

Titration

1. Consider the following statements:

- I Titration is the progressive addition of one reagent to another reagent
- II Titration involves an acid and a base solution.
- III The indicator endpoint in a titration should indicate that chemically equivalent amounts have been brought together.
- IV Titration results in a solution with a pH of 7.0 at the equivalence point.

Which statement(s) regarding titration are **ALWAYS true**?

a	I and II
b	I and III
c	II and III
d	I, II, III and IV

2. Carmen and Isabel were asked to titrate an acidified $\text{Fe}^{2+}(\text{aq})$ solution with an acidified $\text{Na}_2\text{Cr}_2\text{O}_7(\text{aq})$ solution. The correct redox reaction for this titration is _____

a	$6\text{Fe}^{2+}(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^+(\text{aq}) \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 6\text{Fe}^{3+}(\text{aq}) + 14\text{OH}^-(\text{aq})$
b	$6\text{Fe}^{2+}(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^+(\text{aq}) \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 6\text{Fe}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$
c	$6\text{Fe}^{2+}(\text{aq}) + 2\text{Na}^+(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^+(\text{aq}) \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 6\text{Fe}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$
d	$6\text{Fe}^{3+}(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^+(\text{aq}) \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 6\text{Fe}^{2+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$

3. A strong oxidizing agent is to be titrated using a strong reducing agent. The **least** accurate titration technique would be to add the oxidizing agent to the reducing agent by using a _____.

a	Graduated cylinder
b	Medicine dropper
c	Beaker
d	burette

4. Elisabeth prepared a standard acidified solution of $\text{Fe}^{2+}(\text{aq})$ and then titrated a $\text{KMnO}_4(\text{aq})$ solution of unknown concentration. Why did Elisabeth acidify the $\text{Fe}^{2+}(\text{aq})$ rather than the $\text{KMnO}_4(\text{aq})$ solution?

a	$\text{Fe}^{2+}(\text{aq})$ cannot act as a reducing agent without an acid
b	the acid changes $\text{Fe}^{2+}(\text{aq})$ to $\text{Fe}(\text{s})$ to form the standard solution
c	$\text{MnO}_4^-(\text{aq})$ will not act as an oxidizing agent without an acid.
d	Acid is required to dilute the $\text{Fe}^{2+}(\text{aq})$ to a lower concentration

5. In an experiment, 0.21 mol/L $\text{KMnO}_4(\text{aq})$ was titrated to determine the concentration of an acidified $\text{Sn}^{2+}(\text{aq})$ solution. The following data was obtained:

	Trial I	Trial II	Trial III	Trial IV
Volume of $\text{Sn}^{2+}(\text{aq})$ (mL)	10.00	10.00	10.00	10.00
Burette final reading (mL)	11.26	22.15	33.03	43.93
Burette initial reading (mL)	0.0	11.26	22.15	33.03
Volume of $\text{KMnO}_4(\text{aq})$ used (mL)	11.26	10.89	10.88	10.90

The most likely reason that trial I required more $\text{KMnO}_4(\text{aq})$ than the other trials is that the _____

a	flask into which the $\text{Sn}^{2+}(\text{aq})$ was pipetted may have been wet
b	pipet used to transfer the $\text{Sn}^{2+}(\text{aq})$ sample was wet
c	Clean, dry burette was not rinsed with $\text{KMnO}_4(\text{aq})$ before it was filled
d	tip of the burette was not filled with $\text{KMnO}_4(\text{aq})$

6. One of the main techniques used in quantitative measurement of redox reactions is

a	Precipitation
b	Titration
c	Dissociation
d	Neutralization

7. Jody wishes to prepare 100 mL of a 0.0100 mmol/L $\text{SnF}_2(\text{aq})$ to titrate with freshly acidified $\text{KMnO}_4(\text{aq})$ of uncertain concentration. The equipment available to Jody includes a 100 mL volumetric flask, a 10 mL pipette, an electronic balance with a precision of ± 0.01 g, and a 150 mL beaker.

Once Jody obtains the appropriate mass of $\text{SnF}_2(\text{s})$, which procedure should she use to prepare this solution?

a	Place the $\text{SnF}_2(\text{s})$ in the beaker and add exactly 100 mL of water from the volumetric flask
b	Place the $\text{SnF}_2(\text{s})$ in the beaker and add exactly 100 mL of water from the pipette in 10 mL portions
c	Place the $\text{SnF}_2(\text{s})$ in the beaker, dissolve it in more than 100 mL of water, and then pour the solution into the volumetric flask to the 100 mL mark
d	Place the $\text{SnF}_2(\text{aq})$ in the volumetric flask, dissolve it in less than 100 mL of water, and then dilute to the 100 mL mark.

