Midterm Revision

- Stoichiometry
- Ideal Gases,
- Real Gases,
- Liquids
- Solids

MCQ

Question

- What is the term describing the movement of one gas particle through another?
  - Diffusion
  - Effusion
  - Viscosity
  - Surface tension

Solution

- Diffusion

Question

- What is the term describing the resistance of a liquid to an increase in its surface area?
  - Diffusion
  - Effusion
  - Viscosity
  - Surface tension

Solution

- Surface tension

Question

- What is the term describing the resistance of a liquid to flow?
  - Diffusion
  - Effusion
  - Viscosity
  - Surface tension

Solution

- Viscosity

Question

- What is the term describing the passage of a gas through a tiny orifice into an evacuated chamber?
  - Diffusion
  - Effusion
  - Viscosity
  - Surface tension

Solution

- Effusion

Question

- What is the law describing the PV relationship for a fixed amount of a real gas at a constant temperature?
  - Charles's Law
  - Boyle's Law
  - van der Waals Law
  - Dalton's Law

Solution

- van der Waals Law

Question

- How does the intermolecular attraction between molecules affect the real gas pressure?
  - It duplicate the pressure
  - It increases the pressure three times
  - It does not affect the pressure
  - It decreases the pressure

Solution

- It decreases the pressure

Question

- Which of the following exhibits dipole-dipole attraction between molecules?
  - $H-F$
  - $O=O$
  - $Cl-Cl$
  - $H-H$

Solution

- $H-F$

Question

- Which of the following exhibits hydrogen bonding?
  - $H-H$
  - CH_3OCH_3
  - $H-F$
  - CH_4

Solution

- $H-F$

Question

- Which of the following exhibits only London dispersion forces?
  - H_2O
  - CH_3OH
  - $H-F$
  - $Cl-Cl$

Solution

- $Cl-Cl$

Question

- Which of the following does not exhibit dipole-dipole interaction?
  - H_2O
  - CH_3OH
  - $H-F$
  - I_2

Solution

- I_2 (It has only London dispersion forces)

Question

- What is the opposite process to "deposition"?
  - melting
  - condensation
  - freezing
  - sublimation

Solution

- sublimation

Question

- What is the term describing the direct conversion from the solid state to gaseous state without passing by the liquid state?
  - melting
  - condensation
  - freezing
  - sublimation

Solution

- sublimation

Question

- The rate of vaporization of a liquid increases when:
  - The temperature increases
  - The surface area of the liquid increases
  - The intermolecular forces between liquid molecules are weakened
  - All of the above

Solution

- All of the above

Question

- The number of atom(s) per unit cell in a certain metal in the body-centered cubic lattice is:
  - 1
  - 2
  - 3
  - 4

Solution

- 2

Question

- The amount of a gas that occupies 60.82 L at 31°C and 367 torr is:
  - 0.850 mol
  - 0.12 mol
  - 1.18 mol
  - 2.3 mol

Solution

- 1.18 mol

$$n = \frac{PV}{RT} = \frac{(367\,torr)\left(\frac{1atm}{760torr}\right)(60.82\,L)}{\left(0.082\,L.atm.K^{-1}\,mol^{-1}\right)(304K)} = 1.178$$

Question

- The root mean square velocity of hydrogen gas at 25°C is:
  - 1928 m/s
  - 1363 m/s
  - 515 m/s
  - 482 m/s

Solution

- 1928 m/s

$$u_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3 \times 8.314\,(J/K.mol)\,298\,K}{2 \times 10^{-3}}} = 1927.7858$$

Question

- Which gases from the following effuses 4 times slower than H_2 (2 g/mol)?
  - He (4 g/mol)
  - CH_4 (16 g/mol)
  - O_2 (32 g/mol)
  - CO_2 (44 g/mol)

Solution

- O_2 (32 g/mol)

$$\frac{u_{rms}(H_2)}{u_{rms}(gas)} = \sqrt{\frac{M_{gas}}{M_{H_2}}} = \sqrt{\frac{M_{gas}}{2}} = 4$$

$$M_{gas} = 32$$

Question

- 2 g of H_2 gas and 64 g of O_2 gas and 42 g of N_2 g are mixed together at 25°C. What is the mole fraction of H_2?
  - 1.000
  - 0.500
  - 0.333
  - 0.222

