


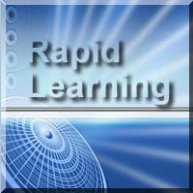
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 **Guide to ACT Science Reasoning**

ACT Rapid Learning Series

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Learning Objectives

By completing this tutorial, you will learn about:

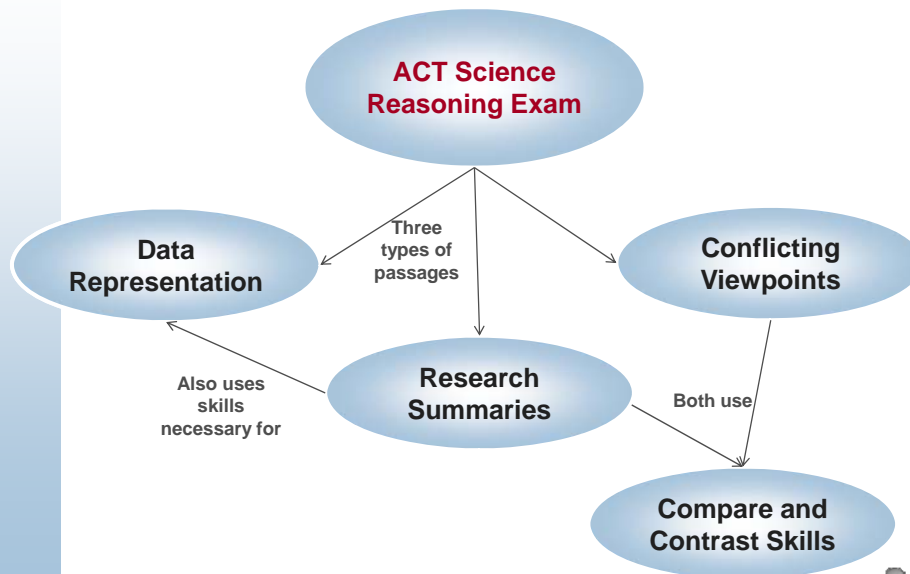


- The three types of passages on the ACT Science exam
 - Data representation
 - Research summaries
 - Conflicting viewpoints
- ACT Science exam tips

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Concept Map




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The ACT Science Exam




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Science Exam Format

- 35 minutes
- 40 questions
- Seven passages
 - Data Representation (2-3 passages)
 - Research Summaries (3-4 passages)
 - Conflicting Viewpoints (1 passage)
- No calculators



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No Calculators

- Simple arithmetic calculations Only - Don't look for any complex computation.
- Quantitative Estimation – Try to estimate not compute.
- Question Type – Focus on science reasoning ability, not numerical ability.

