EXPLANATION SHEET

MCQ

1. Look for a molecule that is nonpolar and has a low molar mass.

2. Use Combined Gas Law
    a. $P_1V_1 / T_1 = P_2V_2 / T_2$
    b. $PV / T = (3P)(xV) / (½T)$
    c. x = ⅙

3. Use MM = dRT / P
    a. MM_{O2} = dRT / P = (0.02500 g / 0.0175 L)(0.08206 Latm/molK)(300.15 K) / (1.000 atm) = 35.17 g/mol
        i. 17.50 mL = 0.0175 L
        ii. 27.0 C = 300.15 K

4. Since he measures the temperature in Celsius, his mistake does not affect the results too much because Kelvin is used in the equation, offsetting the error.

5. Since the problem does not give nor does not ask for the actual size of each city, any numbers can be used. In the following example calculation, the size of the smallest city, Anthrax, is 2.
    a. Doune: 12900 people / 6 area = 2150 people/area
    b. Camelot: 14000 people / 3 area = 4666.67 people/area
    c. Anthrax: 11300 people / 2 area = 5650 people/area

6. Use the formula for molarity and some stoichiometry.
    a. $n_{NaOH} = n_{HCl}$
        i. 1:1 ratio of NaOH to HCl
    b. $n_{HCl} = VM_{HCl}$ = (15.00 mL)(3.00 M) = 45 mmol
    c. n_{NaOH} = 45 mmol / 5.00 M = 9.000 mL

7. Pressure is dependent on height and since both tanks have the same height, the pressure on the valve is the same in both tanks.

8. Use formula for molarity
    a. $n_{KCl} = V_{initial}M_{KCl}$ = (15.0 mL)(4.00 M) = 60.0 mmol
    b. $V_{new} = n_{KCl} / M_{new}$ = 60.0 mmol / 2.50 M = 24.0 mL
    c. $\Delta V = V_{new} - V_{initial}$ = 24.0 mL - 15.0 mL = 9.0 mL

9. Use MM = dRT / P
    a. d_{O2} = MMP / RT = (32.00 g/mol)(0.750 atm) / (0.08206 Latm/molK)(263.15 K) = 1.11 g/L
        i. -10. C = 263.15 K

10. Find the volume of the jar
    a. $V_{jar} = \pi r^2 h = \pi * (2.5\ cm)^2 * (10\ cm) = 196\ cm^3$
    b. Since there cannot be a perfect fit of beans, round down to 180 beans.

FRQ

1. See answer key

2. See answer key

3. See answer key

4. See answer key

5. Use formula for molarity
    a. $M_{NaCl} = n_{NaCl} / V = (0.1711\ mol\ NaCl) / (0.500\ L) =$ **0.342 M** NaCl
        i. $n_{NaCl} = m / MM = (10.0\ g) / (58.440\ g/mol) = 0.1711\ mol$
        ii. There are three significant figures because 10.0 g has three and the volume of water is exact when a volumetric flask is used.

6. See answer key

7. Use formula for buoyancy force
    a. $F_b = d_{water} g V_{displaced} = (0.00100\ kg/cm^3)(9.81\ m/s^2)(64\ cm^3) =$ **0.63 N**
        i. $V_{displaced} = (4.0\ cm)^3 = 64\ cm^3$

8. Use formula for buoyancy force
    a. $F_b = d_{water} g V_{displaced} = (0.00100\ kg/cm^3)(9.81\ m/s^2)(40.\ cm^3) =$ **0.39 N**

9. Use F = ma, d = m / V
    a. $F_{net} = F_g + F_b = (m_{object})(-g) + d_{water} g V_{displaced} = (m_{object})(-9.81\ m/s^2) + (0.00100\ kg/cm^3)(9.81\ m/s^2)(40.\ cm^3) = (-9.81 m_{object})\ N + 0.39\ N$
    b. Divide everything by m_{object}
    c. $a_{net} = -9.81\ m/s^2 + (0.39\ N) / m_{object} = -0.50\ m/s^2$
        i. $a_{net} = 2\Delta y / t^2 = (2)(-1.0\ m) / (2.0\ s)^2 = -0.50\ m/s^2$
        ii. $m_{object} = 0.042\ kg = 42\ g$
    d. $d_{object} = m_{object} / V_{object} = (42\ g) / (40.\ cm^3) =$ **1.1 g/cm³**

10. Use Ideal Gas Law
    a. V = nRT / P = (0.0195 mol)(0.08206 Latm/molK)(303.15 K) / (0.974 atm) = **0.498 L**
        i. (3.00 g) / (153.81 g/mol) = 0.0195 mol
        ii. 30. C = 303.15 K
        iii. (740. torr) / (760 torr/atm) = 0.974 atm

iv. There are three significant figures because when you convert C to K, you are adding, which increases the significant figures of the temperature from 2 to 3.

