

Formulas: $E^\circ_{\text{cell}} = E^\circ_{\text{reduction}} + E^\circ_{\text{oxidation}}$ $\Delta G^\circ = -nFE^\circ_{\text{cell}}$ (for kJ, use $F = 96.5$)

$E_{\text{cell}} = E^\circ - [0.0592/n] \log Q$ $\log K = nE^\circ/0.0592$

$\text{Mol } e^- = [A \cdot \text{time (sec)}/96,500]$ $\text{time (sec)} = \text{mol } e^- \cdot 96,500/\text{current (in A)}$

$t = (t_{1/2}/0.693) \ln (A_0/A_t)$ $\ln (A_0/A_t) = 0.693 \cdot t / t_{1/2}$

$E = \Delta mc^2$ (m in kg, E in J, $c = 3 \times 10^8$ m/s)

1. What is the oxidation number of S in KHSO_4 ?

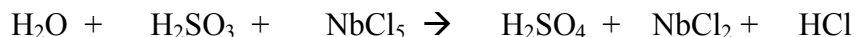
- a. +3
- b. +6
- c. +7
- d. +12
- e. none of the above

2. Balance the following reaction. How many electrons would be transferred?



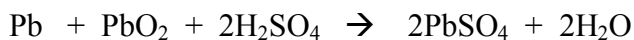
- a. 2
- b. 3
- c. 4
- d. 6
- e. none of the above

3. Balance the following reaction. What would be the coefficient for NbCl_2 ?



- a. 1
- b. 2
- c. 3
- d. 4
- e. none of the above

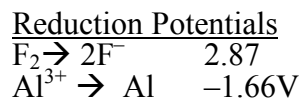
4. Which substance is the oxidizing agent in a car battery, in the reaction shown below?



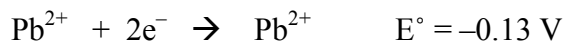
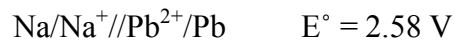
- a. Pb
- b. PbO_2
- c. H_2SO_4
- d. PbSO_4

5. Which transformation could not take place at the cathode of an electrochemical cell?
- NiBr₂ to Ni and Br⁻
 - Cl₂ to Cl⁻
 - H₂O to H₂ and OH⁻
 - H₂O to H⁺ and O₂
6. Molten PbCl₂ is subjected to electrolysis in order to form elemental lead and chlorine. Which of the following is true?
- Elemental chlorine gas is formed at the cathode and bubbles away
 - Elemental lead metal is formed and deposited at the anode
 - Electrons flow from the cathode to the anode
 - Chloride ions are the reducing agents in the reaction
 - none of the above
7. The standard reduction potentials for Pb²⁺ and Ag⁺ are -0.13 and +0.80V respectively. Calculate E° for a cell in which the overall reaction is:
- $$\text{Pb} + 2\text{Ag}^+ \rightarrow \text{Pb}^{2+} + 2\text{Ag}$$
- 0.93V
 - 0.67V
 - 1.73 V
 - 1.47 V
 - none of the above

8. Consider the following half-reactions and voltages. What will be the E° for an electrochemical cell involving the chemicals shown?



- 3.8 V
 - 4.53 V
 - 1.21 V
 - 2.6 V
 - none of the above
9. What is the standard reduction potential for Na⁺, given the following information:



- 2.45 V
- 2.71 V
- +2.45 V
- 2.84 V
- none of the above

10. The standard reduction potentials for Pb^{2+} and Ni^{2+} are -0.13 and -0.28V respectively. Which of the following substances will be oxidized most easily?

- a. Pb^{2+}
- b. Pb
- c. Ni^{2+}
- d. Ni

11. Based on the periodic table and general patterns of activity, which of the following would not react with metallic Mg ?

