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?

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

Often this formula is written as $\mathbf{a = \Delta v/\Delta t}$, 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 = ($\mathbf{v_2}$ = 560 - $\mathbf{v_1}$ = 240) / **t** 10 = 560 – 240 = 320 320 ÷ 10 = 32 m/s

Notes: _____

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. 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 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=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.

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

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

Acceleration Worksheet

Acceleration is how fast an objects's velocity changes.

Average acceleration = $\frac{\text{change in velocity}}{\text{time}}$ $\quad a = \frac{V_{final} - V_{start}}{t}$

CALCULATE THE ACCELERATION FOR THE FOLLOWING QUESTIONS. BE SURE TO WRITE THE EQUATION EACH TIME AND PLUG IN THE NUMBERS AND UNITS IN THE CORRECT PLACES. ALSO SHOW THE ANSWER WITH CORRECT UNITS.

1. A car increases it's velocity from 0 m/s to 14 m/s in 2 seconds.

2. A bicycle rider increases his speed from 5 m/s to 15 m/s in 10 seconds.

3. A racing car's velocity is increased from 44 m/s to 66m/s in 11 seconds.

4.A train moving at a velocity of 15 m/s is accelerated to 24 m/s over a 12 second period.

5. A plane starting from rest is accelerated to its takeoff velocity of 75 m/s during a 5 second period.

6. A ball rolling down a hill for 9 seconds accelerates from 3 m/s to 34.5 m/s.

Acceleration Worksheet.

Name: _____

Date: _____

14.2 Acceleration

Acceleration is the rate of change in the speed of an object. To determine the rate of acceleration, you use the formula below. The units for acceleration are meters per second per second or m/s^2 or $m\ s^{-2}$

$$Acceleration = \frac{Final\ speed - Initial\ speed}{Time}$$

$$a = \frac{v-u}{t}$$

A positive value for acceleration shows speeding up, and negative value for acceleration shows slowing down. Slowing down is also called *deceleration.*

The acceleration formula can be rearranged to solve for other variables such as final speed (v) and time (t). NB: At rest or come to rest means zero speed.

$a = \frac{v-u}{t}$ *swap a and t* $\Rightarrow$ $t = \frac{v-u}{a}$

$v - u = at \Rightarrow v = u + at$ *or* $u = v - at$

EXAMPLES

1. A skater increases her velocity from 2.0 m/s to 10.0 m/s in 3.0 seconds. What is the skater's acceleration?

Looking for Acceleration of the skater	**Solution** $\text{Acceleration} = \frac{10.0\ m/s - 2.0\ m/s}{3\ s} = 2.7\ m/s^2$ The acceleration of the skater is 2.7 meters per second per second.
Given Beginning speed = 2.0 m/s Final speed = 10.0 m/s Change in time = 3 seconds	
Relationship $a = \frac{v-u}{t}$	

2. A car accelerates at a rate of $3.0\ m/s^2$. If its original speed is 8.0 m/s, how many seconds will it take the car to reach a final speed of 25.0 m/s?

Looking for The time to reach the final speed.	**Solution** $\text{Time} = \frac{25.0\ m/s - 8.0\ m/s}{3.0\ m/s^2} = 5.7\ s$ The time for the car to reach its final speed is 5.7 seconds.
Given Beginning speed = 8.0 m/s; Final speed = 25.0 m/s Acceleration = $3.0\ m/s^2$	
Relationship $a = \frac{v-u}{t}$	

Exercise (Calculating Acceleration) Name: _____

1. While traveling along a highway a driver slows from 24 m/s to 15 m/s in 12 seconds. What is the automobile's acceleration? (Remember that a negative value indicates a slowing down or deceleration.)

2. A parachute on a racing dragster opens and changes the speed of the car from 85 m/s to 45 m/s in a period of 4.5 seconds. What is the acceleration of the dragster?

3. The table below includes data for a ball rolling down a hill. Fill in the missing data values in the table and determine the acceleration of the rolling ball.

Time (seconds)	Speed (km/h)
0 (start)	0 (start)
2	3
	6
	9
8	
10	15

Acceleration = _____

4. A car traveling at a speed of 30.0 m/s encounters an emergency and comes to a complete stop. How much time will it take for the car to stop if it decelerates at -4.0 m/s^2?

5. If a car can go from 0 to 60 km/hr in 8.0 seconds, what would be its final speed after 5.0 seconds if its starting speed were 50 km/hr?

6. A cart rolling down an incline for 5.0 seconds has an acceleration of 4.0 m/s^2. If the cart has a beginning speed of 2.0 m/s, what is its final speed?

7. A helicopter's speed increases from 25 m/s to 60 m/s in 5 seconds. What is the acceleration of this helicopter?

8. As she climbs a hill, a cyclist slows down from 25 mi/hr to 6 mi/hr in 10 seconds. What is her deceleration?

9. A motorcycle traveling at 25 m/s accelerates at a rate of 7.0 m/s^2 for 6.0 seconds. What is the final speed of the motorcycle?

10. A car starting from rest accelerates at a rate of 8.0 m/s/s. What is its final speed at the end of 4.0 seconds?

11. After traveling for 6.0 seconds, a runner reaches a speed of 10 m/s. What is the runner's acceleration?

12. A cyclist accelerates at a rate of 7.0 m/s^2. How long will it take the cyclist to reach a speed of 18 m/s?

13. A skateboarder traveling at 7.0 meters per second rolls to a stop at the top of a ramp in 3.0 seconds. What is the skateboarder's acceleration?