Consider the quantities below and select the true statement:
1 mole of carbon
1 mole of water
1 mole of iron
1 mole of octane

A. 1 mole of carbon has the most units.
B. 1 mole of water has the most units.
C. 1 mole of iron has the most units.
D. 1 mole of octane has the most units.
E. All of the quantities above contain the same number of units.

How many atoms are in 7.8 moles of copper?

A. $8.9 \times 10^{24}$ atoms
B. $4.7 \times 10^{24}$ atoms
C. $2.3 \times 10^{24}$ atoms
D. 490 atoms

What is the molar mass of acetone ($C_3H_6O$)?

$1$ g/mol

Report your answer using one decimal place. Do NOT include units in your answer.
Question #: 4

Consider the balanced chemical equation below:
2 P(s) + 3 Cl₂(g) → 2 PCl₃(l)
What molar ratio is needed to convert moles of phosphorus to moles of chlorine?

A. 2 moles P : 2 moles PCl₃
B. 2 moles P : 3 moles Cl₂
C. 3 moles Cl₂ : 2 moles PCl₃
D. 1 mole Cl₂ = 70.9 g

Question #: 5

Calculate the number of moles of aluminum that will react with 6.72 moles of oxygen to form aluminum oxide according to the balanced chemical equation below:
4 Al(s) + 3 O₂(g) → 2 Al₂O₃(l)

A. 4.01 moles Al
B. 7.90 moles Al
C. 37.6 moles Al
D. 8.96 moles Al

Question #: 6

Calculate the number of grams of hydrogen gas (H₂) that form when 38.0 grams of sodium react with excess water according to the balanced chemical equation below:
2 Na(s) + 3 H₂O(l) → 2 NaOH(aq) + H₂(g)

A. 11.9 grams
B. 22.9 grams
C. 1.67 grams
D. 3.48 grams
Question #: 7

What mass of Na₂SO₄ (molar mass = 142.04 g/mol) will be formed by the addition of 28.8 g NaHCO₃ (molar mass = 84.01 g/mol) in aqueous solution to an aqueous solution containing 9.80 g H₂SO₄ (molar mass = 98.08 g/mol)?

H₂SO₄(aq) + 2 NaHCO₃(aq) → Na₂SO₄(aq) + 2 H₂O(l) + 2 CO₂(g)

A. 14.2 grams  
B. 22.9 grams  
C. 7.65 grams  
D. 10.2 grams


Question #: 8

If a reaction of FeS and HCl has a theoretical yield of 9.68 g of H₂S, what is the percent yield if only 9.04 g of H₂S are recovered?

1%  
Report your answer with three significant figures. Do NOT include units or the percent sign in your answer.

1. __________


Question #: 9

The energy of motion is __1__ [kinetic, potential] energy; the energy stored by virtue of an object's position is __2__ [kinetic, potential] energy.

1. __________
2. __________


Question #: 10
The process of breaking chemical bonds is __1__ [endothermic, exothermic]; the process of forming chemical bonds is __2__ [endothermic, exothermic].

Consider the bonds HI, HF, and HCl. The strongest bond among these three compounds is __3__ [HI, HF, HCl].

1. __________
2. __________
3. __________

Question #: 11

Consider the diagram below and complete the following sentences:

The reaction that occurs from A to C is __1__ [faster, slower] than the reaction that occurs from A to B.
The reaction that occurs from A to C is __2__ [endothermic, exothermic].
The reaction that occurs from A to B is __3__ [endothermic, exothermic].

1. __________
2. __________
3. __________
Consider the diagram below and complete the following sentences. Report each answer as a single letter.

For the reaction that occurs from \textbf{A to C}, the difference between point \textbf{1} [A, B, C, D, E] and point \textbf{2} [A, B, C, D, E] is equal to the enthalpy ($\Delta H$) value of the reaction. For the reaction that occurs from \textbf{A to B}, the difference between point \textbf{3} [A, B, C, D, E] and point \textbf{4} [A, B, C, D, E] is equal to the activation energy ($E_a$) of the reaction.

