AS90780

Describe properties of particles and thermochemical principles

Level 3 5 Credits

This achievement standard involves describing properties of atoms, molecules, and ions, and thermochemical principles.

Achievement Criteria

Achievement	Merit	Excellence
Describe properties of particles & thermochemical principles.	Explain & apply properties of particles & thermochemical principles.	Discuss properties of particles & thermochemical principles.

Properties of particles (atoms, ions, and molecules) **include:**

- ❑ Electron configuration of
  - o atoms of the first 36 elements (using *s,p,d* notation)
  - o ions of the first 36 elements (using *s,p,d* notation)
- ❑ Special characteristics of transition metals (limited to iron, vanadium, chromium, manganese, copper and zinc)
  - o variable oxidation state - related to electron configuration
  - o colour - related to electron configuration
- ❑ Periodic trends in
  - o atomic radius
  - o ionisation energy
  - o electronegativity
- ❑ Comparison of atomic and ionic radii
- ❑ Lewis structures and shapes (up to six electron pairs about the central atom) for
  - o molecules
  - o polyatomic ions

  including those with multiple bonds
- ❑ Polarity of molecules
- ❑ Attractive forces between atoms, ions, and molecules. These will include
  - o ionic bonds
  - o covalent bonds
  - o intermolecular attractions due to
    - temporary dipoles (induced dipoles / dispersion forces)
    - permanent dipoles (including hydrogen bonding).

***Thermochemical principles* include:**

- ❑ Transfer of heat between the system and the surroundings
- ❑ Calculations involving the use of specific heat capacity
- ❑ Define & write equations representing: $\Delta_c H^\circ$, $\Delta_f H^\circ$, $\Delta_r H^\circ$, $\Delta_{vap} H^\circ$, $\Delta_{sub} H^\circ$, and $\Delta_{fus} H^\circ$
- ❑ Hess's Law including application of $\Delta_r H = \Sigma\Delta_f H(\text{products}) - \Sigma\Delta_f H(\text{reactants})$
- ❑ Bond enthalpies
  - o definition
  - o calculations involving bond enthalpies.

All working should be shown in calculations. Numerical answers should be rounded to an appropriate number of significant figures (usually three significant figures). Correct units must be included.

***Enthalpy changes,* ΔH** *Units commonly used kJ mol^{-1}*

$\Delta_r H^\circ$, standard enthalpy of reaction when reactants and products are in their standard state (usually the state at 25°C). For example:

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l) \quad \Delta_r H^\circ (H_2O,l) = -570 \text{ kJ mol}^{-1}$$

The term mol^{-1} means one mole of reaction, which is determined by the chemical equation; ie 2 mol of H_2 reacting with 1 mol of O_2 to give 2 mol of H_2O.

$\Delta_f H^\circ$, standard enthalpy of formation, per mole of product. For example, the standard enthalpy of formation of liquid water:

$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(l) \quad \Delta_f H^\circ (H_2O,l) = -285 \text{ kJ mol}^{-1}$$

$\Delta_c H^\circ$, standard enthalpy of combustion, per mole of substance burnt. For example, the standard enthalpy of combustion of hydrogen gas to give liquid water:

$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(l) \quad \Delta_c H^\circ (H_2, g) = -285 \text{ kJ mol}^{-1}$$

Note The superscript ° denotes a defined standard state.

$\Delta_{fus} H$, enthalpy of fusion (melting)
$\Delta_{vap} H$, enthalpy of vaporization
$\Delta_{sub} H$, enthalpy of sublimation

Terms

Describe involves identifying, naming, drawing, giving characteristics of, giving an account of, defining, and/or carrying out simple calculations.

Explain and apply involves describing as well as giving reasons for, making links between chemical concepts and/or observations, or carrying out calculations.

Discuss involves showing understanding by analysing, interpreting, justifying, relating, evaluating, comparing and contrasting, and/or calculating.