

Division of Academic Affairs
Technology Fee – Project Proposal
2014

Revised Proposal Deadline: Tuesday, February 25, 2014

Project Proposal Type

Instructional Technology Enhancement Project (ITEP)

Focused projects proposed by an individual or small team with the intention of exploring new applications of instructional technology. ITEPs will typically be led by a faculty “principal investigator.” ITEPs are time-limited projects (up to two years in length) and allocations of Technology Fee funds to these projects are non-recurring.

Project Title

*MeasureNet—Electronic Measurement Network and Data Collection System:
Phase Two Expansion of Chemistry Laboratory Experiments*

Total Amount of Funding Requested

\$68,785

Primary Project Coordinator

Pamela S. Tanner

Division of Academic Affairs
Instructional Technology Enhancement Project (ITEP) Proposals Template
2014

ITEP proposals must provide the following information:

1. Project description.

In 2011, I received an ITEP grant in the amount of \$58,365 to incorporate the MeasureNet data collection system into General Chemistry I and II labs (CHM 2045L and 2046L). The system was installed in 58A/212. This two year project was consistently ahead of schedule and under budget during the implementation period. During this time, five student employees and one directed study student worked on the project to adapt existing experiments and to develop original experiments. Since implementation 82 general chemistry sections, with up to 24 students each, have used the MeasureNet system to complete their experiments.

The MeasureNet system consists of twelve workstations connected to a network controller and one personal computer equipped with a printer. The workstations are equipped with various probes (pH electrodes, temperature probes, pressure sensors etc). With the network, an instructor or lab coordinator is able to see students' experimental data as it is being collected. This allows guidance and intervention before it is too late and students have left the lab. Students are able to view their high-quality data as they collect it at their workstation. Following the experiment, most students move to the computer lab (58A/211) to export their data into Excel for analysis.

Phase two of the project seeks to install a new, more advanced state-of-the-art MeasureNet system in 58A/208. If funded, this grant would provide students and instructors with a superior lab experience incorporating new advanced technology. The MeasureNet Unity Controller is next generation, state-of-the-art compared to the current controller. It will run Linux in a real-time environment to monitor and control the activity of the twelve workstations. There are probes included in this application which were not available three years ago. These include the colorimetry titration kit which will enhance kinetics-colorimetry experiments. Rather than static measurement of a sample in a tube, it will allow dynamic measurement of a reaction in progress.

Currently when one course uses the system, all other courses move to the alternate room (58A/208) which is not equipped with the system. During a typical fifteen week semester, all courses (General Chemistry I and II, Concepts in Chemistry and Fundamentals of Chemistry Lab) move four times. Twenty-three sections of up to twenty-four students each experienced this transition fall 2013. While students are able to find their way to the alternate room, the room change limits the number of weeks during the semester that students can encounter a modern, enhanced laboratory experience through the use of the system (see appendix one for the highlighted lab schedules). Only one class at a time can use the system due to overlap of scheduled labs. CHM 2045L meets Monday through Saturday in the fall so when this course is using the system, no one else has access.

To-date, we have modified approximately 25% of the general chemistry lab program. Phase two would allow further expansion through the addition of new, updated technology through the advanced MeasureNet system. I anticipate that we can modify another 25% of the program. For instance, we have an elegant experiment studying the rate of chemical reactions that has been developed for CHM 2046L. Its use of malachite green which is a pesticide and fungicide will provide students with a real-world connection. We also have an electrochemical experiment that is ready for use for CHM 2046L. We are unable to use these experiments in optimal format at the present time because of time constraints resulting from only one room equipped with a MeasureNet system and the lack of the more advanced dynamic probes in the new colorimetry titration kit.

Phase two would dramatically expand use of the MeasureNet equipped labs by other courses such as analytical chemistry, basic physical chemistry and physical chemistry. We already use the system in the spring semester for the basic physical chemistry course to conduct the heat of solution experiment. The addition of the more advanced second MeasureNet system would allow development of additional high-technology analytical and physical chemistry labs which are not currently possible with the existing system.

2. Description of project alignment with UWF Strategic Plan.

The project most closely aligns with strategic directions 1 and 3. It aligns with strategic direction 1 in that students are actively engaged in their learning when they are troubleshooting an experiment and evaluating high-quality data. The system is state-of-the-art and has allowed us to modernize our program. Students have an opportunity to conduct experiments in ways which more closely mirror the industrial scientist's experience. For instance when they conduct a titration experiment, they are able to use probes in conjunction with a drop-counter to measure the amount of reactant added. The workstation displays real-time experimental data. This experiment is a vast improvement over a student stirring a reaction mixture by hand-swirling.

It aligns with strategic direction 3 in that it allows us to improve our community partnerships with area schools. Every year we host the Pensacola High School IB Juniors (50-75 students) for a full day of experimentation, campus tours and recruiting. When visitors have an opportunity to examine heat flow using a sensor and the MeasureNet system, this is an improvement over the previous experiment where temperatures were measured by hand with a thermometer inserted into a Styrofoam cup. With the new experiment, visitors see a modern, exciting program which may be an enticement to attend UWF.

3. Description of benefits provided:

a) *Ways in which student access to technology will be enhanced.*

Phase one saw a novel use of probeware and unique experiments that were developed in-house. It cannot be stressed enough that we did not use the canned experiments available from MeasureNet. We explored the limits of the probes. One example includes the CHM 2045L experiment "Reactivity of Metals with HCl" (see appendix

two with pictures of the workstation on page 12). This experiment uses a pressure probe to measure the pressure of the “wet” hydrogen gas generated in the experiment. When the experiment was developed, one probe was selected. The experiment was run repeatedly and the probe was sent to MeasureNet for analysis. No one had previously used a probe in this manner. The probe passed the engineer’s analysis with flying colors and the experiment was adopted. An editor of the *Journal of Chemical Education* is currently evaluating this experiment to determine if it is suitable for publication.

b) *How the student experience will be enhanced.*

The MeasureNet system allows us to move away from “cookbook” experiments towards more open-ended experiments. Students gain experience analyzing and manipulating their data to create data tables and graphs. This experience is in contrast to former experiments which provided a data table that students filled in during the course of the lab. Students are now required to think about the data collected, to decide which variables are dependent and to determine which type of graph will display the data in the most meaningful way. This requires a certain level of “ownership.”

