Fluorine Fails, Oxygen Wins: Highest Oxidation States in Oxides and Fluorides

A metal reaches its highest oxidation state only with oxygen or fluorine. Fluorine is the more electronegative, yet manganese's highest fluoride is MnF_4 (+4) while its oxide reaches +7 (Mn_2O_7, MnO_4^-): one oxygen forms a multiple bond and counts two electrons, one fluorine counts only one. From Sc_2O_3 to Mn_2O_7 the highest oxide's oxidation state equals the group number.

Name: _____ Date: _____ Score: ____ / 15

A. Fill in the blanks

1. The highest oxidation state of Mn in a fluoride is +____.

2. In MnO_4^- the oxidation state of Mn is +____.

3. Oxygen stabilises high oxidation states because it forms ____ bonds with metals.

4. In the highest oxides from Sc to Mn, the oxidation state equals the ____ number.

B. True or False

5. MnF_7 is a well-known compound. True / False

6. Mn_2O_7 is a covalent oxide. True / False

7. Oxygen stabilises higher states than fluorine because it is more electronegative. True / False

C. Assertion and reason

8. Assertion (A): The highest oxide of Mn is Mn_2O_7 but its highest fluoride is MnF_4.
Reason (R): Oxygen can form multiple bonds with metals.

(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: _____

9. Assertion (A): $KMnO_4$ is a strong oxidising agent.
Reason (R): Mn in the +7 state readily accepts electrons.

(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

10. The highest fluoride of manganese:

(a) MnF_2
(b) MnF_3
(c) MnF_4
(d) MnF_7

Answer: _____

11. The highest oxide of vanadium:

(a) VO
(b) V_2O_3
(c) VO_2
(d) V_2O_5

Answer: _____

12. Oxidation state of Mn in MnO_3F:

(a) +4
(b) +5
(c) +6
(d) +7

Answer: _____

E. Numerical problems

13. Find the oxidation state of Cr in $Cr_2O_7^{2-}$.

F. Short answer questions

14. Why does $Cu^+(aq)$ disproportionate?

G. Match the columns

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

Column A	Column B	Your answer
1. Sc_2O_3	(a) +7	1 → ____
2. TiO_2	(b) +3	2 → ____
3. V_2O_5	(c) +4	3 → ____
4. Mn_2O_7	(d) +5	4 → ____

Detailed solutions

1. 4

2. 7

3. multiple

4. group

5. False. It has never been made; the highest Mn fluoride is MnF_4.

6. True. Each Mn is tetrahedrally surrounded by O, with an Mn–O–Mn bridge.

7. False. Fluorine is more electronegative; oxygen wins by multiple bonding.

8. (a) R explains A.

9. (a) R explains A.

10. (c) MnF_4. NCERT Table 4.5.

11. (d) V_2O_5. Group 5, oxidation state +5.

12. (d) +7. $x - 6 - 1 = 0$.

13. $2x + 7(-2) = -2$, so $2x = 12$. **Answer: 6**

14. $2Cu^+ \rightarrow Cu^{2+} + Cu$. $Cu^{2+}(aq)$ has a much more negative hydration enthalpy than $Cu^+(aq)$, which more than compensates for the second ionisation enthalpy of Cu.

15. 1 → (b), 2 → (c), 3 → (d), 4 → (a). Each oxide matches the oxidation state of its metal (= group number).