Supplemental Materials Appendix A: Laboratory Investigations and Activities

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APPENDIX A:

LABORATORY INVESTIGATIONS AND ACTIVITIES

Appendix A1- pH Lab

Hour _____Date _____ Name _____

pH Table Lab

We will be measuring some qualitative and quantitative properties of some common household items. When you get to your assigned lab station please write down any physical observations a *qualitative* property, a property that is measured using your senses, about each solution. You many use only two senses: sight and smell. Using your sense of sight write down anything you see including bubbles, color, *precipitate* (a solid that has formed within the liquid), etc. Using your sense of smell use the wafting technique and write down any odor you smell. **IT IS VERY IMPORTANT you do not smell or touch the solutions directly.** *pH* is a *quantitative* property, a property measured by using values, of solutions that measures the amount of Hydrogen ions there are within a solution. If a solution has a pH below 7 it is considered *acidic*, if a solution has a pH above 7 it is considered *basic*, if a solution has a pH of 7 it is considered *neutral*. Once you have finished making physical observations we will be measuring the pH of these solutions using 2 methods: pH paper and litmus paper. Using the standard pH scale located at your lab stations match the color of the pH paper to the appropriate pH and record it in the table below. Litmus paper identifies if something is an acid, base or neutral solution. Red litmus paper stays red in the presence of an acid and turns blue in the presence of a base. Blue litmus paper turns red in the presence of an acid, and stays blue in the presence of a base. If both the red and blue litmus stay the same color the solution is neutral.

Enter your collected data into the following data table:

Solution	Physical Observations	pH value using pH paper	Color in Blue Litmus Paper	Color in Red Litmus Paper
Coke				
Milk				
Baking Soda				
Borax				
Grapefruit Juice				
Lime Juice				
Egg Whites				
Milk of Magnesia				
Distilled Water				

ACT Follow up Questions

1. Which of the following solutions were basic?
    A. Milk of Magnesia and Coke
    B. Coke and Lime Juice
    C. Milk of Magnesia and Borax
    D. There were no basic solutions

2. Which of the following solutions were neutral?
    F. Distilled Water
    G. Milk
    H. Both distilled water and milk
    J. There were no neutral solutions.

3. Which of the following might be a valid reason pH paper is a better test of pH then using Litmus paper?
    A. pH paper is an objective measurement providing a specific pH value rather then litmus paper providing only
    Type of solution present.
    B. The pH paper was too old to work properly.
    C. The litmus paper does not work when used in solutions.
    D. pH paper is a subjective or an interpretative measurement, which can be less accurate than the litmus paper.

4. Which of the following solutions were acidic?
    F. Coke and Lime Juice
    G. Lime Juice and Baking Soda
    H. Baking Soda and Coke
    J. There were no acidic solutions

5. Which of the following choices properly ranks the solutions used in the lab from highest pH to lowest pH?
    A. Milk of Magnesia, Coke, Water
    B. Milk of Magnesia, Water, Coke
    C. Lime Juice, Water, Milk of Magnesia
    D. Grapefruit Juice, Milk of Magnesia, Water

Please write your answers below and turn in this assignment:

1) _____ 2) _____ 3) _____ 4) _____ 5) _____

Appendix A2- Table Practice #1

Hour _____ Date _____ Name _____

Table Practice Set 1

Passage III

A student performed 2 studies to investigate the factors that affect the germination of peony seeds.

Study 1

Peony seeds were placed in dry containers. Some of the containers were stored at 5°C for either 4, 6, 8, or 10 weeks. The temperature and time periods were defined as the *storage temperature* and the *storage period*, respectively.
The peony seeds were divided evenly so that there were 20 sets of 25 seeds. Twenty petri dishes were then prepared. Each contained damp paper. Each set of seeds was placed in a separate petri dish. Each Petri dish was maintained at 1 of 4 temperatures for 30 days. The temperature and time periods were defined as the *germination temperature* and the *germination period*, respectively. Table 1 shows the number of seeds that germinated in each dish.

Table 1

Storage period (weeks)	**Number of peony seeds that germinated when maintained at a germination temperature of:**			
	13°C	**18°C**	**23°C**	**28°C**
0	0	0	0	0
4	0	2	0	0
6	3	8	6	0
8	7	22	18	0
10	15	24	21	1

Study 2

Peony seeds were placed in dry containers. The containers were stored at various temperatures for 10 weeks.
The peony seeds were divided evenly so that there were 20 sets of 25 seeds. Twenty Petri dishes were then prepared. Each contained damp paper. Each set of seeds was placed in a Petri dish. The Petri dishes were maintained at 1 of 4 temperatures for 30 days. Table 2 shows the number of seeds that germinated in each dish.

Table 2				
Storage temperature (°C)	**Number of peony seeds that germinated when maintained at a germination temperature of:**			
	13°C	**18°C**	**23°C**	**28°C**
0	15	24	21	1
5	16	23	21	1
10	0	6	4	0
15	0	0	0	0
20	0	0	0	0

Tables adapted from Joel Beller, *Experimenting with Plants*. ©1985 by Joel Beller.

1. In general, the results of Study 1 suggest that peony seeds that are placed in a Petri dish containing damp paper are least likely to germinate when they are maintained at which of the following temperatures?

A. 13°C
B. 18°C
C. 23°C
D. 28°C

2. Suppose another storage period of Peony growth had been included in Study 1 and these seeds had a storage period of 9 weeks and a germination temperature of 13°C. Based on the information provided, the number of seeds that would have germinated after being maintained for 30 days would most likely have been closest to:

F. 7
G. 11
H. 15
J. 21

3. In Study 2, at the storage temperature of 15°C, as germination temperature increased from 13°C to 28°C, the number of seeds that germinated:

A. decreased only.
B. increased only.
C. Stayed constant
D. increased, then decreased.

4. All of the following sets of seeds were exposed to different conditions prior to being placed in the Petri dishes EXCEPT?
    F. The seeds from Study 1 that were stored for 10 weeks and the seeds from Study 2 that were stored at 5°C
    G. The seeds from Study 1 that were stored for 8 weeks and the seeds from Study 2 that were stored at 5°C
    H. The seeds from Study 1 that were stored for 8 weeks and the seeds from Study 2 that were stored at 15°C
    J. The seeds from Study 1 that were stored for 10 weeks and the seeds from Study 2 that were stored at 15°C

5. A student stored 100 peony seeds at a temperatures ranging from 13°C to 28°C the student divided the seeds into 4 sets and maintained them as described in Study 1. The results are shown on the right. These seeds most likely had a storage period of:
    A. 0 weeks
    B. 2 weeks
    C. 4 weeks
    D. 6 weeks

Germination temperature (°C)	**Number of seeds that germinated**
13	2
18	7
23	7
28	0

6. The experimental designs of Study 2 and Study 1 were different in that in Study 1:
    F. storage temperature was varied.
    G. storage time was varied.
    H. germination temperature was varied.
    J. germination time was varied.

Please write your answers below and turn in this assignment:

1) _____ 2) _____ 3) _____

4) _____ 5) _____ 6) _____

Appendix A3- Student Measurement Lab

Hour _____ Date _____ Name _____

Student Measurement/Survey Lab

Today you will be surveying the members of your ACT lab groups in many *qualitative* and *quantitative* ways. A *qualitative* measurement is a measurement based on the quality of something- it can be observed without a numerical value. A quantitative measurement is a measurement based on the quantity of something- it is observed using a numerical value. Please fill in your survey's in the order they are provided. For measuring hair length, height, and arm span you will be utilizing a meter stick. **Make sure you measure with accuracy to the tenth's spot (i.e. 5.5 cm).**

Procedure

1) Fill in Name, sex, age, hair color, and hair length (short, medium, or long) for all of the members of your group.

2) Next measure each group member's hair length in centimeters. You will use the string and the meter stick provided at your lab station to aid you in obtaining a more accurate length.

3) Next fill in eye color, t-shirt color, do they play sports for all of your group members.

4) You will now be measuring the distance at which each group member can jump. This distance jumped will be measured as a standing long jump; students will stand and jump as far as they can **safely**. You will measure the distance from the starting point to the back of their heel.

5) Next measure each group member's heights in centimeters using the meter stick.

6) To measure arm span have each student spread their arms directly out as far away from their body as they can. Arms should be parallel to the student's body & you should measure from middle finger tip to middle finger tip.

7) To measure number of breaths per minute (resting) have each student breath normally and count the number of times each individual breathes in 20 seconds. Multiply this number by 3 and record it in your table.

8) You will then have that student do as many jumping jacks as they can in 30 seconds. You will count a single jumping jack when the arms rest on the student's hips. Record this in your table.

9) **Immediately** after the jumping jacks measure number of breaths per minute (after exercise) using the same method in step 7. Remember to multiply this number by 3 and record it in your table.

10) Repeat steps 8-9 with all group members.

11) Once you have completed your table answer the follow-up questions and turn in your lab.

	Student 1	Student 2	Student 3	Student 4
Name				
Sex (Male or Female)				
Age				
Hair Color				
Hair Length (Short, Medium, or Long)				
Hair Length (cm)				
Eye Color				
T-shirt color				
Do they play sports? (yes or no)				
Distance Jumped (cm)				
Height (cm)				
Arm Span (cm)				
Number of Breaths per minute (resting)				
Number of Jumping Jacks in 30 Seconds				
Number of Breaths per minute (after exercise)				

1. Which of the following relationships do number of breathes during rest have to number of breathes after exercise?

A. The number of resting breaths was higher than the number of breathes after exercise.
B. The number of resting breaths was lower than the number of breather after exercise.
C. The number of resting breathes was exactly the same than the number of breathes after exercise.
D. There is no relationship between resting breaths and number of breathes after exercise.

2. What is the relationship between sex (male or female) and height?

F. Male students have a higher average height.
G. Female students have a higher average height.
H. Males and Females have an average height.
J. Sex (male or female) and height have no relationship.

3. What type of relationship do height and arm span have?

A. They have an inverse relationship.
B. They have a direct relationship.
C. They are equal to each other.
D. They have no relationship.

4. Which student had the longest arm span?

F. Student 1
G. Student 2
H. Student 3
J. Student 4

5. Which of the following are all qualitative measurements?

A. Eye color, Height (cm), and T-shirt color
B. Eye color, Hair length (short, medium, or long), and T-shirt color
C. Height (cm), Hair length (cm), and Age
D. Age, Hair length (short, medium, or long), Height (cm)

6. Which student had the biggest difference between their Height (cm) and Arm Span (cm)?

F. Student 1
G. Student 2
H. Student 3
J. Student 4

Please write your answers below and turn in this assignment:

1) _____ 2) _____ 3) _____

4) _____ 5) _____ 6) _____

Appendix A4- Table Practice #2

Hour _____Date _____ Name _____

Table Practice Set 2

Passage II

G. soja (a wild soybean) produces *γ-tocopherol* (a type of vitamin E). It then converts some *γ-tocopherol* into *α-tocopherol* (another type of Vitamin E). In *G. soja* the enzyme *TMT* catalyzes this reaction:

$$\gamma\text{-tocopherol} \xrightarrow{\text{TMT}} \alpha\text{-tocopherol}$$

A. thaliana (a mustard plant) produces *γ-tocopherol* but lacks TMT, so it produces only a small amount of *α-tocopherol*. Because *α-tocopherol* is more effective at reducing cellular damage than is *γ-tocopherol*, a scientist tried to transfer *G. soja* TMT gene into *A. thaliana*.

