AP Chemistry

Name_____
Period _____ Date ___/___/___

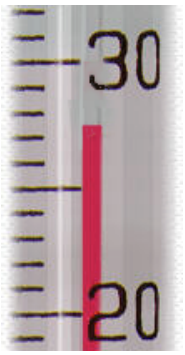
# First Semester Final

**PRACTICE TEST**

**1-Matter and Measurement**

1. The number of significant figures in $0.06060 \times 10^{-5}$ is
   a) 2 d) 5
   b) 3 e) 6
   c\ 4

2. How many significant digits are present in the temperature read from the thermometer illustrated to the right?




   a) 1 b) 2 c) 3 d) 4

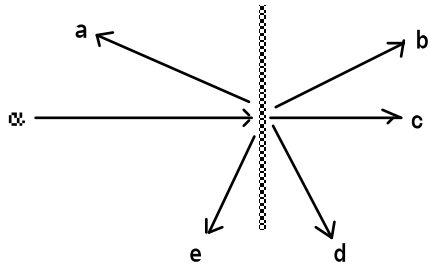
3. The result of 2.350 x (4.0 + 6.311) is,
   a) 24 c) 24.21
   b) 24.2 d) 24.205

**2-Atoms and Elements**

4. Consider the following notation: $^{220}_{86}$Rn
   Which statement below is correct?
   a) This particle contains 86 protons
   b) This particle has a mass number of 86
   c) This particle has an atomic number of 220
   d) This particle contains 220 neutrons

5. Which of the following is a transition metal?
   a) Cl b) Ni c) P d) Ca e) C

6. Pictured below is a schematic of the Rutherford experiment. Which scattered α-particle gives the best evidence for the nuclear atom?




   a) a b) b c) c d) d e) e

7. What is the formula of the ionic compound formed between Ca and P?
   a) $Ca_2P_3$ d) $Ca_2P$
   b) CaP e) $Ca_3P_2$
   c) $Ca_5P_{10}$

8. The correct name for $CCl_4$ is
   a) carbon(I) chloride
   b) carbon chloride
   c) carbon tetrachloride
   d) monocarbon chloride(IV)
   e) carbochlorinate

9. A compound consists of the following elements by weight percent:
   carbon - 40.0%
   oxygen - 53.3%
   hydrogen - 6.7%
   The ratio of carbon : oxygen : hydrogen in the empirical formula is
   a) 1:2:1 c) 1:1:2
   b) 1:1:1 d) 2:1:2

10. What is the percent nitrogen (by mass) in ammonium carbonate, $(NH_4)_2CO_3$?

a) 14.53%  c) 29.16%
b) 27.83%  d) 33.34%

**3-Chemical Equations & Stoichiometry**

11. Calculate the mass of hydrogen formed when 25 g of aluminum reacts with excess hydrochloric acid.

$$2Al + 6HCl \rightarrow 2\,AlCl_3 + 3\,H_2$$

a) 0.41 g  c) 1.2 g
b) 0.92 g  d) 2.8 g

12. How many grams of nitric acid, $HNO_3$, can be prepared from the reaction of 92.0 g of $NO_2$ with 36.0 g $H_2O$?

$$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$$

a) 64  c) 84
b) 76  d) 116

**4-Reactions in Aqueous Solution**

13. In a double replacement reaction, formation of which of the following does not necessarily lead to a chemical change?

a) $HC_2H_3O_2$  d) $H_2S$
b) AgCl  e) NaCl
c) $CO_2$

14. Reaction of an acid with a carbonate (such as $CaCO_3$) always results in the formation of

a) $O_2$  d) $O_3$
b) $C_{(diamond)}$  e) $CO_2$
c) $CH_4$

15. In the double replacement reaction between the weak acid, $HC_2H_3O_2$ and strong base, NaOH, which ion(s) are spectator ions?

a) $Na^+$, $C_2H_3O_2^-$  d) $H^+$, $C_2H_3O_2^-$
b) $Na^+$, $OH^-$  e) $Na^+$ only
c) $OH^-$ only

16. What is the oxidation number of Br in $KBrO_4$?

a) +1  b) –1  c) +5  d) +7  e) +8

**6-Energy & Chemical Reactions**

17. How much energy is required to change the temperature of 2.00 g aluminum from 20.0°C to 25.0°C? The specific heat of aluminum is 0.902 J/g°C.

a) 2.3 J  c) 0.36 J
b) 9.0 J  d) 0.090 J

18. Consider the thermal energy transfer during a chemical process. When heat is transferred to the system, the process is said to be _____ and the sign of ΔH is _____.

a) exothermic, positive
b) endothermic, negative
c) exothermic, negative
d) endothermic, positive

19. For the general reaction

$2\,A + B_2 \rightarrow 2\,AB$,  ΔH is +50.0 kJ.

