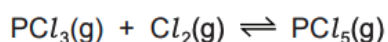


1. Features of an equilibrium

- The reaction is reversible
- Rate of forward reaction = rate of reverse/backward reaction
- The concentration of the reactants and products are no longer changing

2.

PCl_3 reacts with chlorine, Cl_2 , to form PCl_5 . This reaction is exothermic and reaches an equilibrium.



State the effect on the position of equilibrium when the following changes are made:

a. Temperature is increased

- Equilibrium shifts to the LHS
- Because the forward reaction is exothermic

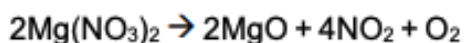
b. Pressure is increased

- Equilibrium shifts to the RHS
- Due to fewer moles of gas in the RHS

3. Iron(II) sulfate can be converted to iron(III) sulfate by potassium manganate(VII) at room temperature.

- What is the role of potassium manganate(VII) in this reaction?** Oxidising agent
- What condition must be used for this reaction to occur?** Presence of an acid
- In terms of electron transfer, what happens to the iron(II) ions in this reaction?**
Loses an electron

4. Magnesium oxide forms when magnesium nitrate is heated strongly. This is an endothermic reaction. Write the chemical equation for this reaction.



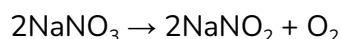
Thermal decomposition of magnesium hydroxide: $Mg(OH)_2 \rightarrow MgO + H_2O$

Thermal decomposition magnesium nitrate: $2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$

Thermal decomposition magnesium carbonate: $MgCO_3 \rightarrow MgO + CO_2$

NOTE: this is similar for all hydroxides, nitrates & carbonates

5. Write chemical equation for the reaction when solid sodium nitrate is heated



6. Aluminium compounds that undergo thermal decomposition to form aluminium oxide

- Aluminium hydroxide
- Aluminium carbonate

- Aluminium nitrate

7. Describe what is seen when aqueous ammonia is added to aqueous copper(II) sulphate, until no further change is seen.

- Blue precipitate
- Precipitate dissolves in excess
- Deep blue solution remains

8. The reaction between ethanoic acid and ethanol reaches equilibrium. The reaction between ethanoic acid and ethanol is exothermic. State and explain the effect, if any, of increasing the temperature on the amount of ester at equilibrium.

- Less ester at equilibrium
- Equilibrium moves left and because forward reaction is exothermic

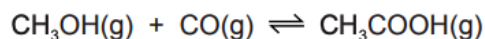
9. State and explain the effect, if any, of removing water from the mixture on the amount of ester at equilibrium.

- More ester at equilibrium
- Equilibrium moves right to replace water

10.

This question is about ethanoic acid, CH₃COOH.

(a) Ethanoic acid is manufactured from methanol and carbon monoxide.



The process is done at 200°C and 30 atmospheres pressure.
The forward reaction is exothermic.

Complete the table using only the words *increases*, *decreases* or *no change*.

	effect on the rate of the forward reaction	effect on the equilibrium yield of CH ₃ COOH(g)
adding a catalyst		no change
increasing the temperature		
decreasing the pressure	decreases	

[4]

M1 increases(1)	No change
M2 increases(1)	M3 decreases(1)
decreases	M4 decreases(1)

11. Why temperature lower than 450°C is not used for Haber process: rate of reaction would be too slow

12. Why pressure greater than 200 atm is not used for Haber process: expensive/ specialist equipment required

NOTE: reaction between an alkane and chlorine: photochemical/ substitution reaction

NOTE: The Contact process

stage 1: Sulphur is converted into sulphur dioxide; by heating sulphur in air

stage 2: Sulphur dioxide is converted into sulphur trioxide; by reacting with more O₂

stage 3: Sulphur trioxide is converted into oleum; by reacting it with concentrated H₂SO₄

stage 4 Oleum is converted into sulfuric acid; by mixing it with water

13. Define catalyst

- substance that speeds up a reaction / increases rate
- unchanged chemically at the end OR not used up
- lowers activation energy OR provides alternative pathway

