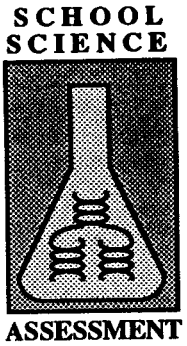


SCIENCE LABORATORY TEST

CHEMISTRY

These tests are being developed through
the University at Buffalo and NORC with support of
the National Science Foundation and
the U.S. Office of Education

Administrator's Manual
for
Science Laboratory Tests
in Chemistry

This packet of information is intended to accompany the science laboratory tests in chemistry. The Administratior's Manual consists of the following sections:

1. Introduction
2. Instructions to students
   -Task station schematic
3. Teacher notes for each task including equipment and material lists
4. Student test booklets.

These test were designed by Fred Chan, Toronto Board of Education, Toronto, Ontario, Canada and Rodney L. Doran, State University of New York at Buffalo, Buffalo, NY.

Revised 1993

1. Introduction

The success of this alternative form of assessment depends strongly on the science teacher who administers the tasks. Therefore, a series of guidelines has been prepared, with attention to setting up the equipment, administering the tasks, and scoring the students' responses. One teacher can effectively monitor the work of 12 students, two working on each of the six tasks. The titles of the six tasks in chemistry are:

1. Acid/Base Titration
2. Kinetics: Reaction Rates
3. The Mole Concept
4. Solubility
5. Melting Point
6. Hydrated Salt

Each task is composed of two booklets labelled Part A and Part B, respectively. In Part A, students are given a problem and asked to plan and design an experiment using the material and equipment provided at their laboratory station. Students are asked to generate hypotheses and formulate a plan that will include an appropriate procedure that can be used to solve the problem. Students are encouraged to manipulate the equipment and write down an appropriate strategy for the solution of the problem, paying attention to safety precautions in a laboratory. They are also asked to suggest methods for organizing the data to be collected, and to suggest appropriate calculations necessary to make inferences. At the conclusion of 30 minutes, the student's plan is collected.

In Part B, students are given a test booklet that provides a detailed plan for data collection and suggestions for organizing the data leading to appropriate graphs, calculations, and conclusions. A student who does not come up with an appropriate plan in Part A can still perform the tasks and obtain credit for work completed. Thus, the detailed plan provided in Part B eliminates "double jeopardy" situations by not requiring the students to proceed with an inaccurately conceived plan from Part A.

The elements of each booklet are outlined in the following figures:

Task Format: PART A - DESIGN

— Introduction
— Problem
— Materials
— Experiment Design

TIME: 30 minutes

Task Format: PART B - EXPERIMENTS

— Instructions
— Procedure
— Safety
— Results/Observations
— Calculations
— Conclusions

TIME: 50 minutes

A total of 80 minutes for student "time on task" is required. With a few minutes of introduction, assignment to task, and collection of booklets, one should schedule a time block of 90 minutes for the testing. The students stay at the same station for the entire 90 minute period. The equipment is available for student familiarity and manipulation during Part A, but they are reminded that performance using the equipment comes later, in Part B.

The teacher responsibilities begin several weeks before the testing. We have assembled a list of the major tasks and timeline for this completion.

1. Reserve room	4 weeks prior to testing
2. Assign student to testing period (include alternates if part of plan)	4 weeks prior to testing
3. Plan for alternative activities for those <u>not</u> being tested.	4 weeks prior to testing
4. Locate equipment and material for tasks	2 weeks prior to testing
5. Assemble, prepare and trial-test equipment	2 weeks prior to testing
6. Copy student test booklets	1 week prior to testing
7. Assemble (and try) equipment and materials as needed for first period testing.	Day before testing
8. Assemble equipment and material for other testing in preparation area.	Day before testing
9. Check with principal and other teachers for duties on testing day	Day before testing

On the testing day, your responsibilities include the following:

1. Assign each student to appropriate station for the task they will do.
2. Assign alternates to task if some students are absent.
3. Send extra alternates to study hall or other planned space or activity.
4. Make students feel welcome. Begin reading directions.
5. Mark beginning time.
6. Check each station to be sure equipment and material are working correctly.
7. Answer questions, usually with the comment, "Reread the directions and do the best you can."
8. When 30 or 40 minutes has elapsed, read directions for changing to next stations or to Part B.
9. Collect Part A booklets and give students Part B booklets.
10. At the end of 80 minutes, read directions for end of testing.
11. Collect student booklets and thank them again as they leave.
12. Check stations. Clean up and replenish material for next students.

2. Instructions to Students

The directions which follow are to be used as oral instructions to students for performance of the chemistry lab tests. Preliminary instructions include assigning students to stations where test booklets and equipment have been made ready. Step-by-step instructions allow the teacher to lead the student through Part A (Experiment Design) and Part B (Experiment Report) of the six chemistry tasks.

The format of the directions is in three type styles: normal, italicized, and capitalized. Directions to the teacher appear in normal type. Instructions to be read aloud to the students are italicized. Performance of an action by the teacher (or by the students following an instruction) appears in capitalized print.

normal	Directions to the teacher.
italics	Instructions to be read aloud.
CAPITALS	Actions to be performed by the teacher or the students.

Instructions to Students

As students enter the room, they should be instructed to sit at one of the stations for their assigned task (numbered one through six). When the students are seated, let them look around the room, then instruct them to look at the equipment in front of them and find their test booklet. Tell the students NOT to touch the equipment until they are told to do so.

When the students have settled, the supervising teacher should read the following text. For ease in administration, all sections to be read are printed in italics.

Good morning (afternoon). My name is _____. Today, you are going to perform some science experiments. A booklet explaining the tasks you are to do should be in front of you. If you cannot find your test booklet or you do not have a pencil, please raise your hand.

DISTRIBUTE NEEDED TEST BOOKLETS AND/OR PENCILS.

Now that each of you has a test booklet and pencil we are ready begin. Listen very carefully to the instructions and do your best. Please write your name, your school, your sex and today's date in the spaces provided on the front page of the booklet.

GIVE THE STUDENTS TIME TO DO THIS.

This is a science laboratory test. The equipment and material that you will need have been set out in front of you. You will be at this station for the entire test. Your booklet will give you specific directions for this experiment. Write the results of your experiments in your booklet.

The science laboratory test is very different than the other science tests that you completed. We are trying to see how testing of science laboratory skills can be done in US high schools. Your responses are very important to us in this project.

Your individual performance will <u>not</u> be used as part of any science grade or evaluation for you. We ask you to do your best so we can learn as much as possible about this alternative method of testing.

Turn to the first page in your booklet. Check to see that you have all the materials listed for your experiment. Raise your hand if anything is missing.

MAKE SURE EVERYONE IS AT THE CORRECT PAGE IN THE BOOKLET AND THAT THEY HAVE ALL THE MATERIALS THEY NEED.

The chemistry laboratory test is organized into two parts, A and B. When 30 minutes has elapsed, I will collect your booklet for Part A and give you the booklet for Part B.

Once you have started your experiment, I cannot help you. I can only assist you right now if you have any materials missing. Please read all directions carefully before you start to work.

We are now ready to begin the test. Are there any questions? Do your best. You may begin.

AFTER 30 MINUTES, COLLECT THE PART A BOOKLETS FROM THE STUDENTS AND GIVE THE PART B BOOKLET.