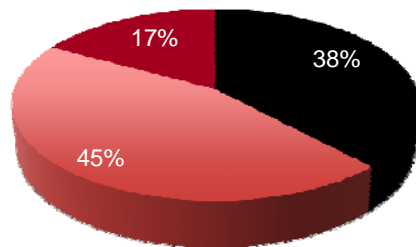


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Types of Passages

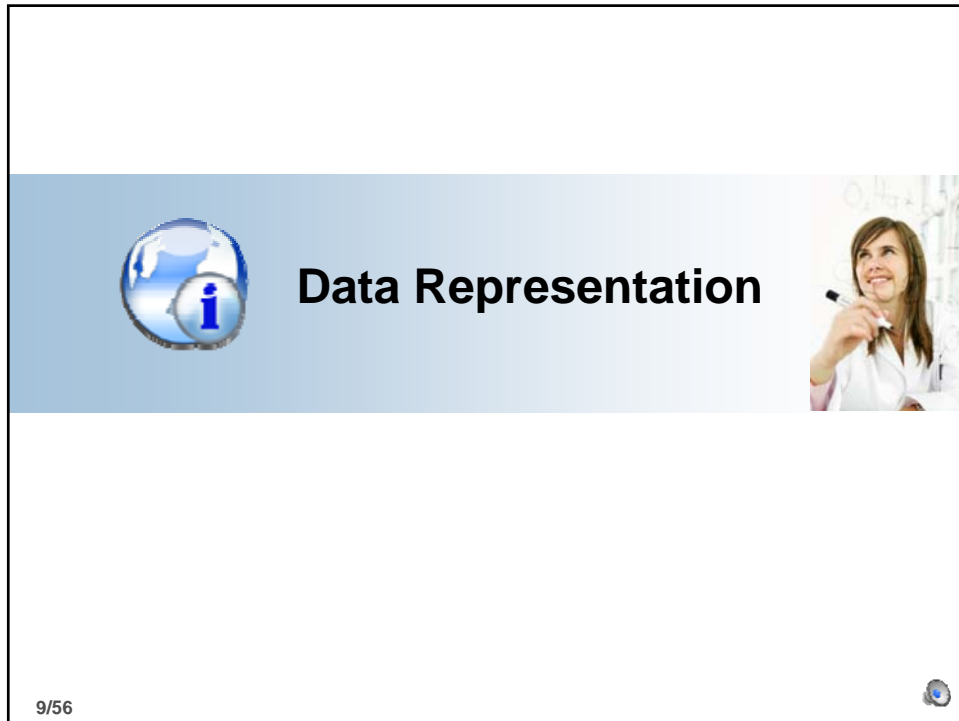
ACT Science Exam






- Data Representation
- Research Summaries
- Conflicting Viewpoints


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 **Data Representation** 


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 **What are Data Representation Passages?**



They present one or more **chart, table, diagram or figure.**

You will need to **interpret the information to answer 5-7 multiple choice questions.**

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Strategies for Data Representation

- Read the graphs and tables
- Identify the variables and units
- Understand the meanings and trends of the data
- Familiarize yourself with the common graph types



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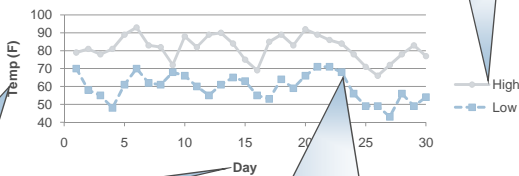
Examine the Data - Graph

1. Read the **intro**.

The graph below shows the observed high and low temperatures (°F) for September.

2. Read the **title**.

High and Low Temperatures for September 2010



3. Read the **legend**.

4. Read the **axis...including units!**

5. Get a general feel for the **data**.

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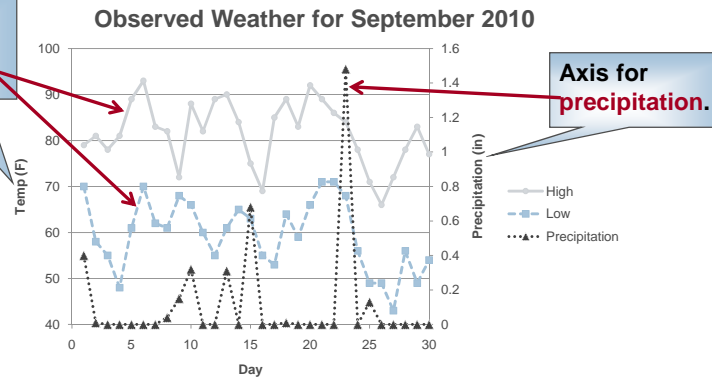




Complex Graphs

Some graphs are much more complex...even having **two different axes**.

Axis for high and low temperatures.



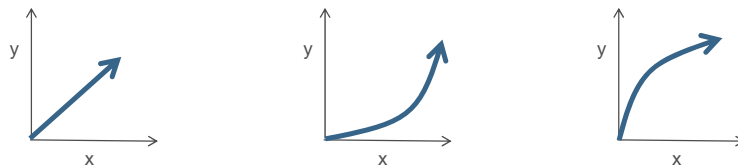
Use the **legend** and the **axis labels and units** to determine which lines go with which axis.

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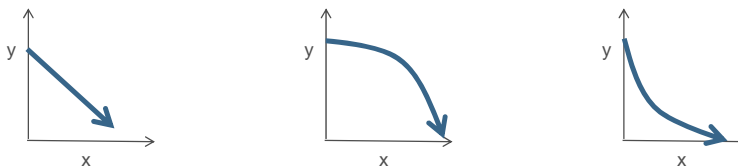


Graphing Common Relationships

Direct relationships: When "x" increases, so does "y"



Inverse relationships: When "x" increases, "y" decreases

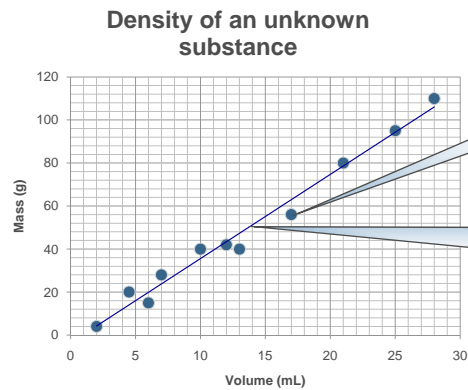


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Interpolation of a Graph - 1

Interpolation: Reading data from a trendline on a graph.