14. How rate of reaction changes as time progresses

- rate decreases
- concentration of particles decreases/ particles further apart/ less particles per unit volume
- fewer collisions per unit time / lower collision frequency
- reaction stops because all the reactant is used up // all the reactant reacts

15. Why rate of reaction increases as temperature increases

- Kinetic energy of particles increases / particles gain KE
- Frequency of collisions between particles increases / higher collision frequency/rate / more number of collisions per unit time
- Greater proportion of particles have energy greater than or equal to activation energy
- More successful collisions

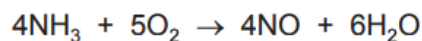
16. Source of hydrogen for manufacture of ammonia

Methane / natural gas / hydrocarbons (reacting with steam)

17.

Ammonia, NH_3 , is used to produce nitric acid, HNO_3 . This happens in a three-stage process.

Stage 1 is a redox reaction.



Identify what is oxidised in stage 1

Substance oxidised: N or NH_3

Reason: change in oxidation state of N from -3 to $+2$ / increase in oxidation number / gain in oxygen / loss of electrons

18. Write a chemical equation for the reaction between magnesium & warm water



19. Word equation for reaction between flour and oxygen. Flour contains carbohydrates

Flour + oxygen \rightarrow carbon dioxide + water

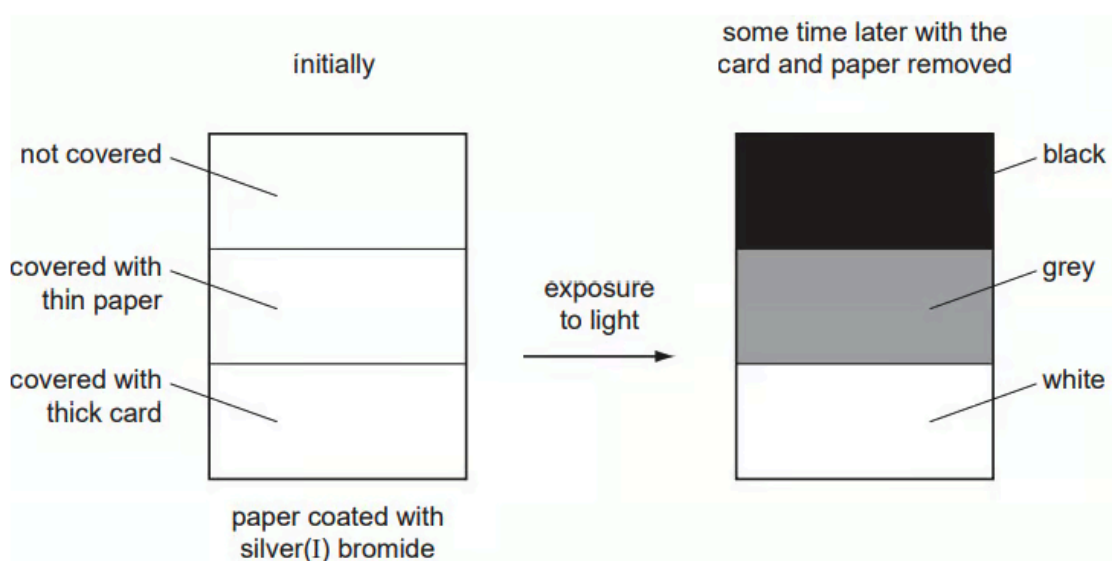
20.

The decomposition of silver(I) bromide is the basis of film photography. The equation for this decomposition is:



This reaction is photochemical.

A piece of white paper was coated with silver(I) bromide and the following experiment was carried out.



Explain the results

- Rate of reaction depends on light
- More light gives a darker / black colour; Less light gives a lighter / white / grey colour
- Thick card allows less light through

21. In fermentation, the reaction mixture is cooled. Suggest why this is important

To stop the yeast being killed OR Stop the enzyme being denatured

22. Technique that can be used to remove cloudiness due to yeast after fermentation

filtration/ use of a centrifuge

23.

The forward reaction for the production of ethanol from ethene is shown below.

