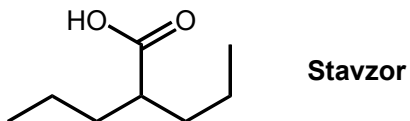


- 9) The ionization energies for period 3 element X are listed in the table below.

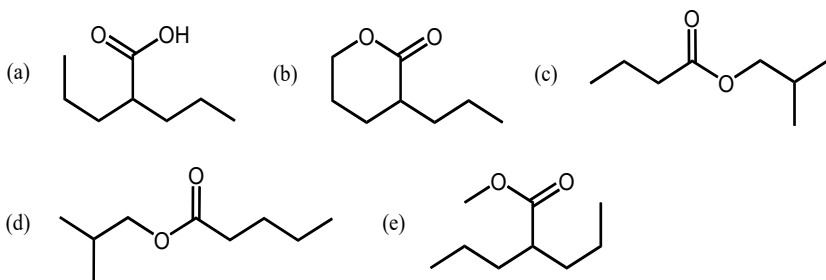
Ionization Energies for element X (kJ mol ⁻¹)				
First	Second	Third	Fourth	Fifth
580	1,815	2,740	11,600	14,800

Based on the data, which statement about element X is **FALSE**?

- A) Its most common oxidation state is +3
 B) It is displaced from aqueous solution by copper metal
 C) It is the most abundant metal in the Earth's crust
 D) Its oxide is insoluble in water
 E) It is a lustrous metal
- 10) Stavzor (structure below) is a medication primarily used to treat epilepsy and bipolar disorder.



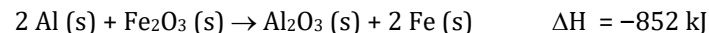
A well-known substance with a characteristic odour of bananas (**A**) is a constitutional isomer of Stavzor. Which of the following is a possible structure for **A**?



- 11) Given the following electrochemical cell data:
 Cell 1 Cd(s) | Cd²⁺ (1.0M) || Cu²⁺ (1.0M) | Cu(s) E° = 0.74 V
 Cell 2 Zn(s) | Zn²⁺ (1.0 M) || Cu²⁺ (1.0 M) | Cu(s) E° = 1.10 V
 Cell 3 Zn(s) | Zn²⁺ (1.0 M) || Cd²⁺ (1.0 M) | Cd(s)

Determine the standard cell potential for Cell 3.

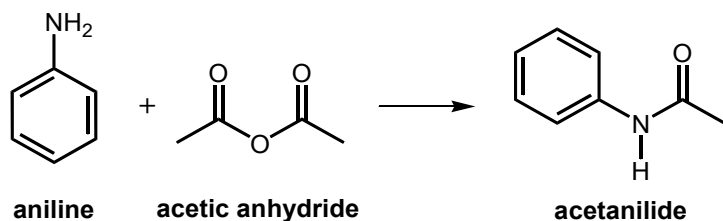
- A) -0.36 V B) 0.36 V C) -1.84 V
 D) -0.18 V E) 0.18 V
- 12) Lead (II) sulfate can decompose into lead (II) sulfite and oxygen gas when heated. If the reaction generates 2.25 g of oxygen gas, what mass of lead (II) sulfate reacted? Assume 100% yield in this reaction.
- A) 42.6 g B) 21.3 g C) 20.2 g D) 10.7 g E) 4.50 g
- 13) A student combines 75 mL of 0.500 mol L⁻¹ hydrochloric acid with 55 mL of 0.125 M KOH. What is the pH of the resulting solution?
- A) 0.30 B) 0.39 C) 0.63 D) 1.51 E) 7.00
- 14) If a system undergoes a reversible cyclic process, which one of the following statements is true? Assume that the surroundings are much, much larger than the system.
- A) ΔS_{surroundings} > 0 B) q > 0 C) q < 0 D) q = w = 0 E) ΔS > 0
- 15) The thermite reaction is the reaction of aluminum metal and iron (III) oxide:



A teacher does a demonstration with 1.00 mol of iron (III) oxide and 2.00 mol of aluminum metal both initially at 25.0 °C. If the combined specific heat of the products is 0.800 J g⁻¹ °C⁻¹ over a wide range of temperatures, what is the final temperature of the products?

- A) 3550 °C B) 4960 °C C) 5010 °C D) 6470 °C E) 6500 °C

- 16) The compound acetanilide is important in the industrial synthesis of several dyes. Acetanilide (mol. wt. = 135.16) can be made in the laboratory by a reaction between aniline and excess acetic anhydride which has a yield of 61.5%:



Aniline and acetic anhydride are both liquids which have densities of 1.219 g mL^{-1} and 1.082 g mL^{-1} respectively.

What volume of aniline was used in this reaction if the recorded mass of acetanilide product was 7.14 g?

