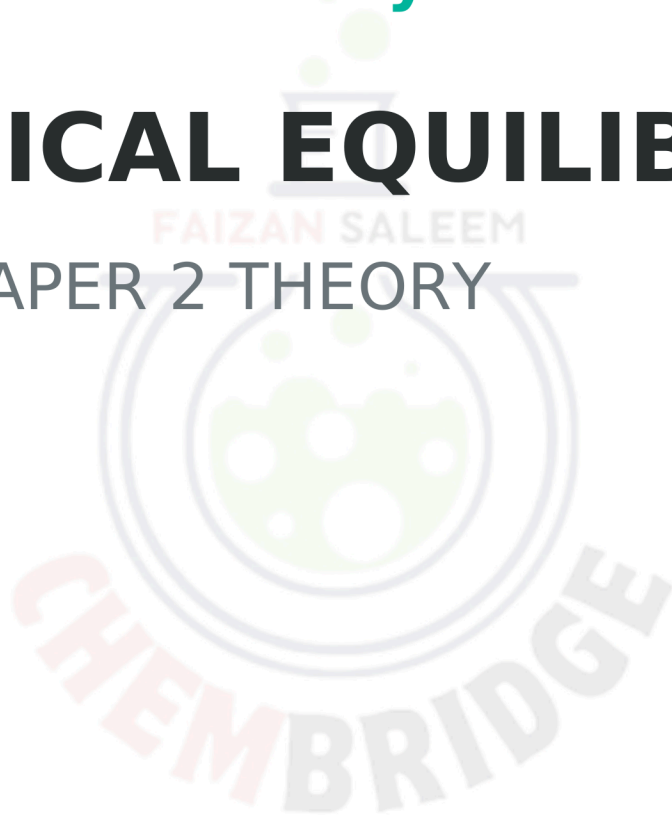




O-LEVEL Chemistry

CHEMICAL EQUILIBRIUM

5070 - PAPER 2 THEORY



2026 EDITION

Q1

5070/21/M/J/23 Q1(e)

Reversible reactions - Easy

- 1 Choose from the following oxides to answer the questions.



Each oxide may be used once, more than once or not at all.

State which oxide:

- (e) turns white anhydrous copper(II) sulfate blue

..... [1]

Q2

5070/22/O/N/23 Q1(b)

Reversible reactions - Easy

- 1 Choose from the list of compounds to answer these questions.

ammonia

ethanol

glucose

magnesium chloride

magnesium oxide

methane

nitrogen dioxide

phosphorus(V) chloride

poly(ethene)

sodium bromide

water

Each compound may be used once, more than once or not at all.

Identify the compound that:

- (b) turns blue cobalt(II) chloride pink

..... [1]

Q3

5070/21/M/J/24 Q1(c)

Reversible reactions - Easy

- 1 Choose from the following substances to answer the questions.

carbon

chlorine

glucose

hydrated copper(II) sulfate

iron

magnesium sulfate

methanoic acid

methanol

nickel

silicon(IV) oxide

vanadium(V) oxide

Each substance can be used once, more than once or not at all.

State which substance:

- (c) changes from a blue solid to a white solid when heated

..... [1]

Q4

5070/22/M/J/24 Q1(c)

Reversible reactions - Easy

- 1 Choose from the following substances to answer the questions.

anhydrous copper(II) sulfate

calcium carbonate

carbon monoxide

chlorine

ethanoic acid

iron

methanoic acid

methanol

nickel

silicon(IV) oxide

vanadium(V) oxide

Each substance can be used once, more than once or not at all.

State which substance:

- (c) changes from a white solid to a blue solid when water is added to it

..... [1]

Q5

5070/21/O/N/25 Q9(a)-(b)

Reversible reactions - Easy

- 9 Anhydrous copper(II) sulfate is a white solid.

- (a) State the meaning of the term anhydrous.

.....
..... [1]

- (b) Anhydrous copper(II) sulfate is added to water.

