Name:

Data

Part A Data:

Metal cylinder number: (A1)

Length of metal cylinder: (A2)

Diameter of metal cylinder: (A3)

Mass of metal cylinder: (A4)

Part B Data:

Unknown metal shot number: (B1)

Mass of metal shot(trial 1): (B2)

Initial volume in graduated cylinder(trial 1): (B3)

Final volume in graduated cylinder(trial 1): (B4)

Mass of metal shot(trial 2): (B5)

Initial volume in graduated cylinder(trial 2): (B6)

Final volume in graduated cylinder(trial 2): (B7)

Mass of metal shot(trial 3): (B8)

Initial volume in graduated cylinder(trial 3): ______ **(B9)**

Final volume in graduated cylinder(trial 3): ______ **(B10)**

Part C Data:

Unknown number of salt solution: ______ **(C1)**

Mass of 10.00 mL of unknown salt solution (trial 1): ______ **(C2)**

Mass of 10.00 mL of unknown salt solution (trial 2): ______ **(C3)**

Mass of 10.00 mL of unknown salt solution (trial 3): ______ **(C4)**

Part D Data:

Unknown number on lamp: ______ **(D1)**

Initial mass of lamp: ______ **(D2)**

Initial temperature of water: ______ **(D3)**

Final temperature of water: ______ **(D4)**

Final mass of lamp: ______ **(D5)**

Part A Analysis:

1.) Calculate the radius (r) of your metal cylinder. Note the “2” is an exact number.

$$r = \frac{(A3)}{2}$$

$$\frac{\boxed{}}{2} = \boxed{} \quad \textbf{(A5)}$$

2.) Calculate the volume of your metal cylinder using the formula for the volume of a cylinder and record it below to the correct number of significant figures with the correct units.

$$V_{cylinder} = \pi r^2 h \qquad r = (A5) \qquad h = (A2)$$

$$V_{cylinder} = (\pi)\left(\boxed{}\right)^2 \boxed{} = \boxed{} \quad \textbf{(A6)}$$

3.) Calculate the density of your metal cylinder using **Equation 1**.

$$\text{density} = \frac{m}{V} \quad \textbf{(Equation 1)}$$

Here m = **(A4)** and V = **(A6)**. Record the density below to the correct number of significant figures with the correct units.

$$\textbf{Density} = \frac{\boxed{}}{\boxed{}} = \boxed{} \quad \textbf{(A7)}$$

Part B Analysis:

The volume of your metal shot is how much the volume in your graduated cylinder increased when you added the metal shot to it. That is, the volume of your metal shot is the final volume minus the initial volume in your graduated cylinder.

$$V_{shot} = \text{Final Volume} - \text{Initial Volume} \quad \text{(Equation 7)}$$

1.) Use Equation 7 to calculate the volume of your metal shot for trial 1 and record it to the correct number of significant figures with the correct units. Here the final volume is **(B4)** and the initial volume is **(B3)**.

V_{shot} = [ ] - [ ] = [ ] **(B11)**

2.) Now calculate the density of your metal shot for trial 1 using **Equation 1** where the mass is **(B2)** and the volume is **(B11)**. Record this density to the correct number of significant figures and with the correct units.

Density = [ ] / [ ] = [ ] **(B12)**

3.) Use Equation 7 to calculate the volume of your metal shot for trial 2 and record it to the correct number of significant figures with the correct units. Here the final volume is **(B7)** and the initial volume is **(B6)**.

V_{shot} = [ ] - [ ] = [ ] **(B13)**

4.) Now calculate the density of your metal shot for trial 2 using **Equation 1** where the mass is **(B5)** and the volume is **(B13)**. Record this density to the correct number of significant figures and with the correct units.

Density = $\frac{\square}{\square}$ = $\square$ **(B14)**

5.) Use Equation 7 to calculate the volume of your metal shot for trial 3 and record it to the correct number of significant figures with the correct units. Here the final volume is **(B10)** and the initial volume is **(B9)**.

V_{shot} = $\square$ - $\square$ = $\square$ **(B15)**

6.) Now calculate the density of your metal shot for trial 3 using **Equation 1** where the mass is **(B8)** and the volume is **(B15)**. Record this density to the correct number of significant figures and with the correct units.

Density = $\frac{\square}{\square}$ = $\square$ **(B16)**

7.) Calculate the average density of your metal shot. The average density is given by:

$$\text{Average Density} = \frac{\text{B12} + \text{B14} + \text{B16}}{3}$$

The "3" is an exact number.

$$\frac{\square + \square + \square}{\mathbf{3}} = \square$$ **(B17)**

8.) Using the following table determine the identity of your unknown metal shot. The metal that has its density closest to the average density you calculated for **(B17)** should be your metal. Record the identity of your unknown along with it's unknown number **(B1)** below.

