Challenge Problem

A 1.42 gram sample of a pure compound, with formula M_2SO_4 was dissolved in water and treated with an excess of aqueous barium chloride, resulting in the precipitation of all the sulfate ions as barium sulfate. The precipitate was collected, dried and found to weigh 2.33 grams. Determine the atomic mass of M and identify M.

Problem Solving Template

Analyze

1A

Question: (what are you trying to find out?)

what is the atomic mass of M & what metal is it?

Known: (what information does the problem give you?)

1.42g pure M_2SO_4 w/ excess $BaCl_2$ (reactants)
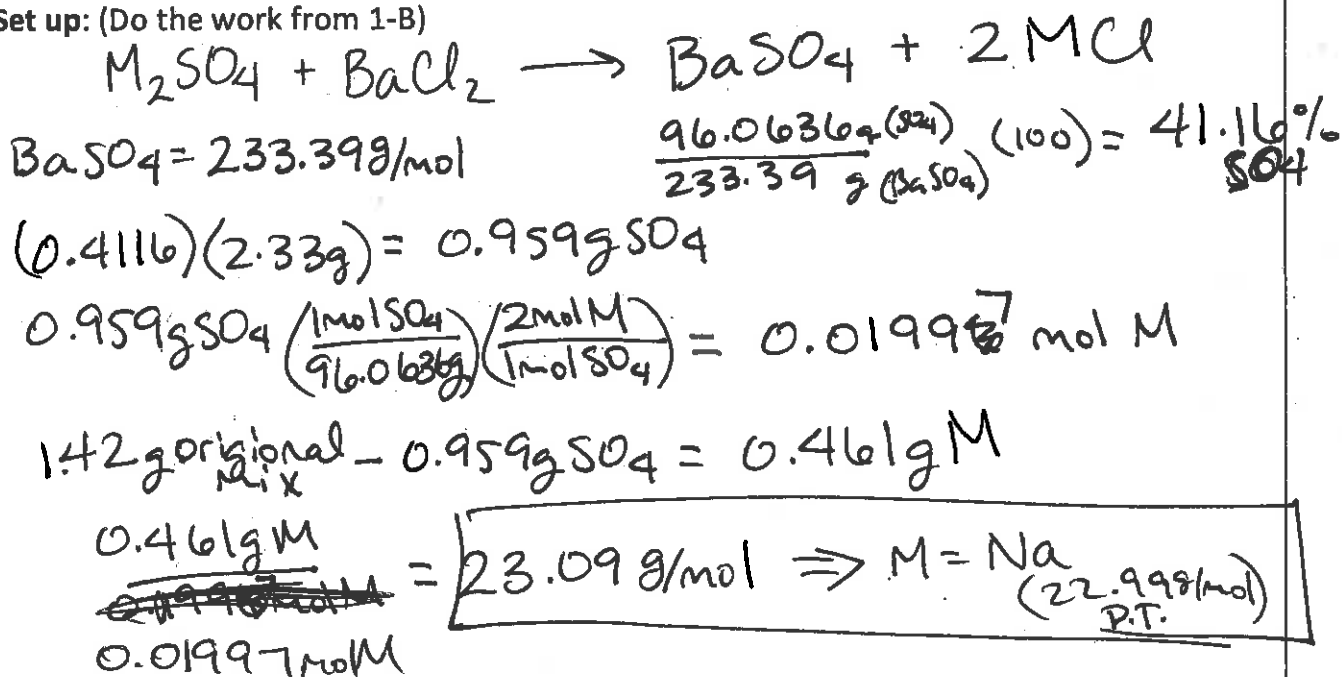
2.33 g $BaSO_4$ product (contains all the SO_4)

1B

What do you **need** to do to solve the **problem?** (break it down into parts)

- Balance Equation
- molar mass $BaSO_4$ → mass % SO_4 → mass SO_4 – mol SO_4
- mass SO_4 → mass M , mol SO_4 → mol M
- check w/ stoichiometry from predicted starting material.

Calculate

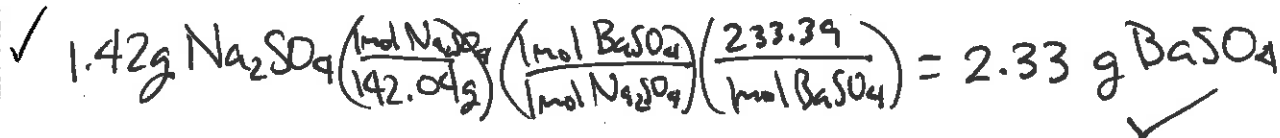**2A**

Set up: (Do the work from 1-B)

$$M_2SO_4 + BaCl_2 \longrightarrow BaSO_4 + 2MCl$$

$BaSO_4 = 233.39 g/mol$

$$\frac{96.0636 g (SO_4)}{233.39 g (BaSO_4)} (100) = 41.16\% \; SO_4$$

$$(0.4116)(2.33g) = 0.959 g SO_4$$

$$0.959 g SO_4 \left(\frac{1 mol SO_4}{96.0636 g}\right)\left(\frac{2 mol M}{1 mol SO_4}\right) = 0.01997 \; mol M$$

$$1.42 g \underset{Mix}{original} - 0.959 g SO_4 = 0.461 g M$$

$$\frac{0.461 g M}{0.01997 mol M} = \boxed{23.09 g/mol \Rightarrow M = Na \; {(22.99 g/mol) \atop P.T.}}$$

2B

Answer the question: (Use the info from above to solve the problem)

$$\checkmark \; 1.42 g \; Na_2SO_4 \left(\frac{mol Na_2SO_4}{142.04 g}\right)\left(\frac{1 mol BaSO_4}{1 mol Na_2SO_4}\right)\left(\frac{233.39}{mol BaSO_4}\right) = 2.33 \; g \; BaSO_4 \checkmark$$

Evaluate

3

Does your answer make **sense?**

$\checkmark$

Problem Solving Template

1A

Question: (what are you trying to find out?)

Known: (what information does the problem give you?)

1B What do you **need** to do to solve the problem? (break it down into parts)

(9) alternate

2A **Set up:** (Do the work from 1-B)

or...

$$2.33g\ BaSO_4 \left(\frac{1 mol\ BaSO_4}{233.39g}\right)\left(\frac{1\ SO_4}{1\ BaSO_4}\right) = 0.00998 mol\ SO_4$$

$$0.00998 mol\ SO_4 \left(\frac{96.063g}{1\ mol\ SO_4}\right) = 0.959g\ SO_4$$

$$0.00998 mol\ SO_4 \left(\frac{2 mol\ M}{1 mol\ SO_4}\right) = 0.01996\ mol\ M$$

$$1.42g\ M_2SO_4 - 0.959g\ SO_4 = 0.461\ g\ M$$

2B **Answer** the question: (Use the info from above to solve the problem)

$$\frac{0.461g\ M}{0.01996\ Mol\ M} = 23.096\ g/mol$$

3 Does your answer make **sense?**

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