

Standard One: Lab Design and Appendix A Lab Skills

Scientific explanations are built by combining evidence that can be observed with what people already know about the world.

What are some sources of information which should be researched before experimentation?

_____ **library books and journals and internet** _____

Learning about the historical development of scientific concepts or about individuals who have contributed to scientific knowledge provides a better understanding of scientific inquiry and the relationship between science and society.

Lamarck proposed a theory of evolution which stated that an organism could pass on acquired characteristics (like muscles to their children if a parent lifted weights). Even though this theory was wrong, how did it help the development of the scientific concept of evolution?

_____ **This theory provided a basis for the theory of others (Darwin-natural selection)** _____

How have **values** entered into the fight over other groups or organizations having knowledge of a person's genetic profile?

_____ **Different groups have different ideas of what is right or wrong** _____

List several sources of inquiry knowledge. **_____journals, internet, encyclopedias, experimentation_____**

Inquiry involves making judgments about the reliability of the source and relevance of information.

Why is information from a scientific journal more reliable than that obtained from a TV advertisement?

_____ **TV ads may be trying to sell something so they are biased** _____

Scientific explanations are accepted when they are consistent with experimental and observational evidence and when they make accurate predictions.

Why must the explanation of an experiment correlate with the data obtained in the experiment?

_____ **If the explanation does not correlate, it is not acceptable.** _____

All scientific explanations are tentative and subject to change or improvement. Each new bit of evidence often creates more questions than it answers.

Why do most experiments in science lead to more questioning?

_____ **Usually some aspect of the results does not fit the hypothesis or the experimenter sees a possible extension or improvement** _____

___ **theory** _____: an explanation of natural events that is supported by strong evidence.

Well-accepted theories are ones that are supported by different kinds of scientific investigations often involving the contributions of individuals from different disciplines.

Why is the cell theory well accepted among most scientists today?

___ **It has been supported by much evidence** _____

List two methods used to retrieve electronic information.

___ **internet web searches and e-mail requests** _____

List **five safety procedures** to be followed in experiments.

- a.) Wear safety goggles when heating substances or using chemicals**
- b.) Wear a safety apron and gloves when using dangerous chemicals.**
- c.) Do not stopper a heated testtube**
- d.) Point heated instruments away from yourself and others**
- e.) Pin specimens securely and cut away from yourself when dissecting.**

___ **hypothesis** _____ -- an intellectual prediction of the possible outcome of an experiment or a solution to the problem. This educated guess can only be made after a great deal of research.

A correctly worded hypothesis can be tested and supported as being correct or incorrect by doing an ___ **experiment** _____.

The best way to write a correct hypothesis is as an “if-then” statement. (ex: If I give lettuce plants fertilizer, then they will grow better.)

The "if" part of the hypothesis is the ___independent___ variable and the "then" part of the hypothesis is the __dependent_____ variable.

List the steps of a controlled experiment

- 1. Problem/Purpose**
- 2. Hypothesis**
- 3. Materials**
- 4. Procedure/Methods**
- 5. Results/Data**
- 6. Conclusion**

What is **bias**?

_____ **having a preconceived idea about experimental results** _____

How does the number of trials and the sample size influence the **validity** of an experiment?

___ **More trials or sample size more valid or acceptable results** _____

Why is it fine if a hypothesis is incorrect? _____ **The role of the hypothesis is to drive the design of the experiment** _____

More trials mean ___ **more** ___ validity.

Claims should be questioned if fact and opinion are intermingled, if adequate evidence is not cited, or if the conclusions do not follow logically from the evidence given.

Give an example of fact being intermingled with opinion in the results of an experiment.

_____ **That exercise wears people out and decreases the speed of clothespin squeezing (the reverse is more frequently true and exercise increases this speed of squeezing)** _____

The results of an experiment need to be _____ **repeatable** _____ to be accepted.

Scientists use peer review to evaluate the results of scientific investigations and the explanations proposed by other scientists. They analyze the experimental procedures, examine the evidence, identify faulty reasoning, point out statements that go beyond the evidence, and suggest alternative explanations for the same observations.

