(1) $\text{Pressure} = \frac{\text{Force}}{\text{area}} = \left(\frac{Kg\ m}{s^2}\right)\left(\frac{1}{m^2}\right) = \frac{Kg}{m\,s^2} = Pa$

(2) $n = \frac{PV}{RT} = \frac{(17)\ atm\left(\frac{101.325\ kPa}{1\ atm}\right)(90.0\ L)}{(8.314\ L\ kPa\ mol^{-1}\ K^{-1})(22+273\ K)} = 636\ mol\ CO_2$

$\text{mass} = (636\ mol)\left(\frac{44.01\ g}{1\ mol}\right)\left(\frac{1\ Kg}{1000\ g}\right) = \boxed{28.0\ Kg}$

(3)

Argon
$V_1 = 0.85L$
$P_1 = 1.4\ bar$

$T_1 = T_2$, $n_1 = n_2$ →

$V_2 = 2.35L$
$P_2 = ?$

$P_1V_1 = nRT$
$P_2V_2 = nRT$

$P_1V_1 = P_2V_2$

$P_2 = \frac{P_1V_1}{V_2} = \frac{(1.4\ bar)(0.85\ L)}{2.35\ L} = 0.506\ bar$

$(0.506\ bar)\left(\frac{101.325\ KPa}{1.01325\ bar}\right) = \boxed{51\ KPa}$

(4) Dalton's Law of Partial Pressure.

- total pressure of a gas mix is equal to the sum of the partial pressure.

(5) $n_{CH_4} = (20.0\ Kg)\left(\frac{1000\ g}{1\ Kg}\right)\left(\frac{1\ mol}{16.04\ g}\right) = 1250\ mol\ CH_4$

$n_{C_2H_6} = (5.0\ Kg)\left(\frac{1000\ g}{1\ Kg}\right)\left(\frac{1\ mol}{30.07\ g}\right) = 170\ mol\ C_2H_6$

$1420\ mol$ Total mol

$PV = nRT$

$$P_{tot} = \frac{(1420\ mol)(8.314\ L\ KPa\ mol^{-1}\ K^{-1})(24+273\ K)}{400.0\ L} \cong 8770\ KPa$$

$$P_{C_2H_6} = X_{C_2H_6} P_{total} = \left(\frac{170}{1420}\right) 8723\ KPa = 1050\ KPa$$

(6) $X_{O_3} = \frac{12.2\ ppm}{10^6\ ppm} = 1.22 \times 10^{-5}$

$$P_{O_3} = (1.22 \times 10^{-5})(752.1\ mmHg) = 9.18 \times 10^{-3}\ mmHg$$

(7) $\bar{E}_{Kinetic} = \frac{3RT}{2N_A}$ or $\frac{3}{2}RT$

↑ KE only depends on temp.

∴ Highest Temp = largest KE

⑧ $\overline{KE}_{200} = \frac{3}{2} RT$

$\overline{KE}_{400} = \frac{3}{2} R(2T) = 2\left(\frac{3}{2}RT\right) = 2\,\overline{KE}_{200}$ ← doubling the temp 200 → 400 doubles the $\overline{KE}$

$\bar{V}_{200} = \sqrt{\frac{3RT}{M}}$

$\bar{V}_{400} = \sqrt{\frac{3R(2T)}{M}} = \sqrt{2} \cdot \sqrt{\frac{3RT}{M}} = 1.41\,\bar{V}_{200}$

↑ 41% increase in $\bar{V}$

⑨ $\frac{\text{rate } 1}{\text{rate } 2} = \sqrt{\frac{M_2}{M_1}}$

$$\frac{\frac{x}{12.0\text{ min}}}{\frac{x}{15.0\text{ min}}} = \sqrt{\frac{M_2}{28.02\text{ g/mol}}}$$

$$\left(\frac{x}{12.0\text{ min}}\right)\left(\frac{15.0\text{ min}}{x}\right) = \sqrt{\frac{M_2}{28.02\text{ g/mol}}}$$

$$\left(\frac{15.0\text{ min}}{12.0\text{ min}}\right)^2 = \frac{M_2}{28.02\text{ g/mol}}$$