Experiment 1

Four versions of *G. soja*'s TMT gene (TMT1-TMT4) were cloned. Each gene was incorporated into a *vector* (a biological structure that carries a gene and transfers it into the cells of an organism). Six genetically identical lines of *A. thaliana* were developed (L1-L6). As shown in Table 1, L1-L4 were each exposed to vector carrying 1 of the 4 cloned genes; L5 was exposed only to the vector; and L6 was left untreated. Next, 10 plants from each line were grown. Table 1 gives the tocopherol concentration and the percent (%) by mass of the 2 types of tocopherol in the plants.

Table 1

Line	Treatment	Tocopherol concentration (mg/kg)	*γ-tocopherol* (%)	*α-tocopherol* (%)
L1	Vector + TMT1	360	3	97
L2	Vector + TMT2	360	3	97
L3	Vector + TMT3	360	51	49
L4	Vector + TMT4	360	2	98
L5	Vector	360	99	1
L6	Untreated	360	99	1

Experiment 2

Four genetically different strains of *A. thaliana* were grown (S1-S4). S1-S4 were exposed to a vector carrying TMT1. Next, 10 plants from each strain were grown. Table 2 shows the tocopherol concentration and the percent by mass of the two types of tocopherol in the plants.

Table 2

Strain	Treatment	Tocopherol concentration (mg/kg)	*γ-tocopherol* (%)	*α-tocopherol* (%)
S1	Vector + TMT1	390	1	99
S2	Vector + TMT1	360	3	97
S3	Vector + TMT1	320	9	91
S4	Vector + TMT1	310	99	1

Tables adapted from D. Shintani and D. DellaPenna, "Elevating the vitamin E Content of Plants Through Metabolic Engineering." ©198 by the American Association for the Advancement of Science.

1. At the end of Experiment 2, which of the 4 strains had the greatest amount of *γ-tocopherol* per kilogram of plant material?
   A. S1
   B. S2
   C. S3
   D. S4

2. One of the *A. thaliana* strains used in Experiment 2 was genetically identical to *A. thaliana* used in Experiment 1. Based on the results of Experiment 1 and 2, this strain was most likely:
   F. S1
   G. S2
   H. S3
   J. S4

3. To determine whether exposure to the vector alone affected tocopherol concentration in Experiment 1, one should compare results from which 2 lines?
   A. L1 and L2
   B. L2 and L4
   C. L3 and L4
   D. L5 and L6

4. The scientist believed that 1 of the 4 cloned genes in Experiment 1 produced an enzyme that was less effective than the enzyme produced by the other 3 genes. Based on the results, the gene was most likely:
   F. TMT1
   G. TMT2

H. TMT3
J. TMT4

5. After reviewing the data from experiment 2, the scientist concluded that the transfer of the TMT gene to 1 of the strains was unsuccessful. This strain was most likely:
   A. S1
   B. S2
   C. S3
   D. S4

6. Which of the following best explains why the scientist wanted to transfer the TMT gene from one organism to another?
   F. To increase the amount of *α-tocopherol* produced by some of the *G. soja* plants
   G. To increase the amount of *α-tocopherol* produced by some of the *A. thaliana* plants
   H. To decrease the amount of *α-tocopherol* produced by some of the *G. soja* plants
   J. To decrease the amount of *α-tocopherol* produced by some of the *A. thaliana* plants

Please write your answers below and turn in this assignment:

1) _____ 2) _____ 3) _____

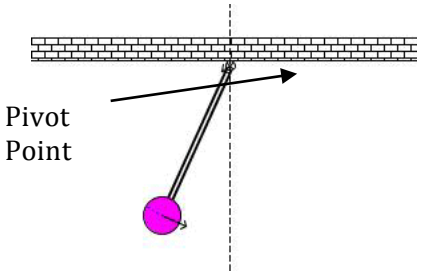
4) _____ 5) _____ 6) _____

Appendix A5- Pendulum Lab

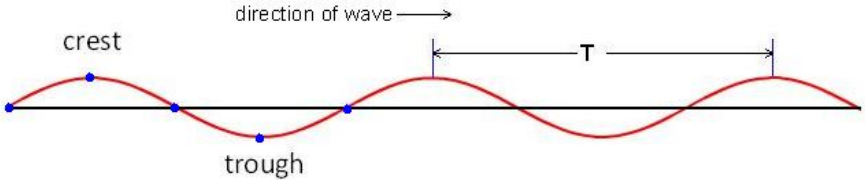
Hour _____ Date _____ Name _____

Pendulum Lab

A *pendulum* is a weight suspended from a pivot so that it can swing freely. A picture of a pendulum is shown below:



You will be conducting an online pendulum simulation. You will look at some factors that may influence the *pendulum's period*. The time required for one complete vibration, for example, from one crest to the next crest, is called the *pendulum's period* and is measured in seconds.



To complete this simulation go to the following website:

http://phet.colorado.edu/sims/pendulum-lab/pendulum-lab_en.html

You will run two experiments with this simulation. In the first experiment you will only alter pendulum length. In the second experiment you will only alter the pendulum's weight. To record the period of each pendulum swing you must click on the photogate timer option and adjust the weight, length and pendulum angle for each set of data points. Hit play and then start the timer. Record your data in the table below. Make sure you run the simulation for each of the conditions listed below. (*Hint: It is very important that you double check your pendulum angle each trial that you do*). Write your results in the data tables below:

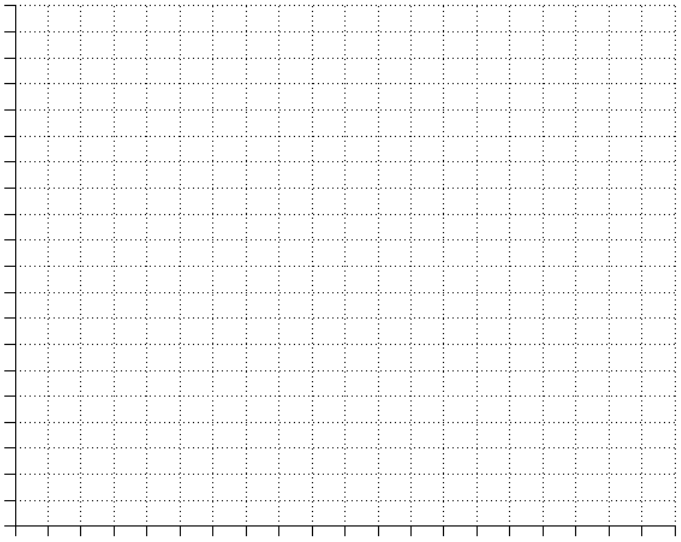
Experiment 1

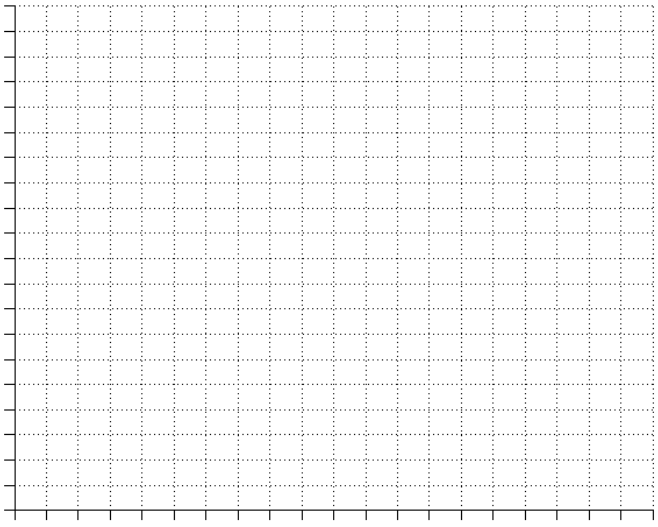
Pendulum Length (m)	Pendulum Angle (^{0})	Pendulum Weight (kg)	Period (s) (Rounded to the thousandths)
0.5	50	1.0	
1.0	50	1.0	
1.5	50	1.0	
2.0	50	1.0	
2.5	50	1.0	

Experiment 2

Pendulum Length (m)	Pendulum Angle (^{0})	Pendulum Weight (kg)	Period (s) (Rounded to the thousandths)
2.0	50	0.25	
2.0	50	0.5	
2.0	50	1.0	
2.0	50	1.5	
2.0	50	2.0	

Once you are finished complete two bar graphs: one with period (sec) on the y-axis and length (m) on the x-axis, the second with period (sec) on the y-axis and pendulum weight on the x-axis. Make sure to title both graphs.





ACT Follow-Up questions:

1. Which of the following variables causes the pendulum's period to change?
    A. Only the mass of the pendulum causes the period to change
    B. Only the length of the pendulum causes the period to change
    C. Both the mass and length of the pendulum cause the period to change
    D. Neither the mass nor length of the pendulum cause the period to change

2. As the length of the pendulum increases what happens to the period?
    F. The period decrease, then increases
    G. The period increases then decreases
    H. The period decreases only
    J. The period increases only

3. If there was another trial conducted in which the length of the pendulum was 3.0 meters and the weight was 1.0 kilograms what would the period most likely be?
    A. 2.0 seconds
    B. 2.5 seconds
    C. 3.0 seconds
    D. Greater than 3.0 seconds

4. As the weight of the pendulum increases what happens to the period?
    F. The period increases only
    G. The period decreases only
    H. The period increases and decreases
    J. The period does not change

5. If there was another trial conducted with in which the length of the pendulum was 1.0 meters and the weight was 3.0 kilograms what would the period most likely be?
    A. Less than 2.0 seconds
    B. Between 2.0 and 2.5 seconds
    C. Between 2.5 and 3.0 seconds
    D. Greater than 3.0 seconds

Please write your answers below and turn in this assignment:

1) _____ 2) _____ 3) _____ 4) _____ 5) _____

Appendix A6- Bar Graph Practice #1

Hour _____ Date _____ Name _____

ACT Bar Graph Practice 1

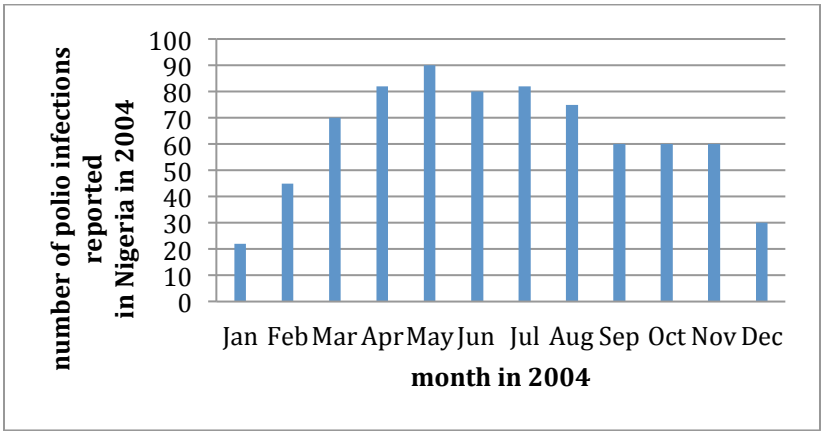
Passage II

Despite a global campaign since 1988 to eradicate *poliomyelitis* (polio), the virus that causes this disease continues to be endemic in four countries. This poliovirus, which can exist as Type I, Type 2, or Type 3, is most often transmitted through water that is contaminated by human waste. People can be immunized from this virus with a highly effective vaccine, which can be administered orally or by injection. Recent analyses of poliovirus transmission have focused on the four polio-endemic countries India, Pakistan, Afghanistan, and Nigeria.

