IGCSE Chemistry

CHEMICAL EQUILIBRIUM

0620 - PAPER 2 MCQ

2026 EDITION

Q1 **0620/22/F/M/21 Q17** Reversible reactions - Easy

17 P is a hydrated metal salt with a blue colour. When P is heated, water is given off, leaving solid Q.

R is a hydrated metal salt with a pink colour. When R is heated, water is given off, leaving solid S.

Which row gives the name of P and the colour of S?

	name of P	colour of S
A	hydrated cobalt(II) chloride	blue
B	hydrated cobalt(II) chloride	white
C	hydrated copper(II) sulfate	blue
D	hydrated copper(II) sulfate	white

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Q2 **0620/22/M/J/22 Q14** Reversible reactions - Easy

14 When the colourless gas N_2O_4 is heated, it forms the brown gas NO_2.

When the reaction mixture is cooled, the brown colour fades and turns back to colourless.

Which type of reaction is described by these observations?

A decomposition

B displacement

C reduction

D reversible

Q3 **0620/21/M/J/22 Q15** Reversible reactions - Easy

15 Water is added to anhydrous copper(II) sulfate.

What happens during the reaction?

A The copper(II) sulfate turns blue and the solution formed gets colder.

B The copper(II) sulfate turns blue and the solution formed gets hotter.

C The copper(II) sulfate turns white and the solution formed gets colder.

D The copper(II) sulfate turns white and the solution formed gets hotter.

Also appears as: 0620/22/M/J/22 Q15, 0620/23/M/J/22 Q15

Q4 **0620/21/M/J/23 Q13** Reversible reactions - Easy

13 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

Q5 **0620/22/M/J/23 Q14** Reversible reactions - Easy

14 Which reaction is reversible?

A an iron nail rusting when left in moist air

B limestone reacting with an acid to form carbon dioxide gas

C magnesium burning in air to produce a white ash

D white anhydrous copper(II) sulfate turning blue when water is added

Q6 **0620/23/M/J/23 Q16** Reversible reactions - Easy

16 A student heats hydrated copper(II) sulfate. The blue crystals change to a white powder.

How can the student reverse this reaction?

A Add anhydrous copper(II) sulfate to the white powder.

B Add water to the white powder.

C Cool the white powder.

D Reheat the white powder.

Q7 **0620/21/O/N/21 Q15** Reversible reactions - Easy

15 X is a pink solid.

Y is a blue solid.

When X is heated, water is produced and the solid turns blue.

When water is added to Y, the solid turns pink.

What are X and Y?

	X	Y
A	anhydrous cobalt(II) chloride	hydrated cobalt(II) chloride
B	hydrated cobalt(II) chloride	anhydrous cobalt(II) chloride
C	anhydrous copper(II) sulfate	hydrated copper(II) sulfate
D	hydrated copper(II) sulfate	anhydrous copper(II) sulfate

Q8 **0620/22/O/N/21 Q15** Reversible reactions - Easy

15 Solid X is heated strongly.

The colour of the solid changes from blue to white.

What is solid X?

A anhydrous cobalt(II) chloride

B calcium carbonate

C hydrated copper(II) sulfate

D lead(II) bromide

Q9 **0620/23/O/N/22 Q15** Reversible reactions - Easy

15 When hydrated copper(II) sulfate is heated, it produces white copper(II) sulfate. When water is added, the white copper(II) sulfate turns blue.

Which type of reaction is shown by these observations?

A decomposition

B displacement

C redox

D reversible

Q10 **0620/23/O/N/23 Q16** Reversible reactions - Easy

16 Anhydrous cobalt(II) chloride is blue and turns pink when water is added.

How is this reaction reversed?

A adding dilute acid

B filtering

C heating

D cooling

Q11 **0620/21/M/J/25 Q14** Reversible reactions - Easy

14 The equation represents the reaction between ethanoic acid and ethanol.

$$CH_3COOH + CH_3CH_2OH \rightleftharpoons CH_3COOCH_2CH_3 + H_2O$$

Which type of reaction does this show?

