Forces and Motion

Major Topic: Forces and Motion

Science SOL PS.1a,b,d,f,g,I,j,k,l,m PS.10a,b

Length of Unit: 10 one hour classes (with additional 2 classes for review and test)

Major Understandings

Students will understand that:

- motion can be described using the concepts of speed, position, velocity, and acceleration.
- equations and graphs can be used to describe, predict, and represent the motion of an object.
- the difference between a law and a theory.
- scientists work collaboratively.
- science is based on observations and data.
- systematic investigations require organized reporting and recording of data.
- systematic investigations require standard measures and reliable tools.
- analysis of data from investigations may provide a basis to reach a reliable conclusion.

Essential Questions

- How can you describe, predict, and represent motion?
- How can forces affect motion?
- How can you relate distance, time, and speed?
- How can you describe change in motion?

Student Objectives

- Student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations
- Student will investigate and understand speed, velocity, acceleration and Newton's Law of Motion

Bloom's Taxonomy Skills	**21st Century Learning Skills**
• Creating • Evaluating • Analyzing • Understanding • Remembering • Applying	• Critical Thinking • Problem Solving • Communication • Creativity & Innovation • Collaboration • Contextual Learning

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Assessment Evidence

Performance Tasks

Student will…..

- measure one-dimensional motion of an object using time and position
- calculate position, time, velocity, changes in velocity, mass, force, and momentum using equations
- graph the motion of an object using a position vs. time graph, a velocity vs. time graph, and an acceleration vs. time graph
- describe the motion of an object using a position vs. time graph, a velocity vs. time graph, and an acceleration vs. time graph
- predict the position, velocity or acceleration of an object given a motion graph

Other Evidence

- Discussion (written or oral)
- Class Participation
- Teacher Observations
- Laboratory assignments/reports
- Group Work
- Notebooks and Illustrations
- Rubric

Technology Computers Internet Connection, Projector System, Interactive White Board, Probeware: Motion Detector, Laptop, Calculators, Powerpoint Multimedia, Logger Lite, Internet, Web Browser, Discovery Education/ United Streaming

Internet Resources:

- Roller Coaster Video: http://www.youtube.com/watch?v=0WpNSImh6Z8the
- Classroom Portal: http://guest.portaportal.com/coolestscienceteacher (used with web hunt)
- Moving Man Simulation: http://phet.colorado.edu/en/simulation/moving-man
- Newton's Laws of Motion (videos and links): http://synergyscience.wordpress.com/2010/10/18/newtons-laws/
- Basics of Physics: Exploring the Law's of Motion: http://streaming.discoveryeducation.com/ (need paid account or find supplement)
- Crash Test Dummies Commercial: http://www.youtube.com/watch?v=yWgOtNMEQGM
- Crash Test Dummies Lab: http://www.vernier.com/experiments/msv/36/crash_dummies/

Supplies/Materials:

Lesson 1

- Laptop with internet and a projector
- Computer lab or laptop cart
- Copies of Physics Web Hunt
- Copies of Speed and Velocity problems
- Calculators

Lesson 2

- Computer Lab/ Laptop cart
- Copies of Moving man Worksheet
- Vernier Motion Detector
- Laptop with projector

Lesson 3

- Computer Lab/ Laptop cart
- Copies of Moving Man: Acceleration & Deceleration Worksheet
- Laptop with internet and projector
- Copies of Acceleration Problems
- Calculators

Lesson 4

- Tennis ball
- Golf ball
- Pie tins
- Quarter
- Index card
- Glass
- Balloon
- Laptop with internet and projector

Lesson 5

- Computer with internet and a projector
- Copies of Crash Dummies Lab
- Toy cars (two types)
- 6-12 inch action figures
- Cardboard (to use as a ramp)
- Meter sticks
- Timers
- Books for stacking
- Weights
- Calculators

Lesson 6

- Laptop with projector
- White boards
- Dry erase markers
- Copies of Forces and Motion Test
- Calculators

Lesson 1: Riding Roller Coasters (3- 60 minute classes)

Engage:

- Students will watch the first 1.5 minutes of the following clip of a roller coaster ride: http://www.youtube.com/watch?v=0WpNSImh6Z8 .
- Ask students what they think is the most exciting part of the roller coaster ride? Allow students a couple of minutes to share comments about the video and their experiences with roller coasters.
- Introduce the unit by discussing how the most enjoyable parts of a roller coaster ride rely on changes in forces and motion.

Explore:

- Students will work individually on laptops or in a computer lab to complete the Physical Science Web Hunt (attached) and will turn in it when finished.