Study 1

In 2004, a temporary ban on polio vaccines was instituted in Nigeria in response to concerns that they were contaminated. Researchers reviewed World Health Organization (WHO) records to determine the number of Type 1 polio virus infections that were reported in Nigeria in 2004 and tallied their findings by month (see Figure 1). The World Health Organization has noted that in polio-endemic countries, official records underestimate the number of people actually infected, because numerous infected individuals do not report their symptoms to clinics or rely on local therapists who are not surveyed. In a polio-endemic country, for every person who has reported an infection, as many as ten people may actually be infected in the local population.

Figure 1

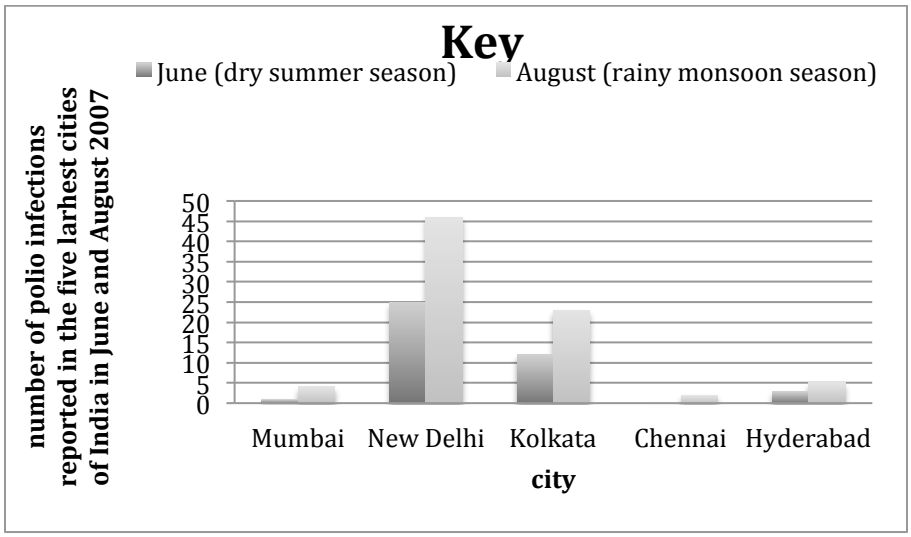


Study 2

Although polio eradication efforts have been most consistent in the urban areas of polio-endemic countries, these areas also have a high risk for a reemergence of polio, especially when the large urban populations are exposed to water contaminated with wastes that harbor the poliovirus. In 2007, researchers analyzed the number of people who reported infections with Type 3 poliovirus in the five largest cities in India. These cities were Mumbai in western India, New Delhi and Kolkata in northern India, and Chennai and Hyderabad in Southern India. The

analysis was undertaken in the months of June and August. June 2007 was chosen as a representative month for the dry summer season in India, during which there was minimal rainfall. August 2007 was chosen as a representative month for the wet monsoon season in India, during which there was daily rainfall. The results of the findings are shown in Figure 2.

Figure 2



7. According to Figure 1, the greatest increase in the number of reported polio infections in Nigeria occurred between which two months?

A. January and February
B. February and March
C. April and May
D. November and December

8. It is estimated that for every person infected with the poliovirus is an endemic country, there are 200 people at risk for contracting the virus. Given the results of Study 1, how many people would have been at risk for becoming at risk for becoming infected with the poliovirus in Nigeria in June 2004

F. 80
G. 200
H. 800
J. 16,000

9. Given the information in Figure 2, which of the following might explain the difference in reported cases of polio in major Indian cities between June and August of 2007?

A. Water is more likely to become contaminated with polio-infected human waste in periods of high rainfall.
B. Water is less likely to become contaminated with polio-infected human waste in periods of high rainfall.
C. The poliovirus infects more people in India during the summer and monsoon seasons than during the autumn and winter seasons.
D. Those diagnosed with the poliovirus in June are able to recover by August.

10. Which of the following hypotheses was most likely tested in Study 2?

F. The number of reported cases of polio infections varies significantly between Nigeria and India.

G. Most cases of polio infections are not reported to medical authorities in India.

H. Poliomyelitis infections affect more people in certain regions in India than in other regions.

J. The number of reported cases of polio infections in India is greatest during the summer and least during the winter.

11. Polio-endemic countries are located in warm climates that harbor many mosquitoes. Would the presence of mosquitoes directly affect the transmission of the poliovirus?

A. Yes, because the poliovirus is primarily transmitted through mosquitoes.

B. Yes, because the poliovirus is primarily transmitted through human waste.

C. No, because the poliovirus is primarily transmitted through mosquitoes.

D. No, because the poliovirus is primarily transmitted through human waste.

12. The comparison of reported polio infections in India in 2007, as shown in Figure 2, indicates that relative to the number of people in Kolkata infected with polio in June, the number of people infected with polio in Kolkata in August was approximately:

F. half as much.

G. the same.

H. twice as much.

J. ten times as much.

Please write your answers below and turn in this assignment:

7) _____ 8) _____ 9) _____

10) _____ 11) _____ 12) _____

Appendix A7- Bar Graph Practice #2

Hour _____ Date _____ Name _____

ACT Bar Graph Practice 2

Passage I

The magnitude of seismic energy released from an earthquake is often described using the logarithmic and unit-less Richter scale. Originating at the epicenter, seismic energy travels though the earth via wave such as L-waves, S-waves, and P-waves. Earthquakes with a Richter scale magnitude of 5.0 or greater can typically be detected throughout the world. Figure 1 depicts the layers of the earth and typical travel patterns of seismic waves. Table 1 lists characteristics of those seismic waves. Figure 2 shows the number of earthquakes (by magnitude) detected at a particular seismic activity monitoring station in the past 30 years, as well as the percentage probability of future earthquakes (by magnitude) in that same region in the next 30 years.

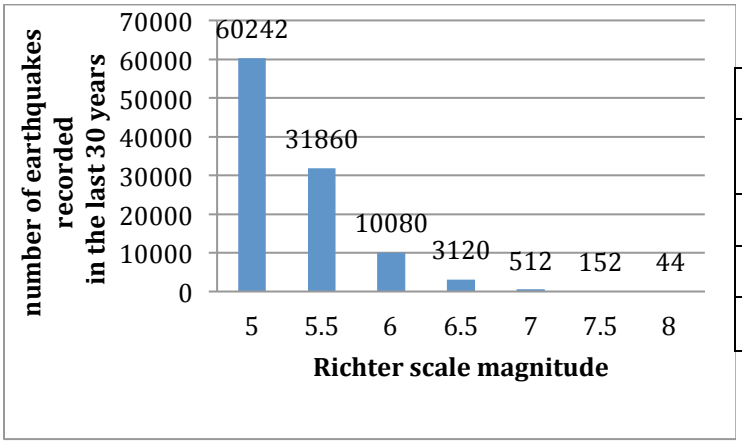
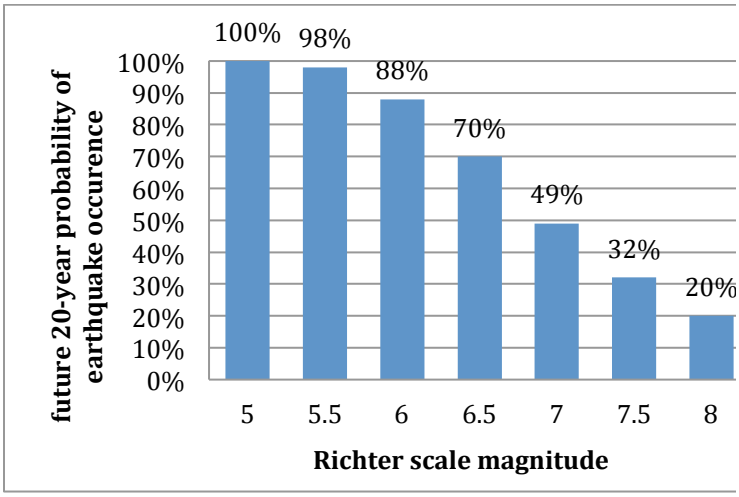


Table 1

Seismic Waves	Depth range (km)	Crust velocity (m/s)
L-wave	0-10	2.0-4.5
S-wave	0-2921	3.0-4.0
P-wave	0-5180	5.0-7.0



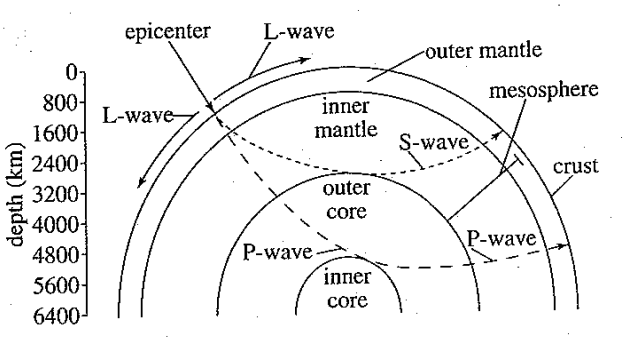


Figure 1

1. Figure 1 defines the mesosphere as a region of the Earth that overlaps which of the following atmospheric layers?

I. Outer Core
II. Inner Mantle
III. Outer Mantle

A. II only
B. I and II only
C. II and III only
D. I, II, and III

2. A series of seismic waves was observed from an observatory station. The average crust velocity of these waves was 3 m/s, and their maximum depth occurred in the inner mantle. Based on Figure 1 and Table 1, the seismic waves observed were most likely:

F. L-waves
G. S-waves
H. P-waves
J. K-waves

3. Given the data in Figure 2, the future probability of an earthquake occurrence decreases by a more than half when comparing which of the following 2 magnitudes?

A. 5.0 and 5.5
B. 5.0 and 6.0
C. 5.0 and 7.0
D. 6.0 and 7.0

4. According to Figure 2, the probability of a future earthquake occurrence is lowest for which of the following ranges of Richter scale magnitude?

F. 5.5 to 6.0
G. 6.0 to 6.5
H. 6.5 to 7.0
J. 7.0 to 7.5

5. Based on Figure 2, the ratio of Richter scale 5.5 earthquakes to Richter scale 5.0 scale earthquakes in the last 30 years can be expressed approximately by which of the following fractions?

