SCIENCE

# Lesson 2.15: Physical Science –Speed, Velocity & Acceleration

**Weekly Focus:** Reading for Comprehension
**Weekly Skill:** Numeracy Skills in Science

**Lesson Summary:** This week students will continue reading for comprehension with reading passages on speed, velocity, and acceleration. Then, students will use numeracy skills to work with formulas related to speed, velocity, and acceleration.

**Materials Needed:**

- Comprehension Reading and Groups Presentations: **Unit 2.15 Handout 1**
- Application of Numeracy Skills: **Unit 2.15 Handout 2**
- Extra Work/Homework: **Unit 2.15 Handout 3**

**Objectives:** Students will be able to…

- Gain a deeper understanding of motion, speed, velocity, and acceleration
- Understand numeracy skills with speed, velocity, and acceleration

**College and Career Readiness Standards:** RI, RST, WHST, SL

**ACES Skills Addressed:** EC, LS, ALS, CT, SM, N

**Notes:** Please review and be familiar with classroom routine notes for: reading for fluency strategies (**Routine 2**), summarizing techniques (**Routine 4**), and self-management skills (**Routine 1**). The notes will help with making a smooth transition to each activity.

## GED 2014 Science Test Overview – For Teachers and Students

The GED Science Test will be 90 minutes long and include approximately 34 questions with a total score value of 40. The questions will have focus on three content areas: life science (~40%), physical science (~40%), and Earth and space science (~20%). Students may be asked to read, analyze, understand, and extract information from a scientific reading, a news brief, a diagram, graph, table, or other material with scientific data and concepts or ideas.

The online test may consist of multiple choice, drop down menu, and fill-in-the-blank questions. There will also be a short answer portion (suggested 10 minutes) where students may have to summarize, find evidence (supporting details), and reason or make a conclusion from the information (data) presented.

The work students are doing in class will help them with the GED Science Test. They are also learning skills that will help in many other areas of their lives.

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# Lesson 2.15: Physical Science –Speed, Velocity & Acceleration

**Activities:**

| **Warm-Up: K-W-L Chart** | **Time: 5 - 10 minutes** |
|---|---|
| • As students enter the class, have the following written on the board or overhead **"What is the difference between speed and velocity?" is a concept in Physical Science. What does it mean to you?** Have students create a **"KWL"** chart on a piece of notebook paper (below). This helps to activate students' prior knowledge by asking them what they already **K**now (column 1); students (collaborating as a classroom unit or within small groups) set goals specifying what they **W**ant to learn (column 2); and after reading students discuss what they have **L**earned (column 3).<br>• Students apply higher-order thinking strategies which help them construct meaning from what they read and help them monitor their progress toward their goals. | |

**KWL Chart:**

| **K - What (else) do I KNOW?** | **W - What do I WANT to know?** | **L - What did I LEARN?** |
|---|---|---|
| | | |

| **Activity 1: Comprehension Reading & Group Presentations (Unit 2.15 Handout 1)** | **Time: 40 - 45 minutes** |
|---|---|
| **1)** Put students into 3 groups labeled A, B, C.<br>**2)** Distribute the appropriate reading **(Unit 2.15 Handout 1)** pages to each group (**A** = Motion 2 pages, **B** = Speed & Velocity 2 pages, **C** = Acceleration 2 pages, and the last 1 page to **all** students (note taking section)).<br>**3)** Ask each group of students to read their assigned sections silently and then summarize and share their findings within their group. Explain how they are reading to become experts of the material and after discussing it in their groups, they will then share their knowledge from their section with the other groups. The other groups will take notes on the information presented.<br>**4)** Tell students when they are done reading silently, they should turn their papers over and discuss and summarize what their section is about to others in their group. They should also discuss how they would like to present the materials to the other groups. Explain that the other groups will have to take notes, or summarize the information presented in order to understand it fully. Students should be reminded they need to present the information and not read from it directly.<br>**5)** After groups have read and discussed their section in groups, each group will present their section of the reading to the whole class. The other groups will take notes of the material presented on last page of **Unit 2.15 Handout 1**.<br>**6)** If there is extra time or to challenge students, they can write a 3 – 5 sentence summary of all of the material presented, use Routine 4: Summarizing Techniques Handout.<br>**7)** While students are reading and discussing, circulate to the groups and discuss with students that when reading for comprehension, there are many strategies to use: read the title to predict what the reading is about; look at the words in bold and their definitions within the context of the reading; while reading remember to ask "What is this all about?" | |

