AP CHEMISTRY 2016 TAKE HOME GAS LAWS EXAM OPEN BOOK/OPEN NOTE 75 POINTS

Directions: Set a timer and limit yourself to one *continuous* 90-minute time interval. You may consult your textbook and your notes. Please do not discuss the exam with any other people in person or via the use of electronic sources. The internet *cannot* be used for this exam.

MULTIPLE CHOICE 25 questions (three points each)

Choose the lettered response that *best* answers the following questions. Write your answer choice in the appropriately numbered space on your scantron form.

1. What will be the μ(rms) speed of water molecules at 95° C?

A) 71 m/s
B) 500 m/s
C) 713 m/s
D) 363 m/s
E) 2257 m/s

2. For which of the following changes is it not clear whether the volume of a particular sample of an ideal gas will increase or decrease?

A) increase the temperature and decrease the pressure
B) increase the temperature and keep the pressure constant
C) keep temperature constant and decrease the pressure
D) increase the temperature and increase the pressure
E) decrease the temperature and increase the pressure

3. Of the following, only _____ is impossible for an *ideal* gas.

A) $V_1T_1 = V_2T_2$
B) $V_1/T_1 = V_2/T_2$
C) $V_1/V_2 = T_1/T_2$
D) $V_2 = T_2/T_1\ (V_1)$
E) $V_1/V_2 = T_1/T_2 = 0$

4. The volume of an ideal gas is theoretically zero at_____.

A) 0° C
B) –45° F
C) –273 K
D) –273° C
E) –363 K

5. Which statement about atmospheric pressure is false?

A) The warmer the air, the higher the atmospheric pressure.
B) As air becomes thinner, its density decreases.
C) Air actually has weight.
D) With an increase in altitude, atmospheric pressure decreases as well.
E) Atmospheric pressure prevents water in lakes, rivers, and oceans from boiling away.

6. In a Torricelli barometer, a pressure of one atmosphere supports a 760 mm column of mercury. If the original tube containing the mercury is replaced with a tube having five times the diameter of the original, what will the height of the mercury column be at one atmosphere of pressure?

A) 152 mm
B) 1.90×10^2 mm
C) 760 mm
D) 121 mm
E) 3.80×10^3 mm

7. An open-end manometer filled with a liquid with a density of _____ g/mL will exhibit the smallest height difference for a given pressure.

A) 0.00234
B) 2.29
C) 18.2
D) 13.6
E) 0.0918

8. *Molecular* compounds of low molecular weight tend to be gases at room temperature. Which of the following is most likely not a gas at room temperature?

A) Cl_2
B) NaCl
C) HCl
D) H_2
E) CH_4

9. One significant difference between gases and solids is that _____.

A) a gas is made up of molecules or atoms
B) a gas assumes the volume of its container
C) a gas may consist of both elements and compounds
D) gases can exist as mixtures
E) All of the above answers are always correct.

Questions 10 and 11 refer to the same sample of gas.

10. A sample of air occupies 3.8 L when the pressure is 1.2 atm. What volume does it occupy at 6.6 atm?

A) 0.96 L
B) 0.69 L
C) 4.5 L
D) 3.14 L
E) 22.41 L

11. What pressure is required in order to compress the gas to 0.075 L?

A) 45 atm
B) 22.41 atm
C) 61 atm
D) 14.71 atm
E) 16 atm

12. Dry ice is solid carbon dioxide. A 0.050 gram sample of dry ice is placed in an evacuated 4.6 L chamber (complete vacuum) at 30.0° C and sealed. Calculate the pressure inside the vessel after all of the dry ice has been converted to CO_2 gas (sublimation).

A) 0.006 atm
B) 0.060 atm
C) 0.003 atm
D) 0.030 atm
E) 0.045 atm

Questions 13 and 14 refer to the combustion of ethanol in air.

13. Properly balance the equation for the combustion of ethanol (C_2H_5OH)

A) $C_2H_5OH\ (l) + 3\ O_2\ (g) \rightarrow 2\ CO_2\ (g) + 3\ H_2O\ (g)$
B) $2\ C_2H_5OH\ (l) + 6\ O_2\ (g) \rightarrow 4\ CO_2\ (g) + 6\ H_2O\ (g)$
C) $C_2H_5OH\ (l) + 5\ O_2\ (g) \rightarrow 2\ CO_2\ (g) + 6\ H_2O\ (g)$
D) $3\ C_2H_5OH\ (l) + 9\ O_2\ (g) \rightarrow 6\ CO_2\ (g) + 4\ H_2O\ (g)$
E) $C_2H_5OH\ (l) + 3\ O_2\ (g) \rightarrow 2\ CO_2\ (g) + 4\ H_2O\ (g)$

14. Determine the volume of air in liters at 35.0° C and 790 mm of Hg required to burn 227 grams of ethanol. (Assume the air is 21.0 percent oxygen by volume).

