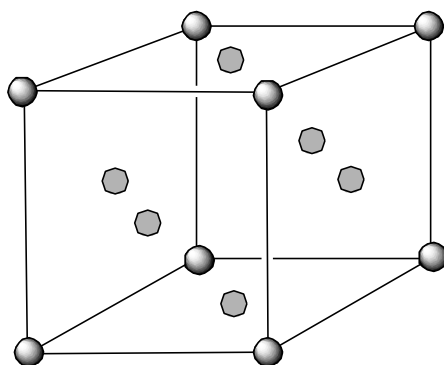


- The diagram below shows the structure of an alloy of copper and gold with a gold atom at each of the corners and a copper atom at each of the corners and a copper atom in the centre of each of the faces.

Marks  
2



● = Au

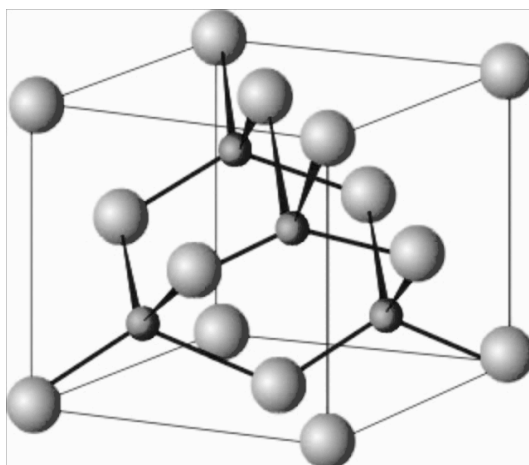
● = Cu

What is the chemical formula of the alloy?

Answer:

**Marks**  
**5**

- The cubic form of boron nitride (borazon) is the second-hardest material after diamond and it crystallizes with the structure shown below. The large spheres represent the nitrogen atoms and the smaller spheres represent boron atoms.



From the unit-cell shown above, determine the empirical formula of boron nitride.

Answer:

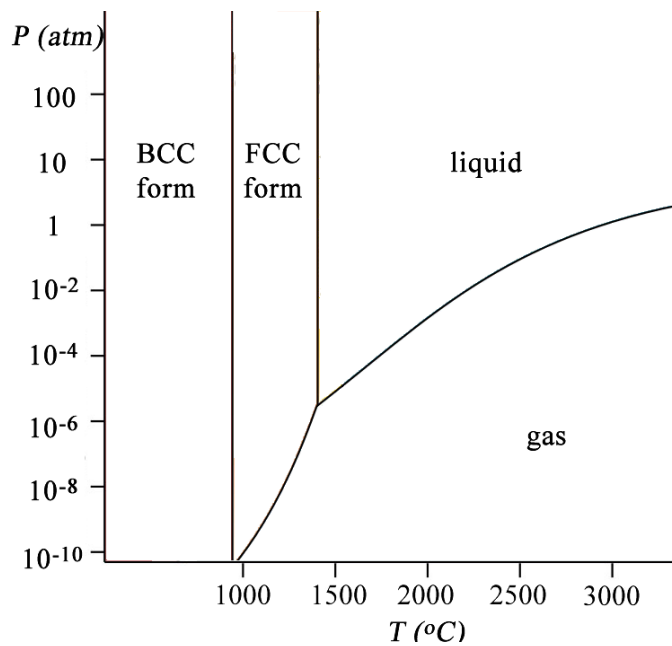
Determine the oxidation state of the boron atoms.

Answer:

The cubic form of boron nitride is more thermally stable in air than diamond. Provide a reasonable explanation for this observation.

- A simplified phase diagram for iron is shown below, with the solid part divided into the body-centred cubic (BCC) and face-centred cubic (FCC) phases.

**Marks**  
**5**



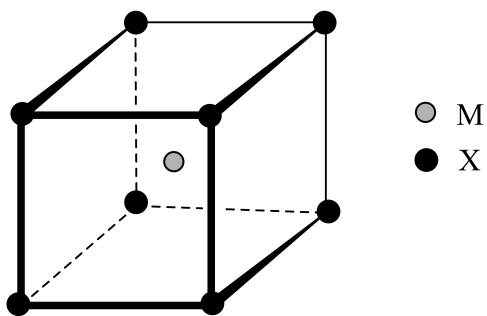
Which form of iron is stable at room temperature and pressure?

If molten iron is cooled slowly to around 1200 °C and then cooled rapidly to room temperature, the FCC form is obtained. Draw arrows on the phase diagram to indicate this process and explain why it leads to the FCC form as a metastable phase.

The line dividing the BCC and FCC forms is almost, but not quite vertical. Predict which way this line slopes and explain your answer.

**Marks**  
**2**

- The unit cell below has a cation (M) at the centre of the cell and anions (X) at the corners.



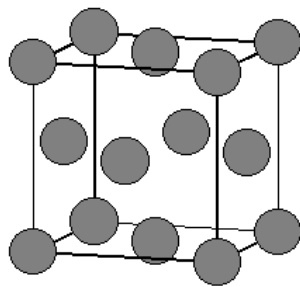
What is the formula of the compound?

