Recitation Worksheet (Optional Extra Practice)

Name: Key

UGA ID:

Textbook:

Chemistry & Chemical Reactivity
by John C. Kotz, Paul M. Treichel, John R. Townsend, David Treichel
11th Edition | Copyright 2024

Instructions:

- This recitation worksheet is optional extra practice for Ch. 10.1-10.2.
- You **do not** need to submit it to Gradescope.
- The answer key has been posted with this worksheet to eLC.
- A periodic table and formula sheet are attached to the end of this worksheet.

1. The instrument used to measure the pressure of the atmosphere is a _______________ whereas the instrument used to measure the pressure of a gas is a _______________.

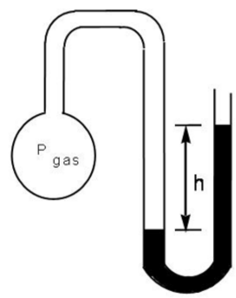
C

A. barometer; barometer
B. manometer; manometer
C. barometer; manometer
D. manometer; barometer
E. None of the above

2. If the atmospheric pressure is 690.4 mmHg and the difference in height in the diagram to the right is 5.4 cm, what is the pressure of the gas in the flask in mm Hg? Report your answer in **standard notation**.

754 mm Hg

744 mm Hg



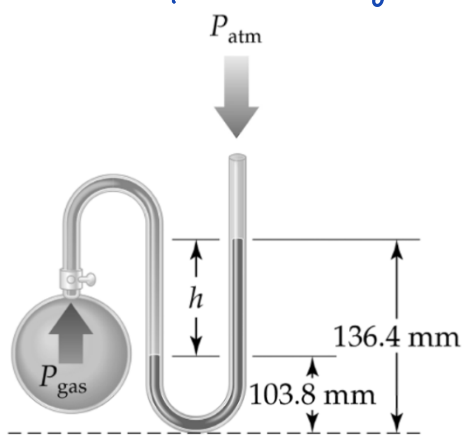
$P_{gas} = P_{atm} + \Delta h$

$= 690.4 \text{ mm Hg} + 54 \text{ mm Hg}$

$= \boxed{744 \text{ mm Hg}}$

3. What is the pressure of the gas in the open-ended manometer below (in torr) if the pressure of the atmosphere is 758 torr?

↳ 758 mm Hg



$\boxed{D}$

$h = 136.4 \text{ mm} - 103.8 \text{ mm} = 32.6 \text{ mm}$

$P_{gas} > P_{atm}$

$P_{gas} = 758 \text{ mm Hg} + 32.6 \text{ mm Hg}$

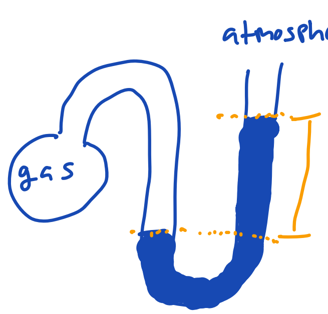
$= 790.6 \text{ mm Hg}$

A. 655 torr
B. 726 torr
C. 638 torr
D. 791 torr
E. 895 torr

4. An open-ended manometer is filled with an unknown gas sample. The liquid mercury on the side open to the atmosphere rises so that it is 0.95 cm higher than the side connected to the gas. If atmospheric pressure is measured at 0.972 atm, what is the pressure (mm Hg) of the gas sample?

↳ 738.72 mm Hg

$\boxed{A}$



0.95 cm → 9.5 mm Hg

A. 748 mm Hg
B. 729 mm Hg
C. 1.92 mm Hg
D. 0.02 mm Hg
E. 1460 mm Hg

$(738.72 + 9.5) \text{ mm Hg} = \boxed{748 \text{ mm Hg}}$

5. Atmospheric pressure is measured as 29.6 in Hg one afternoon. What is the pressure in atmospheres? Report your answer in **standard notation**.