We are in the process of developing an honor’s section of the general chemistry labs. These students will be provided with a task to be accomplished without a procedure. The workstations are very user friendly. Students could select the appropriate probes and design a procedure through menu selections. The system is also adaptable to multi-week experiments which model a scientific research environment.

c) *How assessment will be conducted.*

Two types of assessment occur when the MeasureNet system is used.

I. If students are able to view their data as they collect it, they are able to troubleshoot their own experiments. This provides a unique opportunity for formative assessment as they learn from their mistakes in lab rather than from a graded lab report where there is no opportunity to modify the experiment.

II. Assessment will be conducted as it was in phase one. Students completed pre- and post-surveys for each experiment (see appendix three for the Reactivity of Metals with HCl survey). Each survey consisted of a Likert-type survey of student self-assessment followed by a series of questions and calculations which assess understanding of and ability to apply the concepts involved. Hard copies of the surveys will be distributed and collected before and after each MeasureNet experiment. An excerpt from the Reactivity of Metals assessment follows (please see final report for all assessment results):

The pre- and post-tests were identical. They included a Likert self-assessment survey followed by a series of problems/questions which can be used to gauge the accuracy of students' self assessment.

Legend for the Likert Survey page 18

A=5 B=4 C=3 D=2 E=1

Legend for questions pages 19-20

1=correct answer 2= incorrect answer 3=blank

Mean values for student self-assessment improved in every category on the Likert survey except for question 1. For this question, there was an insignificant decrease from 4.30 to 4.25. None of the questions achieved a score of 5 which corresponds to the most confidence in the topic. When examining the standard deviations, none of the improvements are statistically significant.

For the questions pages 19-20, all of the mean values showed an insignificant improvement.

The concepts in this experiment are the most challenging of the MeasureNet experiments as it combines material from chapters four and five so it is not surprising that while there was improvement, it was not statistically significant.

d) *Which and how many students will be impacted.*

Our program continues to expand as will the numbers of students impacted. Since summer 2012, 1012 students have been enrolled in CHM 2045L and used the MeasureNet system. In the same time period, 405 students were enrolled in CHM 2046L. With the expansion in phase two, students in other classes such as the Fundamentals of Chemistry Lab, Analytical Chemistry and Basic Physical Chemistry Lab will have an opportunity to use the system.

In addition to students enrolled in our labs, student OPS assistants receive enhanced professional development experience in the area of chemical education through their teaching and design work on the MeasureNet system. Two of the five student employees in phase one have since graduated with degrees in chemistry and are now in graduate school. One student employee graduated with a degree in biology and finishes up her Masters in Nursing at the University of South Alabama in May.

e) *How students with special needs or disabilities would be helped.*

Since implementation we have had several students enrolled in the labs who were registered with SDRC including students with handwriting disorders, poor eyesight and a hearing impaired student. The system did not pose a challenge for any of them. In one particular instance where it helped, the student with a writing disorder was accompanied to class by a note taker. This student was able to use the MeasureNet system herself without relying on her note taker. Her data was successfully collected

and stored for future analysis. This eliminated the need for the note taker who in classical experiments would spend the duration of the lab making notes and recording data almost as if she were the student's lab partner taking the course for a grade. The MeasureNet system allows a degree of independence not possible with classical experiments.

- f) *How training of students and faculty in the use of technology would be enhanced.*
I will continue to host MeasureNet Open Houses to train faculty and student assistants. We have written a series of excellent experimental procedures which guide lab students through the use of the system to collect their data, access their data on the shared Google Drive and analyze their data. There are also handouts for the instructors with detailed instructions for setting up the system and uploading student data.

4. How will success be measured? Provide metrics.

Other institutions who use the system report a trickle-up of data manipulation skills from general chemistry through analytical chemistry and other upper level chemistry courses.¹ The results of MeasureNet assessment surveys will be combined with grading rubrics in the upper level courses to assess the impact of data analysis on critical thinking and problem solving. Students who completed the lab during phase one are just now beginning to be enrolled in our upper level courses. See appendix four for a sample grading rubric.

5. Description of resources for the project and projected ongoing resource needs (total cost of ownership for the life of the project) including:

See detailed description (appendix five)

- a) Any hardware requirements—including PC, UPS, MeasureNet workstations, instruments and probes \$56260. The price quote for the PC and the UPS were obtained by Don Thompson, CAS Technology Manager. Don is familiar with the MeasureNet system.
- b) Any software requirements—system software \$525
- c) Any personnel costs—student OPS assistants \$8.75/hr to \$9/hr x 20 hr/week x 15 week/semester x 4 semesters = \$10500 to 10800. The range of pay was suggested by Nicole Lohr (UWF OHR). Students could advance from Technical/Specialized Skills Aides to Assistants as they progressed professionally throughout the project. See item 3d for the positive impact that employment on the project will have for student assistants.
- d) Other—A Advanced Estimate to install looped circuits for desk top systems \$1200. Sandra Thompson, Director of Information Technology Services, arranged for the estimate with A Advanced. The firm has done several projects for UWF and is familiar with the infrastructure issues in the lab.

Total Budget = \$68785

6. Provide the proposed timeline for the project with major milestones and project end dates.

A year consists of three semesters (Fall, Spring & Summer). Project will commence as soon as funding is received.

<i>Semester One/Year One</i>	<i>Semester Two/Year One</i>	<i>Semester Three/Year One</i>	<i>Semester One/Year Two</i>	<i>Semester Two/Year Two</i>	<i>Semester Three/Year Two</i>
Receipt and installation of MeasureNet system.	Training sessions for instructors and teaching assistants.	Use of MeasureNet in a CHM 2045L trial section(s).	Finalize experiments, grading keys and eLearning quizzes for CHM 2046L.	Use of MeasureNet in a CHM 2046L trial section(s).	Use by all enrolled students in CHM 2045L and 2046L.
Student assistance to adapt current General Chemistry I Lab (CHM 2045L) experiments or method develop new experiments.	Continue to method develop experiments with student assistance.	Begin cycle for General Chemistry II Lab (CHM 2046L).	Continue to fine-tune CHM 2045L experiments and use by all enrolled students.	Continue to fine-tune CHM 2045L and 2046L experiments.	Analyze assessment data from previous semester's CHM 2045L & 2046L.
Work with instructors to adapt Lower level (CHM 1020L and 1032L) experiments	Write grading keys and eLearning quizzes.	Work with instructors to adapt upper level Analytical Chemistry, Basic Chemistry experiments	Analyze assessment data from previous semester's CHM 2045L.	Analyze assessment data from previous CHM 2045L.	As a result of analysis, finish fine-tuning of lab program.
					Write up the results in SOTL journal.