What are **indicators**? chemicals which show the classification of a substance

Give **three examples of indicator solutions** we have used in class this year and what they are used for.

a. litmus (turns red in acid and blue in bases)

b. Benedicts solution (turns orange or brick red when heated with simple sugars)

c. starch testing solution (turns blue black if starches are present)

Two things are needed for a controlled experiment:

1. The control contains all the parts of the experiment *EXCEPT* the one experimental factor being tested.
2. The independent variable contains all the factors of the control group *PLUS* the one factor that is being tested.

The control group acts as the comparison with the independent variable group.

Good controlled experiments:

1. Can be repeated/performed the same way and get the same results.
2. Have large sample size/many test subjects.
3. Are performed for long periods of time.
4. The experiment follows established ethical and legal standards.
5. Have only 1 independent variable,

placebo -- an inactive substitute for the variable often used in testing drugs

independent variable is changed or manipulated by the experimenter

Ex: the amount of fertilizer given to a plant.

___ **dependent** ___ variable -- depends upon the independent variable

Ex: the height the plant will grow is dependent upon the amount of fertilizer it is given. So the change in height would be the dependent variable.

Data Tables

Data tables are used to ___ **organize** ___ data which will be plotted in a graph.

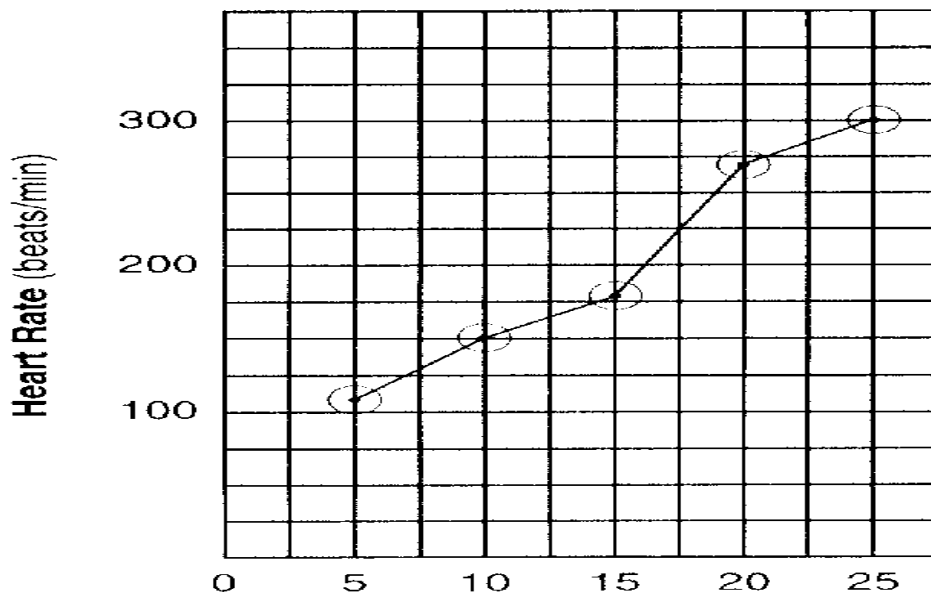
- First column in the table is for the ___ **independent** ___ variable.
- Second column is another for the ___ **dependent** ___ variable.
- Each column should be titled, and include ___ **units** ___ of measurement.
- Data in the table must be arranged in ascending or descending order.

Temperature (°C)	Heart Rate (beats/min)
5	108
10	150
15	180
20	270
25	300

Graphing Key Points

1. Both the x and y axis of the graph must be labeled or titled. These labels are typically the same ones used in the data table. .
2. The ___ **independent variable** ___ is always plotted on the **x-axis**.
3. The ___ **dependent variable** ___ always plotted on the **y-axis**.
4. The x and y axis must be numbered.
 - a. **These numbers must increase by a ___ consistent ___ increment** (that is you must count by 1's, 2's, 5's, 10's, etc).
 - b. **Your numerical scales should take up most of the axes.** Squeezing it all into the bottom corner makes the graph impossible to read and no credit will be given.
 - c. The **numbers must line up with the grid lines** of the graph, not with spaces between them.
 - d. **You do not need to start numbering your axis with ___ 0 ___.**

Change in Heart Rate with Increasing Temperature



Most graphs drawn on the LE Regents have been **line graphs**. Make certain that you create the correct type of graph if asked to do so on the exam.

