CHEM 101: GENERAL CHEMISTRY
TEST #3 FALL 2009

November 13, 2009
KEY ID A

NAME: ___________ KEY A

You will have 55 minutes to complete the test. Follow the instructions carefully:
- The answers to the multiple choice questions must be filled out on the answer sheet provided using a #2 pencil.
Write your name on this test AND on the answer sheet. Indicate the test KEY ID in the KEY ID box on the answer sheet. You will lose 2 points for failing to do these items.
- You may use a calculator, but no books, notes or other information may be used.
- A periodic table and table of atomic masses is available.
- You may write on this test.
- Turn in both test and MC sheet.
- Below are some useful relationships—not all will be used.

\[ T_K = T_C + 273.15 \]

\[ T_F = T_C \left( \frac{9}{5} \right) + 32 \]

\[ D = \frac{m}{V} \]

1 amu = 1.66054 \times 10^{-27} \text{ kg} \]

\[ N_A = 6.022 \times 10^{23} \text{ mol}^{-1} \]

1 ft = 12 in* \]

\[ 1 \text{ in} = 2.54 \text{ cm}^* \]

1 yd = 3 ft* \]

\[ 39.4 \text{ in} = 1 \text{ m} \]

1 mile = 5280 feet* \]

\[ 1 \text{ mL} = 1 \text{ cm}^3* \]

1 lb = 16 oz* \]

\[ 1 \text{ cal} = 4.184 \text{ J}^* \]

1 atm = 760 torr (mm Hg) = 101.325 kPa*

\[ R = 8.314 \frac{\text{kPa} \cdot \text{L}}{\text{mol} \cdot \text{K}} = 0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \]

\[ \frac{PV_1}{T_1} = \frac{PV_2}{T_2} = \frac{P_2V_2}{T_2} \]

1 mole (STP) = 22.4 L

\[ PV = nRT \]

\[ \frac{PV_1}{T_1} = \frac{PV_2}{T_2} \]

\[ q = ms\Delta T \]

- Please do not remove this page from the test.

Total Points (2.5 x # correct) ___________
Review Sheet ___________
Grade ___________ %
7. How much energy in J is required to heat 25.0 g of water a 0.0°C to 25.0°C, if the specific heat of water is 4.184 J/g°C?
A) 25 × 4.184 = 105 J
B) 25 × 4.184 × 25 = 2.610 × 10^3 J
C) (25 + 25) × 4.184 = 209 J
D) 25 × 25 + 4.184 = 149 J

8. 37.1 calories are required to heat a 35.0-g sample of metal from 25°C to 35°C. What is the specific heat of this metal?
A) 37.1 + (35.0 × 10.0) = 0.106 cal/g°C
B) 37.1 + (35.0 + 25.0) = 0.424 cal/g°C
C) 37.1 + (35.0 + 10.0) = 0.824 cal/g°C
D) 37.1 × 35.0 × 10.0 = 1.30 × 10^4 cal/g°C

9. Which of the following is not a major source of fuel for energy in the U.S.?
A) petroleum
B) coal
C) wood
D) natural gas

10. For a reaction to occur:
A) molecules must collide with each other.
B) molecular collisions need to break chemical bonds.
C) new bonds have to form to make products.
D) all of the above.

11. In an endothermic reaction, energy can be considered to be:
A) given off by the reaction.
B) a product of the reaction.
C) not involved in the reaction.
D) a reactant in the reaction.

12. Based on the following reaction, which statement is true?
2H₂O(l) + 137 kcal → 2H₂(g) + O₂(g)
A) 137 kcal are consumed when 2.00 g of H₂ reacts.
B) 137 kcal are consumed when 1.00 g of H₂O reacts.
C) 137 kcal are consumed when 1.00 mol of H₂O reacts.
D) 137 kcal are consumed when 1.00 mol of O₂ is produced.

(more on next page)
17. A burn from steam at 100°C is expected to be more severe than a burn from boiling water at 100°C because
   A) the steam is hotter than the boiling water.
   B) there is more steam than water.
   C) the steam will give off a large amount of heat as it condenses.
   D) you are more likely to come into contact with the steam than with the boiling water.

18. The main interactions between molecules of hydrogen, H₂, are examples of
   A) covalent bonds.
   B) hydrogen bonds.
   C) dipole-dipole interactions.
   D) dispersion forces.

19. In a gas, the distance between the particles is
   A) very close relative to the size of the molecules.
   B) close relative to the size of the molecules.
   C) small relative to the size of the molecules.
   D) very large relative to the size of the molecules.

20. Which of the following has the weakest intermolecular forces?
   A) H₂O
   B) CH₂Cl₂
   C) :C=O:
   D) Ar

21. Ethane (C₂H₆) is a gas at room temperature while decane (C₁₀H₂₂) is a liquid at room temperature. This is because ethane has:
   A) smaller dispersion forces.
   B) smaller dipole-dipole forces.
   C) no hydrogen bonding while decane does.
   D) covalent bonds in the molecule.

22. Propanol (C₃H₇OH, b.p. 91°C) and butane (C₄H₁₀, b.p. 0.5°C) are about the same size molecules. The large difference in boiling point is due to:
   A) dispersion forces
   B) dipole-dipole forces
   C) hydrogen bonding
   D) ionic bonds

(more on next page)
23. Which of the following picture most accurately illustrates hydrogen bonding?