7. Include a plan for sustainability of the project beyond the initial project period if applicable.

MeasureNet guarantees their probes for 5 years. This includes all probes with the exception of the pH probes. When the probes fail after the warranty has expired, the probes will be replaced using lab fee money. The MeasureNet controller and workstations are guaranteed 10 years.

When the system has been fully incorporated into the general chemistry labs, there is interest within the department to expand its use into upper level labs such as analytical chemistry. The system will also allow us to expand our outreach activities to area schools.

8. Provide any resource matching which might be provided by organizations with appropriate commitment authority documentation.

None

9. Indicate which individual or group will implement the project (to help determine any additional costs and resource restraints).

Dr. Pamela Tanner as the general chemistry laboratory coordinator will continue to adapt and modify existing experiments as well as design new experiments to enhance the curriculum. The general chemistry lab advisory committee will provide input and direction. The changes will be made with the assistance of student OPS employees.

10. Indicate a lead person (“Principal Investigator”) for the project for all communications and overall responsibility for reporting and fund utilization.

Dr. Pamela Tanner, Lecturer, Chemistry Department

11. Project proposals should be succinct and submitted to the Technology Fee Committee by the deadline with a notice of submission to the chair and the dean or appropriately designated leadership in the unit (Center Director, etc.).

References

1. Sprague, E. D.; Vorhees, R.; McKenzie, P.; Alexander, J. J.; Padolik, P. *J. Chem. Ed.* **1998**, 75(7), 859.

**CHM 2045L
CHEMISTRY I LABORATORY
FALL 2013**

<u>SECTION</u>	<u>DAY</u>	<u>TIME</u>	<u>SECTION</u>	<u>DAY</u>	<u>TIME</u>
0380	M	8:00AM-12:00PM	0387	W	12:30-4:30PM
0381	M	12:30-4:30 PM	0388	W	5:00-9:00PM
0382	M	5:00-9:00PM	0389	Th	8:00AM-12:00PM
0383	T	8:00AM-12:00PM	0390	Th	12:30-4:30PM
0384	T	12:30-4:30PM	0391	Th	5:00-9:00PM
0385	T	5:00-9:00PM	0392	F	8:00AM-12:00PM
0386	W	8:00AM-12:00PM	0393	F	1:00-5:00PM
			0394	S	9:00AM-1:00PM

Duplicate laboratory notebook and safety glasses are required. Laboratory experiments are available on eLearning site. Grading procedure will be explained by your lab instructor.

<u>Week</u>	<u>Date</u>	<u>Experiment</u>
1	Aug. 26-30 August 31	Course Orientation, Safety Demonstration and Stoichiometry No Lab
2	Sept. 2-6 Sept. 7	No Lab—Labor Day, September 2 Course Orientation, Safety Demonstration and Stoichiometry
3	Sept. 9-14	Introduction to Measurement and Chemistry Calculations— 58A/208
4	Sept. 16-21	Check-in & Significant Figures and Graphical Representation of Data
5	Sept. 23-28	Determination of Water of Hydration— 58A/208
6	Sept. 30-Oct. 5	Transformation of Copper
7	Oct. 7-12	Chemical Reactions on a Microscale
8	Oct. 14-19	Volumetric Determination of Purity of Acid
9	Oct. 21-26	Gas Laws: P-V-T Relationship—MeasureNet
10	Oct. 28-Nov. 2	Reactivity of Metals with Hydrochloric Acid—MeasureNet
11	Nov. 4-9	Heat of Vaporization of Liquid N ₂ & Heat of Solution—MeasureNet
12	Nov. 11 Nov. 12-16	No Lab—Veteran's Day Atomic Spectroscopy; Check-out
13	Nov. 18 Nov. 19-23	Atomic Spectroscopy— 58A/208 Molecular Geometry and Bonding— 58A/208
14	Nov. 25 Nov. 26-30	Molecular Geometry and Bonding; Check-out No Lab—Thanksgiving
15	Dec. 2-7	Makeup Lab Week- M-T Evening December 2- 3 at 5-9 PM

**CHM 2046L
CHEMISTRY II LABORATORY
FALL 2013**

BLDG 58A/ROOM 208	<u>SECTION</u>	<u>DAY</u>	<u>TIME</u>
	0397	M	8AM-12:00PM
	0398	M	12:30-4:30PM
	0399	M	5:00-9:00PM
	0400	T	8AM-12:00PM
	0401	T	12:30-4:30PM
	0402	T	5:00-9:00PM

Duplicate laboratory notebook and safety glasses required. Laboratory experiments are available on eLearning site.

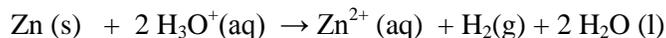
<u>Week</u>	<u>Dates</u>	<u>Experiment</u>
1	August 26-27	Course Expectations Safety, Check-in
2	September 2-3	No Lab—Labor Day, September 2
3	September 9-10	Freezing Point Depression—MeasureNet (58A/212)
4	September 16-17	Synthesis and Recrystallization of a Cobalt Complex
5	September 23-24	Colorimetric and Gravimetric Analysis of Cobalt Complex— MeasureNet (58A/212)
6	Sept. 30-Oct. 1	Qualitative Analysis I
7	October 7-8	Qualitative Analysis II
8	October 14-15	Complete Qualitative Analysis
9	October 21-22	Kinetics
10	October 28-29	Radioactivity** Experiment with Buffer Pre-lab
11	November 4-5	Buffers **
12	November 11-12	No Lab—Veteran’s Day, November 11
13	November 18-19	Weak Acid Titration**—MeasureNet (58A/212)
14	November 25-26	Faraday Experiment and Check-out—MeasureNet (58A/212)
15	December 3	Makeup Lab—Tuesday evening 5:00-9:00 PM

Grading: Grading procedure will be explained by your laboratory instructor.

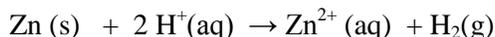
**Denotes a complete “formal” report.

Reactivity of Metals with Hydrochloric Acid

Chapter eighteen illustrates the use of a table of Standard Reduction Potentials (Table 18.1 p. 873) to predict whether an oxidation/reduction reaction will occur between a metal and an acid. By examining the table, we can see that the farther down the table a metal is the greater its reducing strength and activity. The metals below the hydrogen half-reaction are all capable of being oxidized in acid. These reactions are classified as hydrogen displacements. We saw this type of reaction in the Transformation of Copper experiment when zinc metal was placed in sulfuric acid at the end of the experiment. The overall reaction was:



Or represented more simply:



Zn is oxidized and is the reducing agent. H_3O^+ is the oxidizing agent and is reduced. Two electrons are transferred from the reducing agent to the oxidizing agent.

