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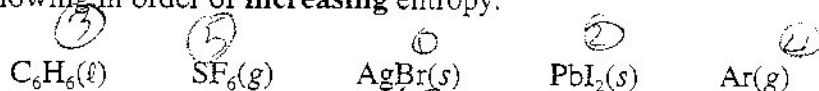
1. Which of these thermodynamic quantities is **NOT** a state function of a system?

- A. Enthalpy
B. Gibbs free energy
C. Entropy
D. Work performed

2. What is the work done against an atmospheric pressure of 1.00 atm when 262 g of Zn dissolves in excess acid at 25.0°C?



- A. -9.93 kJ
B. -0.831 kJ
C. 6.41 kJ
D. 3.65 kJ

3. Rank the following in order of **increasing** entropy.A. $\text{Ar}(g) < \text{C}_6\text{H}_6(\ell) < \text{SF}_6(g) < \text{AgBr}(s) < \text{PbI}_2(s)$ B. $\text{AgBr}(s) < \text{Ar}(g) < \text{C}_6\text{H}_6(\ell) < \text{PbI}_2(s) < \text{SF}_6(g)$ C. $\text{AgBr}(s) < \text{PbI}_2(s) < \text{C}_6\text{H}_6(\ell) < \text{Ar}(g) < \text{SF}_6(g)$ D. $\text{PbI}_2(s) < \text{AgBr}(s) < \text{SF}_6(g) < \text{C}_6\text{H}_6(\ell) < \text{Ar}(g)$ 4. What is the standard molar entropy of vaporization of CCl_2F_2 at its boiling point of 243 K? The standard molar enthalpy (heat) of vaporization of CCl_2F_2 is 20.2 kJ/mol.

- A. -0.673 J/K • mol
B. -4.91 kJ/K • mol
C. 4.91 kJ/K • mol
D. 83.1 J/K • mol

$$\Delta G^\circ = \Delta H^\circ - T \Delta S^\circ$$

$$0 = 20.2 - 243 \Delta S^\circ$$

5. The reaction rate of a certain spontaneous reaction is very slow. Which of the following is the **best** explanation for this observation?

- A. K_p for the reaction is small.
B. $\Delta S_{\text{universe}} < 0$ for the reaction.
C. The activation energy of the reaction is large.
D. The reaction is endothermic.

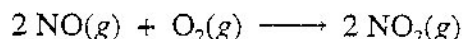
nothing to do with rate of rxn

$\frac{P}{R}$ $\frac{\text{small}}{L}$

6. For which one of the following reactions does ΔG° for the reaction correspond to the standard free energy of formation for the product?

- A. $\text{BF}_3(g) + \text{NH}_3(g) \longrightarrow \text{BF}_3\text{NH}_3(s)$ **C.** $3 \text{H}_2(g) + \text{N}_2(g) \longrightarrow 2 \text{NH}_3(g)$ *want*
 B. $\text{H}_2\text{O}(l) + \frac{1}{2} \text{O}_2(g) \longrightarrow \text{H}_2\text{O}_2(l)$ D. $\text{P}(s) + \frac{3}{2} \text{Cl}_2(g) \longrightarrow \text{PCl}_3(l)$ *1 mole product*

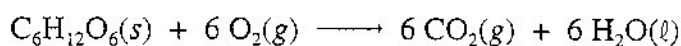
7. Determine ΔG° at 298 K for the reaction



given $\Delta H^\circ = -114 \text{ kJ}$ and $\Delta S^\circ = -146 \text{ J/K}$.