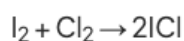


In terms of temperature and pressure, explain which conditions would give an economically viable yield

- The forward reaction is exothermic so it is favoured by low temperatures
- There are more molecules of gas on left-hand side so forward reaction is favoured by high pressure
- The rate is slowed by low temperature AND
So, the temperature is increased to 300 °C
- High pressure is unsafe / expensive / could result in polymerisation of ethene AND
So, the pressure is reduced
- Addition of a catalyst

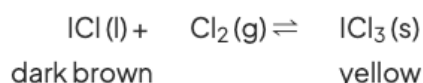
24.

Iodine reacts with chlorine to form dark brown iodine monochloride.



This reacts with more chlorine to give yellow iodine trichloride.

An equilibrium forms between these iodine chlorides.



When the equilibrium mixture is heated, it becomes a darker brown colour. Suggest if the reverse reaction is endothermic or exothermic. Give reason.

- endothermic

- This is the direction that is favoured by high temperatures OR high temperature favours the endothermic reaction / direction

25. Explain using the idea of bond breaking & forming, why a reaction is exothermic

- Bond forming releases energy / is exothermic
- Bond breaking takes in energy / absorbs energy / is endothermic
- More energy is released than taken in

26. Observations when hydrochloric acid reacts with magnesium

- Reaction is exothermic / reaction mixture gets warm
- Bubbles / effervesces / fizzes
- Magnesium disappears or gets smaller

27. how nitrogen is obtained for the Haber process.

Fractional distillation of liquid air

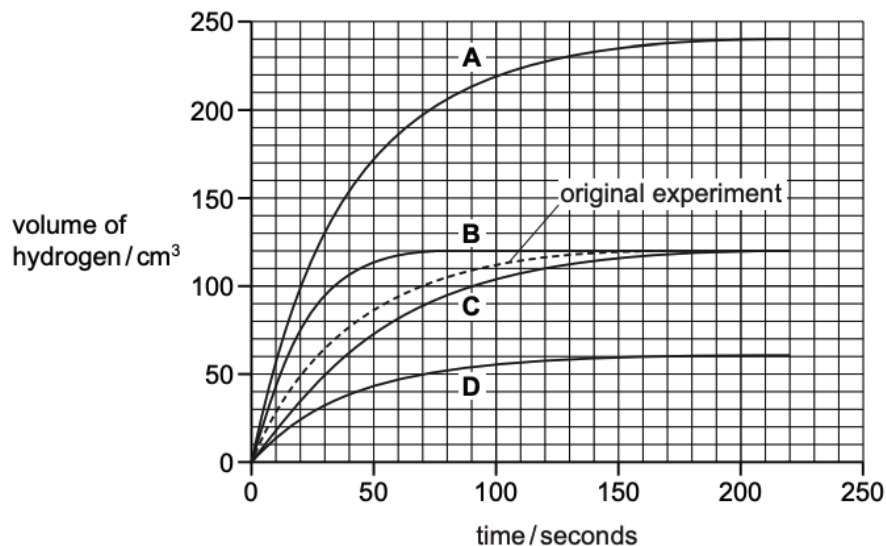
28.

A student adds excess magnesium ribbon to 10 cm³ of 0.5 mol/dm³ sulfuric acid.

The hydrogen gas is collected and its volume measured every 10 seconds.

The experiment is repeated using the same mass of magnesium ribbon with 5 cm³ of 0.5 mol/dm³ sulfuric acid added to 5 cm³ of water.

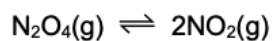
Which graph shows the results of the second experiment?



Answer: D

29.

An equilibrium reaction is shown.



The forward reaction is endothermic.

What is the effect of changing the temperature and pressure on the equilibrium position?

	increasing temperature	increasing pressure
A	moves to the left	moves to the left
B	moves to the left	moves to the right
C	moves to the right	moves to the left
D	moves to the right	moves to the right

Answer: C

30.