$\boxed{0.989}$ atm

$$29.6 \text{ in Hg} \times \left(\frac{2.54 \text{ cm}}{1 \text{ in}}\right) \times \left(\frac{10^{-2-(-3)} \text{ mm}}{1 \text{ cm}}\right) \times \left(\frac{1 \text{ atm}}{760 \text{ mm Hg}}\right)$$

6. The Kelvin temperature of a 9.0 L flexible container was tripled. What is the new volume (L), assuming the moles and pressure of the gas are held constant? Report your answer in **standard notation**.

$\boxed{27}$ L

$$\frac{V_i}{T_i} = \frac{V_F}{T_F} \rightarrow \frac{9.0 \text{ L}}{T_i} = \frac{V_F}{3(T_i)}$$

$$9.0 \text{ L} = \frac{V_F}{3}$$

$$V_F = 27.0 \text{ L}$$

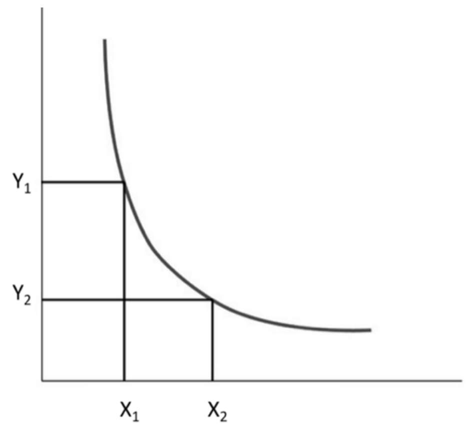
7. A rigid metal tank contains helium gas. What happens to the gas in the tank when some helium is removed at constant temperature?

$\boxed{B}$

A. the volume of the gas decreases
B. the pressure of the gas decreases
C. the total number of gas molecules remains the same
D. the average distance between the gas molecules decreases

8. Two parameters for gases - pressure, volume, moles, or temperature – are held constant, while the other two are varied and measured. The resulting graph is shown below. What two parameters could have been measured and resulted in this graph?

B



A. Volume vs Temperature
B. Pressure vs Volume
C. Volume vs Moles
D. Pressure vs Temperature

↑ V ↓ P

→ not kelvin temp.

9. If the Celsius temperature of a fixed amount of a gas is doubled at constant pressure, the volume is…

C

A. Doubled
B. Halved
C. Increased, but not doubled
D. Quadrupled
E. Constant

10. A sample of a gas is held in an expandable container. If the volume of the container is doubled and the Celsius temperature of the gas is also doubled, what is the final pressure of the container?

G

A. Four times the initial pressure
B. Double the initial pressure
C. The same as the initial pressure
D. Half the initial pressure
E. One-quarter of the initial pressure
F. Greater than the initial pressure but not doubled
G. Less than the initial pressure but not halved

11. The Celsius temperature of a sample of gas is doubled while half of the gas is allowed to escape the container. If the pressure is held constant, what will happen to the volume?

F

A. It will increase by a factor of 2
B. It will increase by a factor of 4
C. It will stay the same
D. It will decrease by ½
E. It will decrease by ¼
F. It will decrease by less than ½

12. A sample of a gas having a volume of 1 L at 25 °C and 1 atm pressure is subjected to an increase in pressure and an increase in temperature. The volume of the gas:

D

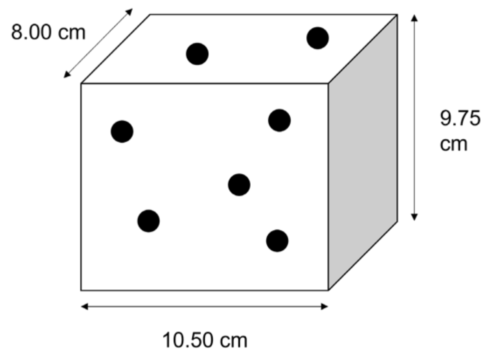
A. Decreases
B. Increases
C. Remains the same
D. Impossible to tell from the information given

$\uparrow P = \downarrow V$

$\uparrow T = \uparrow V$

13. A sample of gas is placed in a container, with the dimensions pictured below. Which of the following changes would result in an increase in the density of the gas?