We can conclude that

a) the reaction is endothermic.
b) the surroundings absorb energy.
c) the standard enthalpy of formation of AB is -50.0 kJ.
d) the molecule AB contains less energy than A or $B_2$.

20. Calculate the enthalpy of combustion of $C_3H_6$:

$C_3H_6(g) + {}^9/_2O_2(g) \rightarrow 3CO_2 + 3H_2O$

using the following data:

$3C(s) + 3H_2(g) \rightarrow C_3H_6(g)$  $\Delta H° = 53.3$ kJ
$C(s) + O_2(g) \rightarrow CO_2(g)$  $\Delta H° = -394$ kJ
$H_2(g) + {}^1/_2O_2(g) \rightarrow H_2O(l)$  $\Delta H° = -286$ kJ

a) -1517 kJ  c) -626 kJ
b) 1304 kJ  d) -2093 kJ

**7-Atomic Structure**

21. A radio station transmits at 110 MHz (110 x $10^6$ Hz). What wavelength is this radio wave?
    a) 3.65 x $10^{-5}$ m  c) 3.81 x $10^{-5}$ m
    b) 3.30 m  d) 2.73 m

22. What is the energy needed to raise an electron in the hydrogen atom from the second energy level to the third energy level?
    a) 1.52 x $10^4$ J  d) 4.48 x $10^{-19}$ J
    b) 3.63 x $10^{-19}$ J  e) 3.03 x $10^{-19}$ J
    c) 2.18 x $10^{-19}$ J

23. What is the de Broglie wavelength of an electron moving at 80.0% the speed of light.
    a) 3.03 x $10^{-12}$ m  c) 3.30 x $10^{11}$ m
    b) 2.42 x $10^{-12}$ m  d) 1.59 x $10^{-25}$ m

24. The value of $\ell$ that is related to the following orbital is:

    a) 0  b) 1  c) 2  d) 3  e) 4

25. The successive ionization energies for one of the period three elements is listed below. Which element is referred to?

| | |
|---|---|
| $E_1$ | 577.4 kJ/mol |
| $E_2$ | 1,816 kJ/mol |
| $E_3$ | 2,744 kJ/mol |
| $E_4$ | 11,580 kJ/mol |
| $E_5$ | 15,030 kJ/mol |

    a) Na  b) Mg  c) Al  d) Si  e) P

26. Which of the following is likely to have the largest atomic radius?
    a) H  b) Mn  c) Cl  d) Rb  e) Ag

27. Which of the following has the greatest ionization energy?
    a) K  b) Ca  c) Fe  d) Ga  e) Br

28. The electron configuration of the indicated atom in the ground state is correctly written for which atom?
    a) Ga  [Ar] $3d^{12}$ $4s^2$
    b) Ni  [Ar] $3d^{10}$
    c) Ni  [Ar] $3s^2$ $3p^8$
    d) Cu  [Ar] $3d^{10}$ $4s^1$

**8-Bonding and Molecular Structure**

29. The molecule $BrF_3$ has how many lone pairs of electrons on the central atom?
    a) 0  b) 1  c) 2  d) 3

30. What is the shape of the $IF_4^-$ ion?
    a) square planar  d) octahedral
    b) tetrahedral  e) T-shaped
    c) square pyramidal

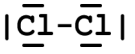
31. Given the bond dissociation energies below, calculate the standard molar enthalpy of formation of $ClF_3$.