State the colour of the solution formed.

..... [1]

Q6

5070/21/M/J/23 Q5(a)

Dynamic equilibrium - Hard

- 5 Ammonium chloride decomposes when heated to make hydrogen chloride and ammonia.

This reaction is reversible. The forward reaction absorbs thermal energy.



- (a) An equilibrium mixture is formed when the reversible reaction happens in a closed system.

- (i) State what is meant by the term equilibrium.

Include ideas about rate of reaction and the concentrations of the reactant and products in your answer.

.....

.....

.....

..... [2]

- (ii) Predict what happens to the **position of equilibrium** when the temperature is increased and the pressure remains constant.

Explain your answer.

prediction

explanation

.....

..... [2]

- (iii) Predict what happens to the **position of equilibrium** when the pressure is increased and the temperature remains constant.

Explain your answer.

prediction

explanation

.....

..... [2]

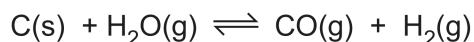
Q7

5070/22/M/J/23 Q5(a)

Dynamic equilibrium - Hard

- 5 Carbon reacts with steam to make carbon monoxide and hydrogen.

This reaction is reversible. The forward reaction absorbs thermal energy.



- (a) An equilibrium mixture is formed when the reversible reaction happens in a closed system.

- (i) Explain why the reversible reaction must be in a closed system for an equilibrium mixture to be formed.

.....
..... [1]

- (ii) Predict what happens to the **position of equilibrium** when the temperature is decreased and the pressure remains constant.

Explain your answer.

prediction
explanation
.....
..... [2]

- (iii) Predict what happens to the **position of equilibrium** when the pressure is decreased and the temperature remains constant.

Explain your answer.

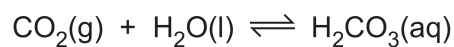
prediction
explanation
.....
..... [2]

Q8

5070/21/M/J/21 Q6(d)(i)-(ii)

Factors affecting equilibrium - Hard

- (d) The carbon dioxide made in power stations can be removed by a reversible reaction with water.



The forward reaction is exothermic.

- (i) The concentration of carbon dioxide is increased.

The temperature is kept constant.

Predict and explain how the position of equilibrium changes.

.....
.....
..... [2]

- (ii) The temperature of the water is increased.

All other conditions are kept constant.

Predict and explain how the position of equilibrium changes.

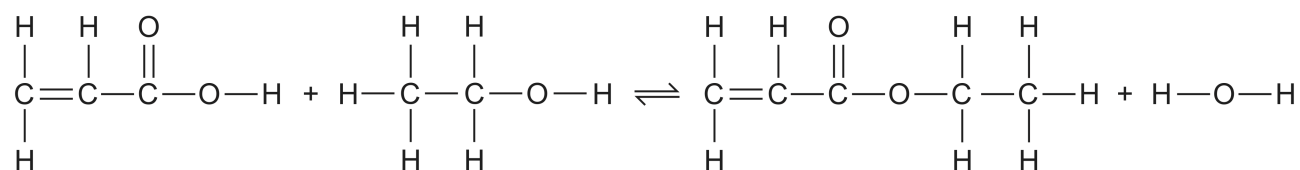
.....
.....
..... [2]

Q9

5070/22/M/J/21 Q9(c)(ii)-(iii)

Factors affecting equilibrium - Hard

- (c) Ethyl propenoate is prepared by the reversible reaction between a carboxylic acid and an alcohol, as shown.



A mixture of the carboxylic acid and the alcohol is allowed to reach equilibrium.

- (ii) The reaction uses an acid catalyst.

State the effect of this catalyst on the position of equilibrium.

..... [1]

- (iii) The concentration of the alcohol is increased.

Describe and explain what happens to the position of equilibrium.

.....

 [2]

Q10

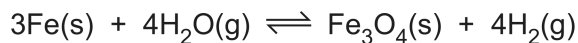
5070/21/M/J/22 Q5(a)(i)-(ii)

Factors affecting equilibrium - Hard

5 Iron reacts with steam and with dilute sulfuric acid.

(a) The reaction between iron and steam is reversible.