8. Some boys argue about the difference between the equivalence point of a titration and the end point of a titration. They titrate an acidic solution of sodium iodide with potassium permanganate solution. The boys make several predictions about what will happen when they reach the endpoint. The TRUE statement below is _____

a	Stephan says a solid will suddenly appear.
b	Jared says a green color will suddenly appear
c	Justin says a purple color will suddenly appear
d	Dale says the pH will suddenly fall.

9. Some boys argue about the difference between the **equivalence point** of a titration and the **endpoint** of a titration. The four boys titrate a solution of tin (II) nitrate with an **acidic** solution of potassium dichromate. Choose the correct prediction below.

a	Kyle predicts that the equivalence point is blue green and the endpoint is brown
b	Matt predicts that the equivalence point is colorless and the endpoint is orange
c	Jason predicts that the endpoint is blue green and the equivalence point is brown
d	Jeremy predicts that the equivalence point is orange and the endpoint is colorless

10. Some girls argue about the difference between the **equivalence point** of a titration and the **endpoint** of a titration. Morgan, Rachel, Chelsea and Lara titrate a solution of tin(II) nitrate with an **acidic** solution of potassium permanganate

Choose the **TRUE** statement below.

a	Chelsea says the equivalence point is purple and the endpoint is colorless
b	Morgan says the endpoint is blue-green and the equivalence point is brown
c	Rachel says the equivalence point is colorless and the endpoint is purple-pink
d	Lara says the equivalence point is brown and the endpoint is blue-green

11. Justin and Martial do an oxidation reduction titration reaction. They titrate a 10 mL sample of 0.010 mol/L $\text{Cr}^{2+}(\text{aq})$ solution with excess acidified 0.010 mol/L $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$. The equivalence point color will be _____ and the endpoint color will be _____

a	Green	Brown
b	Blue	Orange
c	Green	Orange
d	Colorless	Brown

12. Using acidified 0.20 mol/L $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$, a student titrated a solution of $\text{Sn}(\text{NO}_3)_2(\text{aq})$ of unknown concentration. In the titration, 34.0 mL of oxidizing agent was required to react with 43.0 mL of the reducing agent. The concentration of $\text{Sn}(\text{NO}_3)_2(\text{aq})$ _____ mol/L

a	0.16
b	0.47
c	0.25
d	0.76

13. In a titration experiment, a 0.0800 mol/L solution of acidic $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$ was used to oxidize $\text{Sn}^{2+}(\text{aq})$ to $\text{Sn}^{4+}(\text{aq})$. The following data was obtained.

Volume of $\text{Sn}^{2+}(\text{aq})$ used	20.0 mL
Final burette reading of $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$	73.4 mL
Initial burette reading of $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$	14.4 mL

The concentration of $\text{Sn}^{2+}(\text{aq})$ was _____ mol/L

a	0.708
b	0.236
c	8.14×10^{-2}
d	2.84×10^{-4}

14. The mass of $\text{I}_2(\text{s})$ that is formed when 800 mL of 0.100 mol/L $\text{NaI}(\text{s})$ react with excess chlorine gas, $\text{Cl}_2(\text{g})$ is _____ g

a	102
b	203
c	10.2
d	50.8

15. **Numerical response question:** Left justify your answer in the boxes provided.

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Leanne used a standardized 0.125 mol/L potassium dichromate solution to titrate a series of 20.0 mL samples of acidified $\text{Sn}^{2+}(\text{aq})$. The following data was collected

Trial	1	2	3
Final burette reading (mL)	27.2	44.5	30.1
Initial burette reading (mL)	10.1	27.2	12.9

Based on this information, **determine** the chemical amount of potassium dichromate solution used in the titration. Express the answer in the form $a.bc \times 10^{-d}$ mol. The letters a,b,c,d respectively are
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16. **Numerical response question:** Left justify your answer in the boxes provided.

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A standardized 0.225 mol/L solution of $\text{KMnO}_4(\text{aq})$ was used to titrate 10.0 mL samples of acidified $\text{Fe}^{2+}(\text{aq})$. The following data was collected

Trial	1	2	3
Final burette reading (mL)	21.4	31.3	41.0
Initial burette reading (mL)	11.6	21.4	31.3

Based on this information, determine the **concentration** of the $\text{Fe}^{2+}(\text{aq})$ as _____ mol/L

Solutions:

1. B
2. B
3. C
4. C
5. D
6. B
7. D
8. C
9. A
10. C
11. A
12. B
13. A
14. C
15. 2153
16. 1.10