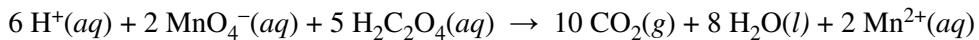
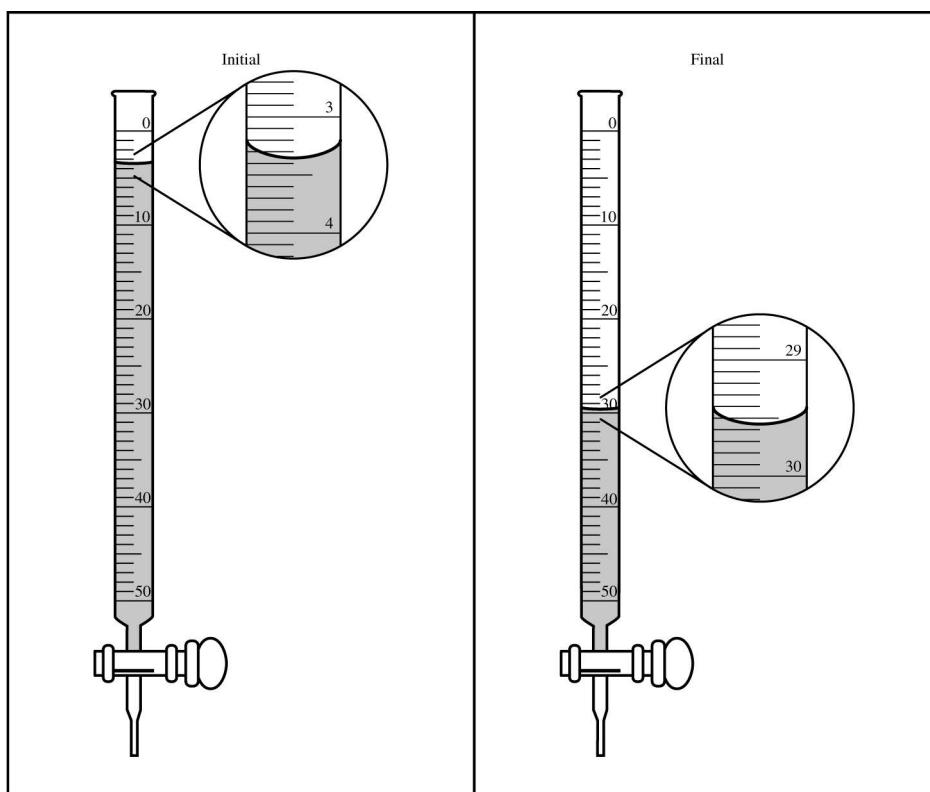


## 2019 AP® CHEMISTRY FREE-RESPONSE QUESTIONS



7. A student dissolved a 0.139 g sample of oxalic acid,  $\text{H}_2\text{C}_2\text{O}_4$ , in water in an Erlenmeyer flask. Then the student titrated the  $\text{H}_2\text{C}_2\text{O}_4$  solution in the flask with a solution of  $\text{KMnO}_4$ , which has a dark purple color. The balanced chemical equation for the reaction that occurred during the titration is shown above.

- (a) Identify the species that was reduced in the titration reaction. Justify your answer in terms of oxidation numbers.
- (b) The student used a 50.0 mL buret to add the  $\text{KMnO}_4(aq)$  to the  $\text{H}_2\text{C}_2\text{O}_4(aq)$  until a faint lavender color was observed in the flask, an indication that the end point of the titration had been reached. The initial and final volume readings of the solution in the buret are shown below. Write down the initial reading and the final reading and use them to determine the volume of  $\text{KMnO}_4(aq)$  that was added during the titration.



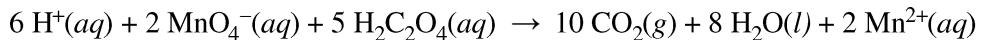
- (c) Given that the concentration of  $\text{KMnO}_4(aq)$  was  $0.0235 M$ , calculate the number of moles of  $\text{MnO}_4^-$  ions that completely reacted with the  $\text{H}_2\text{C}_2\text{O}_4$ .
- (d) The student proposes to perform another titration using a 0.139 g sample of  $\text{H}_2\text{C}_2\text{O}_4$ , but this time using  $0.00143 M \text{ KMnO}_4(aq)$  in the buret. Would this titrant concentration be a reasonable choice to use if the student followed the same procedure and used the same equipment as before? Justify your response.