HNO_3 LiBr FeCl_3 AlCl_3 AuBr_2

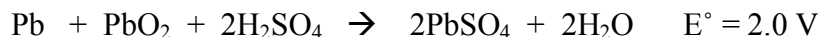
- a. HNO_3
- b. LiBr
- c. FeCl_3
- d. AlCl_3
- e. AuBr_2

12. Given the reduction potential for water, which of the following metals may be produced by electrolysis in aqueous solution? The standard reduction potentials of the metal ions are listed:

Ni^{2+} , -0.28V $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-$ $E^\circ = -0.83\text{V}$
 Mn^{2+} , -1.18V
 Mg^{2+} , -2.38
 Ca^{2+} , -2.76
 Li^+ , -3.04V

- a. magnesium
- b. lithium
- c. nickel
- d. manganese
- e. calcium

13. What is the value for ΔG° (in kJ/mol) for the following reaction? ($F = 96.5\text{ kJ/V}\cdot\text{mol}$)



- a. -98
- b. $+136$
- c. -386
- d. -193
- e. none of the above

14. The ΔG° for a redox reaction is positive. Which of the following statements is true?

- a. The reaction is at equilibrium
- b. E° is negative
- c. The reaction is product-favored
- d. $K > 1$
- e. E° is positive
- f. None of the above

15. What is the value of K for the following reaction?

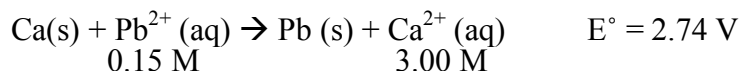


- a. 3.8×10^{-18}
- b. 2.6×10^{-19}
- c. 3.8×10^{18}
- d. 6.7×10^{-22}
- e. none of the above

16. How many seconds will be required to produce 1.0 g of chromium metal by the electrolysis of a $\text{Cr}(\text{NO}_3)_3$ solution using a current of 3.0 A?

- a. 36
- b. 6.3×10^2
- c. 1.9×10^3
- d. 3.7×10^3

17. What is the actual voltage for the following reaction, given the concentrations shown?



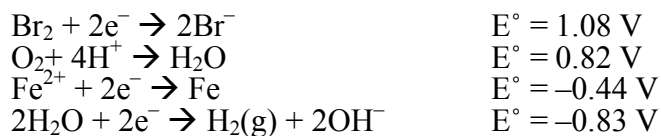
- a. 2.52 V
- b. 2.78 V
- c. 3.28 V
- d. 2.70 V
- e. none of the above

18. Which of the following statements would be false?

Reduction Potentials		
$\text{Br}_2 \rightarrow 2\text{Br}^-$	1.09 V	
$\text{I}_2 \rightarrow 2\text{I}^-$		0.54 V
$\text{Cu}^{2+} \rightarrow \text{Cu}$	0.34 V	
$\text{H}^+ \rightarrow \text{H}_2$	0.00 V	
$\text{Ni}^{2+} \rightarrow \text{Ni}$	-0.28 V	

- a. Br_2 is the strongest oxidizing agent
- b. Ni is the strongest reducing agent
- c. I^- would react with Br_2 , but would not react with Cu^{2+}
- d. Cu would react with both Br_2 and I_2 , but would not react with either H^+ or H_2
- e. Ni would react with both Br^- and I^-

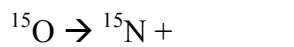
19. Given the following reduction potentials, what is the product at the anode when a current is passed through an aqueous solution of FeBr₂? (Hint: remember which chemicals and ions are really in the solution and subject to the electrolysis.)



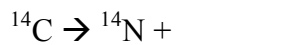
- a. Fe
b. Br₂
c. O₂
d. H₂
e. H₂O
f. None of the above
20. Given the following information, rank the “activity” of the metals as reducing agents:

Cr reacts with NiBr₂ and CdBr₂, but not with ZnBr₂
Cd reacts with NiBr₂, but not with ZnBr₂ or CrBr₃

- a. Zn > Cr > Cd > Ni
b. Ni > Cr > Cd > Zn
c. Zn > Cr > Ni > Cd
d. Zn > Cd > Cr > Ni
21. What is the missing particle for the following radioactive decay reaction?

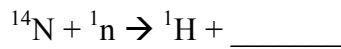


- a. alpha particle
b. beta particle
c. neutron
d. gamma ray
e. positron
22. What is the missing particle for the following radioactive decay reaction?