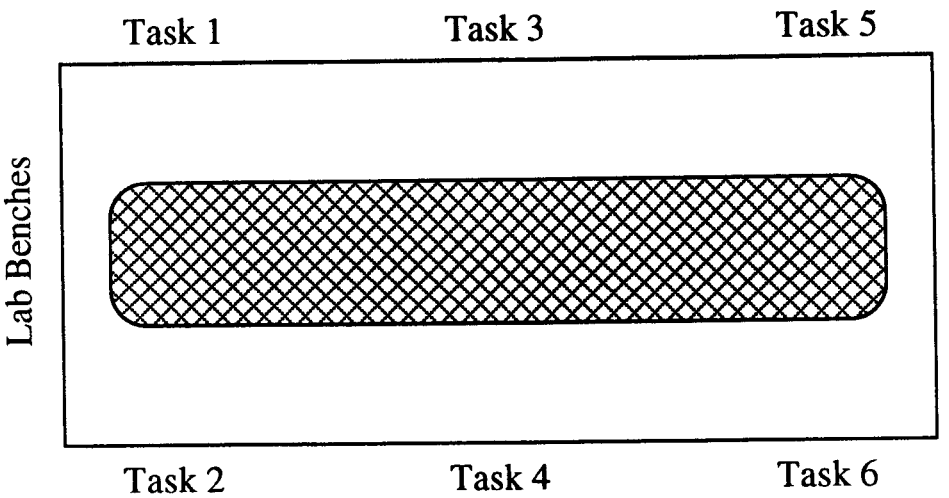
You will have 50 minutes for this part of the test. Do your best. You may begin.

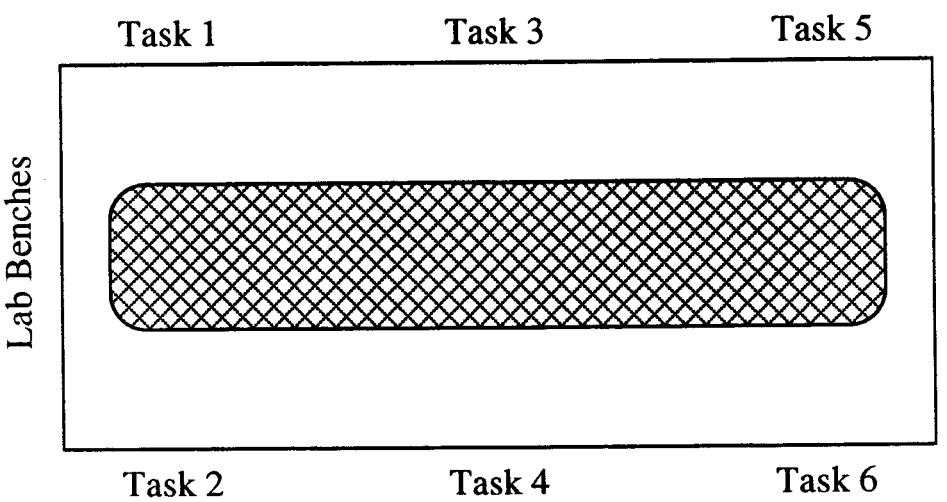
AFTER 50 MINUTES HAS ELAPSED. GIVE THE FOLLOWING INSTRUCTIONS.

This is the end of the laboratory experiments. Please pass in your booklet and pencils.

Thank you for being so attentive and cooperative during the test. Please wait to be dismissed.

Station Set-up for Chemistry





3. Teacher Notes

Teacher Notes provide the information which enables the teacher to gather and prepare materials for set-up of the tasks or stations. Suggestions for performance and calculation of results for each chemistry task are also given. The sections included are:

Materials:	Lists the amounts and sizes of all equipment and materials needed for each task.
Safety:	Gives suggestions regarding safety considerations specific to each task. In some tasks disposal methods are suggested.
Preparation:	Specifies masses, volumes, concentrations, and directions for preparation of the needed materials and samples.
Background Information:	Provides suggestions aimed at helping the teacher through a "trial run" of the experiment.

CHEMISTRY TASK 1

Determination of the concentration of an unknown solution

MATERIALS:

2 beakers, 100 mL
1 burette, 50 mL
4 Erlenmeyer flasks, 250 mL
1 filter funnel, small
1 graduated cylinder, 50 mL
1 burette stand
safety goggles
1 wash bottle of distilled water
1 white tile
hydrochloric acid, 0.1 mol/L
sodium hydroxide, 0.1 mol/L
phenolphthalein indicator
bromothymol blue indicator
unknown solutions X and Y

SAFETY:

(1) Acids and bases are highly corrosive. Students must wear safety glasses at all times and avoid direct contact with any of the reagents. If any of the reagents touches skin, the student must wash off immediately with water and inform the instructor of the incident.
(2) Have eye wash bottles available at a visible and convenient location.

PREPARATION:

(1) 0.1 M NaOH solution : Dissolve 4.10 g of NaOH in 1 liter of distilled water. invert several times to insure adequate mixing.
(2) Phenolphthalein Indicator : Dissolve 1 g of the reagent in 100 ml of distilled water with constant stirring. Filter if a precipitate forms. Alternatively, the indicator can be bought already prepared for use.
(3) Hydrochloric acid : Add 8.3 ml of the concentrated reagent to 1 liter of distilled water to dilute for a 0.1 M solution. Remember: always add acid to water.
(4) Bromothymol blue : Mix 0.1 g of bromothymol blue and 1.6 ml of 0.1 M NaOH. Dilute to 100 ml with distilled water. If purchased as the sodium salt, dissolve 0.1 g in 100 ml of solution. Alternatively, the indicator can be bought already prepared for use.
(5) Unknown samples :
Unknown X will be .1 Molar HCL (150 mL) in a beaker labelled X.
Unknown Y will be .1 Molar NaOH (150 mL) in a beaker labelled Y.
One station should use unknown X and the other unknown Y.

BACKGROUND INFORMATION:

(1) The pH and color range of the indicators used are:

Bromothymol blue :	pH range	6.0 - 7.6	yellow to blue
Phenolphthalein :	pH range	8.2 - 10.0	colorless to pink

(2) CALCULATIONS

(i) Calculate the number of moles of acid/base used to neutralize 25 ml of the unknown sample. Remember:

$$HCl\,(aq) + NaOH\,(aq) = NaCl\,(aq) + H_2O$$

(ii) # of moles of acid (H+) = volume (L) x concentration (mol/L)

(iii) # of moles of acid (H+) = # of moles of base (OH -)

(iv) Calculate the number of moles of H+ or OH - in the 25 ml sample of the unknown.

(v) Calculate the number of moles of H+ or OH - in 1 liter of the unknown.

CHEMISTRY TASK 2

Investigation of factors that affect reaction rates

MATERIALS:

5 beakers, 100 mL
1 centimeter ruler
1 graduated cylinder, 25 mL
1 hot plate
scissors
graph paper
safety goggles
1 thermometer
1 watch or stop clock with a second hand
magnesium ribbon, 50 cm
1.0 M HCl, 250 mL, refrigerated*
1 balance accurate to 0.01 grams
calculator

SAFETY:

(1) Students must wear safety goggles at all times and avoid direct contact with any of the reagents. If any of the acid touches the skin, students must wash off immediately with water and inform the instructor of the incident.

(2) Have eye wash bottles available at visible and convenient locations.

(3) Always add acid to water.

(4) Do not heat acid above 45°C

(5) Do not use open flames (i.e., bunsen burners) due to the flammability of hydrogen.

PREPARATION:

1 M HCl (250 ml): Add 21 mL of 12 M HCl (standard commercial concentrated solution) to 229 mL of distilled water to make 250 ml of solution.

*The first reaction is run below room temperature, at a temperature of 20 degrees Celsius, so students will need to start with acid which has been pre-cooled.

CHEMISTRY TASK 3

Determination of the formula of a metal oxide

MATERIALS:

2 Crucibles and lids
Tongs
Fisher burner (high temperature)
Tripod
Safety goggles
Pipe-clay triangle
Calculator
Balance accurate to 0.01 grams
Magnesium ribbon

SAFETY:

(1) Safety goggles must be worn at all times.

(2) Students are to avoid looking directly at burning magnesium. The light is intense and can cause damage to the eyes.

(3) Teachers should monitor students to insure that crucible lids are partly open to allow air into crucible while burning magnesium. An opening of about 1 cm is good.

