1. Which one of the following represents a physical change?

   A) water, when heated to 100°C, forms steam
   B) bleach turns hair yellow
   C) sugar, when heated, becomes brown
   D) milk turns sour
   E) apples, when exposed to air, turn brown

   Ans: A

2. The SI prefixes mega and deci represent, respectively:

   A) $10^3$ and $10^{-2}$.
   B) $10^6$ and $10^{-1}$.
   C) $10^{-3}$ and $10^{-2}$.
   D) $10^{-6}$ and $10^2$.
   E) $10^2$ and $10^{-3}$.

   Ans: B

3. The element gallium melts at 29.8°C. What temperature is this in °F?

   A) −54.1°F  B) −7.8°F  C) +13.5°F  D) +51.3°F  E) +85.6°F

   Ans: E

4. Bromine is a red liquid at 25°C. Its density is 3.12 g/cm$^3$. What is the volume of 28.1 g of liquid bromine?

   A) 87.7 cm$^3$
   B) 0.111 cm$^3$
   C) 9.01 cm$^3$
   D) 28.1 cm$^3$
   E) None of the above

   Ans: C
5. A piece of metal with a mass of 611 g is placed into a graduated cylinder that contains 25.1 mL of water, raising the water level to 56.7 mL. What is the density of the metal?

A) 2.70 g/cm$^3$  B) 7.13 g/cm$^3$  C) 8.96 g/cm$^3$  D) 10.5 g/cm$^3$  E) 19.3 g/cm$^3$

Ans: E

6. The "escape velocity" from Earth (the speed required to escape Earth's gravity) is $2.5 \times 10^4$ miles per hour. What is this speed in m/s? (1 mile = 1609 m)

A) $4.2 \times 10^{-3}$ m/s  D) $1.1 \times 10^4$ m/s
B) 6.9 m/s  E) $4.0 \times 10^7$ m/s
C) $4.2 \times 10^2$ m/s

Ans: D

7. One of the common intravenous fluids, called physiological saline, is a homogeneous mixture of NaCl in water. In this mixture, 0.89% of the mass is contributed by the NaCl. What mass of NaCl is found in 450 mL of physiological saline?

(Given: density of physiological saline = 1.005 g/cm$^3$)

A) 2.0 g  B) 4.0 g  C) 5.1 g  D) 508 g  E) 400 g

Ans: B

8. Classify the following as an intensive or an extensive property: Boiling point

Ans: intensive

9. When J. J. Thomson discovered the electron, what physical property of the electron did he measure?

A) its charge, $e$  D) its mass, $m$
B) its charge-to-mass ratio, $e/m$  E) its atomic number, $Z$
C) its temperature, $T$

Ans: B
10. What are the two different ions present in the compound Na$_2$S?
   A) Na$^+$, S$^-$   B) Na$^+$, S$^{2-}$   C) Na$^{2+}$, S$^2-$   D) Na$^+$, S$^-$   E) Na$^{2+}$, S$^-$
   Ans: B

11. What is the formula for the ionic compound containing iron (III) ions and iodide ions?
   A) FeI   B) Fe$_2$I   C) FeI$_2$   D) FeI$_3$   E) Fe$_3$I
   Ans: D

12. How many electrons, protons, and neutrons does an iron-55 atom have?
   Ans: 26 electrons, 26 protons, and 29 neutrons

13. What are the ions present in the compound CO$_2$?
   A) C$^{4+}$, 2 O$^{2-}$   B) C$^{2+}$, 2 O$^{-}$   C) C$^{2+}$, O$^{2-}$   D) C$^{2+}$, O$_2^{-}$   E) no ions present
   Ans: E

14. What is the formula for the ionic compound containing barium ions and sulfate ions?
   A) BaSO$_4$   B) Ba$_2$SO$_4$   C) BaS   D) Ba(SO$_4$)$_2$   E) Ba$_3$S$_2$
   Ans: A

15. The name for KHCO$_3$ is
   A) calcium bicarbonate.   B) calcium carbonate.   C) potassium carbonate.
   D) calcium hydrogen carbon trioxide.   E) potassium hydrogen carbonate.
   Ans: E

