AP Chemistry: Practice Test, Ch. 5. – Gases

Name_____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) According to kinetic–molecular theory, in which of the following gases will the root–mean–square speed of the molecules be the highest at 200°C?

A) SF_6

B) H_2O

C) HCl

D) Cl_2

E) None. The molecules of all gases have the same root–mean–square speed at any given temperature.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

2) What two properties of real gases cause deviation from ideal behavior?

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

3) A sample of a gas (5.0 mol) at 1.0 atm is expanded at constant temperature from 10 L to 15 L. The final pressure is _____ atm.

A) 1.5 B) 15 C) 0.67 D) 3.3 E) 7.5

4) A sample of He gas (2.35 mol) occupies 57.9 L at 300.0 K and 1.00 atm. The volume of this sample is _____ L at 423 K and 1.00 atm.

A) 0.709 B) 57.9 C) 41.1 D) 81.6 E) 1.41

5) The density of N_2O at 1.53 atm and 45.2°C is _____ g/L.

A) 0.388 B) 2.58 C) 9.99 D) 1.76 E) 18.2

6) The volume of a sample of gas (2.49 g) was 752 mL at 1.98 atm and 62°C. The gas is _____.

A) NO_2 B) SO_3 C) SO_2 D) Ne E) NH_3

7) What volume (mL) of sulfur dioxide can be produced by the complete reaction of 3.82 g of calcium sulfite with excess HCl (aq), when the final SO_2 pressure is 827 torr at 44°C?

A) 1.39×10^{-4} B) 0.106 C) 1.00×10^{-3} D) 761 E) 578

8) The Mond process produces pure nickel metal via the thermal decomposition of nickel tetracarbonyl:

$$Ni(CO)_4\,(l) \rightarrow Ni\,(s) + 4CO\,(g).$$

What volume (L) of CO is formed from the complete decomposition of 444 g of $Ni(CO)_4$ at 752 torr and 22°C?

A) 255 B) 20.2 C) 63.7 D) 11.0 E) 0.356

9) A 255 mL round–bottom flask is weighed and found to have a mass of 114.85 g. A few milliliters of an easily vaporized liquid are added to the flask and the flask is immersed in a boiling water bath. All of the liquid vaporizes at the boiling temperature of water, filling the flask with vapor. When all of the liquid has vaporized, the flask is removed from the bath, cooled, dried, and reweighed. The new mass of the flask and the condensed vapor is 115.23 g. Which of the following compounds could the liquid be? (Assume the ambient pressure is 1 atm.)

A) C_2H_5OH B) C_4H_{10} C) C_2H_6 D) C_4H_9OH E) C_3H_7OH

10) The pressure in a 12.2 L vessel that contains 2.34 g of carbon dioxide, 1.73 g of sulfur dioxide, and 3.33 g of argon, all at 42°C is _____ mmHg.

A) 116 B) 395 C) 134 D) 263 E) 0.347

11) Sodium hydride reacts with excess water to produce aqueous sodium hydroxide and hydrogen gas:

$$NaH\ (s)\ +\ H_2O\ (l)\ \rightarrow\ NaOH\ (aq)\ +\ H_2\ (g)$$

A sample of NaH weighing _____ g will produce 982 mL of gas at 28°C and 765 torr, when the hydrogen is collected over water. The vapor pressure of water at this temperature is 28 torr.

A) 0.960 B) 925 C) 0.0388 D) 2.93 E) 0.925

12) SO_2 (5.0 g) and CO_2 (5.0 g) are placed in a 750 mL container at 50°C. The partial pressure of SO_2 in the container was _____ atm.

A) 1.60 B) 2.76 C) 4.02 D) 0.192 E) 6.78

13) At 333 K, which of the pairs of gases below would have the most nearly identical rates of effusion?

A) CO and CO_2

B) CO and N_2

C) NO_2 and N_2O_4

D) N_2O and NO_2

E) N_2 and O_2

14) A sample of oxygen gas was found to effuse at a rate equal to two times that of an unknown gas. The molecular weight of the unknown gas is _____ g/mol.