1. __________
2. __________
3. __________
4. __________

Question #: 13

Consider the chemical equation below and complete the following sentences:

\begin{align*}
\text{N}_2(g) + 3\text{H}_2(g) &\rightleftharpoons 2\text{NH}_3(g) & \Delta H &= -22 \text{ kcal/mol}
\end{align*}

Heat is \textbf{1} [absorbed, released] in the reaction.
The bonds in the \textbf{2} [reactants, products] are stronger.
The \textbf{3} [reactants, products] are lower in energy.
**Question #: 14**

How much energy is associated with the consumption of 11.5 moles of hydrogen gas according to the balanced thermochemical equation below:

\[ \text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g) \quad \Delta H = -22 \text{ kcal/mol} \]

A. –166 kcal  
B. 0.501 kcal  
C. –84.3 kcal  
D. –248 kcal

**Question #: 15**

Select the two scenarios that generally **increase** the rate of a chemical reaction.

A. Increase the temperature  
B. Decrease the temperature  
C. Increase the concentration  
D. Decrease the concentration  
E. The absence of a catalyst

**Question #: 16**
Which statement best describes what occurs when a chemical reaction is at equilibrium?

A. The rate of the forward reaction increases.
B. The rate of the reverse reaction increases.
C. The rate of the forward reaction decreases.
D. The rate of the reverse reaction decreases.
E. The rates of the forward reaction and the reverse reactions stop changing.

Question #: 17

Consider the equilibrium constants $K_1 = 20$ and $K_2 = 137$. What reaction is the faster reaction?

A. The reaction with $K_1$ is faster.
B. The reaction with $K_2$ is faster.
C. The equilibrium constant does not describe the rate of reaction.

Question #: 18

Given the equilibrium constant below:
$K = 9.5 \times 10^5$

Are reactants, products, or an equal concentration of reactants and products favored at equilibrium?

A. Reactants are favored at equilibrium.
B. Products are favored at equilibrium.
C. An equal concentration of reactants and products is favored at equilibrium.

Question #: 19
What is the equilibrium constant expression for the balanced chemical equation below?
\[ 2 \text{NH}_3(g) \rightleftharpoons 3 \text{H}_2(g) + \text{N}_2(g) \quad \Delta H = +22 \text{ kcal/mol} \]

A. \[ K = \frac{[\text{NH}_3]^2}{[\text{H}_2]^3[\text{N}_2]} \]
B. \[ K = \frac{[\text{H}_2]^3[\text{N}_2]}{[\text{NH}_3]^2} \]
C. \[ K = \frac{3[\text{H}_2][\text{N}_2]}{2[\text{NH}_3]} \]

Question #: 20

Calculate the equilibrium constant for the balanced chemical equation below given the following concentrations:
\[ \text{CO}(g) + \text{H}_2\text{O}(g) \rightleftharpoons \text{CO}_2(g) + \text{H}_2(g) \]

\([\text{H}_2] = 0.0984 \text{ M} \); \([\text{CO}_2] = 0.0984 \text{ M} \)
\([\text{CO}] = 0.142 \text{ M} \); \([\text{H}_2\text{O}] = 0.0144 \text{ M} \)

A. \( K = 4.73 \)
B. \( K = 0.198 \)
C. \( K = 8.23 \)
D. \( K = 0.989 \)

Question #: 21
Consider the **exothermic** reaction at equilibrium:

\[ \text{H}_2(g) + \text{F}_2(g) \rightleftharpoons 2 \text{HF}(g) \]

If HF\((g)\) is **removed** from the reaction, the equilibrium shifts \(\_1\) [left, right, no change].

If F\(_2\)(\(g\)) is **added** to the reaction, the equilibrium shifts \(\_2\) [left, right, no change].

If the pressure is decreased due to a change in volume, the equilibrium shifts \(\_3\) [left, right, no change].

If the temperature is increased, the equilibrium shifts \(\_4\) [left, right, no change].

1. __________
2. __________
3. __________
4. __________

---

**Question #:** 22

The typical tire pressure is 35 pounds per square inch (PSI). What is this pressure in atmospheres?

1 atm = 14.7 PSI

A. 490 atm
B. 1.3 atm
C. 2.4 atm
D. 3.8 atm

---

**Question #:** 23

When the amount and pressure of an ideal gas are held constant, what happens to the volume of a gas sample when the temperature is **decreased**?