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|---|
| **8)** Remind students that they need to have a good foundational knowledge of speed, velocity, and acceleration in order to answer some questions that may be on the GED 2014 test. |

**Break: 10 minutes**

| Activity 2: Solving Speed, Velocity, and Acceleration Problems (Unit 2.15 Handout 2) | Time: 45 - 50 minutes |
|---|---|
| **1)** Distribute the handout **(Unit 2.15 Handout 2)** to students.<br>**2)** Explain to students that they will need to refer back to their notes from the first activity in order to answer questions and solve problems related to speed, velocity, and acceleration.<br>**3)** Ask students if they are familiar with using the correct "units" in their answers. (i.e.: miles – km – meters – seconds, etc.)<br>**4)** Work with the whole class on the first few problems to make sure students understand the previous activity's formulas and can use them with word problems. You may want to show the work on the whiteboard or overhead and even ask for volunteers to do the work. If students are "shy" to do the work, ask them to direct you on what to do.<br>**5)** After doing a few problems together, ask students to continue with the rest on their own.<br>**6)** Students may need to have calculators in order to do the work. If there are various math competencies in the class, ask students to work in pairs or table groups to help each other with the problems.<br>**7)** If there is extra time, students can present their answers to the whole class or you may want to review it with the class.<br>**8)** If some students finish early, ask them to write their own speed, velocity, or acceleration word problems on a separate sheet of paper. This can be used as a review with others or as extra work/homework. | |

| Wrap-Up: Summarize | Time: 5 minutes |
|---|---|
| Have students turn to a partner (or write in their journals) about what they have learned today about speed, velocity, and acceleration. Have students refer back to the K-W-L chart and fill in the "**L**" portion. They may want to discuss some of the areas that they would like to do further study on in the future. Their summary may include any wonderings they have about the subject. *Note: Use Routine 4 Handout* | |

| Extra Work/Homework: Unit 2.15 Handout 3 | Time: 20 minutes outside of class |
|---|---|
| Students can read and answer questions from the **Unit 2.15 handout 3** (3 pages total) It is a way to review concepts from earlier lessons (Unit 2.13 & 2.14 light & energy) | |

| Differentiated Instruction/ELL Accommodation Suggestions | Activity |
|---|---|
| If some student groups finish early, they can turn their paper over and summarize their section of the presentations. **(Unit 2.15 Handout 1)** | **Activity 1** |

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|---|---|
| There may be some new math ideas and concepts for students. Please make sure they are comfortable with the work requested of them. If needed, have students work in groups. (**Unit 2.15 Handout 2**) | **Activity 2** |

## Online Resources:

**Online Interactive Resources:**

If students have Internet connection, they should try to use the online virtual car: velocity and acceleration from PBS Learning Media:

http://www.pbslearningmedia.org/resource/phy03.sci.phys.mfw.accel/virtual-car-velocity-and-acceleration/

Students can also view other aspects of motion, velocity, and acceleration with relationship to NFL Football. This has a video that may help grasp the concepts in a different context.

http://www.nbclearn.com/nfl/cuecard/50770

## Suggested Teacher Readings:

- GED Testing Service – GED Science Item Sample (to get an idea of what the test *may* be like)

  http://www.gedtestingservice.com/itemsamplerscience/

- Assessment Guide for Educators: A guide to the 2014 assessment content from GED Testing Service:

  http://www.riaepdc.org/Documents/ALALBAASSESSMENT%20GUIDE%20CHAPTER%203.pdf

- Minnesota is getting ready for the 2014 GED test! – website with updated information on the professional development in Minnesota regarding the 2014 GED.

  http://abe.mpls.k12.mn.us/ged_2014_2

- ATLAS: ABE Teaching & Learning Advancement System: 2014 GED ® Classroom: Science: Minnesota's state-wide website for resources for the science module

  http://atlasabe.org/resources/ged/science

Unit 2.15 Handout 1 (7 total pages)

**GROUP A** (page 1 of 2) **Motion**

***Relative Motion****, Speed, Velocity and Acceleration*

**Background for all groups:**

Groups will present information about **relative motion**, speed, velocity, and acceleration. Take notes on the page provided about each area in order to gain a better understanding of each concept in physical science.