A) 128 B) 8.0 C) 8 D) 16 E) 64

15) Arrange the following gases in order of increasing average molecular speed at 25°C.

$$Cl_2,\ O_2,\ F_2,\ N_2$$

A) $Cl_2 < O_2 < F_2 < N_2$

B) $N_2 < F_2 < Cl_2 < O_2$

C) $Cl_2 < F_2 < O_2 < N_2$

D) $F_2 < O_2 < N_2 < Cl_2$

E) $Cl_2 < F_2 < N_2 < O_2$

16) Zinc reacts with aqueous sulfuric acid to form hydrogen gas:

$$Zn\ (s) + H_2SO_4\ (aq) \rightarrow ZnSO_4\ (aq) + H_2\ (g)$$

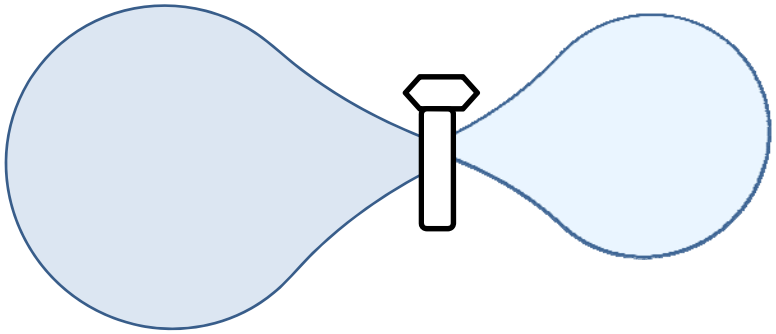
In an experiment, 201 mL of wet H_2 is collected over water at 27°C and a barometric pressure of 733 torr. The vapor pressure of water at 27°C is 26.74 torr. The partial pressure of hydrogen in this experiment is _____ atm.

A) 0.929 B) 760 C) 706 D) 1.00 E) 0.964

17) A sample of He gas (3.0 L) at 5.6 atm and 25°C was combined with 4.5 L of Ne gas at 3.6 atm and 25°C at constant temperature in a 9.0 L flask. The total pressure in the flask was _____ atm. Assume the initial pressure in the flask was 0.00 atm.

A) 24 B) 2.6 C) 9.2 D) 1.0 E) 3.7

18. Consider the flasks in the following diagram.
    (a) What are the final partial pressures of He and Ar after the stopcock between the two flasks is opened? (Assume that the final volume is 4.00 L.)
    (b) What is the total pressure (in torr)?



3.00 L He
632 torr

1.00 L Ar
103 torr

19. Sketch graphs of the following ideal gas relationships for a given sample of gas:
    a. P vs. V (assume constant T)
    b. V vs. T (in K) (assume constant P)
    c. P vs. T (in K) (assume constant V)
    d. Now predict what will happen to the pressure of an inflated balloon for which you double the number of moles of gas but do not allow the T or V of the balloon to change

20. Convert a gas pressure of 191 atm to kPa.
21. Convert a gas pressure of 191 mmHg to kPa.
22. Name a common instrument that is used to measure gas pressure.
23. Magnesium metal is reacted with excess HI to produce hydrogen gas. The gas is collected over water.

45.82 ml of the wet hydrogen gas is collected at 30.0 °C. The water level in the eudiometer is equalized with the water in another vessel before the volume of H_2 gas is determined. The atmospheric pressure in the laboratory is 0.972 atm.

$$Mg\,(s) + 2HI\,(aq) \rightarrow H_2(g) + MgI_2\,(aq)$$

    a. What is the vapor pressure of water under these conditions?
    b. What is the partial pressure of H_2 gas (i.e., the pressure of the dry H_2 gas) in the eudiometer?
    c. What mass of Mg metal was consumed in the reaction (assume 100% yield)?