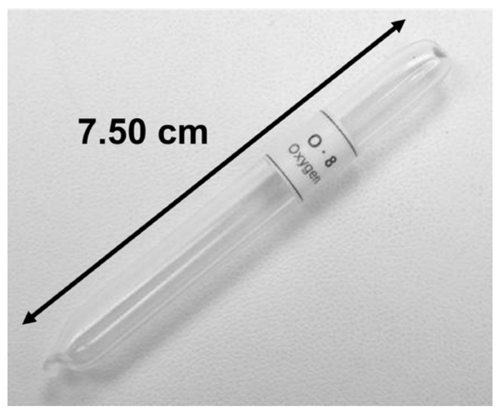
D



A. Raising the temperature of the container
B. Removing ½ of the gas from the container
C. Increasing the length of the 8.00 cm side
D. Decreasing the length of the 10.50 cm side
E. Decreasing the pressure of the container

14. Sealed ampoules are a common way to store and ship small samples of gas. They are sealed in order to be completely airtight. Oxygen gas is sealed in the ampoule below. Which of the following are **true**? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

CDE



A. The pressure of the gas would ~~decrease~~ increase if the gas were put in an ampoule with the same dimensions except with a length of 5.00 cm.
B. The pressure of the ampoule would double if the temperature were raised from 10.0 °C to 20.0 °C.
C. The pressure of the ampoule would increase, but not double, if the temperature were raised from 10.0 °C to 20.0 °C. not in Kelvin
D. The moles of gas in the ampoule would stay the same if the temperature were raised from 10.0 °C to 20.0 °C. → no change in moles regardless of temp. change
E. The pressure of the gas would increase if the gas were put in an ampoule with the same dimensions except with a length of 5.00 cm.
↳ smaller volume ↓ V ↑ P

15. An open 55-gallon drum containing only air is heated to 100 °C and then sealed. What is the final pressure of the air in the drum when the temperature has cooled to 25 °C? The initial pressure is 1.0 atm. Assume the drum is rigid and does not collapse.

$\downarrow$ 298.15 K

$\boxed{D}$

$$\frac{P_i}{T_i} = \frac{P_f}{T_f} \rightarrow \frac{1.0 \text{ atm}}{373.15 \text{ K}} = \frac{P_f}{298.15 \text{ K}}$$

A. 4.00 atm
B. 1.25 atm
C. 0.25 atm
D. 0.80 atm

* Be sure to use kelvin temp.!

16. Consider an expandable container that contains 1.45 moles of Xe gas and occupies 1200.0 mL. If 0.75 moles of Ar gas is added to the container, what will be the new volume of the container (in L)? Report your answer in **standard notation**.

$\boxed{1.82}$ L

$n_f = 1.45$ moles $+$ 0.75 moles
$= 2.20$ moles

$$\frac{V_i}{n_i} = \frac{V_f}{n_f} \rightarrow \frac{1200.0 \text{ mL}}{1.45 \text{ moles}} = \frac{V_f}{2.20 \text{ moles}}$$

$\downarrow$

$V_f = 1.82069\text{e}3$ mL
$= \boxed{1.82 \text{ L}}$

17. A sample of gas is added to a container at 349 K and 1.45 atm and occupies a volume of 0.941 L. If the volume is compressed to 245 mL, and the container is heated to 145 °C, what will the new pressure be (in mm Hg)? Report your answer in **scientific notation** → 418.15 K → 0.245 L

$\boxed{5.07} \times 10^{\boxed{3}}$ mm Hg

$$\frac{P_i V_i}{T_i} = \frac{P_F V_F}{T_F} \rightarrow \frac{(1.45 \text{ atm})(0.941 \text{ L})}{(349 \text{ K})} = \frac{(P_F)(0.245 \text{ L})}{(418.15 \text{ K})}$$

$$P_F = 6.67823 \text{ atm} = \boxed{5.07 \times 10^3 \text{ mm Hg}}$$

18. A sample of N_2 gas is initially at 0.00 °C and 1.00 atm. The gas is expanded to twice its original volume, while doubling the Kelvin temperature. What is the final pressure in torr units?