Actual **data point**.

Trendline drawn as a visual average of the data

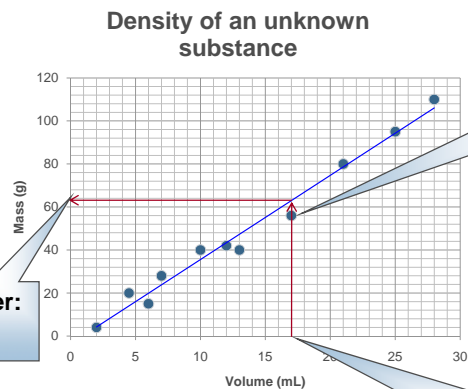
Always read the **trendline**...not actual data points!

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Interpolation of a Graph - 2

Example: What would be the expected mass of a 17 mL sample?



Don't use the actual **data point** even if there is one at 17 mL!

Answer:
64 g

Find 17 mL, go up until you hit the **trendline** and then over to find mass.

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Examine the Data - Tables

1. Read the introduction. A reaction produces a compound that absorbs light at 650 nm. The reaction was completed three times without a catalyst and absorption readings were taken every 30 seconds. The reaction was then completed three times with a catalyst present. Data is presented in the table below.

2. Read the title.

Absorption over time with and without presence of catalyst

Time (sec)	Without Catalyst			With Catalyst		
	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
0	0	0	0	0	0	0
30	0.1	0.1	0	0.3	0.2	0.3
60	0.1	0.2	0.1	0.6	0.5	0.4
90	0.2	0.2	0.1	0.8	0.6	0.7
120	0.3	0.3	0.2	0.9	0.8	0.8
150	0.3	0.4	0.2	0.9	0.8	0.9

3. Read the column headings.

4. Read the row headings.

5. Get a general feel for the data.

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Data Representation Question – 1a

A position-time graph displays an object's position (d) relative to its origin at a given time (t). The slope of the line, m , gives the object's velocity, v , as the object moves from one point (d_1) to another (d_2) during that time period ($t_2 - t_1$).

$$m = v = \frac{\text{rise}}{\text{run}} = \frac{d_2 - d_1}{t_2 - t_1}$$

The graph below is a position time graph for a dog running beside a fence.

Position-Time Graph

1. According to the graph, which of the following is true:

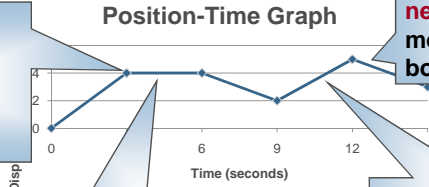
- The dog ran in one direction only.
- The dog stopped running briefly at $t = 3$, $t = 6$, $t = 9$ and $t = 12$.
- The dog ran faster between $t = 9$ and $t = 12$ than between $t = 0$ and $t = 3$.
- The dog stood still for 3 seconds.

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Data Representation Question – 1b

Data points at $t = 3, 6, 9$ and 12 don't mean the dog stopped running there.



Positive and negative slopes means the dog ran in both directions.

Position (y-axis) didn't change during this time...the dog stood still.

Slope is less steep between 9 and 12 seconds, so the dog ran slower then.

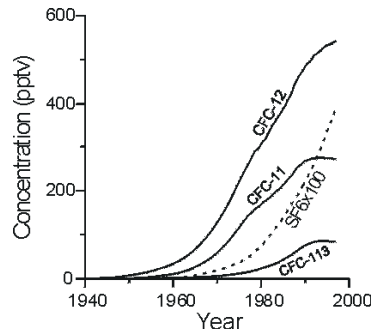
1. According to the graph, which of the following is true:

- ~~a. The dog ran in one direction only.~~
- ~~b. The dog stopped running briefly at $t = 3, t = 6, t = 9$ and $t = 12$.~~
- ~~c. The dog ran faster between $t = 9$ and $t = 12$ than between $t = 0$ and $t = 3$.~~
- d. The dog stood still for 3 seconds.

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Data Representation Question – 2a



Atmospheric mixing ratios of CFC-11, CFC-12, CFC-113, and SF6 in North American air.