24. Calculate the volume occupied by 15.0 g of ammonia gas at 22.8 °C and 124 kPa.

Answer Key
Testname: CH_05_PRAC_TEST.TST

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) B
ID: chem9b 10.1–112

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

2) In contrast to the assumptions used for ideal gases, real molecules and atoms have finite (not zero) volumes, and they do attract one another.
ID: chem9b 10.1–133

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

3) C
ID: chem9b 10.1–30

4) D
ID: chem9b 10.1–40

5) B
ID: chem9b 10.1–70

6) A
ID: chem9b 10.1–67

7) D
ID: chem9b 10.1–79

8) A
ID: chem9b 10.1–81

9) A
ID: chem9b 10.1–86

10) D
ID: chem9b 10.1–91

11) E
ID: chem9b 10.1–99

12) B
ID: chem9b 10.1–102

13) B
ID: chem9b 10.1–119

14) A
ID: chem9b 10.1–125

15) C
ID: chem9b 10.1–122

16) A
ID: chem9b 10.2–10

17) E
ID: chem9b 10.1–92

AP Chemistry
Ch. 5 Practice Test - GASES

① $u_{rms} = \sqrt{\frac{3RT}{M}}$ so, if we sub in the molar mass for M in each case, the substance with the smallest molar mass will give the largest u_{rms}.

$SF_6 = 32.1 + (6)(19) = 146\ g/mol$ $H_2O = 1+1+16 = 18\ g/mol$ (B)

$HCl = 35.45 + 1.01 = 36.46\ g/mol$ $Cl_2 = 35.45 \times 2 = 70.9\ g/mol$

② 1) the particles of a gas do not, in reality, have zero volume
2) the particles of a gas do not, in reality, have zero attraction/repulsion with regard to other gas particles

③ $P_1 = 1.0\ atm$ $P_2 = ?$
$V_1 = 10\ L$ $V_2 = 15\ L$

$\frac{P_1V_1}{V_2} = P_2 = \frac{(1\ atm)(10\ L)}{15\ L} = 0.7\ atm$ (C)

④ $P_1 = 1.00\ atm = P_2$ $T_2 = 423\ K$
$V_1 = 57.9\ L$ $V_2 = ?$
$T_1 = 300.0\ K$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$V_2 = \frac{V_1T_2}{T_1} = \frac{(57.9\ L)(423\ K)}{300.0\ K} = 81.6\ L$ (D)

⑤ $D = \frac{m}{V}$ assume 1 mol for simplicity

$N+N+O = 28+16 = 44\ g/mol \therefore 1\ mol = 44\ g$

$= \frac{44.0\ g}{17.1\ L} = 2.58\ g/L$ (B)

$17.1\ L = V = \frac{nRT}{P} = \frac{(1.00\ mol)(0.08206\ \frac{L\ atm}{K\ mol})(273 + 45.2\ K)}{1.53\ atm}$

(6) $V = 752\,ml = 0.752\,L$ $R = 0.08206 \frac{L\,atm}{K\,mol}$

$P = 1.98\,atm$

$T = 62 + 273 = 335\,K$ $n = ?$

$PV = nRT$

$$n = \frac{PV}{RT} = \frac{(1.98\,atm)(0.752\,L)}{(0.08206 \frac{L\,atm}{K\,mol})(335\,K)} = 0.0542\,mol$$

$$\text{molar mass} = \frac{\#g}{\#mol} = \frac{2.49\,g}{0.0542\,mol} = 46.09\,g/mol$$ (A)

$NO_2 = 14 + 16 + 16 = 46$

(7) $Ca^{2+}\ SO_3^{2-} \Rightarrow CaSO_3$

$$CaSO_3 + HCl \rightarrow SO_2 + H_2O + CaCl_2$$

*reasoning: carbonates react to give CO_2, H_2O, and a salt. I figured sulfites would do the same thing.

