

Stoichiometry and Chemical Reactions
IJSO Theory Mock Test
Answer Sheet

Problem 1 – Chemical Analysis (9.00 points)

Part A – Chemical Equations (1.50 points)

A1. Write the balanced chemical reactions for all the 3 compounds.

(1.50 points)

Calculation:

Part B – Composition (4.00 points)

B1. Determine the masses of Na_2CO_3 , Na_2SO_4 , NaCl and the inert compound in the original 9.00 g sample.

(3.50 points)

Calculation:





Mass of Na_2SO_4 =

Mass of Na_2CO_3 =

Mass of NaCl =

Mass of the inert compound =

B2. Determine the mass percent composition of the mixture.

(0.50 points)

Calculation:



Mass % of Na_2SO_4 =

Mass % of Na_2CO_3 =

Mass % of NaCl =

Mass % of the inert compound =

Part C – Carbon Dioxide (2.50 points)

C1. If the mass of CO_2 released was measured, how many grams would be expected?

(0.70 points)

Calculation:



Mass of CO_2 =

C2. If the CO_2 were collected in a syringe at STP, how many litres of CO_2 would have been collected?

(0.50 points)

Calculation:

$V =$

C3. Write the balanced chemical equation and then calculate the mass of CaCO_3 that would be produced.

(0.70 points)

Calculation:

Mass of $\text{CaCO}_3 =$

C4. Find the CO_2 cost of producing 1.00 ton of CaCO_3

(0.60 points)

Calculation:

Cost =



Part D – Formation of Double Salts (1.00 points)

D1. Write the balanced chemical equation for the formation of the double salt.

(0.50 points)

Calculation:

D2. If the reaction is complete and all KCl is used, calculate the mass of the double salt formed.

(0.50 points)

Calculation:



Mass of the double salt =

Extra Space for Problem 1:



Problem 2 – Experimental Chemistry (6.40 points)

Part A – Tricky Yields - 1.50 points

A1. Write the equation of the reaction taking place.

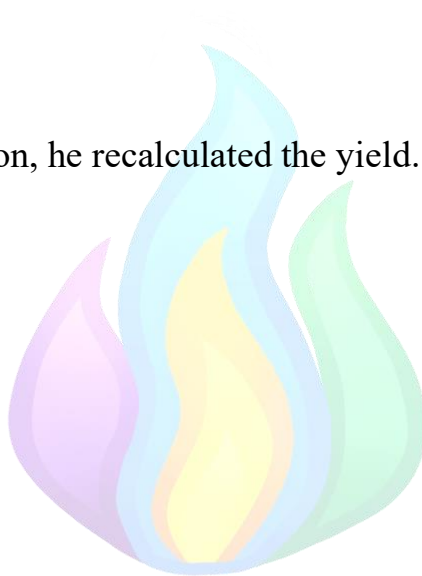
(0.30 points)

Calculation:

A2. Using this information, he recalculated the yield. What value did he get?

(1.20 points)

Calculation:



$\eta_{\text{actual}} =$

Part B – Thermochemistry (2.00 points)

B1. Find the chemical symbol of metal M

(0.75 points)

Calculation:



Symbol :

B2. Find the halogen in compound X

(0.75 points)

Calculation:



Symbol :

B3. Write the balanced equations of all the described reactions.

(0.50 points)

Calculation:

Part C – The Iron Nail (2.10 points)

C1. Write the equations of the reactions taking place.

(0.60 points)

Calculation:

C2. Calculate the mass change of the iron nail

(1.50 points)

Calculation:



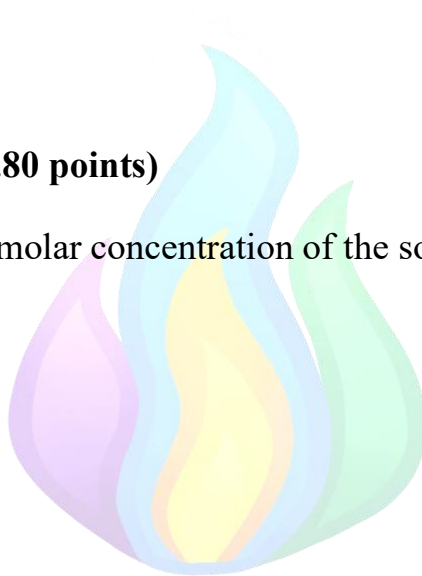
Mass change =

Part D – Wrong Salt (0.80 points)

D1. Calculate the actual molar concentration of the solution.

(0.80 points)

Calculation:



Actual molar concentration =

Extra Space for Problem 2:



Problem 3 – Tomatoes can be Poisonous! (5.85 points)

Part A – Acid and Aluminum (2.50 points)

A1. Write the balanced equation of metallic aluminum dissolving in acid.

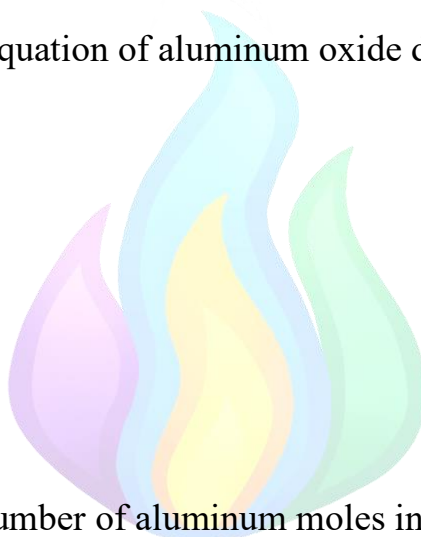
(0.40 points)

Calculation:

A2. Write the balanced equation of aluminum oxide dissolving in acid.