11. Use Dalton's Law of Partial Pressures, Boyle's Law
    a. $P_{total} = P_{Gas1} + P_{Gas2} + P_{Gas3}$ = 2.0 atm + 1.5 atm + 4.0 atm = 7.5 atm
    b. $P_2 = P_1V_1 / V_2$ = (7.5 atm)(9.5 L) / (8.0 L) = **8.9 atm**
        i. $V_1 = V_{Gas1} + V_{Gas2} + V_{Gas3}$ = 3.0 L + 2.0 L + 4.5 L = 9.5 L

12. Use formula for specific gravity
    a. $G_{object} = W_{in\ air} / (W_{in\ air} - W_{in\ water})$ = (0.1825 N) / (0.1825 N - 0.15 N) = **5.6**
        i. $W_{in\ air} = gm$ = (9.81 m/s2)(0.01860 kg) = 0.1825 N
            1. 18.60 g = 0.01860 kg

HANDS-ON PORTION

Station 1

1. Use formula for density
    a. d = m / v = (19.08 g) / (9 mL) = 2 g/mL
    b. The graduated cylinder limits the significant figures to one: 71 mL - 62 mL = 9 mL
2. Specific gravity is density of the object compared to the density of, in this case, water, so 2 (without units)
3. Use formula for specific gravity
    a. $G_{object} = W_{in\ air} / (W_{in\ air} - W_{in\ water})$
    b. $W_{in\ water} = W_{in\ air} - W_{in\ air} / G_{object}$ = 0.1872 N - (0.1872 N) / ((19.08 g) / (9 mL)) = 0.1 N
        i. $W_{in\ air} = gm$ = (9.81 m/s2)(0.01908 kg) = 0.1872 N
            1. 19.08 g = 0.01908 kg
4. See answer key

Station 2

1. Use formula for density
    a. d = m / v = (16.26 g) / (1.8 cm * 3.4 cm * 1.0 cm) = 2.7 g/cm^3
    b. The rulers limit the number of significant figures to two.
2. Use formula for density
    a. d = m / v = (43.91 g) / (2.1 cm * (3.6 cm)^2 * π)) = 0.51 g/cm^3
    b. The rulers limit the number of significant figures to two.
3. Use formula for density
    a. d = m / v = (77.02 g) / (4/3 * π * (2.3 cm)^3) = 1.5 g/cm^3
    b. The rulers limit the number of significant figures to two.
4. Compare the densities of the objects to the density of water. Use the formula for force of buoyancy.
    a. d_{water} = 1.00 g/cm^3
        i. Objects A and C will sink

b. Object A: $F_b = d_{water} g V_{displaced}$ = (0.00100 kg/cm^3)(9.81 m/s^2)(1.8 cm * 3.4 cm *1.0 cm) = 0.060 N
    i. The rulers limit the number of significant figures to two.
c. Object C: $F_b = d_{water} g V_{displaced}$ = (0.00100 kg/cm^3)(9.81 m/s^2)(4/3 * π * (2.3 cm)^3) = 0.50 N
    i. The rulers limit the number of significant figures to two.

Station 3

1. Use ratios
    a. $d_{water} / W_{water} = d_{oil} / W_{oil} \rightarrow W_{oil} = d_{oil} / (d_{water} / W_{water})$ = (0.93 g/mL) / ((1.00 g/mL) / (0.25 N)) = 0.23 N
2. Use ratios
    a. $d_{water} / W_{water} = d_{unknown} / W_{unknown} \rightarrow d_{unknown} = (W_{unknown})(d_{water} / W_{water})$ = (0.33 N)((1.00 g/mL) / (0.25 N)) = 1.3 g/mL
3. Look at the table
    a. 1.32 g/mL is closest to light corn syrup

Station 4

1. Use ratios. Use a periodic table for molar masses of gases.
    a. P_{argon} / MM_{argon} [or] $P_{neon} / MM_{neon} = P_{unknown} / MM_{unknown} \rightarrow MM_{unknown} = P_{unknown} / (P_{argon} / MM_{argon})$ [or] $P_{unknown} / (P_{neon} / MM_{neon})$ = (1.77 atm) / ((2.53 atm) / (39.948 g/mol) [or] (1.77 atm) / ((1.28 atm) / (20.180 g/mol) ≈ 28 g/mol
    b. Find gases with a molar mass close to 28 g/mol
        i. Examples: CO (28.010 g/mol), ethene/ethylene (28.054 g/mol), N_2 (28.014 g/mol)
2. Equal grams means rank by molar mass. The higher the molar mass, the smaller number of moles (and molecules) there will be with equal grams. For example, 10. g of Argon gas would yield 0.25 moles of Argon while 10. g of Neon gas would yield 0.50 moles of Neon. A<C<B
3. Since equal moles means equal molecules of each gas and the volume of each container is equal, the number density will be the same for all three containers.