$CaSO_3 + HCl \longrightarrow SO_2 + H_2O + CaCl_2$

$3.82\,g$ (~~excess~~) $\longrightarrow$ $827\,torr$

$44 + 273 = 317\,K$

$V = ?$

n = moles = can be determined via stoichiometry

1 1
40.08
32.07
48
120.15

$$3.82\,g\ CaSO_3 \times \frac{1\,mol\,CaSO_3}{120.15\,g\,CaSO_3} \times \frac{1\,mol\,SO_2}{1\,mol\,CaSO_3} = 0.0318\,mol\,SO_2$$

$PV = nRT$

$$V = \frac{nRT}{P} = \frac{(0.0318\,mol)(0.08206 \frac{L\,atm}{K\,mol})(317\,K)}{1.09\,atm}$$

$827\,torr \times \frac{1\,atm}{760\,torr} = 1.09\,atm$

$$= 0.760\,L \times \frac{1000\,ml}{1\,L} = 760\,ml$$ D

(8) $Ni(CO)_4 \rightarrow Ni + 4CO$

$Ni(CO)_4$: mol ↑ 444g — CO: mol ↓ L → mixture, $PV=nRT$ here since not at STP

$$444\,g\ Ni(CO)_4 \times \frac{1\ mol\ Ni(CO)_4}{170.69\ g\ Ni(CO)_4} \times \frac{4\ mol\ CO}{1\ mol\ Ni(CO)_4} = 10.4\ mol\ CO$$

Ni 58.69
C 12 } ×4
O 16 }
170.69 g / 1 mol

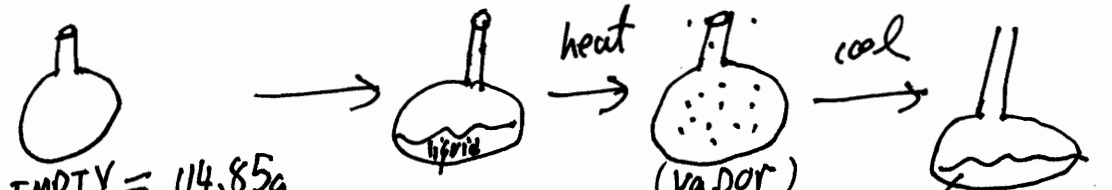
$PV=nRT \Rightarrow V=\frac{nRT}{P} = \frac{(10.4\ mol)(0.08206\ \frac{L\,atm}{K\,mol})(295\ K)}{0.989\ atm}$

22 + 273 = 295 K

$= 254\ L$ (A)

$752\ torr \times \frac{1\ atm}{760\ torr} = 0.989\ atm$

(9)



EMPTY = 114.85g
V = 0.255L

V of vapor = 0.255L

T = 373K = temp of boiling water bath

mass of flask + condensate = 115.23g

$P_{\text{of vapor}}$ when in boiling bath = 1 atm because the flask was open to the air

m of vapor = 115.23 − 114.85 = 0.38g

$PV=nRT \Rightarrow n=\frac{PV}{RT} = \frac{(1.00\ atm)(0.255\ L)}{(0.08206\ \frac{L\,atm}{K\,mol})(373\ K)}$

$= 0.00833\ mol$

molar mass $= \frac{0.38\ g}{0.00833\ mol} = 45.69\ g/mol$

$C_2H_5OH = 24+5+16+1 = 46\ g/mol$ (A)

(10) $PV = nRT \Rightarrow P = \frac{nRT}{V}$

$42 + 273 = 315\ K$

$2.34\ g\ CO_2 \times \frac{1\ mol}{44.0\ g} = 0.0532\ mol\ CO_2$ $\quad 12+16+16 = 44\ g/mol$

$1.73\ g\ SO_2 \times \frac{1\ mol}{64.07\ g} = 0.0270\ mol\ SO_2$ $\quad 32.07+16+16 = 64.07\ g/mol$

$3.33\ g\ Ar \times \frac{1\ mol}{39.95\ g} = 0.0834\ mol\ Ar$

total moles of gas $= 0.0532 + 0.0270 + 0.0834 = 0.164\ mol$

$$P = \frac{(0.164\ mol)\left(0.08206 \frac{L\,atm}{K\,mol}\right)(315\ K)}{12.2\ L} = 0.347\ atm$$

$0.347\ atm \times \frac{760\ mm\ Hg}{1\ atm} = 264\ mm\ Hg$ (D)

