10 Ammonia

Set A Answer key

A From the lesson

11 MARKS

1 **B** It speeds up the reaction. [1]

A catalyst speeds up the reaction but does not change the yield, and it is not used up. The backward reaction still happens.

2 **A** increasing the pressure [1]

A higher pressure gives a higher yield. A higher temperature lowers the yield, a catalyst does not change the yield, and the cooler is needed to remove the ammonia.

3 **(a)** $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ [1]

(b) The cracking of crude oil fractions. [1]

(c) So that they are not wasted: they pass over the catalyst again to make more ammonia. [1]

(d) A reaction that can go both forward and backward. [1]

4 **C** burning charcoal [1]

The ash cannot be turned back into charcoal. The other three can go both forward and backward.

5 **(a)** $NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$ [1]

(b) Ammonia has a lower relative molecular mass (17) than hydrogen chloride (36.5) [1]

so ammonia diffuses faster and reaches the litmus paper first. [1]

(c) Ammonium chloride: ammonia and hydrogen chloride combine again where the tube is cooler (both points for the mark). [1]

B Practice

13 MARKS

6 **A** cracking of oil fractions [1]

Hydrogen comes from cracking crude oil fractions. Fractional distillation of liquid air is the source of nitrogen.

7 **B** Hydrogen is obtained from fractional distillation of liquid air. [1]

Nitrogen, not hydrogen, is obtained from liquid air. Hydrogen comes from cracking crude oil fractions.

8 **C** Iron is used to increase the yield of ammonia. [1]

Iron is a catalyst. It speeds up the reaction but does not change the yield.

9 **A** increase the pressure to 450 atm [1]

A higher pressure increases the yield. A higher temperature lowers the yield, the gases react in a 1 : 3 ratio, and a catalyst does not change the yield.

10 **B** At 250 °C, the rate of ammonia production is too low. [1]

450 °C is a compromise. At 250 °C the yield is higher, but the reaction is far too slow.

11 **C** High pressure is used to increase the rate and yield of the reaction. [1]

High pressure gives both a faster rate and a higher yield. Only nitrogen comes from liquid air, iron does not change the yield, and a high temperature lowers the yield.

12 **(a)** $N_2 + 3H_2 \rightleftharpoons 2NH_3$: correct balanced equation [1]

Reversible arrow ⇌ [1]

(b) Nitrogen from the fractional distillation of liquid air *or* hydrogen from the cracking of crude oil fractions. [1]

13 **(a)** A reaction that can go both forward and backward at the same time. [1]

(b) A pressure of 250 atm and a temperature of 450 °C. [1]

14 **(a)** 450 °C, 250 atm and a finely divided iron catalyst. [1]

(b) The reaction between nitrogen and hydrogen is reversible. [1]