A. 1/3
B. 1/2
C. 2/3
D. 3/2

Please write your answers below and turn in this assignment:

1) _____ 2) _____ 3) _____ 4) _____ 5) _____

Appendix A8- Bowling Ball Lab

Hour _____ Date _____ Name _____

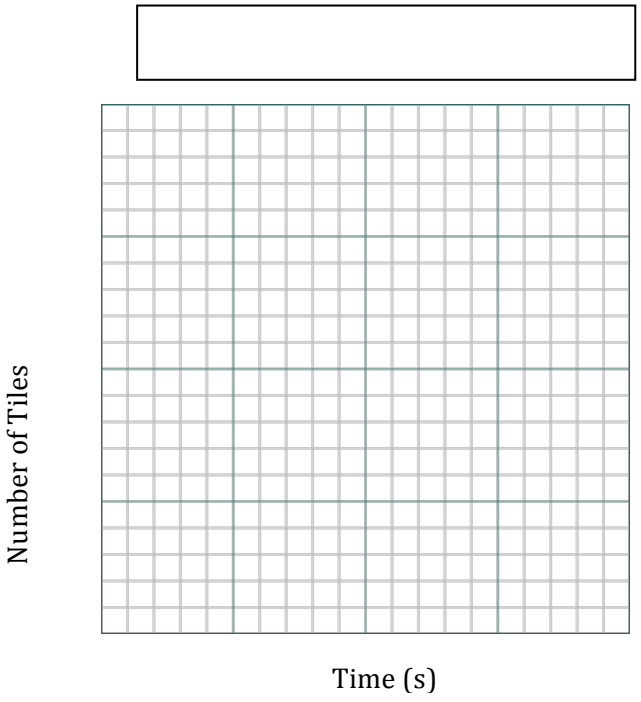
Bowling Ball Lab

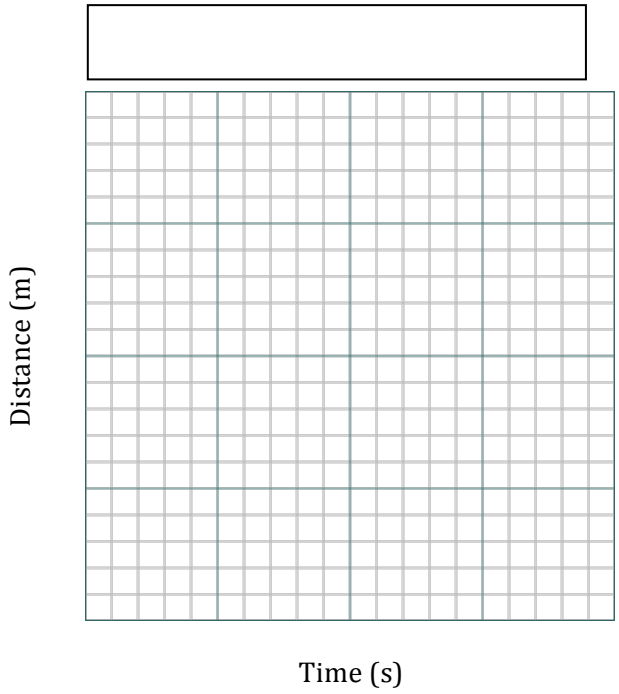
Today you will be collecting data on a bowling ball's *velocity*. *Velocity* is the rate of change of the position of an object; two equations you will utilize to calculate velocities are listed below:

$$\text{Velocity} = \frac{\text{distance(m)}}{\text{time(s)}} \quad \text{velocity} = \frac{\text{\# of tiles}}{\text{time (s)}}$$

You will be assigned a timing station. You will stand at your timing station and hit stop on your stopwatch when the bowling ball crosses the tile edge. Ms. Hamilton will walk down the line of timing stations and will record each time. Once Ms. Hamilton has collected all of the data return promptly to the classroom. Once you are back in the classroom record the class data in the data table below. Once you have copied all of the data down construct two line graphs. One line graph will compare tile # to time and the other will compare distance to time. Once you have finished your graphs answer the follow-up questions and turn in your assignment.

Tile #	Distance (m)	Time (s)
0	0	0
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		





ACT Follow-Up Questions

1. Which of the following describes the relationship between distance (m) and time (s) observed in this lab?
F. As time increases the distance decreases only
G. As time decreases distance increases only
H. As time increases distance increases only
J. As time increase distance increases or decreases

2. How are the two graphs related to one another?
A. They are not related.
B. They are directly related.
C. They are indirectly related.
D. They both stay constant.

3. Which of the following equations would also be representative of velocity?

F. $\frac{\text{time}}{\text{distance}}$

G. $\frac{\text{miles}}{\text{hours}}$

H. $\frac{\text{hours}}{\text{miles}}$

J. $\frac{\text{seconds}}{\text{meters}}$

4. Which of the following is NOT a plausible interference with accuracy to this data?
A. Friction
B. Human timing error
C. The tiles are not equal is size
D. The number of students collecting data

5. Which of the following factors was the independent variable of this lab?
A. Time
B. Distance
C. # of Tiles
D. There was no independent variable

Please write your answers below and turn in this assignment:

1) _____ 2) _____ 3) _____ 4) _____ 5) _____

Appendix A9- Single-Line Graph Practice #1

Hour _____ Date _____ Name _____

Single-Line Graph Practice 1

Passage VI

The pH at which a protein is uncharged is called its *isoelectric point (pI)*. As the surrounding pH decreases, proteins gain an increasing positive charge. As the surrounding pH increases, proteins gain an increasingly negative charge. In *gel electrophoresis*, a mixture of proteins are first dissolved in a solvent and then placed at the starting point of an agarose gel. A current is applied to the gel and the proteins migrate different distances according to their charge (see **Figure 1**).

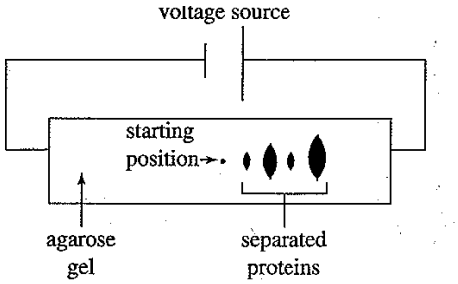


Figure 1

Table 1	
Protein	pI
A	8.2
B	7.4
C	6.8
D	5.9
Solvent	pH
1	8.9
2	9.6
3	10.2

The following experiments were done to determine how varying the pH of a solvent affects the separation of proteins with gel electrophoresis. **Table 1** shows the isoelectric points of the proteins and the pH values of the solvents used. The pH scale is logarithmic. Solutions with a pH less than 7.0 are acidic, while those with a pH more than 7.0 are basic.

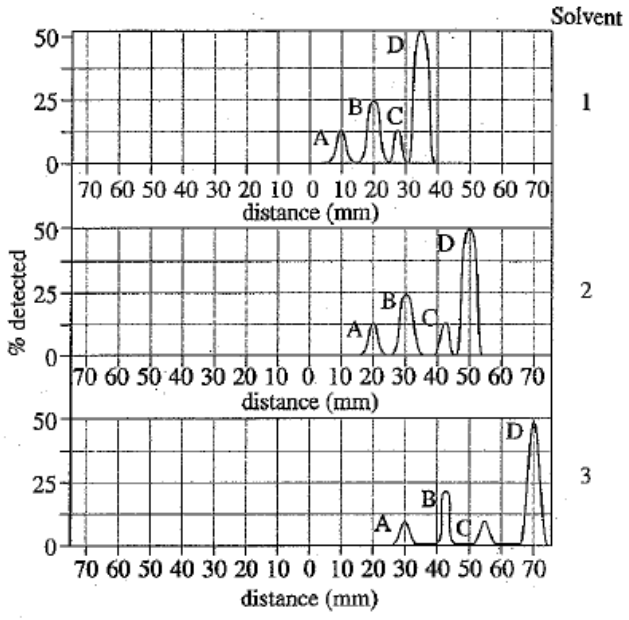


Figure 2

Experiment 1

A special paper 150 mm long is treated with an aragose gel. Electrodes were attached on each end and wired to a 100-volt source. A 150 μg mixture of proteins A-D was added to Solvent 1 to make a 200μL solution. The solution was placed at the starting point of the gel and allowed to separate for 60 minutes. The density of the separated proteins was plotted as a percentage over their distance traveled. The procedure was repeated for Solvents 2 and 3 and the results presented in **Figure 2**.

Experiment 2

The procedures of Experiment 1 were repeated after reversing the electrode attachments on the voltage source Results are shown in **Figure 3**.

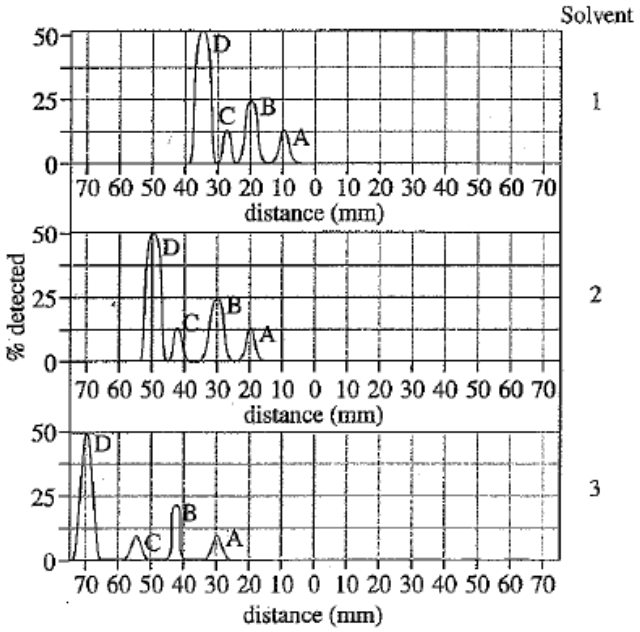


Figure 3

28. In Experiment 2, when Solvent 2 was used, the majority of Protein D migrated a distance from the starting point closest to:

F. 15 mm.
G. 35 mm.
H. 50 mm.
J. 65 mm.

29. Supposed that Experiment 1 were repeated using a solvent with a pH of 8.4. The migration distance of Protein A would most likely peak at:

A. less than 10mm
B. between 10 mm and 20 mm.
C. between 20 mm and 30 mm.
D. greater than 30 mm.

30. Protein L has an isoelectric point (pI) of 6.6. The results of Experiments 1 and 2 would be most similar to the plots shown in Figures 1 and 2 if, in each trial, Protein L were added to the protein mixture after removing:

F. Protein A
G. Protein B
H. Protein C
J. Protein D

31. The resolution of gel electrophoresis decreases as the overall distance between the peaks on the density plot decreases. Based on the results of Experiments 1 and 2, which of the following sets of conditions had the lowest resolution for the separation?

Experiment 1	Experiment 2
A. Solvent 1	Solvent 1
B. Solvent 3	Solvent 3
C. Solvent 2	Solvent 3
D. Solvent 3	Solvent 1

32. Suppose that Experiment 1 will be repeated using Solvent 2, but Protein Y (pI=7.1) is added to the overall mixture. Which of the following best predicts the order of migration distances of the 5 proteins, from shortest to longest?