A. Volume increases.
B. Volume decreases.
C. The volume remains unchanged.
D. The volume of gas cannot be increased at constant pressure.

---

**Question #:** 24
When the amount and temperature of an ideal gas are held constant, what happens to the gas pressure when the volume is **decreased**?

A. Pressure increases.
B. Pressure decreases.
C. The pressure remains unchanged.
D. The pressure of an ideal gas cannot be increased at constant temperature.

---

**Question #**: 25

How many moles of gas are contained in a typical human breath that takes in 0.50 L of air at 1.0 atm pressure and 37°C?

A. 0.0196 moles
B. 0.186 moles
C. 0.0678 moles
D. 0.0325 moles

---

**Question #**: 26

The air pressure in Denver, CO is 620 mmHg. What is the partial pressure of O₂ (in mmHg) if the atmosphere is composed of 78% N₂ and 21% O₂?

The partial pressure of O₂ is **1** mmHg.

Report your answer with **two** significant digits. Do **NOT** include units in your answer. Use the format 2.2e2 or 2.2e-2 for answers in scientific notation.

1. __________
Consider the quantities below and select the true statement:
1 mole of carbon
1 mole of water
1 mole of iron
1 mole of octane

A. 1 mole of carbon has the most units.
B. 1 mole of water has the most units.
C. 1 mole of iron has the most units.
D. 1 mole of octane has the most units.
E. All of the quantities above contain the same number of units.
How many atoms are in 7.8 moles of copper?

A. $8.9 \times 10^{24}$ atoms
✓ B. $4.7 \times 10^{24}$ atoms
C. $2.3 \times 10^{24}$ atoms
D. 490 atoms

Question #: 3

What is the molar mass of acetone (C₃H₆O)?

1 g/mol

Report your answer using one decimal place. Do NOT include units in your answer.

1. 58.1

Question #: 4

Consider the balanced chemical equation below:

$$2 \text{ P}(s) + 3 \text{ Cl}_2(g) \rightarrow 2 \text{ PCl}_3(l)$$

What molar ratio is needed to convert moles of phosphorus to moles of chlorine?

A. 2 moles P : 2 moles PCl₃
✓ B. 2 moles P : 3 moles Cl₂
C. 3 moles Cl₂ : 2 moles PCl₃
D. 1 mole Cl₂ = 70.9 g

Question #: 5

Calculate the number of moles of aluminum that will react with 6.72 moles of oxygen to form aluminum oxide according to the balanced chemical equation below:

$$4 \text{ Al}(s) + 3 \text{ O}_2(g) \rightarrow 2 \text{ Al}_2\text{O}_3(l)$$
A. 4.01 moles Al  
B. 7.90 moles Al  
C. 37.6 moles Al  
✓D. 8.96 moles Al

Question #: 6

Calculate the number of grams of hydrogen gas (H₂) that form when 38.0 grams of sodium react with excess water according to the balanced chemical equation below:

\[ 2 \text{Na}(s) + 3 \text{H}_2\text{O}(l) \rightarrow 2 \text{NaOH}(aq) + \text{H}_2(g) \]

A. 11.9 grams  
B. 22.9 grams  
✓C. 1.67 grams  
D. 3.48 grams

Question #: 7

What mass of Na₂SO₄ (molar mass = 142.04 g/mol) will be formed by the addition of 28.8 g NaHCO₃ (molar mass = 84.01 g/mol) in aqueous solution to an aqueous solution containing 9.80 g H₂SO₄ (molar mass = 98.08 g/mol)?

\[ \text{H}_2\text{SO}_4(aq) + 2 \text{NaHCO}_3(aq) \rightarrow \text{Na}_2\text{SO}_4(aq) + 2 \text{H}_2\text{O}(l) + 2 \text{CO}_2(g) \]

✓A. 14.2 grams  
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D. 10.2 grams

Question #: 8

If a reaction of FeS and HCl has a theoretical yield of 9.68 g of H₂S, what is the percent yield if only 9.04 g of H₂S are recovered?
Report your answer with three significant figures. Do NOT include units or the percent sign in your answer.

