wer 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)	$0.015 m^3$	0.400 mol	37°C
152,000 Pa	(2)	2.00 mol	298 K
31,000 Pa	$0.25 m^3$	(3)	271 K
250 kPa	$0.75 dm^3$	0.580 mol	(4)

(1) $PV = nRT$

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

$0.015 P = 1030.44 m^3 Pa$

$P = 68696 Pa$

$= \boxed{68.7 kPa}$

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

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

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

$\boxed{n = 3.4 moles}$

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

$\boxed{T = 38.9 K}$

(b) $256 cm^3$ 0.800g CHCl → $48.47 g\ mol^{-1}$

$P = 1.00 \times 10^5 Pa$

$T = 373 K$

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

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

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

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

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

$\boxed{C_2H_2Cl_2}$

$C_4H_9OH(l) + 6O_2(g) \rightarrow 4CO_2(g) + 5H_2O(g)$

b) $1.250\ cm^3\ C_4H_9OH$

excess O_2

$1.921\ dm^3\ H_2O(g)$

P_{H_2O} : $125.0\ kPa$

T_{H_2O} : $150.0°C + 273 = 423K$

$n_{but} = ?$

$PV = nRT$

$125.0\ kPa(1.921\ dm^3) = n_{H_2O}(8.31\ kPa\ dm^3\ mol^{-1}K^{-1})(423K)$

$n_{H_2O} = 0.068312\ mol\ H_2O \times \frac{1\ mol\ C_4H_9OH}{5\ mol\ H_2O} = \boxed{0.0136624\ mol\ C_4H_9OH}$

c) $0.0136624\ mol\ C_4H_9OH \times \frac{74.14g}{mol} = 1.01293g$

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

6. $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ (A)

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

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

7. $2NaN_3(s) \rightarrow 2Na(s) + 3N_2(g)$

g NaN_3 ?

$0.07m^3\ N_2$ $1.01 \times 10^5\ Pa$ $26.0°C + 273 = 299K$

$PV = nRT$

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

$n = 2.845\ mol\ N_2$

$2.845\ mol\ N_2 \times \frac{2\ mol\ NaN_3}{3\ mol\ N_2} = 1.89695\ mol\ NaN_3 \times \frac{65.02g\ NaN_3}{1\ mol\ NaN_3}$

$= \boxed{123.3g\ NaN_3}$

w/correct sig figs... 100g NaN_3 ☹

$4.01g\ N_2 \times \frac{1 mol\ N_2}{28.02g} \times \frac{2 mol\ NH_3}{1 mol\ N_2} \times \frac{22.7 dm^3 NH_3}{1 mol\ NH_3} = 22.7 dm^3$

(B)

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

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

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

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

$V_2 = 4.54 dm^3$

(C)

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

1 atm = 100 kPa

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

(B)

11. $2NaN_3(s) \rightarrow 2Na(s) + 3N_2(g)$

a) N_3^-

b) $V = 65.0 dm^3\ N_2$

273 K

100 kPa

g NaN_3 = ?

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

$n = 2.865 mol\ N_2 \times \frac{2 mol\ NaN_3}{3 mol\ N_2} = 1.91 mol\ NaN_3 \times \frac{65.02g\ NaN_3}{mol} =$

124.195g

sig figs...

124g NaN_3

12. gas w/ least IMF

so smallest LDF

H_2 (B)

$CO_{(g)} + 2H_2(g) \rightarrow CH_3OH(l)$

$4.0 g\,min^{-1}$ CH_3OH 0-5 min @ 3 min = 12.0 g CH_3OH

Volume H_2 after 3 min?

$$12.0\,g\,CH_3OH \times \frac{mol}{32.05g} = 0.374\,mol\,CH_3OH \times \frac{2\,mol\,H_2}{1\,mol\,CH_3OH} = 0.749\,mol\,H_2$$

$$0.749\,mol\,H_2 \times \frac{22.7\,dm^3}{mol} = \boxed{17.0\,dm^3\,H_2} \times \frac{10^3\,cm^3}{1\,dm^3}$$

put it all together...

$$\frac{12 \times 2 \times 22.7}{(12.01 + 4.04 + 16.00)}$$ → this would give answer in dm^3 so... $$\frac{12 \times 2 \times 22.7 \times 10^3}{(12.01 + 4.04 + 16.00)}$$

(B)

14. $$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$ ($P_2 \rightarrow 2P_1$, $T_2 \rightarrow 1/2 T_1$)

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

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

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

(C)