A) 1600 L
B) 2100 L
C) 1700 L
D) 2500 L
E) 1200 L

Questions 15 and 16 refer to the following lab scenario. A volume of a pure sample of HCl *gas* was 289. mL at 25°C and 208 mmHg. The HCl gas was completely dissolved in 70.0 mL of water and titrated with NaOH solution.

15. What would be the resulting molarity of HCl?

A) 0.05432 M
B) 0.0329 M
C) 0.986 M
D) 0.0462 M
E) 0.00652 M

16. If 19.43 mL of the NaOH solution were required to neutralize the HCl, what is the molarity of the NaOH solution?

A) 0.234 M
B) 0.00154 M
C) 0.065 M
D) 0. 232 M
E) 0.166 M

Questions 17 and 18 refer to the atmospheric conditions on Mount Everest.

17. At the summit of Mt. Everest, the atmospheric pressure is 200. mmHg and the air density is 0.406 kg/m^3. Calculate the air temperature, in Celsius, given that the molar mass of air is 29.0 g/mol.

A) 2.0 °C
B) 12.0 °C
C) -23 °C
D) -44 °C
E) -79 °F

18. Assuming that the composition of air does not change between sea level and the summit, calculate the percent decrease in oxygen gas from sea level to the top of Everest.

A) 21.4 % decrease
B) 73.7 % decrease
C) 94.2 % decrease
D) 57.1 % decrease
E) 43.4 % decrease

Questions 19 and 20 refer to the same gas sample.

19. Using the data shown in the table marked FIGURE A, calculate the pressure exerted by 2.5 moles of CO_2 gas confined to a volume of 5.00 L at 450 K. (use Van der Waal's eq.)

A) 54 atm
B) 27 atm
C) 29 atm
D) 37 atm
E) 18 atm

20. Calculate the pressure that would be predicted if the gas was an ideal gas.

A) 54 atm
B) 27 atm
C) 29 atm
D) 37 atm
E) 18 atm

Questions 21 - 23 refer to the following scenario:

Nitrogen monoxide (NO) reacts with molecular oxygen as follows: $2NO\ (g) + O_2\ (g) \rightarrow 2NO_2\ (g)$

Initially NO and O_2 are separated as shown in the diagram labeled FIGURE B. When the valve is opened, the reaction quickly goes to completion. Assume the gases remain at 25°C before *and* after the reaction.

21. Determine what gases remain at the end of the reaction.

A) NO, NO_2 and O_2 remain
B) only NO_2 and O_2 remain
C) only NO and O_2 remain
D) only NO_2 remains
E) only NO and NO_2 remain

22. Calculate the moles of gases that remain at the end of the reaction.

A) 0.0610 mol of NO_2 and 0.0170 mol NO remain
B) 0.0730 mol of NO_2 and 0.0513 mol O_2 remain
C) 0.0370 mol of NO_2 and 0.0130 mol O_2 remain
D) 0.0970 mol of NO_2 and 0.0230 mol NO remain
E) 0.0570 mol of NO_2 and 0.0430 mol O_2 remain

23. Calculate the partial pressures of all gases that remain after the reaction is complete.

A) 0.397 atm NO_2 and 0.411 atm O_2
B) 0.294 atm NO_2 and 0.221 atm NO
C) 0.294 atm NO_2 and 0.221 atm O_2
D) 0.397 atm NO_2 and 0.411 atm NO
E) 0.194 atm NO_2, 0.221 atm O_2 and 0.231 atm NO

24. If effusion was used to separate a mixture of butane (C_4H_{10}) and isopentane (C_5H_{12}), how many times faster would the butane separate from the mixture?

A) 2.22 x faster
B) 7.77 x faster
C) 4.44 x faster
D) 3.33 x faster
E) 1.11 x faster

25. A sample of zinc metal reacts completely with an excess of hydrochloric acid according to the following rxn:

$$Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2\,(aq)} + H_{2\,(g)}$$

The hydrogen gas produced is collected over water at 25.0° C. The volume of the gas is 7.80 L, and the pressure is 0.980 atm. Calculate the amount of grams of zinc metal consumed in the reaction
(Vapor pressure of water at 25.0° C = 23.8 mm of Hg).

A) 21.5 g
B) 9.84 g
C) 14.2 g
D) 23.7 g
E) 19.8 g

FIGURE A

GAS	a = $\frac{(atm)(L)^2}{(mol)^2}$	b = L/mol
He	0.034	0.0237
Ne	0.211	0.0171
Ar	1.34	0.0322
Kr	2.32	0.0398
Xe	4.19	0.0266
H_2	0.244	0.0266
N_2	1.39	0.0391
O_2	1.36	0.0318
Cl_2	6.49	0.0562
CO_2	3.59	0.0427
CH_4	2.25	0.0428
CCl_4	20.4	0.138
NH_3	4.17	0.0371
H_2O	5.46	0.0305

FIGURE B