A copper cage is used to enclose either Mg or Al during this experiment's reactions. Where is copper on Table 18.1? It is above the hydrogen half-reaction. It is less active than magnesium or aluminum and will not react with the acid. During the reaction, the more active metals will oxidize and lose electrons. These electrons move to the copper wire where they reduce the acid and form hydrogen gas. You should see H_2 gas form on the copper wire. This method leaves the active metal surface free for reaction and speeds up the reaction.

In chapter five we learned that when gases were generated in reactions they could be collected over water (see figure 5.14). In this lab, the hydrogen gas will be collected in an inverted buret. Its volume will be determined by taking into account the "dead space" in the uncalibrated, unmarked portion of a buret. The volume of hydrogen generated will be calculated using the following relationship:

$$\text{Volume H}_2 = 50 \text{ mL} - \text{final buret reading} + \text{Vuncalibrated}$$

The pressure of the hydrogen gas can be determined by taking into account the vapor pressure of water (see table 5.4). The relationship is:

$$P_{\text{TOTAL}} = P_{\text{H}_2} + P_{\text{H}_2\text{O}}$$

The total pressure of the gas in the buret is obtained by adding the barometric pressure to the final sensor pressure (use three significant figures). The above equation can be rearranged to determine the pressure of the dry hydrogen gas.

Now that you have the pressure, volume and temperature of the hydrogen gas, you can use the ideal gas equation to determine the number of moles of hydrogen generated in the metal displacement reaction. With a balanced redox reaction, you can use the mole ratios to calculate the theoretical number of moles of metal that reacted with the hydrogen gas. The experimental ratio of moles metal to moles hydrogen can be obtained and the percent error can then be calculated. The experimental ratio can be used to calculate the final charge on the metal.

Equipment and reagents:

- Pressure Transducer and MeasureNet workstation
- 50 mL buret
- Tygon tubing
- Ring stand

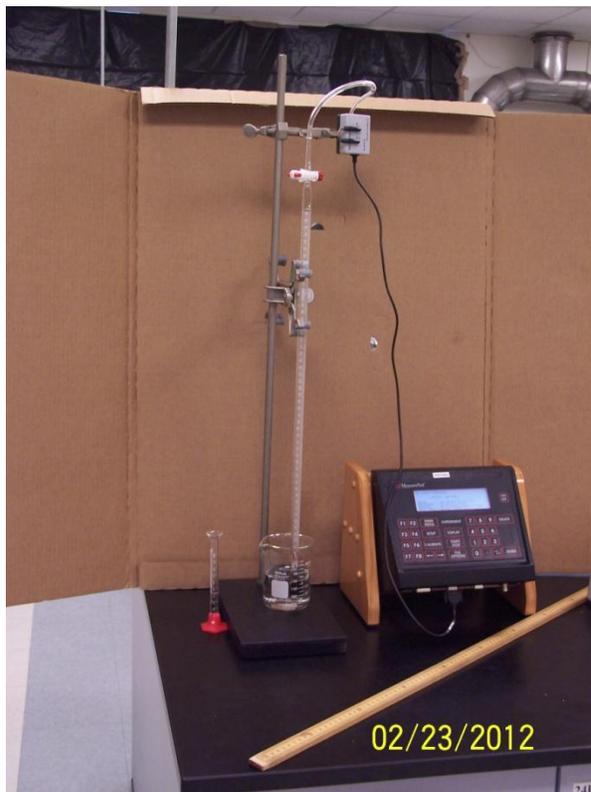
Appendix Two—Sample Experiment

- Buret clamp
- Three prong clamp
- 400 mL beaker
- Copper wire
- Rubber stopper with one or two holes
- Thermometer
- Metric ruler
- Pieces of aluminum (≤ 0.032 g) and magnesium (≤ 0.042 g) (these are maximum masses)
- Concentrated hydrochloric acid (12M HCl)

Safety Precautions:

Hydrochloric acid is irritating to lungs and causes burns to skin and eyes. Use care when handling. Wear gloves to protect your hands and clean up any spills immediately with sodium bicarbonate. Wear OSHA approved safety glasses/goggles.

Set-up during experiment:



Experimental Procedure:

1. Record the number of the workstation.
2. Turn on the MeasureNet Station
3. Record the barometric pressure in torr. The conversion factor is 1 mmHg = 1 torr.
4. If not already connected, connect the pressure transducer to the station port.
5. Press | Main Menu | then | F4 | for Pressure and | F3 | for Pressure vs. Time
6. Press | Calibrate | on the MeasureNet station

Appendix Two—Sample Experiment

7. Enter the barometric pressure and press | Enter | .
8. Make sure the pressure transducer is open to the atmosphere. Wait for a stable value and hit | Enter |
9. Hit the | Setup | button followed by | F1 | . Scroll down to “Xmax” with the arrow keys and enter 3600 followed by | Enter | and then | Display | to accept the values. Pressure versus time data will be saved. **You will use the final sensor pressure obtained from the MeasureNet data in your calculations.**
10. Assemble a ring stand and clamp, a 50 mL buret and a 400 mL beaker.
11. Clean the buret and place it in the clamp.
12. Using a three pronged clamp secure the pressure transducer near the top of the buret.
13. For Part A, select a piece of magnesium. For Part B, select a piece of aluminum. Weigh each piece of metal on an analytical balance. Record these weights to four decimal places. See the maximum masses page 2.
14. Using about 6 inches of thin copper wire, coil it around a large glass stir rod to make a basket, leaving about 5 cm straight as a tail. Loosely ball up the metal and place it into the copper basket, and then close off the end of the basket by folding the ends of the wire. Do not compress the metal too tightly, it will increase the time the reaction takes. Test the cage size in your buret before continuing.
15. Fill a 400 mL beaker with about 150 mL of DI water and place it under the buret.
16. Determine the volume of the uncalibrated lower portion of the buret using a 10 mL graduate cylinder. Fill the buret with deionized water to a volume slightly greater than the 50 mL mark. Adjust the bottom of the meniscus to exactly 50 mL. Now dispense the remaining water into the 10 mL graduate cylinder. This is the “dead space” or uncalibrated volume of your buret. Record this value to one decimal place.
17. If you haven’t already, put on gloves. Make sure that the stopcock on your buret is closed. Use a funnel to pour concentrated hydrochloric acid into your buret. Use 3 mL for magnesium, 20 mL for aluminum. These volumes are adjusted for the activities of the metals. If too much acid is used, hydrogen gas will be expelled out of the buret along with HCl/water as the reaction progresses. If this occurs, you will have to repeat the experiment.
18. Use your wash bottle to *slowly* fill the buret past 0 mL to the brim, being careful not to mix the denser acid and water.
19. Insert the metal wrapped in the copper basket and secure it about 4 cm down the buret securing the tail of the copper basket with a rubber stopper. Make sure there are no air bubbles trapped in the top of the buret.
20. Using your gloved hand, cover the hole in the rubber stopper and invert the buret putting the stoppered end under the water in the 400 mL beaker and secure the buret back to the ring stand. Upon inversion, the denser acid diffuses down the buret and reacts with the metal. The H₂ gas collects in the top of the buret and displaces the HCl/water through the stopper into the beaker.
21. Place the tygon tubing on the tip of the buret snugly, open the stopcock and press | Start/Stop |
22. When the reaction is complete the metal will be dissolved. Tap the buret gently to free any gas bubbles adhering to the sides of the buret and wire. Press | Start Stop | again.