(From <http://water.usgs.gov/lab/chlorofluorocarbons/background/>)

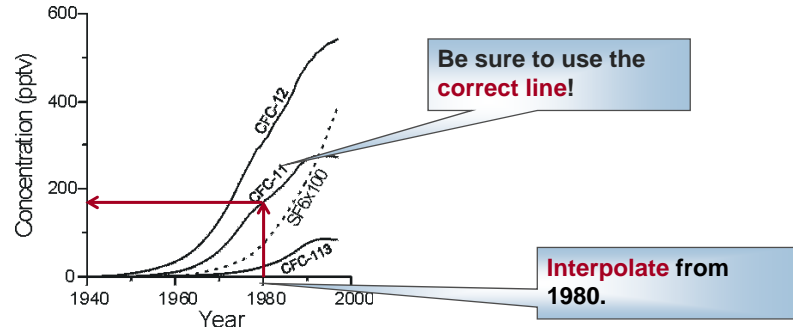
2. According to the graph, the concentration of CFC-11 in 1980 was approximately:

- a. 10 pptv
- b. 90 pptv
- c. 175 pptv
- d. 300 pptv

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Data Representation Question – 2b



2. According to the graph, the concentration of CFC-11 in 1980 was approximately:

- a. 10 pptv
- b. 90 pptv
- c. 175 pptv
- d. 300 pptv

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Research Summaries



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What are Research Summary Passages?

They describe **one or more related experiments or studies**.



You will need to **analyze or interpret** the information to answer 5-7 multiple choice questions.

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Strategies for Research Summaries

- Understand the design of the experiment
- Know the variables of the experiment
- Familiar with the scientific terms of research summaries
 - Observation – the facts observed during the experiment
 - Hypothesis – the proposed explanation for the observation
 - Experiment – systematic approach to conduct in testing an idea.



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Research Summary Skills

- Be able to **recognize** in a experiment or set of experiments:
 - Assumptions
 - Controls and variables
 - Similarities and differences
 - Strength and weaknesses



You'll also need to use **the data representation skills** presented earlier in this tutorial!

You must identify the controlling variables and dependent/independent variables involved in the experiments.

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Research Summary Passage - 1

- A student investigated the cold tolerance of *Drosophila melanogaster* (fruit fly). Fruit flies fall into a cold comma when chilled for a period of time. Cold tolerance can be determined by recording the time before the flies recover from the cold comma once returned to warmer temperatures.

Table 1

- **Experiment 1:** The student used fruit flies from varying latitudes of the same altitude. The flies were chilled for 3 hours at 20° C. After returning the flies to room temperature, the number of flies waking up each minute was recorded. Results are displayed in **Table 1**.

Time (min)	Latitude		
	40° N	20° N	Equator
10	1	0	0
11	3	0	0
12	5	0	0
13	4	2	0
14	2	3	0
15	1	5	1
16	1	5	1
17	0	2	3
18	0	0	5
19	0	0	4
20	0	0	3

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Research Summary Passage - 2

- **Experiment 2:** The student used fruit flies from varying altitudes at the same latitude. The flies were chilled for 3 hours at 20° C and the number of flies waking each minute after being returned to room temperature were recorded. Results are displayed in **Table 2**.

Table 2

Time (min)	Altitude		
	200 ft	500 ft	1000 ft
10	0	0	2
11	0	0	3
12	0	1	4
13	0	1	5
14	1	2	3
15	1	6	0
16	2	4	0
17	3	3	0
18	5	0	0
19	4	0	0
20	3	0	0

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Research Summary Question – 1a

- 3.** The difference between Experiment 1 and Experiment 2 is that
- a. Experiment 1 measured time to achieve cold comma while Experiment 2 measured recovery time.
 - b. Experiment 1 utilized flies from the same location while Experiment 2 varied origin location of flies.
 - c. Experiment 1 studied difference in latitude of fly origin while Experiment 2 studied difference in altitude of fly origin.
 - d. Experiment 2 was a repeat of Experiment 1 to confirm results.

Find **relevant** portion of the passage.

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Research Summary Question – 1b

- A student investigated the cold tolerance of *Drosophila melanogaster* (fruit fly). Fruit flies fall into a cold coma when chilled for a period of time. Cold tolerance can be determined by recording the time before the flies recover from the cold coma once returned to warmer temperatures.
- Experiment 1: The student used fruit flies from varying latitudes of the same altitude. The flies were chilled for 3 hours at 20° C. After returning the flies to room temperature, the number of flies waking up each minute was recorded. Results are displayed in **Table 1**.
- Experiment 2: The student used fruit flies from varying altitudes at the same latitude. The flies were chilled for 3 hours at 20° C and the number of flies waking each minute after being returned to room temperature were recorded. Results are displayed in **Table 2**.

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Research Summary Question – 1c

3. The difference between Experiment 1 and Experiment 2 is that
- a. Experiment 1 measured time to achieve cold coma while Experiment 2 measured recovery time.
 - b. Experiment 1 utilized flies from the same location while Experiment 2 varied origin location of flies.
 - c. Experiment 1 studied difference in latitude of fly origin while Experiment 2 studied difference in altitude of fly origin.
 - d. Experiment 2 was a repeat of Experiment 1 to confirm results.

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Research Summary Question – 2a

4. According to the results of Experiment 1:
- As altitude increases, recovery time increases.
 - As altitude increases, recovery time decreases.
 - As latitude increases, recovery time increases.
 - As latitude increases, recovery time decreases.

Be sure to look at the correct **set of data!**

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Research Summary Question – 2b

Experiment 1 is about **latitude!**

Table 1

Time (min)	Latitude		
	40° N	20° N	Equator
10	1	0	0
11	3	0	0
	5	0	0
13	4	2	0
14	2	3	0
15	1	5	1
16	1	5	1
17	0	2	3
18	0	0	5
19	0	0	4
20	0	0	3

As we move right to left on the table, time **decreases!**

This table has **latitude increasing from right to left.**

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Research Summary Question – 2c

4. According to the results of Experiment 1:
- a. As altitude increases, recovery time increases.
 - b. As altitude increases, recovery time decreases.
 - c. As latitude increases, recovery time increases.
 - d. As latitude increases, recovery time decreases.

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Conflicting Viewpoints



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What are Conflicting Viewpoints Passages?



They describe **alternate (opposing) theories, hypothesis or viewpoints.**

You will need to determine **strengths, weaknesses, similarities and differences.**

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Strategies for Conflicting Viewpoints

- Skim the passages and understand the main idea of the passage
- Identify and highlight the key points of disagreement. Also note the points agreed.
- Mark down the supporting data in the passage.
- Answer the questions – ALL of the them.



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Conflicting Viewpoint Passage - 1

- Two students observe a demonstration in class. The teacher places a burning piece of paper into a glass milk bottle. A peeled boiled egg is placed on the opening of the container (it is too big to slide into the opening). The flame goes out inside the bottle and after a short time, the egg slides down into the bottle. The students are then asked to explain what they observed.
- Student 1: The egg stops oxygen from being able to get into the bottle. Once all of the oxygen in the milk bottle was used up by the fire, the fire could no longer continue and stopped. There is now no oxygen inside the bottle and oxygen outside the bottle. The higher pressure on the outside of the bottle pushed the egg into the bottle.



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Conflicting Viewpoint Passage - 2

- Student 2: The fire heated the air inside the bottle before the egg was placed on top. The hot air expands and therefore some of the gas molecules leave the bottle. Once the egg is placed on top, the movement of gas molecules in and out of the bottle is stopped. The fire could not continue to burn after all of the oxygen had been used up in the bottle. When the fire went out, the gas molecules cooled. Therefore the pressure inside the bottle decreased. The pressure on the outside of the bottle was then higher than inside the bottle and it pushed the egg into the bottle.



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Conflicting Viewpoint Question – 1a

5. Student 1 and Student 2 disagree on which of the following points:

- a. The egg stopped gas molecules from entering or leaving the bottle.
- b. The fire stopped when all the oxygen inside the bottle had been used.
- c. The temperature changes were the cause of the pressure changes.
- d. The higher pressure on the outside of the bottle pushed the egg inside the bottle.

Look at the **similarities and differences!**

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Conflicting Viewpoint Question – 1b

■ **Student 1:** The egg

stops oxygen from being able to get into the bottle.

Once all of the oxygen in the milk bottle was used up by the fire, the fire could no longer continue and stopped. There is now no oxygen inside the bottle and oxygen outside the

bottle. The higher pressure on the outside of the bottle pushed the egg into the bottle.

■ **Student 2:** The fire heated the air inside the bottle before the egg was placed on top. The hot air expands and therefore some of the gas molecules leave the bottle. Once the egg

is placed on top, the movement of gas molecules in and out of the bottle is stopped. The fire

could not continue to burn after all of the oxygen had been used up in the bottle. When the fire went out, the gas molecules

cooled. Therefore the pressure inside the bottle decreased. The pressure on the outside of the bottle was then higher than inside the bottle and it pushed the egg into the bottle.