Metal	**Density**
Aluminum	2.70 g/cm^3
Lead	11.34 g/cm^3
Nickel	8.908 g/cm^3
White Tin	7.365 g/cm^3
Gray Tin	5.769 g/cm^3
Tungsten	19.25 g/cm^3
Titanium	4.506 g/cm^3
Zirconium	6.49 g/cm^3

Unknown Number: ______ **(B1)**

Identity (Name) of unknown: ______ **(B18)**

Part C Analysis:

1.) Calculate the density of your unknown salt solution from trial 1 using **Equation 1**. Here m = **(C2)** and V = 10.00 mL (4 significant figures!). Record the density of your unknown salt solution below to the correct number of significant figures. Make sure to include the correct units.

Density = $\frac{\boxed{}}{\boxed{}}$ **=** ______ **(C5)**

2.) Calculate the density of your unknown salt solution from trial 2 using **Equation 1**. Here m = **(C3)** and V = 10.00 mL (4 significant figures!). Record the density of your unknown salt solution below to the correct number of significant figures. Make sure to include the correct units.

Density = $\frac{\boxed{}}{\boxed{}}$ **=** $\boxed{}$ **(C6)**

3.) Calculate the density of your unknown salt solution from trial 3 using **Equation 1**. Here m = **(C4)** and V = 10.00 mL (4 significant figures!). Record the density of your unknown salt solution below to the correct number of significant figures. Make sure to include the correct units.

Density = $\frac{\boxed{}}{\boxed{}}$ **=** $\boxed{}$ **(C7)**

4.) Calculate the average density of your unknown salt solution. The average density is given by:

$$\text{Average Density} = \frac{\text{C5} + \text{C6} + \text{C7}}{3}$$

The “3” is an exact number.

$\frac{\boxed{} + \boxed{} + \boxed{}}{\mathbf{3}}$ **=** $\boxed{}$ **(C8)**

5.) The following equation (equation 8), is the equation of the best-fit straight line of the graph of the data in the table below. We can see that there is a linear relationship between the density of a solution of sodium chloride and the mass % sodium chloride in that solution.

y = 0.007624x + 0.9962 (Equation 8)

Mass % Sodium Chloride	Density (g/mL)
0.00	0.9960
3.50	1.023
5.25	1.036
8.75	1.063
11.25	1.082
14.50	1.107
16.75	1.124
19.00	1.141
23.50	1.175
27.25	1.204

When we rearrange equation 8 to solve for "**x**", we get equation 9 below. Since "**x**" represents the mass % of sodium chloride in your solution, this is what we need to find. The density of your unknown solution is "**y**" in equation 9.

$$x = \frac{y - b}{m}$$ **(Equation 9)**

Use the average density of your unknown solution, **(C8)**, for "y" in equation 9, and the values of m (0.007624) and b(0.9962) from equation 8 in the boxes below to calculate the mass % sodium chloride in your unknown solution **(C9)**.

$$x = \frac{\boxed{} - \boxed{}}{\boxed{}} = \boxed{}$$ **(C9)**

Record the mass % sodium chloride in your unknown **(C9)** and your unknown salt solution number **(C1)** below.

Unknown number of salt solution:		**(C1)**
Mass % sodium chloride unknown salt solution:		**(C9)**

Part D Analysis

The amount of energy that goes into the water, causing the temperature of the water to rise (q_{water}) we assume is equal to the amount of energy that comes of of the liquid when it burns (q_{liquid}). We can calculate q_{water} using the specific heat equation:

$$q_{water} = m_{water} \cdot s_{water} \cdot \Delta T_{water}$$

Here m_{water} is the mass of the water in grams. Knowing the volume of water we used (25.00 mL) and the density of water at the initial temperature we can fins the mass of the water.

Using the table on the next page, find the density of water at the initial temperature of your water **(D3)**. In the table the densities are in **g/mL** and the temperatures are in **^{o}C**.

To use the table, find the temperature **(D3)** to the ones place in the left column. Move across that row until you get to the column that corresponds to the number in the tenths place of your temperature. The number in that cell is your density. Write that density here, using the correct units.

Density of water =		**(D6)**

For example, if your temperature is 14.7 ^{o}C, your density is shown by the intersection of the green cells (0.999144 g/mL).

Density of Water (g/mL) as a Function of Temperature (^oC)

