

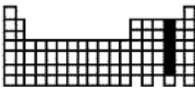
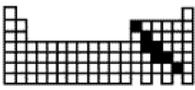
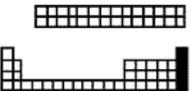
# Virginia Chemistry Olympiad First Year Exam

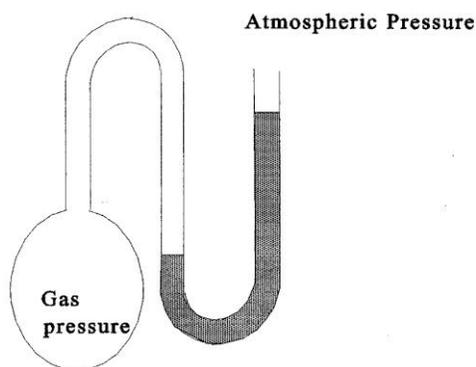
## Directions for the First Year Virginia Olympiad Local Section Examination

When you have selected your answer to each question, blacken the corresponding space on the answer sheet using a #2 pencil. If you decide to change an answer, erase the unwanted mark very carefully, and remark the correct space. There is only one correct answer to each question. Any questions for which more than one response is given will not be counted.

Your score will be based on the number of correctly answered questions. It is to your advantage to answer every question.

- The prefix meaning 1/100 of a unit is:  
a) kilo                      b) centi  
c) deci                      d) milli
- The correct name for the compound  $\text{BaSO}_3$  is:  
a) barium sulfate  
b) barium sulfur trioxide  
c) barium trisulfide  
d) barium sulfite
- Which light in the electromagnetic spectrum has the least energy?  
a) radio waves                      b) infrared radiation  
c) blue light                      d) gamma rays
- How many neutrons does the gold-190 isotope have?  
a) 190                      b) 111  
c) 79                      d) 145
- How many significant figures does 0.05320 and 100100 have, respectively?  
a) 3, 6                      b) 6, 6  
c) 5, 4                      d) 4, 4
- 300 mL of an unknown liquid weighs 93 grams. What is the density of this liquid?  
a) 0.98 g/mL                      b) 0.31 g/mL  
c) 0.01 g/mL                      d) 3.1 g/mL
- The sum of the coefficients for the reaction:  
 $\text{Al}_4\text{C}_3 + \text{HCl} \rightarrow \text{AlCl}_3 + \text{CH}_4$   
when using whole numbers is:  
a) 7                      b) 13                      c) 20                      d) 23
- What is the oxidation state of Sn in  $\text{SnO}_2$ ?  
a) +2                      b) +4  
c) -4                      d) -2
- If I weigh 205 pounds, what is my weight in kilograms? (454 g = 1 lb. or 2.2 lb = 1 kg)  
a) 0.444                      b) 93.2  
c) 93100                      d) 451
- An ionic bond is a bond in which  
a) both atoms in the bond share the electrons equally  
b) One atom has less of the electron density than the other atom involved in the bond.  
c) one atom donated both electrons to form a bond  
d) one atom gives up an electron completely and the other atom accepts the electron
- Which of the following statements are correct for chemical reactions?  
(I) The sum of the reactant atoms equals the sum of the product atoms  
(II) For endothermic reactions the sum of the energy of the reactant moles equals the sum of the energy of the product moles  
(III) The sum of the mass of the reactants equals the sum of the mass of the products  
(IV) A chemical reaction may require or release heat, depending on the reactants and products  
a) I and III only                      b) I, III and IV only  
c) I, II and III only                      d) II, III and IV only
- How many moles of Argon are present in a 0.5 L container at 327°C and 1.5 atm?  
a) 66.3                      b) 0.015  
c) 0.028                      d) 36.0
- What is the normal boiling point and freezing point of water?  
a) 32°C, 100°C                      b) 32°C, 0°C  
c) 100°C, 0°C                      d) 0°C, 100°C

