AP CHEMISTRY • EXERCISE SHEET

2.2 Intramolecular Force and Potential Energy

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

Objective

Build the skills to answer exam questions on **intramolecular force and potential energy** —the Coulombic picture of a bond.

You must be able to:

- read a **potential-energy vs distance** 势能-距离 curve for two atoms
- identify the **bond length** 键长 (minimum) and **bond energy** 键能 (well depth)
- link stronger bonds to deeper, narrower wells

1 Worked examples

Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

The potential-energy curve

As two atoms approach, attraction lowers the energy until repulsion of the nuclei takes over. The curve has a **minimum**: that distance is the **bond length**, and the depth of the well below zero is the **bond energy** (energy to separate the atoms).

Reading the curve

- The x-position of the minimum = bond length.
- The depth of the minimum = bond energy (how strongly bonded).
- To the left of the minimum, energy rises steeply —nuclei repel.

Comparing bonds

A **stronger** bond has a **deeper** well (larger bond energy) and usually a **shorter** bond length. A triple bond is deeper and shorter than a double, which is deeper and shorter than a single.

Coulomb's law link

Bond strength grows with the product of the charges and shrinks with distance ($E \propto \frac{q_1 q_2}{r}$). Smaller, more highly charged ions bond more strongly.

2 Practice

Now apply the methods above.

2.1 On a potential-energy curve, what does the position of the minimum represent? [1]

2.2 What does the depth of the well represent? [1]

2.3 Two bonds A and B have well depths 400 and 250 kJ/mol. Which is stronger? [1]

3 Exam-style questions

3.1 On a potential-energy vs distance curve, the bond length is the distance where the energy is [1]

- **A** zero
- **B** maximum
- **C** minimum
- **D** infinite

3.2 Two diatomic molecules have potential-energy curves. Molecule X has its minimum at 110 pm with depth 500 kJ/mol; molecule Y at 130 pm with depth 300 kJ/mol.

(a) Which has the shorter bond? [1]

(b) Which has the stronger bond? [1]

(c) State the relationship between bond length and bond strength suggested here. [1]

3.3 Using Coulomb's law, explain why the ionic bond in MgO (ions 2+ and 2−) is stronger

than in NaCl (ions 1+ and 1−). [2]

4 Go further

You are now ready for the real exam questions on this subtopic:

- work through the **2.2 Intramolecular Force and Potential Energy** lesson on the **Learn** page;
- read the **Intramolecular Force and Potential Energy** section of the AP Chemistry handout on the **Know** page.

Solutions

2.1 The bond length (the equilibrium separation of the atoms).

2.2 The bond energy —the energy needed to break the bond.

2.3 A (deeper well, 400 kJ/mol).

3.1 C —the bond length is at the energy minimum.

3.2 (a) X (110 pm). (b) X (500 kJ/mol). (c) Shorter bonds tend to be stronger.

3.3 Coulomb's law $E \propto \frac{q_1 q_2}{r}$: MgO has charges $2 \times 2 = 4$ vs $1 \times 1 = 1$ for NaCl, so the attraction (and bond strength) is much greater.