F. D, C, Y, B, A
G. D, Y, C, B, A
H. A, B, Y, C, D
J. A, Y, B, C, D

33. In Experiment 2, for Solvent 2, at the migration distance where Protein B returned to its 0% migration detection, the percent of Protein A that migrated using Solvent 3 was closest to:

A. 0%
B. 25%
C. 50%
D. 75%

Please write your answers below and turn in this assignment:

28) _____ 29) _____ 30) _____

31) _____ 32) _____ 33) _____

Appendix A10- Single-Line Graph Practice #2

Hour _____ Date _____ Name _____

Single Line Graph Practice 2

Passage I

A study was conducted regarding the fossil shells of a particular species of turtle that lives off the coast of the Opulasian Peninsula. Scientists discovered a continuous record of fossilized shells in the seabed off the coast dating back 120,000 years. In additional to examining the fossilized turtle shells, the scientists also examined the shells of living turtles.

From each layer of seabed, the scientists randomly selected five complete, unbroken fossilized shells. Each shell was carefully prepared, measure, and photographed. A bit of each shell was then clipped off and sent to a laboratory for radiocarbon dating to determine the precise age of each shell.

Study 1

All of the living turtles had a distinct band of hexagonal *scutes* (bony plates) running the length of their shells, from head to tail. The fossilized shells' scutes were not visible to the naked eye; however upon application of a particular dye, a similar band of scutes from head to tail was observed in every shell.

Scutes extending greater than 1/8 of the length of the shell were labeled *major* (M), where the scutes extending less than or equal to 1/8 of the length of shell were labeled *minor* (m). The pattern of scutes was recorded for each fossil. For each time period, the percent of fossils exhibiting each pattern is given in Table 1.

Table 1

% shells with the following scute pattern:			
Age of shells (years)	M-m-M-M-m	M-M-m-m-M	M-m-M-m-M
120,000	46	44	10
90,000	42	54	4
87,000	30	67	3
85,000	21	72	7
80,000	20	66	14
50,000	76	21	3
27,000	100	0	0
15,000	100	0	0
8,000	100	0	0
4,000	100	0	0
1,000	68	28	4
300	74	20	6
0	86	2	12

Study 2

For each shell, the surface area of the shell, the height of the shell's bridge (part of the shell linking the upper and lower plates), and the total number of scutes were recorded (see Figure 1).

For the shells of each age, the average of each measurement was calculated. The results are present in Figure 2.

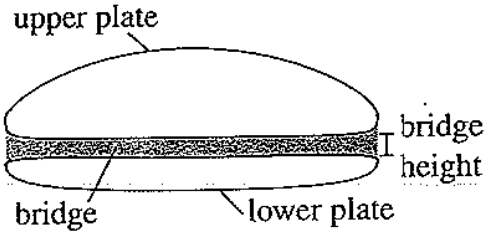


Figure 1

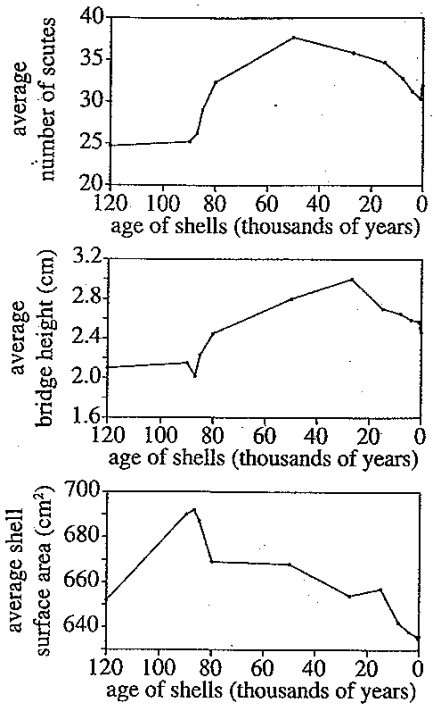
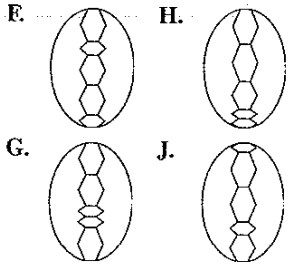


Figure 2

1. In a layer of seabed determined to be 250,000 years old, the scientists found fragments of twelve turtle shells, but no complete intact shells. Which of the following is the most likely reason this layer of seabed wasn't included in the study?

A. 250,000 years is too old to obtain an accurate radiocarbon date.
B. Shells that were 250,000 years old would have been irrelevant to the studies.
C. Accurate measurements of the dimensions of the shells could have been impossible to obtain.
D. The scientists would not have been able to accurately determine the color of the shells.

2. With regard to the descriptions given in Study 1, the shells with the M-M-m-m-M band of scutes probably most closely resembled which of the following?



3. According to the results of Study 2, how do the average number of scutes and the average bridge height of living turtles of the Opulasian Peninsula compare to those of the Opulasian Peninsula from 120,000 years ago?

For the living turtles:

A. Both the average number of scutes and the average bridge height are larger.
B. Both the average number of scutes and the average bridge height are smaller.
C. The average number of scutes is larger, and the average bridge height is smaller.
D. The average number of scutes is smaller, and the average bridge height is larger.

4. Suppose, in Study 1, the scientists had found another seabed layer with fossilized shells that were radiocarbon dated and found to be around 86,000 years old. Based on the results of Study 1, the scute pattern percents for the group of shells would most likely have been closest to which of the following?

	M-m-M-M-m	**M-M-m-m-M**	**M-m-M-m-M**
F.	100%	0%	0%
G.	50%	25%	25%
H.	36%	61%	4%
J.	26%	69%	5%

5. In Study 2, the average shell surface area of fossilized turtle shells that were 80,000 years old was closest to:

A. 670 cm^2
B. 680 cm^2
C. 690 cm^2
D. 700 cm^2

6. Which of the following statements best describes how Study 1 differed from Study 2?

F. In Study 1, the scientists examined 3 characteristics regarding the shape and size of turtle shells; but in Study 2, the scientists examined the frequency of occurrence of different patterns of scutes on turtle shells.
G. In Study 1, the scientists examined the frequency of occurrence of different patterns of scutes on turtle shells; but in Study 2, the scientists examined the environment in which turtles live.
H. In Study 1, the scientists examined the frequency occurrence of different patterns of scutes on turtle shells; but in Study 2, the scientists examined 3 characteristics regarding the shape and size of turtle shells.
J. In Study 1, the scientists examined 3 characteristics regarding the shape and size of turtle shells; but in Study 2, the scientists examined the environment in which turtles live.

Please write your answers below and turn in this assignment:

1) _____ 2) _____ 3) _____

4) _____ 5) _____ 6)_____

Appendix A11- Grow Toy Lab

Hour _____ Date _____ Name _____

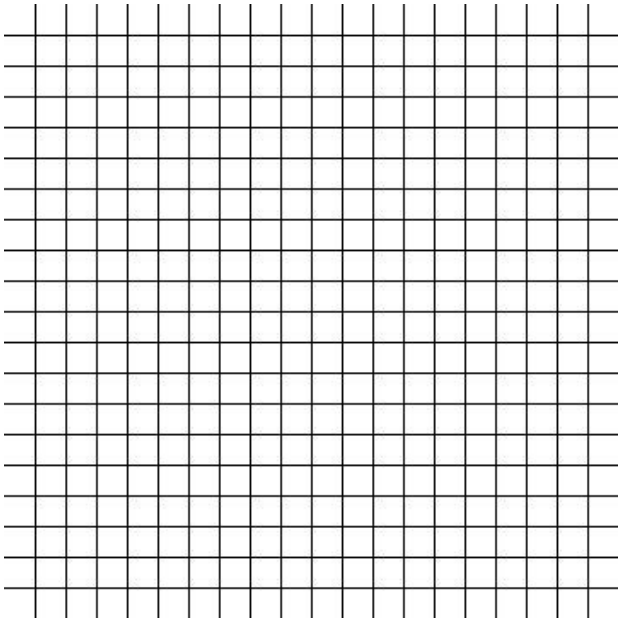
Grow Toy Lab

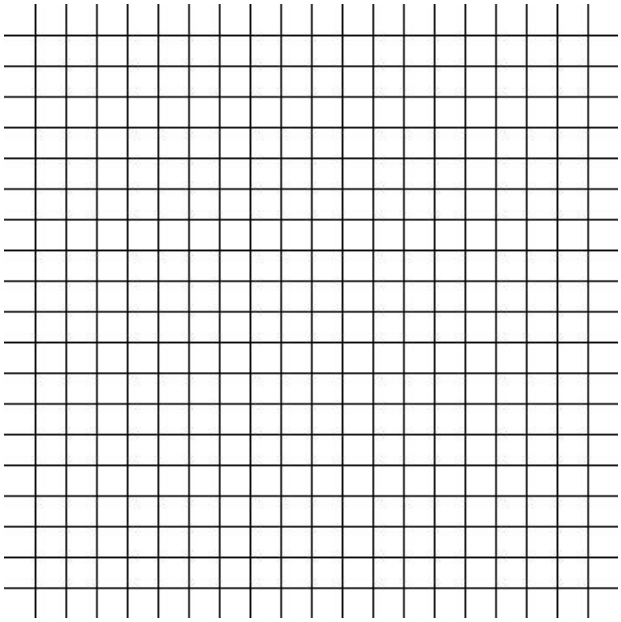
You will be collecting a series of data utilizing grow toys. Grow toys are toys made of a superabsorbent polymer. *Superabsorbent polymers* are large macromolecules that can absorb and retain extremely large amounts of liquid relative to their own mass. Some grow toys claim to grow up to 600% of their original size. You will be evaluating these claims of growth. You will record the mass in grams, length in centimeters, and width in centimeters before and after the grow toy is left in a particular liquid overnight. You will also measure the amount of milliliters left in the container after growth. You will be collecting data on three different solutions: tap water, distilled water and sugar water at various amounts: 500, 1000 and 2000 milliliters. Record your information in the tables below then graph the following data using the provided graphs. To calculate the % increase in mass, length, and width use the following equation:

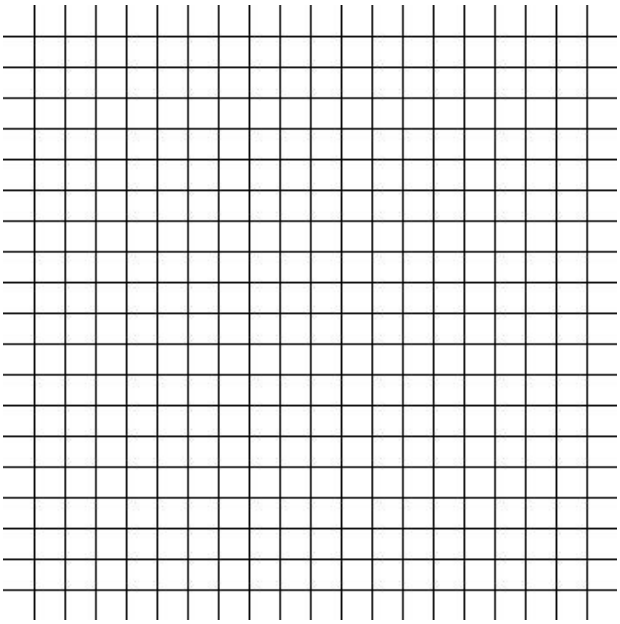
$$\frac{\text{Mass/Length/Width After} - \text{Mass/Length/Width Before}}{\text{Mass/Length/Width/Diameter Before}} \times 100 = \%\ \text{increase}$$

	Tap Water			**Distilled water**			**Sugar Water**		
	500 (ml)	1,000 (ml)	2,000 (ml)	500 (ml)	1,000 (ml)	2,000 (ml)	500 (ml)	1,000 (ml)	2,000 (ml)
Mass Before (g)									
Length from head to tail Before (cm)									
Width Before from top to bottom (cm)									
Mass After (g)									
Length from head to tail After (cm)									
Width from top to bottom After (cm)									
Amount of H_2O remaining in container after (ml)									
Mass Increase (%)									
Length Increase (%)									
Width Increase (%)									

Use the following graphs to graph the mass, length, width and diameter % increase for each solution. Make sure to use appropriate axis labels, keys and titles when graphing all the information. You may want to check your axis with Ms. Hamilton before you begin graphing your data.