A)  
\[ \begin{array}{c}
\text{H} \\
\text{C} \quad \text{H} \\
\text{H} \\
\end{array} \]

B)  
\[ \begin{array}{c}
\text{H} \\
\text{O} \\
\text{H} \\
\end{array} \]

C)  
\[ \begin{array}{c}
\text{H} \\
\text{C} \quad \text{H} \\
\text{O} \\
\end{array} \]

D)  
\[ \begin{array}{c}
\text{H} \\
\text{C} \quad \text{Cl} \\
\text{H} \\
\end{array} \]

24. When a solid is converted directly to a gas, the change of state is called
   A) freezing.  
   B) melting.  
   C) condensation.  
   D) sublimation.

25. Which transformation is called condensation?
   A) gas → solid  
   B) solid → liquid  
   C) gas → liquid  
   D) liquid → solid

26. Boiling water to evaporation is a(n) ___ process.
   A) endothermic  
   B) exothermic  
   C) energy neutral  
   D) oxidation

27. 1-butanethiol, one of the compounds giving skunks their distinctive odor, freezes at -115.7°C and boils at 98.5°C. What is its phase at 37°C, the normal body temperature of humans?
   A) solid  
   B) liquid  
   C) gas  
   D) a mixture of solid and liquid

28. The term *abad*, as used in Genesis 2:15, refers to
   A) serve and keep  
   B) till, dress, and serve  
   C) keeping the creation as God keeps us  
   D) enjoy, but not destroy creation

29. Which of the following does not characterize the ideal gas law?
   A) based on experiments  
   B) summarizes observed behavior  
   C) relates the bulk properties of a gas  
   D) explains gases in terms of the motions of particles

30. Temperature is a measure of
   A) the energies of motion of the molecules  
   B) the number of molecules in a gas  
   C) the strength of intermolecular forces  
   D) the rate of collisions between the molecules and the walls of the container

31. The *normal boiling point* is defined as
   A) the temperature at which the vapor pressure of a liquid equals 1 atm.  
   B) the pressure at which any liquid boils at 273.15 K.  
   C) the temperature at which water always boils.  
   D) the pressure of a gas when its temperature reaches 373.15 K.

(more on next page)
CHEM 101: GENERAL CHEMISTRY
TEST #3  FALL 2009

32. Under which of the following conditions could you use the equation:

\[
\frac{P_1}{T_1} = \frac{P_2}{T_2}
\]

A) A gas is compressed at constant T.
B) A latex balloon of helium is moved from boiling water to liquid nitrogen.
C) Methane and oxygen react inside a sealed vessel of volume \( V' \).
D) A weather balloon rises through the atmosphere.

33. Consider a cylinder fitted with a movable piston. The initial pressure inside the cylinder is \( P_i \) and the initial volume is \( V_i \). What is the new pressure in the system when the piston decreases the volume of the cylinder by half (\( V' = (1/2)V_i \))?

A) \( 2P_i \)
B) \( 2V_i/P_i \)
C) \( (1/2)V_i \)
D) \( P_i \)

34. A pressure of 314 mm Hg corresponds to:

A) 3.09 atm
B) 2.42 atm
C) 41.8 atm
D) 0.413 atm

35. The boiling point of water at sea level is 100°C. At higher altitudes, the boiling point of water will be

A) lower, because temperatures are lower.
B) lower, because the atmospheric pressure is lower.
C) higher, because the altitude is greater.
D) the same, because water always boils at 100°C.

36. The temperature of a 500. mL sample of gas increases from 150 K to 350 K. What is the final volume of the sample of gas, if the pressure in the container is kept constant?

A) \( 500 \text{ mL} \times \frac{150 \text{ K}}{350 \text{ K}} = 210 \text{ mL} \)
B) \( 500 \text{ mL} \times \frac{350 \text{ K}}{150 \text{ K}} = 1170 \text{ mL} \)
C) \( \frac{500 \text{ mL}}{350 \text{ K} + 150 \text{ K}} = 1 \text{ L} \)
D) \( 350 \text{ mL} \times \frac{150 \text{ K}}{500 \text{ K}} = 105 \text{ mL} \)

37. At 570. mm Hg and 25°C, a gas sample has a volume of 2270 mL. What is the final pressure (in mm Hg) at a volume of 1250 mL and a temperature of 75°C?

A) 1560 mm Hg
B) 210. mm Hg
C) 690. mm Hg
D) 470. mm Hg

A balloon is filled with helium gas as shown below, in a room at atmospheric pressure and room temperature. For the question(s) that follow, select the letter of the balloon diagram that corresponds to the given change in conditions.

38. The balloon is put into a chamber whose pressure is greater than the atmospheric pressure while it remains at room temperature.

A) A
B) B
C) C
D) cannot determine

39. For the balloon above, the temperature is changed from +50°C to +150°C while the pressure is decreased.

A) A
B) B
C) C
D) cannot determine

(more on next page)
40. Nitrogen contributes 0.78 atm to the pressure of atmospheric air. This value corresponds to the:
   A) atmospheric pressure of $N_2$,
   B) partial pressure of $N_2$,
   C) vapor pressure of $N_2$,
   D) ideal pressure of $N_2$.

41. The volume of 2.50 moles of propane ($C_3H_8$) at STP is:
   A) 22.4 L
   B) 56.0 L
   C) 61.1 L
   D) 24.5 L

---

Postscript

A small piece of ice which lived in a test tube fell in love with a Bunsen burner. "Bunsen! My flame! I melt whenever I see you" said the ice. The Bunsen burner replied: "It's just a phase you're going through".

Did you hear about the chemist who was reading a book about Helium? He just couldn't put it down.