(4) Hot objects must be handled with tongs.

(5) Hot objects are not to be placed on the balance.

BACKGROUND INFORMATION:

(1) Moles of Mg = (Mass of Mg)/24 .3;
Moles of oxygen = (Mass of oxygen)/16.0.

(2) Empirical formula can be found by determining the whole number ratio of moles of magnesium to moles of oxygen. Molat ratio of magnesium to oxygen should be nearly 1:1.

CHEMISTRY TASK 4

Construction of a solubility curve for an unknown compound

MATERIALS:

4 boiling tube (large test tube)
1 bunsen burner and mat
1 beaker, 400-500 mL
1 measuring cylinder, 50 mL
unknown X
graph paper
safety goggles
stirring rod
1 thermometer
1 spatula
1 balance accurate to 0.01 grams
1 tripod
distilled water
tongs
marking pencil

SAFETY:

(1) Safety goggles must be worn at all times.

(2) Hot objects should be handled with tongs.

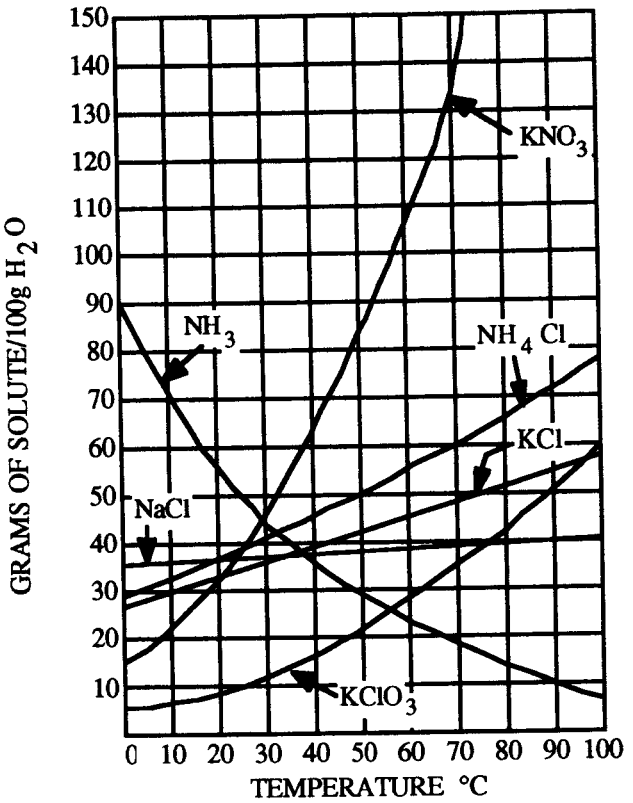
(3) For optimum clarity and safety, teachers should monitor student water baths to be sure they do not exceed 60 degrees Celsius.

PREPARATION:

The unknown salt is potassium nitrate, KNO_3.

Place 30 grams of KNO_3 in a separate container labelled "sample X" for each station.

SOLUBILITY CURVES



CHEMISTRY TASK 5

MELTING POINT
Identification of pure substances

MATERIALS:

rubber bands	capillary tubes (melting point tubes)
mortar and pestle	thermometer
support stand	clamp
250 ml beaker	bunsen burner
boiling chips	gauze mat
samples labelled A and B	spatula
one-holed cork/rubber stopper	dispo-pipettes, glass, 5 3/4 inch

NOTES and PREPARATION:

(1) Use the following substances:

	melting point
A : lauric acid	44 degrees C
B : napthalene	80 degrees C

(2) Prepare two "melting point tubes", one containing sample A and one containing sample B, for each student as follows:

a. Fuse the narrow ends of several dispo-pipettes with a bunsen burner.
b. Grind lauric acid and naphthalene with mortar and pestle.
c. Fill narrow ends of dispo-pipettes with appropriate substance to the point where the dispo-pipette begins to widen.
d. Label the dispo-pipette with lauric acid as "sample A"; with napthalene as "sample B".
e. Plug the upper end of dispo-pipette with cotton or other appropriate material.
f. Prepare several extra melting point tubes so that replacements are available in case of breakage.

(3) A thermometer pre-inserted into a stopper should be prepared in advance for each student both to economize time during testing and to minimize breakage.

-Use great care when inserting the thermometer into the stopper (glycerine may help).

-Make sure the stopper does not block the temperature scale for the above substances.

MELTING POINTS OF SUBSTANCES

Substance	Melting Point
pilocarpine	34°C
lauric acid	44°C
p-dichlorobenzene	53°C
chloroacetic acid	63°C
napthalene	80°C
methylmaleic acid	94°C
maltose, monohydrate	102°C
chloroacetamide	121°C

CHEMISTRY TASK 6

HYDRATED SALT

Determination of the formula of a hydrated salt.

MATERIALS:

1 crucible with cover
1 crucible tongs
1 porcelain triangle
1 tripod
balance
bunsen burner and matches
hydrate sample (e.g., copper sulfate), approximately 150 grams.
safety glasses
heat resistant tile
access to a periodic table

PREPARATION:

The hydrated sample X will be:
hydrated magnesium sulfate crystals, $MgSO_4$ 7 H_2O (sample X)
(Hydrated magnesium sulfate is also known as "Epsom Salts").

Place sample in a separate beaker and label with chemical name (NOT formula).

SAFETY and DISPOSAL:

The hydrate crystals pose no acute toxicity or corrosion hazard.

(1) Should skin contact occur, flush thoroughly with water.

(2) Safety glasses must be worn at all times.

(3) Hot objects must be handled with tongs at all times. Students should be cautioned about working with an open flame and handling hot labware.

(4) The hydrate can safely be disposed of by dissolving in water and flushing the solution down the drain. Please note that the anhydrous crystals produced by the students will liberate some heat when mixed with water. Care should be taken in dissolving them prior to disposal.

4. Student Test Booklets

The student test booklets which follow for Chemistry Tasks 1 through 6 consist of two booklets, labelled Parts A and B, for each of the six tasks. In Part A, which is 30 minutes in length, students are given a problem and asked to plan and design an experiment using the material and equipment provided at their laboratory station. In most tasks, students are asked to generate a hypothesis and formulate a plan that would include an appropriate procedure that could be used to solve the problem. Students are encouraged to manipulate the equipment and write a strategy for the solution of the problem, with attention to safety precautions in a laboratory. Students are also asked to suggest methods for organizing the data to be collected, and to suggest calculations necessary for making inferences. At the conclusion of 30 minutes, the student's plan is collected.

In Part B, which is 50 minutes in length, students are given a test booklet that provides a detailed plan for data collection and suggestions for organizing the data leading to appropriate graphs, calculations, and conclusions. A student who does not formulate an adequate plan in Part A can still perform the task and obtain credit for work completed in Part B. Thus, the detailed plan provided in Part B eliminates "double jeopardy" situations by not requiring students to proceed with an inadequately conceived plan from Part A.

For information regarding scoring of the Chemistry Tasks, see the Scoring Manual.

SCHOOL SCIENCE ASSESSMENT

SCIENCE LABORATORY TEST

CHEMISTRY

TASK NUMBER 1
ACID/BASE TITRATION

PART A

TIME : 30 MINUTES

NAME _____ SEX _____

SCHOOL _____ DATE _____

These tests are being developed through
the University at Buffalo and NORC with support of
the National Science Foundation and
the U.S. Office of Education

ACID-BASE TITRATION

Determination of the concentration of an unknown solution

Introduction

This laboratory test presents a problem. Your task in Part A is to plan and design an experiment to solve the problem. You will have **30 minutes** to complete Part A. At the end of the 30 minutes, your answer sheet will be collected. You will then receive separate directions for Part B. In Part B you will use materials and equipment provided in the laboratory kit to collect experimental data for this problem. You may wish to do your preliminary planning on the sheet labelled "Working Copy." Write this plan on the appropriate answer sheet in your test booklet.