**STOP**

**END OF EXAM**

**AP<sup>®</sup> CHEMISTRY  
2019 SCORING GUIDELINES**

**Question 7**



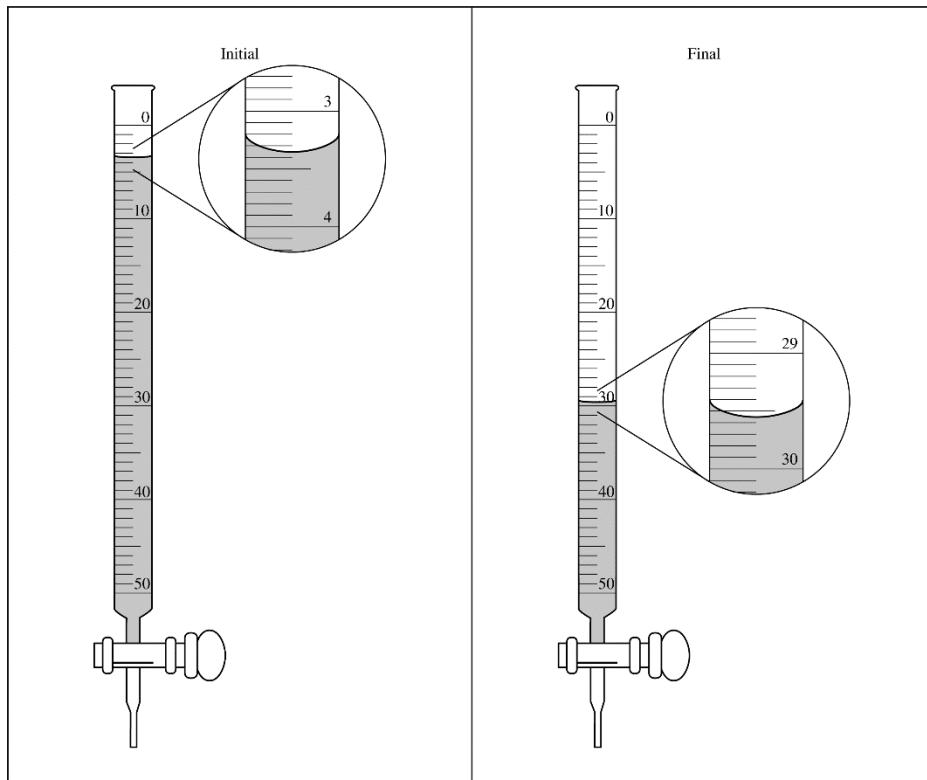
A student dissolved a 0.139 g sample of oxalic acid,  $\text{H}_2\text{C}_2\text{O}_4$ , in water in an Erlenmeyer flask. Then the student titrated the  $\text{H}_2\text{C}_2\text{O}_4$  solution in the flask with a solution of  $\text{KMnO}_4$ , which has a dark purple color. The balanced chemical equation for the reaction that occurred during the titration is shown above.

- (a) Identify the species that was reduced in the titration reaction. Justify your answer in terms of oxidation numbers.

$\text{MnO}_4^-$  is reduced to  $\text{Mn}^{2+}$  as the oxidation number of Mn changes from +7 to +2, indicating a gain of 5 electrons.

1 point is earned for the correct answer with justification.

- (b) The student used a 50.0 mL buret to add the  $\text{KMnO}_4(\text{aq})$  to the  $\text{H}_2\text{C}_2\text{O}_4(\text{aq})$  until a faint lavender color was observed in the flask, an indication that the end point of the titration had been reached. The initial and final volume readings of the solution in the buret are shown below. Write down the initial reading and the final reading and use them to determine the volume of  $\text{KMnO}_4(\text{aq})$  that was added during the titration.



$$29.55 \text{ mL} - 3.35 \text{ mL} = 26.20 \text{ mL}$$

1 point is earned for the correct answer.

**AP<sup>®</sup> CHEMISTRY  
2019 SCORING GUIDELINES**

**Question 7 (continued)**

- (c) Given that the concentration of  $\text{KMnO}_4(aq)$  was  $0.0235\text{ M}$ , calculate the number of moles of  $\text{MnO}_4^-$  ions that completely reacted with the  $\text{H}_2\text{C}_2\text{O}_4$ .

$(0.02620\text{ L})(0.0235\text{ mol/L}) = 0.000616\text{ mol}$	1 point is earned for the correct answer.
---	---

- (d) The student proposes to perform another titration using a  $0.139\text{ g}$  sample of  $\text{H}_2\text{C}_2\text{O}_4$ , but this time using  $0.00143\text{ M}$   $\text{KMnO}_4(aq)$  in the buret. Would this titrant concentration be a reasonable choice to use if the student followed the same procedure and used the same equipment as before? Justify your response.

No. The $0.00143\text{ M}$ titrant solution is so diluted that the volume of titrant needed to reach the end point would be much greater than the $50\text{ mL}$ capacity of the buret.	1 point is earned for the correct answer with appropriate justification.
---	--