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Level 3 Chemistry, 2008

90780 Describe properties of particles and thermochemical principles

Interactive paper

Credits: Five

You should answer ALL the questions in this paper.

Type your answers in the fields provided. Copy and paste any special characters needed from the box at the top of each page. Use the *Comment and Markup* tools to draw diagrams, circle options and so on. When you have finished, click the Show Answers button at the end of the paper. This will reveal the answers and marking schedule, and boxes for you to enter the grades (N, A, M or E). As you mark the paper your totals and overall performance will appear in the boxes below.

For Assessor's use only	**Achievement Criteria**	
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Describe aspects of organic chemistry.	Explain and apply aspects of organic chemistry.	Discuss aspects of organic chemistry.
Overall Level of Performance		

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

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.

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

Sc

Br^-

Mn^{2+}

(c) Account for the following:

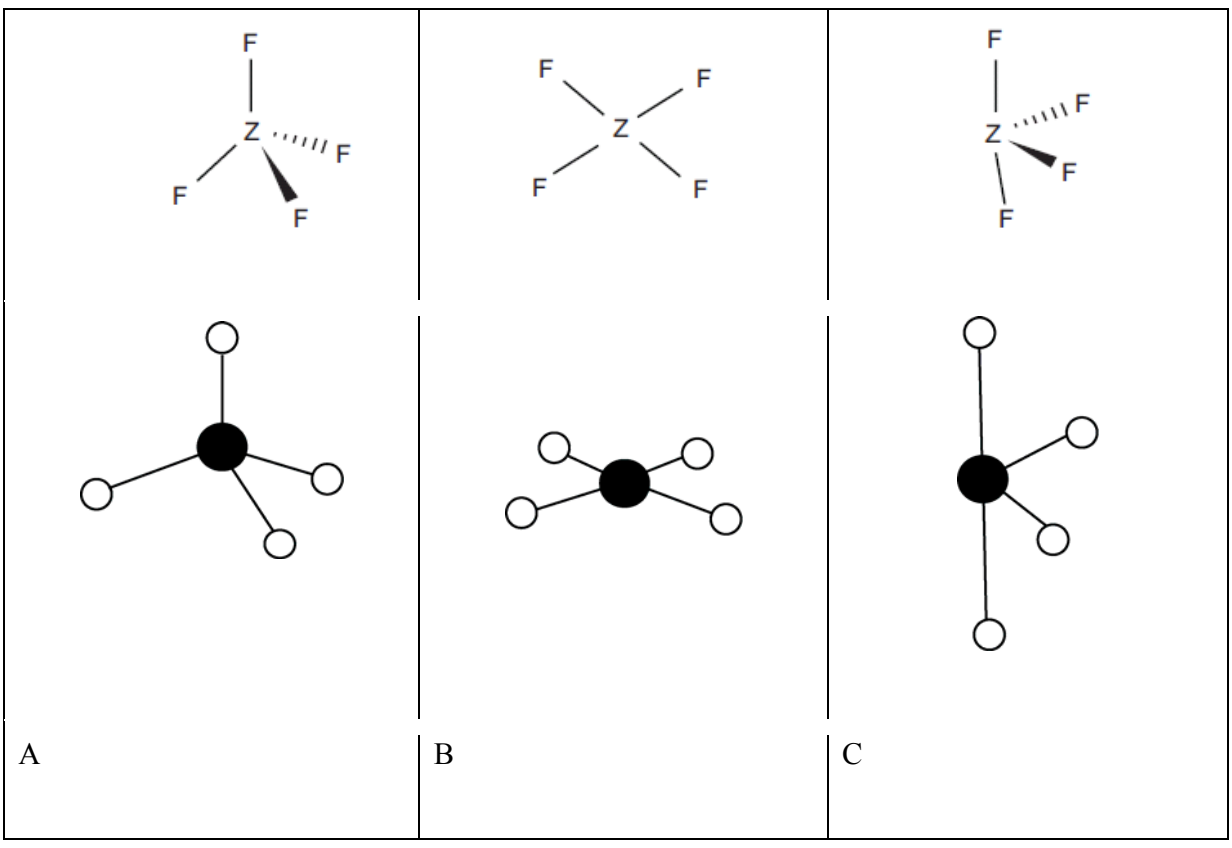
(i) A bromine atom, Br, has more electrons than a scandium atom, Sc, but its radius is smaller.

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

QUESTION TWO : MOLECULES, IONS ANDTHEIR PROPERTIES

(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.



A B C

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

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

(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

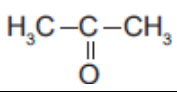
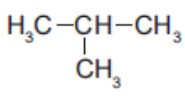
Justify your answer.

(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.

(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

(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.

$$(NH_2)_2CO(s) + 3½O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell) + 2NO_2(g) \qquad \Delta_r H = -632 \text{ kJ mol}^{-1}$$

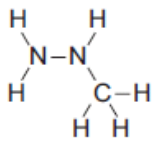
$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g) \qquad \Delta_r H = -906 \text{ kJ mol}^{-1}$$

$$NO(g) + ½O_2(g) \rightarrow NO_2(g) \qquad \Delta_r H = -57 \text{ kJ mol}^{-1}$$

$$H_2O(\ell) \rightarrow H_2O(g) \qquad \Delta_{vap} H = +41 \text{ kJ mol}^{-1}$$

(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.

$$N_2H_3CH_3(g) + 2½O_2(g) \rightarrow CO_2(g) + N_2(g) + 3H_2O(g)$$

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

Mark Answers

PERIODIC TABLE OF THE ELEMENTS

1	*2*											*13*	*14*	*15*	*16*	*17*	*18*
																	2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 40.0
19 **K** 39.1	20 **Ca** 40.1	21 **Sc** 45.0	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.9	27 **Co** 58.9	28 **Ni** 58.7	29 **Cu** 63.6	30 **Zn** 65.4	31 **Ga** 69.7	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.9	36 **Kr** 83.8
37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** 98.9	44 **Ru** 101	45 **Rh** 103	46 **Pd** 106	47 **Ag** 108	48 **Cd** 112	49 **In** 115	50 **Sn** 119	51 **Sb** 122	52 **Te** 128	53 **I** 127	54 **Xe** 131
55 **Cs** 133	56 **Ba** 137	71 **Lu** 175	72 **Hf** 179	73 **Ta** 181	74 **W** 184	75 **Re** 186	76 **Os** 190	77 **Ir** 192	78 **Pt** 195	79 **Au** 197	80 **Hg** 201	81 **Tl** 204	82 **Pb** 207	83 **Bi** 209	84 **Po** 210	85 **At** 210	86 **Rn** 222
87 **Fr** 223	88 **Ra** 226	103 **Lr** 262	104 **Rf** 261	105 **Db** 262	106 **Sg** 263	107 **Bh** 264	108 **Hs** 265	109 **Mt** 268									

Atomic Number

H 1.0

Molar Mass/ g mol^{-1}

Lanthanide Series	57 **La** 139	58 **Ce** 140	59 **Pr** 141	60 **Nd** 144	61 **Pm** 147	62 **Sm** 150	63 **Eu** 152	64 **Gd** 157	65 **Tb** 159	66 **Dy** 163	67 **Ho** 165	68 **Er** 167	69 **Tm** 169	70 **Yb** 173
Actinide Series	89 **Ac** 227	90 **Th** 232	91 **Pa** 231	92 **U** 238	93 **Np** 237	94 **Pu** 239	95 **Am** 241	96 **Cm** 244	97 **Bk** 249	98 **Cf** 251	99 **Es** 252	100 **Fm** 257	101 **Md** 258	102 **No** 259