

Answer key: Gas Laws Practice Problems: Group Work

C.
volume will decrease by a factor of 2 according to Boyle's Law $P_1V_1 = P_2V_2$

2. C.
high pressure/low temp = more opportunity to form IMF

3. D.

4. a)

P	V	n	T
(1) 152,000 Pa	0.015 m ³	0.400 mol	37°C
31,000 Pa	(2) 0.25 m ³	2.00 mol	298 K
250 kPa	0.75 dm ³	(3) 0.580 mol	271 K
			(4)

(1) $PV = nRT$

$$P(0.015 \text{ m}^3) = 0.400 \text{ mol} (8.31 \text{ m}^3 \text{ Pa mol}^{-1} \text{ K}^{-1})(310 \text{ K})$$

$$0.015 P = 1030.44 \text{ m}^3 \text{ Pa}$$

$$P = \frac{68696 \text{ Pa}}{1} = \boxed{68.7 \text{ kPa}}$$

(2) $152,000 \text{ Pa } V = 2.00 (8.31 \text{ m}^3 \text{ Pa mol}^{-1} \text{ K}^{-1})(298 \text{ K})$

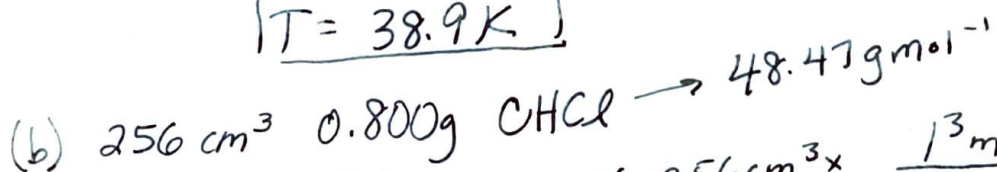
$$V = \boxed{0.0326 \text{ m}^3}$$

(3) $31,000 \text{ Pa} (0.25 \text{ m}^3) = n (8.31 \text{ m}^3 \text{ Pa mol}^{-1} \text{ K}^{-1})(271 \text{ K})$

$$n = \boxed{3.4 \text{ moles}}$$

(4) $250 \text{ kPa} (0.75 \text{ dm}^3) = 0.580 \text{ mol} (8.31 \text{ m}^3 \text{ Pa mol}^{-1} \text{ K}^{-1})(T)$

$$T = \boxed{38.9 \text{ K}}$$



$$P = 1.00 \times 10^5 \text{ Pa}$$

$$T = 373 \text{ K}$$

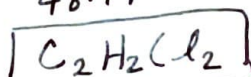
$$V = 256 \text{ cm}^3 \times \frac{1^3 \text{ m}^3}{100^3 \text{ cm}^3} = 2.56 \times 10^{-4} \text{ m}^3$$

$$1.00 \times 10^5 \text{ Pa} (2.56 \times 10^{-4} \text{ m}^3) = n (8.31 \text{ m}^3 \text{ Pa mol}^{-1} \text{ K}^{-1})(373 \text{ K})$$

$$n = 8.26 \times 10^{-3} \text{ mol}$$

$$\frac{96.86}{48.47} = 2$$

$$0.800 \text{ g} / 8.26 \times 10^{-3} \text{ mol} = 96.86 \text{ g mol}^{-1}$$





b) $1.250\text{ cm}^3 \text{ C}_4\text{H}_9\text{OH}$

excess O_2

$1.921\text{ dm}^3 \text{ H}_2\text{O}(g)$

$P_{\text{H}_2\text{O}} : 125.0\text{ kPa}$

$T_{\text{H}_2\text{O}} : 150.0^\circ\text{C} + 273 = 423\text{ K}$

$n_{\text{but}} = ?$

$PV = nRT$

$125.0\text{ kPa}(1.921\text{ dm}^3) = n_{\text{H}_2\text{O}}(8.31\text{ kPa dm}^3\text{ mol}^{-1}\text{ K}^{-1})(423\text{ K})$

$n_{\text{H}_2\text{O}} = 0.068312\text{ mol H}_2\text{O} \times \frac{1\text{ mol C}_4\text{H}_9\text{OH}}{5\text{ mol H}_2\text{O}} = 0.0136624\text{ mol C}_4\text{H}_9\text{OH}$

c) $0.0136624\text{ mol C}_4\text{H}_9\text{OH} \times \frac{74.14\text{ g}}{\text{mol}} = 1.01293\text{ g}$

$\frac{1.01293\text{ g}}{1.250\text{ cm}^3} = 0.8103\text{ g cm}^{-3}$

6. $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

(A)

$\frac{1.00\text{ atm}(5.00\text{ dm}^3)}{293\text{ K}} = \frac{1.60\text{ atm}(V_2)}{283\text{ K}}$

$\frac{1.00\text{ atm}(5.00\text{ dm}^3)(283\text{ K})}{(293\text{ K})(1.60\text{ atm})} = V_2$



g NaN_3 ?

