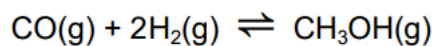


(Reversible reactions and dynamic equilibrium)

Q1. (2018)

In industry, methanol is produced by reacting carbon monoxide with hydrogen.

The equation for the reaction is:



How many moles of carbon monoxide react completely with 4.0×10^3 moles of hydrogen?

[1 mark]

Tick **one** box.

1.0×10^3 moles

☐

2.0×10^3 moles

☐

4.0×10^3 moles

☐

8.0×10^3 moles

☐

Q2. (2018)

The reaction is carried out at a temperature of 250 °C and a pressure of 100 atmospheres.

The forward reaction is exothermic.

Explain what happens to the yield of methanol if a temperature higher than 250 °C is used.

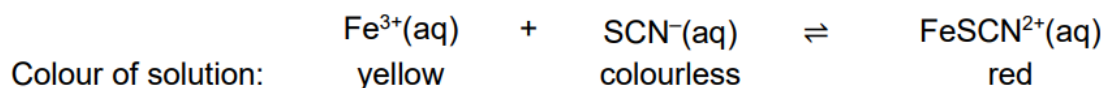
[2 marks]

Q3. a). (2020)

This question is about a reversible reaction.

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

The ionic equation for the reaction is:



The colour of the equilibrium mixture is orange at room temperature.

Give the name of the solvent used to dissolve the ions in this reaction.

[1 mark]

Q3. b). (2020)

A few drops of a colourless solution containing a high concentration of thiocyanate ions (SCN^-) are added to the orange equilibrium mixture.

Explain the colour change observed.

[3 marks]

Q4. a). (2020)

A water bath is set up at a temperature above room temperature.

When a test tube containing the orange equilibrium mixture is placed in the water bath, the mixture becomes more yellow.

Explain what this shows about the energy change for the forward reaction.

[3 marks]

Q4. b). (2020)

Explain why a change in pressure does **not** affect the colour of the equilibrium mixture.

[2 marks]

Q4. c). (2020)

Other metal ions form coloured equilibrium mixtures with thiocyanate ions.

Which metal ion could form a coloured equilibrium mixture with thiocyanate ions?

[1 mark]

Tick (✓) **one** box.

Al^{3+}

☐

Co^{2+}

☐

Mg^{2+}

☐

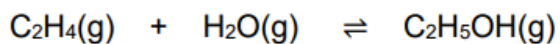
Na^{+}

☐

Q5. (2021)

Ethanol can be produced from ethene and steam.

The equation for the reaction is:



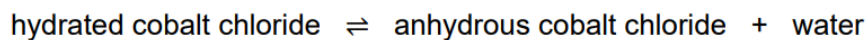
The forward reaction is exothermic.

Explain how the conditions for this reaction should be chosen to produce ethanol as economically as possible.

[6 marks]

A student investigated the change in mass when hydrated cobalt chloride was heated.

The word equation for the reaction is:



This is the method used.

1. Add 2.0 g of hydrated cobalt chloride to an empty test tube.
2. Measure the mass of the test tube and contents.
3. Heat the test tube and contents gently for 30 seconds.
4. Allow the test tube and contents to cool.
5. Measure the mass of the test tube and contents.
6. Repeat steps 3 to 5 until the mass of the test tube and contents does not change.

Table 1 shows the results.

Table 1

Total heating time in seconds	Mass of test tube and contents in grams
0	26.5
30	26.2
60	25.9
90	25.6
120	25.6

Determine the mass of the empty test tube.

[1 mark]

Mass of empty test tube = _____ g

Q6. b). (2022)

Explain why the mass of the test tube and contents decreased.

[2 marks]

Q6. c). (2022)

Suggest why the test tube and contents were heated until the mass did not change.

[1 mark]

Q7. (2022)

What type of reaction takes place when hydrated cobalt chloride is heated?

[1 mark]

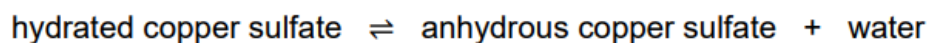
Q8. (2023)

This question is about reversible reactions.

When 4.68 g of hydrated copper sulfate changes into anhydrous copper sulfate:

- 2.99 g of anhydrous copper sulfate is produced
- 1.47 kJ of energy is taken in from the surroundings.

The equation for the reversible reaction is:



Calculate the maximum mass of water that can be produced from 11.7 g of hydrated copper sulfate.

[3 marks]

Mass = _____ g

15.0 g of anhydrous copper sulfate completely changes into hydrated copper sulfate when water is added.

Calculate the amount of energy transferred to the surroundings.

[2 marks]

Energy = _____ kJ

Q10. (2024)

This question is about water.

Hydrogen gas reacts with oxygen gas to produce water.

Water is decomposed into hydrogen gas and oxygen gas using electricity.

Which **two** words describe the reaction between hydrogen gas and oxygen gas?

[2 marks]

Tick (✓) **two** boxes.

Alloying

☐

Combustion

☐

Corrosion

☐

Endothermic

☐

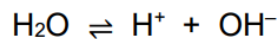
Reversible

☐

Q11. (2024)

Water molecules break down into hydrogen ions and hydroxide ions.

The equation for the reaction is:



Which sentence describes this reaction at equilibrium?

[1 mark]

Tick (✓) **one** box.

Water molecules break down at a higher rate than they reform.

☐

Water molecules break down and reform at the same rate.

☐

Water molecules break down at a lower rate than they reform.

☐