An object is in **motion** when it is continuously changing its position relative to a reference point and as observed by a person or detection device. For example, you can see that an automobile is moving with respect to the ground.

The distance the object goes in a period of time is its speed. If the speed of an object is in a specific direction, it is called velocity. The change in velocity over a period of time is the acceleration of the object.

Some questions you will need to answer at the end of the group presentations are:

- Why must motion be with respect to the observer?
- What is the difference between speed and velocity?
- Where is acceleration used?

This lesson will answer those questions.

**Motion**

All motion is relative to the observer or to some fixed object. Motion can be described as a measure of the distance an object moves in a certain length of time.

**Example with bus and car**

For example, when you see a bus drive by, it is moving with respect to you. However, if you are in a car that is moving in the same direction, the bus will be moving at a different velocity with respect to you.

If your car is moving in the same direction and same speed as the bus, the bus will appear to not move with respect to you. Of course, if you compare the speed with the ground, both of you will be moving at some velocity.

**GROUP A** (page 2 of 2) **Motion**

Suppose you saw a person walking to the front of the moving bus. The person would be moving faster than the bus from your viewpoint. However, the person would not notice the speed of the bus while he walks to the front.

**Point of reference**

In talking about motion, it is important to indicate your point of reference. In the case of moving automobiles, it is usually assumed the speed is with respect to the ground. But there are situations where the speed or velocity may be with respect to another object or an observer.

For example, suppose a car was traveling at 60 miles per hour (mph) and hit another car, but there was hardly a dent. The reason could be that the second car was traveling in the same direction at 59 mph, so the car was going only 1 mph with respect to the second car when it hit it.

**Sun looks like it is moving in the sky**

Another example of relative motion is how the sun appears to move across the sky, when the earth is actually spinning and causing that apparent motion.

Usually, we consider motion with respect to the ground or the Earth. Within the Universe there is no real fixed point. The basis for Einstein's *Theory of Relativity* is that all motion is relative to what you define as a fixed point.

**Notes:** ______________________________________________________________

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# Lesson 2.15: Physical Science –Speed, Velocity & Acceleration

**GROUP B** (page 1 of 2) **Speed and Velocity**

*Relative Motion**, Speed, Velocity** and Acceleration*

**Background for all groups:**

Groups will present information about relative motion, **speed, velocity**, and acceleration. Take notes on the page provided about each area in order to gain a better understanding of each concept in physical science.

An object is in motion when it is continuously changing its position relative to a reference point and as observed by a person or detection device. For example, you can see that an automobile is moving with respect to the ground.

The distance the object goes in a period of time is its **speed.** If the speed of an object is in a specific direction, it is called **velocity**. The change in velocity over a period of time is the acceleration of the object.

Some questions you will need to answer at the end of the group presentations are:

- Why must motion be with respect to the observer?
- What is the difference between **speed and velocity**?
- Where is acceleration used?

This lesson will answer those questions.

**Speed and Velocity**

**Speed** is how fast an object is going with respect to an object. **Velocity** is a measure of the speed *in a given direction*. An object's velocity can be constant or changing. An object might move without changing its speed or its direction. That object's velocity is constant. Velocity changes when an object changes speed, or direction, or both. You can say the top speed of an airplane is 300 kilometers per hour (kph). But its velocity is 300 kph in a northeast direction.

We distinguish between speed and velocity because if you add the speeds of objects, their directions are important. For example, the velocity of an airplane with respect to the ground would vary according to the direction of the wind.

**GROUP B** (page 2 of 2)

## Speed and Velocity

**Measurement**

To measure speed you use units of length and time. These are measure such as kilometers per hour (km/h) or miles per hour (mi/h). The speed of a moving object may changes. Think of a jogger out on a morning run. The jogger's speed changes during his run. He runs faster on a level or flat path than he does when he runs uphill. He runs fastest downhill. When he stops, time continues to pass, but he is not moving. His speed is zero.

Average speed is the total distance traveled dived by the total time it takes to go that distance. You can use a formula to figure average speed. You probably have used the formula in the past. For GED Science 2014 purposes, the formula to remember is:

**Speed = distance ÷ time**

For example, if a car went 120 miles in 2 hours, its average speed would be the distance of 120 miles divided by the time of 2 hours equaling 60 miles per hour (mph): 60 = 120 ÷ 2

You can use a variation of the formula to calculate time. (time = distance ÷ speed) If you travel from Milwaukee to Chicago (90 miles) at an average velocity of 60 mph, it would take you 90 mi. ÷ 60 mph = 1.5 hours to travel the distance.

