

Name _____

General instructions:

1. Don't panic! Write down what you know and what you need to figure out. Think about all relevant equalities. Make sure to keep track of units. Check your answer and see if it makes sense! Some questions are easier than others, so make sure you look all the questions over.
2. **Remember the honor system.** No notes, books, stored information in calculators, or external help is allowed.
3. Use the space provided for answers. The back of pages can be used as scrap paper. **Show work for partial credit!** Write legibly!
4. Questions are numbered and parts of questions are lettered. Numbers in parentheses indicated the point value of the question/part. If you can not get an answer to a prior part of a question, make up a number and carry on with it. You will not be penalized twice for an incorrect answer.
5. Use significant figures where appropriate.
6. This exam has 11 pages. If you are missing page, now would be a good time to tell us about it.

Some useful information (plus see the periodic table):

$$0 \text{ K} = -273.2 \text{ }^\circ\text{C}$$

$$1 \text{ atm} = 760 \text{ torr (mm Hg)}$$

Avogadro's number	N	$6.02214 \times 10^{23} \text{ mol}^{-1}$
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Gas constant	R	$0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1}$
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1. (10) What is the concentration (molarity) of pure ethanol ($\text{C}_2\text{H}_5\text{OH}$) at $20\text{ }^\circ\text{C}$?
The density of ethanol is 0.789 g cm^{-3} at $20\text{ }^\circ\text{C}$.

2. (10) What is the mass (in grams) of one atom of ^{12}C ?

3. A certain metal can form two chloride salts that are 47.26% and 64.19% metal by mass.

A. (10) Show that these compounds obey the law of multiple proportions.

B. (5) Determine the simplest formula for each of the two compounds.

C. (10) What is the atomic mass and most likely identity of the metal in these salts?

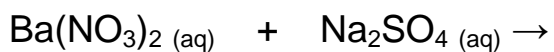
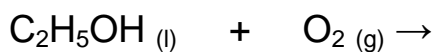
4. Combustion of 10 g of a pure hydrocarbon with excess oxygen results in the formation of CO_2 gas and H_2O gas. The gaseous products are collected in a 10 liter flask at 120°C . The total pressure in the flask is measured to be 4096 torr and the partial pressure of CO_2 is determined to be 1643 torr.

A. (20) What is the *empirical* formula of the hydrocarbon?

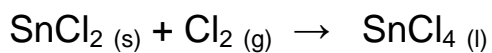
B. (10) If the initial volume of the hydrocarbon was 8.15 L at 25°C , what is the molecular formula?

C. (5) Write a balanced equation for this reaction.

5. (30) Complete the following reactions and **balance** the final equation. Indicate the type of reaction that is occurring. Write the net ionic equation if appropriate.



6. (15) Which of the following reactions involve oxidation/reduction? For those that do, indicate what is being oxidized and what is being reduced.



7. (20) Write the formulas and draw the structures of *simple* CHO containing compounds (i.e. no more than 2 C's) in which every carbon has the indicated oxidation states. Not all of the compounds need to contain all three atom types. Every carbon atom should have four single bonds around it and every oxygen atom should have two single bonds around it.

-4

-3

-2

-1

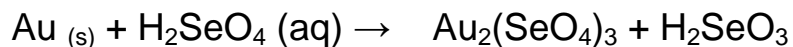
8. Concentrated hydrochloric acid (HCl) is made by bubbling HCl gas through water until it is saturated. Concentrated HCl is 63% H₂O by mass and has a density of 1.18 g cm⁻³.

A. (10) What is the molarity of concentrated HCl?

B. (10) Using concentrated HCl, describe how you would make 500 ml of a 1 M standard solution of HCl.

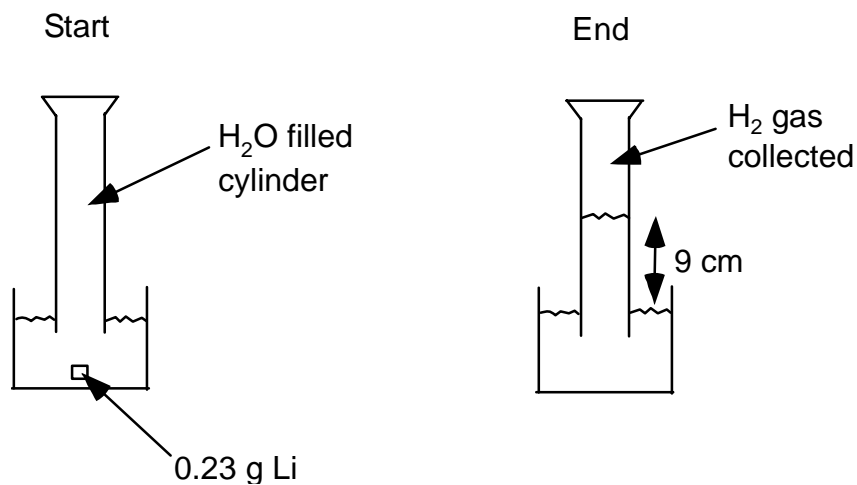
C. (10) How much of this standard solution would you need to neutralize 300 ml of 600 mM KOH?

10. (20) Selenic acid (H_2SeO_4) is a powerful acid that is able to dissolve gold via the following unbalanced reaction. Balance the equation using half reactions, indicating the oxidizing agent, the reducing agent, and the oxidation states of all atoms involved.