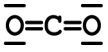
$$Cl_2(g) + 3\ F_2(g) \rightarrow 2\ ClF_3(g)$$

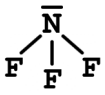
| Bond | Dissociation Energy (kJ/mol) |
|---|---|
| Cl-Cl | 243 |
| F-F | 159 |
| Cl-F | 255 |

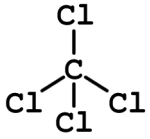
    a) 210 kJ/mol  d) -45 kJ/mol
    b) 147 kJ/mol  e) -405 kJ/mol
    c) -33 kJ/mol

32. Which one of the following molecules is a polar molecule?

a) 

c) 

b) 

d) 

33. The molecule $BrF_3$ has a steric number of ___ on the central atom?

a) 3 b) 4 c) 5 d) 6

34. What is the hybridization of Br in $BrF_3$?

a) sp
b) $sp^2$
c) $sp^3$
d) $sp^3d$
e) $sp^3d^2$

35. How many sigma (σ) and pi (π) electrons pairs are in a carbon dioxide molecule?

a) four σ and zero π
b) three σ and two π
c) two σ and two π
d) two σ and four π
e) one σ and three π

36. What is the hybridization of the oxygen atoms in $CH_3OH$ and $CO_2$, respectively?

a) $sp^3$, $sp^3$
b) $sp^3$, $sp^2$
c) $sp^2$, $sp^3$
d) $sp^2$, $sp^2$
e) $sp^3$, sp

**5-Gases & Their Properties**

37. A 31.0 mL sample of gas is collected at a temperature of 37 °C and pressure of 720 mmHg. What is its volume at 17 °C and 580 mmHg.

a) 23 mL
b) 27 mL
c) 36 mL
d) 41 mL
e) 58 mL

38. A mixture of gases at 810 kPa pressure contains:
3.0 moles of oxygen gas,
2.0 moles of helium gas, and
4.0 moles of carbon dioxide gas.
What is the partial pressure of helium gas, $P_{He}$.

a) 405 kPa
b) 1620 kPa
c) 810 kPa
d) 81.0 kPa
e) 180 kPa

39. The ratio of the average velocities of $SO_2(g)$ to $CH_4(g)$ at 300 K is

a) 1:4
b) 1:2
c) 4:1
d) 2:1

40. At STP, it was found that 1.12 L of a gas had a mass of 2.78 g. Its molar mass is

a) 2.78 g/mol
b) 27.8 g/mol
c) 55.6 g/mol
d) 111 g/mol

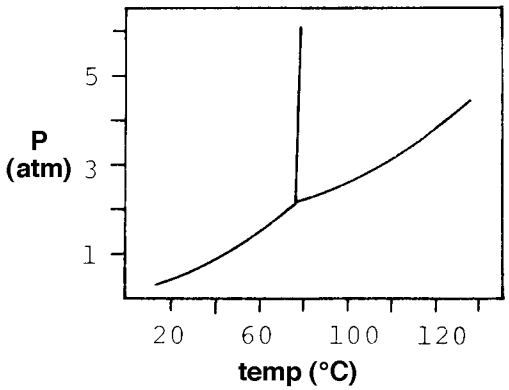
**9-Intermolecular Forces, Liquids, & Solids**

41. For which substance would you predict the highest heat of vaporization?
a) $F_2$ b) $H_2O$ c) HF d) NaCl e) $Br_2$

42. Which one of the following is linked with the correct intermolecular force of attraction?

a) $NH_3$.....dipole-dipole
b) $CH_4$.....London dispersion forces
c) $H_2$.....hydrogen bonding
d) $C_2H_4$.....covalent bonding
e) HCl .....ionic

43. The phase diagram of a substance is given below. What occurs when the substance is heated from 100° C to 120 °C at 3 atm pressure?




a) it melts
b) it sublimes
c) it boils
d) it freezes
e) no phase change occurs

44. Which of the following has the **<u>lowest</u>** boiling point?

a) $H_2O$
b) $H_2S$
c) $H_2Se$
d) $H_2Te$
e) $NH_3$

**10-Solutions**

45. Concentrated salt solutions have boiling points lower than those calculated using the equation, $T_b = K_b \cdot m \cdot i$ Which of the following is a reasonable explanation of this observation?

a) Positive ions repel each other more at high concentration.
b) Ions of opposite charge will tend to stay paired instead of breaking up.
c) The water molecules will have a greater attraction for each other.
d) Concentrated solutions really have small particles of non-dissolved salt, thus lowering the molality.
e) The difference between the crystal lattice energy and the heat of hydration must be taken into consideration.

