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Level 3 Chemistry, 2006

90780 Describe properties of particles and thermochemical principles

Credits: Five

You should answer ALL the questions in this booklet.

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.

QUESTION ONE: PROPERTIES OF ATOMS AND IONS

(a)   Compare the relative sizes of the Ca^{2+} and Cl^- ions, and explain the difference in their radii.

(b)   (i)   Describe what is meant by "the first ionisation energy of chlorine".

     (ii)   Place magnesium, calcium and chlorine atoms in order of increasing first ionisation energies (IE). Justify your answer in terms of the factors that affect ionisation energy.

        Order of increasing IE is

QUESTION TWO: SHAPES AND POLARITIES

(a)   Complete the table below by:
    (i)   drawing Lewis diagrams for phosphorus trifluoride, PF_3 , and tetrachloroiodide ion ICl_4^-,
    (ii)   identifying the shape of BF_3, PF_3 and ICl_4^-.

		BF_3	PF_3	ICl_4^-
(i)	**Lewis diagram**	$\ddot{F} - B - \ddot{F}$ with $\overset{\vert}{\underset{\cdot\cdot}{\ddot{F}}}$		
(ii)	**Shape**			

(b)   Discuss reasons for the difference in the polarities of BF_3 and PF_3 molecules.

QUESTION THREE: TRANSITION METALS

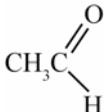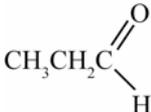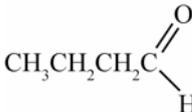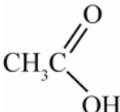(a)   Write the electron configuration for:

Cr

Mn

Mn^{2+}

(b)   Explain why manganese and chromium form a variety of different compounds and ions with oxygen.

(c)   Explain why most manganese and chromium compounds are coloured.

QUESTION FOUR: ENTHALPY OF VAPORISATION

Use the following information to answer the question below.

	ethanal	propanal	butanal	ethanoic acid
	$CH_3C{=}O$ H	$CH_3CH_2C{=}O$ H	$CH_3CH_2CH_2C{=}O$ H	$CH_3C{=}O$ OH
$\Delta_{vap}H$ / kJ mol^{-1}	26	30	34	52

Discuss the trend in $\Delta_{vap}H$ of the compounds in the table above in terms of the **attractive forces** between the particles and the **factors** affecting those forces.

QUESTION FIVE: ENTHALPY OF FORMATION AND COMBUSTION

(a)   Write the equation for the reaction that has an enthalpy change equal to $\Delta_c H^\circ(H_2, g)$

(b)   Explain why $\Delta_f H^\circ(H_2O, \ell)$ is equal to $\Delta_c H^\circ(H_2, g)$.

(c)   (i)   Calculate the enthalpy of formation of water in the **gas** state, $\Delta_f H^\circ(H_2O, g)$, using the following bond enthalpies.

Bond	Bond enthalpy / kJ mol^{-1}
H–H	436
O–H	463
O=O	498

(ii)   The experimental value for $\Delta_f H^\circ(H_2O, \ell)$ is -286 kJ mol^{-1}.

Using the information above, calculate the $\Delta_{vap} H^\circ(H_2O)$, and also the heat required to vaporise 100 g of water.

(d)   Calculate $\Delta_f H^\circ(C_2H_5OH, \ell)$ using the following data.

$\Delta_c H^\circ(C_2H_5OH, \ell)$ $= -1367$ kJ mol^{-1}

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

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