1) When the reaction shown is balanced, there are ______ atoms of oxygen and ______ atoms of hydrogen on each side.

\[(\text{NH}_4)_2\text{SO}_4 (aq) + \text{Ba(}2\text{C}_2\text{H}_3\text{O}_2)2 (aq) \rightarrow \text{BaSO}_4 (s) + \text{NH}_4\text{C}_2\text{H}_3\text{O}_2 (aq)\]

1) _______

A) 6; 11 B) 8; 14 C) 4; 7 D) 16; 28 E) 16; 18

2) In the correctly balanced reaction

\[\_ \text{Al(OH)}_3 + \_ \text{H}_2\text{SO}_4 \rightarrow \_ \text{Al}_2(\text{SO}_4)_3 + \_ \text{H}_2\text{O}\]

the coefficient for the \(\text{H}_2\text{O}\) is: 2) _______

A) 8 B) 3 C) 2 D) 1 E) 6

3) In a chemical reaction

A) there are always the same number of products as there are reactants.
B) there are equal numbers of molecules on each side of the reaction arrow.
C) there are equal numbers of atoms on each side of the reaction arrow.
D) the number of atoms depends present in a reaction can vary when the conditions change during the reaction.
E) none of the above

4) The oxidation number of chlorine in the compound \(\text{FeCl}_3\) is _______. 4) _______

A) +2 B) −3 C) +3 D) −1 E) −2

5) In the reaction shown, what is the mole ratio that would be used to determine the number of moles of oxygen needed to react with 3.2 moles of \(\text{C}_4\text{H}_1\text{O}_2\)?

\[2 \text{C}_4\text{H}_10 + 13 \text{O}_2 \rightarrow 8 \text{CO}_2 + 10 \text{H}_2\text{O}\]

5) _______

A) \[
\frac{2}{\text{moles } \text{C}_4\text{H}_10} \]

B) \[
\frac{13}{\text{moles } \text{O}_2} \]

C) \[
\frac{3.2}{\text{moles } \text{C}_4\text{H}_10} \]

D) \[
\frac{2}{\text{moles } \text{C}_4\text{H}_10} \]

E) \[
\frac{3.2}{\text{moles } \text{O}_2} \]

6) \(\text{Fe(s) + CuCl}_2 (aq) \rightarrow \text{Cu(s) + FeCl}_2 (aq)\) In the redox reaction shown, ________ is oxidized and becomes ________.

6) _______
A) Cu²⁺; Cu
B) Cu; Cu²⁺
C) Fe; Fe²⁺
D) Fe; Fe⁺
E) none of the above

7) The number of grams in 2.65 mol of SO₂ is _______.
A) 24.2.
B) 1.60 x 10²⁴.
C) 64.1.
D) 170.
E) 2.65.

8) The oxidation number of sulfur in calcium sulfate, CaSO₄, is _______.
A) –2    B) +4    C) +2    D) +6    E) 0

9) The formula weight of ammonium carbonate, (NH₄)₂CO₃, is _______ amu.
A) 96.09    B) 120.13    C) 64.11    D) 82.10    E) 180.17

10) How many molecules are present in 4.25 mol of CCl₄? ______
A) 9.26 x 10²⁵
B) 153.81
C) 653.69
D) 2.56 x 10²⁴
E) 36.91

11) When the reaction shown is correctly balanced, the coefficients are

\[
\text{HBr} + \text{Ca(OH)}_2 \rightarrow \text{CaBr}_2 + \text{H}_2\text{O}
\]

A) 2, 2, 1, 1    B) 2, 1, 1, 2    C) 1, 1, 1, 2    D) 2, 1, 1, 1    E) 2, 1, 2, 2

12) In a precipitation reaction the insoluble product can be identified by the symbol _______.
A) (s)
B) (aq)
C) (l)
D) (g)
E) none of the above

13) Consider the reaction shown:

\[
452\text{ kcal} + 4\text{ PCl}_5(s) \rightarrow \text{P}_4(s) + 10\text{ Cl}_2(g)
\]

This reaction is _______ because the sign of ΔH is _______.
A) endothermic; positive
B) endothermic; negative
C) exothermic; positive
D) exothermic; negative
E) exothermic; neither positive nor negative

14) The function of a catalyst in a reaction system is to 14) ______
A) decrease the amount of energy consumed in the reaction.
B) decrease the amount of reactants consumed.
C) increase the rate of the reaction.
D) decrease the amount of heat produced.
E) increase the yield of product.