A different way to use the formula is to calculate the distance, distance = time x speed. If you travel from Minneapolis to Chicago at 65 mph for 7 hours, you can calculate the distance traveled.
65 x 7 = 455

**Notes:** ____________________________________________

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**GROUP C** (page 1 of 2) **Acceleration**

*Relative Motion, Speed, Velocity and* ***Acceleration***

Groups will present information about relative motion, speed, velocity, and **acceleration**. Take notes on the page provided about each area in order to gain a better understanding of each concept in physical science.

An object is in motion when it is continuously changing its position relative to a reference point and as observed by a person or detection device. For example, you can see that an automobile is moving with respect to the ground.

The distance the object goes in a period of time is its speed. If the speed of an object is in a specific direction, it is called velocity. The change in velocity over a period of time is the **acceleration** of the object.

Some questions you will need to answer at the end of the group presentations are:

- Why must motion be with respect to the observer?
- What is the difference between speed and velocity?
- Where is **acceleration** used?

This lesson will answer those questions.

**Acceleration**

Acceleration happens when speed, or direction, or both change. Acceleration is the increase of velocity over a period of time, but it can also be a change in direction. Speeding up is acceleration and slowing down is deceleration. When you start running or jogging, you accelerate (increase your velocity) until you reach a constant speed. A small acceleration tells you that the velocity is changing slowly. A large acceleration tells you that the velocity is changing quickly.

**Measurement**

To measure acceleration, you use units of velocity (**v**) and time (**t**) in a formula. However, you have to know both the ending and beginning velocities for the formula. Suppose the velocity of a car increased from 50 km/h to 80 km h in 5 seconds as it gets on the highway. What is the average acceleration of the car?

**GROUP C** (page 2 of 2) **Acceleration**

First find the change in velocity. The change in velocity is the difference between the ending velocity ($v_2$) and the beginning velocity ($v_1$). Then divide this difference by the time (t) that had passed. Below is the formula for acceleration:

$$\mathbf{a = (v_2 - v_1)/(t)}$$

where :

- $\mathbf{v_2 - v_1}$ is the end velocity minus the beginning velocity
- **t** is the measured time period between the two velocities

**a** (acceleration) = (**$v_2$** (80 km/h) – **$v_1$** (50km.h) ) / (**t** (5 sec) ) or: 6 km per second = 30 ÷ 5

Often this formula is written as **a = Δv/Δt**, where **Δ** is the Greek letter "*delta*" and stands for *difference*.

Another example is if an object speeds up from a velocity of 240 meters/second to 560 meters/second in a time period of 10 seconds, the acceleration is:

$$\mathbf{a = (v_2 - v_1)/(t)}$$

**a** = (**$v_2$** = 560 - **$v_1$** = 240) / **t** 10 = 560 – 240 = 320 320 ÷ 10 = 32 m/s

**Notes:** ______________________________________________________________

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# Lesson 2.15: Physical Science –Speed, Velocity & Acceleration

**All Groups** (page 1 of 1) *Relative Motion, Speed, Velocity and Acceleration*

*Write notes from the group presentations from each area in the space below.*

**Motion:** ______________________________________________

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**Speed & Velocity:** ______________________________________________

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**Acceleration:** ______________________________________________

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**Summary**

Motion is change in position. All motion is relative to some fixed point or object. Speed is a measurement of that change in position over time. Velocity is speed in a given direction. Acceleration is the increase in speed or velocity over a period of time. Deceleration is the decrease of speed or velocity over time.

Information used with permission from: http://www.school-for-champions.com/science/motion.htm#.Uxt1215dCCc
by Ron Kurtus (revised 28 October 2007)

Unit 2.15 Handout 2 (4 pages total) **Problem Solving**

Solve the following problems. To solve each, write the equation that will be used. Work out the problem by replacing the words in the equation with the number values from the word problem. Finish by solving for the answer. Be sure to give answer with correct units.