A addition

B neutralisation

C reduction

D reversible

Q12 **0620/22/M/J/25 Q29** Reversible reactions - Easy

29 Water is added separately to anhydrous copper(II) sulfate and to anhydrous cobalt(II) chloride.

Which row shows the colour changes?

	anhydrous copper(II) sulfate	anhydrous cobalt(II) chloride
A	blue to white	blue to pink
B	blue to white	pink to blue
C	white to blue	blue to pink
D	white to blue	pink to blue

Also appears as: 0620/23/M/J/25 Q29

Q13 **0620/22/F/M/22 Q18** Dynamic equilibrium - Easy

18 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?

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.

Q14 **0620/21/M/J/21 Q17** Dynamic equilibrium - Easy

17 Which statement about a reaction in equilibrium is correct?

A Both the forward and the backward reactions are proceeding at the same rate.

B Neither the forward nor the backward reaction is proceeding.

C The amount of product present is no longer affected by changes in temperature or pressure.

D The amount of product present is only affected by a change in pressure.

Q15 **0620/23/M/J/24 Q18** Dynamic equilibrium - Easy

18 Nitrogen reacts with hydrogen to form ammonia in the presence of an iron catalyst. The reaction is reversible.

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

Which statement about this reaction is correct?

A The iron catalyst decreases the activation energy of only the forward reaction.

B When equilibrium is reached, the forward reaction has stopped.

C When the pressure changes, the concentration of ammonia at equilibrium remains constant.

D Nitrogen and hydrogen never completely convert to ammonia.

Q16 **0620/23/O/N/22 Q20** Dynamic equilibrium - Hard

20 Ammonia, NH_3, dissolves in water to form a dilute solution of ammonium hydroxide, NH_4OH.

The reaction is reversible and exists as an equilibrium mixture.

$$NH_3(g) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

Which statement about the mixture is correct?

A All of the ammonia and water molecules have turned into ions.

B The ammonia and water molecules have stopped changing into ions.

C The concentrations of the ammonia molecules and ammonium ions are always equal.

D The rate of the formation of ammonia molecules is equal to the rate of formation of the ammonium ions.

Q17 **0620/23/M/J/25 Q16** Dynamic equilibrium - Hard

16 The reaction between aqueous iron(III) ions, Fe^{3+}, and aqueous thiocyanate ions, SCN^-, is reversible.

The equation for the reaction is shown.

$$Fe^{3+}(aq) + SCN^-(aq) \rightleftharpoons FeSCN^{2+}(aq)$$
yellow colourless red

At equilibrium, the concentrations of Fe^{3+} ions, SCN^- ions, and $FeSCN^{2+}$ ions are identical, and the mixture appears orange.

When a few drops of aqueous thiocyanate ions are added to the mixture, a new equilibrium forms.

How does the colour of the mixture change?

A It becomes colourless.

B It becomes a lighter orange.

C It becomes more yellow.

D It becomes more red.

Q18 **0620/22/O/N/25 Q18** Dynamic equilibrium - Hard

18 The equation shows the equilibrium between dinitrogen tetroxide, N_2O_4, and nitrogen dioxide, NO_2.

The colours of the reactant and product are shown.

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

colourless brown

The forward reaction is endothermic.

Which statement is **not** correct?

A At equilibrium, the concentrations of the reactant and the product stay constant.

B At equilibrium, the rate of the forward reaction is equal to the rate of the reverse reaction.

C When the pressure is increased, a darker brown colour is seen.

D When the temperature is increased, a darker brown colour is seen.

Q19 **0620/22/F/M/23 Q17** Factors affecting equilibrium - Hard

17 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?

A P, Q, R and S

B P and Q only

C P, Q and R only

D S only

Q20 **0620/22/F/M/25 Q20** Factors affecting equilibrium - Hard

20 The equation for the reaction between ammonia and oxygen is shown.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g) \qquad \Delta H = -909\,kJ/mol$$

Which two changes to the reaction conditions will **both** move the position of equilibrium to the right?

	change 1	change 2
A	increasing the temperature	decreasing the pressure
B	increasing the temperature	increasing the pressure
C	decreasing the temperature	increasing the pressure
D	decreasing the temperature	decreasing the pressure

Q21 **0620/22/M/J/21 Q17** Factors affecting equilibrium - Hard

17 When bismuth(III) chloride, $BiCl_3$, reacts with water, a white precipitate of bismuth(III) oxychloride, $BiOCl$, is formed. The equation for the reaction is shown.

$$BiCl_3(aq) + H_2O(l) \rightleftharpoons BiOCl(s) + 2H^+(aq) + 2Cl^-(aq)$$

The reaction is in equilibrium.