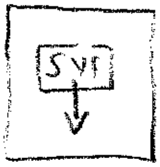
$M_2 = 43.8$ g/mol

↑ larger MM is consistent with a slower rate $\left(\frac{x}{15.\text{ min}}\right)$ compared to N_2

(10) Energy = capacity to do work units $\frac{Kg\ m^2}{s^2}$

(11) Heat = transfer of thermal energy in units of $\frac{Kg\ m^2}{s^2}$

(12)



$q_{sys} = -928\ J$

$\Delta E_{sys} = q + w$

$-1.47 \times 10^3\ KJ = -928\ J + w$

$w_{sys} = -1.47 \times 10^3\ KJ + 928\ KJ$

$= -542\ KJ$ ← work done by the system

(13) $\left(\frac{mol \cdot °C}{x\ J}\right)\left(\frac{y\ g}{mol}\right)\left(\frac{1}{100g}\right)\left(\frac{200\ KJ}{1}\right)\left(\frac{1000\ J}{1\ KJ}\right) = 2000\ \frac{y}{x}\ °C$ ← largest $y\left(\frac{g}{mol}\right)$ ← smallest $x\left(\frac{J}{mol\ °C}\right)$

Silver $\frac{107.9}{25.35} = 4.26$

Al $\frac{26.98}{24.35} = 1.11$

Hg $\frac{200.6}{27.98} = 7.15$ ← largest ratio!

Cu $\frac{63.55}{24.44} = 2.60$

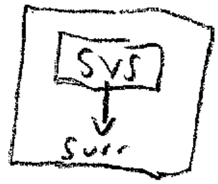
Fe $\frac{55.85}{25.10} = 2.26$

(14) $q_{rxn} = -q_{cal} = -m_{cal} C_{cal} \Delta T$

$$= -(200.0\,mL)\left(\frac{1.00\,g}{mL}\right)\left(\frac{4.18\,J}{g\,°C}\right)(30.4 - 24.0\,°C)$$

$$= -5350\,J$$ ← neg sign is consistent with exothermic rxn

$q_{rxn} = -5.35\,kJ$



(15) $q_{rxn} = -q_{cal} = -C_{cal}\,\Delta T$ and $E_{molar} = \dfrac{q_{rxn}}{n_{Benz}}$

$$C_{cal} = \frac{-q_{rxn}}{\Delta T} = \frac{-(q_{molar})(n_{Benz})}{\Delta T} = \frac{(-)(-3.22\times10^{4}\,kJ/mol)(1.350\,g)\left(\frac{1\,mol}{122.12\,g}\right)}{(25.4°C - 22.5°C)}$$

$$C_{cal} = 122.7\,\frac{kJ}{°C}$$ ← must be positive for a heat capacity

(16) Rules for Formation Rxn

1. must be balanced for number and type of atoms
2. Single product w/ stoich = 1
3. Reactants are elements in std state

(17) $W_{sys} = -P\Delta V$

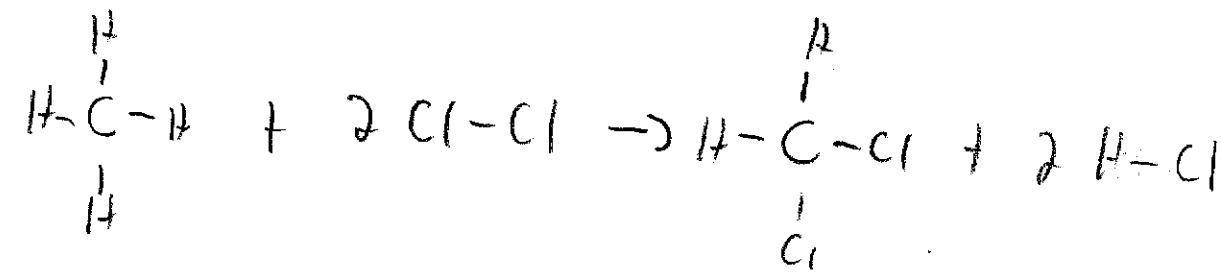
$= -(102.2\ KPa)(1.65L - 0.100L)$

$= -158\ KPa \cdot L$

note: $1\,J = 1\,Pa \cdot m^3 \left(\frac{1000\,L}{1\,m^3}\right) = 1\,KPa \cdot L$

$\left(-158\ KPa \cdot L\right)\left(\frac{1\,J}{1\,KPa \cdot L}\right) = -158\,J$

↑ work done by the system
this is consistent with
a balloon expanding.