**Average Speed**

Use the following equation to calculate speed, you may have to modify the equation to solve problems.

$$\text{Average Speed} = \frac{\text{Total Distance}}{\text{Total Time}}$$

**Examples:**

1. A plane travels 1000 miles in 5 hours. What is the plane's average speed?

Equation: Work: Answer:

***s=d/t*** ***s=1000 miles/ 5hours*** ***200 miles per hour***

2. A plane travels 550 miles/hour in 4 hours. How far did the plane travel?

Equation: Work: Answer:

**d=s x t** **d=550 miles/hour x 4 hours** **2200 miles**

3. A girl on a bicycle rides down a hill 500 meters long in 50 seconds. What is the girl's speed?

Equation: Work: Answer:

4. A car moving at a uniform speed travels 32 miles in 0.5 hours. What is the speed of the car? Express your answer in miles per hour.

Equation: Work: Answer:

5. If a marathon runner runs an average speed of 11 miles/hour for three hours. How far did the runner run in in the three hours?

Equation: Work: Answer:

**Velocity**

Velocity is the speed of an object in a particular direction. Velocity changes as speed or direction changes. Below calculate velocity. Be sure to include the final direction traveled.

**Example:**

6. A plane travels 500 miles east and lands in Arizona. Then the plane travels another 500 miles east and lands in California. The entire trip was completed in 5 hours. What is the average velocity of the plane?

| Equation: | Work: | Answer: |
|---|---|---|
| **velocity=distance/time** | **v=500mi +500mi** / **5** | **200 miles/hour east** |

7. A girl on a bicycle rides down a hill 600 meters. Then the girl rides up the hill 100 meters and falls off her bicycle. The entire bicycle trip lasted 50 seconds. What is the average velocity of the girl?

| Equation: | Work: | Answer: |
|---|---|---|

**Acceleration**

Use the following equation to calculate acceleration and <u>include a reference direction</u> (direction traveled).

$$\text{Acceleration} = \frac{\text{final velocity} - \text{starting velocity}}{\text{time it takes to change velocity}}$$

**Example:**

8. A runner accelerates from a velocity of 5 miles/hour east until reaching a velocity of 10 miles/hour east in 20 seconds. What was the runner's acceleration?

| Equation: | Work: | Answer: |
|---|---|---|
| **Use above equation.** | **a=10 mi/hr – 5 mi/hr** / **20s** | **.25 mi/hr/s east** |

9. A car traveling at 45 km/hr south passes another car accelerating to 60 km/hr south in 5 seconds. What was the car's acceleration?

Equation: Work: Answer:

10. At point A, a runner is jogging at 3 m/s. Forty seconds later; at point B, the jogger's velocity is only 1 m/s. What is the jogger's acceleration from point A to point B?

(note: jogger is decelerating)

Equation: Work: Answer:

Extra work:

11. Write your speed problem below and have a classmate solve it.

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________________________________________________________________________

12. Write your distance problem below and have a classmate solve it.

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Name ______________________ Date ____________

# Determining Speed and Velocity

**Speed** is a measure of how fast an object is moving. **Velocity** is a measure of how fast an object is traveling in a certain direction. An object can travel at a constant speed that does not change. However, if the direction in which it is traveling does, then its velocity has changed. To find the velocity of an object, use this formula.

$$\text{speed} = \frac{\text{distance}}{\text{time}} \qquad \text{velocity} = \frac{\text{distance}}{\text{time}} \text{ in a specific direction}$$

1. Find the velocity of a truck that travels 75 miles north in 2.5 hours.

   ____________ kilometers per hour

2. Find the speed of a bicyclist who took an hour and a half to travel 10 kilometers.

   ____________ kilometers per hour

3. Find the velocity of a plane that traveled 3,000 miles west in 5 hours.

   ____________ miles per hour

4. Find the velocity of a car that took 7.5 hours to travel 491.25 miles due south.

   ____________ miles per hour

5. Find the average speed of a train that traveled 543 kilometers in 6 hours.

   ____________ kilometers per hour

6. Find the velocity of a train that traveled 420 miles northeast to northwest between two cities in 3.5 hours.

   ____________ miles per hour

7. A plane flies due west for 4 1/2 hours. It travels a total of 5,400 kilometers. What was its velocity?

   ____________ kilometers per hour

8. A cork floats a distance of 8 3/4 miles downriver after a period of 3 hours 30 minutes. What was its average speed?

   ____________ miles per hour

Unit 2.15 Handout 2

## Teacher Answer Key

**Examples:**

1. A plane travels 1000 miles in 5 hours. What is the plane's average speed?

| Equation: | Work: | Answer: |
|---|---|---|
| ***s=d/t*** | ***s=1000 miles/ 5hours*** | ***200 miles per hour*** |

