Stage 3 - Set 1 Answers: Gases

1. a) i) $15 + 273 = 288$ K
   ii) $117 + 273 = 390$ K
   iii) $-105 + 273 = 168$ K

   b) i) $298 - 273 = 25^{o}C$
   ii) $473 - 273 = 200^{o}C$
   iii) $112 - 273 = -161^{o}C$

2. a)
$$n(CO_2) = \frac{0.450 \times 120.1}{299 \times 8.315}$$
$$= 2.17 \times 10^{-2} \text{ mol}$$

   b)
$$n(CH_4) = \frac{0.889 \times 99.3}{(41 + 273) \times 8.315}$$
$$= 3.38 \times 10^{-2} \text{ mol}$$

   c)
$$n(N_2) = \frac{27.5 \times 145}{(273 + 55) \times 8.315}$$
$$= 1.46 \text{ mol}$$

3. a)
$$n = \frac{0.559 \times 105}{(25 + 273) \times 8.315}$$
$$= 2.37 \times 10^{-2} \text{ mol}$$
$$M = \frac{2.22}{2.19 \times 10^{-2}}$$
$$= 93.7 \text{ g mol}^{-1}$$

   b)
$$n = \frac{1.22 \times 98.5}{(75 + 273) \times 8.315}$$
$$= 4.15 \times 10^{-2} \text{ mol}$$
$$M = \frac{0.456}{4.15 \times 10^{-2}}$$
$$= 11.0 \text{ g mol}^{-1}$$

   c)
$$n = \frac{3.33 \times 68.4}{(120 + 273) \times 8.315}$$
$$= 6.97 \times 10^{-2} \text{ mol}$$
$$M = \frac{6.46}{6.97 \times 10 - 2}$$
$$= 92.7 \text{ g mol}^{-1}$$

4. $$n = \frac{0.6684 \times 98.0}{(273 + 25) \times 8.315}$$
$= 2.64 \times 10^{-2}$ mol
$$M = \frac{0.761}{2.64 \times 10^{-2}}$$
$= 28.8$ g mol^{-1}
C_2H_4 (ethene)

5. $CaCO_3(s) + 2H^+(aq) \rightarrow CO_2(g) + H_2O(\ell) + Ca^{2+}(aq)$
$$n(CO_2) = \frac{0.0255 \times 10^5}{(273 + 25) \times 8.315}$$
$= 1.08 \times 10^{-3}$ mol
$n(CaCO_3) = n(CO_2)$
$= 1.08 \times 10^{-3}$ mol
$m(CaCO_3) = 1.08 \times 10\text{-}3\ (40.08 + 12.01 + 48.0)$
$= 0.108$ g

6. a) i) $X + 2H^+ \rightarrow X^{2+} + H_2$
ii) $2X + 6H^+ \rightarrow 2X^{3+} + 3H_2$

b) $$n(H_2) = \frac{1.34 \times 115}{(32 + 273) \times 8.315}$$
$= 6.08 \times 10^{-2}$ mol

i) $n(X) = 2 \times n(H_2)$
$= 0.122$ mol
$$M(X) = \frac{2.76}{0.122}$$
$= 22.7$ g mol^{-1}

ii) $n(X) = n(H_2)$
$= 6.08 \times 10^{-2}$ mol
$$M(X) = \frac{2.76}{6.08 \times 10^{-2}}$$
$= 45.4$ g mol^{-1}

iii) $n(X) = 2/3\ n(H_2)$
$= 4.05 \times 10^{-2}$ mol
$$M(X) = \frac{2.76}{4.05 \times 10^{-2}}$$
$= 68.1$ g mol^{-1}

c) If monovalent X = Na
For divalent, no value as close as Na
For trivalent no viable choice.