The forward reaction is exothermic.



An equilibrium mixture is formed when the reversible reaction happens in a closed system.

(i) Predict what happens to the amount of hydrogen in the equilibrium mixture if the temperature is increased and the pressure remains constant.

Explain your answer.

prediction

explanation

[2]

(ii) Predict what happens to the amount of hydrogen in the equilibrium mixture if the pressure is increased and the temperature remains constant.

Explain your answer.

prediction

explanation

[2]

Q11

5070/22/M/J/22 Q5(a)(i)-(ii)

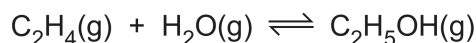
Factors affecting equilibrium - Hard

- 5 Ethanol is manufactured by the reaction between ethene and steam.

The conditions used are 300 °C, a high pressure and a phosphoric acid catalyst.

- (a) The reaction between ethene and steam is reversible.

The forward reaction is exothermic.



An equilibrium mixture is formed when the reversible reaction happens in a closed system.

- (i) Predict what happens to the amount of ethanol in the equilibrium mixture if the temperature is decreased and the pressure remains constant.

Explain your answer.

prediction

explanation

.....

.....

[2]

- (ii) Predict what happens to the amount of ethanol in the equilibrium mixture if the pressure is decreased and the temperature remains constant.

Explain your answer.

prediction

explanation

.....

.....

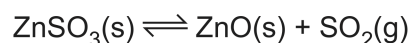
[2]

Q12

5070/21/M/J/24 Q5(a)-(b)

Factors affecting equilibrium - Hard

- 5 When a sample of zinc sulfite is heated in a closed system, an equilibrium mixture is formed.



The forward reaction is endothermic.

- (a) The temperature of the closed system is increased and the pressure is kept constant.

Predict how the position of equilibrium of this reaction is affected.

Explain your answer.

.....

.....

..... [2]

- (b) The pressure of the closed system is decreased and the temperature is kept constant.

Predict how the position of equilibrium of this reaction is affected.

Explain your answer.

.....

.....

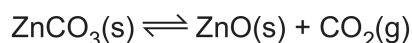
..... [2]

Q13

5070/22/M/J/24 Q5(a)-(b)

Factors affecting equilibrium - Hard

- 5 When a sample of zinc carbonate is heated in a closed system, an equilibrium mixture is formed.



The forward reaction is endothermic.

- (a) The temperature of the closed system is decreased and the pressure is kept constant.

Predict how the position of equilibrium of this reaction is affected.

Explain your answer.

.....

.....

..... [2]

- (b) The pressure of the closed system is increased and the temperature is kept constant.

Predict how the position of equilibrium of this reaction is affected.

Explain your answer.

.....

.....

..... [2]

Q14

5070/21/O/N/21 Q7(d)(i)-(ii)

Factors affecting equilibrium - Hard

- (d) When zinc carbonate is warmed in a closed container, an equilibrium mixture is formed.



The forward reaction is endothermic.

- (i) Describe and explain the effect, if any, on the position of equilibrium when the temperature is decreased.

.....

.....

..... [2]

Q14 (continued)

5070/21/O/N/21 Q7(d)(i)-(ii)

Factors affecting equilibrium - Hard

- (ii) Describe and explain the effect, if any, on the position of equilibrium when the concentration of carbon dioxide is increased.

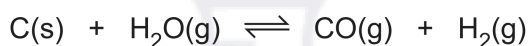
.....
.....
..... [2]

Q15

5070/22/O/N/21 Q7(d)(i)-(ii)

Factors affecting equilibrium - Hard

- (d) When carbon is heated with steam in a closed container an equilibrium mixture is formed.



The forward reaction is endothermic.

- (i) Describe and explain the effect, if any, on the position of equilibrium when the temperature is increased.