11. A. (5) The relationship between the densities (d) and heights (h) of two substances that might be used in a gas/pressure related problem is given by $d_1h_1 = d_2h_2$. Using this relationship, calculate the height of water that would correspond to a pressure of 1 ATM. The density of water is 1.00 g cm^{-3} and that of Hg is 13.6 g cm^{-3} .

B. (20) In the experiment diagrammed below, a 0.23 g piece of Li metal is placed underneath an inverted cylinder filled with water. The Li reacts according to the *unbalanced* reaction shown, releasing H₂ gas up into the cylinder. What is the maximum volume of H₂ gas that could be obtained at 25 °C and 750 torr?



C. (10) What volume of 100 mM H₂SO₄ would be required to neutralize the resulting LiOH solution, given that the volume of aqueous solution in the experiment is 5 L.

D. (20) At the end of the experiment, the H_2 gas produced by this reaction is collected at the top of the cylinder, as shown above. The height of the water in the cylinder is 9 cm above the height of the water in the dish. If the atmospheric pressure is 750 torr on the day of the experiment, calculate the pressure of the gases inside the cylinder.

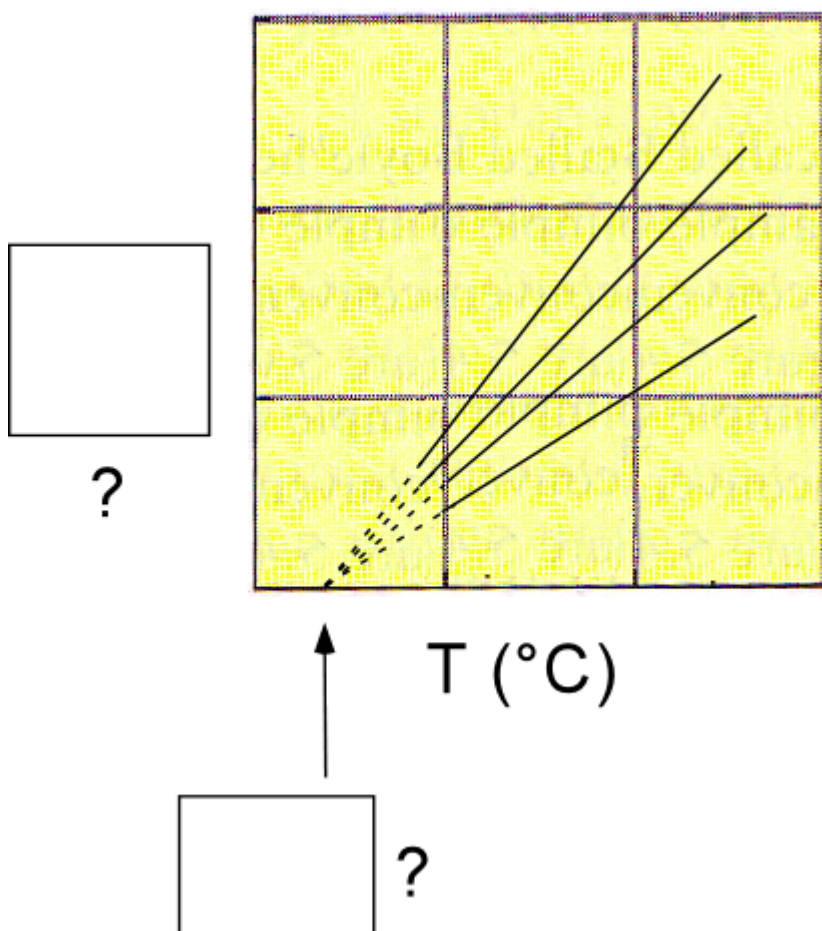
E. (10) If the partial pressure of water at 25 °C is 23.76 torr, what is the partial pressure of H_2 in the cylinder?

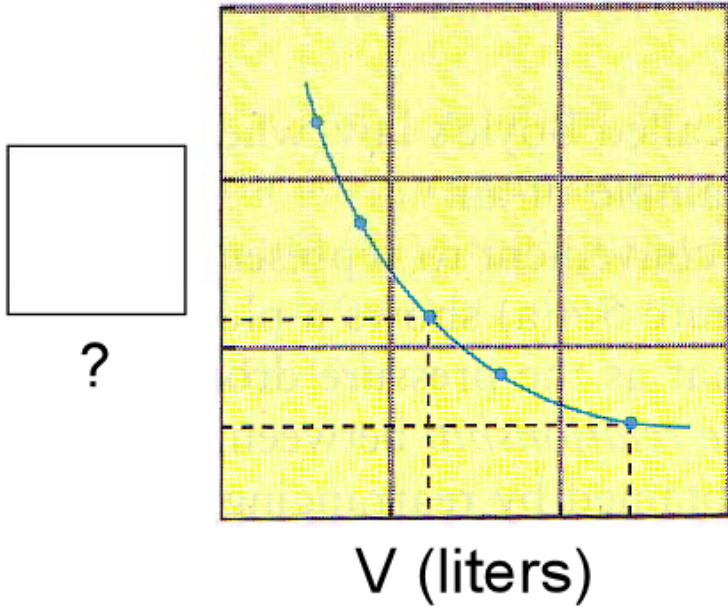
F. (10) If the volume of the collected gases in the cylinder is 355 ml, how many moles of H_2 were captured?

G. (10) What is the percent yield of the H_2 produced in this experiment?

12. (10) What is the density of hydrogen sulfide gas (H_2S) at 1.00 ATM and 0 °C?

13. (15) For each of the following graphs pertaining to gas law relationships, fill in the ? boxes with the missing quantities.





?
 gas