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Conflicting Viewpoint Question – 1c

5. Student 1 and Student 2 disagree on which of the following points:

- ~~a. The egg stopped gas molecules from entering or leaving the bottle.~~
- ~~b. The fire stopped when all the oxygen inside the bottle had been used.~~
- c. The temperature changes were the cause of the pressure changes.**
- ~~d. The higher pressure on the outside of the bottle pushed the egg inside the bottle.~~

Only Student 2 talked about **temperature**.

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Conflicting Viewpoint Question – 2a

6. Suppose a second demonstration was done. This time the flame was not placed inside the bottle, but the bottle was placed on top of a flame, the egg was placed on the bottle and then the flame was blown out. If the egg still slid into the bottle, this would support which student's explanation:

- a. Student 1.
- b. Student 2.
- c. Student 1 and Student 2.
- d. Neither Student 1 nor Student 2.

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 **Conflicting Viewpoint Question – 2b**


Student 1

- Egg was pushed in because oxygen was used up.
- Oxygen wouldn't be used up in this new experiment.

Student 2


- Egg was pushed in because temperature changes caused changes in pressure.
- Temperature changes are still occurring in this experiment.

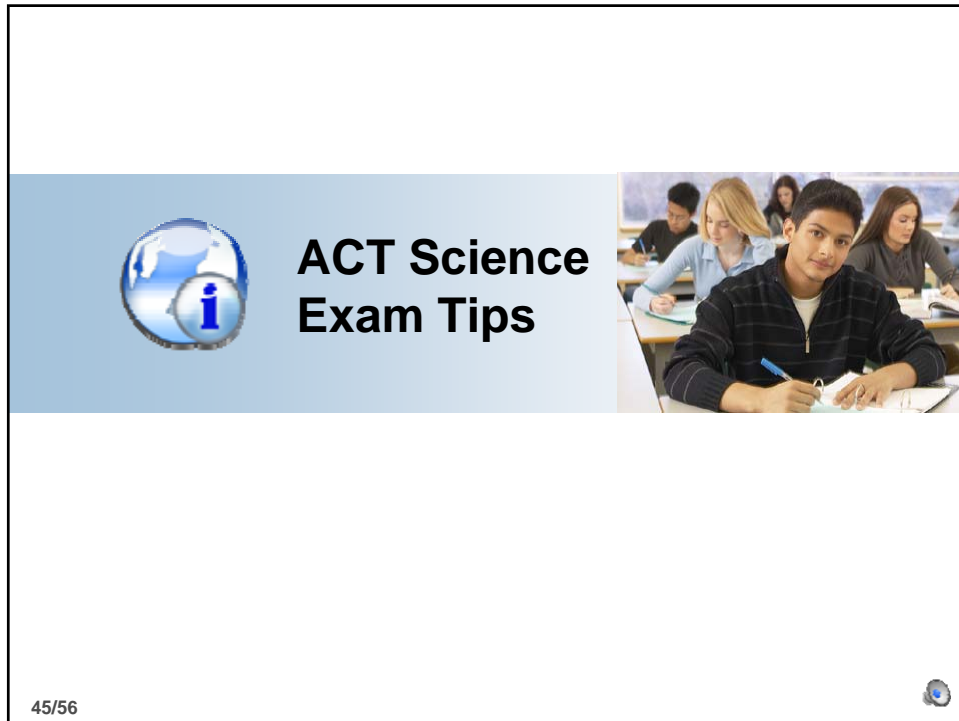
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 **Conflicting Viewpoint Question – 2c**



6. Suppose a second demonstration was done. This time the flame was not placed inside the bottle, but the bottle was placed on top of a flame, the egg was placed on the bottle and then the flame was blown out. If the egg still slid into the bottle, this would support which student's explanation:

- a. Student 1.
- b. Student 2.
- c. Student 1 and Student 2.
- d. Neither Student 1 nor Student 2.