1. 93.4

Question #: 9

The energy of motion is 1 kinetic [kinetic, potential] energy; the energy stored by virtue of an object's position is 2 potential [kinetic, potential] energy.

1. kinetic
2. potential

Question #: 10

The process of breaking chemical bonds is 1 endothermic [endothermic, exothermic]; the process of forming chemical bonds is 2 exothermic [endothermic, exothermic].

Consider the bonds HI, HF, and HCl. The strongest bond among these three compounds is 3 HF [HI, HF, HCl].

1. endothermic
2. exothermic
3. HF

Question #: 11

Consider the diagram below and complete the following sentences:
The reaction that occurs from A to C is 1 [faster, slower] than the reaction that occurs from A to B.

The reaction that occurs from A to C is 2 [endothermic, exothermic].

The reaction that occurs from A to B is 3 [endothermic, exothermic].

1. faster
2. exothermic
3. endothermic

**Question #: 12**

Consider the diagram below and complete the following sentences. Report each answer as a single **letter**.
For the reaction that occurs from **A to C**, the difference between point **1** [A, B, C, D, E] and point **2** [A, B, C, D, E] is equal to the enthalpy (ΔH) value of the reaction.

For the reaction that occurs from **A to B**, the difference between point **3** [A, B, C, D, E] and point **4** [A, B, C, D, E] is equal to the activation energy (E_a) of the reaction.

1. A
2. C
3. A
4. E

**Question #: 13**

Consider the chemical equation below and complete the following sentences:

\[ N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -22 \text{ kcal/mol} \]

Heat is **1** [absorbed, released] in the reaction.

The bonds in the **2** [reactants, products] are stronger.

The **3** [reactants, products] are lower in energy.

1. released
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\[ \text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g) \quad \Delta H = -22 \text{ kcal/mol} \]

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D. –248 kcal

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$2\text{NH}_3(g) \rightleftharpoons 3\text{H}_2(g) + \text{N}_2(g)$ $\Delta H = +22 \text{ kcal/mol}$

A. $K = \frac{[\text{NH}_3]^2}{[\text{H}_2]^3[\text{N}_2]}$

✓B.
C. \[
K = \frac{[H_2]^3[N_2]}{[NH_3]^2}
\]

Question #: 20

Calculate the equilibrium constant for the balanced chemical equation below given the following concentrations:

\[
\text{CO}(g) + \text{H}_2\text{O}(g) \rightleftharpoons \text{CO}_2(g) + \text{H}_2(g)
\]

\[
[H_2] = 0.0984 \text{ M} ; [\text{CO}_2] = 0.0984 \text{ M}
\]
\[
[\text{CO}] = 0.142 \text{ M} ; [\text{H}_2\text{O}] = 0.0144\text{M}
\]

✓ A. \(K = 4.73\)
B. \(K = 0.198\)
C. \(K = 8.23\)
D. \(K = 0.989\)

Question #: 21

Consider the **exothermic** reaction at equilibrium:

\[
\text{H}_2(g) + \text{F}_2(g) \rightleftharpoons 2\text{HF}(g)
\]

If HF\((g)\) is **removed** from the reaction, the equilibrium shifts **1** [left, right, no change].

If F\(_2\)(\(g\)) is **added** to the reaction, the equilibrium shifts **2** [left, right, no change].

If the pressure is decreased due to a change in volume, the equilibrium shifts **3** [left, right, no change].
If the temperature is increased, the equilibrium shifts __4__ [left, right, no change].

1. right
2. right
3. no change
4. left

---

**Question #**: 22

The typical tire pressure is 35 pounds per square inch (PSI). What is this pressure in atmospheres?

1 atm = 14.7 PSI

A. 490 atm
B. 1.3 atm
✓C. 2.4 atm
D. 3.8 atm

---

**Question #**: 23

When the amount and pressure of an ideal gas are held constant, what happens to the volume of a gas sample when the temperature is **decreased**?

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C. The volume remains unchanged.
D. The volume of gas cannot be increased at constant pressure.

---

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✓ A. 0.0196 moles
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The partial pressure of O₂ is __ mmHg.

Report your answer with two significant digits. Do NOT include units in your answer. Use the format 2.2e2 or 2.2e-2 for answers in scientific notation.

1. 1.3e2

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |