PVPHS AVID Juniors
SAT/ACT Prep
2017/2018

STUDY HUT TUTORING

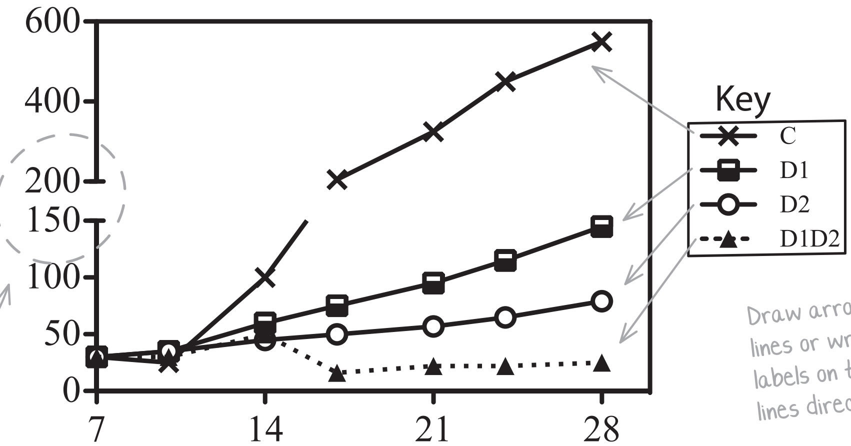
Packet #8: ACT Science
Part B

STUDYHUT.COM

Graph Structure

THE SPLIT AXIS:
Removing a portion of an axis allows a small graph to show a much wider range of data, but it can also wreak havoc on careless test takers!

Don't fall victim to this trap. Be careful which portion of the axis you need to use.



Draw arrow to lines or write labels on the lines directly.

HOT TIP!

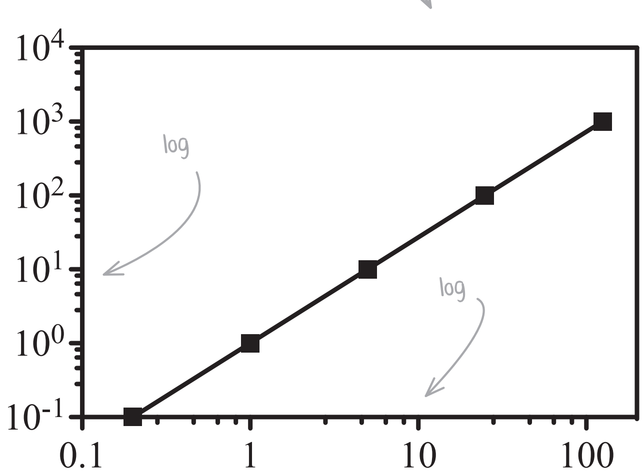
Use keys actively!

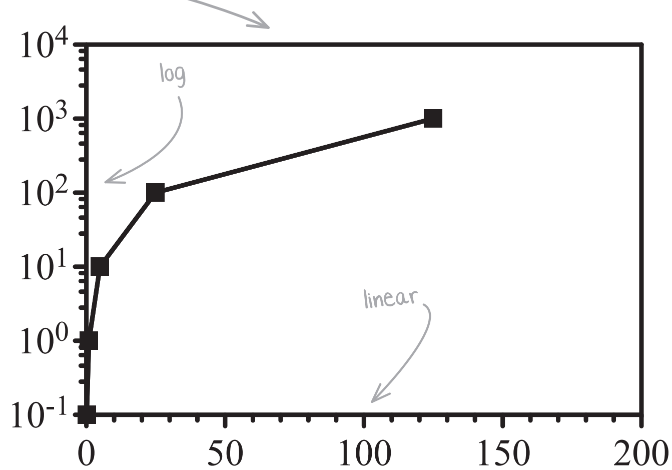
- Read the keys and the axis labels.
- Transfer the information in the key to the graph itself

Look for non-standard scales

- Is either the axis split? On which side do your data fall?
- Recognize log-based (a.k.a. exponential) scales
- Look at the spacing of tick marks to tell if the scale is log or linear.

Same Data, DIFFERENT SCALES!



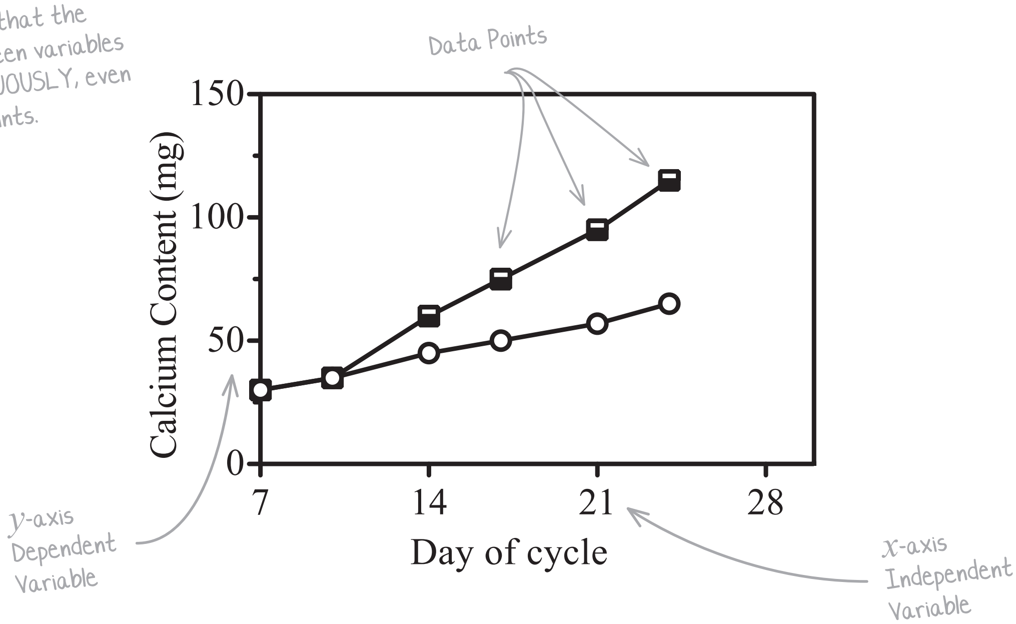


Line Graphs

Graphs show relationships

- Each type of graph is used to highlight relationships within the data being presented.
- Become familiar with the different graph types, and their variations, so that you are not surprised on the test.

Line Graphs imply that the relationship between variables changes CONTINUOUSLY, even between data points.



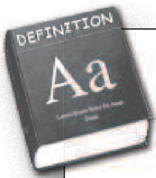
INDEPENDENT VARIABLE (N):
A variable whose value does NOT depend on the value of other variables in the graph. Usually plotted on the x-axis.

DEPENDENT VARIABLE (N):
A variable whose value DOES depend on the value of other variables in the graph. Usually plotted on the y-axis.

Ask yourself: does calcium content depend on the day of the cycle, or does the day of the cycle depend on the calcium content? You can often figure this out without understanding anything more about the study.

So, which is the dependent variable in this graph?

Scatter Plots



QUANTITATIVE (ADJ):

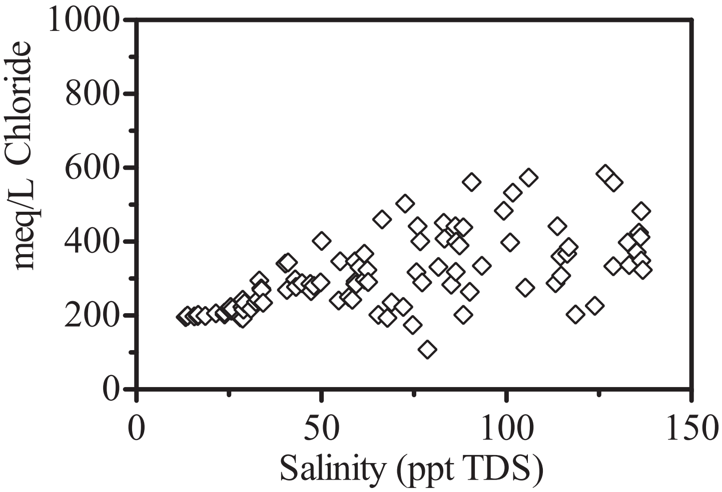
A correlation that can be described <u>numerically</u>. A teaspoon and a swimming pool hold *quantitatively* different volumes of water.

QUALITATIVE (ADJ):

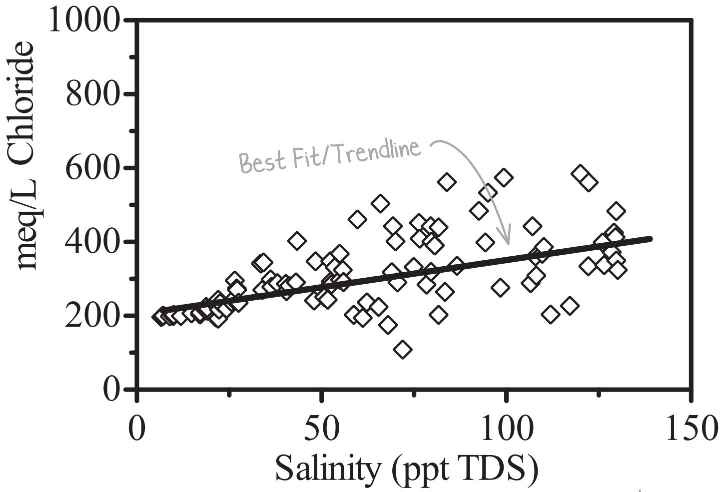
A correlation that is best described <u>non-numerically</u>. The pool with the waterslide is *qualitatively* different than the lap pool.

Scatter Plots are used to show how data correlate. Each point is one measurement.

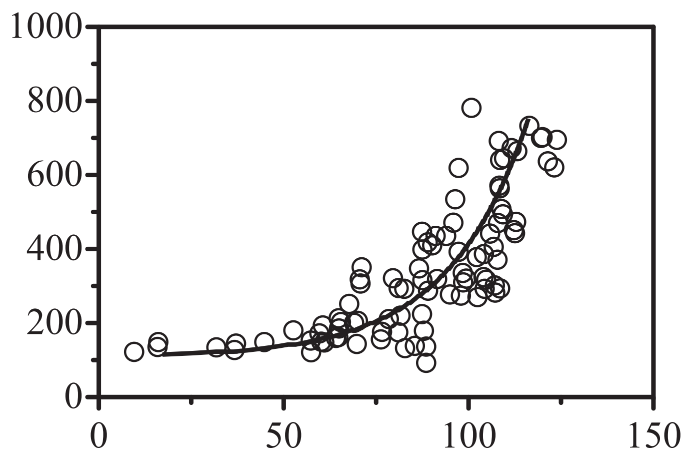
The pattern of points indicates <u>quantitative</u> and <u>qualitative</u> correlations



CONCLUSION #1: The correlation between salinity and meq/L chloride is <u>quantitatively more variable at higher salinity</u>.



CONCLUSION #2: The correlation between salinity and meq/L chloride appears <u>qualitatively linear</u>.



CONCLUSION: The correlation shown here appears <u>qualitatively exponential</u>.

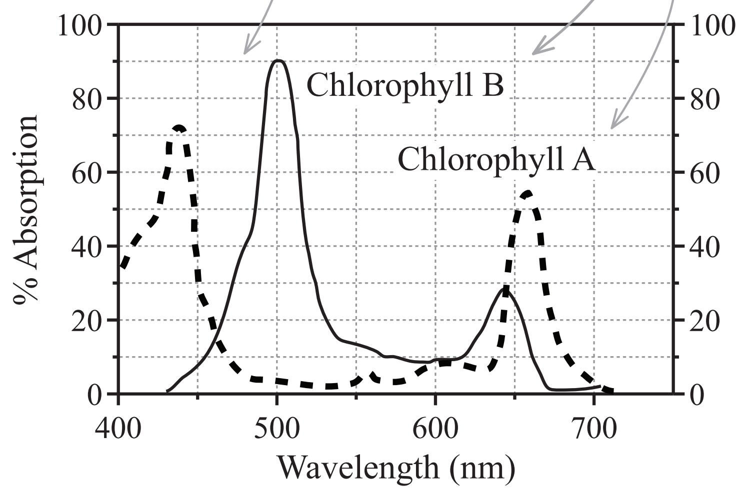
Graph Variations

Variations occur in all types of graphs

- Many graphs present multiple datasets in one plot.
- Only rarely on the ACT will you find graphs with dual y-axes. Learn how to catch them, and how to read them!

Gridlines help you estimate values

Keys may be absent; data may be labeled within a plot.

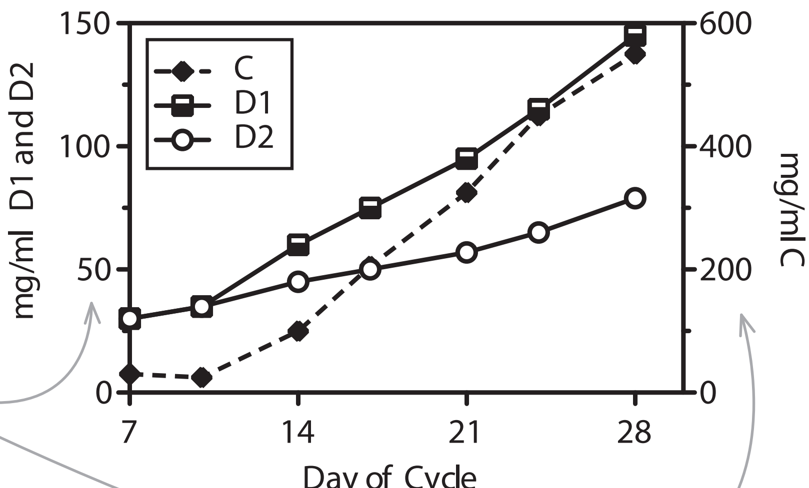


Plotting multiple data on a single graph can help you make comparisions.

What comparision can you make from this graph?

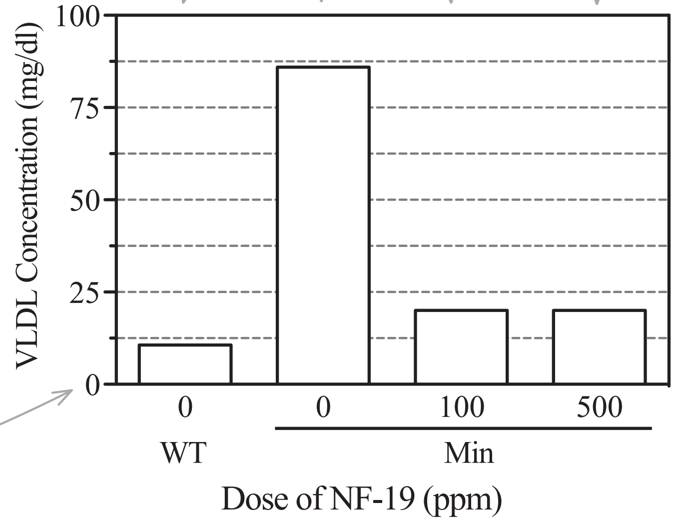
WATCH OUT FOR DUAL Y-AXES!
In graph above, the right y-axis is harmless; it's just there to help.

In the graph to the right, the right y-axis plots values of C, while the left axis plots the other values



Bar Charts

BAR CHARTS:
Bar charts are a great tool for highlighting specific values, rather than trends.



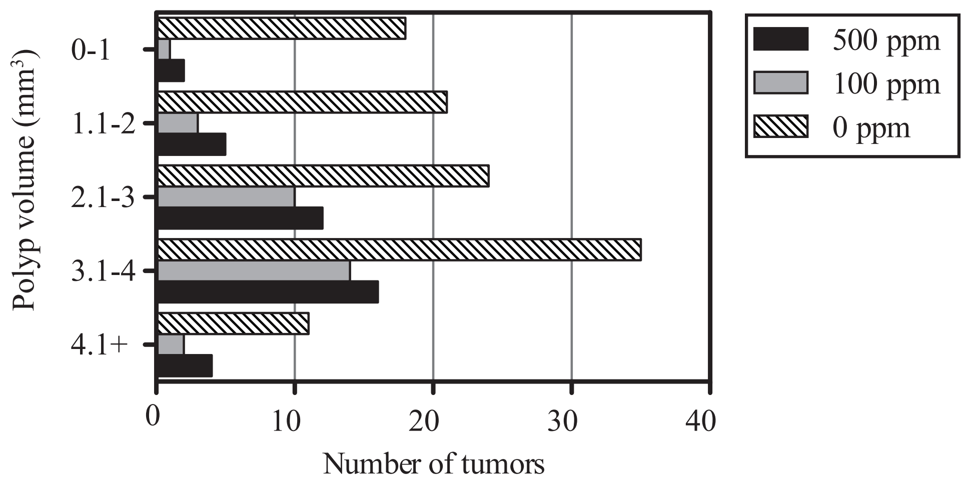
WORK SYSTEMATICALLY:
Begin by reading the chart left to right or top to bottom. This will help you make sure you don't miss any important details or relationships between variables.

GRID LINES:
Remember that the gridlines are there to help you read and interpret the chart.

THE Y-AXIS on this bar chart begins at zero, but be careful because bar charts often leave out part of the axis so they can focus more narrowly on relevant portion.

GROUPED DATA ON BAR CHARTS:
Remember to look at the trends among groups within an experiment.

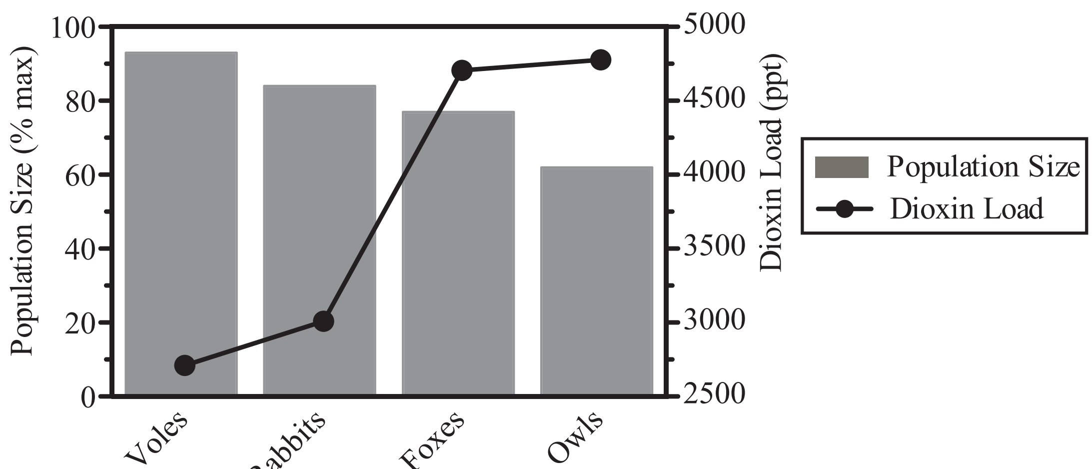
In the example to the right, the 0 ppm group had 18 tumors of 0 - 1 mm^3, while the 500ppm group had only 2 of this size.



COMBINATION GRAPHS:
These can be very useful, but they're definitely confusing at first glance.

Two datasets are plotted on separate y-axes, one on the left and one on the right.

Be sure to note which axis goes with which dataset!



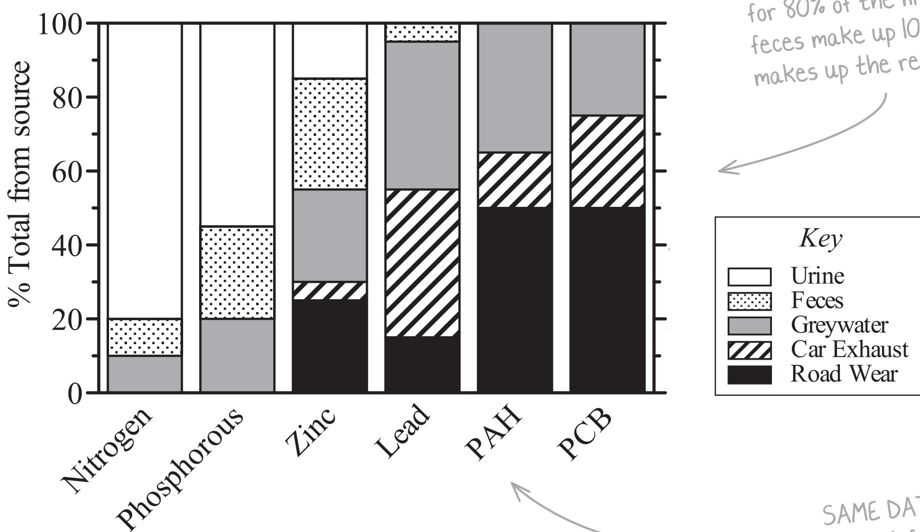
Stacked Bar and Pie Charts

Parts of a Whole

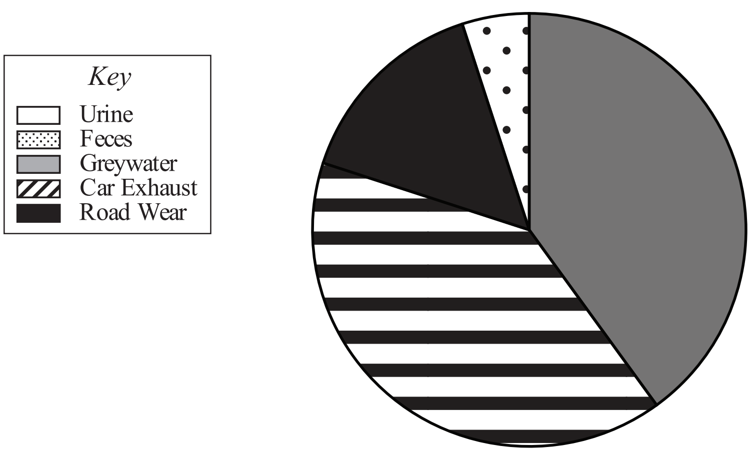
- Elements of Stacked Bar and Pie charts ALWAYS add to 100%

STACKED BARS:
Stacked bars show up all the time on the ACT, so make sure you know how to read them.

In this experiment, urine accounts for 80% of the nitrogen in the sample, feces make up 10%, and greywater makes up the remaining 10%.



SAME DATA, different format



HOT TIP!

Graphs are EVERYWHERE in the Science Reasoning Section

Take time to familiarize yourself with the different graph types, their variations and interpretation. READ THE AXIS LABELS AND KEYS.

Remember to mark up the graph: draw lines from the key to the data, or just write over the data itself. AFTER you familiarize yourself with the graph, use it to answer your problem.

Tables

THE TABLE TITLE:
These aren't always useful, but they're always worth reading!

INFORMATION ROW:
Every table will have a row or column (or both) with essential information.

Table 2					
Cup	Mass of water (g)	Mass of sodium hydroxide (g)	Initial temperature (°C)	Final temperature (°C)	q (J)
1	100	2	22	25	1200
2	100	4	22.5	28.5	
3	100	6	23	32	5400
4	100	8	23	35	
Example (Cup 1): q = 100g*(4 J/g°C)*3°C = 1200 J					

UNITS OF MEASUREMENT:
Watch out for answers that use the wrong units of measurement.

BONUS INFORMATION:
Some tables include extra info that you may find helpful, like this.

Table Strategies

- Note which values *do not change*. "Mass of water" and "Initial Temperature" don't vary (much). Feel free to cross out information that doesn't help you experiment.
- Look for patterns in the data. "Mass of sodium hydroxide" changes in an orderly way. It is probably the independent variable in this experiment. Both "Final temperature" and "q" seem directly related to it. Why?

QUALITATIVE DATA
can also be shown in tables. This format simplifies comparisons between elements of a dataset.

Solubility of Ionic Compounds				
	Ca^{2+}	Fe^{3+}	Ag^{+}	Pb^{2+}
F^-	Dark Grey	White	White	Dark Grey
Cl^-	White	White	Dark Grey	White
Br^-	White	White	Dark Grey	Light Grey
I^-	White	White	Dark Grey	Dark Grey
OH^-	Light Grey	White	Black	Dark Grey
SO_4^{2-}	Light Grey	White	Light Grey	Dark Grey
CO_3^{2-}	Dark Grey	Dark Grey	Dark Grey	Dark Grey

White : Soluble
Black : not determined
Light Grey : Slightly Soluble
Dark Grey : Insoluble

Table-Graph Conversions

HOT TIP!

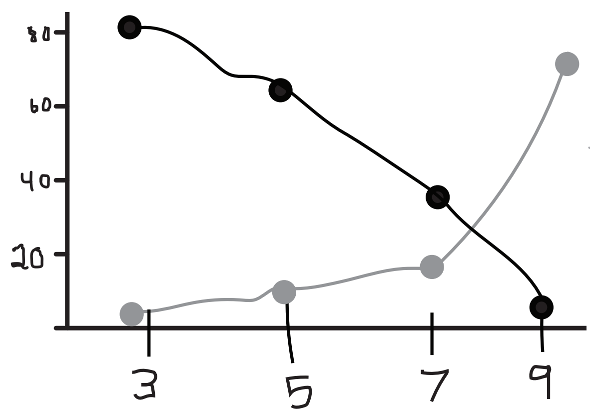
Simplify the table whenever you can.

Tables often contain excess information that isn't required for most problems. Look for the important information. Then consider making a quick graph to see relationships.

Table 1				
	Brightness (lumens)			
Filament Diameter	0.3 mm	0.5 mm	0.7 mm	0.9 mm
Trial 1	85	65	32	10
Trial 2	81	65	34	8
Trial 3	86	64	38	10
Trial 4	83	62	31	10
Trial 5	85	65	33	9
Average	**84**	**64**	**34**	**9**

Table 2				
	Time until breakage (seconds)			
Filament Diameter	0.3 mm	0.5 mm	0.7 mm	0.9 mm
Trial 1	2.5	8.2	15.1	45.5
Trial 2	2.8	8.6	17.9	94.1
Trial 3	0.2	7.9	14.0	78.0
Trial 4	3.0	7.8	18.2	107
Trial 5	2.6	8.0	15.2	58.8
Average	**2.2**	**8.1**	**16.1**	**76.6**

Sketching a rough graph lets you visualize relationships.



The graph makes it clear that the data from Table 1 are directly (i.e. linearly) related, while data from Table 2 are not.

Compare the tables: Looks like they have the same Filament Diameter and both also have an average row at the end.

DEFINITION

DIRECTLY (LINEARLY) RELATED (ADJ):

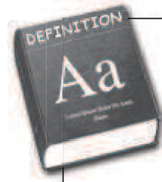
The value of y is a MULTIPLE OF x, basically. Put into algebra, it looks like $y=kx$, where k is any number. The slope can go up or down, but the plot is always a straight line.

INVERSELY RELATED (ADJ):

The value of y is some number DIVIDED BY x, basically. Algebraically, this means $y=k/x$, where k is any number. With inversely related data, y rises as x falls, and falls as it rises. The plot is never a straight line.

Extrapolate/Interpolate

These words are just math jargon. As far as the ACT is concerned, you just need to look for a trend in the data and figure out where your value would be.



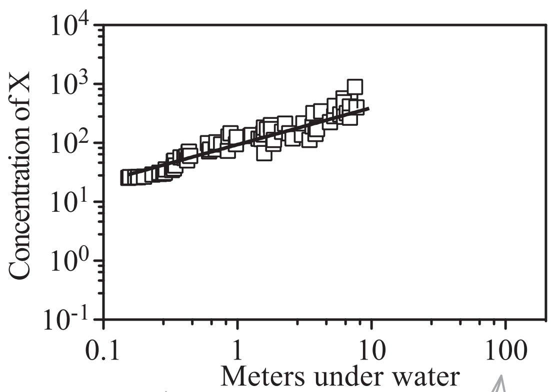
EXTRAPOLATE (V):

Infer an unknown value based on trends in data. When extrapolating, the unknown value lies beyond the data that you have.