16. Name the compound Co(NO$_3$)$_2$
   A) Cobalt (I) nitrate   B) Cobalt (II) nitrate   C) Cobalt (I) nitride
   D) Cobalt nitrite   E) Cobalt (II) nitride
   Ans: B
17. Name the acid H$_2$SO$_3$ (dissolved in water).
   A) Sulfuric acid  D) Persulfuric acid
   B) Sulfurous acid  E) Hyposulfurous acid
   C) Hydrosulfuric acid
   Ans: B

18. How many carbon atoms are in one molecule of CH$_3$(CH$_2$)$_3$CH$_3$?
   Ans: 5

19. Name the following compound: Cl$_2$O$_7$.
   Ans: dichlorine heptoxide

20. Give the formula of ammonium sulfate.
   Ans: (NH$_4$)$_2$SO$_4$

21. Name the compound CH$_3$CH$_2$NH$_2$
   Ans: Ethylamine

22. An atom of bromine has a mass about four times greater than that of an atom of neon. Which choice makes the correct comparison of the relative numbers of bromine and neon atoms in 1,000 g of each element?
   A) The number of bromine and neon atoms is the same.
   B) There are one thousand times as many bromine atoms as neon atoms.
   C) There are one thousand times as many neon atoms as bromine atoms.
   D) There are four times as many neon atoms as bromine atoms.
   E) There are four times as many bromine atoms as neon atoms.
   Ans: D

23. One mole of iron
   A) is heavier than one mole of lead (Pb).  D) weighs the same as one mole of lead.
   B) is 77.0 g of iron.  E) None of the above.
   C) is 26.0 g of iron.
   Ans: E
24. How many moles of H are in 4.56 moles of NH₂NH₂?
   A) 4.52 moles H       D) 18.39 moles H
   B) 4.56 moles H       E) 18.24 moles H
   C) 9.12 moles H

   Ans: E

25. Calculate the mass of N in 2.34 g of N₂H₄?
   A) 4.68 g N    B) 65.6 g N    C) 28.02 g N    D) 2.05 g N    E) 2.34 g N

   Ans: D

26. Zircon is a mineral with the empirical formula ZrSiO₄. If all the zirconium is ⁹⁰Zr, all the silicon is ²⁸Si, and all the oxygen is ¹⁶O, what mass of oxygen is present in 10. g of zircon?
   A) 0.88 g    B) 1.2 g    C) 1.8 g    D) 3.5 g    E) 5.4 g

   Ans: D

27. A compound with an empirical formula of C₂H₄Br has a molar mass of 215.90 g/mol. What is the molecular formula?
   A) C₄H₈Br₂    B) C₂H₄Br    C) CHBr    D) C₆H₁₂Br₃    E) C₄H₈Br

   Ans: A

28. An organic thiol compound is 38.66% C, 9.73% H, and 51.61% S by mass. What is the empirical formula of this compound?
   A) C₂H₆S    B) C₃H₈S    C) C₄H₁₀S    D) C₄H₁₂S    E) C₅H₁₄S

   Ans: A
29. Which one of the following is an example of a balanced chemical reaction?
   A) \( \text{C}_3\text{H}_6\text{O} + 4\text{O}_2 \rightarrow 3\text{CO}_2 + 3\text{H}_2\text{O} \)
   B) \( 2\text{C}_3\text{H}_6\text{O} + 9\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} \)
   C) \( \text{C}_3\text{H}_6\text{O} + 3\text{O}_2 \rightarrow 3\text{CO}_2 + 3\text{H}_2\text{O} \)
   D) \( 2\text{C}_3\text{H}_6\text{O} + 9\text{O}_2 \rightarrow 6\text{CO}_2 + 3\text{H}_2\text{O} \)
   E) \( \text{C}_3\text{H}_6\text{O} + 9\text{O}_2 \rightarrow 3\text{CO}_2 + 3\text{H}_2\text{O} \)

   Ans: A

30. Chlorine gas can be made from the reaction of manganese dioxide with hydrochloric acid.

   \[ \text{MnO}_2(s) + 4\text{HCl}(aq) \rightarrow \text{MnCl}_2(aq) + 2\text{H}_2\text{O}(l) + \text{Cl}_2(g) \]

   According to the above reaction, determine the limiting reactant when 5.6 moles of \( \text{MnO}_2 \) are reacted with 7.5 moles of \( \text{HCl} \)?