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

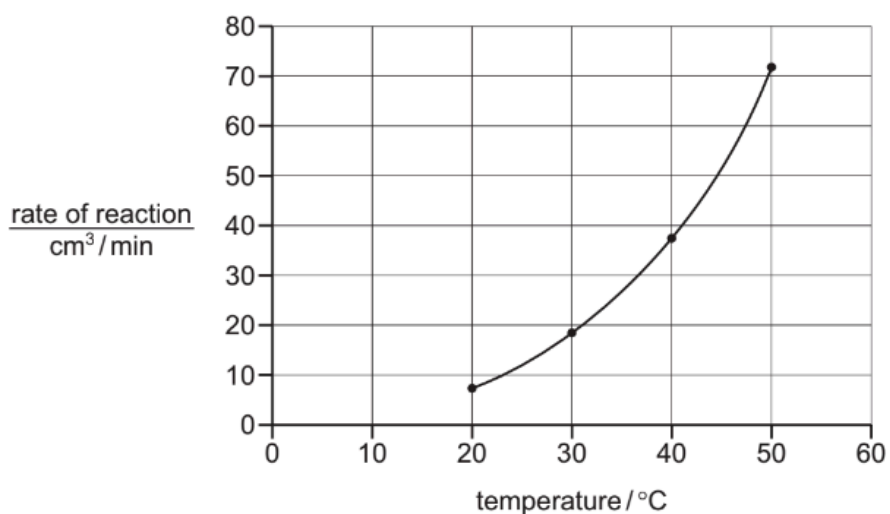
Answer: D

Conditions used is asked, NOT ideal conditions

31.

The rate of reaction between calcium carbonate chips and hydrochloric acid is studied by collecting the volume of gas released in one minute at different temperatures.

A graph of rate of reaction against temperature is shown.



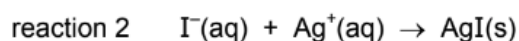
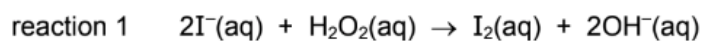
Which statement fully explains why increasing the temperature has this effect on the rate?

- A** The kinetic energy of the particles increases so the collisions are harder.
- B** The number of collisions between particles increases.
- C** The activation energy needed for the particles to react is reduced.
- D** There are more frequent collisions between particles with enough energy to react.

Answer: D

32.

The equations for two reactions of iodide ions are shown.



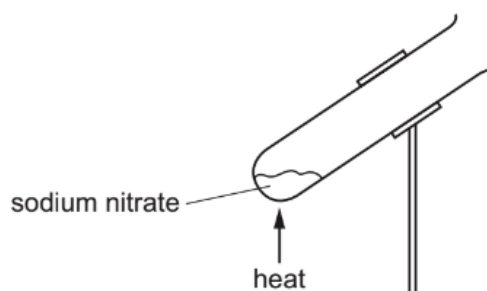
Which statement is correct?

- A** Both reactions are redox reactions.
- B** Neither reaction is a redox reaction.
- C** Only reaction 1 is a redox reaction.
- D** Only reaction 2 is a redox reaction.

Answer: C

33.

Sodium nitrate is a white crystalline solid that decomposes on heating.



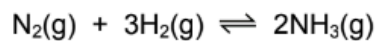
Which row describes the decomposition products formed when sodium nitrate is heated strongly?

	solid products	gaseous products
A	sodium nitrite	NO ₂ and O ₂
B	sodium nitrite	O ₂ only
C	sodium oxide	NO ₂ and O ₂
D	sodium oxide	O ₂ only

Answer: B

34.

Ammonia is manufactured by the Haber process.



What are the conditions used in the Haber process?

	temperature / °C	pressure / atm
A	400	100
B	400	300
C	20	300
D	20	100

Answer: B

35.

A student suggests three uses of calcium carbonate (limestone).

- 1 manufacture of cement
- 2 manufacture of iron
- 3 treating alkaline soils

Which suggestions are correct?

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

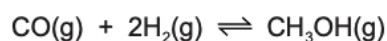
Answer: A

36. Phosphorus reacts with air to produce phosphorus(V) oxide. What type of reaction is this?

Redox / combustion

37.