- a. alpha particle
b. beta particle
c. neutron
d. gamma ray
e. positron

23. What is the missing particle for the following radioactive decay reaction?



- a. ^{13}N
- b. ^{14}C
- c. ^{13}C
- d. ^{14}O
- e. none of the above

24. What is the other product when ^{232}Th undergoes alpha emission??

- a. ^{236}U
- b. ^{232}Pa
- c. ^{228}Ra
- d. ^{228}Rn
- e. none of the above

25. Which of the following is true when a nuclide emits a positron?

- a. The mass number and atomic number increase
- b. The mass number increases
- c. The atomic number decreases
- d. The nuclide is unchanged
- e. None of the above

26. Cs-137 has a half-life of 30 years. How much of a 240g sample will remain after 120 years?

- a. 30 g
- b. 15 g
- c. 7.0 g
- d. 2.8 g
- e. none of the above

27. C-14 has a half-life of 5730 years. The C-14 in a sample of cotton is found to have a disintegration rate of 10.4 (disintegrations/gram-minute). The disintegration rate of "live" carbon is 15.3. What is the age of the cotton sample?

- a. 3110 years
- b. 3190 years
- c. 3320 years
- d. 3440 years
- e. none of the above

28. A 3.60 g sample of a radioactive isotope decays to 1.62 g over a period of 35 days. What is the half-life of the isotope?

- a. 29.2 days
- b. 30.4 days
- c. 31.7 days
- d. 32.5 days
- e. none of the above

29. What is the binding energy in kJ/mol for ${}^4_2\text{He}$, given the following respective masses?

Proton: 1.00783

Neutron: 1.00867

He-4: 4.00150

- a. 5.09×10^{10} kJ/mol
- b. 2.84×10^9 kJ/mol
- c. 7.48×10^{12} kJ/mol
- d. 4.22×10^{10} kJ/mol
- e. none of the above

30. Which of the following statements is **true**:

- a. Fission reactions involve the combination of two smaller nuclides to make a larger nuclide
- b. Fusion involves the splitting of larger nuclides into smaller nuclides
- c. In both fission and fusion reactions, energy is released because the mass of the product nuclides is smaller than the mass of the reactant nuclides
- d. The mass of a nuclide is greater than the sum of the masses of its constituent protons and neutrons
- e. Protons attract each other, and this explains why a nucleus holds together

31. Which of these nuclides is certain to be radioactive?



- a. ${}^6_6\text{C}$ is the only radioactive nuclide
- b. ${}^{21}_{13}\text{Al}$ is the only radioactive nuclide
- c. ${}^{263}_{103}\text{Lr}$ is the only radioactive nuclide
- d. ${}^{21}_{13}\text{Al}$ and ${}^{263}_{103}\text{Lr}$ are both radioactive
- e. ${}^{21}_{13}\text{Al}$, ${}^{263}_{103}\text{Lr}$ and ${}^{103}_{45}\text{Rh}$ are all radioactive

32. Fact: ^{19}O is unstable and radioactive. Is its n/p ratio too high or too low? In that case, which process could lead to stability, and what nuclide would be produced?
- Its n/p ratio is too low, it should undergo electron capture to produce ^{19}N
 - Its n/p ratio is too low, it should undergo alpha emission to produce ^{23}Ne
 - Its n/p ratio is too low, it should undergo either electron capture or positron emission to produce ^{19}F .
 - Its n/p ratio is too high, it should undergo beta emission to produce ^{19}F .
 - Its n/p ratio is too high, it should undergo positron emission to produce ^{19}F .
33. The standard reduction potentials for Sn^{2+}/Sn ($E^\circ = -0.14$) and Cu^{2+}/Cu ($E^\circ = +0.34$). For an electrochemical cell involving Sn and Cu, which of the following statements is true?
- Copper is oxidized and serves as the anode
 - Tin is reduced and serves as the cathode
 - The oxidizing agent is Cu^{2+}
 - The reducing agent is Cu
 - The cathode metal electrode will dissolve away as the reaction proceeds

Answers, Test4–210–Version 3

Electrochemistry and Nuclear Chemistry

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|-------|-------|
| 1. B | 18. E |
| 2. D | 19. C |
| 3. B | 20. A |
| 4. B | 21. E |
| 5. D | 22. B |
| 6. D | 23. B |
| 7. A | 24. C |
| 8. B | 25. C |
| 9. B | 26. B |
| 10. D | 27. B |
| 11. B | 28. B |
| 12. C | 29. B |
| 13. C | 30. C |
| 14. B | 31. D |
| 15. B | 32. D |
| 16. C | 33. C |
| 17. D | |