Paper 1

Questions are applicable for both core and extended candidates

1 Which reaction is reversible?

A reaction of aqueous sodium hydroxide with dilute hydrochloric acid

B formation of anhydrous copper(II) sulfate from hydrated copper(II) sulfate

C oxidation of methane to form carbon dioxide and water

D combustion of sulfur to form sulfur dioxide

2 Which statement about hydrated cobalt(II) chloride is correct?

A It turns blue when it is heated.

B It turns blue when water is added to it.

C It turns pink when water is added to it.

D It turns white when it is heated.

3 Solid copper(II) sulfate exists in two different forms, anhydrous and hydrated.

One of these forms is blue and the other is white.

The change between these two forms is reversible.

$$\text{blue form} \rightleftharpoons \text{white form}$$

What is the blue form and how is the change from the blue form to the white form brought about?

	blue form	change to white form
A	anhydrous	add water
B	anhydrous	heat
C	hydrated	add water
D	hydrated	heat

Paper 2

Questions are applicable for both core and extended candidates unless indicated in the question

4 In the Haber process, nitrogen and hydrogen are reacted to make ammonia.

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

The forward reaction is exothermic.

Which conditions produce the maximum yield of ammonia? **(extended only)**

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

5 The Ostwald process is used to make nitric acid. **(extended only)**

The conditions used in this process are:

1 a catalyst containing a transition element

2 a pressure of 10 atm

3 a temperature of 800 °C.

Which of these conditions are also used in the Contact process? **(extended only)**

A 1 and 2

B 1 only

C 2 and 3

D 3 only

6 The reversible reaction shown takes place in a closed system at constant temperature.

$$P(g) + Q(g) + R(g) \rightleftharpoons S(g) + T(g)$$

When the reaction has reached equilibrium, more T is added.

After the addition of T, which other substances increase in concentration? **(extended only)**

A P, Q, R and S

B P and Q only

C P, Q and R only

D S only

7 Sulfuric acid is produced by the Contact process.

Which row shows the typical conditions used in the process? **(extended only)**

	catalyst	pressure / kPa	temperature / °C
A	iron	200	300
B	iron	20 000	450
C	vanadium(V) oxide	200	450
D	vanadium(V) oxide	20 000	300

8 Methanol is prepared by the reversible reaction shown.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The forward reaction is exothermic.

Which conditions produce the highest equilibrium yield of methanol? **(extended only)**

	temperature	pressure
A	high	high
B	high	low
C	low	high
D	low	low

9 The reaction used to manufacture ammonia from nitrogen and hydrogen is reversible.

An equilibrium is established between ammonia, nitrogen and hydrogen.

Which statement describes the equilibrium? **(extended only)**

A Both the forward reaction and the backward reaction have the same rate.

B The rate of the backward reaction is greater than the rate of the forward reaction.

C The rate of the forward reaction is greater than the rate of the backward reaction.

D The forward and backward reactions have both stopped.

10 Ammonia is produced using the Haber process.

Which row shows the source of the raw materials and the reaction conditions? **(extended only)**

	source of nitrogen	source of hydrogen	temperature / °C	pressure / atm
A	air	hydrocarbons	200	200
B	hydrocarbons	air	450	2
C	air	hydrocarbons	450	200
D	air	hydrocarbons	450	2

11 How many species are acting as bases in this reversible reaction?

$$HNO_3 + H_2O \rightleftharpoons H_3O^+ + NO_3^-$$

A 3 **B** 2 **C** 1 **D** 0

12 The equation for a reaction occurring in the Contact process is shown.

$$2SO_2 + O_2 \rightarrow 2SO_3$$

What is the catalyst used in this reaction? **(extended only)**

A iron

B phosphoric(V) acid

C sulfuric acid

D vanadium(V) oxide

13 The equation for the manufacture of ammonia in the Haber process is shown.

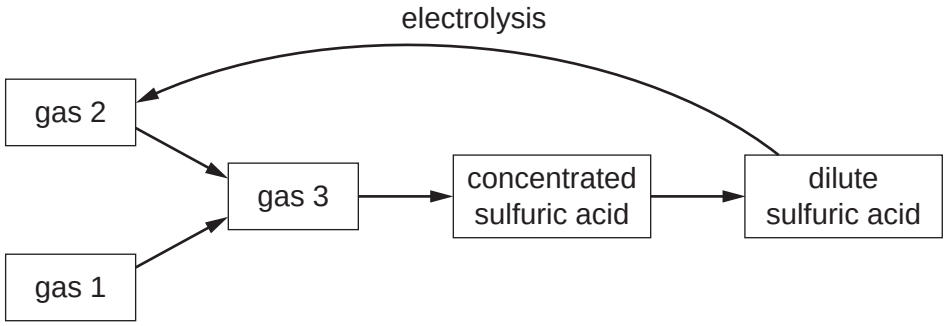
$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

Which row describes the effect of the stated change on the reaction rate and the yield of ammonia? **(extended only)**

	change	effect on reaction rate	effect on yield of ammonia
A	decrease pressure	increases	decreases
B	decrease temperature	decreases	increases
C	increase pressure	increases	decreases
D	increase temperature	increases	increases

14 The flow chart shows part of the process for the manufacture of sulfuric acid and its electrolysis.



What are gases 1, 2 and 3? **(extended only)**

	gas 1	gas 2	gas 3
A	sulfur dioxide	hydrogen	sulfur trioxide
B	sulfur dioxide	oxygen	sulfur trioxide
C	sulfur trioxide	hydrogen	sulfur dioxide
D	sulfur trioxide	oxygen	sulfur dioxide

15 Dinitrogen tetroxide, N_2O_4, is converted into nitrogen dioxide, NO_2, in a reversible reaction.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

The forward reaction is endothermic.

Which conditions give the highest equilibrium yield of nitrogen dioxide? **(extended only)**

	pressure / atmospheres	temperature
A	2	high
B	2	low
C	50	high
D	50	low

16 Which row explains why a high temperature and an iron catalyst are used in the manufacture of ammonia by the Haber process? **(extended only)**

	high temperature	iron catalyst
A	increases the rate of the reaction	increases the equilibrium yield of ammonia
B	increases the rate of the reaction	increases the rate of the reaction
C	increases the equilibrium yield of ammonia	increases the equilibrium yield of ammonia
D	increases the equilibrium yield of ammonia	increases the rate of the reaction

17 The scheme shows four stages in the conversion of sulfur to sulfuric acid.

In which stage is a catalyst used? **(extended only)**