$\boxed{B}$

$$1.00 \text{ atm} \xrightarrow{\text{double volume}} 0.500 \text{ atm}$$

$$0.500 \text{ atm} \xrightarrow{\text{double K temp.}} 1.00 \text{ atm} = 760. \text{ torr}$$

A. 1.00 torr
B. 760. torr
C. 1520 torr
D. 3040 torr

19. What will happen to a 3.00 L sample of gas if the pressure decreases from 1.71 atm to 1.16 atm and the temperature is decreased from 293 K to 266 K?

$\boxed{C}$

A. The volume of gas will decrease by 1.01 L
B. The moles of gas will decrease by 0.0539 moles → no change in moles
C. The volume of gas will increase by 1.01 L
D. The moles of gas will increase by 0.0539 moles → no change in moles
E. There will be no change in the volume of gas

$$\frac{P_i V_i}{T_i} = \frac{P_f V_f}{T_f} \rightarrow \frac{(1.71 \text{ atm})(3.00 \text{ L})}{(293 \text{ K})} = \frac{(1.16 \text{ atm})(V_f)}{266 \text{ K}}$$

$$\downarrow$$

$$V_f = 4.01489 \text{ L}$$

20. An ideal gas is held in a spherical flexible container having a radius of 1.00 cm. The gas is heated at a constant pressure from 27°C to 88˚C. Determine the radius of the spherical container in centimeters after the gas is heated. Report your answer in **standard notation**.

Volume of a sphere = $\frac{4}{3}\pi r^3$ → $V = \frac{4}{3}\pi(1.00 \text{ cm})^3 = 4.188790 \text{ cm}^3$

$\boxed{1.06}$ cm $\quad \frac{V_i}{T_i} = \frac{V_f}{T_f}$

$27°C + 273.15 = 300.15 \text{ K}$
$88°C + 273.15 = 361.15 \text{ K}$

$$\frac{4.188790 \text{ cm}^3}{300.15 \text{ K}} = \frac{V_f}{361.15 \text{ K}} \rightarrow V_f = 5.040085 \text{ cm}^3$$

$$V = \frac{4}{3}\pi r^3$$

$$5.040085 \text{ cm}^3 = \frac{4}{3}\pi r^3$$

$$r^3 = 1.2032317 \text{ cm}^3 \rightarrow r = \sqrt[3]{1.2032317 \text{ cm}^3}$$

$$\downarrow$$

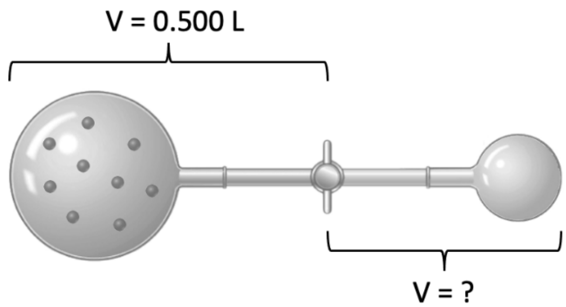
$$r = 1.06 \text{ cm}$$

21. Consider two bulbs connected by a closed stopcock in the illustration below. The left bulb is occupied by an unknown gas which exerts a pressure of 2.02 atm. Once the stopcock is opened, it is determined that the pressure exerted by the gas is 950. mm Hg. Based on this information, what is the volume of the *right hand bulb*? Report your answer in **standard notation**.

1.25 atm

Note: the image given below is not drawn to scale.