- A.** -70.5 kJ B. -158 kJ C. 43.6 kJ D. -43.4 kJ

8. What is the standard free energy change for the following reaction at 25°C



given the following information? *ΔG is zero for standard element*

ΔG°
 $\Delta G^\circ = -n$

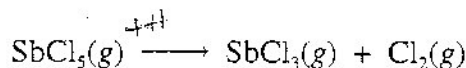
	$\Delta H_f^\circ(\text{kJ/mol})$	$\Delta G_f^\circ(\text{kJ/mol})$	$S^\circ(\text{J/K} \cdot \text{mol})$
$\text{C}_6\text{H}_{12}\text{O}_6(s)$	-1274.5	-910.56	212.1
$\text{CO}_2(g)$	-393.5	-394.4	213.6
$\text{H}_2\text{O}(l)$	-285.8	-237.2	69.9

$\Delta G = \Delta H^\circ +$

$\Delta G = \Delta H - T\Delta S$

- A. -973.8 kJ **B.** -2879 kJ C. -4700. kJ D. -279 kJ

9. The reaction

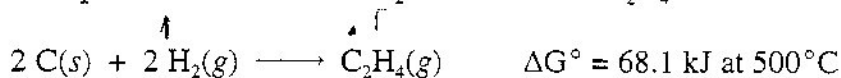


is endothermic. This reaction is

$\Delta G = \Delta H - T\Delta S$
 $+ \quad -T(+)$

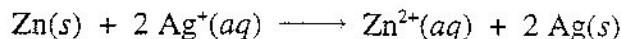
- A.** spontaneous at high temperatures only.
 B. spontaneous at low temperatures only.
 C. never spontaneous.
 D. None of the above.

10. Calculate ΔG for the formation of ethylene (C_2H_4) from carbon and hydrogen at 500°C when the partial pressures are 100 atm H_2 and 0.100 atm C_2H_4 .



- A.** -5.89 kJ B. -34.2 kJ C. +54.2 kJ D. +108 kJ

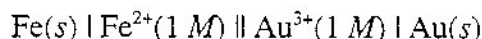
11. An electrochemical cell based on the reaction



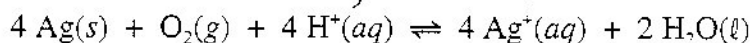
run under standard-state conditions has an $E^\circ_{\text{cell}} = 1.56 \text{ V}$. Which of the following statements is **TRUE**?

- A. ~~Ag⁺ ions migrate to the anode, where they are reduced.~~
- B. The half-reaction occurring at the cathode is $\text{Ag}^+(aq) + e^- \longrightarrow \text{Ag}(s)$.
- C. E°_{cell} is calculated by the equation $E^\circ_{\text{cell}} = E^\circ_{\text{Zn/Zn}^{2+}} + 2 E^\circ_{\text{Ag}^+/\text{Ag}}$.
- D. Electrons flow into the zinc electrode from the external circuit.
12. When the following reaction is balanced with the minimum whole-number coefficients in acidic solution,
- $$\text{MnO}_4^-(aq) + \text{SO}_2(aq) \longrightarrow \text{Mn}^{2+}(aq) + \text{SO}_4^{2-}(aq)$$
- Handwritten notes: $5 \text{H}^+ + \text{MnO}_4^- \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O}$ (oxidation); $2 \text{SO}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{SO}_4^{2-} + 4\text{H}^+$ (reduction)*
- A. ~~there are 5 H⁺ on the product side.~~ C. there are 3 SO₄²⁻ on the product side.
 B. there are 5 MnO₄⁻ on the reactant side. D. there are 2 H₂O on the reactant side.

13. What is E° of the following electrochemical cell?



- A. 4.32 V B. 1.94 V C. 1.68 V D. 1.06 V
14. Which of these reagents is capable of reducing $\text{Al}^{3+}(aq)$ to $\text{Al}(s)$ under standard conditions?
- A. $\text{Mg}^{2+}(aq)$ B. $\text{Mg}(s)$ C. $\text{Fe}(s)$ D. $\text{Ag}^+(aq)$
- Handwritten note: Want E_{cell} to be positive*
15. What is the equilibrium constant for this balanced reaction under standard conditions at 298 K?



- A. 1.4×10^3 B. $.2 \times 10^{29}$ C. 2.3×10^{-13} D. 6.9×10^{-4}
16. An electrochemical cell based on the following reaction had a cell voltage of 0.00 volts at 25°C:



If the initial $[\text{Cd}^{2+}]$ was 0.050 M, what was the initial $[\text{Fe}^{2+}]$?

