



3. For the reaction:  $\text{BrO}_3^- (\text{aq}) + 5 \text{Br}^- (\text{aq}) + 6 \text{H}^+ (\text{aq}) \rightarrow 3 \text{Br}_2 (\text{aq}) + 3 \text{H}_2\text{O} (\text{l})$   
The following data were obtained.

Experiment	$[\text{BrO}_3^-]$ (M)	$[\text{Br}^-]$ (M)	$[\text{H}^+]$ (M)	Initial Rate (M/s)
1	0.10	0.10	0.10	1.2
2	0.20	0.10	0.10	2.4
3	0.10	0.30	0.10	3.6
4	0.20	0.10	0.20	9.6

- a)  $\text{Rate} = k [\text{BrO}_3^-] [\text{Br}^-] [\text{H}^+]^{3/2}$   
 b)  $\text{Rate} = k [\text{BrO}_3^-]^2 [\text{Br}^-] [\text{H}^+]$   
 c)  $\text{Rate} = k [\text{BrO}_3^-] [\text{Br}^-]^2 [\text{H}^+]^2$   
 d)  $\text{Rate} = k [\text{BrO}_3^-] [\text{Br}^-] [\text{H}^+]^2$   
 e)  $\text{Rate} = k [\text{BrO}_3^-] [\text{Br}^-] [\text{H}^+]$

4. For the decomposition of ozone,  $2 \text{O}_3 (\text{g}) \rightarrow 3 \text{O}_2 (\text{g})$ , the observed rate law is:  $\text{rate} = k \frac{[\text{O}_3]^2}{[\text{O}_2]}$

When the concentration of  $\text{O}_2$  is doubled, what happens to the rate?

- a) The rate increases by a factor of two.  
 b) The rate decreases by a factor of two.  
 c) The rate increases by a factor of four.  
 d) The rate decreases by a factor of four.  
 e) The rate stays the same.

5. For the reaction:  $(\text{CH}_3)_3\text{CBr} (\text{aq}) + \text{OH}^- (\text{aq}) \rightarrow (\text{CH}_3)_3\text{COH} (\text{aq}) + \text{Br}^- (\text{aq})$   
The following data were obtained at  $55^\circ\text{C}$ .

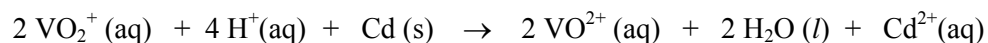
Experiment	$[(\text{CH}_3)_3\text{CBr}]$ (M)	$[\text{OH}^-]$ (M)	Initial Rate (M/s)
1	0.10	0.10	$1.0 \times 10^{-3}$
2	0.20	0.10	$2.0 \times 10^{-3}$
3	0.10	0.20	$1.0 \times 10^{-3}$
4	0.30	0.40	?

What will the initial rate be for Experiment 4?

- a)  $1.0 \times 10^{-3} \text{ M/s}$   
 b)  $2.0 \times 10^{-3} \text{ M/s}$   
 c)  $4.0 \times 10^{-3} \text{ M/s}$   
 d)  $3.0 \times 10^{-3} \text{ M/s}$   
 e)  $6.0 \times 10^{-3} \text{ M/s}$

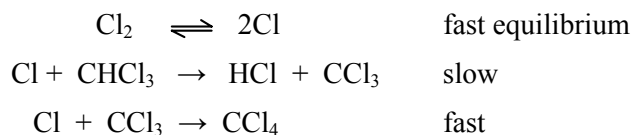
6. Electrolysis of a molten metal chloride ( $MCl_2$ ) using a current of 2.50 A for 149 seconds deposits 0.217 g of metal at the cathode. Determine the molar mass of the metal.
- a) 112 g/mol
  - b) 45 g/mol
  - c) 24 g/mol
  - d) 56 g/mol
  - e) none of these

7. In the reaction below, what substance is reduced?



- a)  $\text{VO}_2^+$
  - b)  $\text{Cd}^{2+}$
  - c) Cd
  - d)  $\text{VO}^{2+}$
  - e)  $\text{H}^+$
8. Electrolysis of water produces  $\text{O}_2$  (g) and  $\text{H}_2$  (g). How many moles of  $\text{H}_2$ (g) are produced from the electrolysis of water by a current of 2.80 A in 15.0 minutes?
- a) 0.026 mol
  - b) 0.013 mol
  - c) 38.5 mol
  - d) 76.9 mol
  - e) none of these
9. For the reaction,  $A \rightarrow B$ , the activation energy,  $E_a = 75$  kJ/mol, and  $\Delta E = 35$  kJ/mol. What is the activation energy for the reverse reaction,  $B \rightarrow A$ ?
- a) 110 kJ/mol
  - b) 40 kJ/mol
  - c) 35 kJ/mol
  - d) 75 kJ/mol
  - e) None of these

Use the following mechanism to answer questions 10 and 11.