.....
.....
..... [2]

- (ii) Describe and explain the effect, if any, on the position of equilibrium when the pressure is decreased.

.....
.....
..... [2]

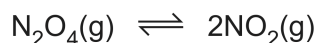
Q16

5070/21/O/N/22 Q6(a)(i)-(ii)

Factors affecting equilibrium - Hard

6 This question is about compounds of nitrogen.

- (a) The equation represents the equilibrium between N_2O_4 and NO_2 at a high temperature in a closed container.



- (i) Predict what happens to the position of equilibrium when the pressure is decreased.

Explain your answer.

prediction

explanation

.....

.....

[2]

- (ii) The table shows the concentration of NO_2 in the closed container at three different temperatures.

temperature in °C	concentration of NO_2 in mol/dm ³
100	0.04
150	0.40
200	4.00

State what this information shows about the enthalpy change of the forward reaction.

Explain your answer.

enthalpy change

explanation

.....

.....

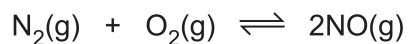
[2]

Q17

5070/22/O/N/22 Q6(b)(i)-(ii)

Factors affecting equilibrium - Hard

- (b) The equation represents the equilibrium between nitrogen and oxygen at a high temperature in a closed container.



- (i) Predict what happens to the position of equilibrium when the pressure is increased.

Explain your answer.

prediction

explanation

.....

.....

[2]

- (ii) The table shows the concentration of nitrogen(II) oxide, NO, in the closed container at three different temperatures.

temperature in °C	concentration of NO in mol/dm ³
800	0.02
1000	0.20
1200	20.00

State what this information shows about the enthalpy change of the forward reaction.

Explain your answer.

enthalpy change

explanation

.....

.....

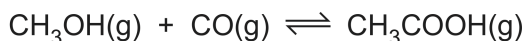
[2]

Q18

5070/21/O/N/23 Q8(a)(i)-(ii)

Factors affecting equilibrium - Hard

- 8 (a) Ethanoic acid is manufactured from methanol.



The forward reaction is exothermic.

- (i) Predict and explain the effect, if any, on the position of equilibrium when the pressure is decreased and the temperature remains constant.

.....

 [2]

- (ii) Predict and explain the effect, if any, on the position of equilibrium when the temperature is decreased and the pressure remains constant.

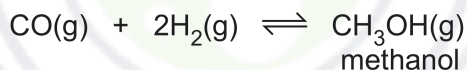
.....
 [1]

Q19

5070/22/O/N/23 Q8(a)(i)-(ii)

Factors affecting equilibrium - Hard

- 8 (a) The equation for the reaction of carbon monoxide with hydrogen at a high temperature in a closed container is shown.



The forward reaction is exothermic.

- (i) Predict and explain the effect, if any, on the position of equilibrium when the pressure is increased and the temperature remains constant.

.....

 [2]

- (ii) Predict and explain the effect, if any, on the position of equilibrium when the temperature is increased and the pressure remains constant.

.....
 [1]

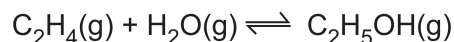
Q20

5070/21/O/N/25 Q7(b)(i)-(ii)

Factors affecting equilibrium - Hard

- (b) Ethene reacts with steam to make ethanol.

This is a reversible reaction.



- (i) Describe and explain the effect of increasing the temperature on the **rate** of the forward reaction.

.....

 [2]

- (ii) Describe and explain the effect of increasing the pressure on the **position of equilibrium** while keeping the temperature constant.

.....

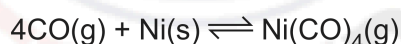
 [2]

Q21

5070/22/O/N/25 Q5(e)

Factors affecting equilibrium - Hard

- (e) The equation for the reversible reaction between carbon monoxide and nickel is shown.



The forward reaction is exothermic.

The reversible reaction is allowed to reach equilibrium in a closed system.

