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NZQA

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# Level 3 Chemistry, 2018

## 91390 Demonstrate understanding of thermochemical principles and the properties of particles and substances

2.00 p.m. Thursday 15 November 2018
Credits: Five

| Achievement | Achievement with Merit | Achievement with Excellence |
|---|---|---|
| Demonstrate understanding of thermochemical principles and the properties of particles and substances. | Demonstrate in-depth understanding of thermochemical principles and the properties of particles and substances. | Demonstrate comprehensive understanding of thermochemical principles and the properties of particles and substances. |

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

**You should attempt ALL the questions in this booklet.**

A periodic table and relevant formulae are provided in the Resource Booklet L3–CHEMR.

If you need more room for any answer, use the extra space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–11 in the correct order and that none of these pages is blank.

**YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.**

**TOTAL**

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## QUESTION ONE

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(a) Complete the following table.

| Symbol | Electron configuration (use *s, p, d* notation) |
|---|---|
| V | |
| $Cu^+$ | |
| $Br^-$ | |

(b) Explain the factors influencing the trends in first ionisation energy and atomic radius across the second period of the periodic table.

In your answer, you should:

- describe the trends in both first ionisation energy and atomic radius across the second period
- explain the factors influencing the trends in first ionistion energy and atomic radius across the second period
- relate the trend in first ionisation energy to the trend in atomic radius.

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(c) (i) Complete the table below.

| | $AsF_5$ | $BrF_5$ |
|---|---|---|
| **Lewis diagram** | | |
| **Name of shape** | | |

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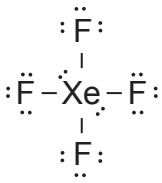
(ii) The Lewis diagram and shape for $XeF_4$ are given below.



square planar

Elaborate on the shape and polarity of $XeF_4$.

## QUESTION TWO

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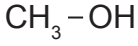
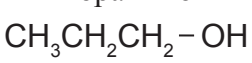
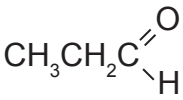
The standard enthalpy of vaporisation, $\Delta_{vap}H°$, of methanol, propan-1-ol, and propanal, are given in the table below.

(a) (i) List all the forces of attraction between the molecules in their liquid state.

| **Molecule** | **$\Delta_{vap}H°$ /kJ mol$^{-1}$** | ***M*** **/g mol$^{-1}$** | **Attractive forces** |
|---|---|---|---|
| Methanol  | 38 | 32 | |
| Propan-1-ol  | 47 | 60 | |
| Propanal  | 30 | 58 | |

(ii) Compare and contrast the enthalpy of vaporisation of methanol, propan-1-ol, and propanal.

Your answer should include an explanation of the relative strength of the attractive forces between the molecules.

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(b) (i) The equation for the combustion of propan-1-ol is:

$$C_3H_7OH(\ell) + 4.5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell)$$

Calculate the standard enthalpy of combustion, $\Delta_c H°$, of propan-1-ol, given the following data:

$\Delta_f H°(C_3H_7OH(\ell)) = -255$ kJ mol$^{-1}$

$\Delta_f H°(CO_2(g)) = -394$ kJ mol$^{-1}$

$\Delta_f H°(H_2O(\ell)) = -286$ kJ mol$^{-1}$

(ii) Explain how $\Delta_c H°$(propan-1-ol) would differ if water was produced as a gas rather than a liquid.

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(c) The equation for the formation of $Al_2Cl_6(s)$ is:

$$2Al(s) + 3Cl_2(g) \rightarrow Al_2Cl_6(s)$$

Calculate the enthalpy change, $\Delta_r H°$, for this reaction using the following data:

$$2Al(s) + 6HCl(aq) \rightarrow Al_2Cl_6(aq) + 3H_2(g) \qquad \Delta_r H° = -1003 \text{ kJ mol}^{-1}$$

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g) \qquad \Delta_r H° = -184 \text{ kJ mol}^{-1}$$

$$HCl(g) \rightarrow HCl(aq) \qquad \Delta_r H° = -72.4 \text{ kJ mol}^{-1}$$

$$Al_2Cl_6(s) \rightarrow Al_2Cl_6(aq) \qquad \Delta_r H° = -643 \text{ kJ mol}^{-1}$$

## QUESTION THREE

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(a) (i) Write an equation to represent the enthalpy of fusion (melting), $\Delta_{fus}H°$, of water.

(ii) Why is the enthalpy of vaporisation of water larger than its enthalpy of fusion?

(b) When 10.6 g of ammonium chloride, $NH_4Cl$, is dissolved in 65.0 mL of water, the temperature of the water changes from 20.9°C to 11.5°C.

The mass of the final solution is 75.6 g

Assume specific heat capacity of aqueous ammonium chloride = 4.18 J $g^{-1}$ $°C^{-1}$

$M(NH_4Cl)$ = 53.5 g $mol^{-1}$

Calculate the enthalpy change, $\Delta_r H°$, for dissolving ammonium chloride in water.

(c) The dissolving of ammonium chloride in water is an endothermic process, but ammonium chloride readily dissolves in water.

$$NH_4Cl(s) \rightarrow NH_4^+(aq) + Cl^-(aq)$$

Justify, in terms of the entropy changes of the system and the surroundings, why ammonium chloride readily dissolves in water.

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**Extra space if required.**
**Write the question number(s) if applicable.**

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