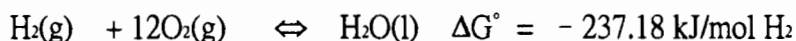


※ 考生請注意：本試題可使用計算機

1. Two samples of a monatomic ideal gas are in separate containers at the same conditions of pressure, volume, and temperature ($V = 1.00 \text{ L}$ and $P = 1.00 \text{ atm}$). Both samples undergo changes in conditions and finish with $V = 2.00 \text{ liters}$ and $P = 2.00 \text{ atm}$. However, in the first sample, the volume is changed to 2.0 liters while the pressure is kept constant, and then the pressure is increased to 2.00 atm while the volume remains constant. In the second sample, the opposite is done. The pressure is increased first, with constant volume, and then the volume is increased under constant pressure. Calculate the difference in ΔE , the difference in W and the difference in q between sample one and sample two. (10%)

2. Consider the hydrogen - oxygen fuel cell where



Which of the following statements is true? (10%)

- A) At standard conditions, the maximum work the fuel cell could do on the surroundings is 237.18 kJ/mol .
- B) In the real world, the actual amount of useful work the cell can do is less than 237.18 kJ .
- C) More energy is dissipated as waste heat in the fuel cell than in the reversible path way.
- D) a, b, and c are all true.
3. A concentration cell is constructed using two Co electrodes with Co^{2+} concentrations of 0.10 M and $1.00 \times 10^{-5} \text{ M}$ in the two half-cells. Determine the reduction potential of Co^{2+} given that the potential of the cell at 25°C is 0.118 V . (10%)
4. When ethyl chloride, $\text{CH}_3\text{CH}_2\text{Cl}$, is dissolved in 1.0 M NaOH , it is converted into ethanol, $\text{CH}_3\text{CH}_2\text{OH}$, by the reaction



At 25°C the reaction is first order in $\text{CH}_3\text{CH}_2\text{Cl}$, and the rate constant is $1.0 \times 10^{-3} \text{ s}^{-1}$. If the activation parameters are $A = 3.4 \times 10^{14} \text{ s}^{-1}$ and $E_a = 100.0 \text{ kJ/mol}$, what will the rate constant be at 28°C ? ($R = 8.314 \text{ J/mol} \cdot \text{K}$) (10%)

- A) $1.5 \times 10^{-3} \text{ s}^{-1}$
- B) $8.9 \times 10^2 \text{ s}^{-1}$
- C) $1.1 \times 10^{-3} \text{ s}^{-1}$
- D) $9.2 \times 10^{-3} \text{ s}^{-1}$
- E) $3.8 \times 10^{14} \text{ s}^{-1}$
5. Explain the context and meanings of the terms "orbit" and "orbital", making a clear distinction between them. (10%)

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6. Which of the following observations that most clearly supports the conclusion of “electrons have wave properties” ? (10%)
- A) Emission spectrum of hydrogen
 - B) The photoelectric effects
 - C) Scattering of alpha particles by metal foil
 - D) Diffraction
 - E) Cathode “rays”
7. Which of the following is incorrect? (10%)
- A) The importance of the equation $E = mc^2$ is that energy has mass
 - B) Electromagnetic radiation can be thought of as a stream of particles called photons
 - C) The energy of matter is not continuous and is actually quantized
 - D) Energy can only occur in discrete unit called quanta
 - E) All of these are correct
8. Please calculate the pH value of a solution, which was a mixture of 50 mL 0.10 M NH_3 solution and 50 mL 0.040 M HCl solution. The K_a of NH_3 is 1.8×10^{-5} (10%)
9. If the K_{sp} of PbI_2 is 7.1×10^{-9} . Please calculate the potation E for the following reaction.
 $\text{PbI}_2 + 2e^- \Leftrightarrow \text{Pb}_{(s)} + 2\text{I}^-$ ($\text{Pb}^{2+} + 2e^- \Leftrightarrow \text{Pb}_{(s)}$ $E^\circ = -0.126 \text{ V}$) (10%)
10. Which statement is true? (10%)
- A) All real processes are irreversible.
 - B) A thermodynamically reversible process takes place infinitely fast.
 - C) In a reversible process, the state functions of the system are always much greater than those of the surroundings.
 - D) There is always more heat given off to the surroundings in a reversible process than in an irreversible one.
 - E) All statements (a to d) are true.