Predict and explain the effect of increasing the pressure on the position of equilibrium. The temperature remains constant.

prediction

explanation

..... [2]

Q22

5070/21/M/J/22 Q9(a)

Industrial equilibrium processes - Easy

9 Ammonia, NH_3 , is used to make nitrogenous fertilisers.

(a) Ammonia is manufactured using the reversible reaction between nitrogen and hydrogen.

Construct the equation for this reversible reaction.

..... [2]

Q23

5070/21/M/J/24 Q1(a)

Industrial equilibrium processes - Easy

1 Choose from the following substances to answer the questions.

carbon

chlorine

glucose

hydrated copper(II) sulfate

iron

magnesium sulfate

methanoic acid

methanol

nickel

silicon(IV) oxide

vanadium(V) oxide

Each substance can be used once, more than once or not at all.

State which substance:

(a) is a catalyst in the Haber process

..... [1]

Q24

5070/22/M/J/24 Q1(a)

Industrial equilibrium processes - Easy

- 1 Choose from the following substances to answer the questions.

anhydrous copper(II) sulfate

calcium carbonate

carbon monoxide

chlorine

ethanoic acid

iron

methanoic acid

methanol

nickel

silicon(IV) oxide

vanadium(V) oxide

Each substance can be used once, more than once or not at all.

State which substance:

- (a) is a catalyst in the Contact process

..... [1]

Q25

5070/21/O/N/21 Q9(a)

Industrial equilibrium processes - Easy

- 9 This question is about ammonia and nitrates.

- (a) State the source of the hydrogen and nitrogen used in the manufacture of ammonia by the Haber process.

source of hydrogen

source of nitrogen

[2]

Q26

5070/22/O/N/21 Q9(a)(i)-(ii)

Industrial equilibrium processes - Easy

9 This question is about sulfuric acid and sulfates.

- (a) (i) Sulfur is one of the raw materials used in the Contact process to make sulfuric acid. Name two other raw materials used to make sulfuric acid.

..... and [1]

- (ii) Name the catalyst used in the Contact process.

..... [1]

Q27

5070/21/O/N/22 Q4(a)(i)-(ii)

Industrial equilibrium processes - Easy

4 This question is about ammonia and ammonium salts.

- (a) Ammonia is manufactured by the Haber process.

- (i) Name the catalyst used in the Haber process.

..... [1]

- (ii) Explain how a catalyst increases the rate of reaction.

.....

..... [1]

Q28

5070/22/O/N/22 Q1(a)

Industrial equilibrium processes - Easy

1 The diagram shows part of the Periodic Table.

I	II											III	IV	V	VI	VII	VIII						
													C	N	O	F							
	Mg											Al				Cl	Ar						
K	Ca				Cr		Fe			Cu	Zn				Br								
															I								
									Pt														

Answer the following questions using only the symbols of the elements in the diagram.

Each symbol may be used once, more than once or not at all.

Give the symbol of the element that:

(a) is a catalyst in the Haber process

..... [1]

Q29

5070/21/O/N/23 Q2(f)(ii)

Industrial equilibrium processes - Easy

(ii) Name the catalyst used in the Contact process.

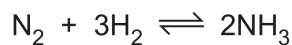
..... [1]

Q30

5070/21/O/N/23 Q6(a)(i)-(ii)

Industrial equilibrium processes - Easy

- 6 The equation for the Haber process used in the production of ammonia is shown.



- (a) (i) The nitrogen for this process comes from the air.

State the percentage by volume of nitrogen in clean, dry air.

..... [1]

- (ii) State a source of hydrogen for the Haber process.

..... [1]

Q31

5070/21/O/N/23 Q7(e)(iii)

Industrial equilibrium processes - Easy

- (e) Sulfur dioxide contributes to acid rain.

- (i) State **one** source of sulfur dioxide in the air.

..... [1]

- (ii) Describe **one** method of reducing the amount of sulfur dioxide getting into the air.

..... [1]

- (iii) In the Contact process, sulfur dioxide reacts with oxygen.