1. Which of the following had the overall biggest percent increase when placed in the distilled water?

A. Mass
B. Length
C. Width
D. Diameter

2. Which of the following best states the relationship among % increase in mass, length and width and solution size?

F. As % increase of mass increased the solution size increased.
G. As % increase of mass decreased the solution size decreased
H. As the solution size decreased the % of mass increase decreased then increased
J. There was no trend in mass when you increased the amount of solution.

3. If the toy company claimed their toys can grow up to 400% larger would you approve this claim? Why?

A. No, because the length increase was less than 400%
B. No, because the length increase was greater than 400%
C. Yes, because the length increase was less than 400%
D. Yes, because the length increase was greater than 400%

4. Which of the solutions caused the greatest increase in width?

F. Tap water
G. Distilled water
H. Sugar water
J. There was no solution with the greatest increase in diameter.

5. If a diaper company used the same superabsorbent polymer in their product and claimed they could hold up to 250 ml of urine would you recommend their product to parents of infants? Why or why not?

A. Yes, the absorbency is greater than 250 ml of urine
B. No, the absorbency would is greater than 250 ml of urine
C. Yes, the absorbency is less than 250 ml of urine
D. No, the absorbency is less than 250 ml of urine.

6. If there was an additional measurement taken using 750 milliliters in tap water which of the following would be an appropriate estimation of percent increase in length?

F. Less than 100% increase
G. Between 100% and 200% increase
H. Between 200% and 300% increase
J. More than 300% increase

Please write your answers below and turn in this assignment:

1) _____ 2) _____ 3) _____

4) _____ 5) _____ 6) _____

Appendix A12-Multi-Line Graph Practice #1

Hour _____ Date _____ Name _____

Multi-Line Graph Practice 1

Passage III

Osmotic pressure (II) is the amount of pressure, in atm, required to maintain equilibrium of a solvent across a semipermeable membrane. At a constant temperature, osmotic pressure is dependent only on a solute's ability to dissociate or ionize in the solvent (*van't Hoff factor, i*) and the concentration of solute particles. The osmotic pressure is determined by the equation:

$$\Pi = iMRT$$

M represents the concentration (in molarity, M), *R* is the ideal gas constant (0.0821 L atm mol^{-1} K^{-1}), and *T* (300 K) is the temperature in Kelvin (K). The value of *R* is assumed to be a constant for all osmotic pressure calculations.

The dissociation of a solute depends on its unique chemical properties. The van't Hoff factors for some common substances are displayed in Table 1. Higher van't Hoff factors correlate with greater dissociation or ionization. The effect of the van't Hoff factor on the osmotic pressure may be seen in Figure 1.

Table 1	
Substance	van't Hoff factor*
Sucrose	1.0
NaCl	1.9
$MgCl_2$	2.7
$FeCl_3$	3.4
*Values at 300 K	

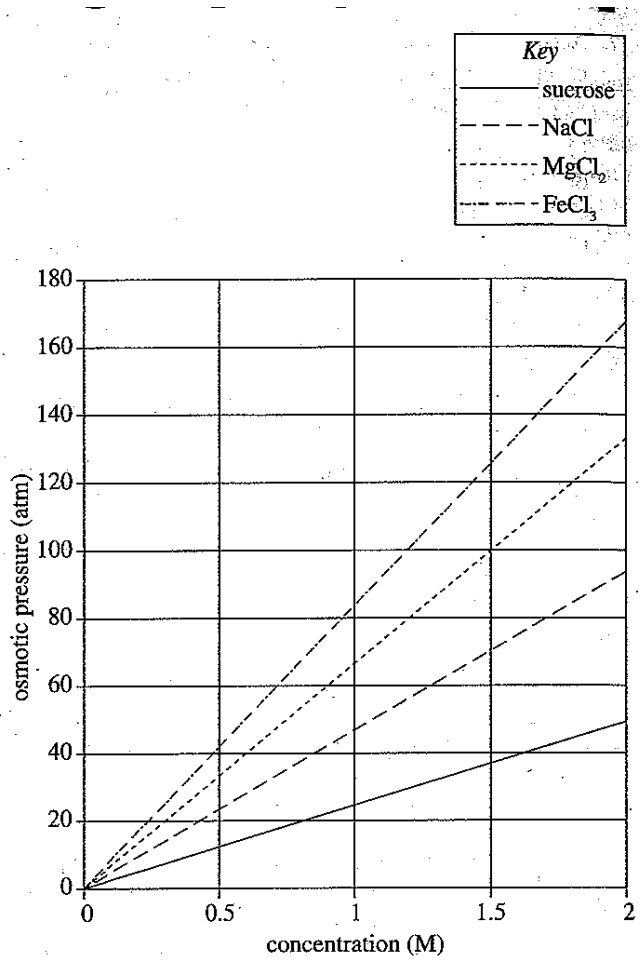


Figure 1

13. According to Figure 1, which of the following solutions would exhibit the *least* osmotic pressure?

A. 1.0 M $FeCl_3$ solution
B. 1.0 M $MgCl_2$
C. 2.0 M NaCl solution
D. 2.0 M sucrose solution

14. If 1.0 M solutions of various solutes were prepared, which of the following solutions would have the highest level of ionization?

F. Sucrose
G. NaCl
H. MgCl2
J. $FeCl_3$

15. Which of the following solutions would exhibit the closest osmotic pressure to that of a 1.5 M NaCl solution at 300 K, if the gas constant is 0.0821 L atm/mol^{-1} K^{-1}?

A. 1.0 M NaCl solution (i=1.9)
B. 2.0 M NaCl solution (i=1.9)
C. 2.9 M Sucrose solution (i=1.0)
D. 3.5 M Sucrose solution (i=1.0)

16. Based on Figure 1, as the concentration of solute decreases, the pressure required to hold solvent concentration across a membrane at equilibrium will:

F. increase only.
G. decrease only.
H. remains constant.
J. increase, then remain constant.

17. A scientist recently discovered a compound that ionizes readily in a solution (i=3.8) and results in low osmotic pressures. Are the findings of this scientist consistent with Figure 1?

A. Yes, because $FeCl_3$ causes higher osmotic pressure than sucrose.
B. No, because sucrose causes higher osmotic pressure than $FeCl_3$.
C. Yes, because $FeCl_3$ causes lower osmotic pressure than sucrose.
D. No, because sucrose causes lower osmotic pressure than $FeCl_3$.

Please write your answers below and turn in this assignment:

13) _____ 14) _____ 15) _____ 16) _____ 17) _____

Appendix A13- NOAA weather graphing Lab

Hour _____ Date _____ Name _____

Lansing Meteorological Data 2013 Graphing Activity

The following NOAA collected data is measured values for precipitation (inches), relative humidity (%) and average maximum temperature (^{0} F) for Lansing, Michigan throughout 2013.**Using all three measurements please construct a line graph.**

Step 1: Place time in months on your x axis and every 5 lines you will place a month starting with January and ending in December. Make sure to include a title for your x axis with units.

Step 2: Label the y-axis on the left relative humidity. Every 5 lines will represent 10%. Make sure to include a title with units.

Step 3: Using the data table below graph the relative humidity of Lansing, Michigan for 2013. Make sure to use a ruler to connect your data points.

Step 4: Use a green marker or colored pencil and trace over your relative humidity line.

Step 5: Label the first y-axis on the right precipitation. Every 2 lines will represent 0.2 inches. Make sure to include a title with units.

Step 6: Using the data table below graph the precipitation of Lansing, Michigan for 2013. Make sure to use a ruler to connect your data points.

Step 7: Use a black marker or colored pencil and trace over your precipitation line.

Step 8: Label the second y-axis on the right average maximum temperature. Every 5 lines will represent 10^0 Make sure to include a title with units.

Step 9: Using the data table below graph the average maximum temperature of Lansing, Michigan for 2013. Make sure to use a ruler to connect your data points.

Step 10: Use a yellow marker or colored pencil and trace over your average maximum temperature line.

Step 11: Title your graph and make a legend with a key.

Step 12: Using your graph answer the ACT questions found on the back of this page.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Relative Humidity (%)	74	74	69	66	61	70	72	72	73	75	69	78
Precipitation (inches)	1.11	0.54	0.97	1.66	2.69	3.12	0.38	3.39	0.49	1.52	0.85	0.80
Average Maximum Temperature (^{0} F)	34.2	31.9	38.2	53.6	73.3	77.2	81.6	80.0	72.7	61.8	44.0	30.2

ACT Follow up Questions

1) All of the following statements are true about the average maximum temperature EXCEPT:
    a) The hottest months are July and August
    b) The coldest months are December and February
    c) The biggest difference in temperature occurred between September and October
    d) The smallest difference in temperature occurred between July and August

2) Which of the following describes the trend in precipitation in Lansing, Michigan throughout 2013:
    a) The precipitation levels steadily increase from January to December
    b) The precipitation levels increase and decrease from season to season
    c) The precipitation levels steadily decrease from January to December
    d) The precipitation levels do not change from season to season

3) Which of the following explain the relationship between relative humidity and precipitation levels in Lansing Michigan during 2013:
    a) As relative humidity increases so does precipitation
    b) As precipitation increase relative humidity decreases
    c) As relative humidity changes precipitation stays the same
    d) There is no direct relationship between relative humidity and precipitation.