2.02 atm



0.308 L

$P_i V_i = P_f V_f$

$(2.02 \text{ atm})(0.500 \text{ L}) = (1.25 \text{ atm})(V_f)$

$V_f = 0.808 \text{ L}$

$0.808 \text{ L} - 0.500 \text{ L} = 0.308 \text{ L}$

Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.01																	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.63	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc [97]	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
37 Cs 132.91	56 Ba 137.33		72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po [209]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra [226]		104 Rf [267]	105 Db [268]	106 Sg [269]	107 Bh [270]	108 Hs [269]	109 Mt [277]	110 Ds [281]	111 Rg [282]	112 Cn [285]	113 Nh [286]	114 Fl [290]	115 Mc [290]	116 Lv [293]	117 Ts [294]	118 Og [294]

57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm [145]	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
89 Ac [227]	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]	103 Lr [262]

Formula Sheet

Length
1 kilometer = 0.62137 mile
1 inch = 2.54 centimeters (exactly)
1 Ångstrom = 1 × 10^{-10} meter

Energy
1 joule = 1 kg·m^2/s^2
1 calorie = 4.184 joules
1 Calorie = 1 kilocalorie = 1000 calories
1 L·atm = 101.325 joules

Pressure
1 pascal = 1 N/m^3 = 1 kg/m·s^2
1 atmosphere = 101.325 kilopascals = 760 mm Hg = 760 torr = 14.70 lb/in^2
1 bar = 1 × 10^5 Pa (exactly)

Temperature
0 K = −273.15°C
K = °C + 273.15
°C = (5/9)(°F − 32)

Mass
1 kg = 2.205 lbs

Volume
1 mL = 1 cm^3 = 1 cc

Constants
c = 2.998 × 10^8 m/sec
h = 6.626 × 10^{-34} J·sec
R = 0.08206 L·atm/mol·K = 8.314 J/mol·K
Specific heat of water = 4.184 J/g·K
Mass of an electron: 9.109 x 10^{-31} kg
Mass of a proton: 1.673 x 10^{-27} kg
RH = 2.18 x 10^{-18} J
Specific heat of water = 4.184 J/g·K
Avogadro's number: 6.022 × 10^{23}
F = 96485 J/(V·mol e^-)
K_w = 1.0 × 10^{-14} at 25 °C
k_b = 1.381 × 10^{-23} J/K

Equations
$(P + a(n^2/V^2))\cdot(V - nb) = nRT$
molar mass (M) = mRT/PV
density (d) = MP/RT

$$KE = \frac{3}{2}RT$$

$$\mu_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\frac{Rate\ of\ effusion\ A}{Rate\ of\ effusion\ B} = \sqrt{\frac{MW_B}{MW_A}}$$

$$\Delta E = -2.18 \times 10^{-18} J(\frac{1}{n_f^2} - \frac{1}{n_i^2})$$

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$C_g = kP_g$
$P_{solution} = P_{solvent}\, X_{solvent}$
$P_{solution} = \sum P_j = \sum P_j X_j$
$\pi = MRTi$

Thermodynamic and Electrochemistry
$S = k_b \times \ln(W)$
$\Delta S = q_{rev}/T$
$\Delta G = \Delta G° + RT \cdot \ln Q$
R=8.314 J/mol.K
$\Delta G° = -RT \cdot \ln K$
$\Delta G = -nFE_{cell}$
$E°_{cell} = RT/nF \ln K$
$E°_{cell} = (0.0257/n) \ln K = (0.0592/n) \log K$
$E_{cell} = E°_{cell} - (RT/nF) \ln Q$
$E_{cell} = E°_{cell} - (0.0257/n) \ln Q$
Electrolysis: Q (total charge) = I × t = n × F

Integrated Rate Laws & half-life

$$\ln\frac{[A]}{[A]_0} = -kt$$

$$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$$

$$[A] = -kt + [A]_0$$

$$t_{1/2} = \frac{[A]_0}{2k}$$

$$t_{1/2} = \frac{\ln 2}{k} = \frac{0.693}{k}$$

$$t_{1/2} = \frac{1}{k[A]_0}$$

$$ln\frac{k_2}{k_1} = -\frac{\mathrm{E_a}}{\mathrm{R}}(\frac{1}{\mathrm{T_2}} - \frac{1}{\mathrm{T_1}})$$

Equilibrium and Acid / Base
$K_P = K_c \times (RT)^{\Delta n}$

$$ln\frac{K_2}{K_1} = \frac{\Delta H^{\circ}_{rxn}}{R}(\frac{1}{T_1} - \frac{1}{T_2})$$