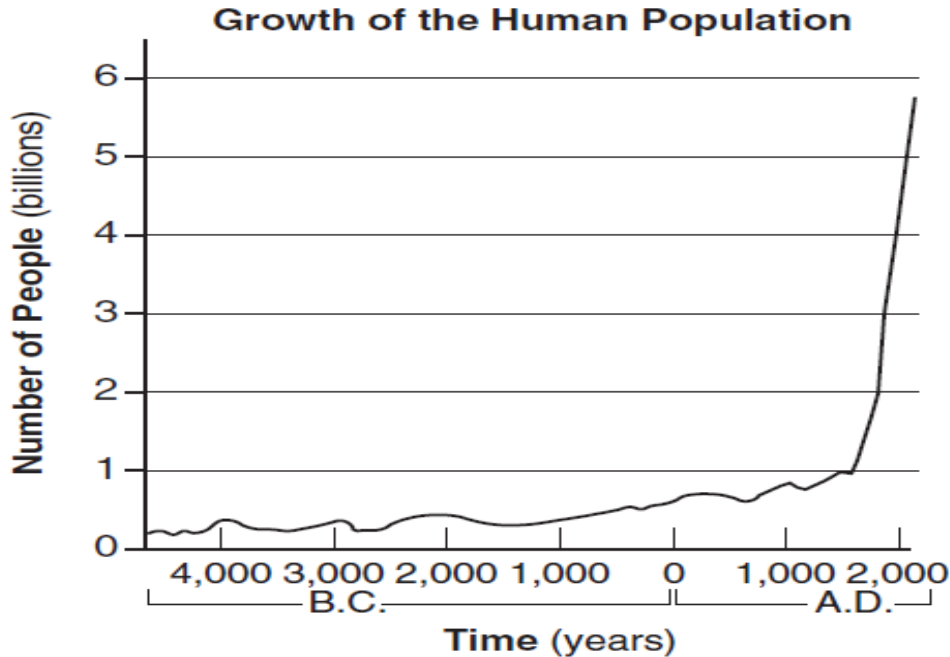
Other Terms:

Observation: What is seen or measured.

Inference: A conclusion based on observation or evidence.

Sample question involving an inference:

The graph below shows how the human population has grown over the last several thousand years.

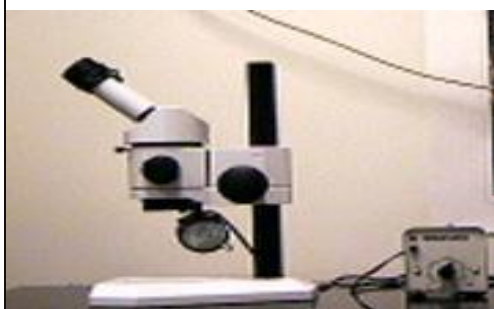


Which statement is a valid inference that can be made if the human population continues to grow at a rate similar to the rate shown between 1000 A.D. and 2000 A.D.?

- (1) **Future ecosystems will be stressed and many animal habitats may be destroyed.**
- (2) Global warming will decrease as a result of a lower demand for fossil fuels.
- (3) One hundred years after all resources are used up, the human population will level off.
- (4) All environmental problems can be solved without a reduction in the growth rate of the human population.

