AP CHEMISTRY • EXERCISE SHEET

2.4 Structure of Metals and Alloys

Name: _____ Class: _____ Date: _____ **Total: 12 marks**

Objective

Build the skills to answer exam questions on the **structure of metals and alloys**.

You must be able to:

- describe metallic bonding as cations in a **sea of delocalized electrons** 离域电子
- explain metallic properties (conductive, malleable, ductile) from this model
- describe **interstitial** and **substitutional** alloys

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 electron-sea model

A metal is a lattice of **cations** immersed in a ”sea” of **delocalized** valence electrons that move freely throughout the whole solid.

Properties from the model

- **Conducts electricity and heat** —the mobile electrons carry charge and energy.
- **Malleable and ductile** —layers of cations slide past one another while the electron sea keeps holding them together, so the metal bends rather than shatters.
- **Lustrous** —the free electrons reflect light.

Alloys

An **alloy** 合金 mixes a metal with other elements:

- **Substitutional** —similar-sized atoms replace some of the host atoms (e.g. brass: zinc in copper).
- **Interstitial** —small atoms fit in the **gaps** between the metal atoms (e.g. carbon in iron → steel).

Why alloys are often harder

The different-sized atoms disrupt the regular layers, so they no longer slide easily — the alloy is **harder** and stronger than the pure metal.

2 Practice

Now apply the methods above.

2.1 What carries the electric current in a metal? [1]

2.2 Explain why metals are malleable. [2]

2.3 Name the two types of alloy. [2]

3 Exam-style questions

3.1 Metallic bonding is best described as [1]

- **A** shared pairs of electrons between two atoms
- **B** transfer of electrons to form ions
- **C** cations in a sea of delocalized electrons
- **D** no electron interaction

3.2 Steel is an alloy of iron and a small amount of carbon.

(a) State whether it is interstitial or substitutional, with a reason. [2]

(b) Explain why steel is harder than pure iron. [2]

3.3 Explain why metals conduct electricity in both the solid and molten states, unlike

ionic compounds. [2]

4 Go further

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

- work through the **2.4 Structure of Metals and Alloys** lesson on the **Learn** page;
- read the **Structure of Metals and Alloys** section of the AP Chemistry handout on the **Know** page.

Solutions

2.1 The delocalized (free) electrons.

2.2 Layers of metal cations can slide over each other while the delocalized electrons still hold them together, so the metal deforms without breaking.

2.3 Substitutional and interstitial.

3.1 C —cations in a sea of delocalized electrons.

3.2 (a) Interstitial —carbon atoms are much smaller than iron and fit in the gaps between iron atoms. (b) The carbon atoms disrupt the regular layers so they cannot slide easily, making the metal harder.

3.3 In a metal the delocalized electrons are mobile in both the solid and the molten state; an ionic compound needs its ions to move, which happens only when molten or dissolved.