Study Guide/ Practice Questions

In many courses students study for exams by memorizing the information presented during class. We suggest that you consider an alternate method to study for exams in this course. You will find that the skills that you have been developing are the more important than a body of information. Concentrate on the big ideas behind the questions, not necessarily the specific subject matter in the questions. The questions on the exams will be like the end of module questions and the end of class questions – they will require you to apply the skills you have learned in this class to different problems.

The following are some of the things you should know and be able to do for the exam:

1. What is the difference in an observation and an inference? You might be expected to identify observations and inferences from a scenario.

2. You should be able to construct a scatter-type graph and a histogram with the standards established in this class. You should be able to interpret the graph and decide if there is a relationship between the two variables that you have plotted. You should be able to use the graph to decide if two things are similar or different (e.g. are the pennies within one box similar in mass to the pennies in the other box?). You should also be able to identify problems with graphs if there is an error in plotting, labeling, or organizing a graph.

3. If given a situation, you should be able to discuss the scientific models presented. We will not expect you to critique the science, but you should be able to determine if data support or reject a model. You should also be able to determine if an idea or model is testable.

4. You should be able to determine how an object changes when one or more dimensions of the object is (are) changed (made smaller or larger by a factor). If the object is doubled (or halved or increased in all dimensions by a factor of 1.3), how has the object changed in perimeter, length, area, and volume of the object changed? You should be able to answer these kinds of questions without using a formula to calculate the changes. (after all, we don’t know the formula for a baby elephant or a millipede).

5. You should be able to make unit conversions (we will supply the identities for you).

6. You should be able to determine the height of the rain if given the volume of water collected and the area of the rain gauge. You should also be able to determine the volume of water collected if you have the height of the water and the area of the opening in the rain gauge. And so forth……

7. You should be able to apply these basic principles to other situations. For example, what volume of soil is needed to cover an area if we want a certain depth of soil? The principles are the same as the rain gauge problems.
Practice Questions:

The purpose of these study questions is to give you practice answering questions that are similar in style to the questions that might be on the exam. I make no promises that if you know the answers to these questions that you will be able to do the ones on the exam! However, practice is important to develop the skills needed to solve the problems that will appear on the exam.

Attempt the questions prior to coming to class on October 21. We will spend part of the day in groups working on the questions. If you have attempted to solve the questions and have answers to the questions, you will be assigned to a group. If you have not worked on the questions, you will work with other students who have not completed the questions.

1. A very ‘wet’ cloud dumped ‘buckets’ of rain onto your collection of containers (A, B, C, and D). Two centimeters of rain fell throughout the duration of this storm.

   a) Would the height of rainwater in each container be the same? _________ Explain your logic.

   b) Would the amount (volume) of water in each container be the same? __________ Explain your logic.

   c) Calculate the volume of rainwater found in each container.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   d) What property of a container determines how much (volume) rainwater will be collected? __________

   e) What property of a container determines the height of rainwater in the container?________
f) If the heights of the columns of rainwater in a collection of containers are the same, what is the relationship between volume of rain in each container and the area of each container?

g) Another rain gauge was used to collect rain in the same storm. If the tube at the bottom of the gauge is only two inches in diameter and one-ninth the area of the top of the gauge, determine:

The volume of the water in the tube ________________

(Hint: Remember the area is one ninth of the area of the top).
Height (as measured with a ruler) of the water in the gauge:

e) Discuss why rain gauges are designed with a greater cross-sectional area at the top compared to the cross-sectional area at the base.

f) What are the most reasonable units for measuring rainfall?

2. Observation/Inference

A student is given a sealed box with an unknown item or items contained inside. (Sound familiar?) The student is asked to try to characterize the object(s) in the box by shaking and moving the box. The following is what the student recorded:

Makes a tinny sound when shaken.
Feels heavy
rolls on one side, slides on the other
sounds like metal
only one object in the box
object is small
shape is a tube or cylinder

a. Which items on the list are observations about the object(s) in the box? Explain.

b. Which are inferences? Explain.

c. Which do you think are overly vague or non-specific?

3. A model is scientific if it can be tested by experiments. For each of the following three models, state whether you think the model can be tested and then give an example of a test that could be done or explain why no test is possible.

   a. As trees grow, the trunks of trees get new tree “rings” every year.
i. Can this model be tested?
ii. Describe a possible test or explain your reasoning.

b. The trees that grow fastest are the trees that want to grow fastest.
   i. Can this model be tested?
   ii. Describe a possible test or explain your reasoning.