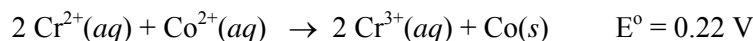
10. Considering the mechanism given above, which of the following statements is true?

- a) Cl is an intermediate
- b)  $\text{CCl}_3$  is an intermediate
- c) Both Cl and  $\text{CCl}_3$  are intermediates
- d) Both Cl and  $\text{CCl}_3$  are catalysts
- e)  $\text{CHCl}_3$  is a catalyst

11. What is the rate law for the mechanism given above?

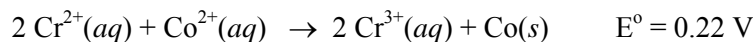
- a)  $\text{Rate} = k [\text{Cl}_2] [\text{CHCl}_3]^2$
- b)  $\text{Rate} = k [\text{Cl}_2]^{1/2} [\text{CHCl}_3]$
- c)  $\text{Rate} = k [\text{Cl}_2]^{1/2} [\text{CCl}_3]$
- d)  $\text{Rate} = k [\text{Cl}_2] [\text{CHCl}_3]$
- e)  $\text{Rate} = k [\text{Cl}_2]^2 [\text{CHCl}_3]$

12. Consider the following galvanic cell at 25°C.  $\text{Pt} | \text{Cr}^{2+} (0.44 \text{ M}), \text{Cr}^{3+} (1.5 \text{ M}) || \text{Co}^{2+} (0.35 \text{ M}) | \text{Co}$   
Calculate the cell potential, E, for this galvanic cell under these conditions.



- a) 0.17 V
- b) 0.27 V
- c) 0.13 V
- d) 0.25 V
- e) 0.22 V

13. Consider the same galvanic cell at 25°C.  $\text{Pt} | \text{Cr}^{2+} (0.44 \text{ M}), \text{Cr}^{3+} (1.5 \text{ M}) || \text{Co}^{2+} (0.35 \text{ M}) | \text{Co}$   
Calculate the cell potential after the reaction has operated long enough for the  $[\text{Cr}^{2+}]$  to have changed by 0.30 M.



- a) 0.13 V
- b) 0.27 V
- c) 0.17 V
- d) 0.31 V
- e) 0.11 V

Answer questions 14, 15 and 16 using the following half reactions:

	<u>E° (V)</u>
$\text{Au}^{3+} + 3 \text{e}^- \rightarrow \text{Au (s)}$	1.50
$\text{Cl}_2 + 2\text{e}^- \rightarrow 2 \text{Cl}^-$	1.36
$\text{NO}_3^- + 4 \text{H}^+ + 3 \text{e}^- \rightarrow \text{NO} + 2 \text{H}_2\text{O}$	0.96
$\text{ClO}_2 + \text{e}^- \rightarrow \text{ClO}_2^-$	0.95
$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag (s)}$	0.80
$\text{I}_2 + 2 \text{e}^- \rightarrow 2 \text{I}^-$	0.54
$\text{Cu}^{2+} + 2 \text{e}^- \rightarrow \text{Cu (s)}$	0.34
$\text{SO}_4^{2-} + 4 \text{H}^+ + 2 \text{e}^- \rightarrow \text{H}_2\text{SO}_3 + \text{H}_2\text{O}$	0.20
$\text{Ni}^{2+} + 2 \text{e}^- \rightarrow \text{Ni (s)}$	- 0.23
$\text{Co}^{2+} + 2 \text{e}^- \rightarrow \text{Co (s)}$	- 0.28
$\text{Al}^{3+} + 3 \text{e}^- \rightarrow \text{Al (s)}$	- 1.66

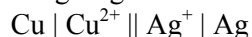
14. Does Cu (s) dissolve in nitric acid, HNO<sub>3</sub> (aq)?

- a) Yes
- b) No
- c) Can not be determined from the information provided.

15. Using the above half reactions, which species can be reduced by Ni (s) but can not be reduced by Ag (s)?

- a) I<sup>-</sup>
- b) Cu (s)
- c) I<sub>2</sub>
- d) Co<sup>2+</sup>
- e) H<sub>2</sub>SO<sub>3</sub>

16. A galvanic cell is constructed in which an Ag<sup>+</sup>/Ag half-cell is connected to a Cu<sup>2+</sup>/Cu half-cell. Calculate ΔG° for this reaction at 25°C.



- a) - 220.0 kJ
- b) - 44.4 kJ
- c) + 44.4 kJ
- d) - 88.8 kJ
- e) + 88.8 kJ

**Answers:** 1. d    2. a    3. d    4. b    5. d    6. a    7. a    8. b  
 9. b    10. c    11. b    12. a    13. a    14. a    15. c    16. d