14. The oxygen ion ( $O^{2-}$ ) has
- gained 1 electron
  - lost 1 electron
  - gained 2 electrons
  - lost 2 electrons
15. What is the valence shell electron configuration of Copper?
- $3d^9$
  - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^9$
  - $4s^2$
  - $4s^2 3d^9$
16. How many molecules are present in 10 moles of  $C_2H_4$ ?
- $1.57 \times 10^{25}$
  - $6.02 \times 10^{23}$
  - $6.02 \times 10^{24}$
  - 10.0
17. A chemical reaction in which two complex molecules react to form a new molecule is called
- $$CuO + H_2O \rightarrow Cu(OH)_2$$
- combination or synthesis reaction
  - decomposition reaction
  - combustion reaction
  - single replacement
18. A beaker is divided into two compartments by a semi permeable membrane. Compartment A contains a 5% sucrose solution. Compartment B contains a 10% sucrose solution. Which of the following statements is true?
- water will move from A to B
  - water will move from B to A
  - sucrose will move from A to B
  - sucrose will move from B to A
19. Which of the following statements about gases is false?
- The Gases' kinetic energy is directly proportional to the temperature.
  - Gases may contain molecules
  - The molecules of gases are always moving
  - Gases do not fill the container in which they are present.
20. Which represents the elements with the valence-shell ground-state electron configuration  $ns^2 np^4$ ?
- a) 
- b) 
- c) 
- d) 
21. The species below which violates the octet rule is
- $CF_4$
  - $BF_3$
  - $SiF_4$
  - $NF_3$
22. Which one of the following is a very strong acid?
- $HC_2H_3O_2$
  - NaCl
  - HCl
  - KOH
23. What is produced in a neutralization reaction between an acid and a base?
- precipitate
  - acid
  - salt
  - liquid
24. Which branch of chemistry deals with the study of matter that is derived from living or once living things?
- inorganic
  - biochemistry
  - physical
  - organic
25. Which of the following is a colligative property of solutions?
- pressure
  - distillation
  - freezing point
  - density
26. Identify the reactants and the products in the chemical equation.
- $$H_2SO_4 + Ba(OH)_2 \rightarrow BaSO_4 + 2 H_2O$$
- | REACTANTS                   | PRODUCTS                 |
|-----------------------------|--------------------------|
| a) $H_2SO_4$ and $2 H_2O$   | $Ba(OH)_2$ and $BaSO_4$  |
| b) $Ba(OH)_2$ and $BaSO_4$  | $H_2SO_4$ and $2 H_2O$   |
| c) $BaSO_4$ and $2 H_2O$    | $H_2SO_4$ and $Ba(OH)_2$ |
| d) $H_2SO_4$ and $Ba(OH)_2$ | $BaSO_4$ and $2 H_2O$    |

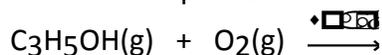


27. A Manometer is a device used to measure pressure. In the diagram to the right, the pressure of the gas inside the bulb is
- greater than atmospheric pressure
  - less than atmospheric pressure
  - the same as atmospheric pressure
  - can not determine the pressure
28. A chemical reaction that absorbs heat from the surroundings is said to be \_\_\_\_\_ and has a \_\_\_\_\_ value of  $\Delta H$ .
- endothermic, positive
  - endothermic, negative
  - exothermic, positive
  - exothermic, negative
29. Which of the following methods is the best for separating salt from sea water?
- filtration
  - distillation
  - chromatography
  - centrifugation
30. How many grams does 50 moles of water weigh?
- 18
  - 0.36
  - 900
  - 50
31. Gold has a melting point of  $1063^{\circ}\text{C}$  and a boiling point of  $2966^{\circ}\text{C}$ . What physical state will gold be present in at  $2000^{\circ}\text{C}$ ?
- gas
  - Liquid
  - solid
  - plasma
32. What class of organic compound is the following:
- $$\begin{array}{c} \text{O} \\ || \\ \text{H}-\text{C}-\text{OH} \end{array}$$
- aldehyde
  - ketone
  - carboxylic acid
  - ester
33. An ideal gas is at a pressure of 2.5 atm in a 2.0 L container if the pressure is changed to 380 torr, assuming the temperature of the gas remains constant, will the volume of the gas
- increase
  - decrease
  - remain the same
  - unknown, can not solve the problem
34. Which of the following processes requires that energy is added as heat?
- fusion
  - vaporization
  - freezing
  - Condensation
35. Reno, Nevada is about 4500 feet above sea level, if the Barometric pressure is 680 torr, at what temperature will water boil?
- at  $0^{\circ}\text{C}$
  - at  $100^{\circ}\text{C}$
  - below  $100^{\circ}\text{C}$
  - above  $100^{\circ}\text{C}$
36. A Bronsted-Lowry base is defined as a substance, which
- increases  $[\text{H}^+]$  when placed in water
  - increase  $[\text{OH}^-]$  when placed in water
  - acts as a proton acceptor in any system
  - acts as a proton donor in any system
37. Which one of the following substances would be the most soluble in  $\text{CCl}_4$ ?
- $\text{CH}_3\text{CH}_2\text{CH}_3$
  - $\text{H}_2\text{O}$
  - $\text{NH}_3$
  - $\text{NaCl}$
38. Which of the following is **not** a postulate of the kinetic molecular theory?
- The average kinetic energy of the particles is directly proportional to the absolute temperature.
  - The moving particles in a gas undergo perfectly elastic collisions with the walls of the container.
  - The forces of attraction and repulsion between the particles are insignificant
  - Gas particles have most of their mass concentrated in the nucleus of the atom.
  - The volume of the gas molecule is considered to be insignificant compared to the volume between the molecules.