4. a) Student Bob tells student Keith, that the wood in a tree comes from the tree absorbing water and nutrients from the soil. *(This question is about models, not plants).*

Is Bob’s model a scientifically testable model of plant growth?

b) The current hypothesis for the demise of the dinosaurs was the impact of a comet or meteor which created a catastrophic series of ecological events that lead to the extinction of dinosaurs.

An alternative suggestion for the extinction of the dinosaurs prior to the impact hypothesis was that dinosaurs died away at about the same time that angiosperms (flowering plants) evolve and that dinosaurs eat too many of these plants and died of stomach aches (really! 😊). Is this idea a useful scientific idea? Why/Why not?

5. Imagine that you work for the National Science Foundation and it is your job to evaluate research proposals for funding. Answer the questions below for the proposed plan below:

The purpose of this proposed study is to see if putting fertilizer around trees would decrease global warming. Carbon dioxide is one of the primary “greenhouse” gases in the atmosphere. Higher air temperatures are thought to happen when there are increases in the level of carbon dioxide in the atmosphere. Increases in carbon dioxide are due to emissions from all types of combustion including cars, buses, burning of coal and natural gas as well as several other sources. Naturally vegetation removes carbon dioxide from the atmosphere in the photosynthesis process. Our proposal is to evaluate whether increased tree growth due to the application of fertilizer in parts of the Snoqualmie National forest (near Snoqualmie Pass) will decrease the level of carbon dioxide in the atmosphere, thereby decreasing the effect of the greenhouse effect compared to a similar stand of trees that will not be fertilized in the Mt. Baker National Forest near Bellingham.

What is the dependent variable in this experiment?

What is the independent variable in this experiment?

If funded will the results of the study be applicable to other areas of the world?

6. Weather and climate phenomena are often too large to measure directly so scientists resort to measuring a sample and assuming that the rest of the sample is similar (this is an example of extrapolation). During the first minute of a rain shower, Ajay noticed that 30 raindrops fell in a one-foot by one-foot section of his deck. During that same minute, how
many raindrops would you estimate fell on his entire 20-foot by 20-foot deck? (Show your work AND explain your reasoning.)

7. The following two graphs show two different ways of representing the data for average temperature as a function of year. Which method is preferred and why?

8. The Earth's atmosphere was once much warmer and contained more oxygen than it does today. As a result many of the organisms that thrived then cannot survive under modern conditions. 280 million years ago there were two families of dragonfly. One had a wingspan of about 5 centimeters (2 inches), and was thus the same size and shape as the dragonflies of today. Another, called *Meganeuria*, was much larger with a wingspan of
75 centimeters (30 inches), but was the same shape with the same proportions as today's dragonfly (that is to say *Meganeuria* was longer, thicker, and wider than today's dragonfly).

a) How did the surface area of *Meganeuria* compare with the surface area of dragonflies today? (Be quantitative and explain your answer.)

b) How did the volume of *Meganeuria* compare with the volume of dragonflies today? (Be quantitative and explain your answer.)

9. And you thought it rained a lot here. In 1996, the town of Aurora, Illinois, received 17 inches of rainfall in one day (daily rainfall above an inch is uncommon in soggy western Washington).

a. A rain gauge is built with a cylindrical tube at the base and a funnel at the top (it is just like the “standard” rain gauges used in class). The top of the rain gauge has a diameter of 3.5 inches and the base of the rain gauge has a diameter of 1.7 inches (aside from that, the sides of the rain gauge are straight with a funnel at the top). If we calibrate this rain gauge in inches, how far from the bottom should we place the mark of 0.5 inches of rain?

b. Assume you had a rain gauge in Aurora that was capable of collecting all the rain on that day. The top of the rain gauge has a diameter of 3.5 inches and the base of the rain gauge has a diameter of 1.7 inches. If the rain gauge was able to collect all of that rain without overflowing, how tall would it have to be?

c. Buildings and roads have a big influence on drainage because they are waterproof. Imagine a developed segment of Aurora, Illinois, where 80% of the land is either paved or covered with a building. The remaining land is covered with lawn and shrubs. If nothing special was done to handle the drainage from the roads and buildings (in other words, no storm drains and no gutters leading to special drainage areas) how many inches of rain would the grass-covered land have to absorb?

10. Joey is building a new gravel road around the edge of his ranch. The whole road will be a quarter of a mile long and 15 feet wide. He has to spread the gravel to a depth of 2 inches.

a. How many cubic yards of gravel does he need?

b. Since gravel is good for drainage, the city will allow him to get a permit to build a new barn if the gravel covers an area greater than half of an acre. Is the road big enough to get him the permit?