(0.40 points)

Calculation:



A3. Calculate the total number of aluminum moles in the sauce after 60 min.

(0.30 points)

Calculation:

Aluminum moles =

A4. Find the mass of H_3Cit needed to react fully with the Al_2O_3 layer

(0.60 points)

Calculation:



$m_{\text{H}_3\text{Cit}} =$

A5. Find the mass of aluminum (not the oxide layer) that dissolves into the acid.

(0.30 points)

Calculation:

$m_{\text{Al}} =$

A6. Assuming that all aluminum reacts to form the aluminum-citrate complex, find the mass of citric acid left in the solution

(0.50 points)

Calculation:

Remaining $\text{H}_3\text{Cit} =$

Part B – Aluminum Treatment (2.00 points)

B1. Write the balanced chemical reaction where the aluminum-citrate complex reacts with the sodium hydroxide.

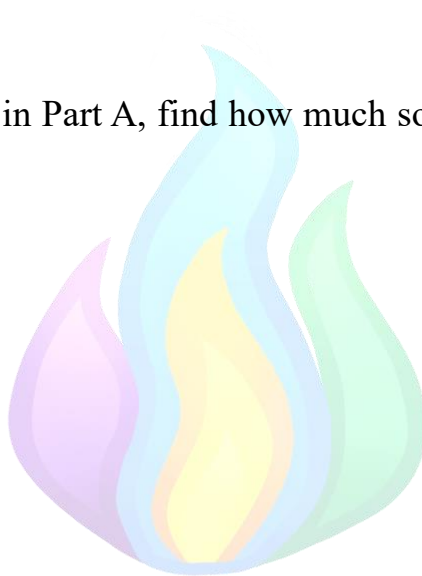
(0.50 points)

Calculation:

B2. Using your findings in Part A, find how much sodium hydroxide the owner will need.

(0.50 points)

Calculation:



$n_{\text{NaOH}} =$

B3. Write the values of a, b, c, d, e, and f.

(1.00 points)

Calculation:



a -

b -

c -

d -

e -

f -

Part C – Painting the Pot (1.35 points)

C1. Calculate the concentration of Pb^{2+} in mg L^{-1} .

(0.50 points)

Calculation:

Concentration of Pb^{2+} =



C2. If so, state by what percent is the lead concentration higher than the WHO standard. If not, by what percent is it lower than the WHO standard?

(0.35 points)

Calculation:

% higher =

C3. What mass of metallic chromium was obtained from 1g of lead chromate?

(0.50 points)

Calculation:



Metallic chromium obtained =

Extra Space for Problem 3:



Problem 4 – Some Chemical Puzzles (8.75 points)

Part A – Finding Unknown Compounds (4.55 points)

A1. Find the formulas of compounds **M**, **a**, **e**, **f**

(1.40 points)

Calculation:



M =

E =

A =

F =

A2. Find the formulas of the other compounds in the reaction scheme

(2.40 points)

Calculation:



A3. Write the balanced equations of reactions 5, 7 and 9

(0.75 points)

Calculation:

Part B – Finding Suitable Reagents (1.50 points)

B1. What reagents can you use to turn $X = \text{FeCl}_3$ into $Y = \text{Fe}$, from:

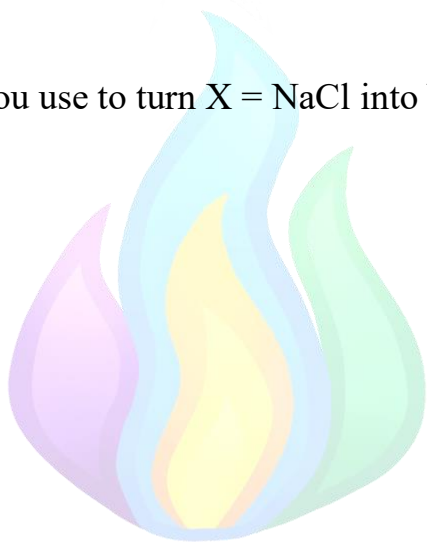
- ☐ Ag
- ☐ Cu
- ☐ Zn
- ☐ Na

B2. What reagents can you use to turn $X = H_2$ into $Y = HBr$, from:

- ☐ $AlBr_3$
- ☐ $CuBr_2$
- ☐ Br_2
- ☐ KBr

B3. What reagents can you use to turn $X = NaCl$ into $Y = NaF$, from:

- ☐ KF
- ☐ F_2



Part C – A Chemical Crossword (2.70 points)

C1. Fill the free white cells with chemical substances.

(1.20 points)

Na_2O_2	+		→	Na_2SO_4	+	
↑						
Na	+	H_2O	→		+	
+				+		+
						Cl_2
						↓
				↓		
	+		→			
				+		

C2. What mass of sodium would provide the stoichiometric amount of product required to further react with 10 grams of chlorine?

(0.75 points)

Calculation:

Mass of Na required =

C3. What is the mass percent concentration of the obtained solution?

(0.75 points)

Calculation:

Concentration =