(11) $NaH + H_2O \rightarrow NaOH + H_2$

$P_{TOTAL} = P_{H_2O} + P_{H_2}$

$765\ torr = 28\ torr + P_{H_2}$

$737\ torr = P_{H_2} = 737\ torr \times \frac{1\ atm}{760\ torr} = 0.970\ atm$

$P = 0.970\ atm$
$V = 0.982\ L$
$T = 28 + 273 = 301\ K$
$n = ?$

$$n = \frac{PV}{RT} = \frac{(0.970\ atm)(0.982\ L)}{\left(0.08206 \frac{L\,atm}{K\,mol}\right)(301\ K)}$$

$= 0.0386\ mol\ H_2$

next page →

(11) (continued)

$$0.0386\,\text{mol}\,H_2 \times \frac{1\,\text{mol}\,NaH}{1\,\text{mol}\,H_2} \times \frac{24.01\,\text{g}}{1\,\text{mol}\,NaH} = 0.926\,\text{g}\,NaH$$

(E)

$23 + 1.01 = 24.01\,\text{g/mol}$

(12) $SO_2 = 32.07 + 16 + 16 = 64.07\,\text{g/mol}$

~~$CO_2 = 44.0\,\text{g/mol}$~~ → (unimportant)

$$5.0\,\text{g}\,SO_2 \times \frac{1\,\text{mol}}{64.07\,\text{g}} = 0.0780\,\text{mol}\,SO_2$$

~~$5.0\,\text{g}\,CO_2 \times \frac{1\,\text{mol}}{44.0\,\text{g}} = 0.114\,\text{mol}\,CO_2$~~ ← (unimportant)

$$P = \frac{nRT}{V} = \frac{(0.0780\,\text{mol}\,SO_2)\left(0.08206\,\frac{\text{L atm}}{\text{K mol}}\right)(323\,\text{K})}{0.750\,\text{L}}$$

$$= 2.76\,\text{atm}$$ (B)

(13) A: the two which have nearly identical molar masses.

(B) 28 g/mol and 28 g/mol

(14) $$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

r_1 = rate of effusion of O_2 M_1 = molar mass of O_2

r_2 = rate of effusion of unknown gas M_2 = molar mass of unk gas

$$\frac{r_1}{r_2} = 2 = \frac{\sqrt{M_2}}{\sqrt{32}} \Rightarrow (2)(\sqrt{32}) = \sqrt{M_2}$$

$$11.31 = \sqrt{M_2} \Rightarrow (11.31)^2 = (\sqrt{M_2})^2$$

(A) $128\,\text{g/mol} = M_2$

(15) $Cl_2 = 70.9\ g/mol$ $F_2 = 38\ g/mol$
$O_2 = 32\ g/mol$ $N_2 = 28\ g/mol$

slowest ⟶ fastest

$Cl_2 \rightarrow F_2 \rightarrow O_2 \rightarrow N_2$

heaviest ⟶ lightest

(C)

(16) $P_{TOT} = 733\ torr = P_{H_2} + P_{H_2O}$

$733\ torr = P_{H_2} + 26.74\ torr$

$P_{H_2} = 706.26\ torr$ $= 706\ torr$

$706.26\ torr \times \frac{1\ atm}{760\ torr} = 0.929\ atm$ (A)

(17)

He

$V = 3.0\ L$
$T = 298\ K$
$P = 5.6\ atm$
$n = ?$

$n = \frac{PV}{RT}$

$= \frac{(5.6\ atm)(3.0\ L)}{(0.08206\ \frac{L\,atm}{K\,mol})(298\ K)}$

$= 0.687\ mol$

Ne

$V = 4.5\ L$
$P = 3.6\ atm$
$T = 298\ K$
$n = ?$

$n = \frac{PV}{RT}$

$= \frac{(3.6\ atm)(4.5\ L)}{(0.08206\ \frac{L\,atm}{K\,mol})(298\ K)}$

$= 0.662\ mol$

TOTAL

$V = 9.0\ L$
$T = 298\ K$
$n = 0.687 + 0.662$
$= 1.35\ mol$

$P = ? = \frac{nRT}{V}$

$= \frac{(1.35\ mol)(0.08206\ \frac{L\,atm}{K\,mol})(298\ K)}{9.0\ L}$

$= 3.67\ atm$ (E)

