Mole Calculations Questions

(Atomic masses used are C = 12.0 g mol^{-1}, O = 16.0 g mol^{-1}, H = 1.01 g mol^{-1}, Cu = 63.5 g mol^{-1}, Br = 79.9 g mol^{-1}, Fe = 55.8 g mol^{-1}, N = 14.0 g mol^{-1}, S = 32.0 g mol^{-1})

1. a. What is the molecular weight of methanol (CH_3OH)?
   b. How many moles are there in 5.0 g of methanol?

2. How much would 0.50 moles of CO_2 weigh?

3. a. Calculate the M_r of a compound if 3.0 moles of it weighed 54 g.
   b. What do you think this compound might be?

4. How many moles of $CuCO_3$ would weigh 9.0 g?

5. a. What would be the mass of 2.0 cm^3 of Br_2? (Br_2 has a density of 3.1 g cm^{-3})
   b. How many moles would 2.0 cm^3 of Br_2 contain?

6. What would be the mass of 0.25 moles of Fe?

7. How many moles would 3.0 g of cyclohexane (C_6H_{12}) contain?

8. How much would 4.00 moles of benzene weigh?

9. $Bu_4N^+ Br^- + Br_2 \longrightarrow Bu_4N^+ Br_3^-$

   a. 1.0 g of tetrabutylammonium bromide ($Bu_4N^+ Br^-$) contains how many moles?
   b. Assuming $Bu_4N^+ Br^-$ reacts in a 1:1 ratio with Br_2, how many moles of Br_2 would you need for a complete reaction?
   c. What volume of Br_2 would you need (Br_2 has a density of 3.10 g cm^{-3})?

10.
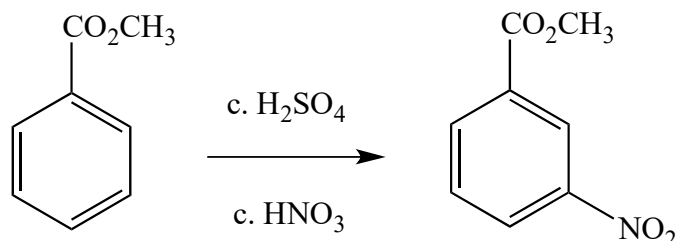
a. Give the name of the reaction mechanism and explain the role of sulfuric acid.
b. If 6.0 g of methyl benzoate reacts with 4.0 cm^3 of concentrated nitric acid (density 1.51 g cm^{-3}) and 16.0 cm^3 of concentrated sulfuric acid (density 1.83 g cm^{-3}), what is the limiting reagent?
c. How many moles of product would be made?
d. What would the maximum theoretical product weigh?
e. Give the name of the product of the reaction.
f. Give the names of two position isomers of the product.

11. Ethyl ethanoate (density 0.90 g cm^{-3}) is made by refluxing 6.00 g of a carboxylic acid with 6.00 g of an alcohol, in the presence of a few drops of concentrated sulfuric acid, which acts as a catalyst. At the end of the reaction 6.40 cm^3 of ethyl ethanoate is formed.

a. Give the name of this type of reaction and define the term catalyst.
b. Calculate the % yield of the reaction.
c. Calculate the atom economy.
d. Explain how IR spectroscopy could be used to determine when the conversion of reactants into ethyl ethanoate is complete.