Name:_____ Science Olympiad Team Name:_____

1. At your work area, you have a container of sodium hydroxide of unknown concentration. Using the 0.325M hydrochloric acid and phenolphthalein provided, determine the concentration of the sodium hydroxide solution. SHOW ALL WORK IN THE SPACE PROVIDED. BE SURE TO INCLUDE A BALANCED CHEMICAL EQUATION FOR THE NEUTRALIZATION THAT OCCURS. (6 points: 2 points for equation, 4 points for calculations)

SOLVE EACH OF THE PROBLEMS BELOW. BE SURE TO SHOW ALL WORK. THE VALUES
FOR ANY NEEDED CONSTANTS (melting points, K_f, etc) CAN BE FOUND ON THE LAST
PAGE OF THIS EXAMINATION.

2a. A solution is made containing 100.0 g of the nonvolatile electrolyte ethylene glycol ($C_2H_6O_2$)
per 900.0 g of water. What is the weight percentage of solute in this solution? (1 point)

2b. What is the molality of this same solution? (1 point)

2c. Calculate the freezing point of this solution. (2 points)

3. A solution of an unknown nonvolatile nonelectrolyte was prepared by dissolving 0.250 grams in 40.0 grams CCl_4. The normal freezing point was decreased by 2.11ºC. Calculate the molar mass of the solute. Assume ideal behavior. (3 points)

4. There are several factors that can affect the rate of a chemical reaction. Design and perform an experiment to determine the effect of one of those factors (temperature, concentration, or particle size) on reaction rate. You will be given the following reagents:

    powdered zinc
    zinc shot
    1 M hydrochoric acid
    3 M hydrochloric acid
    6 M hydrochloric acid

Hot plates, ice, and thermometers will also be provided.

4a. Write your experimental protocol here. (3 points)

4b. Record your data on this page. (2 points)

4c. Explain, in terms of BOTH number of and effectiveness of collisions, why changing the temperature has the effect that it does on reaction rate. (1 point)

4d. Explain, in terms of BOTH number of and effectiveness of collisions, why changing the concentration has the effect that it does on reaction rate. (1 point)

4e. Explain, in terms of BOTH number of and effectiveness of collisions, why changing the particle size has the effect that it does on reaction rate. (1 point)

5. The following data were collected for the decomposition of compound AB into its elements. The reaction is first-order AB. (5 points total: 3 points for graph, 1 point for EACH rate determination)

[AB] (mol/L)	Time (s)
0.300	0
0.246	50
0.201	100
0.165	150
0.135	200
0.111	250
0.090	300
0.075	350

5a. Make a graph of concentration (y-axis) versus time (x-axis) on the graph paper provided.

5b. Determine the rate of this reaction at time = 100 seconds. Record your answer in the space provided.

5c. Determine the rate of this reaction at time = 250 seconds. Record your answer in the space provided.

Table of Normal Freezing Points and Molal-Freezing Point Constants

Solvent	Normal Freezing Point(^{o}C)	Kf(^{o}C/m)
Water, H_2O	0.0	1.86
Benzene, C_6H_6	5.5	5.12
Carbon Tetrachloride, CCl_4	-22.3	29.8
Ethanol, C_2H_5OH	-114.6	1.99
Chloroform, CH_3Cl	-63.5	4.68