What is the coordination number of each type of ion?

**THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.**

**Marks**  
**3**

- A face centred cubic (FCC) unit cell has the maximum possible space filling of 74 %. Show the close packed layers, labelling them A, B and C, on the unit cell below.



How many atoms are in the unit cell?

**Marks**  
**3**

- What are the structural differences between graphite and diamond and how do these differences impact on their physical properties? Mention at least three physical properties.

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**THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.**

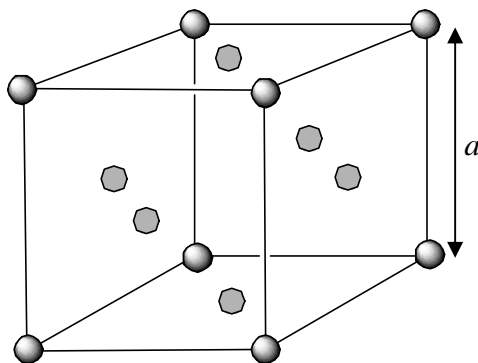
- A binary alloy has a face-centered cubic structure with atoms of element A in the faces and atoms of element B at the corners. What is the formula of the alloy? Explain your reasoning.

**1**

**THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.**

**Marks**  
**5**

- The diagram below shows the structure of an alloy of copper and gold with a gold atom at each of the corners and a copper atom in the centre of each of the faces. The unit cell dimension (edge length,  $a$ ) for this alloy is 0.36 nm.



● = Au

● = Cu

What is the chemical formula of the alloy?

	Answer:
--	---------

Pure gold is 24 carat, whilst gold alloys consisting of 75 % gold by weight are termed 18 carat gold. What carat gold is this alloy?

	Answer:
--	---------

What is the volume (in  $\text{cm}^3$ ) of the unit cell?

	Answer:
--	---------

What is the density (in  $\text{g cm}^{-3}$ ) of the alloy?

	Answer:
--	---------



- Define what is meant by an “allotrope”. Give an example of a pair of allotropes involving (i) oxygen and (ii) a pair not involving oxygen.

**2**

**Marks**  
**3**

- An alloy is formed by combining elements A and B. The alloy has a face-centred cubic structure, with atoms of A at the corners and atoms of B in the faces. What is the formula of the alloy? Explain your reasoning.

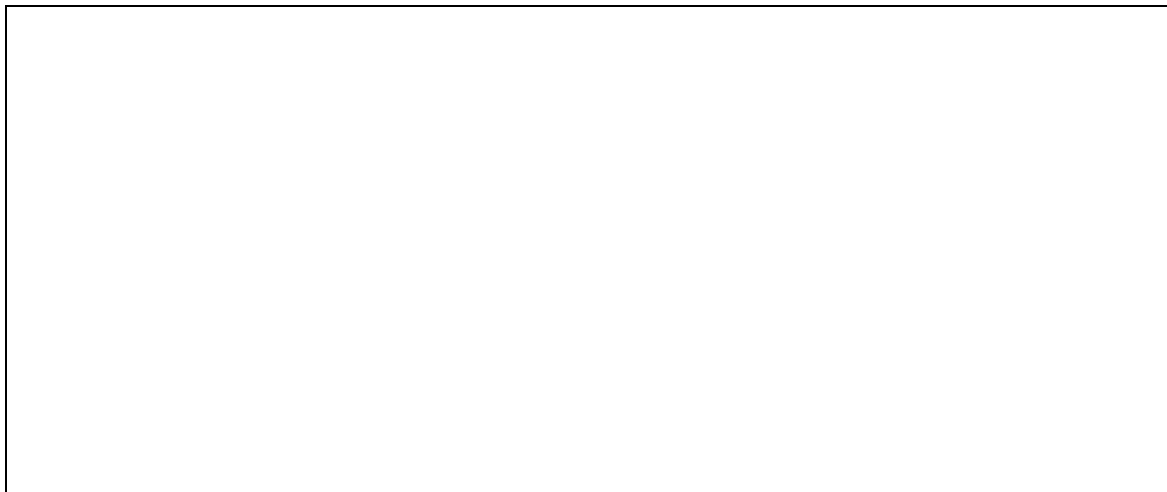
Answer:

- Define what is meant by an “allotrope”. Give an example of a pair of allotropes involving (i) phosphorus and (ii) a pair not involving phosphorus.

**2**

Draw the face-centred cubic unit cell.

**2**



**Marks**  
**3**

- Many elemental metals crystallise in one of three cubic forms, either with a face-centred cubic, a body-centred cubic or a simple cubic unit cell. Explain the main differences and similarities between these different crystalline forms.

**3**

- Teeth are made from hydroxyapatite,  $\text{Ca}_5(\text{PO}_4)_3\text{OH}$ . Why does an acidic medium promote tooth decay? Use chemical equations where appropriate.

How does the fluoridation of drinking water aid the prevention of tooth decay?