15) Consider the reaction:

\[
2 \text{ CO} (g) + \text{O}_2 (g) \rightleftharpoons 2 \text{CO}_2 (g)
\]

The equilibrium expression for this reaction is 15) ______
A) \(\frac{[\text{CO}][\text{O}_2]}{[\text{CO}_2]}\)
B) \(\frac{[\text{CO}][\text{O}_2]}{[\text{CO}_2]^2}\)
C) \(\frac{[\text{CO}]^2[\text{O}_2]}{2[\text{CO}] [\text{O}_2]}\)
D) \(\frac{[\text{CO}][\text{O}_2]}{[\text{CO}_2]^2}\)
E) \(\frac{[\text{CO}][\text{O}_2]}{[\text{CO}_2]^2}\)

16) Consider the reaction shown:

\[
2 \text{ CO} (g) + \text{O}_2 (g) \rightarrow \text{CO}_2 (g) + 135.2 \text{ kcal}
\]

This reaction is ______ because the sign of \(\Delta H\) is ______. 16) ______
A) endothermic; negative
B) endothermic; positive
C) exothermic; neither positive nor negative
D) exothermic; positive
E) exothermic; negative

17) If we add a catalyst to the following equation, \(\text{CO} + \text{H}_2\text{O} + \text{heat} \rightleftharpoons \text{CO}_2 + \text{H}_2\), which way will the equilibrium shift? 17) ______
A) To the right  B) To the left
C) No effect  D) Not enough information

18) A process or reaction which takes in heat from the surroundings is said to be 18) ______
A) exothermic.
B) endergonic.
C) endothermic.
D) conservative.
E) isothermal.

19) In the process of dissolving sugar in water, the entropy increases. This means that the sign of $\Delta S$ is ________, and that the randomness of the system ________. 19)

A) negative; decreases  
B) undetermined; increases  
C) positive; decreases  
D) negative; increases  
E) positive; increases

20) Which factors would decrease the rate of a reaction?
   I. Lowering the temperature  
   II. Increasing the concentration of reactants  
   III. Adding a catalyst  
20)

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

21) Entropy can be defined as  

A) the state of equilibrium in a system.  
B) the amount of disorder in a system.  
C) the amount of energy required to initiate a reaction.  
D) the amount of energy required to rearrange chemical bonds.  
E) the number of chemical bonds which are changed during a reaction.

22) What is the osmolarity of a 0.20 M solution of KCl?  
22)

A) 0.40 Osmol  
B) 0.80 Osmol  
C) 0.20 Osmol  
D) 0.10 Osmol  
E) 0.30 Osmol

23) What is the % (w/v) concentration of a solution containing 12 grams of solute in 400 mL of solution?  
23)

A) 12%  
B) 3.0%  
C) 1.2%  
D) 6.0%  
E) 4.0%

24) All of the statements about molarity are correct except  

A) the molarity of a diluted solution is less than the molarity of the original solution.  
B) the abbreviation is M.  
C) the interpretation of the symbol is "moles of solute per mole of solvent."  
D) moles = molarity * volume.  
E) volume = moles/molarity.

25) In a mixture of 5 mL water, 10 mL alcohol, and 50 mL acetone the solvent(s) is(are) ________. 25)

A) alcohol  
B) alcohol and water  
C) water  
D) acetone  
E) acetone and alcohol

26) How many grams of NaOH are needed to make 750 mL of a 2.5% (w/v) solution?  
26)

A) 7.5 g  
B) 50 g  
C) 19 g  
D) 20 g  
E) 3.9 g
27) How many moles of solute are present in 5.00 L of 6.00 M HCl?  
A) 5.00 mol  B) 6.00 mol  C) 1.20 mol  D) 0.833 mol  E) 30.0 mol

28) Which of the following can serve as the solvent in a solution?  
A) a liquid  
B) a gas  
C) a solid  
D) a mixture of comingled liquids  
E) all of the above

29) If the concentration of H₃O⁺ is 3.5 × 10⁻³ M, the concentration of OH⁻ is ______ M.  
A) 3.5 × 10⁻¹¹  
B) 1.0 × 10⁻¹²  
C) 2.9 × 10⁻¹²  
D) 10.5 × 10⁻³  
E) 1.0 × 10⁻⁷

30) Which of the following statements is correct?  
A) In a basic solution, [H₃O⁺] > 10⁻⁷; [OH⁻] > 10⁻⁷.  
B) In a basic solution, [H₃O⁺] > 10⁻⁷; [OH⁻] < 10⁻⁷.  
C) In a basic solution, [H₃O⁺] < 10⁻⁷; [OH⁻] > 10⁻⁷.  
D) In a basic solution, [H₃O⁺] < 10⁻⁷; [OH⁻] < 10⁻⁷.  
E) In a basic solution, [H₃O⁺] > 10⁻⁷; [OH⁻] = 10⁻⁷.