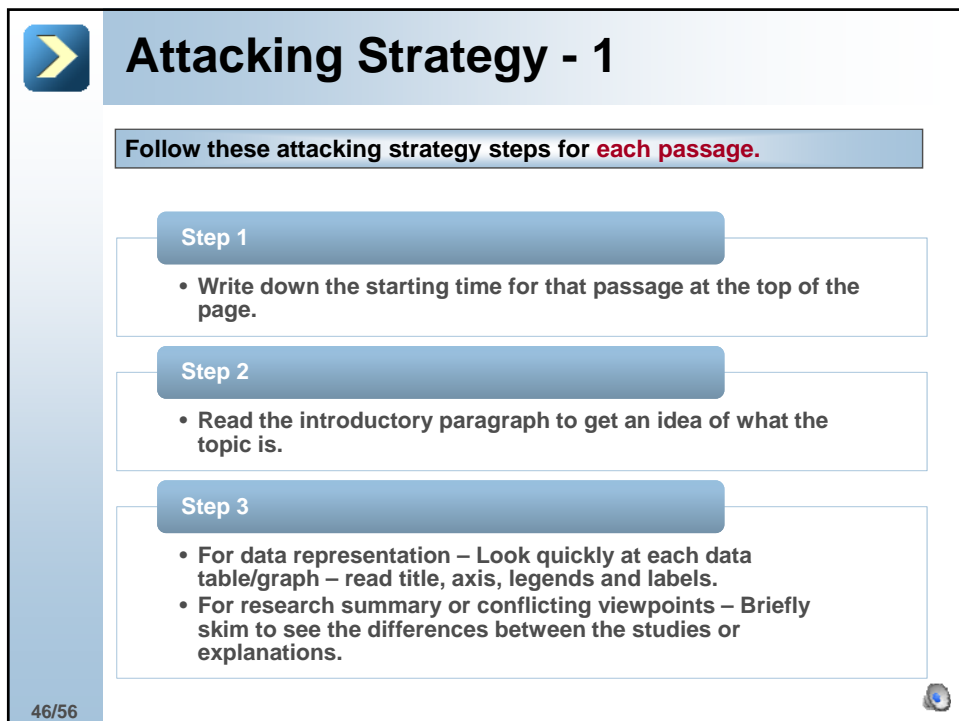
44/56 




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 **ACT Science Exam Tips** 

This slide features a light blue header with a globe icon containing a lowercase 'i' on the left and the text 'ACT Science Exam Tips' in bold black font. To the right is a photograph of several students sitting at desks in a classroom, with a young man in the foreground looking towards the camera. The slide number '45/56' is in the bottom left corner, and a small globe icon is in the bottom right corner.



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 **Attacking Strategy - 1**

Follow these attacking strategy steps for **each passage**.

Step 1

- Write down the starting time for that passage at the top of the page.

Step 2

- Read the introductory paragraph to get an idea of what the topic is.

Step 3

- For data representation – Look quickly at each data table/graph – read title, axis, legends and labels.
- For research summary or conflicting viewpoints – Briefly skim to see the differences between the studies or explanations.

This slide has a light blue background with a yellow arrow icon pointing right. The title 'Attacking Strategy - 1' is in bold black font. Below the title is a light blue box with the text 'Follow these attacking strategy steps for each passage.' in bold black font. Three steps are listed, each with a blue header box: 'Step 1' (Write down the starting time...), 'Step 2' (Read the introductory paragraph...), and 'Step 3' (For data representation... and For research summary...). The slide number '46/56' is in the bottom left corner, and a small globe icon is in the bottom right corner.



Attacking Strategy - 2

Step 4

- Read question #1 – the **WHOLE** question

Step 5

- Go to the graph, figure, data table or study that it discusses. Read and study it in more depth looking for information for question #1.

Step 6

- Read **EACH** of the answer choices.

Step 7

- Choose the best choice

Repeat steps 4-7 for **each question in that passage.**

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Attacking Strategy - 3

After 5 minutes,
MOVE ON!



There are **easier questions in each passage** – you don't want to get stuck on harder ones and not finish all the easier ones!

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Attacking Strategy - 4

Educational Guess – Since there is no penalty for wrong answers. If unsure, eliminate the obvious and guess using the multiple-choice techniques.



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Attacking Strategy - 5

Estimate not Calculate – Since there are no science passage type questions that require a complex calculation. Just estimate the numerical answer and pick the closest answer choice.



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Attacking Strategy - 6

Use the Passage – Don't count on your common sense outside of the passage. All answers must be based on the context of the passages. Pick your answer from the passage information provided.