4) Which month had the lowest precipitation and warmest temperature in Lansing, Michigan for 2013:
    a) August
    b) July
    c) June
    d) May

5) If the trend for temperature stays the same for Lansing, Michigan what month would you expect to have the lowest average maximum temperature in 2014:
    a) November
    b) December
    c) January
    d) February

6) Which of the following describes the trend in average maximum temperature:

    a) The average maximum temperature decreases from February to July and then increases from July to December
    b) The average maximum temperature increases from February to December
    c) The average maximum temperature increases from February to July and then decreases from July to December
    d) The average maximum temperature steadily decreases from February to December

Please write your answers below, attach your graph, and turn in this assignment:

1) _____ 2) _____ 3) _____

4) _____ 5) _____ 6) _____

Appendix A14- Multi-Line Graph Practice #2

Hour _____ Date _____ Name _____

Multi-Line Graphing Practice 2

Passage VII

A scientist studying hemoglobin investigated the impact of temperature and carbon dioxide (CO_2) concentrations on the binding of oxygen (O_2). The scientist observed the binding of oxygen to hemoglobin molecules as the pressure of oxygen was increased. The temperature and CO_2 were varied to identify their direct impact on the binding capacity of O_2.

Figure 1 displays the impact of changes in temperature on the binding (percent of hemoglobin saturated) of oxygen. Figure 2 displays the impact of varying carbon dioxide concentrations on oxygen binding. Under normal conditions, the core body temperature is 37⁰ C and has carbon dioxide and oxygen concentrations of 40mmHg and 100mmHg respectively.

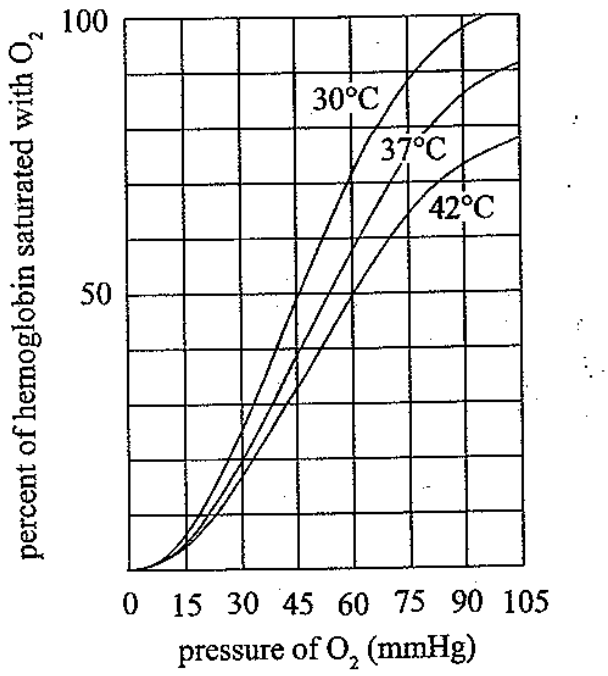


Figure 1

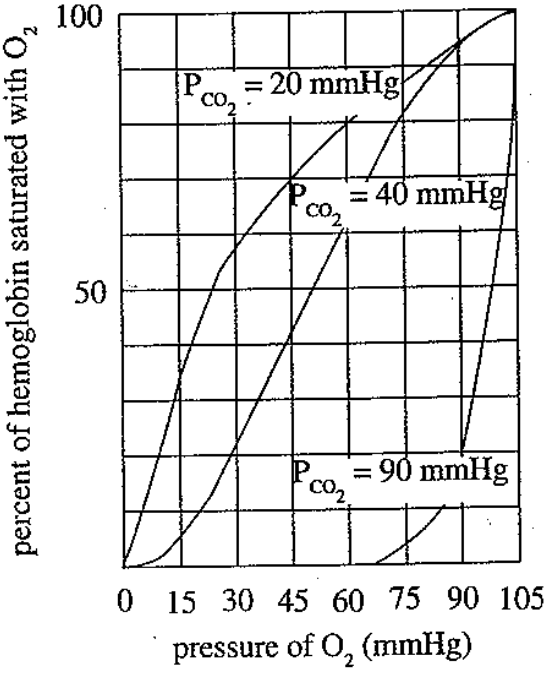


Figure 2

36. According to Figure 1, if the temperature is 42^{0}Cm which of the following changes in pressure of oxygen will cause the least increase in the percent of hemoglobin saturated with O_2?

F. 0-15mmHg
G. 15-20mmHg
H. 30-45mmHg
J. 45-60 mmHg

37. According to Figure 1, which of the following sets of temperature and pressure of oxygen results in the lowest hemoglobin saturation with oxygen?

	Temperature (^{0}C)	**Pressure of Oxygen (mmHg)**
A.	37	45
B.	37	60
C.	42	45
D.	42	60

38. According to Figure 1, if the pressure of oxygen is 100 mmHg and 65% of hemoglobin molecules are saturated with oxygen then the core body temperature is most likely within which of the following ranges?

F. Less than 30^{0}C
G. 30^{0}C-37^{0}C
H.37^{0}C-42^{0}C
J. Greater than 42^{0}C

39. Based on Figure 2, if an individual has 70% of his hemoglobin molecules saturated at a pressure of 75 mmHg of oxygen, then the individual's carbon dioxide pressure is most likely closest to which of the following?

A. 30 mmHg
B. 50 mmHg
C. 70 mmHg
D. 90 mmHg

40. According to Figure 2, at a CO_2 pressure of 90 mmHg, as the pressure of O_2 is increased from 45 mmHg to 90 mmHg, the percent of hemoglobin saturated with oxygen:

F. remains constant, then increases.
G. remains constant, then decreases.
H. increase, then decreases.
J. decreases, then increases.

Please write your answers below and turn in this assignment:

36) _____ 37) _____ 38) _____ 39) _____ 40) _____

Appendix A15- Multi-Line Graph Practice #3

Hour _____ Date _____ Name _____

Multi-Line Graph Practice 3

Passage VII

An experiment is set up to look at the physics of bouncing a ball, as shown in Figure 1.

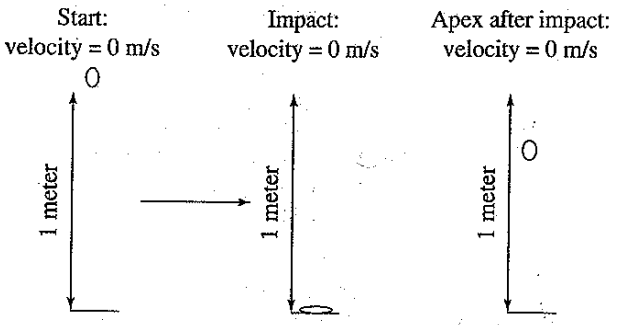


Figure 1

When a ball is dropped the initial velocity is 0 m/s. Velocity will increase until impact with the ground, at which point the ball's velocity immediately drops to 0 m/s again. After impact, velocity almost immediately increases to maximum post-impact velocity, and then begins to fall again as gravity works against it, slowing it down. The ball's velocity returns to 0 m/s when the ball is at its *apex*, or highest vertical point, post impact.

When a ball bounces, it deforms and become flatter. This is called *elasticity*. The more *elasticity* a material has, the better it is able to act like a spring and absorb force by being compressed, then use this force to "spring" back into the air. Post-impact velocity and the amount of time between velocity of 0 m/s at impact and velocity of 0 m/s at post-impact apex are affected by elasticity. Figure 2 shows the velocity of a ball versus time for balls with various elasticity and weight dropped from 1 meter height. Because gravity causes all objects to fall at the same speed regardless of weight, pre-impact velocities are identical for all balls.

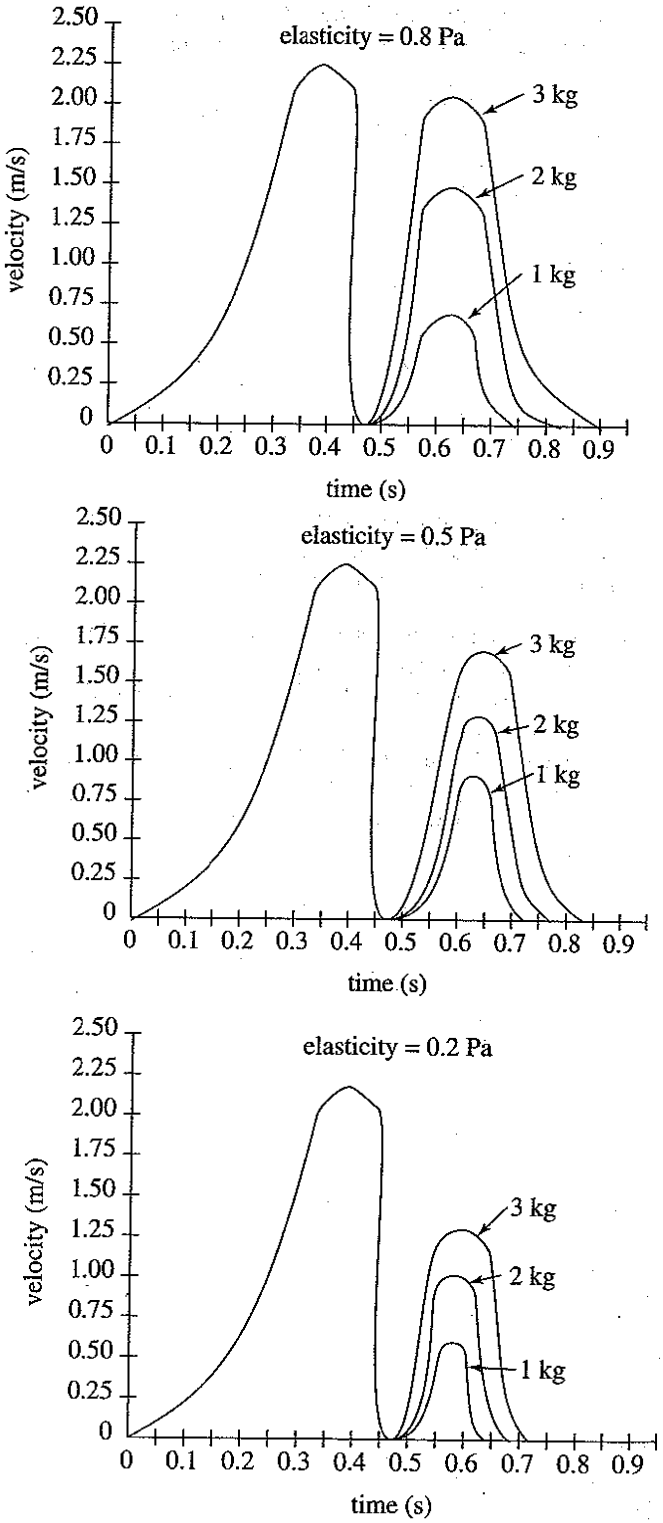


Figure 2

36. Based on data in Figure 2, the maximum post-impact velocity of a ball will be smallest if the elasticity of the ball is:

F. 1.5 Pa
G. between 1 and 1.5 Pa
H. between 0.5 and 1 Pa
J. 0.5 Pa

37. Based on the information in Figure 2, a ball being dropped from 1 meter height with an elasticity of 0.2 Pa and a weight of 0.5 kg would have a maximum post-impact velocity of:

A. less than 0.50 m/s.
B. 0.75 m/s.
C. 1.0 m/s.
D. greater than 1.25 m/s.

38. Consider a ball as it completes one bounce, from drop to post-impact apex. If this ball has a weight of 2 kg and an elasticity of 0.50 Pa, based on the data in Figure 2, how many times does the ball have a velocity of 1.00 m/s?

