Iron Bends, Steel Holds: Interstitial Compounds and Alloys

Pure iron bends because layers of atoms slide over each other; less than 2 % carbon in the gaps locks the layers and gives hard steel. Interstitial compounds form when small atoms such as H, C or N are trapped in a metal lattice (TiC, Mn_4N, Fe_3H, $VH_{0.56}$, $TiH_{1.7}$): non-stoichiometric, very hard, higher melting than the pure metal, still conducting and chemically inert. Alloys form when atoms of similar size (metallic radii within about 15 %, e.g. Fe 126 and Cr 129 pm) are distributed randomly among each other: stainless steel, brass (Cu–Zn) and bronze (Cu–Sn), hard and often high melting.

Name: Date: Score: ____ / 25

A. Fill in the blanks

1. Compounds formed when small atoms like H, C or N are trapped in a metal's crystal lattice are called ____ compounds.

2. Interstitial compounds are usually non-____.

3. A blend of metals prepared by mixing the components is an ____.

4. Alloys form readily when metallic radii are within about ____ percent of each other.

5. Brass is an alloy of copper and ____.

6. Bronze is an alloy of copper and ____.

B. True or False

7. Interstitial compounds have higher melting points than the pure metals. True / False

8. Interstitial compounds do not conduct electricity. True / False

9. $VH_{0.56}$ corresponds to a normal oxidation state of vanadium. True / False

10. Transition metals form alloys readily because their metallic radii are similar. True / False

11. An alloy always has a fixed chemical formula. True / False

C. Assertion and reason

12. Assertion (A): Interstitial compounds are very hard.
Reason (R): Small atoms in the gaps block the layers of metal atoms from sliding.

(a) Both A and R are true, and R explains A
(b) Both A and R are true, but R does not explain A
(c) A is true, R is false
(d) A is false, R is true

Answer: _____

13. Assertion (A): Transition metals form alloys easily.
Reason (R): Their atoms have similar metallic radii (within about 15 %).

(a) Both A and R are true, and R explains A
(b) Both A and R are true, but R does not explain A
(c) A is true, R is false
(d) A is false, R is true

Answer: _____

D. Choose the correct option

14. Which is an interstitial compound?

(a) NaCl
(b) TiC
(c) H_2O
(d) CO_2

Answer: _____

15. Interstitial compounds are:

(a) chemically very reactive
(b) chemically inert
(c) liquids
(d) ionic salts

Answer: _____

16. Stainless steel contains iron mainly with:

(a) Cu and Zn
(b) Cr and Ni
(c) Sn and Pb
(d) Na and K

Answer: _____

17. Metallic radius of Fe is 126 pm and of Cr 129 pm. The difference is about:

(a) 2.4 %
(b) 15 %
(c) 24 %
(d) 48 %

Answer: _____

18. Which atom is too large to occupy the gaps of a metal lattice?

(a) H
(b) C
(c) N
(d) K

Answer: _____

19. Steel is harder than pure iron mainly because:

(a) carbon atoms block the sliding layers
(b) iron loses electrons
(c) it is an ionic compound
(d) it contains water

Answer: _____

E. Numerical problems

20. Cu = 128 pm and Zn = 137 pm. Find the percentage difference in radius.

21. Na = 186 pm and Fe = 126 pm. Find the percentage difference in radius.

F. Short answer questions

22. What are interstitial compounds? Give two examples.

23. State four properties of interstitial compounds.

24. Why do transition metals form alloys readily?

G. Match the columns

25. Match each item in Column A with the correct item in Column B.

Column A	Column B	Your answer
1. TiC	(a) Fe + Cr + Ni	1 → ____
2. brass	(b) Cu + Sn	2 → ____
3. bronze	(c) non-stoichiometric	3 → ____
4. stainless steel	(d) Cu + Zn	4 → ____
5. $VH_{0.56}$	(e) interstitial compound (C in Ti)	5 → ____

Detailed solutions

1. interstitial

2. stoichiometric

3. alloy

4. 15

5. zinc

6. tin

7. True. NCERT 4.3.13 (i).

8. False. They retain metallic conductivity.

9. False. It is non-stoichiometric.

10. True. e.g. Fe 126, Cr 129 pm.

11. False. It is a blend; atoms are distributed randomly.

12. (a) Some borides approach diamond.

13. (a) Atoms of one can take the place of the other.

14. (b) TiC. C trapped in the Ti lattice.

15. (b) chemically inert. NCERT 4.3.13 (iv).

16. (b) Cr and Ni. Cr gives corrosion resistance.

17. (a) 2.4 %. (3/126) × 100.

18. (d) K. Interstitial atoms are small: H, C, N.

19. (a) carbon atoms block the sliding layers. Small atoms in the gaps lock the layers.

20. (137 − 128)/128 × 100. **Answer: ≈ 7 % (within 15 %)**

21. (186 − 126)/126 × 100. **Answer: ≈ 48 % (no easy alloy)**

22. Compounds formed when small atoms like H, C or N are trapped inside the crystal lattices of metals; usually non-stoichiometric. Examples: TiC, Mn_4N (also Fe_3H, $VH_{0.56}$, $TiH_{1.7}$).

23. High melting points, higher than pure metals; very hard (some borides approach diamond); retain metallic conductivity; chemically inert.

24. Their metallic radii are similar (within about 15 %), so atoms of one metal can be distributed randomly among the atoms of the other in a solid solution; the alloys are hard and often high melting.

25. 1 → (e), 2 → (d), 3 → (b), 4 → (a), 5 → (c).