- A. 0.024 M B. 0.24 M C. 0.76 M D. 1.1 M

$$\Delta G = -nFE$$

$$22.55 = \frac{x}{.05}$$

3

$$\Delta G = \Delta G^\circ - \frac{RT}{nF} \ln\left(\frac{x}{.05}\right)$$

$$0 = (-.40 + .44) = \frac{RT}{nF} \ln\left(\frac{x}{.05}\right)$$

2

17. In a standard dry-cell battery (Leclanché cell) *used in flashlights radios*
- A. the oxidizing agent is $PbO_2(s)$. *Anode = Zn*
 B. the reducing agent is $MnO_2(s)$. *Reduced MnO_2*
 C. the anode material is zinc metal.
 D. 100% of the chemical energy of the reactants is converted to electrical energy.

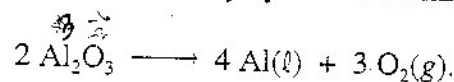
18. Which one of the following statements is TRUE?

- A. The only metal to undergo corrosion is iron.
 B. Only water needs to be present for iron to rust.
 C. Attaching a piece of magnesium metal to iron prevents rusting of the iron.
 D. Zinc plated iron (galvanized iron) does not prevent the rusting of iron once the zinc coating is scratched and the iron underneath is exposed.

19. Which of the following statements about electrolysis is FALSE?

- A. Electrolysis of molten $NaCl$ is used commercially to make sodium metal and chlorine gas.
 B. Electrolysis is used to make non-spontaneous reactions occur.
 C. Electrolysis requires the presence of ions in solution to carry the electric current. $H_2 \rightarrow$
 D. The electrolysis of a 0.1 M H_2SO_4 solution produces hydrogen gas and SO_3 .

20. Aluminum metal is produced commercially by electrochemically driving the reaction



If a current of 2.00 amperes is passed through a cell containing Al_2O_3 for 1.00 hour, how many grams of aluminum metal are produced? Assume 100% electrochemical efficiency.

- A. 0.034 g B. 0.17 g C. 0.67 g D. 6.0 g

21. Which one of the following is NOT a purification method for metals? *Roasting is not purification*

- A. electrolysis B. roasting C. zone refining D. distillation

22. In a metallic electrical conductor,

- A. electrons travel freely through a set of closely spaced orbitals called the conduction band.
 B. there is a large energy gap between the filled valence band and the empty conduction band.
 C. strong, localized molecular orbitals hold the metal atoms together.
 D. donor impurities are needed to "dope" a metal, providing conduction electrons.

23. Which of the following, when doped into pure silicon, would give a p-type semiconductor?

- A. Phosphorus B. Germanium C. Aluminum D. Carbon

in lead batt. anode is Pb. autos

mercury Zn oxidant in medicine

Solid state lithium solid with electrolyte. lithium = anode

Fuel cells major source of energy anode H_2 or H_2 being oxidized CH_4 anode CH_4 is oxidized

Chemical electrolytic reduction

per Acatur 21. distribution electrolysis zone refining

roasting to oxidize metal

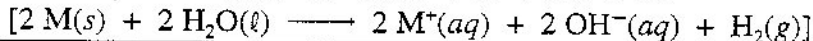
why

mercury battery

fuel cells

24. Which of the following is **incorrect**?

- A. ionic radius(M^+): $Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$
- B. atomic radius: $Li < Na < K < Rb < Cs$
- C. first ionization energy: $Li < Na < K < Rb < Cs$
- D. reactivity with water: $Li < Na < K < Rb < Cs$



25. In which pair is an alkaline earth species matched with an **incorrect** property or application?

- ✓ A. CaO - Quicklime removes acidic oxides during steelmaking.
- ✓ B. Mg - Magnesium burns brightly in signal flares.
- ⊙ C. Ca - Calcium is used to construct the hulls of ocean-going ships.
- ✓ D. Mg^{2+} - Magnesium ions are found in the plant pigment chlorophyll, important in photosynthesis.

→ metals
reactivity

reactivity increases ←

Li most reactive why?

$CaOH$ = slaked lime hydrated

CaO = quick lime

Calcium serves as an alloying element
for metals as

dehydrant agent
bones etc.

Aluminum chief use is aircraft construction

Mg Chlorophyll.