Problem

Chemists are often required to determine the concentration of unknown acidic or basic solutions. You will be provided with an unknown solution that is either acidic or basic. Your problem is to design an experiment, using the materials (and/or others) listed below, to determine the concentration of the unknown solution provided. Express your concentration of the unknown material in moles of $H^+(aq)$ per liter or moles of $OH^-(aq)$ per liter of solution.

a) Under the heading PROCEDURE list in order the steps of the procedure you will use to solve the problem. You may include a diagram to help illustrate your plans for the experiment. Include any safety procedures you would follow.

b) Construct a DATA TABLE or indicate any other method that you could use to record the observations and results that will be obtained.

PLEASE NOTE: In Part A you are NOT to proceed with any part of the actual experiment. You are just to plan and organize a way to investigate the problem.

Materials

2 beakers, 100 ml
1 burette, 50 ml
4 Erlenmeyer flasks, 250 ml
1 filter funnel, small
1 graduated cylinder, 50 ml
1 burette stand
safety goggles
calculator
1 wash bottle of distilled water
1 white tile
hydrochloric acid, 0.1 mol/L
sodium hydroxide, 0.1 mol/L
phenolphthalein indicator
bromothymol blue indicator
unknown solution

ANSWER SHEET

PART A — Experiment Design

Organize your experiment design under the following headings:
PROCEDURE and DATA TABLE.
Use the front and back of these sheets if necessary.

PROCEDURE (Include diagram if appropriate)

ANSWER SHEET

PART A — Experiment Design

Organize your experiment design under the following headings:
PROCEDURE and DATA TABLE.
Use the front and back of these sheets if necessary.

DATA TABLE (For results and observations)

WORKING COPY

PART A — Experiment Design

This sheet is provided as a work space (or scrap sheet).
Be sure to enter your final plan on the appropriate answer sheets.
No work on this sheet will be considered for credit.

SCHOOL SCIENCE ASSESSMENT

SCIENCE LABORATORY TEST

CHEMISTRY

TASK NUMBER 1
ACID/BASE TITRATION

PART B

TIME : 50 MINUTES

NAME _____ SEX _____

SCHOOL _____ DATE _____

These tests are being developed through
the University at Buffalo and NORC with support of
the National Science Foundation and
the U.S. Office of Education

ACID-BASE TITRATION

Determination of the concentration of an unknown solution

You will have **50 minutes** to complete this part. You have been provided with a detailed Procedure (see next page) which you are to follow. Record your work for Part B on the answer sheet under the appropriate headings.

a) Perform the experiment by following the steps outlined in the procedure.

b) Under the heading RESULTS/OBSERVATIONS record the results of the experiment. Use statements, descriptive paragraphs, and tables of data where appropriate.

c) Under the heading CALCULATIONS show all equations and calculations used.

d) Under the heading CONCLUSION give an interpretation of your results. What did you learn from the experiment?

e) You have also been provided with a sheet labelled "Working Copy." Use this scrap sheet for any initial calculations or conclusion. However, be sure to enter your final work on the appropriate answer sheets.

f) At the end of the 50 minutes, your answer sheets will be collected.

Safety

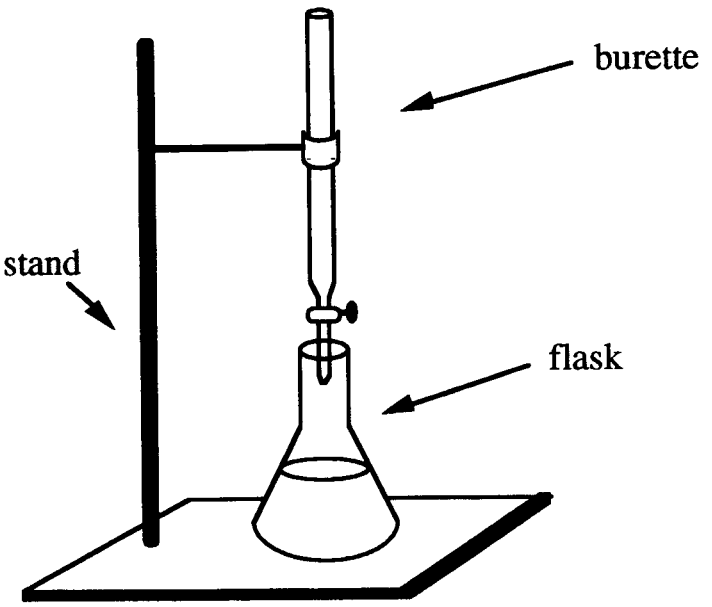
Acids and bases are highly corrosive!

(1) Students must wear safety goggles at all times and avoid direct contact with any of the reagents.

(2) If any of the reagents touches skin, the student must wash off immediately with water and inform the instructor of the incident.

Materials

2 beakers, 100 ml
1 burette, 50 ml
4 Erlenmeyer flasks, 250 ml
1 filter funnel, small
1 graduated cylinder, 50 ml
1 burette stand
1 wash bottle of distilled water
1 white tile
hydrochloric acid, 0.1 mol/L
sodium hydroxide, 0.1 mol/L
phenolphthalein indicator
bromothymol blue indicator
unknown solution
safety goggles
calculator



ACID-BASE TITRATION

Determination of the concentration of an unknown solution

Procedure

1. Transfer 25 ml of the unknown to a clean, dry Erlenmeyer flask using a graduated cylinder.

2. Add three drops of either bromothymol blue OR phenolphthalein indicator to the unknown solution using the dropper. Do either A or B below.

   A. BROMOTHYMOL BLUE:
   a) If the color of the unknown solution is blue, SLOWLY add HCl solution from a burette. As the HCl solution is added, gently agitate the Erlenmeyer flask until the endpoint is reached (solution turns green). Measure the volume of HCl added to carry out the neutralization. Record your results in the table.
   b) If the color of the unknown solution is yellow/green, SLOWLY add NaOH from a burette. As the NaOH is added, gently agitate the Erlenmeyer flask until the endpoint is reached (solution turns blue). Measure the volume of NaOH added. Record your results in the table.

   — OR —

   B. PHENOLPHTHALEIN:
   a) If the unknown solution remains colorless, SLOWLY add NaOH from a burette. As the NaOH is added, gently agitate the Erlenmeyer flask until the endpoint is reached (solution turns pink). Measure the volume of NaOH added to carry out the neutralization. Record your results in the table.
   b) If the color of the unknown solution is pink, SLOWLY add HCl from a burette. As the HCl is added, gently agitate the Erlenmeyer flask until the endpoint is reached (solution becomes colorless). Measure the volume of HCl added. Record your results in the table.

3. Repeat the titration at least three times to gather more data. Take the average of these readings.

4. Calculate the number of moles of acid/base used to neutralize 25 ml of the unknown solution. Remember:

$$HCL\,(aq) + NaOH\,(aq) \longrightarrow NaCl\,(aq) + H_2O$$

and

$$H_3O^+\,(aq) + OH^-\,(aq) \longrightarrow 2H_2O\,(l)$$

ANSWER SHEET

PART B — Experiment Report

Organize your experiment report under the following headings:
RESULTS/OBSERVATIONS, CALCULATIONS, and CONCLUSIONS.
Use the front and back of these sheets if necessary.

RESULTS/OBSERVATIONS

Indicator: _____

	Volume of Unknown	Volume of Acid/Base Added
Trial 1		
Trial 2		
Trial 3		
Average		

SCHOOL SCIENCE ASSESSMENT

SCIENCE LABORATORY TEST

CHEMISTRY

TASK NUMBER 2

KINETICS: REACTION RATES

PART A

TIME : 30 MINUTES

NAME _____ SEX _____

SCHOOL _____ DATE _____

These tests are being developed through
the University at Buffalo and NORC with support of
the National Science Foundation and
the U.S. Office of Education

KINETICS : REACTION RATES

Investigation of factors that affect reaction rates

Introduction

This laboratory test presents a problem. Your task in Part A is to plan and design an experiment to solve the problem. You will have **30 minutes** to complete Part A. At the end of the 30 minutes, your answer sheet will be collected. You will then receive separate directions for Part B. In Part B you will use materials and equipment provided in the laboratory kit to collect experimental data for this problem. You may wish to do your preliminary planning on the sheet labelled "Working Copy." Write this plan on the appropriate answer sheet in your test booklet.