Appendix Two—Sample Experiment

23. Record the final sensor pressure reading from the MeasureNet station and access your data (.txt) to verify this reading. **Add barometric pressure to the final sensor reading to obtain P_{TOTAL} .**
24. Press | File Options |, then | F3 |, followed by 301 as the file number and press | Enter | to save your data.
25. Measure and record to one decimal place the temperature of the gas by holding a thermometer to the side of the buret.
26. Record the final buret reading on your data table by reading the buret to one decimal place.
27. Disconnect the tygon and pressure transducer from the top of the buret. Raise the buret up out of the 400 mL beaker, open the stopcock and allow the remaining solution to drain into the beaker and properly discard the acidic solution into a labeled waste bottle. Discard the copper basket into the labeled box, after it has been used for both metals.
28. Clean equipment used and repeat the steps above with the other metal starting with step #12. Save the file as 302.
29. Show all work in a separate sample calculations section for both trials.

Appendix Two—Sample Experiment

Part A—Data Table for First Determination (Mg)

Identity of metal	_____
Weight of metal, g	_____
Volume uncalibrated portion of buret, mL	_____
Final buret reading, mL	_____
Calculated volume H ₂ , mL	_____
Volume 12 M HCl, mL	_____
Calculated moles HCl, mol	_____
Temperature of H ₂ , °C	_____
Calculated temperature of H ₂ , K	_____
Barometric Pressure, torr	_____
Final Sensor Pressure, torr	_____
P _{TOTAL} , torr	_____
Vapor pressure of water, torr (table)	_____
Calculated partial pressure of H ₂ , torr	_____
Calculated experimental moles of H ₂ , n	_____
Balanced Reaction:	
Use balanced reaction to determine the ratio of moles metal to moles H ₂ :	
Experimental Moles metal from mass	_____
Experimental ratio of moles metal to moles H ₂	_____
Theoretical ratio of moles metal to moles H ₂	_____
Percent error	_____
Final experimental charge on metal	_____

Appendix Two—Sample Experiment

Part B—Data Table for Second Determination (Al)

Weight of metal, g _____

Volume uncalibrated portion of buret, mL _____

Final buret reading, mL _____

Calculated volume H₂, mL _____

Volume 12 M HCl, mL _____

Calculated moles HCl, mol _____

Temperature of H₂, °C _____

Calculated temperature of H₂, K _____

Barometric Pressure, torr _____

Final Sensor Pressure, torr _____

P_{TOTAL} , torr _____

Vapor pressure of water, torr (table) _____

Calculated partial pressure of H₂, torr _____

Calculated experimental moles of H₂, n _____

Balanced Reaction:

Use balanced reaction to determine the ratio of moles metal to moles H₂:

Experimental Moles metal from mass _____

Experimental ratio of moles metal to moles H₂ _____

Theoretical ratio of moles metal to moles H₂ _____

Percent error _____

Final experimental charge on metal _____

Appendix Two—Sample Experiment

Pre-lab Questions:

1. Arrange Zn, Mg, Al and H₂ in an activity series similar to table 18.1
2. Write a balanced redox reaction for aluminum metal in acid.
3. Starting with 0.032 g of Al, calculate the number of moles hydrogen gas generated.

4. Using the above number of moles, what volume of hydrogen gas would be generated if collected over water at 20 °C and 720 torr?

Name _____

SURVEY ON UNDERSTANDING KEY CONCEPTS

For each of the concepts or skills listed below, select one of the 5-options below that best describes your understanding of that concept at this point in your learning, using the scale below:

- A.** I am very confident of my understanding of the concept and required skill, and I am certain I could explain it so others could understand it and apply the necessary skill.
- B.** I am reasonably confident of my understanding of the concept and required skill. I can apply the skill and I might be able to explain it so others could understand it.
- C.** I have some understanding of the concept and required skill. I can apply the skill but I could not explain it to others.
- D.** I have heard of the concept, but I do not understand it. I cannot apply the required skill.
- E.** I have not heard of the concept or the required skill.

Please mark one of the 5-options to represent your understanding of each concept:	A	B	C	D	E
1. Familiarity with the Ideal Gas equation.					
2. Familiarity with Dalton's law of partial pressures.					
3. Being able to apply Dalton's law when a mixture of gases is collected over aqueous solution.					
4. If provided with a balanced reaction, being able to identify the reaction type: precipitation, oxidation-reduction, acid-base or gas forming.					
5. Being able to interpret an activity series to determine if a metal will react with acid.					
6. If the metal reacts with the acid, being able to predict the products of the reaction.					
7. If the metal reacts with the acid, being able to balance an oxidation-reduction reaction.					
8. If the metal reacts with the acid, being able to assign oxidation numbers.					
9. If the metal reacts with the acid, being able to identify the oxidizing and reducing agents.					
10. Using a balanced reaction, being able to perform stoichiometric calculations.					
11. Being able to obtain data using the MeasureNet data collection system.					
12. Understanding the data obtained and performing calculations.					