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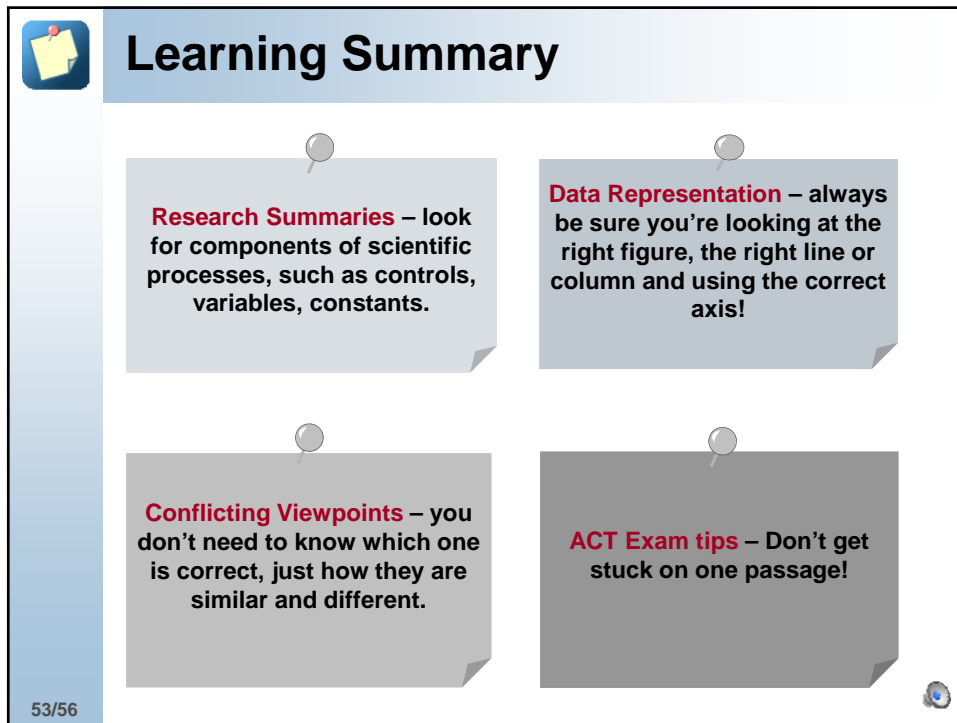
Attacking Strategy - 7

Know the Jargon – familiarize yourself with the common scientific terms and know the basic science vocabulary.



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Learning Summary

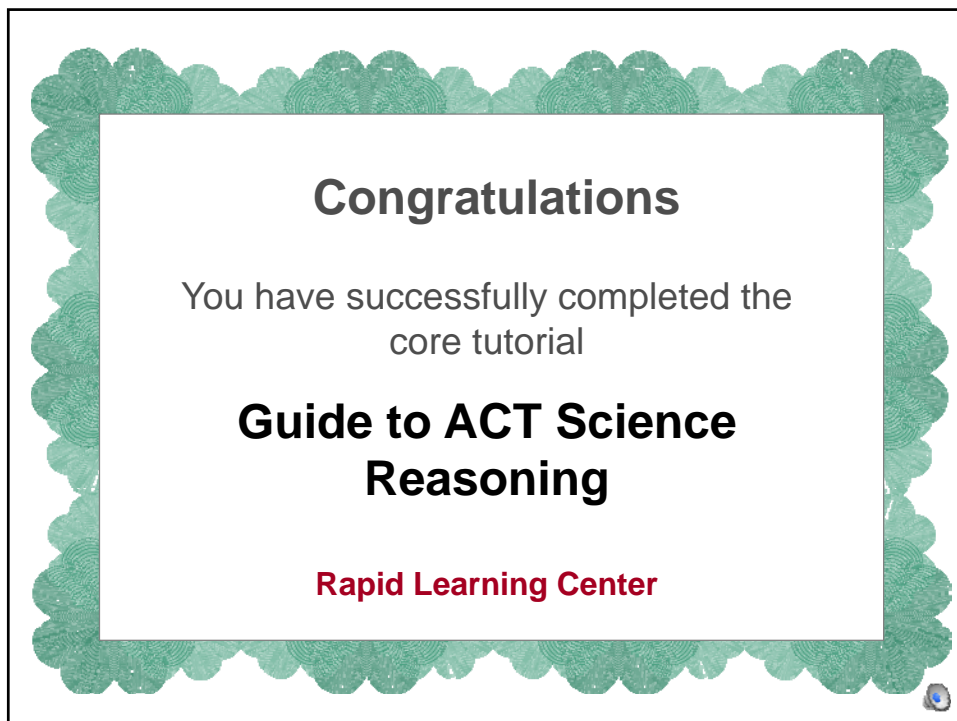
Research Summaries – look for components of scientific processes, such as controls, variables, constants.

Data Representation – always be sure you're looking at the right figure, the right line or column and using the correct axis!

Conflicting Viewpoints – you don't need to know which one is correct, just how they are similar and different.

ACT Exam tips – Don't get stuck on one passage!

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Congratulations

You have successfully completed the core tutorial

Guide to ACT Science Reasoning

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What's Next ...

Step 1: Concepts – Core Tutorial (Just Completed)

→ Step 2: Practice – Interactive Problem Drill

Step 3: Recap – Super Review Cheat Sheet

Go for it!



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