Problem

In many industries, chemists are faced with the task of slowing down explosive reactions or speeding up "slow" reactions in order to synthesize a product.

Your problem is: (a) to determine two factors other than catalysis that effect the speed of a chemical reaction, and (b) design an experiment, using the materials (and/or others) listed below, to determine quantitatively the effect of these two factors on the rate of a chemical reaction. Include relevant units appropriate to the data that will be collected.

a) State a HYPOTHESIS for this investigation that can be experimentally tested.

b) Under the heading PROCEDURE list in order the steps of the procedure you will use to solve the problem. You may include a diagram to help illustrate your plans for the experiment. Include any safety procedures you would follow.

c) Construct a DATA TABLE or indicate any other method that you could use to record the observations and results that will be obtained.

PLEASE NOTE: In Part A you are NOT to proceed with any part of the actual experiment. You are just to plan and organize a way to investigate the problem.

Materials

5 beakers, 100 ml
1 centimeter ruler
1 graduated cylinder, 25 ml
1 hot plate
scissors
graph paper
safety goggles
1 thermometer
1 watch or stop clock with a second hand
1 balance accurate to 0.01 grams
magnesium ribbon, 50 cm
1.0 M HCL, 250 ml
calculator

ANSWER SHEET

PART A — Experiment Design

Organize your experiment design under the following headings:
HYPOTHESIS, PROCEDURE, and DATA TABLE.
Use the front and back of these sheets if necessary.

HYPOTHESIS

PROCEDURE (Include diagram if appropriate)

ANSWER SHEET

PART A — Experiment Design

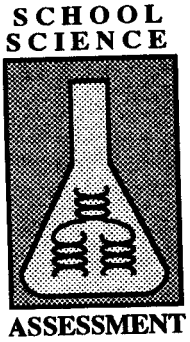
Organize your experiment design under the following headings:
HYPOTHESIS, PROCEDURE, and DATA TABLE.
Use the front and back of these sheets if necessary.

DATA TABLE (For results and observations)

WORKING COPY

PART A — Experiment Design

This sheet is provided as a work space (or scrap sheet).
Be sure to enter your final plan on the appropriate answer sheets.
No work on this sheet will be considered for credit.



SCIENCE LABORATORY TEST

CHEMISTRY

TASK NUMBER 2
KINETICS: REACTION RATES

PART B

TIME : 50 MINUTES

NAME _____ SEX _____

SCHOOL _____ DATE _____

These tests are being developed through
the University at Buffalo and NORC with support of
the National Science Foundation and
the U.S. Office of Education

KINETICS : REACTION RATES

Investigation of factors that affect reaction rates

You will have **50 minutes** to complete this part. You have been provided with a detailed Procedure (see next page) which you are to follow. Record your work for Part B on the answer sheet under the appropriate headings.

a) Perform the experiment by following the steps outlined in the procedure.

b) Under the heading RESULTS/OBSERVATIONS record the results of the experiment. Use statements, descriptive paragraphs, and tables of data where appropriate.

c) Construct a GRAPH that demonstrates the relationship between reaction rate and temperature.

d) Under the heading CALCULATIONS show all equations and calculations used.

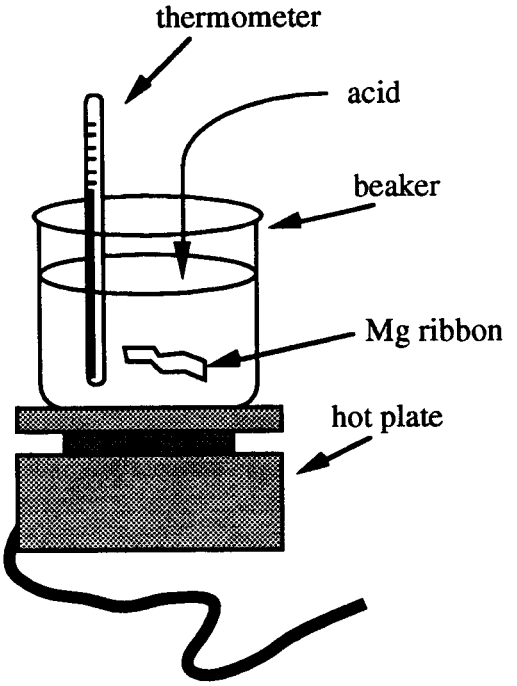
e) Under the heading CONCLUSION give an interpretation of your results. What did you learn from the experiment?

f) You have also been provided with a sheet labelled "Working Copy." Use this scrap sheet for any initial calculations or conclusion. However, be sure to enter your final work on the appropriate answer sheets.

g) At the end of the 50 minutes, your answer sheets will be collected.

Materials

5 beakers, 100 ml
1 centimeter ruler
1 graduated cylinder, 25 ml
1 hot plate
1 thermometer
1 watch or stop clock
1 balance accurate to 0.01 g
safety goggles
calculator
scissors
graph paper
magnesium ribbon, 50 cm
1.0 M HCL, 250 ml
(cooled to below room temp; i.e., < 20°C)



KINETICS : REACTION RATES

Investigation of factors that affect reaction rates

Procedure

Temperature is a factor that affects the reaction rate.

1. Determine the mass of 20 cm of magnesium ribbon.
2. Measure and cut four 5 cm lengths of Mg ribbon.
3. Heat 25 ml of 1.0 M HCl solution to about 20°C. Remove from the heat source. Immediately record the temperature and place one 5 cm length of Mg ribbon in the beaker. Measure the total time for all the Mg to react (disappear).
4. Record your data in table form. Pay attention to units.
5. Dispose of the acid. Rinse the beaker with distilled water.
6. Repeat steps 3, 4, and 5 for temperatures of about 25°C, 30°C, and 35°C.
7. Calculate the reaction rate for each temperature. Plot the collected data on the graph provided.
8. Based on your data table and graph, formulate appropriate conclusions.

Safety

Acids and bases are highly corrosive!

(1) Students must wear safety goggles at all times.

(2) Avoid direct contact with the reagents. If any of the acid touches the skin, you must wash off immediately with water and inform the instructor of the incident.

(3) Always add acid to water.

(4) DO NOT HEAT ACIDS ABOVE 45°C

(5) Do not use open flames (i.e., bunsen burners) due to the flammability of hydrogen.

ANSWER SHEET

PART B — Experiment Report

Organize your experiment report under the following headings:
RESULTS/OBSERVATIONS, CALCULATIONS, GRAPH, and CONCLUSIONS.
Use the front and back of these sheets if necessary.

RESULTS/OBSERVATIONS

Mass of 5 cm of Mg ribbon = _____

Factor: Temperature

	Temp (°C)	Time		Reaction Rate (grams/minute)
		Start	End	
Sample 1				
Sample 2				
Sample 3				
Sample 4				

CALCULATIONS

ANSWER SHEET

PART B — Experiment Report

Organize your experiment report under the following headings:
RESULTS/OBSERVATIONS, CALCULATIONS, and CONCLUSIONS.
Use the front and back of these sheets if necessary.