Methanol is made industrially by reacting carbon monoxide with hydrogen. The gases react at a temperature of 250 °C and a pressure of 75 atmospheres.



The forward reaction is exothermic.

Complete the table using only the words *increases*, *decreases* or *no change*.

	effect on the rate of the reverse reaction	effect on the equilibrium yield of CH ₃ OH(g)
adding a catalyst		no change
increasing the temperature	increases	
decreasing the pressure		

effect on the rate of the reverse reaction	effect on the percentage of methanol in the equilibrium mixture
M1 increases(1)	no change
increases	M3 decreases(1)
M2 decreases(1)	M4 decreases(1)

38. How adding lumps of solid affects rate (compared to powdered solid)

- (lumps have) smaller surface area OR powder has larger surface area
- (lumps have) fewer collisions per unit time / less collision frequency OR powder has more collisions per unit time / more collision frequency

39. Chlorine reacts with aqueous potassium bromide. State colour change of the solution

- From colourless
- To orange/brown

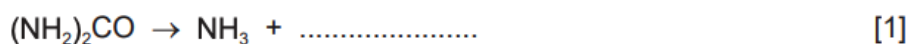
40. Aqueous bromine reacts with aqueous potassium iodide. State colour change of the solution

- From colourless
- To brown

41.

One molecule of urea breaks down to form one molecule of ammonia and one other molecule.

Complete the chemical equation to show the formula of the other molecule formed in this reaction.



Answer: HCNO

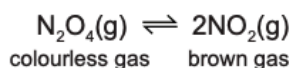
NOTE: remember to refer to equilibrium in answers; equilibrium shifts left/right.

For temperature, state whether reaction is exothermic/endothermic

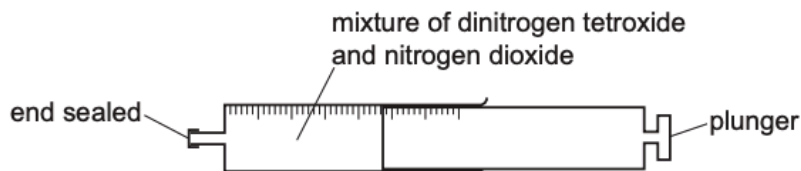
For pressure, state which side has more gaseous molecules/ moles

42.

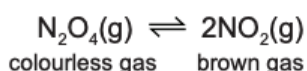
Dinitrogen tetroxide, N_2O_4 , decomposes into nitrogen dioxide, NO_2 . The reaction is reversible.



A gas syringe containing a mixture of dinitrogen tetroxide and nitrogen dioxide gases was sealed and heated. After reaching equilibrium the mixture was a pale brown colour.



The plunger of the gas syringe is pushed in. The temperature does not change. The mixture initially turns darker brown. After a few seconds the mixture turns lighter brown because the equilibrium shifts to the left.



Explain why the mixture initially turns darker brown.

(increased pressure) nitrogen dioxide particles or molecules (forced) closer together OR

same number of nitrogen dioxide particles or molecules in a smaller volume

43. State the source of each gas used in the Haber process

- Nitrogen: air
- Hydrogen: methane (hydrocarbons)

44. 2 methods by which sulphur dioxide is obtained

- Roasting sulphide ores in air
- Burning sulphur in air

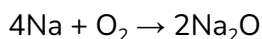
45. Methods to increase rate of reaction

- Increase temperature
- Use catalyst
- Use powdered reactant (for solid)
- Increase concentration of reactant (for liquid)
- Increase pressure (for gas)

46. Describe what is seen when aqueous copper(II) sulphate is added to aqueous sodium hydroxide, NaOH(aq).

Blue precipitate

47. Write the chemical equation for the reaction of sodium with oxygen.



NOTE: hydrogen peroxide \rightarrow catalyst \rightarrow water + oxygen

NOTE: when asked to calculate the oxidation number/ give the oxidation number, write it in normal numbers, with the sign.

Eg. +5

48. What is the oxidation number of nitrogen in NH₃?

-3