Reactivity of Metals Pre-experiment quiz

1. In the following activity series, which metal(s) will react with acid?

Stronger
Oxidizing
Agent



$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$	$E^0 = 0.80\text{V}$
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$	$E^0 = 0\text{ V}$
$\text{Fe}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Fe}(\text{s})$	$E^0 = -0.036\text{V}$
$\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Al}(\text{s})$	$E^0 = -1.66\text{V}$

2. Balance the following reaction.



3. For the above reaction, the oxidizing agent is _____

and the reducing agent is _____

4. Aluminum was allowed to react with hydrochloric acid. At 22°C the barometric pressure was 765.1 torr and the final sensor pressure was -19.0 torr. What is the total pressure inside the buret?

_____ torr

5. If the vapor pressure of water at 22°C is 19.8 torr, what is the pressure of the hydrogen gas?

_____ torr

_____ atm

6. If the volume of the dry hydrogen is 40.0 mL, how many moles of hydrogen were generated? [$R = 0.0821\text{ L atm mol}^{-1}\text{ K}^{-1}$]

_____ moles

Reactivity of Metals Pre-experiment quiz

7. How many moles of aluminum reacted to form the hydrogen?

_____ moles

8. If the molar mass of aluminum is 26.98 g, what was the weight of metal?

_____ g

Appendix Four—Grading Rubric For CHM 4610L Lab Reports¹

Student Name _____	Experiment _____			Date _____			
	5	4	3	2	1	0	Assigned
Title Page (5)	Title is succinct and clear. It describes the experiment in 4-13 words. It reflects accurately and clearly the paper's content and emphasis. All terms are spelled out. Jargon, symbols, formulas and abbreviations are avoided. There are no spelling errors. Author's full given name is correctly listed along with laboratory partner's name.		Title is adequate but is a little too short, too long or not sufficiently clear. It may contain abbreviations, misspelled or incorrect names.		Title does not correctly identify the content of the paper. It is either ambiguous, too lengthy or both. It contains grammatical and/or spelling errors.	No title or byline provided.	
Abstract (10)	The abstract is a brief three to six sentence summary of the experiment. It accurately describes the content of the paper. It states the purpose of the work, the theoretical or experimental plan, and summarizes the principal findings and conclusions. It is concise and self-contained. It is an appropriate length (80-200 words) and contains no grammatical or spelling errors.		Adequately describes most of the content but fails the "stand-alone" test. Too short or too long, some errors in chemical content, grammar or spelling.		Does not accurately reflect the content of the paper. It is carelessly written with many errors.	None provided.	
Introduction (15)	Provides a concise lead-in to the report, explaining the topic, giving appropriate background discussion, citing pertinent literature and explaining the goals of the current work. It is one to two paragraphs and contains no scientific errors, ambiguities or spelling/grammar errors.		Gives some background but also material which is marginally relevant to the current work. Literature cited is insufficient or not pertinent. It is too long or too short. There are errors in spelling/grammar or scientific content.		Introduction does not provide background necessary for an understanding of the work that follows. It is careless and shoddy with many omissions and errors.	None provided.	
Experimental (15)	Procedures are clear and easily reproducible by other experienced co-workers. Includes a written description of experimental apparatus which may include a drawing of a more complex apparatus, a complete description of reagents including the order, quantities and method for their addition, the experimental techniques, percent yield, characterizations including melting point and spectroscopic methods. Standard procedures are not described in detail but references given where necessary. All deviations from literature methods are clearly identified.		Most of the steps are understandable but lack some detail. Modifications are not described. References to literature are not complete.		Insufficient detail or references to enable the procedures to be reproduced.	None provided.	

Results	Summarizes the data collected in a clear and concise manner. Equations, figures, graphs and tables are used where necessary. All information referred to in the discussion is readily accessible. All spectra are included as either figures in this section or at the end of the paper in an appendix. All calculations are correct.	Most of the results are well presented and mostly complete. Some equations and calculations are missing. Labeling of spectra is incomplete or careless.	Results section is incomplete. Several pieces of important information are missing including required calculations and spectral data.	Reporting of results is inadequate or not included.
Discussion (may be combined with results) (40 pts total)	Interpretation of the data collected. Data is clearly discussed. All information is carefully evaluated and all conclusions concerning the characterizations or properties of any compound synthesized are justified by the experimental data. The discussion is objective and all features, deficiencies and limitations of the work are acknowledged. References are given for all information and data taken from the literature.	The results are adequately discussed but organization could be improved. Some statements and conclusions are not sufficiently justified (references and scope of the work). There are some scientific errors but basically the discussion is sound.	The discussion is poor or inadequate. The organization is poor and the evidence for reaching the conclusions is weak. There are few references to current knowledge in the field.	The discussion section is missing or totally inadequate.
References (5)	All work is referenced at the end of the report following ACS guidelines. Student "accesses the information using well-designed search strategies and most appropriate information sources." ²	All work of others is referenced but the format is incorrect or careless. "Accesses information using variety of search strategies and some relevant information sources. Demonstrates ability to refine search." ²	Not all of the work of others is referenced. "Accesses information using simple search strategies, retrieves information from limited and similar sources." ²	No references are given or student has accessed irrelevant, low quality information in a random fashion. ²
Presentation (10)	The type-written paper is well organized. The layout allows the content to be easily followed. The writing is clear, uses appropriate language and is succinct. "Students use correctly all of the following information use strategies (use of citations and references; choice of paraphrasing, summary or quoting; using information in ways that are true to original context; distinguishing between common knowledge and ideas requiring attribution) and demonstrate a full understanding of the ethical and legal restrictions on the use of published, confidential, and/or proprietary information." ²	The layout is sometimes confusing. The writing is generally clear but there may be unnecessary words or too much simplification. The meaning is sometimes hidden. The paragraph or sentence structure may be repetitive. Students use three of the information use strategies listed previously and "demonstrate a full	The layout and organization make it hard to understand the paper. Students use two of the information use strategies listed previously and "demonstrate a full understanding of the ethical and legal restrictions on the use of published, confidential, and or proprietary information." ²	The paper is very poorly presented. The organization is so poor that the paper is almost impossible to understand. Students use one of the information use strategies and "demonstrate a full understanding of the ethical and

			understanding of the ethical and legal restrictions on the use of published, confidential, and or proprietary information.” ²			legal restrictions on the use of published, confidential, and or proprietary information.” ²	
Assigned Questions	All assigned questions were answered correctly in either the introduction, discussion or a separate section. The answers were clearly attached to the assigned questions. Points will be assigned based upon the number of questions and the level of difficulty. These points will be part of the 40 points for results and discussion.					The questions were not answered correctly or it was difficult to correlate answers to the questions.	