46. Which of the following would have a boiling point closes to that of 1 *m* NaCl?

a) 1 *m* sucrose ($C_{12}H_{22}O_{11}$)
b) pure $H_2O$
c) 1 *m* $MgCl_2$
d) 0.5 *m* $CH_3OH$
e) 1 *m* $NH_4NO_3$

47. What is the primary energetic factor in the lack of miscibility between $CCl_4$(l) and water?

a) the strength of intermolecular forces between $CCl_4$ molecules
b) the strength of intermolecular forces between $H_2O$ molecules
c) the charge on the C atom in $CCl_4$
d) the difference between the molecular weights of the molecules
e) the electronegativity difference between carbon and chlorine

48. A student prepared a solution containing 0.30 mol solute and 1.00 mole solvent. The mole fraction of ***solvent*** is

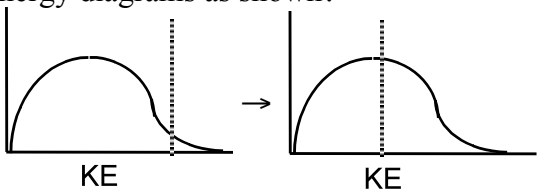
a) 1.30
b) 1.00
c) 0.77
d) 0.30
e) 0.23

49. A solution is prepared by dissolving 0.500 g of non-dissociating solute in 12.0 g of cyclohexane. The freezing point depression of the solution is 8.94°C. The $K_{fp}$ for cyclohexane is 20.0°C/*m*. Calculate the molar mass of the solute.

a) 93.2 g/mol
b) 112 g/mol
c) 128 g/mol
d) 182 g/mol
e) 205 g/mol

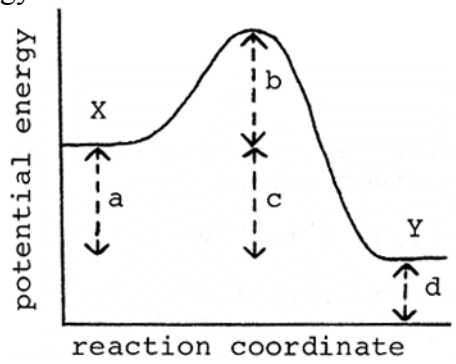
**11-Kinetics**

50. What would cause the change in the kinetic energy diagrams as shown?




a) increasing the ΔH
b) decreasing the temperature
c) increasing the surface area
d) addition of a catalyst
e) increasing the concentration of reactant

51. What distance corresponds to the activation energy for the reaction of X to Y?




a) a
b) b
c) c
d) d
e) e

52. Assume a reaction occurs by the mechanism given below. What is the rate law for the reaction?

$A + B \leftrightarrow C$ fast

$C \rightarrow D$ slow

a) Rate = k[A][B][C]
b) Rate = $k[A]^2$
c) Rate = k[A][B]
d) Rate = k[A][B]/[D]
e) Rate = k[A]

53. Below is some rate data for the hypothetical reaction, $2A + B \rightarrow C$. What is the rate law for this reaction?

| Experiment | $[A]_o$ | $[B]_o$ | Rate (M/s) |
|---|---|---|---|
| 1 | 2.0 M | 1.0 M | 0.100 |
| 2 | 2.0 M | 2.0 M | 0.400 |
| 3 | 4.0 M | 1.0 M | 0.100 |

a) Rate = k[A][B]
b) Rate = $k[A]^2[B]$
c) Rate = $k[A][B]^2$
d) Rate = $k[A]^2[B]^2$
e) Rate = $k[B]^2$

54. The reaction $3O_2 \rightarrow 2O_3$ is proceeding with a rate of disappearance of $O_2$ equal to 0.60 mol/L·s. What is the rate of appearance of $O_3$, in mol/L·s?

a) 0.60
b) 0.40
c) 0.10
d) 0.90
e) 1.20

55. What is the rate constant for a first order reaction for which the half-life is 85.0 sec?

a) 0.00814 $sec^{-1}$
b) 4.44 $sec^{-1}$
c) 0.170 $sec^{-1}$
d) 0.0118 $sec^{-1}$
e) 58.9 $sec^{-1}$

56. A reaction and its rate law are given below. When $[C_4H_6]$ = 2.0 M, the rate is 0.106 M/s. What is the rate when $[C_4H_6]$ = 4.0 M?

$2\ C_4H_6 \rightarrow C_8H_{12}$ Rate = $k[C_4H_6]^2$

a) 0.053 M/s
b) 0.212 M/s
c) 0.106 M/s
d) 0.424 M/s
e) 0.022 M/s