Solution

- 0.222

$$\chi_{H_2} = \frac{n_{H_2}}{n_T} = \frac{2\ g \times \left(\frac{1\ mol}{2\ g}\right)}{2\ g \times \left(\frac{1\ mol}{2\ g}\right) + 64\ g \times \left(\frac{1\ mol}{32\ g}\right) + 42\ g \times \left(\frac{1 mol}{28\ g}\right)} = 0.222$$

Question

- What volume of acetylene gas, C_2H_2, would be required at STP to obtain a 200.0 g C_2H_2 sample ?
  - 344.6 L
  - 172.3 L
  - 582.4 L
  - 86.2 L

Solution

- 172.3 L

$$V = \frac{nRT}{P} = \frac{\left(200g \times \frac{1\ mol}{26\ g}\right)\left(0.082\ L.atm.K^{-1}\ mol^{-1}\right)(273K)}{(1\ atm)} = 172.2\ L$$

Question

- Which of the following exhibits dipole-dipole attraction between molecules?
  - $H-F$
  - $O=O$
  - $Cl-Cl$
  - $H-H$

Solution

- $H-F$

Question

- Which of the following exhibits only London dispersion forces?
  - H_2O
  - CH_3OH
  - $H-F$
  - $Cl-Cl$

Solution

- $Cl-Cl$

Question

- Which of the following does not exhibit dipole-dipole interaction?
  - H_2O
  - CH_3OH
  - $H-F$
  - I_2

Solution

- I_2 (It has only London dispersion forces)

Question

- The number of atom(s) per unit cell in a certain metal in the body-centered cubic lattice is:
  - 1
  - 2
  - 3
  - 4

Solution

- 2

Question

- The general equation for a non-ideal gas is:
  - $PV = nRT$
  - $P_i = X_i P_{total}$
  - $[P + a(n/V)^2](V - nb) = RT$
  - $\ln P = -\Delta H_{vap}/RT + C$ (Clausius-Clapeyron)

Solution

- $[P + a(n/V)2](V - nb) = RT$

Question

- Underline the correct answer ?

Real gases approach the ideal behavior at

(high P and low T, high T and low P, normal T and P, high P and high T) ?

Solution

"(high P and low T, high T and low P, normal T and P, high P and high T)

Question Underline the correct answer ?

The average kinetic energy of O_2 molecules increases with increasing

(volume, temperature, pressure, density) ?

Solution

(volume, temperature, pressure, density)

Question Complete the following:

A device to measure atmospheric pressure is called ----------

Solution

The barometer

Question Complete the following:

The SI system of pressure is ----------

Solution

(Pa: Pascal) =N m^{-2}

Question Complete the following:

"The volume of a gas at a constant pressure increases linearly with the gas temperature" is a statement for (Boyle, Charles, Avogadro, Dalton)'s law

Solution

Charles's Law

Question

- *State true or False correcting the false statements*

According to KMT, particles of only noble gases are assumed to exert no forces on each other

Solution

False: According to KMT, particles of ALL gases are assumed to exert no forces on each other

Question

Underline the correct word between brackets

- *Gas A and gas B are mixed together in a container at a certain temperature. The partial pressure of gas B will be*

$P_B = n_B P_{total}$

$P_B = \frac{n_B}{P_{total}}$

$P_B = X_B P_A$

$P_B = X_B P_{total}$

Solution

$P_B = X_B P_{total}$

Question Calculate

To the correct number of significant figures:

$$(1.8+0.020)\times 0.3315=$$

Solution

$$(1.820)\times 0.3315=$$

$$(1.8)\times 0.3315=0.5967$$

$$=0.60$$

Question Solve

The speed of light is 3.00 × 10^8 meters per second. What is the speed of light in kilo-meters per min.? (1 kilo-meter = 1000 meter, 1 min. = 60 second).

Solution

$$C=\frac{3.00\times 10^8\ m}{s}=$$

$$\frac{3.00\times 10^8\ m}{s}\times\frac{1\ km}{1000\ m}\times\frac{60\ s}{1\ \text{min}}=\frac{1.8\times 10^7\ km}{\text{min}}$$

Question ⇩ **Solve**

A sample of N_2 gas (2.0 mmole) effused through a pinhole in 5.5 s. How long will it take for the same amount of CH_4 to effuse under the same conditions?