Complete the symbol equation for this reaction.



Q32

5070/21/M/J/21 Q5(c)

Industrial equilibrium processes - Hard

5 Iron pyrite, FeS_2 , is an ore of iron.

(c) Describe how sulfur dioxide is converted into sulfuric acid in the contact process.

.....

.....

.....

.....

..... [3]

Q33

5070/22/M/J/21 Q5(c)

Industrial equilibrium processes - Hard

5 Petroleum (crude oil) provides the raw materials for making ethanol and ammonia.

(c) Describe how hydrogen is converted into ammonia in the Haber process.

Include the conditions used in the Haber process.

.....

.....

.....

.....

..... [3]

Q1

5070/21/M/J/23 Q1(e)

Reversible reactions - Easy

1(e)	H ₂ O (1)	1
------	----------------------	---

Q2

5070/22/O/N/23 Q1(b)

Reversible reactions - Easy

1(b)	water	1
------	-------	---

Q3

5070/21/M/J/24 Q1(c)

Reversible reactions - Easy

1(c)	hydrated copper(II) sulfate	1
------	-----------------------------	---

Q4

5070/22/M/J/24 Q1(c)

Reversible reactions - Easy

1(c)	anhydrous copper(II) sulfate	1
------	------------------------------	---

Q5

5070/21/O/N/25 Q9(a)-(b)

Reversible reactions - Easy

9(a)	substance which contains no water	1
9(b)	blue	1

Q6

5070/21/M/J/23 Q5(a)

Dynamic equilibrium - Hard

5(a)(i)	(a reversible reaction) in which the rate of the forward reaction is the same as the rate of the backward reaction (1) and the concentrations of the reactants and the products do not change / are constant (1)	2
5(a)(ii)	(position of equilibrium) moves to the right (1) because the reaction is endothermic / to minimise temperature increase by absorbing energy (1)	2
5(a)(iii)	position of equilibrium moves to the left (1) because more moles of gas on product side / fewer moles of gas on reactant side (1)	2

Q7

5070/22/M/J/23 Q5(a)

Dynamic equilibrium - Hard

5(a)(i)	so reactants cannot escape / so products cannot escape (1)	1
5(a)(ii)	(position of equilibrium) moves to the left (1) because the (forward) reaction is endothermic / to minimise temperature decrease by releasing energy / because the backward reaction is exothermic (1)	2
5(a)(iii)	(position of equilibrium) moves to the right (1) because more moles of gas on product side / less moles of gas on reactant side (1)	2

Q8

5070/21/M/J/21 Q6(d)(i)-(ii)

Factors affecting equilibrium - Hard

6(d)(i)	position of equilibrium moves to the right (1) to use up the extra carbon dioxide / to reduce the concentration of carbon dioxide (1)	2
6(d)(ii)	position of equilibrium moves to the left (1) to absorb heat / because forward reaction is exothermic / backward reaction is endothermic (1)	2

Q9

5070/22/M/J/21 Q9(c)(ii)-(iii)

Factors affecting equilibrium - Hard

9(c)(ii)	no effect	1
9(c)(iii)	moves to the right / moves to the side of the ester (1) uses up the extra alcohol / to reduce concentration of alcohol (1)	2

Q10

5070/21/M/J/22 Q5(a)(i)-(ii)

Factors affecting equilibrium - Hard

5(a)(i)	amount of hydrogen decreases (1) (equilibrium shifts to the left) to absorb energy (1)	2
5(a)(ii)	amount of hydrogen stays the same (1) (position of equilibrium does not shift) same number of moles of gas on both sides of equation (1)	2

Q11

5070/22/M/J/22 Q5(a)(i)-(ii)

Factors affecting equilibrium - Hard

5(a)(i)	more ethanol (1) (equilibrium shifts to the right) to release energy / to release heat (1)	2
5(a)(ii)	less ethanol (1) (position of equilibrium shifts to the left) more of moles of gas on reactant side of equation / less moles of gas on product side (1)	2