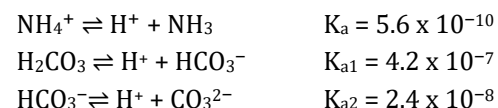
- A) 4.03 mL B) 9.75 mL C) 4.92 mL
 B) 5.99 mL E) 6.56 mL
- 17) One of the Twelve Principles of Green Chemistry is that “synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product”. One way to consider this is to calculate the *atom economy* (AE) of a chemical reaction where AE is defined as follows:

$$\text{atom economy} = \frac{\text{molecular mass of desired product}}{\text{molecular mass of all reactants}} \times 100\%$$

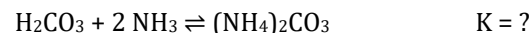
The atom economy of the reaction in the previous question (#16) is:

- C) 61.5% B) 69.2% C) 100% D) 68.9% E) 74.4%

- 18) Given the following set of equilibria and their respective constants

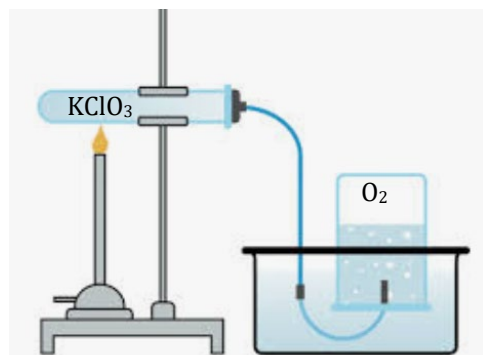


what would the equilibrium constant be for the reaction below?



- A) 1.8×10^{-5} B) 4.4×10^{-7} C) 9.0×10^{-6}
 D) 3.2×10^{-5} D) 3.1×10^{-5}
- 19) The subshell filling order used for the quantum mechanical model of the atom is an approximation of the relative subshell energies, which assumes the energies remain fixed. In reality, subatomic particles cause the energies to fluctuate, leading to exceptions. Which of the following statements best explains the configuration of chromium which is Cr: [Ar] $4s^1 3d^5$?
- A) The Aufbau Principle and 4s is higher in energy than 3d.
 B) Hund’s Rule and 4s and 3d are now degenerate.
 C) The Pauli Exclusion Principle and electrons do not pair.
 D) The Heisenberg Uncertainty Principle and we cannot be certain if the electrons are in 4s or 3d.
 E) The filling rules are based on the approximations and do not apply to exceptions.
- 20) A vessel contains 2.50 mol of O_2 gas, 0.50 mol of N_2 gas and 1.00 mol of CO_2 gas. The total pressure is 200 kPa. The partial pressure exerted by the O_2 in the mixture is:
- A) 25 kPa B) 50 kPa C) 100 kPa D) 125 kPa E) 150 kPa

- 21) The $O_2(g)$ produced in the decomposition of 3.275 g mixture of potassium chlorate and potassium chloride which is 65.82% $KClO_3$ is collected over water at 21.0 °C. Assume ideal gas conditions. If atmospheric pressure is 753.5 mmHg, water vapour pressure at 21.0°C is 18.7 mmHg, once the pressure in the gas collection vessel was equalized with atmospheric pressure, how many milliliters of O_2 gas would be produced according to the reaction:



- A) 130 mL B) 439 mL C) 563 mL
D) 658 mL E) 1320 mL
- 22) The equilibrium $CO(g) + NO_2(g) \rightleftharpoons CO_2(g) + NO(g)$ is established in four different, but identical containers. Each container started with a different composition as follows:

Container	CO (mol)	NO_2 (mol)	CO_2 (mol)	NO (mol)
1	1	1	0	0
2	1	0	1	1
3	1	1	1	0
4	0	1	1	1
5	1	1	1	1

After equilibrium is established, which container would have the largest concentration of CO (g)

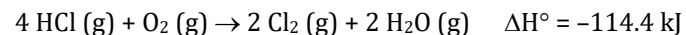
- A) 1 B) 2 C) 3 D) 4 E) 5

- 23) For the reaction $H_2(g) + I_2(g) \rightleftharpoons 2 HI(g)$ $\Delta H^\circ = +52.96 \text{ kJ}$. Which of the following statement is/are correct?

- I. The heat of formation of 1 mol of HI is +26.48 kJ
II. As the temperature increases, the reaction will proceed to the right
III. As the pressure increases, the reaction will proceed to the right

- A) I only B) I and II only C) I, II and III
D) II and III only E) III only

- 24) Calculate ΔG° at 25 °C for the reaction given the data below



$$S_{Cl_2}^\circ = 223.0 \text{ J mol}^{-1} \text{ K}^{-1}$$

$$S_{H_2O}^\circ = 188.7 \text{ J mol}^{-1} \text{ K}^{-1},$$

$$S_{O_2}^\circ = 205.0 \text{ J mol}^{-1} \text{ K}^{-1}$$

$$S_{HCl}^\circ = 186.8 \text{ J mol}^{-1} \text{ K}^{-1}$$

- A) + 14.4 kJ B) -111.18 kJ C) + 3105.6 kJ
D) + 38 kJ E) - 76.0 kJ

- 25) For the reaction $2 NO(g) + Cl_2(g) \rightarrow 2 NOCl(g)$ the table below provide experimental data for 3 different reactions.

Experiment	[NO] (mol L ⁻¹)	[Cl ₂] (mol L ⁻¹)	Initial Rate (mol L ⁻¹ s ⁻¹)
1	0.0125	0.0128	1.14×10^{-5}
2	0.0125	0.0511	4.55×10^{-5}
3	0.0250	0.0255	9.08×10^{-5}

What is the rate constant for the reaction?

- A) $140 \text{ L mol}^{-1} \text{ s}^{-1}$ B) $0.0714 \text{ L mol}^{-1} \text{ s}^{-1}$ C) $5.70 \text{ L}^2 \text{ mol}^{-2} \text{ s}^{-1}$
D) $0.562 \text{ L mol}^{-1} \text{ s}^{-1}$ E) $1.39 \text{ L}^2 \text{ mol}^{-2} \text{ s}^{-1}$

End of Part A of the contest
Go back and check your work