The Orange That Turns Green: Potassium Dichromate

Potassium dichromate is made from chromite ore: fusion with sodium carbonate in air gives yellow sodium chromate (Fe_2O_3 is filtered off), acid turns it into orange sodium dichromate (two CrO_4 tetrahedra share one oxygen), and KCl precipitates the less soluble $K_2Cr_2O_7$. Chromate and dichromate interconvert with pH while Cr stays +6. In acid, $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ ($E° = 1.33$ V): a strong oxidising agent that turns orange to green, oxidising Fe^{2+}, I^-, H_2S and, in the 1954 breathalyser, ethanol.

Name: Date: Score: ____ / 24

A. Fill in the blanks

1. Potassium dichromate is prepared from the ore called ____.

2. Sodium chromate solution is ____ in colour.

3. On acidification, chromate changes to orange ____.

4. In acid, one dichromate ion accepts ____ electrons.

5. The Cr–O–Cr bond angle in the dichromate ion is about ____°.

B. True or False

6. In the chromate–dichromate interconversion, the oxidation state of Cr changes. True / False

7. Sodium dichromate is more soluble than potassium dichromate. True / False

8. Acidified potassium dichromate oxidises Fe^{2+} to Fe^{3+}. True / False

9. The green colour after oxidation is due to dichromate ions. True / False

10. The chromate ion is tetrahedral. True / False

C. Assertion and reason

11. Assertion (A): $K_2Cr_2O_7$ is a strong oxidising agent in acid.
Reason (R): Each Cr in $Cr_2O_7^{2-}$ can gain 3 electrons going from +6 to +3.

(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: _____

12. Assertion (A): KCl is added to sodium dichromate solution in the preparation.
Reason (R): Potassium dichromate is less soluble than sodium dichromate.

(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

13. Chromite ore is:

(a) Fe_2O_3
(b) $FeCr_2O_4$
(c) Cr_2O_3
(d) K_2CrO_4

Answer: _____

14. During fusion of chromite, iron ends up as:

(a) Fe
(b) FeO
(c) Fe_2O_3
(d) $FeCl_3$

Answer: _____

15. On adding NaOH to orange $K_2Cr_2O_7$ solution, the colour becomes:

(a) green
(b) yellow
(c) violet
(d) colourless

Answer: _____

16. In acidic medium, Cr in dichromate changes from:

(a) +6 to +3
(b) +3 to +6
(c) +6 to +2
(d) +7 to +2

Answer: _____

17. E° for $Cr_2O_7^{2-}/Cr^{3+}$ is about:

(a) +0.34 V
(b) +0.77 V
(c) +1.33 V
(d) +2.01 V

Answer: _____

18. Acidified $K_2Cr_2O_7$ oxidises H_2S to:

(a) SO_2
(b) S
(c) H_2SO_4
(d) SO_3

Answer: _____

E. Numerical problems

19. How many moles of Fe^{2+} are oxidised by 1 mol of $Cr_2O_7^{2-}$ in acid?

20. How many moles of I_2 are formed when 2 mol of $Cr_2O_7^{2-}$ react with excess iodide in acid?

F. Short answer questions

21. Describe the preparation of potassium dichromate from chromite ore with equations.

22. Explain the effect of pH on a dichromate solution.

23. Write ionic equations for acidified $K_2Cr_2O_7$ with iodide and with H_2S.

G. Match the columns

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

Column A	Column B	Your answer
1. CrO_4^{2-}	(a) orange, two tetrahedra sharing one O	1 → ____
2. $Cr_2O_7^{2-}$	(b) yellow, tetrahedral, Cr +6	2 → ____

Detailed solutions

1. chromite

2. yellow

3. dichromate

4. six

5. 126

6. False. Cr is +6 in both.

7. True. That is why KCl gives $K_2Cr_2O_7$ crystals.

8. True. $Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$.

9. False. Green is the product, Cr^{3+}.

10. True. Cr at the centre, four O at the corners.

11. (a) E° = 1.33 V.

12. (a) So it crystallises out.

13. (b) $FeCr_2O_4$. Iron(II) chromite.

14. (c) Fe_2O_3. It is filtered off.

15. (b) yellow. Dichromate → chromate.

16. (a) +6 to +3. Each Cr gains $3e^-$.

17. (c) +1.33 V. A strong oxidant.

18. (b) S. A pale yellow deposit of sulphur.

19. $Cr_2O_7^{2-}$ accepts $6e^-$; each Fe^{2+} gives $1e^-$. **Answer: 6 mol**

20. $2 \times 6e^- = 12e^-$; $2I^- \rightarrow I_2 + 2e^-$. **Answer: 6 mol I_2**

21. $4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$; filter off Fe_2O_3; $2Na_2CrO_4 + 2H^+ \rightarrow Na_2Cr_2O_7 + 2Na^+ + H_2O$; $Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$ (orange crystals).

22. $2CrO_4^{2-} + 2H^+ \rightleftharpoons Cr_2O_7^{2-} + H_2O$. Acid favours orange dichromate; base (OH^-) converts it back to yellow chromate. Cr remains +6, so the change is not redox.

23. $Cr_2O_7^{2-} + 14H^+ + 6I^- \rightarrow 2Cr^{3+} + 3I_2 + 7H_2O$; $Cr_2O_7^{2-} + 8H^+ + 3H_2S \rightarrow 2Cr^{3+} + 3S + 7H_2O$.

24. 1 → (b), 2 → (a).