(18) 

Break 2 C-H = 2 X 414 = 828 ⎫
Break 2 Cl-Cl = 2 X 243 = 486 ⎭ 1314

Form 2 C-Cl = 2 X 339 = 678 ⎫
Form 2 H-Cl = 2 X 431 = 862 ⎭ 1540

1314 − 1540 = −226 KJ/mol

(19) $[3(-393.5) + 3(-241.8)] - [-671.0]$

$= -1180.5 - 725.4 + 671.0$

$= -1234.9$ KJ/mol

(20) $\frac{1}{2} m v^2 = \frac{(5.6\ g)\left(\frac{1\ Kg}{1000\ g}\right)\left(\frac{650\ m}{s}\right)^2}{2}$

$= 1183\ \frac{Kg\ m^2}{s^2}$

$= 1200$ J

(21.) $n = \frac{PV}{RT}$

$$n(NH_3) = \frac{(100.0\ KPa)(50.0\ L)}{(8.314\ L\,KPa\,mol^{-1}K^{-1})(298\ K)} = 2.02\ mol$$

$\frac{4\,NO}{4\,NH_3} = 2.02$ mol NO

$P_{O_2} = 220.0 - 100.0 = 120$ KPa

(Start mol NH_3 ½
Pressure O_2 ½
Start mol O_2 ½
limiting Reactant ½)

$$n(O_2) = \frac{(120.0\ KPa)(50.0\ L)}{(8.314\ L\,KPa\,mol^{-1}K^{-1})(298\ K)} = 2.42\ mol$$

$\frac{4\,NO}{5\,O_2} = 1.94$ mol NO ← limiting Reactant!

	$4\,NH_3$	$+\ 5\,O_2$	$\rightarrow 4\,NO$	$+\ 6\,H_2O$
I	2.02	2.42	0	0
C	−1.94	−2.42	+1.94	+2.90
End	0.084	0	1.94	2.90
	↑ gas		↑ gas	

(End mol NH_3 ½
End mol NO ½)

Total moles of gas = 1.94 + 0.08 = 2.02 (Total mols gas ½ mark)

$$P_{tot} = \frac{(2.02\ mol)(8.314\ L\,KPa\,mol^{-1}K^{-1})(273\ K)}{50.0\ L} = \boxed{91.7\ KPa}$$ (½ mark)

$$P_{NH_3} = X_{NH_3}P_{tot} = \left(\frac{0.08}{2.02}\right)91.7\ KPa = \boxed{3.63\ KPa}$$ (½ mark)

$$P_{NO} = X_{NO}P_{tot} = \left(\frac{1.94}{2.02}\right)91.7\ KPa = \boxed{88.1\ KPa}$$ (½ mark)

(Total 5 marks)

(22)

- Equation 1 - as is
- Reverse eqn 3
- Eqn 2 - multiply by 2

$C_2H_2 + \cancel{\frac{5}{2}O_2} \rightarrow \cancel{2CO_2} + \cancel{H_2O}$	-1300	($\frac{1}{2}$ mark)
$\cancel{2CO_2} + \cancel{3H_2O} \rightarrow C_2H_6 + \cancel{\frac{7}{2}O_2}$	$+1560$	(1 mark)
$2H_2 + \cancel{\frac{2}{2}O_2} \rightarrow \cancel{2H_2O}$	$-(2)286$ or -572	($1\frac{1}{2}$ mark)
(+) $C_2H_2 + 2H_2 \rightarrow C_2H_6$	-312 KJ/mol	(1 mark)

- The reaction releases heat (exothermic) ($\frac{1}{2}$ mark)
- $\Delta H_{molar} / C_2H_6 = -312$ KJ/mol C_2H_6 ($\frac{1}{2}$ mark)

(Total = 5 marks)