F. One time
G. Two times
H. Three times
J. Four times

39. Based on the data in Figure 2, how does the velocity of a ball change as it goes from impact to apex?

	Drop to Impact	**Impact to Apex**
A.	Increases only	Increases only
B.	Decreases only	Increases then decreases
C.	Increase then decreases	Increases then decreases
D.	Decreases then increases	Increases only

40. A ball will deform permanently and not spring back off the ground if the velocity with which it hits the ground exceeds the ball's elastic limit. Based on the data in Figure 2, if a ball is dropped from one meter and has a weight of 3 kg, an elasticity of 0.8 Pa, and an elastic limit of 2.75 m/s, will the ball deform permanently?

F. Yes, because the velocity with which the ball hits the ground is less than its elastic limit.
G. Yes, because the velocity with which the ball hits the ground is greater than its elastic limit.
H. No, because the velocity with which the ball hits the ground is less than its elastic limit.
J. No, because the velocity with which the ball hits the ground is greater than its elastic limit.

Please write your answers below and turn in this assignment:

36) _____ 37) _____ 38) _____ 39) _____ 40) _____

Appendix A16- Conflicting Hypothesis Practice Set #1

Hour _____ Date _____ Name _____

Conflicting Hypothesis Practice Set 1

Passage VII

Introduction

The *nucleus* (core) of an atom contains *protons* (positively charged particles) and *neutrons* (uncharged particles). Protons and neutrons are also called *nucleons*. Nucleons are attracted to each other by *strong nuclear forces*. Two models of the nucleus are discussed below.

The Liquid Drop Model

Some nuclear properties resemble the collective properties of the molecules in a drop of pure water.

- The stability of a nucleus is related to its shape. A nucleus is most stable (unreactive) when spherical; drop-shaped nuclei are more likely to undergo *fission* (split apart) then spherical nuclei.

- The mass and volume of a nucleus are proportional to the number of nucleons in the nucleus.

- The combing of 2 nuclei resembles the combining of 2 drops of water.

- Collisions of high-energy nucleons with the nuclei of certain elements cause the nuclei to undergo fission, just as projectiles disrupt drops of water.

The Shell Model

A Nucleus contains distinct bands of energy called *energy shells*. Its nucleons are restricted to these shells. Each nucleus contains many such shells, but not all the shells contain nucleons. Each shell is identified by a number. Table 1 contains the capacities of the first 3 shells.

Table 1

Shell	Maximum Number of:		
	Protons	Neutrons	Nucleons
1	2	2	4
2	6	6	12
3	12	12	24

- When every shell is either empty or contains its maximum number of protons or neutrons, a nucleus is *magic*. For example, the nucleus with a total of 20 protons and 19 neutrons has a *magic number* of protons, because the only shells that contain any protons (Shells 1,2, and 3) contain their maximum numbers of protons. Magic nuclei are generally more stable than other nuclei. The nucleus with 20 protons and 20 neutrons is *doubly magic* (magic in both protons and neutrons). Doubly magic nuclei are the most stable nuclei and are shaped like spheres.

- Low- energy neutrons will pass through the nuclei of many elements without being impeded. This implies that the nucleons inside a nucleus will not interfere with each other and is consistent with nucleons being in shells.

34. According to the Liquid Drop Model, a nucleus is *most* likely to undergo fission under which of the following conditions?

F. When its nucleons occupy partially filled shells
G. When its nucleons occupy filled shells
H. When the nucleus is shaped like an ellipse
J. When the nucleus is shaped like a sphere

35. According to the Shell Model, if a nucleus contains 21 protons, a maximum of how many of its energy shells could be filled to capacity with protons?

A. 4
B. 3
C. 2
D. 1

36. In very massive stars, energy is produced when a helium nucleus and a beryllium nucleus combine to form a carbon nucleus. According to the Liquid Drop Model, the formation of a carbon nucleus can be likened to the:

F. fission of a liquid drop.
G. combing of 2 liquid drops.
H. fission of 2 liquid drops.
J. escape of a molecule from a liquid drop.

37. The 2 theories agree that the most stable nuclei are those that:

A. contain equal numbers of protons and neutrons.
B. contain partially filled shells.
C. have spherical shapes.
D. readily undergo fission.

38. In the description of the Shell Model, a nucleus with 20 protons and 20 neutrons is discussed. Therefor, the nucleus is *doubly magic* with respect to protons and neutrons, because:

F. many of its shells contain to neutrons at all.
G. none of is shells contains the maximum number of the neutrons.
H. one of its shells contains some neutrons but not the maximum number of neutrons.
J. only one of its shells contains the maximum number of neutrons.

39. According to the Shell Model, a nucleus would most likely be spherical if the total numbers of protons and neutrons in its first 2 shells equaled which of the following values? (Note: Assumer that Shells 3 and higher are empty)

A. 2 protons, 3 neutrons
B. 6 protons, 6 neutrons
C. 8 protons, 7 neutrons
D. 8 protons, 8 neutrons

40. A supporter of the Liquid Drop Model favors the view that nucleons in a nucleus interact with each other like the molecules in a drop of water. A supporter of the Shell Model would refute this view using which of the following observations?

F. Collisions between high-energy nucleons and nuclei can cause the nuclei to undergo fission.

G. Low-energy neutrons pass through the nuclei of many elements unimpeded.

H. Nuclei act like drops of fluid.

J. Some nuclei are spherical.

Please write your answers below and turn in this assignment:

34) _____ 35) _____ 36) _____ 37) _____

38) _____ 39) _____ 40) _____

Appendix A17- Conflicting Hypothesis Practice Set #2

Hour _____ Date _____ Name _____

Conflicting Hypothesis Practice Set 2

Passage VII

Introduction

Students studying a unit on motion and conservation of energy were given the following information:

- *Kinetic energy* (energy that changes as an object's speed changes) and *gravitational potential energy* (energy that changes as an object's altitude changes) are forms of mechanical energy.

- An object's *total mechanical energy* is the sum of its kinetic energy and its gravitational potential energy.

- If an object's total mechanical energy is constant, its total mechanical energy is said to be *conserved*.

- Friction causes some of an object's total mechanical energy to be lost, in which case its total mechanical energy is *not* conserved.

The students' teacher then described the following experiment:

Suppose a student placed a block upon a surface and gave the block a single push. As the block moved along the surface, the student measured the block's speed twice in succession and found that the second measured speed was lower than the first.

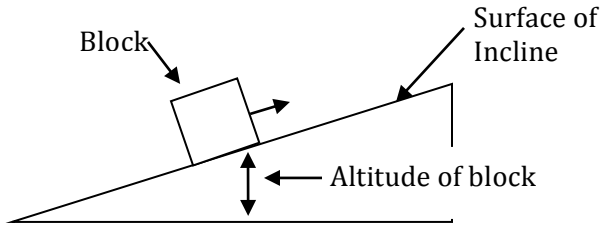
Given no other information, 3 students were asked to explain the results of the 2 measurements and to predict the blocks motion after the 2 measurements.

Student 1

The block was moving on a rough, *horizontal* surface (a surface with no incline). There was a constant frictional force between the block and the surface. This force alone caused the block to slow down at a constant rate and would have caused the block eventually to stop. Once stopped, the block would have remained at rest.

Student 2

When the 2 measurements were made, the block was moving up a frictionless, inclined surface shown in the figure, and was slowing down at a constant rate. No air was present.

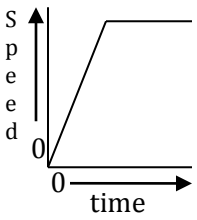


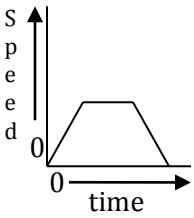
Eventually, the block would have stopped moving up the incline; then gravity would have caused the block to accelerate down the incline. At any specified altitude, the blocks' speed going down the incline would be the same as its earlier speed going up the incline.

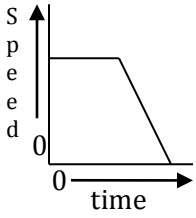
Student 3

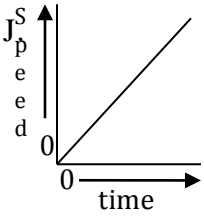
The block moved on a frictionless, horizontal surface. As a result of its motion, the block encountered air resistance. Air resistance alone caused the block to slow down and lose mechanical energy. The rate at which the block slowed down depended upon the amount of air resistance it encountered. As the block's speed decreased, the amount of air resistance decreased.

34. Assume that the block was pushed and then released at time=0. Student 2's description of the block's speed overtime after its release is best illustrated by which of the following graphs?

F. 

G. 

H. 

J. 

35. The 3 explanations of the block's motion are similar to each other in that all 3 explanations:

A. contradicted the law of conservation of total mechanical energy.
B. were formulated using the assumption that no friction would exist between the block and the air.
C. were formulated using the assumption that there would be no friction between the block and the surface on which it moved.
D. described the blocks speed as decreasing.

36. Based on the explanations of 3 students, the 3 students most likely assumed about the block's speed between the times the 2 measurements were made?

F. The first speed was lower.
G. The speed decreased than increased.
H. The speed increased, than decreased.
J. The second speed was lower.

37. The teacher posed another question: Suppose, in a second experiment, the student placed the block and the surface in a frictionless chamber. Then the student repeated the procedure from the first experiment, except that he measured the block's speed throughout the experiment. If the block's speed remained constant throughout this second experiment, the explanation(s) of which student(s) for the results of the first experiment would be best supported?

A. Student 1 only
C. Students 2 and 3 only
B. Students 1 and 3 only
D. Student 2 only

38. Based on Student 1's explanation, the block's gravitational potential energy when the block was stopped most likely equaled:

F. The block's kinetic energy one-third of the way across the horizontal surface.
G. The block's gravitational potential energy two-thirds of the way across the horizontal surface.
H. The block's total mechanical energy.
J. Zero.

39. According to Student 3, while the block was moving, did the block's speed affect the amount of air resistance acting on the block?

A. Yes: as the block's speed decreased, the air resistance force on the block increased only.
B. Yes: as the block's speed decreased, the air resistance force on the block decreased only.
C. No; as the block's speed decreased, the air resistance force on the block decreased, then increased.
D. No; as the block's speed decreased, the air resistance force on the block was unaffected.

40. Assuming that Student 3's explanation is correct, while the block moved, was the total mechanical energy of the block conserved?

F. Yes, because the block's kinetic energy decreased and its gravitational potential energy increased.
G. Yes, because both the block's kinetic energy and its gravitational potential energy increased.
H. No, because the block's kinetic energy decreased and its gravitational potential energy remained constant.
J. No, because the block's kinetic energy and its gravitational potential energy decreased.

Please write your answers below and turn in this assignment:

34) _____ 35) _____ 36) _____ 37) _____

38) _____ 39) _____ 40) _____