INTERPOLATE (V):

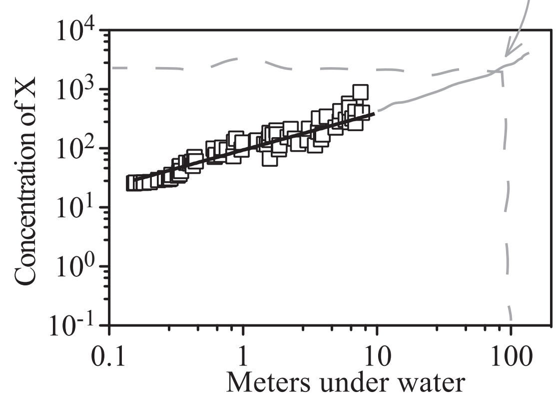
Infer an unknown value based on trends in the data. This is exactly like extrapolating, except that the unknown value lies within the range of data that you have.

EXTRAPOLATION:
Given this scatterplot, how could you estimate the concentration of X at 100 m under water?



The y-values are rising. Extend the line, then trace from 100 m up to the line and over to the y-axis.

The concentration of X is between 10^3 and 10^4. You just extrapolated!



These techniques work in tables as well. Can you estimate the solubility of sucrose at 82C?

Solubility (g per 100 ml water)				
Temp.	Sodium Chloride NaCl (g*)	Cerium (IV) Sulfate $Ce(SO_4)_2$ (g*)	Trisodium Phosphate Na_3PO_4 (g*)	Sucrose $C_{12}H_{22}O_{11}$ (g*)
0°C	36.0	21.4	1.50	182
20°C	35.8	9.84	8.80	202
60°C	35.9	3.87	20.9	289
100°C	36.0	0.013	77.0	476

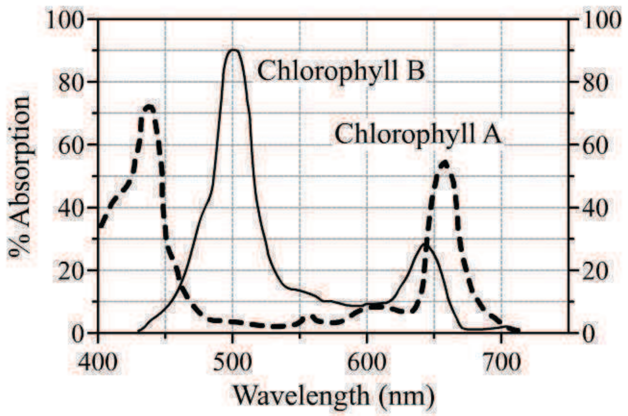
Sure! First look over the table to eliminate excess info. You can ignore columns 2-4 and focus instead on column 5, Sucrose.

Then look for the trend in temperature and sucrose.

Then make your estimate. That's all interpolation is, an estimate.

Plants use a variety of *pigments* to convert solar energy into chemical energy in the process of *photosynthesis*. These include chlorophyll a and three accessory pigments: chlorophyll b, carotene and xanthophyll. Each pigment absorbs specifc *wavelengths* of light, as shown in Figure 1. Wavelength is measured in nanometers (nm); visible light ranges from approximately 400 nm (violet) to 750 nm (red). Note that the observed green (550-625 nm) color of leaves is the result of low absorption of light at those wavelengths by photosynthetic pigments. Low absorption allows these wavelengths to be reflected, and thus be visible to our eyes.

Photosynthesis makes use of highly structured *Photosystems*. In Photosystem I, several hundred accessory pigment molecules surround a single chlorophyll a molecule in an *antenna complex*. The accessory pigments transfer the solar energy that they absorb to chlorophyll a, thereby capturing a broader range of solar energy than could chlorophyll a alone.



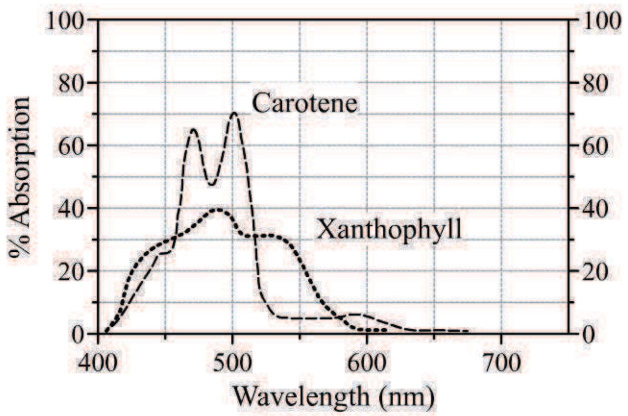


Figure 1

1. According to Figure 1, chlorophyll a absorbs light of which wavelength best?

A. 430 nm
B. 480 nm
C. 650 nm
D. 675 nm

2. According to Figure 1, which wavelength of light would be absorbed the LEAST in a leaf in which xanthophyll was the only pigment?

F. 425 nm
G. 465 nm
H. 500 nm
J. 675 nm

3. If a plant could be genetically engineered to produce fewer pigments, which of the following leaves would appear to be the most blue? (Assume that the wavelength of blue light is 450 nm.)