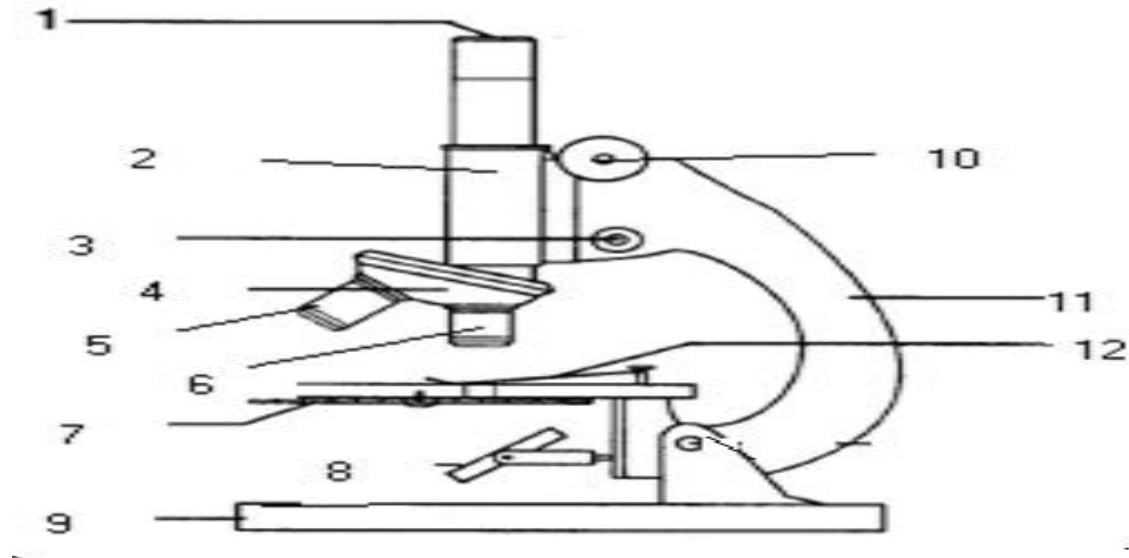
Review of Microscopy

Stereo Microscope



The image at the left is that of a **dissecting** or **stereo microscope**. The specimen to be observed is an **opaque** object (light does not pass through it). The observer sees the surface of the dissection specimen or other specimen being studied. This specimen is placed in a container on the stage of the microscope.

Light or Compound Microscope

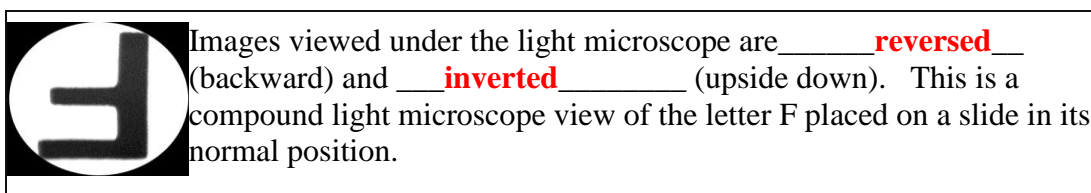


Microscope Part	Function of Part
1. eyepiece	Magnifies
2. body tube	Lets light go from objective to eyepiece
3. fine adjustment knob	Focuses on high power
4. nosepiece	Turns objectives
5. high power objective	Magnifies
6. low power objective	Magnifies
7. diaphragm	Regulates light reaching specimen

8. light (mirror)	Provides light
9. base	Holds up microscope
10. coarse adjustment knob	Focuses on low power
11. arm	Handle for microscope
12. stage clip	Holds slide in place on stage

Other Points About the Compound Microscope

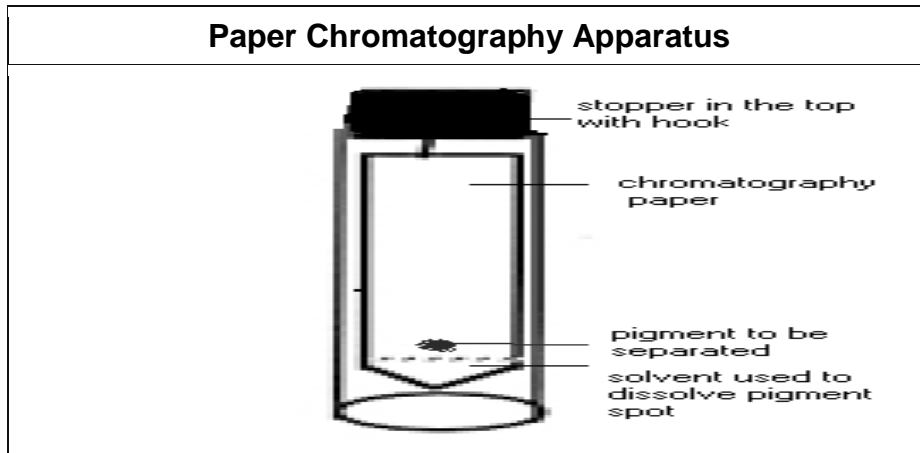
1. Always begin focusing on the **lowest** possible power. Remember to **center** the specimen you are observing in the field of view before switching to a higher power. Make certain that you move the objectives **away** from the specimen when focusing so there is no collision between the objective being used and the slide/cover slip.
2. As you switch from **low** to **high** power, the field of view becomes darker. To deal with this the **diaphragm** needs to be opened to allow in more light.
3. As you switch from low to high power the field of view becomes _____.