31) Which reaction best illustrates the behavior of the weak base H₂PO₄⁻ in aqueous solution?  
A) H₂PO₄⁻ (aq) ⇌ H⁺ (aq) + HPO₄²⁻ (aq)  
B) H₂PO₄⁻ (aq) + H₂O (l) ⇌ H₃PO₄ (aq) + OH⁻ (aq)  
C) H₂PO₄⁻ (aq) ⇌ 2H⁺ (aq) + PO₄³⁻ (aq)  
D) H₂PO₄⁻ (aq) + H⁺ (aq) ⇌ H₃PO₄ (aq)  
E) H₂PO₄⁻ (aq) + H₂O (l) ⇌ HPO₄²⁻ (aq) + H₃O⁺ (aq)

32) The pH of a solution with [H₃O⁺] = 5.9 × 10⁻³ M, to the correct number of significant figures, is ______.  
A) 2.229  
B) 5.9 × 10⁻³  
C) 2.23  
D) 2.2  
E) 1.01

33) Which compound has a value of K_a that is close to 10⁻⁵?  
A) NH₃  
B) NaCl  
C) KOH  
D) CH₃CH₂CO₂H  
E) HNO₃

34) All of the reactions shown are oxidation-reduction reactions except  
A) N₂ (g) + O₂(g) → 2 NO(g).  
B) 2 Zn(s) + 2 HCl(aq) → ZnCl₂ (aq) + H₂ (g).
C) $K_2SO_4$ (aq) + $BaCl_2$ (aq) → $BaSO_4$ (s) + 2 $KCl$ (aq).
D) 2 $Fe_2O_3$ (s) → 4 Fe(s) + 3 $O_2$ (g).
E) 2 $NaI$ (aq) + $Cl_2$ (g) → 2 $NaCl$ (aq) + I$_2$.

35) How many grams of C will be consumed when 5.00 grams of $Na_2SO_4$ react according to the balanced reaction shown?

$$Na_2SO_4 + 2 C \rightarrow Na_2S + 2 CO_2$$

35) ______

A) 0.038 g  B) 0.844 g  C) 0.211 g  D) 1.69 g  E) 17.1 g

36) Which of the following is always a spectator ion in a chemical reaction? 36) ______
A) $Na^+$
B) $Cl^-$
C) $Mg^{2+}$
D) $S_2^-$
E) all of these ions

37) Which reaction is an example of an acid-base reaction? 37) ______
A) 2 $Hg$ (l) + $O_2$ (g) → 2 $HgO$ (s)
B) $H_2CO_3$ (aq) → $H_2O$(l) + $CO_2$ (g)
C) $FeCl_3$ (aq) + 3 $KOH$ (aq) → $Fe(OH)_3$ (s) + 3 $KCl$ (aq)
D) 6 $HCl$ (aq) + 2 $Al$ (s) → 2 $AlCl_3$ (aq) + 3 $H_2$ (g)
E) $H_2SO_4$ (aq) + $Ca(OH)_2$ (aq) → $CaSO_4$ (aq) + 2 $H_2$O(l)

38) To simplify comparisons, the energy value of fuels is expressed in units of 38) ______
A) kcal/L.
B) kcal/g.
C) kcal.
D) kcal/mol.
E) some other unit

39) When a reaction system is at equilibrium 39) ______
A) the amounts of reactants and products are exactly equal.
B) the rates of the reaction in the forward and reverse directions are exactly equal.
C) there is no more chemistry happening.
D) the reaction rate in the reverse direction is at a minimum.
E) the reaction rate in the forward direction is at a maximum.

40) For a chemical reaction to occur, all of the following must happen except 40) ______
A) reactant particles must collide with the correct orientation.
B) reactant particles must collide with enough energy for change to occur.
C) a large enough number of collisions must occur.
D) chemical bonds in the reactants must break.
E) chemical bonds in the products must form.