   A) \( \text{MnO}_2 \) B) \( \text{HCl} \) C) \( \text{MnCl}_2 \) D) \( \text{Cl}_2 \) E) No reagent is limiting.

   Ans: B

31. Balance the following chemical equation:

   \[ \text{C} + \text{Fe}_2\text{O}_3 \rightarrow \text{Fe} + \text{CO} \]

   Ans: \( 3\text{C} + \text{Fe}_2\text{O}_3 \rightarrow 2\text{Fe} + 3\text{CO} \)

32. What is the theoretical yield of \( \text{PI}_3 \) from the reaction of 27.0 g of \( \text{P} \) and 68.0 g of \( \text{I}_2 \)?

   \[ 2\text{P}(s) + 3\text{I}_2(s) \rightarrow 2\text{PI}_3(s) \]

   Ans: 73.5 g
33. Ferrocene, Fe(C₅H₅)₂(s), can be prepared by reacting 3.0 g of FeCl₂(s) with an equal mass of cyclopentadiene, C₅H₆(l), and an excess of KOH, as shown in the following reaction

\[ \text{FeCl}_2 + 2\text{C}_5\text{H}_6 + 2\text{KOH} \rightarrow \text{FeC}_{10}\text{H}_{10} + 2\text{H}_2\text{O} \]

A. What is the limiting reagent in this procedure?
B. Based on your answer to part A, what mass of Fe(C₅H₅)₂ could theoretically be formed?
C. A student who carried out this reaction obtained 2.7 g of ferrocene. What was the percent yield for this reaction?

Ans: A. C₅H₆ is limiting  
B. 4.2 g of ferrocene  
C. 64% yield

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CHEM 1411 Formulas and Constants

<table>
<thead>
<tr>
<th>Formula</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>mass of proton</td>
<td>1.00728 amu</td>
</tr>
<tr>
<td>mass of neutron</td>
<td>1.00866 amu</td>
</tr>
<tr>
<td>c</td>
<td>3.00 X 10⁸ m/s</td>
</tr>
<tr>
<td>F</td>
<td>96500 C/(mol of e⁻) = 96500 J/(V mol of e⁻)</td>
</tr>
<tr>
<td>K</td>
<td>°C + 273.15</td>
</tr>
<tr>
<td>R</td>
<td>0.08206 (L atm)/(mol K) = 8.314 J/(mol K)</td>
</tr>
<tr>
<td>1 g</td>
<td>6.022 X 10²³ amu</td>
</tr>
<tr>
<td>1 atm</td>
<td>760 mm Hg</td>
</tr>
</tbody>
</table>

1 mL = 1 cm³

Temperature scales/Conversion:

• Tₖ = Tₖ + 273  (Celsius to Kelvin)
• Tₖ = Tₖ – 273  (Kelvin to Celsius)
• Tₙ = (1.8×Tₙ) + 32  (Celsius to Fahrenheit)
• Tₙ = (Tₙ – 32) / 1.8  (Fahrenheit to Celsius)

Percent by mass = \[ \frac{\text{mass of solute}}{[\text{mass of solute} + \text{mass of solvent}]} \times 100\% \]

Two-component solution:
Mole fraction of solute A: \[ X_A = \frac{\text{moles of solute A}}{\text{moles of solute A} + \text{moles of solvent B}} \]

Molarity = number of moles of solute in 1 L of solution:
Molarity = \( \frac{\text{moles of solute}}{\text{Liters of solution}} \)

Molality = number of moles of solute dissolved in 1 kg (1000 g) of solvent:
Molality = \( \frac{\text{moles of solute}}{\text{Mass of solvent (1 kg)}} \)

Density = \( \frac{\text{Mass}}{\text{Volume}} \).