RESULTS/OBSERVATIONS

Mass of crucible and lid	
Mass of crucible, lid and hydrated salt	
Mass of hydrated salt	
Mass of crucible, lid and solid after heating	
Mass of anhydrous salt remaining after heating	
Mass of water (lost from hydrated salt)	
Moles of anhydrous salt *	
Moles of water **	

* Gram molecular weight of anhydrous salt X = 120.4 g/mole
** Gram molecular weight of water = 18.0 g/mole

CALCULATIONS

ANSWER SHEET

PART B — Experiment Report

Organize your experiment design under the following headings:
RESULTS/OBSERVATIONS, CALCULATIONS, and CONCLUSIONS.
Use the front and back of these sheets if necessary.

CONCLUSIONS

WORKING COPY

PART B — Experiment Report

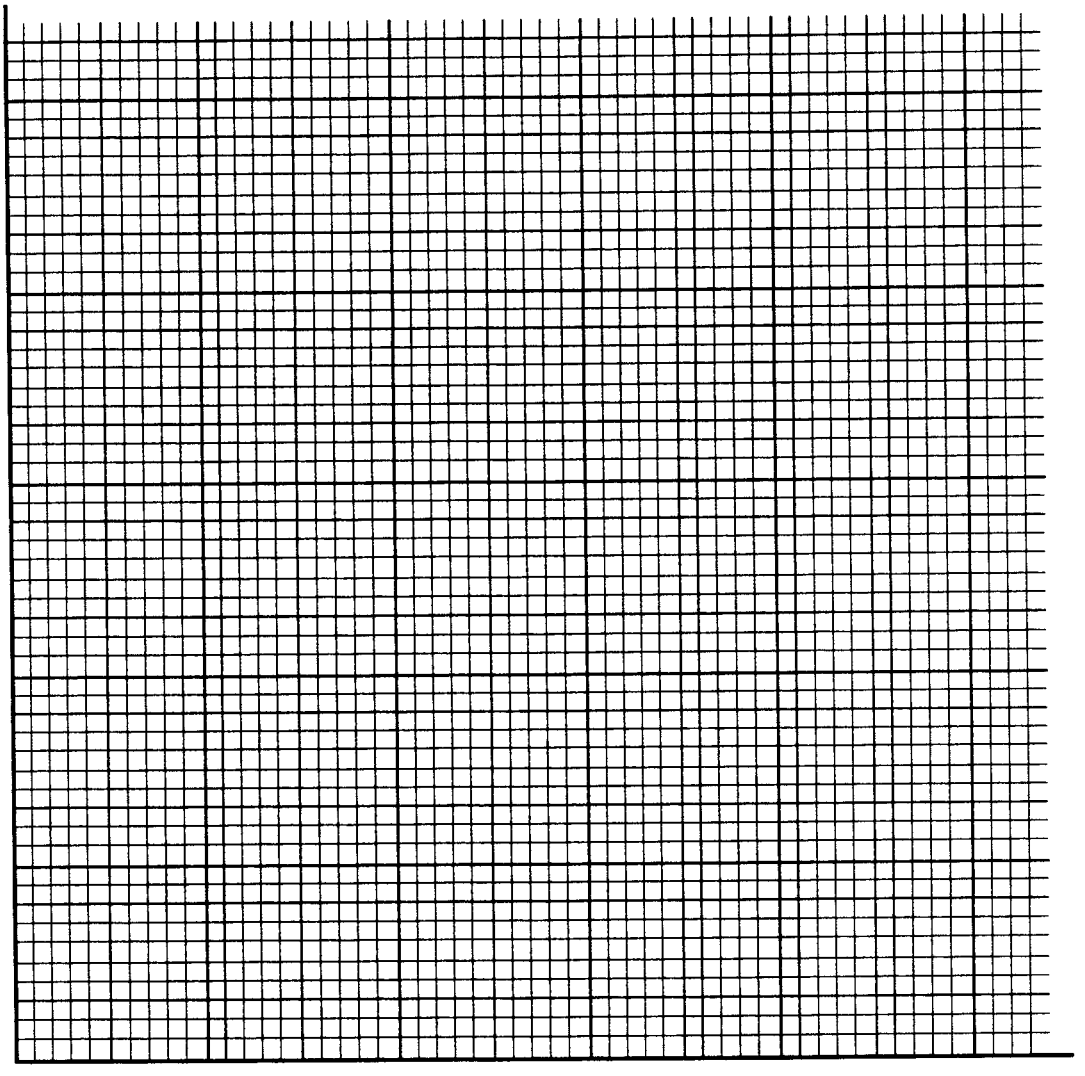
This sheet is provided as a work space (or scrap sheet).
Be sure to enter your final plan on the appropriate answer sheets.
No work on this sheet will be considered for credit.

ANSWER SHEET

PART B — Experiment Report

Organize your experiment design under the following headings:
RESULTS/OBSERVATIONS, CALCULATIONS, GRAPH, and CONCLUSIONS.
Use the front and back of these sheets if necessary.

GRAPH



CONCLUSIONS

WORKING COPY

PART B — Experiment Report

This sheet is provided as a work space (or scrap sheet).
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SCHOOL SCIENCE ASSESSMENT

SCIENCE LABORATORY TEST

CHEMISTRY

TASK NUMBER 3
THE MOLE CONCEPT

PART A

TIME : 30 MINUTES

NAME _____ SEX _____

SCHOOL _____ DATE _____

These tests are being developed through
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THE MOLE CONCEPT

Determination of the formula of a metal oxide

Introduction

This laboratory test presents a problem. Your task in Part A is to plan and design an experiment to solve the problem. You will have **30 minutes** to complete Part A. At the end of the 30 minutes, your answer sheet will be collected. You will then receive separate directions for Part B. In Part B you will use materials and equipment provided in the laboratory kit to collect experimental data for this problem. You may wish to do your preliminary planning on the sheet labelled "Working Copy." Write this plan on the appropriate answer sheet in your test booklet.

Problem

Chemists are often required to determine the empirical formula of a compound. This formula specifies the simplest, whole number, mole ratio of the elements in the compound. You will be provided with a metal ribbon. Your problem is to design and carry out an experiment, using the materials (and/or others) listed below, to determine the empirical formula of the compound formed in the synthesis reaction of the metal and oxygen.

a) Under the heading PROCEDURE list in order the steps of the procedure you will use to solve the problem. You may include a diagram to help illustrate your plans for the experiment. Include any safety procedures you would follow.

b) Construct a DATA TABLE or indicate any other method that you could use to record the observations and results that will be obtained.

PLEASE NOTE: In Part A you are NOT to proceed with any part of the actual experiment. You are just to plan and organize a way to investigate the problem.

Materials

2 Crucibles and lids
Tongs
Pipe-clay triangle
Tripod
Calculator
Fisher burner
Balance accurate to 0.01 grams
Metal ribbon
Scissors
Safety goggles

ANSWER SHEET

PART A — Experiment Design

Organize your experiment design under the following headings:
PROCEDURE and DATA TABLE.
Use the front and back of these sheets if necessary.

PROCEDURE (Include diagram if appropriate)

ANSWER SHEET

PART A — Experiment Design

Organize your experiment design under the following headings:
PROCEDURE and DATA TABLE.
Use the front and back of these sheets if necessary.