39. If a light bulb in a conductivity apparatus glows brightly when testing a solution, which of the following is true?
- The solution is highly ionized.
  - The solution is slightly ionized.
  - The solution is highly reactive.
  - The solution is slightly reactive.
  - none of the above

40. What is the hydrogen ion concentration in a saliva specimen that registers a pH of 6 on a strip of pH paper?
- 0.6 M
  - 0.000 01 M
  - 0.000 06 M
  - 0.000 001 M
  - 0.000 006 M

41. Complete the following chemical reaction and indicate the products.



- C + H<sub>2</sub>O
- CO + H<sub>2</sub>
- CO + H<sub>2</sub>O
- CO<sub>2</sub> + H<sub>2</sub>
- CO<sub>2</sub> + H<sub>2</sub>O

42. Which of the following is the electron dot formula for an atom of oxygen?

- $\text{O} \cdot$
- $\text{O} \cdot \cdot$
- $\cdot \text{O} \cdot$
- $\cdot \text{O} \cdot \cdot$
- $\cdot \text{O} \cdot \cdot$

43. An oxide of iron contains 69.9% iron. What percent by mass of oxygen does this compound contain?

- 69.9 %
- 30.1 %
- 45.6 %
- 16.0 %
- not enough information to calculate

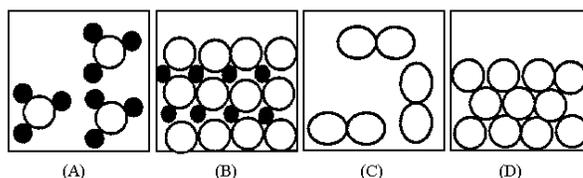
44. Which of the following radioactive atoms would be expected to most readily substitute for calcium in bone?

- potassium – 40
- strontium – 90
- iodine – 131
- cesium – 133
- uranium – 238

45. A catalyst increases the rate of a chemical reaction by providing a lower-energy mechanism for the reaction. When this occurs, which one of the following is not affected?

- activation energy for the forward reaction
- activation energy for the reverse reaction
- equilibrium constant
- rate of the reverse reaction

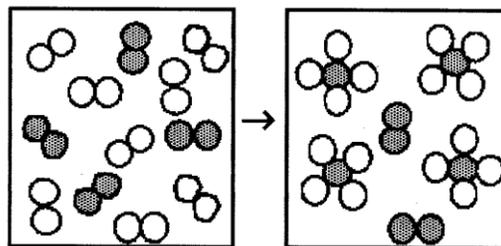
46. Which of the following pictures best represents a solid ionic compound?



47. What is the difference between a scientific hypothesis and a natural law?

- A hypothesis is a tentative proposal and a law is a tested proposal.
- A law is a tentative proposal and a hypothesis is a tested proposal.
- A hypothesis explains behavior and a law states a measurable relationship.
- A law explains behavior and a hypothesis states a measurable relationship.
- none of the above

48. The following diagrams represent the reaction of A<sub>2</sub> (shaded spheres) with B<sub>2</sub> (unshaded spheres). Identify the limiting reagent and write a balanced equation for the reaction.



- A<sub>2</sub> is limiting;  $\text{A} + 4 \text{B} \rightarrow \text{AB}_4$
- A<sub>2</sub> is limiting;  $\text{A}_2 + 4 \text{B}_2 \rightarrow 2 \text{AB}_4$
- B<sub>2</sub> is limiting;  $\text{A} + 4 \text{B} \rightarrow \text{AB}_4$
- B<sub>2</sub> is limiting;  $\text{A}_2 + 4 \text{B}_2 \rightarrow 2 \text{AB}_4$

49. Which one of the following is most polar?

- a)  $\text{H}_2$  (g)                      b)  $\text{CO}_2$  (g)  
c)  $\text{BCl}_3$  (g)                    d)  $\text{CH}_3\text{F}$  (g)