41) How many mL of a 5.00% (w/v) glucose solution are needed to provide 20.0 g of glucose? 41) ______
A) 4.00 mL  B) 20.0 mL  C) 400. mL  D) 200. mL  E) 5.00 mL

42) Which solution has the greatest osmolarity? 42) ______
A) 0.6 M NaCl  
B) 0.14 M KF  
C) 0.2 M CaBr₂  
D) 0.35 M AlCl₃  
E) 0.10 M KNO₃

43) The net ionic equation for the reaction of formic acid, a weak acid, with potassium hydroxide, a strong base, is 43)

A) \( \text{HCO}_2^-(aq) + \text{KOH}(aq) \rightarrow \text{KHCO}_2(aq) + \text{OH}^-(aq) \)
B) \( \text{HCO}_2\text{H}(aq) + \text{K}^+(aq) + \text{OH}^-(aq) \rightarrow \text{K}^+(aq) + \text{HCO}_2^-(aq) + \text{H}_2\text{O}(l) \)
C) \( \text{H}^+(aq) + \text{HCO}_2^-(aq) + \text{K}^+(aq) + \text{OH}^-(aq) \rightarrow \text{K}^+(aq) + \text{HCO}_2^-(aq) + \text{H}_2\text{O}(l) \)
D) \( \text{HCO}_2\text{H}(aq) + \text{KOH}(aq) \rightarrow \text{KHCO}_2(aq) + \text{H}_2\text{O}(l) \)
E) \( \text{HCO}_2\text{H}(aq) + \text{OH}^-(aq) \rightarrow \text{HCO}_2^-(aq) + \text{H}_2\text{O}(l) \)

44) How many mL of 0.100 M NaOH are needed to neutralize 24.0 mL of 0.150 M HCl? 44) 
A) 18.0 mL  
B) 48.0 mL  
C) 36.0 mL  
D) 24.0 mL  
E) 12.0 mL

45) \( 2 \text{AgNO}_3(aq) + \text{K}_2\text{SO}_4(aq) \rightarrow 2 \text{KNO}_3(aq) + \text{Ag}_2\text{SO}_4(s) \)
The spectator ions in the reaction shown are 45) 
A) silver ion and sulfate ion.  
B) potassium ion and sulfate ion.  
C) potassium ion and nitrate ion.  
D) silver ion and nitrate ion.  
E) hydrogen ion and hydroxide ion.

46) Which change to this reaction system would cause the equilibrium to shift to the right?

\[ \text{N}_2(g) + 3 \text{H}_2(g) \rightleftharpoons 2 \text{NH}_3(g) + \text{heat} \] 46) 
A) removal of \( \text{H}_2 \) (g)  
B) heating the system  
C) lowering the temperature  
D) addition of a catalyst  
E) addition of \( \text{NH}_3 \) (g)

47) If a normal blood sample contains 4.5 mEq/L of calcium ion, how many mg of calcium are contained in a 25.0 mL blood sample? 47) 
A) 5.6 mg  
B) 9.0 mg  
C) 2.8 mg  
D) 1.4 mg  
E) 2.3 mg

48) What is the conjugate base of \( \text{HSO}_4^- \)? 48) 
A) \( \text{H}_2\text{SO}_3 \)  
B) \( \text{SO}_4^{2-} \)  
C) \( \text{OH}^- \)  
D) \( \text{H}_2\text{SO}_4 \)  
E) \( \text{H}_3\text{O}^+ \)

49) An aqueous solution of nickel (Ni²⁺) ions will oxidize each of the following metals except: 49) 
A) barium  
B) potassium  
C) aluminum  
D) tin  
E) chromium

50) Consider the endothermic reaction:
\[ \text{N}_2 \text{ (g)} + 2 \text{H}_2 \text{ (g)} \rightarrow \text{N}_2\text{H}_4 \text{ (l)} \]

The entropy change of this reaction is ________ and the enthalpy change is ________, so at a very high temperature, this reaction is probably ________. 50) ______

A) favorable; unfavorable; nonspontaneous
B) unfavorable; unfavorable; nonspontaneous
C) unfavorable; favorable; spontaneous
D) favorable; unfavorable; spontaneous
E) unfavorable; unfavorable; spontaneous