DATA TABLE (For results and observations)

WORKING COPY

PART A — Experiment Design

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WORKING COPY

PART A — Experiment Design

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SCHOOL SCIENCE ASSESSMENT

SCIENCE LABORATORY TEST

CHEMISTRY

TASK NUMBER 4
SOLUBILITY

PART B

TIME : 50 MINUTES

NAME _____ SEX _____

SCHOOL _____ DATE _____

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ANSWER SHEET

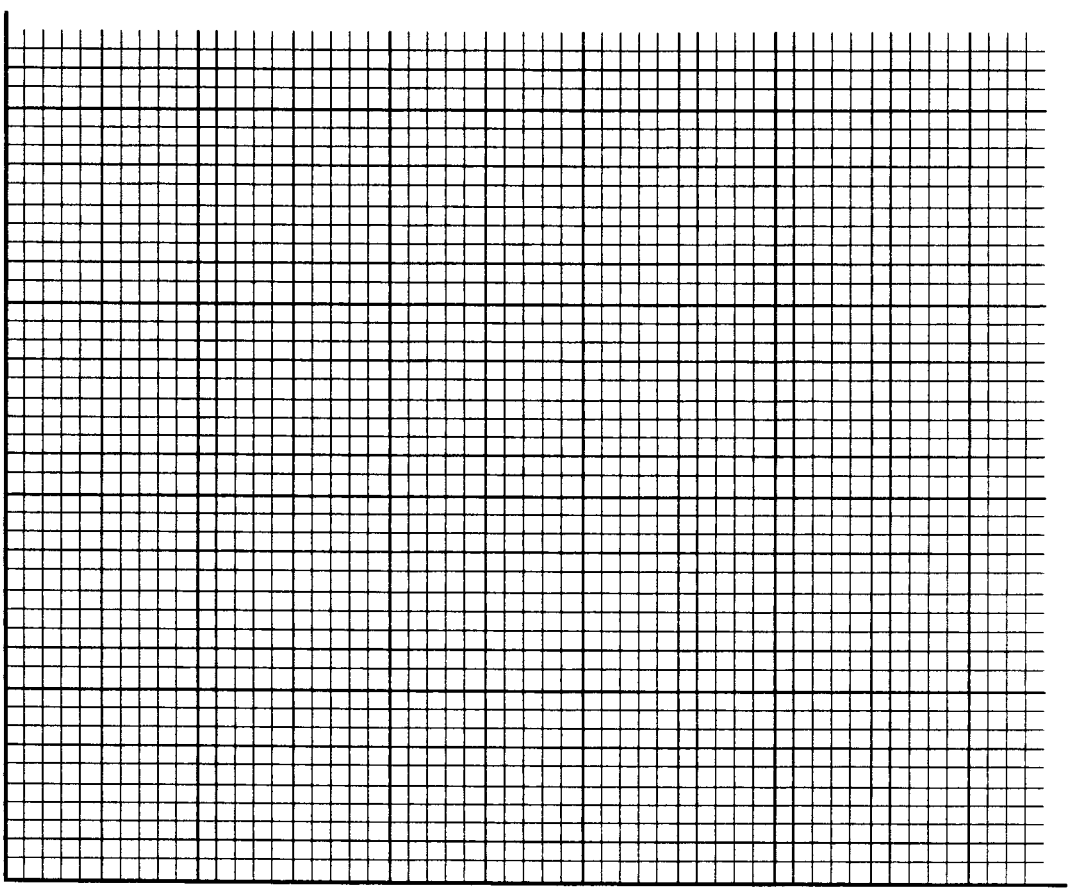
PART B — Experiment Report

Organize your experiment report under the following headings:
RESULTS/OBSERVATIONS, GRAPH and CONCLUSIONS.
Use the front and back of these sheets if necessary.

RESULTS/OBSERVATIONS

	Mass of Substance X	Volume of Water	Temperature
Sample 1			
Sample 2			
Sample 3			
Sample 4			

GRAPH



WORKING COPY

PART B — Experiment Report

This sheet is provided as a work space (or scrap sheet).
Be sure to enter your final plan on the appropriate answer sheets.
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SCHOOL SCIENCE ASSESSMENT

SCIENCE LABORATORY TEST

CHEMISTRY

TASK NUMBER 5
MELTING POINT

PART A

TIME : 30 MINUTES

NAME _____ SEX _____

SCHOOL _____ DATE _____

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MELTING POINT

Identification of pure substances

Introduction

This laboratory test presents a problem. Your task in Part A is to plan and design an experiment to solve the problem. You will have **30 minutes** to complete Part A. At the end of the 30 minutes, your answer sheet will be collected. You will then receive separate directions for Part B. In Part B you will use materials and equipment provided in the laboratory kit to collect experimental data for this problem. You may wish to do your preliminary planning on the sheet labelled "Working Copy." Write your final plan on the appropriate answer sheet in your test booklet.

Problem

Chemists often use the physical properties of substances, e.g. melting point or boiling point, to identify substances. Your task is to plan and design an experiment, using the materials (and/or others) listed below and the property of melting point, to identify two substances (samples A and B).

a) Under the heading PROCEDURE list in order the steps of the procedure you will use to solve the problem. You may include a diagram to help illustrate your plans for the experiment. Include any safety procedures you would follow.

b) Construct a DATA TABLE or indicate any other method that you could use to record the observations and results that will be obtained.

PLEASE NOTE: In Part A you are NOT to proceed with any part of the actual experiment. You are just to plan and organize a way to investigate the problem.

Materials

- rubber bands
- mortar and pestle
- spatula
- support stand
- 250 ml beaker
- boiling chips
- samples labelled A and B
- capillary/ melting-point tubes
- thermometer
- gauze mat
- clamps
- bunsen burner
- one-holed cork/rubber stopper
- safety goggles

ANSWER SHEET

PART A — Experiment Design

Organize your experiment design under the following headings:
PROCEDURE and DATA TABLE.
Use the front and back of these sheets if necessary.

PROCEDURE (Include diagram if appropriate)

ANSWER SHEET

PART A — Experiment Design

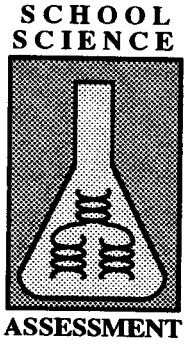
Organize your experiment design under the following headings:
PROCEDURE and DATA TABLE.
Use the front and back of these sheets if necessary.

DATA TABLE (For results and observations)

WORKING COPY

PART A — Experiment Design

This sheet is provided as a work space (or scrap sheet).
Be sure to enter your final plan on the appropriate answer sheets.
No work on this sheet will be considered for credit.



SCIENCE LABORATORY TEST

CHEMISTRY

TASK NUMBER 5
MELTING POINT

PART B

TIME : 50 MINUTES

NAME _____ SEX _____

SCHOOL _____ DATE _____

These tests are being developed through
the University at Buffalo and NORC with support of
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MELTING POINT

Identification of pure substances

You will have **50 minutes** to complete this part. You have been provided with a detailed Procedure (see next page) which you are to follow. Record your work for Part B on the answer sheet under the appropriate headings.

a) Perform the experiment by following the steps outlined in the procedure.

b) Under the heading RESULTS/OBSERVATIONS record the results of the experiment. Use statements, descriptive paragraphs, and tables of data where appropriate.

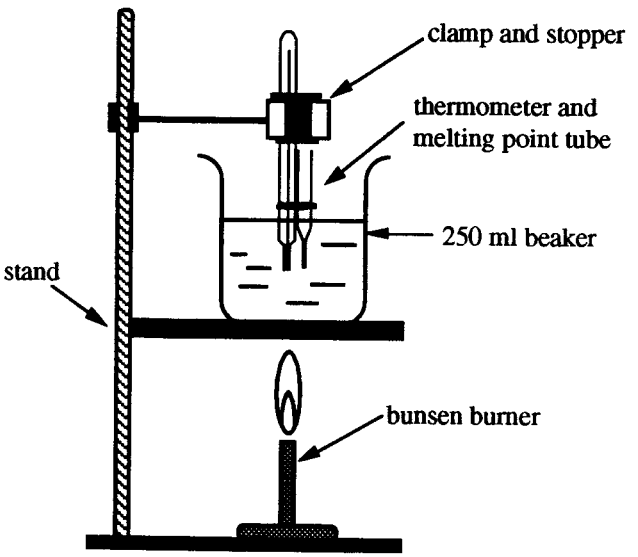
c) Under the heading CONCLUSION give an interpretation of your results. What did you learn from the experiment?

d) You have also been provided with a sheet labelled "Working Copy." Use this scrap sheet for any initial calculations or conclusion. However, be sure to enter your final work on the appropriate answer sheets.

e) At the end of the 50 minutes, your answer sheets will be collected.