Q12

5070/21/M/J/24 Q5(a)-(b)

Factors affecting equilibrium - Hard

5(a)	(position of equilibrium) moves to the right / (position of equilibrium) moves to the product side / (position of equilibrium) moves to sulfur dioxide or zinc oxide side (1) to absorb thermal energy (1)	2
5(b)	(position of equilibrium) moves to the right / (position of equilibrium) moves to the product side / (position of equilibrium) moves to sulfur dioxide or zinc oxide side (1) more moles of gas on right hand side / more moles of gas on product side (1)	2

Q13

5070/22/M/J/24 Q5(a)-(b)

Factors affecting equilibrium - Hard

5(a)	(position of equilibrium) moves to the left / (position of equilibrium) moves to the reactant side / (position of equilibrium) moves to zinc carbonate side (1) to release thermal energy (1)	2
5(b)	(position of equilibrium) moves to the left / (position of equilibrium) moves to the reactant side / (position of equilibrium) moves to zinc carbonate side (1) fewer moles of gas on left hand side / fewer moles of gas on reactant side (1)	2

Q14

5070/21/O/N/21 Q7(d)(i)-(ii)

Factors affecting equilibrium - Hard

7(d)(i)	equilibrium moves to the left / less product formed / more reactant formed (1) decreasing temperature pushes the reaction in the direction of releasing energy / decreasing temperature pushes the reaction in the direction of the exothermic reaction (1)	2
7(d)(ii)	equilibrium moves to the left / less product formed / more reactant formed (1) reaction goes in the direction to reduce the concentration of carbon dioxide (1)	2

Question	Answer	Marks
----------	--------	-------

Q15

5070/22/O/N/21 Q7(d)(i)-(ii)

Factors affecting equilibrium - Hard

7(d)(i)	equilibrium moves to the right / more product formed (1) (increasing the temperature) pushes the reaction in the direction of absorbing energy / (increasing the temperature) pushes the reaction in the direction of the endothermic reaction (1)	2
---------	---	---

Q15 (continued)

5070/22/O/N/21 Q7(d)(i)-(ii)

Factors affecting equilibrium - Hard

7(d)(ii)	equilibrium moves to the right / more product formed (1) more <u>gas</u> molecules on right than on left / more moles of <u>gas</u> on right than on left / when pressure decreased reaction moves in direction of more <u>gas</u> molecules (1)	2
----------	---	---

Question	Answer	Marks
----------	--------	-------

Q16

5070/21/O/N/22 Q6(a)(i)-(ii)

Factors affecting equilibrium - Hard

6(a)(i)	position of equilibrium moves to the right (1) fewer moles of <u>gas</u> on left of the equation / lower volume of <u>gas</u> on left of the equation (1)	2
6(a)(ii)	the reaction is endothermic (1) because there is a higher concentration of (NO ₂) at higher temperatures / there is a lower concentration of N ₂ O ₄ at lower temperatures (1)	2

Q17

5070/22/O/N/22 Q6(b)(i)-(ii)

Factors affecting equilibrium - Hard

6(b)(i)	no effect (on position of equilibrium) (1) equal number of moles of <u>gas</u> on each side of the equation / equal volumes of <u>gas</u> on each side of the equation (1)	2
6(b)(ii)	the reaction is endothermic (1) because there is a higher concentration of (NO) at higher temperatures / there is a lower concentration of N ₂ and O ₂ at lower temperatures (1)	2

Q18

5070/21/O/N/23 Q8(a)(i)-(ii)

Factors affecting equilibrium - Hard

8(a)(i)	position of equilibrium moves to the left (1) more moles of <u>gas</u> on the left of the equation / fewer moles of <u>gas</u> on the right of the equation (1)	2
8(a)(ii)	position of equilibrium moves to the right AND because the forward reaction is exothermic	1

Q19

5070/22/O/N/23 Q8(a)(i)-(ii)