¹This rubric was adapted by permission from that of Stephen P. Tanner. Students should refer to the course handout “Scientific Laboratory Report Guide” written by Pamela Tanner for a detailed description of each section as well as additional sources.

² These portions of the rubric are used verbatim from the VALUE Rubrics at www.aacu.org/value/rubrics



University of West Florida Network Quote

Part no.	Description	Price ea.	Number	Sub-total (\$)
MMDS-D-101	MeasureNet Work-Station (desk-top)	\$1,575.00	0	-
MMDS-W-102	MeasureNet Work-Station (req. mounting stand)	\$1,575.00	12	18,900.00
MSTND-211	Optional Wooden Work-Station Stand	\$200.00	13	2,600.00
MPH-103	pH Probe	\$110.00	12	1,320.00
MTMP-104	Temperature Probe	\$125.00	12	1,500.00
MLVT-105	Voltage Probe	\$45.00	12	540.00
MPRS-106	Pressure Probe	\$195.00	12	2,340.00
MDRPCNTR-109	Multi-Function Drop Counter	\$205.00	12	2,460.00
MDBC-138	Advanced Colorimeter	\$450.00	12	5,400.00
MDBC-CCTK	Colorimeter Titration Kit	\$195.00	12	2,340.00
MCNDT-114	Conductivity Probe	\$325.00	0	-
DUAL-ADPT	Dual Input Adapter (Temperature/Pressure/Voltage)	\$9.00	0	-
MGCC-111	GC / HPLC Connector	\$115.00	0	-
SPEC-UV/VIS-D	MNet UV-vis Spectrometer (200-850nm) desk-top	\$6,995.00	0	-
SPEC-UV/VIS-W	MNet UV-vis Spectrometer (200-850nm) req. stand	\$6,995.00	1	6,995.00
MBLNC-202	Ohaus Scout Pro 202 Balance (200+/-0.01gm)	\$510.00	0	-
M-NDS6755EA	Parr Solution Calorimeter (includes Thermometer)	\$8,295.00	0	-
MELTEMP-KIT	Meltemp Kit	\$240.00	0	-
EPC-AP-500	ElectroChemistry Probe (Requires Drop-Counter)	\$395.00	12	4,740.00
MNET-ISE-XX	Ion-Selective Electrode	\$375.00	0	-

	(est.)			
MNC-200	MeasureNet UNITY Controller	\$2,995.00	1	2,995.00
QNWP10-108	Quick-Net Wiring Pkg.	\$215.00	1	215.00
PCPR-117	Network PC and Inkjet Printer	\$2,050.00	0	-
MNETSFT-120	System Software	\$525.00	1	525.00

Product Sub Total = \$52,870.00

TO:		
University of West Florida	Packing/Shipping Charges(EST.)=	\$300.00
	Installation/Set-up/Training(EST.) =	\$2,500.00
	TOTAL=	\$55,670.00
	30% Deposit Payable with Order	\$16,701.00
	For orders over	\$15,000

By: Robert Voorhees
MeasureNet Tech., Ltd
4240 Airport Rd.
Cincinnati, OH 45226
866-396-6765
voorhees@measurenet-tech.com
Quote #: RTV010814-1

Quote good for 30 Days

Date of Quote: January 8, 2014

A ADVANCED SUPERIOR PHONE AND DATA,
 INC.
 1936 EDGEWOOD DRIVE
 NAVARRE, FL 32566

Quote

Date	Estimate #
1/3/2014	1016a

Name / Address
UWF ITS ITS NETWORKING AND TELCOM 11000 UNIVERSITY PARKWAY PENSACOLA , FL 32514

P.O. No.	Terms	Rep	Account #	Project	Other
	COD				

Description	Qty	Cost	Total
WO 116691	1	1,200.00	1,200.00
Install looped circuits for desk top systems. Building 58A room 208. Additional Lab will be same price if needed.		0.00	0.00
Thanks , Neal			

Phone #	Fax #	E-mail	Web Site
(850)939-7654		aaspdinc@gmail.com	



APC Back-UPSES550—"Green" 550VA UPS

Mfg. Part: BE550G | CDW Part: 1524034 | UNSPSC: 39121011



- UPS
- External
- 550 VA power capacity
- 3.2 min battery run time (up to)
- 330 Watt power provided
- AC 120 V
- 3 year warranty

Availability: **In Stock**

Ships same day if ordered before 4pm CT

CDW's Lowest Online Price

\$58.64

National IPA Technology Solutions
Education

Recommended Warranty

APC Extended Warranty Renewal - technical support (renewal) - 1 year

\$36.00

FL APC IT Hardware

Product Overview

Main Features

- UPS
- External
- 550 VA power capacity
- 3.2 min battery run time (up to)
- 330 Watt power provided
- AC 120 V
- 3 year warranty

The Back-UPS provides abundant battery backup power, so you can work through medium length power outages. It safeguards your equipment against damaging surges and spikes that travel along utility and data lines. The Back-UPS also features automatic voltage regulation (AVR), which instantly adjusts high and low voltages to safe levels, so you can work indefinitely during brownouts and overvoltages.

The Back-UPS also includes unique "green" features, like power-saving outlets that automatically turn off idle peripherals. A high efficiency charging system and "AVR Bypass" also reduce power consumption. With the rest of the Back-UPS standard features, this is the perfect unit to protect your productivity from the constant threat of bad power and lost data.

Technical Specifications

Specifications are provided by the manufacturer. Refer to the manufacturer for an explanation of the print speed and other ratings.