Materials

rubber bands
support stand
250 ml beaker
boiling chips
thermometer
gauze mat
clamps
bunsen burner
one-holed cork/rubber stopper
safety goggles
melting point tubes filled with samples labelled A and B

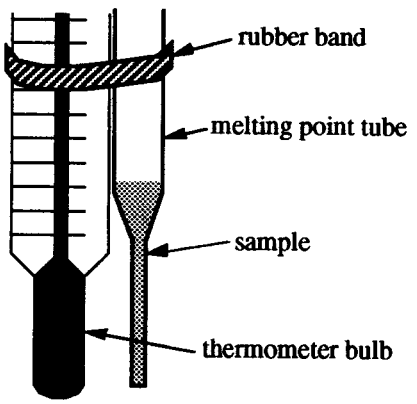


MELTING POINT

Identification of pure substances

Procedure

1. Attach the melting point tube containing sample A to the bulb of the thermometer using the rubber band (see diagram below).
2. Set up the apparatus as shown in the diagram on the previous page.
3. Heat the water gently and observe the temperature at which the substance melts. Record this data.
4. Repeat the procedure for sample B. Record your results.
5. Raise your hand to contact your instructor. The instructor will check to see that you have completed steps 1 through 5, then give you a sheet labelled "Melting Points of Substances." Using your data and the information in the "Melting Points of Substances" sheet, determine which substance was sample A and which was sample B.



Magnified version of melting point set-up

Safety

(1) Safety goggles must be worn at all times.

(2) Hot objects must be handled with tongs.

(3) Be careful handling the melting point tubes. They are very fragile.

ANSWER SHEET

PART B — Experiment Report

Organize your experiment report under the following headings:
RESULTS/OBSERVATIONS and CONCLUSIONS.
Use the front and back of these sheets if necessary.

RESULTS/OBSERVATIONS

Melting temperature

Substance A = _____

Substance B = _____

CONCLUSIONS

WORKING COPY

PART B — Experiment Report

This sheet is provided as a work space (or scrap sheet).
Be sure to enter your final plan on the appropriate answer sheets.
No work on this sheet will be considered for credit.

SCHOOL SCIENCE ASSESSMENT

SCIENCE LABORATORY TEST

CHEMISTRY

TASK NUMBER 6
HYDRATED SALT

PART A

TIME : 30 MINUTES

NAME _____ SEX _____

SCHOOL _____ DATE _____

These tests are being developed through
the University at Buffalo and NORC with support of
the National Science Foundation and
the U.S. Office of Education

HYDRATED SALT

Determination of the formula of a hydrated salt

Introduction

This laboratory test presents a problem. Your task in Part A is to plan and design an experiment to solve the problem. You will have **30 minutes** to complete Part A. At the end of the 30 minutes, your answer sheet will be collected. You will then receive separate directions for Part B. In Part B you will use materials and equipment provided in the laboratory kit to collect experimental data for this problem. You may wish to do your preliminary planning on the sheet labelled "Working Copy." Write this plan on the appropriate answer sheet in your test booklet.

Problem

A hydrated salt is a solid substance with water molecules at some of the lattice points in the crystal. The formula of a hydrated salt is written in a form that includes the number of water molecules associated with it. This water can be driven out of the crystal by heating. Your task is to design an experiment, using the materials (and/or others) listed below, which will determine an empirical formula for a hydrated salt X. Be sure to tell how you know when all the water has been removed from the hydrate crystals.

a) Under the heading PROCEDURE list in order the steps of the procedure you will use to solve the problem. You may include a diagram to help illustrate your plans for the experiment. Include any safety procedures you would follow.

b) Construct a DATA TABLE or indicate any other method that you could use to record the observations and results that will be obtained.

PLEASE NOTE: In Part A you are NOT to proceed with any part of the actual experiment. You are just to plan and organize a way to investigate the problem.

Materials

1 crucible with cover
1 pair of crucible tongs
1 porcelain triangle
1 tripod
balance
bunsen burner with matches
heat resistant tile
hydrated sample X
access to a periodic table
safety goggles
calculator

ANSWER SHEET

PART A — Experiment Design

Organize your experiment design under the following headings:
PROCEDURE and DATA TABLE.
Use the front and back of these sheets if necessary.

PROCEDURE (Include diagram if appropriate)

ANSWER SHEET

PART A — Experiment Design

Organize your experiment design under the following headings:
PROCEDURE and DATA TABLE.
Use the front and back of these sheets if necessary.

DATA TABLE (For results and observations)

WORKING COPY

PART A — Experiment Design

This sheet is provided as a work space (or scrap sheet).
Be sure to enter your final plan on the appropriate answer sheets.
No work on this sheet will be considered for credit.

SCHOOL SCIENCE ASSESSMENT

SCIENCE LABORATORY TEST

CHEMISTRY

TASK NUMBER 6
HYDRATED SALT

PART B

TIME : 50 MINUTES

NAME _____ SEX _____

SCHOOL _____ DATE _____

These tests are being developed through
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the National Science Foundation and
the U.S. Office of Education

HYDRATED SALT

Determination of the formula of a hydrated salt

You will have **50 minutes** to complete this part. You have been provided with a detailed Procedure (see next page) which you are to follow. Record your work for Part B on the answer sheet under the appropriate headings.

a) Perform the experiment by following the steps outlined in the procedure.

b) Under the heading RESULTS/OBSERVATIONS record the results of the experiment. Use statements, descriptive paragraphs, and tables of data where appropriate.

c) Under the heading CALCULATIONS show all equations and calculations used.

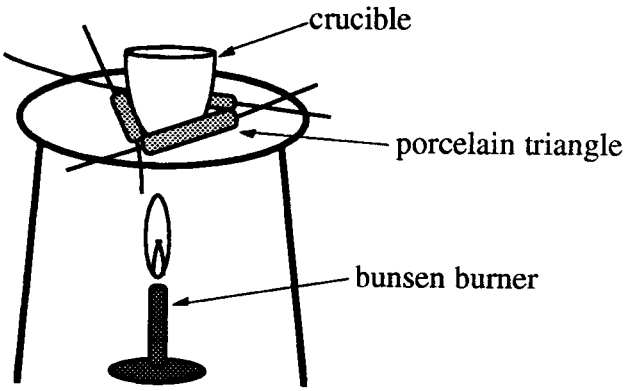
d) Under the heading CONCLUSION give an interpretation of your results. What did you learn from the experiment?

e) You have also been provided with a sheet labelled "Working Copy." Use this scrap sheet for any initial calculations or conclusion. However, be sure to enter your final work on the appropriate answer sheets.

f) At the end of the 50 minutes, your answer sheets will be collected.

Materials

1 crucible with cover
1 pair of crucible tongs
1 porcelain triangle
1 tripod
balance
bunsen burner with matches
heat resistant tile
hydrated sample X
safety goggles
calculator



HYDRATED SALT

Determination of the formula of a hydrated salt

Procedure

1. Determine the mass of a clean dry crucible and cover. Record the data in the data table.
2. Place about 4 grams of sample X in the crucible.
3. Weigh the crucible, lid and hydrated sample. Record this data in the data table.
4. Set up the apparatus as shown in the diagram on the previous page.
5. Heat the crucible gently at first and then more strongly. Continue heating for about 5 minutes, and no more than 8 minutes.
6. Stop heating and weigh the crucible, lid and solid left. Record the data in the data table.
7. Given your data, determine the empirical formula of hydrated salt X, of the form: $X \bullet \_\_\_\_\_ H_2O$

Safety

The hydrate crystals pose no acute toxicity or corrosivity hazard. However :

(1) Safety goggles must be worn at all times.

(2) Hot objects must be handled with tongs at all times.

(3) Should skin contact occur, flush thoroughly with water.