Level 3 Chemistry: practice paper 2026

AS 91390 Demonstrate understanding of thermochemical principles and the properties of particles and substances · Vertex Academy practice paper, not an NZQA paper

Attempt ALL the questions. Show ALL working. Write your answers on lined paper, or in the space under each question.

QUESTION ONE

(a) Ironsand from the west coast of the North Island is made into steel at Glenbrook, south of Auckland. Write the electron configurations, using s, p, d notation, of: (i) Fe (ii) Fe^{3+} (iii) Br^{-}.

(b) Name the shape of each molecule: PCl_5, SF_4 and XeF_4.

(c) Explain the general trend in first ionisation energy across Period 3, from sodium to argon, and explain why potassium has a lower first ionisation energy than sodium.

(d) Sulfur tetrafluoride, SF_4, and xenon tetrafluoride, XeF_4, both have four fluorine atoms bonded to the central atom. Electronegativities: F 4.0, S 2.6, Xe 2.6.
Discuss the shapes and the polarities of the two molecules.

QUESTION TWO

(a) The table gives data for three substances with similar molar masses.
Identify all the types of intermolecular force between the molecules in each substance.

Substance	Formula	Molar mass (g mol^{-1})	Boiling point (°C)
propane	$CH_3CH_2CH_3$	44.0	−42
ethanal	CH_3CHO	44.0	20
ethanol	CH_3CH_2OH	46.0	78

(b) State whether the entropy of the system increases or decreases in each process, and give a reason:
(i) $H_2O(l) \rightarrow H_2O(g)$
(ii) $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$
(iii) $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$

(c) Use the data in the table to explain the order of boiling points: propane, then ethanal, then ethanol.

(d) Ammonium nitrate dissolves in water at 25 °C, even though dissolving it is endothermic:
$NH_4NO_3(s) \rightarrow NH_4^+(aq) + NO_3^-(aq)$ $\Delta rH = +25.7$ kJ mol^{-1}
Discuss why this process is spontaneous, considering the entropy changes of both the system and the surroundings.

QUESTION THREE

(a) A student dissolves 2.00 g of sodium hydroxide, NaOH (M = 40.0 g mol^{-1}), in 50.0 g of water. The temperature rises from 19.2 °C to 29.4 °C. The specific heat capacity of water is 4.18 J g^{-1} $°C^{-1}$. Calculate ΔsolH for sodium hydroxide, in kJ mol^{-1}. Assume the solution has a mass of 50.0 g.

(b) The standard enthalpy of formation of ethanol, $C_2H_5OH(l)$, is −277 kJ mol^{-1}.
Write the thermochemical equation for this enthalpy change, with states.

(c) Standard enthalpies of formation (kJ mol^{-1}): $C_2H_5OH(l)$ −277, $CO_2(g)$ −394, $H_2O(l)$ −286.
Calculate the standard enthalpy of combustion of ethanol, ΔcH°, showing the equation you use.

(d) In a spirit-burner experiment, burning 1.15 g of ethanol ($M = 46.0$ g mol^{-1}) heated 200 g of water in a metal can from 20.0 °C to 41.5 °C. The specific heat capacity of water is 4.18 J g^{-1} °C^{-1}.
Calculate the experimental enthalpy of combustion of ethanol, and discuss why it differs from your answer to (c).

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