Power Supply

Device Energy Rating:	365 Joules
Device Output Connector Type:	Power NEMA 5-15

Battery

Enclosure Type:	Internal
Load Type:	At full load
Recharge Time:	24 hours
Run Time (Up To):	3.2 min

Power Output Connectors Details

Connector Qty:	4
Connector Type:	Power NEMA 5-15
Protection Type:	Surge

Protection Type:	UPS and surge
------------------	---------------

Interface Provided

Qty:	1
Type:	Management (USB)

Cable

Connectivity Details Length:	6 ft
Connectivity Details Type:	Power cable
Connectivity Details Type:	USB cable

Service

Support Details Full Contract Period:	3 years
Support Details Type:	Limited warranty

Dataline Surge Protection

Connector Type:	RJ-11
Type:	Phone line

Environmental Parameters

Humidity Range Operating:	5 - 95%
Max Operating Temperature:	104 °F
Min Operating Temperature:	32 °F
Sound Emission:	45 dBA

Header

Brand:	APC
Compatibility:	PC
Manufacturer:	APC
Model:	550
Packaged Quantity:	1
Product Line:	APC Back-UPS ES

Miscellaneous

Color:	Black
Compliant Standards:	cUL , FCC Part 15 B , FCC Part 68 , NOM , RoHS , UL 1778 , UL 497A , UL 497B
Equipment Protection Value:	75000 US Dollars
Product Color:	Black

Networking

Remote Management Interface:	USB
------------------------------	-----

Power Device

Circuit Protection:	Circuit breaker
Form Factor:	External
Frequency Provided:	60 Hz
Frequency Required:	60 Hz
Input Connector Qty:	1
Input Connector Type:	Power NEMA 5-15

Input Voltage Range:	AC 88 - 139 V
Output Connector Qty:	8
Power Capacity (VA):	550 VA
Power Device Features:	Audible alarm , LED indicators
Power Provided:	330 watt
Surge Suppression:	Yes
UPS Output Waveform:	Stepped approximation to a sinewave
UPS Technology:	Off-line
Voltage Provided:	AC 120 V
Voltage Required:	AC 120 V

Service & Support

Type:	3 years warranty
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Dimensions & Weight

Depth:	7 in
Height:	3.3 in
Weight:	13 lbs
Width:	12 in

Cable Details

Included Qty:	1
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Dimensions & Weight (Shipping)

Shipping Depth:	5.5 in
Shipping Height:	9.5 in
Shipping Weight:	14.3 lbs
Shipping Width:	17.2 in

General

Product Type:	UPS
Subcategory:	UPS

Run Time Details

Load Type:	Full load
Run Time (Up To):	3.2

UPS

Batteries Qty:	1
Battery Technology:	Lead acid

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Print Summary



OptiPlex 9020 Mini Tower – Build Your Own

Price \$1,675.99
 Instant Savings \$620.12

Price \$1,055.87

Preliminary Ship Date: **12/17/2013**

My Selections **All Options**

- **OptiPlex 9020 Mini Tower – Build Your Own**

Date 12/6/2013 7:26:58 AM Central Standard Time

Catalog Number 25 Retail rc971997

Catalog Number / Description	Product Code	Qty	SKU	Id
Processor:				
Intel® Core™ i7-4770 Processor (Quad Core HT, 3.4GHz Turbo, 8MB, w / HD Graphics 4600)	I74770	1	[338-BCCG]	146
Operating System :				
Keyboard:				
US English (QWERTY) Dell KB212-B QuietKey USB Keyboard Black	8KBUS	1	[580-AAQX]	4

Mouse:	USBOP	1	[570-AACR]	12
Dell MS111 USB Optical Mouse				
1394 FireWire Adapter:				
NO ADD-IN CONTROLLER CARD, PCI	NOCNTL	1	[340-ADBJ]	9
Power Cord:				
System Power Cord (English)	US125V	1	[450-AAOJ]	20
Network Card:				
No Bcom required	NOBCOM	1	[555-BBKH]	13
Speakers:				
Internal Speaker	SPKR	1	[520-AABP]	18
Low Power Mode:				
No Bios Required	NOBIOS	1	[696-BBBC]	38
Documentation:				
No Quick Reference Guide	NOTSH	1	[340-ABKW]	21
Diagnostic CD/ Diskette:				
Resource DVD contains Diagnostics and Drivers	RDVD	1	[340-ABJK]	50
Productivity Software:				
Microsoft® Office Trial	13TMUI	1	[630-AABP]	22
Digitally Delivered Software:				
No Cirrus	NOUPGRD	1	[340-ADBJ]	640
E-Star:				
No Estar	NOESMRT	1	[387-BBCG]	122
ADD-IN Port Cards:				
No Add On Cards	NOADDIN	1	[382-BBBZ]	698
Wireless Drivers:				
No Wireless	NOWRLS	1	[555-BBFO]	7
Thermals:				
Heatsink, Performance, Minitower	THMT9	1	[412-AAAV]	412

Packaging:

Shipping Material for System, Minitower	SHPDAO	1	[340-ABVE]	465
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Chassis intrusion switch:

Chassis Intrusion Switch	NTRSN	1	[461-AAAZ]	289
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Placemat:

No Quick Reference Guide	NOTSH	1	[340-ABKW]	60
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Chassis Options:

OptiPlex 9020 Mini Tower for Standard Power Supply	MTAPT	1	[329-BBID]	116
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Dell Backup & Recovery:

	DBRMW7	1	[637-AAAK]	200076
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Dell Backup and Recovery Manager for Windows 7	NOSCRTY	1	[650-AAHJ]	1014
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Security Software:

No Anti-Virus SW	REGMEX	1	[389-BCCV]	676
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Regulatory Label:

Regulatory Label	NOAHD	1	[340-ADBJ]	637
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Additional Hard Drive:

No Additional Hard Drive	VICI7	1	[389-BBWO]	749
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Processor Branding:

Intel® Core™ I7 VPro Label				
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Additional Opticals:					
No Optical Drive	NODD	1	[429-AAHB]	105	
Systems Management:					
Intel® vPro Technology Enabled	VPRO	1	[631-AABI]	49	
Operating System Media:					
OS-Window s Media Not Included for N-Series	NOMEDIA	1	[620-AALW]	200013	
Optical Software:					
PowerDVD Software not included	NOPDVD	1	[429-AAGQ]	597	
Intel Rapid Start Technology and Smart Connect:					
NO INTEL RESPONSIVE	NOINTR	1	[551-BBBJ]	346	
			[389-BCCZ] [421-4047][421- 9982][422-0008] [632-BBBZ] [632-BBCB] [640-BBDF][640- BBEV][658- BBMQ][658- BBMT][658- BBNH]		
Non-Microsoft Application Software:					
Additional Software for Window 7	CYC3W7	1		1003	
Raid Connectivity:					
					
NO RAID	NORAID	1	[817-BBBN]	1009	
Encryption Software:					
No DDPE Encryption Software	NODDPE	1	[954-3465]	156	
Canada Ship Options:					
US No Canada Ship Charge	USNONE	1	[332-1286]	111	
Hardware Support Services:					
3 Year Basic Hardware Service with 3 Year NBD Limited Onsite Service After Remote Diagnosis	U3OS	1	[935-6167][939- 1018][939-2491]	29	
			[996-1172]		

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