Factors affecting equilibrium - Hard

8(a)(i)	position of equilibrium moves to the right (1) more moles of <u>gas</u> on the left of the equation / fewer moles of <u>gas</u> on the right of the equation (1)	2
8(a)(ii)	position of equilibrium moves to the left AND because the (forward) reaction is exothermic / position of equilibrium moves to the backward side to absorb (thermal) energy	1

Q20

5070/21/O/N/25 Q7(b)(i)-(ii)

Factors affecting equilibrium - Hard

7(b)(i)	rate increases because particles move faster / particles have more kinetic energy (1) more successful collisions / more collisions (involve particles) with equal or more than activation energy / more effective collisions (1)	2
7(b)(ii)	M1 (position of equilibrium) moves to the right (1) M2 because more moles of gas on reactant side / fewer moles of gas on product side / greater volume of gas on reactant side / smaller volume of gas on product side (1)	2

Q21

5070/22/O/N/25 Q5(e)

Factors affecting equilibrium - Hard

5(e)	M1 (position of equilibrium) moves to the right (1) M2 because more moles of gas on reactant side / fewer moles of gas on product side / greater volume of gas on reactant side / smaller volume of gas on product side (1)	2
------	--	---

Q22

5070/21/M/J/22 Q9(a)

Industrial equilibrium processes - Easy

9(a)	$\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ balanced equation (1) use of reversible symbol (1)	2
------	---	---

Q23

5070/21/M/J/24 Q1(a)

Industrial equilibrium processes - Easy

1(a)	iron	1
------	------	---

Q24

5070/22/M/J/24 Q1(a)

Industrial equilibrium processes - Easy

1(a)	vanadium(V) oxide	1
------	-------------------	---

Q25

5070/21/O/N/21 Q9(a)

Industrial equilibrium processes - Easy

9(a)	hydrogen: (cracking) hydrocarbons (1) nitrogen: air (1)	2
------	--	---

Q26
5070/22/O/N/21 Q9(a)(i)-(ii)

Industrial equilibrium processes - Easy

9(a)(i)	air AND water	1
9(a)(ii)	vanadium(V) oxide	1

Q27
5070/21/O/N/22 Q4(a)(i)-(ii)

Industrial equilibrium processes - Easy

4(a)(i)	iron	1
4(a)(ii)	lowers the activation energy (of the reaction)	1

Q28
5070/22/O/N/22 Q1(a)

Industrial equilibrium processes - Easy

1(a)	Fe	1
------	----	----------

Q29
5070/21/O/N/23 Q2(f)(ii)

Industrial equilibrium processes - Easy

2(f)(ii)	vanadium(V) oxide	1
----------	-------------------	----------

Q30
5070/21/O/N/23 Q6(a)(i)-(ii)

Industrial equilibrium processes - Easy

6(a)(i)	78%	1
6(a)(ii)	Methane	1

Q31
5070/21/O/N/23 Q7(e)(iii)

Industrial equilibrium processes - Easy

7(e)(i)	burning fossil fuels (containing sulfur compounds)	1
7(e)(ii)	flue-gas desulfurisation / using low-sulfur fuels	1
7(e)(iii)	2SO ₃	1

Q32

5070/21/M/J/21 Q5(c)

Industrial equilibrium processes - Hard

5(c)	sulfur dioxide reacted with oxygen to make sulfur trioxide (1) this reaction uses a V_2O_5 catalyst / temperatures between 450 and 600 °C / 1 to 10 atmosphere pressure (1) sulfur trioxide reacted with $H_2SO_4(l)$ to make oleum which is then reacted with water (to make sulfuric acid) (1)	3
------	--	---

Q33

5070/22/M/J/21 Q5(c)

Industrial equilibrium processes - Hard

5(c)	(reaction with) nitrogen (1) AND Any two conditions from: Fe (catalyst) (1) 400 to 500 °C (1) 200 to 400 atmosphere (pressure) (1)	3
------	---	---