$= 3.7\ atm$

(18) $P_{TOT} = P_{He} + P_{Ar} = 474 + 25.75$
$= 500 \text{ torr}$
$= 5.00 \times 10^2 \text{ torr}$

a) $P_{He} = 474 \text{ torr}$
$P_{Ar} = 26 \text{ torr}$

b) $P_{TOT} = 500 \text{ torr}$

P_{He} afterward is P_2

$P_1V_1 = P_2V_2$

$P_2 = \frac{P_1V_1}{V_2} = \frac{(632 \text{ torr})(3.00 \text{ L})}{4.00 \text{ L}}$

$= 474 \text{ torr} = P_{He}$ afterward

P_{Ar} afterward is P_2

$P_1V_1 = P_2V_2$

$P_2 = \frac{P_1V_1}{V_2} = \frac{(103 \text{ torr})(1.00 \text{ L})}{4.00 \text{ L}}$

$= 25.75 \text{ torr} = P_{Ar}$ afterward

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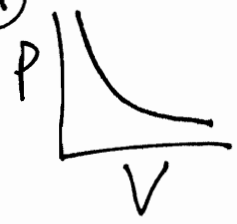
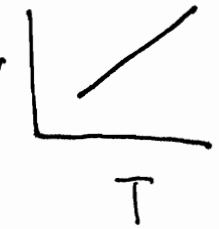
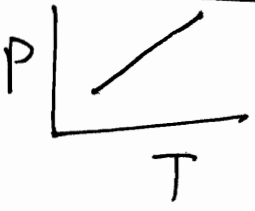
(19) (a)



(b)



(c)



(d) If you stuff twice as much gas into the same space, then the P will double (as long as you keep T constant). Try it with a basketball or car tire.

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(20) $19 \text{ atm} \times \frac{101.3 \text{ kPa}}{1 \text{ atm}} = 1.93 \times 10^4 \text{ kPa}$

(21) $19 \text{ mmHg} \times \frac{101.3 \text{ kPa}}{760 \text{ mmHg}} = 25.5 \text{ kPa}$

(22) barometer is the first that comes to mind

(23) $Mg + 2HI \rightarrow H_2 + MgI_2$

(a) I looked it up in the book: 31.824 mm Hg @ 30.0 °C

(b) $0.972\ atm \times \frac{760\ mm\ Hg}{1\ atm} = \underline{\quad 738.72 \quad} mm\ Hg$

$P_{TOT} = P_{H_2} + P_{H_2O(g)} = 738.72 = P_{H_2} + 31.824\ mm\ Hg$

$P_{H_2} = 738.72 - 31.824 = 707\ mm\ Hg$

$P = 707\ mm\ Hg \times \frac{1\ atm}{760\ mm\ Hg} = 0.930\ atm$

$V = 0.04582\ L$

$n = ?$

$R = 0.08206\ \frac{L\,atm}{K\,mol}$

$T = 30 + 273 = 303\ K$

$PV = nRT$

$n = \frac{PV}{RT} = \frac{(0.930\ atm)(0.04582\ L)}{(0.08206\ \frac{L\,atm}{K\,mol})(303\ K)}$

$= 0.00171\ mol\ H_2$

$0.00171\ mol\ H_2 \times \frac{1\ mol\ Mg}{1\ mol\ H_2} \times \frac{24.31\ g\ Mg}{1\ mol\ Mg} = \underline{\quad 0.0417 \quad} g\ Mg$

(24) $PV = nRT$

$V = \frac{nRT}{P} = \frac{(0.881\ mol)(8.31\ L\,kPa/K\,mol)(295.8\ K)}{124\ kPa}$

$15.0\ g\ NH_3 \times \frac{1\ mol}{17.03\ g} = \underline{\quad 0.881 \quad} mol$

$= 17.5\ L$