2. A plane travels 550 miles/hour in 4 hours. How far did the plane travel?

| Equation: | Work: | Answer: |
|---|---|---|
| **d=s x t** | **d=550 miles/hour x 4 hours** | **2200 miles** |

3. A girl on a bicycle rides down a hill 500 meters long in 50 seconds. What is the girl's speed?

| Equation: | Work: | Answer: |
|---|---|---|
| **s=d/t** | **s=500 meters/ 50 seconds** | **10 meters per second** |

4. A car moving at a uniform speed travels 32 miles in 0.5 hours. What is the speed of the car? Express your answer in miles per hour.

| Equation: | Work: | Answer: |
|---|---|---|
| **s=d/t** | **s=32 miles/ .5 seconds** | **16 miles per hour** |

5. If a marathon runner runs an average speed of 11 miles/hour for three hours. How far did the runner run in in the three hours?

| Equation: | Work: | Answer: |
|---|---|---|
| **d=s x t** | **d=11 miles/hour x 3 hours** | **33 miles** |

**Velocity**

Velocity is the speed of an object in a particular direction. Velocity changes as speed or direction changes. Below calculate velocity. Be sure to include the final direction traveled.

**Example:**

6. A plane travels 500 miles east and lands in Arizona. Then the plane travels another 500 miles east and lands in California. The entire trip was completed in 5 hours. What is the average velocity of the plane?

| Equation: | Work: | Answer: |
|---|---|---|
| **Velocity = distance/time** | **v=<u>500mi +500mi</u>** | **200 miles/hour east** |
| | **5** | |

7. A girl on a bicycle rides down a hill 600 meters. Then the girl rides up the hill 100 meters and falls off her bicycle. The entire bicycle trip lasted 50 seconds. What is the average velocity of the girl?

| Equation: | Work: | Answer: |
|---|---|---|
| **Velocity = distance/time** | **v=<u>600m-100m</u>** | **10 m/s down** |
| | **50 s** | |

**Acceleration**

Use the following equation to calculate acceleration and include a reference direction (direction traveled).

$$\text{Acceleration} = \frac{\text{final velocity} - \text{starting velocity}}{\text{time it takes to change velocity}}$$

**Example:**

8. A runner accelerates from a velocity of 5 miles/hour east until reaching a velocity of 10 miles/hour east in 20 seconds. What was the runner's acceleration?

| Equation: | Work: | Answer: |
|---|---|---|
| **Use above equation.** | **a=<u>10 mi/hr – 5 mi/hr</u>** | **.25 mi/hr/s east** |
| | **20s** | |

9. A car traveling at 45 km/hr south passes another car accelerating to 60 km/hr south in 5 seconds. What was the car's acceleration?

| Equation: | Work: | Answer: |
|---|---|---|
| **Use above equation.** | **a= <u>60km/hr – 45 km/hr</u>** | **3km/hr/s south** |
| | **5 s** | |

10. At point A, a runner is jogging at 3 m/s. Forty seconds later; at point B, the jogger's velocity is only 1 m/s. What is the jogger's acceleration from point A to point B?

(note: jogger is decelerating)

| Equation: | Work: | Answer: |
|---|---|---|
| **Use above equation.** | **a= <u>1m/s – 3 m/s</u>** | **-0.5 m/s/s** |
| | **40s** | **(any direction)** |

**The jogger is decelerating so the answer is negative.**

**Page 3**

1. 30 kilometers per hour
2. 6.67 kilometers per hour
3. 600 miles per hour
4. 65.5 miles per hour
5. 90.5 kilometers per hour
6. 120 miles per hour
7. 1200 kilometers per hour
8. 2.5 miles per hour

Unit 2.15 Handout 3 (3 pages total) Name: ___________________________________________

Name ______________________________

Daily Science
**Big Idea 6**
**WEEK 4**

**Day 3**

*Weekly Question*

## How do fireworks work?

The chemical pellets that produce the sparks of light and color in a firework are called *stars*. Metallic elements within the stars each emit a specific color of light as they burn, due to differences in their atomic structures. When a metallic element burns, its atoms absorb thermal energy, which temporarily moves the atoms' outer electrons up to a higher energy level. The electrons then return to their original energy level, releasing radiant energy as light in the process.