Chromatography

Paper chromatography is a procedure used to separate substances in a liquid mixture such as **plant** pigments.

A small concentrated sample of a mixture is placed on the chromatography paper above the line of a solvent mixture. The paper is in contact with a solvent solution (water in our lab) at its bottom.

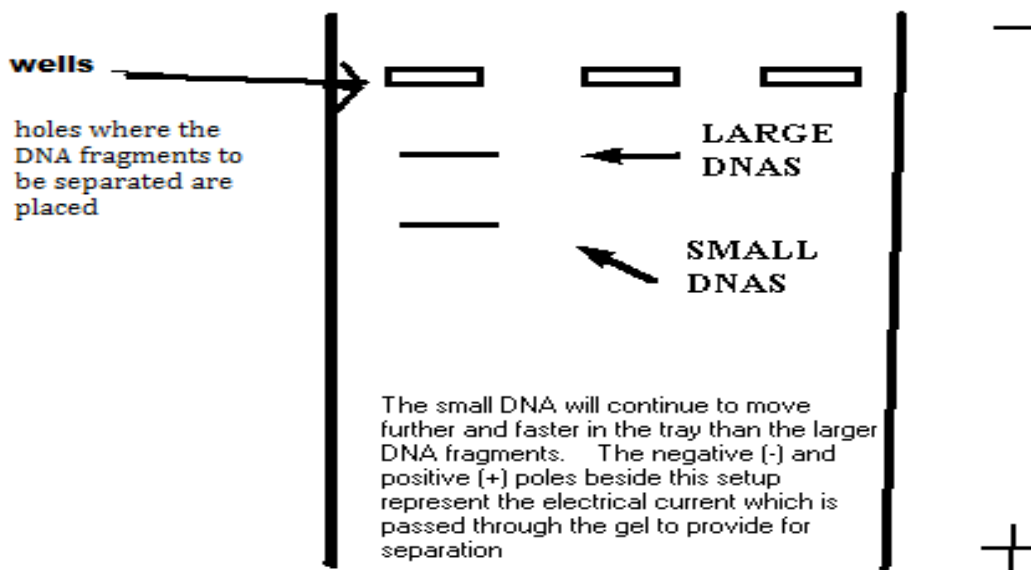


Identify two errors which can be made doing a chromatography of different plants, even when being provided with appropriate materials.

_____placing the plant pigment in the solvent and not above it, using the same eyedropper for several different plant pigments causing contamination) _____

Electrophoresis

Gel electrophoresis is a procedure used to separate charged molecules of different sizes like **DNA fragments** by passing them through a gel in an electrical field. The gel contains microscopic pores for the separation of the molecules of different sizes. The gel is usually composed of a jelly-like material called agarose which is made from seaweed.



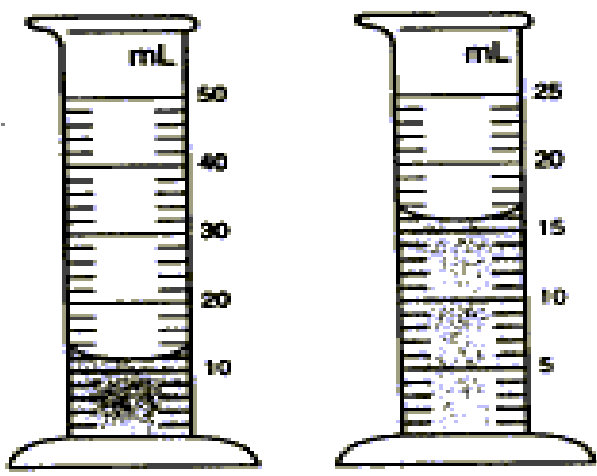
restriction enzyme -- used to cut DNA is cut into pieces so it can fit through the gel to be separated in an electrophoresis