Which changes cause the white precipitate to dissolve?

1 adding acid

2 adding water

3 adding sodium chloride solution

A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

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Q22 **0620/21/M/J/24 Q20** Factors affecting equilibrium - Hard

20 Hydrogen is made by reacting carbon with steam. The equation for the reaction is shown.

$$C(s) + H_2O(g) \rightleftharpoons H_2(g) + CO(g)$$

The forward reaction is endothermic.

Which row describes changes in the pressure and the temperature that will **both** shift the position of equilibrium to the right?

	pressure	temperature
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

Q23 **0620/22/M/J/24 Q14** Factors affecting equilibrium - Hard

14 The equation represents the reversible reaction between ethene and steam.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \qquad \Delta H \text{ is negative}$$

Which row describes the conditions that produce the greatest yield of ethanol?

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

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Q24 **0620/22/O/N/21 Q20** Factors affecting equilibrium - Hard

20 The equation shown represents a reaction at equilibrium.

m and n represent the balancing numbers for the reactant and product respectively.

$$mP(g) \rightleftharpoons nQ(g)$$

A high temperature increases the concentration of Q.

A high pressure increases the concentration of Q.

Which statement about the reaction is correct?

A The forward reaction is exothermic and m is greater than n.

B The forward reaction is exothermic and m is less than n.

C The forward reaction is endothermic and m is greater than n.

D The forward reaction is endothermic and m is less than n.

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Q25 **0620/21/O/N/22 Q15** Factors affecting equilibrium - Hard

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?

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

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Also appears as: 0620/22/O/N/22 Q16, 0620/23/O/N/22 Q13

Q26 **0620/22/O/N/23 Q16** Factors affecting equilibrium - Hard

16 The decomposition of dinitrogen tetroxide, N_2O_4, into nitrogen dioxide, NO_2, is a reversible reaction.

The equation for the reaction is shown.

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

The forward reaction is endothermic.

Which row shows the effect on the position of equilibrium and the rate of the reverse reaction when the temperature is increased?

	position of equilibrium	rate of the reverse reaction
A	shifts to the left	decreases
B	shifts to the left	increases
C	shifts to the right	decreases
D	shifts to the right	increases

Q27 **0620/22/O/N/24 Q16** Factors affecting equilibrium - Hard

16 Hydrogen gas reacts with iodine gas to form hydrogen iodide gas in an equilibrium reaction.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H = +26.5\,kJ/mol$$

Which changes increase the yield of HI at equilibrium?

1 adding a catalyst

2 adding more hydrogen gas

3 increasing the pressure

4 increasing the temperature

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

Q28 **0620/23/O/N/24 Q17** Factors affecting equilibrium - Hard

17 In the Haber process, an equilibrium is established.

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

The forward reaction is exothermic.

Which change to the reaction conditions will move the position of equilibrium to the left?

A decreasing the pressure by 100 atm

B decreasing the temperature by 100 °C

C adding more nitrogen gas to the mixture

D removing the iron catalyst

Q29 **0620/23/O/N/25 Q19** Factors affecting equilibrium - Hard

19 Ethanol is manufactured by the addition of steam to ethene.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

The reaction conditions are 300 °C and 60 atm.

The forward reaction is exothermic.

Which rows describe the effect on the equilibrium yield of C_2H_5OH when the stated change is made?

	change	equilibrium yield of C_2H_5OH
1	adding a catalyst	no change
2	decreasing the temperature	increases
3	decreasing the pressure	increases

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

Q30 **0620/22/F/M/22 Q29** Industrial equilibrium processes - Easy

29 Ammonia is produced using the Haber process.

Which row shows the source of the raw materials and the reaction conditions?