A. A leaf containing only chlorophyll a
B. A leaf containing only chlorophyll b
C. A leaf containing only xanthophyll
D. A leaf containing only carotene and chlorophyll a

4. Maple trees turn red-orange in the fall (i.e. absorption of 650 nm light decreases). Based on Figure 1, which hypothesis is most likely to be true?

F. Decreased sunlight causes the production of chlorophylls a and b to decrease.
G. Decreased temperatures cause the production of carotene to decrease.
H. Decreased sunlight causes the natural destruction of chlorophylls a and b to decrease.
J. Decreased temperatures and sunlight cause xanthophyll to shift its light absorption profile.

5. Some herbicides inhibit the production of photosynthetic pigments. Based on the description of Photosystem I, blocking the production of which pigment would be the most deleterious to a plant?

A. Carotene
B. Chlorophyll a
C. Chlorophyll b
D. Xanthophyll

SCIENCE: Weather Forecasting

Weather forecasting is conducted through measurement and analysis of atmospheric conditions such as temperature, air pressure, wind speed and direction, precipitation, and cloud patterns. Data is collected using instruments such as weather balloons, satellites, and radar, and then entered into super-computers which analyze the information in comparison to historical weather events. These supercomputers create numerical weather prediction models, or computerized simulations of the atmosphere.

A large number of computer modeling programs currently exist, and in predicting short-range weather patterns, they tend to produce very accurate, and therefore very similar, forecasts. However, when these programs attempt to make long-range forecasts, their predictions vary widely and are typically quite inaccurate.

Three scientists debate the cause of inaccuracies in long-term computer weather modeling.

Scientist 1
Computer models produce inaccurate long-range forecasts due to imprecise instruments. Although thermometers, barometers, and anemometers measure atmospheric conditions with a high degree of precision, there is always a degree of inaccuracy to the reported measurement. Long-range forecasting requires analysis of a huge amount of data gathered from over a large geographic area. The large volume of data, along with the attempt to project the analysis of data far into the future, compounds the significance of the inaccurate measurements, leading to inaccurate forecasts.

Scientist 2
The problem stems not from inaccurate data, but rather from incomplete data. It is impossible to measure atmospheric conditions at every individual point in the atmosphere, so weather models are constructed using data available from existing instruments, which are not necessarily representative of the atmosphere as a whole. This imperfection in the data leads to unreliability in long-range forecasting.

Scientist 3

The cause of inaccurate long-range weather forecasts is inadequate computing power. The magnitude of the data necessary to create accurate long-range weather predictions in unmanageable even to the world's fastest supercomputers. It would take today's computers approximately three days to analyze the amount of data necessary to create a reasonably accurate long-range forecast, and three days is an unacceptable timeframe. As technology improves and computers are able to analyze vast amounts of data more quickly, long-range weather modeling will improve in accuracy.

1. Which of the scientists would most likely agree that imperfect data is a primary cause of inaccuracies in long-range weather forecasting?

A. Scientist 1 only
B. Scientist 2 only
C. Scientists 1 and 2 only
D. Scientists 1, 2, and 3

2. According to Scientist 3, which of the following factors most directly contributes to the inaccuracy of long-range weather forecasts?

F. Changes in atmospheric conditions
G. Poorly calibrated instruments
H. Incomplete atmospheric data
J. Inadequate computing power

3. Which of the following generalizations about weather forecasts produced by computer models is most consistent with the information provided?

A. Short-range predictions are typically very accurate.
B. Short-range predictions are typically very inaccurate.
C. Long-range predictions are typically very accurate.
D. Long-range predictions are impossible to produce.

4. Which scientist would likely argue that an increased number of weather stations measuring atmospheric conditions would be likely to improve the accuracy of long-range weather forecasting?

F. Scientist 1 only
G. Scientist 2 only
H. Scientists 1 and 3 only
J. Scientists 2 and 3 only

5. Imagine that a computer model consistently produced accurate long-range weather forecasts but took so long to deliver the information that the forecasts were obsolete by the time they were made. This scenario would most strengthen the argument made by which scientist?

A. Scientist 1 only
B. Scientist 2 only
C. Scientist 3 only
D. Scientists 2 and 3 only

6. Computer models predicted that a blizzard would potentially strike a major city on a date seven days in the future. Instead, the city experienced only snow flurries. Which explanation is most consistent with Scientist 2's perspective?

- **F.** The available information was sufficiently accurate and complete.
- **G.** The available information was sufficiently accurate but incomplete.
- **H.** The available information was inaccurate but complete.
- **J.** The available information was inaccurate and incomplete.

7. Assume that technological advances lead to faster supercomputers and more precise meteorological instruments. Which scientists would most likely expect these advances to result in improved accuracy in long-range weather forecasting?

- **A.** Scientist 2 only
- **B.** Scientist 3 only
- **C.** Scientists 1 and 2 only
- **D.** Scientists 1 and 3 only