$0.07\text{ m}^3 \text{ N}_2$ $1.01 \times 10^5\text{ Pa}$ $26.0^\circ\text{C} + 273 = 299\text{ K}$

$PV = nRT$

$1.01 \times 10^5\text{ Pa}(0.07\text{ m}^3) = n(8.31\text{ m}^3\text{ Pa mol}^{-1}\text{ K}^{-1})(299\text{ K})$

$n = 2.845\text{ mol N}_2$

$2.845\text{ mol N}_2 \times \frac{2\text{ mol NaN}_3}{3\text{ mol N}_2} = 1.89695\text{ mol NaN}_3 \times \frac{65.02\text{ g NaN}_3}{1\text{ mol NaN}_3}$

$= 123.3\text{ g NaN}_3$

w/correct sig figs... 100 g NaN_3 !!

$$4.01 \text{ g N}_2 \times \frac{1 \text{ mol N}_2}{28.02 \text{ g}} \times \frac{2 \text{ mol NH}_3}{1 \text{ mol N}_2} \times \frac{22.7 \text{ dm}^3 \text{ NH}_3}{1 \text{ mol NH}_3} = 22.7 \text{ dm}^3$$

(B)

9. 6.00g ethane $M_r = 30 \text{ g mol}^{-1}$ 273K 100kPa

$$6.00 \text{ g} \times \frac{1 \text{ mol}}{30 \text{ g}} = 0.2 \text{ mol ethane} \times \frac{22.7 \text{ dm}^3}{1 \text{ mol}} = 4.54 \text{ dm}^3 \text{ ethane}$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{100 \text{ kPa} (4.54 \text{ dm}^3)}{273 \text{ K}} = \frac{200 \text{ kPa} (V_2)}{546 \text{ K}}$$

$$V_2 = 4.54 \text{ dm}^3$$

(C)

10. low temps, high pressures = most deviation from ideal gas

$$1 \text{ atm} = 100 \text{ kPa}$$

all temps are the same, so choice w/ the highest pressure

(B)



a) N_3^-

b) $V = 65.0 \text{ dm}^3 \text{ N}_2$

273K
100 kPa

g $\text{NaN}_3 = ?$

$$100 \text{ kPa} (65.0 \text{ dm}^3) = n (8.31 \text{ kPa dm}^3 \text{ mol}^{-1} \text{ K}^{-1}) (273 \text{ K})$$

$$n = 2.865 \text{ mol N}_2 \times \frac{2 \text{ mol NaN}_3}{3 \text{ mol N}_2} = 1.91 \text{ mol NaN}_3 \times \frac{65.02 \text{ g NaN}_3}{\text{mol}} =$$

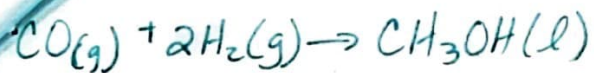
124.195g

sig figs...

124g NaN_3

12. gas w/ least IMF
so smallest LDF

H_2 (B)



4.0g min⁻¹ CH₃OH 0-5 min @ 3min = 12.0g CH₃OH

Volume H₂ after 3 min?

$$12.0\text{g CH}_3\text{OH} \times \frac{\text{mol}}{32.05\text{g}} = 0.374\text{mol CH}_3\text{OH} \times \frac{2\text{mol H}_2}{1\text{mol CH}_3\text{OH}} = 0.749\text{mol H}_2$$

$$0.749\text{mol H}_2 \times \frac{22.7\text{dm}^3}{\text{mol}} = \boxed{17.0\text{dm}^3\text{ H}_2} \times \frac{10^3\text{cm}^3}{1\text{dm}^3}$$

put it all together...

$$\frac{12 \times 2 \times 22.7}{(12.01 + 4.04 + 16.00)}$$

→ this would give answer in dm³

so... $\frac{12 \times 2 \times 22.7 \times 10^3}{(12.01 + 4.04 + 16.00)}$

(B)

$$14. \frac{P_1 V_1}{T_1} = \frac{2P_1 V_2}{\frac{1}{2}T_1}$$

$$\frac{P_1 V_1}{T_1} = \frac{2P_1 V_2}{\frac{1}{2}T_1}$$

$$\frac{P_1 V_1 (\frac{1}{2}T_1)}{T_1} = 2P_1 V_2$$

$$\frac{P_1 V_1 (\frac{1}{2}T_1)}{P_1 2P_1} = V_2 \Rightarrow \frac{1}{4}V_1 = V_2$$

(C)