	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

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Q31 **0620/22/F/M/22 Q31** Industrial equilibrium processes - Easy

31 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?

A iron

B phosphoric(V) acid

C sulfuric acid

D vanadium(V) oxide

Q32 **0620/22/F/M/23 Q16** Industrial equilibrium processes - Easy

16 Ammonium sulfate is used as a fertiliser.

It is made from ammonia and sulfuric acid.

The .....1..... is made by the .....2..... process in which .....3..... is used as a catalyst.

Which words complete gaps 1, 2 and 3?

	1	2	3
A	ammonia	Contact	iron
B	ammonia	Haber	vanadium(V) oxide
C	sulfuric acid	Contact	vanadium(V) oxide
D	sulfuric acid	Haber	iron

Q33 **0620/22/M/J/21 Q30** Industrial equilibrium processes - Easy

30 Which natural resource **cannot** provide a raw material for the manufacture of ammonia?

A air

B limestone

C petroleum

D water

Q34 **0620/22/M/J/21 Q31** Industrial equilibrium processes - Easy

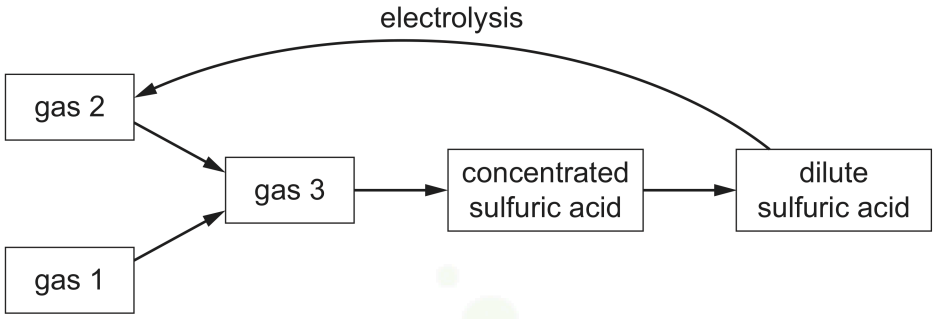
31 Ammonia is made in the Haber process.

Which conditions are used in the Haber process?

	temperature / °C	pressure / atmospheres	catalyst used
A	450	200	iron
B	450	5	vanadium(V) oxide
C	200	450	iron
D	200	5	vanadium(V) oxide

Q35 **0620/21/M/J/22 Q32** Industrial equilibrium processes - Easy

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



What are gases 1, 2 and 3?

	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

Q36 **0620/22/M/J/22 Q33** Industrial equilibrium processes - Easy

33 Which reaction in the Contact process requires the use of a catalyst?

A $S + O_2 \rightarrow SO_2$

B $2SO_2 + O_2 \rightarrow 2SO_3$

C $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$

D $H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

Q37 **0620/22/M/J/23 Q13** Industrial equilibrium processes - Easy

13 In the Contact process, sulfur dioxide is reacted with oxygen to form sulfur trioxide.

Which conditions are used in this reaction?

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

Q38 **0620/22/M/J/24 Q15** Industrial equilibrium processes - Easy

15 Which row identifies the pressure and the catalyst used for the conversion of sulfur dioxide to sulfur trioxide in the Contact process?

	pressure / atm	catalyst
A	2	iron
B	2	vanadium(V) oxide
C	200	iron
D	200	vanadium(V) oxide

Q39 **0620/22/M/J/25 Q16** Industrial equilibrium processes - Easy

16 Which row describes the conditions used in the manufacture of sulfuric acid by the Contact process?

	catalyst	pressure	temperature
A	iron	high	high
B	iron	low	low
C	vanadium(V) oxide	high	low
D	vanadium(V) oxide	low	high

Q40 **0620/21/O/N/21 Q30** Industrial equilibrium processes - Easy

30 Which statements about the Haber process are correct?

1 One of the raw materials is extracted from liquid air by fractional distillation.

2 One of the raw materials is produced by the reaction of steam and methane.

3 The catalyst for the Haber process is vanadium(V) oxide.

A 1 only **B** 1 and 2 only **C** 2 and 3 only **D** 1, 2 and 3

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Q41 **0620/21/O/N/21 Q31** Industrial equilibrium processes - Easy

