IB · DP · Chemistry

50 mins 6 questions

Practice Paper 2

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Total Marks **/50**

1 (a) Dichloromethyl benzene reacts with chlorine to produce trichloromethyl benzene. State the name of this type of menchanism and the required condition.

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(2 marks)

(b) Outline the mechanism for the reaction occurring in part a).

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(4 marks)

(c) A reaction pathway is shown below. Compound **J** reacts with bromine water to form a colourless solution.

State the IUPAC name for Compound J.

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(1 mark)

(d) Identify the reagents and conditions for the formation of Compound Y from Compound J.

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(2 marks)

2 (a) The equilibrium constant for the first dissociation of formic acid is 1.8×10^{-4} mol dm^{-3}.

State, with a reason, the strength of formic acid.

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(2 marks)

(b) Outline **one** laboratory method used to distinguish between equimolar solutions of formic acid and hydrochloric acid, giving the expected observations.

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(1 mark)

(c) Formic acid has the chemical formula HCOOH. Identify the conjugate base of formic acid and state whether it is a weak or strong conjugate base.

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(2 marks)

(d) Draw the structure of formic acid and give its systematic IUPAC name.

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(2 marks)

3 (a) Ammonia, NH_3, is a chemical that is key in the manufacture of certain fertilisers and cleaning products.

An ammonia molecule will react with an H^+ ion, to form the ammonium ion, NH_4^+.

Draw a Lewis (electron dot) diagram to show the bonding in the ammonium ion and name the type of bond formed between the ammonia molecule and the hydrogen ion.

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(2 marks)

(b) Lewis (electron dot diagrams) are used to show the electron arrangement in the valence shells of covalently bonded molecules.

Draw Lewis diagrams for the following molecules:

(i) Hydrogen cyanide.

(ii) Carbon dioxide.

(iii) Boron trifluoride.

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(3 marks)

(c) Using your answer to part (b), identify and explain the species that is likely to form a coordinate covalent bond.

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(2 marks)

(d) Using your answer to part (c), Explain, with the help of a diagram, the covalent bond formed between the species in part (c) and ammonia.

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(3 marks)

4 (a) Butane, C_4H_{10}, is typically used as fuel for cigarette lighters and portable stoves, a propellant in aerosols, a heating fuel, a refrigerant, and in the manufacture of a wide range of products.

Write an equation for the complete combustion of butane.

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(1 mark)

(b) Determine the enthalpy of formation of butane, C_4H_{10} , using the enthalpy of combustion data below.

$C\ (s) + O_2\ (g) \rightarrow CO_2\ (g)$ $\quad \Delta H^{\ominus}_f = -394$ kJ

$H_2\ (g) + 0.5O_2\ (g) \rightarrow H_2O\ (l)$ $\quad \Delta H^{\ominus}_f = -286$ kJ

$C_4H_{10}\ (g) + 6.5O_2\ (g) \rightarrow 4CO_2\ (g) + 5H_2O\ (l)$ $\quad \Delta H^{\ominus}_f = -2878$ kJ

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(4 marks)

(c) Butane can be formed from the hydrogenation of butene. Using the data in **Table 1**, determine a value for the enthalpy of formation.

Table 1

Bond	Mean Bond Enthalpy $\Delta H^{\ominus}$ (kJ mol^{-1})
C-C	346
C-H	414
H-H	436
C=C	614

(3 marks)

(d) The data book value for the hydrogenation of butene is -126 kJ mol-1. Suggest why your answer to part (c) may be different to this value.

(1 mark)

5 (a) State the meaning of the term *rate of reaction*.

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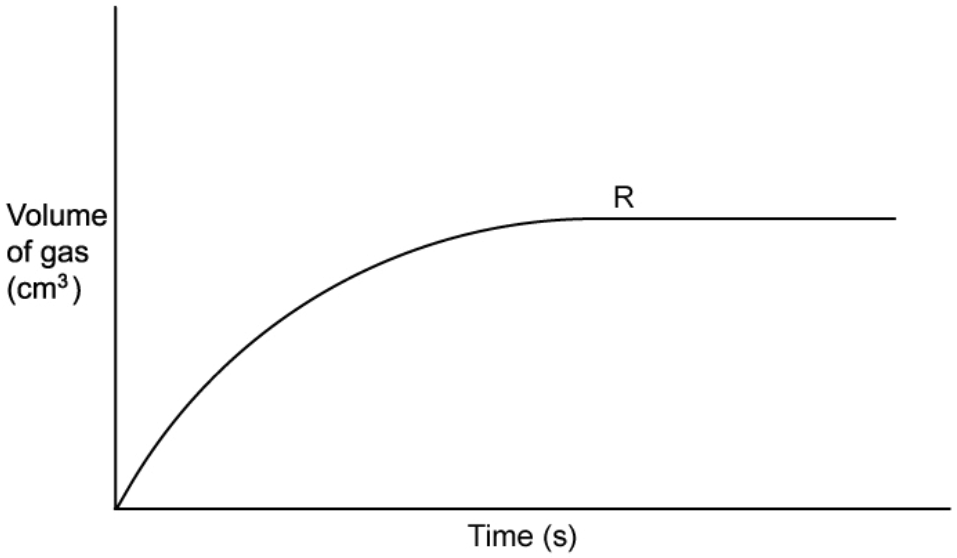
(1 mark)

(b) A group of students were completing a practical, investigating the factors which affect the rate of the chemical reaction shown below.

A (s) + B (aq) → C (g)

The students collected the gas produced and plotted the graph shown in **Figure 1**.

Figure 1



i) State and explain what the letter R represents on the students graph in **Figure 1.**

ii) In the original reaction above, the students used 0.5 g of **A** and 50 cm^3 of 1.0 mol dm^{-3} **B**.

Sketch a curve on the graph to show how the total volume of gas collected would change if the students still used 0.5 g of **A,** but used 50 cm^3 of 2.0 mol dm^{-3} of **B**.

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(3 marks)

(c) Explain why the gradient of the curve in part (b) decreases as the time of the reaction progresses.

(2 marks)

(d) Another way to increase the rate of reaction is to increase the temperature.

Explain why a small increase in temperature has a large effect on the initial rate of a chemical reaction.

(2 marks)

6 (a) Using your knowledge of atomic structure, complete **Table 1** below for the particles found in an atom.

Table 1

Particle	Relative charge	Relative mass
Proton		
Neutron		
Electron		

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(3 marks)

(b) The actual mass of protons, neutrons and electrons is given in **Table 2**.

Table 2

	Proton	Neutron	Electron
Mass (kg)	1.672622×10^{-27}	1.674927×10^{-27}	9.109383×10^{-31}

Calculate the mass, in g, of a nitrogen molecule.

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(1 mark)

(c) Oxygen consists of three stable isotopes, oxygen-16, oxygen-17, and oxygen-18.

State the particles present in each isotope and outline what differences would be expected in the chemical reactivity of the three isotopes.

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(2 marks)

(d) Suggest why some elements have several isotopes and others, like fluorine, have only one known isotope (known as monoisotopic elements).

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(1 mark)