The amount of radiant energy emitted, which is unique to each element, determines the color of the light. Light is the only visible form of radiant energy on the **electromagnetic spectrum**. The colors of light include red, orange, yellow, green, blue, indigo, and violet. Energy increases from red to violet along the spectrum.

**Vocabulary**
**electromagnetic spectrum**
ee-LEK-troh-mag-NEH-tik SPEK-trum
*the complete range of radiant energy types, including microwaves, x-rays, and light*

**A.** The diagram below shows the colors of light. Four metallic elements are given in parentheses under the colors they emit. Use the diagram and information in the passage to answer the questions.

**Colors of Light**

**lower energy** ← red (strontium) | orange | yellow (sodium) | green (barium) | blue (copper) | indigo | violet → **higher energy**

**1.** Which metallic elements would you mix to create an orange firework?

_______________________________________________

**2.** Which metals would you mix to create a purple firework?

_______________________________________________

**3.** Which element, sodium or copper, releases a higher level of energy when it burns? ______________

**B.** Explain why different metals emit different colors of light.

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Lesson 2.15: Physical Science –Speed, Velocity & Acceleration

Name ______________________________

Daily Science Big Idea 6

WEEK 4

Day 4

*Weekly Question*

## How do fireworks work?

Firework stars produce not only light and color, but also heat and sound. In addition to metals, stars contain carbon and potassium perchlorate (per-KLOR-ayt). When the stars are ignited, the chemicals react with each other. The bonds between their atoms break apart, and the atoms rearrange to form new chemicals. Chemical energy in the stars is released as radiant energy in the form of colored light, as thermal energy in the form of heat, and as sound energy in the form of a **shock wave**.

Although it travels in waves like light, sound is not a form of radiant energy. Lightwaves are radiation that can move through empty space, whereas sound waves are vibrations that travel only through the molecules of matter—usually air. So sound energy is actually a form of mechanical energy. Just like an ocean wave, it is the sound wave that travels, not the molecules of matter. The molecules merely vibrate in place, stimulating the molecules next to them.

So the next time you hear the thunderous boom of fireworks exploding into a spectacular burst of lights and colors, remember that you are witnessing firsthand the transformation of energy.

**Vocabulary**

**shock wave**
SHAHK wayv
*a pulse of high pressure traveling through matter and caused by an explosion or an object moving faster than sound*

**A.** Write what is produced by each form of energy in a fireworks explosion.

**Radiant energy:** ____________ **Sound energy:** ____________

**Thermal energy:** ____________

**B.** Describe two differences between a lightwave and a sound wave.

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______________________________

Name ______________________________

Day 5

*Weekly Question*

# How do fireworks work?

Daily Science Big Idea 6

WEEK 4

**A.** Use the words in the box to complete the sentences.

| | | |
|---|---|---|
| cylindrical | spectrum | manifestations |
| mixture | shock wave | |

**1.** The ____________________ generated by a jet plane is heard as a sonic boom.

**2.** The visible portion of the electromagnetic ____________________ matches the order of the colors of the rainbow.

**3.** Sneezing and coughing are ____________________ of a cold.

**4.** A firework shell is launched from a ____________________ tube.

**5.** Air is a ____________________ of nitrogen, oxygen, water, carbon dioxide, and argon.

**B.** Answer the questions.

**1.** What type of energy does an unlit firework contain? ____________________

**2.** What type of energy is sound energy? ____________________

**C.** Summarize how fireworks demonstrate the transformation of energy.

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Unit 2.15 Handout 3

## Teacher Answer Key

**Page 1**

A. 1. strontium and sodium

2. strontium and copper

3. copper

B. *Answers may vary, suggested answer:* Due to differences in their atomic structures, each metal emits a different amount of radiant energy when it burns

**Page 2**

A. Radiant energy: colored light

Thermal energy: heat

Sound energy: shock wave

B. *Answers may vary, suggested answer:* A light wave moves through empty space and a sound wave moves only through matter. Light waves and electromagnetic radiation, and sound waves are vibrations

**Page 3**

A. 1. Shockwave 2. Spectrum 3. manifestations

4. cylindrical 5. mixture

B. 1. Chemical energy 2. Mechanical energy

C. *Answers may vary, suggested answer:* When a firework is lit, its chemical energy is transformed into thermal energy, which converts to mechanical energy to launch the firework. The chemical energy in the pellets then transforms into radiant energy as colored light, and sound energy in the form of a shock wave.