

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