50. What is the chemical formula of a compound that contains 2 Aluminum, 6 Carbons and 12 oxygen atoms?

- a)  $\text{Al}_2\text{3}(\text{C}_2\text{O}_4)$                       b)  $\text{Al}_2(\text{C}_3\text{O}_9)_3$   
c)  $\text{Al}_2(\text{C}_2\text{O}_4)_3$                     d)  $\text{Al}_2(\text{Ca}_6\text{Ox}_{12})_2$

51. As the temperature of a reaction is increased, the rate of the reaction increases because the

- a) reactant molecules collide less frequently  
b) reactant molecules collide more frequently  
c) activation energy is lowered  
d) reactant molecules collide more frequently and with greater energy  
e) reactant molecules collide less frequently and with less energy

52. To make a 2.00 M solution, one could take 2.00 moles of solute and add

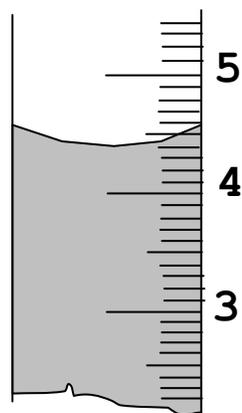
- a) 1.00 L of solvent  
b) 1.00 kg of solvent  
c) enough solvent to make 1.00 L of solution  
d) enough solvent to make 1.00 kg of solution.

53. The radioisotope Tc-99m has a half-life of 6 hours. If a patient is given 100 mg to determine a possible liver and gall bladder problem, how much Tc-99m will remain in the patient after 36 hours?

- a) 0.5 mg                              b) 1.6 mg  
c) 12.5 mg                            d) 100 mg

54. If X (not on the periodic table) reacts with fluorine to form an ionic compound with the formula  $\text{XF}_2$ , then X will react with O to form

- a)  $\text{XO}_2$                                 b)  $\text{XO}$   
c)  $\text{X}_2\text{O}_3$                               d)  $\text{X}_3\text{O}_2$

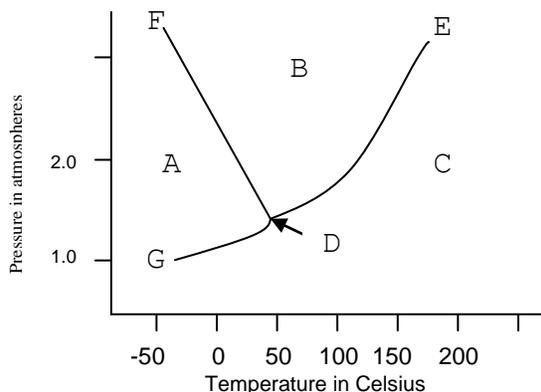


55. What is the volume of the aqueous solution in the buret shown in the figure below?

- a) 4.4 mL                              b) 5.40 mL  
c) 4.6 mL                              d) 4.40 mL  
e) 5.60 mL

56. Which of the following reactions is a reduction-oxidation (REDOX) reaction?

- a)  $2 \text{KClO}_3 \rightarrow 2 \text{KCl} + 3 \text{O}_2$   
b)  $2 \text{HCl} + \text{Na}_2\text{CO}_3 \rightarrow 2 \text{NaCl} + \text{CO}_2 + \text{H}_2\text{O}$   
c)  $3 \text{CaCl}_2 + 2 \text{Na}_3\text{PO}_4 \rightarrow \text{Ca}_3(\text{PO}_4)_2 + 6 \text{NaCl}$   
d)  $2 \text{Fe}_2\text{S}_3 + 3 \text{CO}_2 \rightarrow 2 \text{Fe}_2\text{O}_3 + 3 \text{CS}_2$



57. What phase changes occur when the temperature is held constant at  $25^\circ\text{C}$  and the pressure is increased from 0.5 atm to 3 atm?

- a) gas to liquid to solid  
b) gas to solid to liquid  
c) liquid to solid to gas  
d) solid to liquid to vapor

58. Which of the following statements is not true?
- a) the reverse of a spontaneous reaction is always nonspontaneous.
  - b) A spontaneous process always moves toward equilibrium
  - c) A non spontaneous process cannot be caused to occur.
  - d) A highly spontaneous process need not occur rapidly.

59. Using the VSEPR model, what is the molecular shape of the  $\text{CS}_2$  molecule?
- a) linear
  - b) bent
  - c) tetrahedral
  - d) trigonal planar

60. What would the change in temperature be if a 25 g cube of aluminum absorbs 350 J of heat?
- a) 14.0
  - b) 12.6
  - c) 15.5
  - d) 22.6

**Specific Heat**

$\text{Al}_{(s)}$  0.902 J/g, °C

Complete the Tie Breaker on a separate sheet.

**END OF TEST**