31 Which raw material is used in the Contact process?

A air

B ammonia

C carbon

D nitrogen

Q42 **0620/21/O/N/25 Q17** Industrial equilibrium processes - Easy

17 Which equation represents one of the reactions in the Contact process?

A $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

B $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(aq)$

C $2SO_3(g) + O_2(g) \rightleftharpoons 2SO_4(aq)$

D $2SO_3(g) + O_2(g) \rightleftharpoons 2SO_4(g)$

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Q43 **0620/22/O/N/25 Q17** Industrial equilibrium processes - Easy

17 Which statement about the conditions used in the Haber process and in the Contact process is correct?

A The typical pressure used in the Haber process is similar to that used in the Contact process.

B The typical temperature used in the Haber process is similar to that used in the Contact process.

C The Haber process uses a vanadium(V) oxide catalyst, and the Contact process uses an iron catalyst.

D Both processes produce an acidic gas.

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Q44 **0620/23/O/N/25 Q20** Industrial equilibrium processes - Easy

20 Which row identifies the conditions used to make sulfur trioxide in the Contact process?

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

Q45 **0620/22/F/M/24 Q17** Industrial equilibrium processes - Hard

17 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?

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

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Q46 **0620/21/M/J/21 Q29** Industrial equilibrium processes - Hard

29 Ammonia is made by reacting nitrogen with hydrogen in the Haber process.

The equation for the process is shown.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Which changes in reaction conditions would produce a greater yield of ammonia?

1 adding more iron catalyst

2 increasing the reaction pressure

3 increasing the particle size of the iron catalyst

A 1 only **B** 2 only **C** 1 and 2 **D** 2 and 3

Q47 **0620/23/M/J/21 Q28** Industrial equilibrium processes - Hard

28 Ammonia is made from nitrogen and hydrogen. The equation for the reaction is shown.

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

The forward reaction is exothermic.

Which conditions give the greatest equilibrium yield of ammonia?

	temperature / °C	pressure / atm
A	200	15
B	200	150
C	500	15
D	500	150

Q48 **0620/21/M/J/22 Q30** Industrial equilibrium processes - Hard

30 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?

	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

Q49 **0620/23/M/J/22 Q33** Industrial equilibrium processes - Hard

33 In the Contact process, sulfur dioxide is converted into sulfur trioxide.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

What is the effect of lowering the pressure on the rate of formation and percentage yield of sulfur trioxide at equilibrium?

	rate of formation	percentage yield
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

Q50 **0620/21/M/J/24 Q21** Industrial equilibrium processes - Hard

21 Which row shows the conditions used for the conversion of sulfur dioxide to sulfur trioxide in the Contact process?

	pressure / atm	temperature / °C	catalyst
A	250	200	vanadium(V) oxide
B	2	450	vanadium(V) oxide
C	250	200	iron
D	2	450	iron

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Q51 **0620/23/M/J/24 Q16** Industrial equilibrium processes - Hard

16 The Contact process is used to convert sulfur dioxide to sulfur trioxide. Vanadium(V) oxide is the catalyst in this process.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction in this equilibrium is exothermic.

Which statements about this process are correct?

1 The catalyst increases the rate of both the forward and backward reactions.

2 A low pressure increases the yield of sulfur trioxide.

3 A low pressure is used to keep the costs low.

4 A high temperature increases the yield of sulfur trioxide.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

Q52 **0620/21/M/J/25 Q16** Industrial equilibrium processes - Hard

16 Industrially, ammonia is made by the Haber process. The equation is shown.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ/mol$$

The conditions used are 450 °C and 200 atm.

Which statements about the conditions are correct?

1 Temperatures below 450 °C give a lower rate of reaction.

2 Temperatures below 450 °C give a lower yield of ammonia.

3 Pressures above 200 atm give a lower yield of ammonia.

4 Pressures above 200 atm are too expensive to maintain.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

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Q53 **0620/21/O/N/21 Q14** Industrial equilibrium processes - Hard

14 Ammonia is made by reacting nitrogen with hydrogen.

The equation for the reaction is shown.

