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NZQA

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For Supervisor's use only

Level 3 Chemistry, 2008

90780 Describe properties of particles and thermochemical principles

Credits: Five
9.30 am Friday 28 November 2008

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 answer ALL the questions in this booklet.

A periodic table is provided on the Resource Sheet L3–CHEMR.

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–8 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.

For Assessor's use only	**Achievement Criteria**		
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Describe properties of particles and thermochemical principles. ☐	Explain and apply properties of particles and thermochemical principles. ☐	Discuss properties of particles and thermochemical principles. ☐
Overall Level of Performance ☐		

You are advised to spend 45 minutes answering the questions in this booklet.

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QUESTION ONE: ATOMS, IONS AND THEIR PROPERTIES

(a) (i) Place the following species in order of increasing size: H, H^+, H^-.

_____ < _____ < _____

(ii) Justify your answer.

_____

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(b) Write the electron configuration using *s, p, d* notation for:

Sc _____

Br^- _____

Mn^{2+} _____

(c) Account for the following:

(i) A bromine atom, Br, has more electrons than a scandium atom, Sc, but its radius is smaller.

_____

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(ii) A bromine atom, Br, is smaller than a scandium atom, Sc, but its ionisation energy is larger.

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QUESTION TWO: MOLECULES, IONS AND THEIR PROPERTIES

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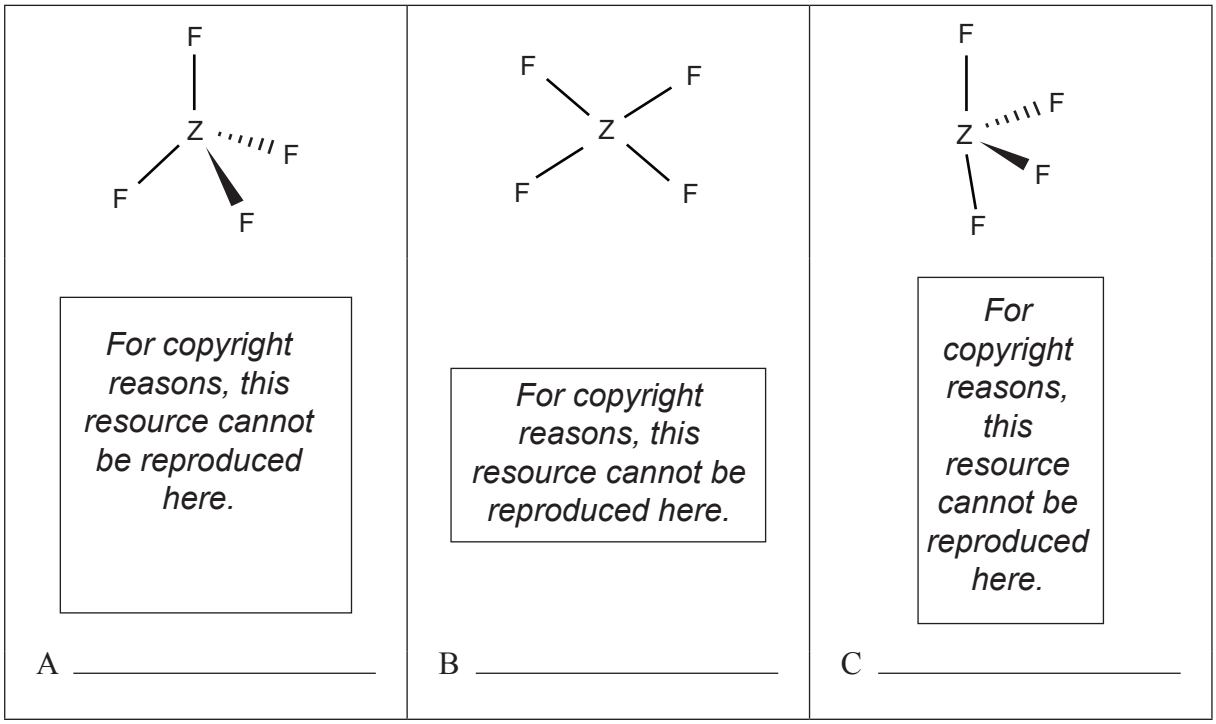
(a) The drawings below are three possible shapes for a molecule ZF_4, where 'Z' represents the central element. 'Z' has lower electronegativity than F.

Name the shapes represented by the three diagrams.



www.askthetachemistryhelp.com/geometry2.html

(b) Explain why C is the only shape that can give rise to a polar molecule for ZF_4.

_____

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(c) Draw the Lewis diagram for the ion BrF_4^-.

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(d) (i) Choose the structure for the BrF_4^- ion from those pictured in part (a), on the previous page.

(ii) Give a reason for your answer.

(iii) Circle the element, from the following list, which would be the central element Z in a molecule ZF_4 that has shape C (see part(a)).

Be C Se Si Xe

Justify your answer.

(e) Account for the difference in the boiling points for the following pairs of compounds by comparing the main forces between the molecules in each case.

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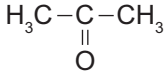
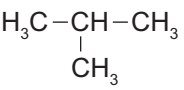
(i)

	Boiling point / °C	Molar mass / g mol^{-1}
Compound A, CH_3OH	65	32.0
Compound B, CH_3SH	6	48.1

(ii)

	Boiling point / °C	Molar mass / g mol^{-1}
Compound C, 	58	58.0
Compound D, 	–12	58.0

QUESTION THREE: ENTHALPY CHANGES

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(a) Urea, $(NH_2)_2CO$, which is a white crystalline solid, is widely used as a fertiliser.
Write the equation for which the enthalpy change is:

(i) the enthalpy of formation, $\Delta_f H°$, for urea

(ii) the enthalpy of fusion, $\Delta_{fus} H°$, for urea

(b) Urea breaks down in moist soil into carbon dioxide and ammonia.

$$(NH_2)_2CO(s) + H_2O(\ell) \rightarrow CO_2(g) + 2NH_3(g)$$

Calculate the enthalpy change for this reaction, $\Delta_r H$, using the information below.

$$(NH_2)_2CO(s) + 3\tfrac{1}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell) + 2NO_2(g) \quad \Delta_r H = -632 \text{ kJ mol}^{-1}$$
$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g) \quad \Delta_r H = -906 \text{ kJ mol}^{-1}$$
$$NO(g) + \tfrac{1}{2}O_2(g) \rightarrow NO_2(g) \quad \Delta_r H = -57 \text{ kJ mol}^{-1}$$
$$H_2O(\ell) \rightarrow H_2O(g) \quad \Delta_{vap} H = +41 \text{ kJ mol}^{-1}$$

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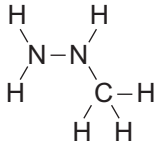
(c) Methylhydrazine, $N_2H_3CH_3$, can be used as a fuel.

The structural formula for methylhydrazine is 

(i) Define the term bond enthalpy.

(ii) Use the bond enthalpies given in the table below to calculate the energy released when one mole of methylhydrazine vapour is burned.

$$N_2H_3CH_3(g) + 2\frac{1}{2}O_2(g) \rightarrow CO_2(g) + N_2(g) + 3H_2O(g)$$

Bond	Bond enthalpy / kJ mol^{-1}
N–N	163
N–H	391
N–C	286
N≡N	941

Bond	Bond enthalpy / kJ mol^{-1}
C=O	804
O–H	463
C–H	414
O=O	498

Extra paper for continuation of answers if required.
Clearly number the question.

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Question number