Some Uses for the Gel Electrophoresis DNA Separation

1. It may be used to determine an individual's genetic relationship to his or her ancestors, as the **more** closely matched the banding pattern between two individuals, the more closely they will be genetically related. In theory, no two individuals will form the same DNA banding pattern when the electrophoresis is completed.
2. It may be used to identify an individual that have committed **a crime** based on the ability to match the suspects **DNA** to evidence which has been collected at a crime scene.
3. It may be used to determine evolutionary relationships between organisms, as organisms with a **closer** genetic relationship will form more similar banding patterns.

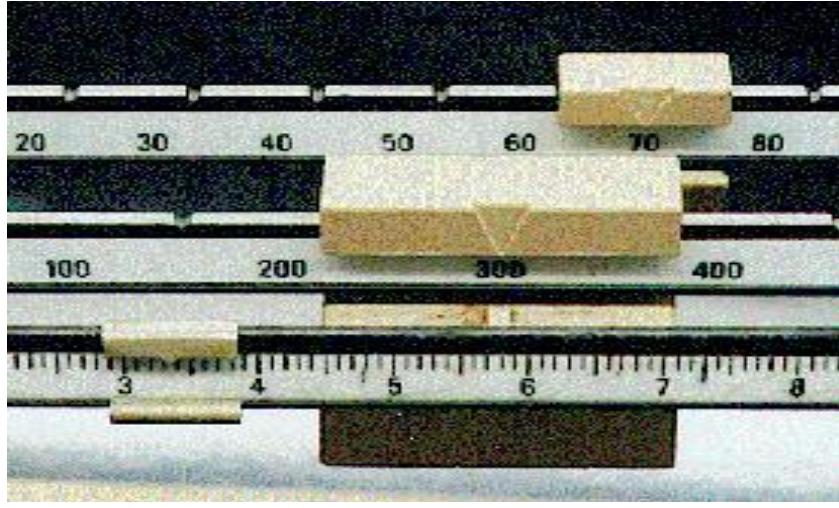
Volume Measurement

A commonly used instrument to measure liquid **volume** is the graduated cylinder. This instrument usually measures liquid volume in milliliters (ml).

Using a Graduated Cylinder	
	<p>It is important to remember to read to the bottom of the curved line or meniscus when measuring solutions involving water or most liquids. What is the volume in each of these graduated cylinders?</p> <p>12 ml at the left and 16 ml at the right</p>

Mass Measurement

Using the Triple Beam Balance



What is the mass of this object?

Length Measurement

Using a Ruler to Measure Length

Problem: How long is leaf A?



Microscopic Measurement

Formula for Total Microscope Magnification

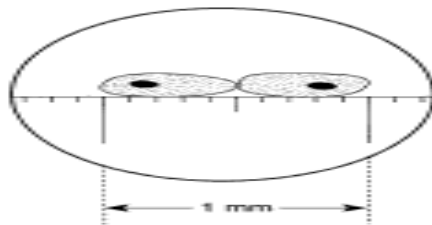
$$\text{Total magnification} = \text{Power of the eyepiece} \times \text{Power of the objective}$$

Finding the Size of a Microscope Field of View



In the pictured field of view at the left, it can be observed that there are approximately 3 1/2 divisions equal to a length of 3 1/2 mm. or 3500 micrometers.

Finding the Size of Multiple Cells in a Field of View



The two cells in this field take up a field of view of one millimeter. Therefore, the size of the specimen is equal to 1 mm/2 cells or 0.5 mm per cell. Since 1 mm = 1,000 micrometers. The average size of each cell is 500 micrometers.

Estimating Cell Size When the Field of View is Known



This amoeba considered lengthwise appears to occupy approximately 1/3 of the field of view. The field of view in the left image is 3 mm. Its approximate length is 3 mm X 1/3 = 1 mm or 1000 micrometers for the approximate length of this amoeba.

The student is viewing the same amoeba in the field of view at the right on a higher power. The field of view gets smaller which makes the amoeba appear larger.