	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.999841	0.999847	0.999854	0.999860	0.999866	0.999872	0.999878	0.999884	0.999889	0.999895
1	0.999900	0.999905	0.999909	0.999914	0.999918	0.999923	0.999927	0.999930	0.999934	0.999938
2	0.999941	0.999944	0.999947	0.999950	0.999953	0.999955	0.999958	0.999960	0.999962	0.999964
3	0.999965	0.999967	0.999968	0.999969	0.999970	0.999971	0.999972	0.999972	0.999973	0.999973
4	0.999973	0.999973	0.999973	0.999972	0.999972	0.999972	0.999970	0.999969	0.999968	0.999966
5	0.999965	0.999963	0.999961	0.999959	0.999957	0.999955	0.999952	0.999950	0.999947	0.999944
6	0.999941	0.999938	0.999935	0.999931	0.999927	0.999924	0.999920	0.999916	0.999911	0.999907
7	0.999902	0.999898	0.999893	0.999888	0.999883	0.999877	0.999872	0.999866	0.999861	0.999855
8	0.999849	0.999843	0.999837	0.999830	0.999824	0.999817	0.999810	0.999803	0.999796	0.999789
9	0.999781	0.999774	0.999766	0.999758	0.999751	0.999742	0.999734	0.999726	0.999717	0.999709
10	0.999700	0.999691	0.999682	0.999673	0.999664	0.999654	0.999645	0.999635	0.999625	0.999615
11	0.999605	0.999595	0.999585	0.999574	0.999564	0.999553	0.999542	0.999531	0.999520	0.999509
12	0.999498	0.999486	0.999475	0.999463	0.999451	0.999439	0.999427	0.999415	0.999402	0.999390
13	0.999377	0.999364	0.999352	0.999339	0.999326	0.999312	0.999299	0.999285	0.999272	0.999258
14	0.999244	0.999230	0.999216	0.999202	0.999188	0.999173	0.999159	0.999144	0.999129	0.999114
15	0.999099	0.999084	0.999069	0.999054	0.999038	0.999023	0.999007	0.998991	0.998975	0.998959
16	0.998943	0.998926	0.998910	0.998893	0.998877	0.998860	0.998843	0.998826	0.998809	0.998792
17	0.998774	0.998757	0.998739	0.998722	0.998704	0.998686	0.998668	0.998650	0.998632	0.998613
18	0.998595	0.998576	0.998558	0.998539	0.998520	0.998501	0.998482	0.998463	0.998444	0.998424
19	0.998405	0.998385	0.998365	0.998345	0.998325	0.998305	0.998285	0.998265	0.998244	0.998224
20	0.998203	0.998183	0.998162	0.998141	0.998120	0.998099	0.998078	0.998056	0.998035	0.998013
21	0.997992	0.997970	0.997948	0.997926	0.997904	0.997882	0.997860	0.997837	0.997815	0.997792
22	0.997770	0.997747	0.997724	0.997701	0.997678	0.997655	0.997632	0.997608	0.997585	0.997561
23	0.997538	0.997514	0.997490	0.997466	0.997442	0.997418	0.997394	0.997369	0.997345	0.997320
24	0.997296	0.997271	0.997246	0.997221	0.997196	0.997171	0.997146	0.997120	0.997095	0.997069
25	0.997044	0.997018	0.996992	0.996967	0.996941	0.996914	0.996888	0.996862	0.996836	0.996809
26	0.996783	0.996756	0.996729	0.996703	0.996676	0.996649	0.996621	0.996594	0.996567	0.996540
27	0.996512	0.996485	0.996457	0.996429	0.996401	0.996373	0.996345	0.996317	0.996289	0.996261
28	0.996232	0.996204	0.996175	0.996147	0.996118	0.996089	0.996060	0.996031	0.996002	0.995973
29	0.995944	0.995914	0.995885	0.995855	0.995826	0.995796	0.995766	0.995736	0.995706	0.995676
30	0.995646	0.995616	0.995586	0.995555	0.995525	0.995494	0.995464	0.995433	0.995402	0.995371
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9

Now calculate the mass of your water, $\mathbf{m_{water}}$, by multiplying it's volume (25.00 mL) by the density you just found **(D6)**.

$$m_{water} = (25.00\ mL)\cdot(D6)$$

m_{water} =(25.00 mL)· ______ = ______ **(D7)**

Now find the change in temperature of your water, $\mathbf{\Delta T_{water}}$.

$$\Delta T_{water} = T_{final} - T_{initial} = (D4) - (D3)$$

ΔT_{water} = ______ - ______ = ______ **(D8)**

Next we calculate the amount of energy that went into the water, $\mathbf{q_{water}}$.

$$q_{water} = (D7)\cdot(4.184\ J/g^oC)\cdot(D8)$$

q_{water}= ______ ·(4.184 J/g°C)· ______ = ______ **(D9)**

Now that we know $\mathbf{q_{water}}$, we know $\mathbf{q_{liquid}}$ since $\mathbf{q_{liquid} = -q_{water}}$.

The energy content of the liquid is just the amount of energy that was released when it burned divided by the mass of the liquid that burned.

$$m_{liquid} = (D5) - (D2) = (D10)$$

$$\text{Energy Content} = \frac{-(D9)}{(D10)} = (D11)$$

m_{liquid} = [ ] **-** [ ] **=** [ ] **(D10)**

Energy Content = $\frac{[\ \ ]}{[\ \ ]}$ **=** [ ] **(D11)**

Write your unknown number **(D1)** here too.

Unknown liquid number **(D1)**: [ ] **(D1)**