Solution

$$\frac{\text{Rate of effusion for gas 1}}{\text{Rate of effusion for gas 2}} = \frac{u_{rms}\text{ for gas 1}}{u_{rms}\text{ for gas 2}} = \frac{\sqrt{M_2}}{\sqrt{M_1}}$$

Effusion of the same amount

$$\frac{u_{rms}\text{ for gas 1}}{u_{rms}\text{ for gas 2}} = \frac{t_2}{t_1} = \frac{\sqrt{M_2}}{\sqrt{M_1}}$$

$$t_2 = \frac{t_1\sqrt{M_2}}{\sqrt{M_1}} = \frac{5.5s\sqrt{16}}{\sqrt{28}} = 4.16\ s$$

Question ⇩ **Calculate**

The average kinetic energy and density of CO_2 gas at 100°C and 10.0 atm?

Solution

$$(KE)_{avg} = \frac{3}{2}RT =$$

$$\frac{3\,(8.314\ JK^{-1}mol^{-1})373\ K}{2} = 4.65\ kJ\ mol^{-1}$$

$$d = \frac{PM}{RT} = \frac{(10\ atm)(44\ g\ mol^{-1})}{(0.082\ L\ atm\ K^{-1}mol^{-1})(373\ K)} = 14.39\ g\ L^{-1}$$

Question Solve:

A sample of N_2 gas has a volume of 1.75 L at STP. How many molecules of N_2 are present?

Solution

$$PV = nRT$$

$$(1\,atm)(1.75) = n\left(\frac{0.082\,L\,atm}{K\,mol}\right)(273\,K)$$

$$n = 0.0782\,mol$$

$$no.\,of\,molecules = (0.0782\,mol)\left(\frac{6.023\times10^{23}}{mol}molecule\right)$$

$$= 4.7\times10^{22}\,molecule$$

Question Alternatively

You may utilize the fact that a mole of any gas occupy 22.4L at STP

Solution

$$22.4L \rightarrow 1mol$$

$$1.75 \rightarrow n\,mole$$

$$n = \frac{1.75}{22.4} = 0.078\,mol$$

$$no.\,of\,molecules = (0.0782\,mol)\left(\frac{6.023\times10^{23}}{mol}molecule\right)$$

$$= 4.7\times10^{22}\,molecule$$

Question

- Calculate the root mean square velocity for the atoms in a sample of helium gas at 25°C.

Solution

The mass of a mole of He in kilograms?

$$M = 4.0\frac{g}{mol} \times \frac{1\,kg}{1000\,g} = 4.0\times10^{-3}\frac{kg}{mol}$$

$$u_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3\left(\frac{8.314\ J}{K\ mol}\right)(298K)}{\left(4.0\times10^{-3}\frac{kg}{mol}\right)}} = \sqrt{1.86\times10^{6}\frac{J}{kg}}$$

$$= \sqrt{1.86\times10^{6}\frac{kg\ m^2}{kg\ s^2}} = \frac{1.36\times10^{3}\,m}{s}$$

Question

- At the same temperature, compare $U_{rms}\,H_2$ with $U_{rms}\,O_2$

Solution

$$\frac{u_{rms}(H_2)}{u_{rms}(O_2)} = \frac{\sqrt{\frac{3RT}{M_{H_2}}}}{\sqrt{\frac{3RT}{M_{O_2}}}} = \sqrt{\frac{M_{O_2}}{M_{H_2}}} = \sqrt{\frac{32}{2}} = 4$$

Hydrogen moves 4 times faster than oxygen

Question

The density of a gas was measured at 1.50 atm and 27°C and found to be 1.95 g/L. Calculate the molar mass of the gas

Solution

$$M = \frac{dRT}{P}$$

$$= \frac{\left(1.95\,\frac{g}{L}\right)\left(\frac{0.08206\ L\,atm}{K\ mol}\right)(300\,K)}{1.0\,atm}$$

$$= 32.0\,\frac{g}{mol}$$

Question

- *The normal boiling of liquid ammonia is –33.4°C and it has a heat of vaporization of 23.5 kJ/mol. Calculate its vapor pressure at –50.0°C ?*

Solution

$P_1 = 760$ torr

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

$$\ln\frac{760}{P_2} = \frac{23.5\times1000}{8.314}\left(\frac{1}{-50+273} - \frac{1}{-33.4+273}\right) = 0.876$$

$P_2 = 316$ torr