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

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

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

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

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

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

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

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

$$22.4L \rightarrow 1mol$$

$$1.75 \rightarrow n\ mole$$

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

$$no.\ of\ molecules =$$

$$= 4.7 \times 10^{22}\ molecule$$

$$(0.0782\ mol)\left(\frac{6.023 \times 10^{23}}{mol}\ molecule\right)$$

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?

$$M = 4.0\frac{g}{mol} \times \frac{1\,kg}{1000\,g} = 4.0 \times 10^{-3}\,\frac{kg}{mol}$$

$$u_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3\left(\frac{8.314\ J}{K\ mol}\right)(298\,K)}{\left(4.0 \times 10^{-3}\,\frac{kg}{mol}\right)}} = \sqrt{1.86 \times 10^{6}\,\frac{J}{kg}}$$

$$= \sqrt{1.86 \times 10^{6}\,\frac{kg\ m^2}{kg\ s^2}} = \frac{1.36 \times 10^{3}\,m}{s}$$

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

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

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

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

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

$$\ln P = -\frac{\Delta H_{vap}}{RT} + C$$

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

$$\ln \frac{760}{P_2} = \frac{23.5 \times 1000}{8.314}\left(\frac{1}{-50+273} - \frac{1}{-33.4+273}\right) = 0.876$$

P_2 = 316 torr