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

The forward reaction is exothermic.

Which changes in temperature and pressure decrease the yield of ammonia?

	temperature	pressure
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

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Q54 **0620/23/O/N/21 Q15** Industrial equilibrium processes - Hard

15 Sulfuric acid is manufactured using the Contact process. One of the reactions is shown.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.

statement 1	The equation has more molecules on the left-hand side than on the right-hand side.
statement 2	Using a higher pressure shifts the equilibrium to the left.
statement 3	Higher temperatures increase the rate of reaction.
statement 4	Increasing the temperature shifts the equilibrium to the right.

Which alternative is correct?

A Statement 1 is correct and explains statement 2.

B Statement 1 and statement 3 are correct.

C Statement 2 and statement 4 are correct.

D Statement 3 is correct and explains statement 4.

Q55 **0620/21/O/N/22 Q30** Industrial equilibrium processes - Hard

30 Which row explains why a high temperature and an iron catalyst are used in the manufacture of ammonia by the Haber process?

	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

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Q56 **0620/23/O/N/23 Q17** Industrial equilibrium processes - Hard

17 The reaction between hydrogen and nitrogen is reversible.

The forward reaction is exothermic.

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

Which change to the conditions would increase the yield of ammonia?

A add a catalyst

B increase the pressure

C increase the temperature

D reduce the concentration of nitrogen

Q57 **0620/21/O/N/24 Q15** Industrial equilibrium processes - Hard

15 Which statements about the Haber process are correct?

1 A high temperature is used because the reaction is slow at room temperature.

2 A high pressure is used because there are more moles of gaseous reactants than moles of gaseous product.

3 A nickel catalyst is used to increase the rate of reaction.

4 An iron catalyst is used to increase the equilibrium yield of ammonia.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 4 only

Q58 **0620/22/O/N/24 Q15** Industrial equilibrium processes - Hard

15 Sulfur dioxide is converted to sulfur trioxide in the Contact process.

The conditions used are 450 °C and 200 kPa with a vanadium(V) oxide catalyst.

Which row describes and explains the effect of changing conditions on the rate of reaction?

	change in conditions	effect on rate	explanation
A	no catalyst	lower	the activation energy is higher
B	higher pressure	higher	the particles have more kinetic energy
C	lower temperature	lower	the particles collide more frequently
D	lower pressure	higher	there are more particles per unit volume

Q59 **0620/21/O/N/25 Q19** Industrial equilibrium processes - Hard

19 In the Haber process, nitrogen and hydrogen react to form ammonia.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

The forward reaction is exothermic.

Which changes in pressure and temperature increase the yield of ammonia?

	change in pressure	change in temperature
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

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Q3	B	0620/21/M/J/22 Q15
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Q5	D	0620/22/M/J/23 Q14
Q6	B	0620/23/M/J/23 Q16
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Q11	D	0620/21/M/J/25 Q14
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Q16	D	0620/23/O/N/22 Q20
Q17	D	0620/23/M/J/25 Q16
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Q19	C	0620/22/F/M/23 Q17
Q20	D	0620/22/F/M/25 Q20
Q21	B	0620/22/M/J/21 Q17
Q22	B	0620/21/M/J/24 Q20
Q23	C	0620/22/M/J/24 Q14
Q24	C	0620/22/O/N/21 Q20

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Q25	A	0620/21/O/N/22 Q15
Q26	D	0620/22/O/N/23 Q16
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Q29	A	0620/23/O/N/25 Q19
Q30	C	0620/22/F/M/22 Q29
Q31	D	0620/22/F/M/22 Q31
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Q38	B	0620/22/M/J/24 Q15
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Q44	B	0620/23/O/N/25 Q20
Q45	B	0620/22/F/M/24 Q17
Q46	B	0620/21/M/J/21 Q29
Q47	B	0620/23/M/J/21 Q28
Q48	B	0620/21/M/J/22 Q30

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Q	ANS	Paper Number
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Q56	**B**	0620/23/O/N/23 Q17
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Q58	**A**	0620/22/O/N/24 Q15
Q59	**C**	0620/21/O/N/25 Q19

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