Explain:

- Check over the web hunt with students.
- Students will volunteer to share their explanation for #3; why the horses on the outside travel faster than the ones on the inside. (They have to cover more distance in the same amount of time.)
- Ask students, based on the explanation, what two factors affect the speed of an object? (Distance and time)
- Students will be referring back to the web hunt throughout the unit.

Elaborate:

- Students will copy notes from a PowerPoint Presentation on speed and velocity (file name: Distance_Displacement_Speed_and_Velocity Notes.ppt).
- After the notes, students will be given a worksheet with speed and velocity problems (attached).

Evaluate:

- The teacher will work out questions 1-2 on the board or overhead.
- Students will work on problems 3-5 with their table partner.
- Students will then answer the remaining questions individually.

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Lesson 2: Moving Man (2-60 minute classes)

Engage:

- Students will answer speed and velocity practice problems on their science starter (attached).
- The teacher will circulate around the room as students are answering the questions.
- After all students have answered the questions, ask for volunteers to work the problems out on the board or document camera.
- Students will make corrections to their own work and ask questions if necessary.
- The teacher will then explain that now that students are comfortable with speed and velocity problems, today they will begin learning how graphs can also help to solve motion problems.

Explore:

- Students will work with partners on the introduction and first scenario of the *Moving Man* simulation worksheet (attached, including teacher directions).

Explain:

- Students will draw and explain graphs based on scenarios #2 and #3 on the *Moving Man* worksheet.

Elaborate:

- Students will answer questions 4-6 on their worksheet, creating their own scenarios and graph.
- Following the completion of the worksheet, students will try to match the graph on Logger Lite program using the Vernier motion detector and the suggestions of their classmates. To do this, plug in the Motion detector and launch Logger Lite. Click *Match the Graph* to get different motions to match.

Evaluate:

- Students will answer the *Moving Man* follow- up questions (attached) as a "ticket out of door" activity.

Lesson 3: Putting Things in Motion (2- 60 minute classes)

Engage:

- Students will complete Motion Graphs Warm-up (attached).
- Students will then review the first warm up question with their table partner before discussing answers & reasoning for last question (involving acceleration).

- Ask students the following questions to guide their thinking towards changing velocity.
  - Can a car go instantly from rest to 30 mph at a stoplight? Why or why not?
  - How does the speedometer change as the car goes from 0 to 30 mph?
- Explain that the Moving Man activity should help them understand the concept of acceleration and that we will come back to these questions at the end of the lesson. For now, they just need to know that acceleration means "speeding up" or "slowing down".

Explore:

- Students will work in pairs to complete the *Moving Ma*n: Acceleration and Deceleration worksheet (attached).

Explain:

- After everyone has finished, discuss what it means to accelerate from rest (speed up) or to decelerate when moving forward.
- Have students draw graphs of each of these situations in their notes.

Elaborate:

- Students will write in their notes the formula for acceleration.
- After the notes, students will be given a worksheet with acceleration problems and graphs (attached).

Evaluate:

- The teacher will work out questions 1-2 on the board or overhead.
- Students will work on problems 3-5 with their table partner.
- Students will then answer the remaining questions individually.

Lesson 4: The Laws (1-60 minute class)

Engage:

- The teacher will stand at the front of the room with a tennis ball in one hand and a golf ball in the other.
- Have students predict which will hit the ground first if they are both dropped from the ground at the same time.
- Drop the balls to see if their predictions are correct. If they believe that they hit the ground at the same time, place pie tins upside down on the ground and drop both balls onto the pie tins. Students should hear only one "bang" as the balls land at the same time.
- For the next demonstration, place a quarter on top of an index card which should be covering the mouth of a glass.

Lesson Contributed by: Melinda S. Wallace
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- Have students predict what will happen to the quarter.
- Quickly flick away the index card (The quarter should fall into the glass. ALWAYS practice before you perform it for students).
- For the third demonstration, blow up a balloon.
- Have students predict what will happen if you let go of the balloon.
- Let go of the balloon and let the students make observations.
- After completing the demonstrations, ask students what the demonstrations have to do with motion.
- Encourage them to revisit their Physics Web Hunt to review Newton's laws.

Explore:

- Students will watch videos on Newton's three laws of motion found on http://synergyscience.wordpress.com/2010/10/18/newtons-laws/ (You will need to scroll down to FMA Live: Newton's 1st, then FMA Live: Newton's 2nd and FMA Live: Newton's 3rd).
- Instruct students to write down a summary of each video in their notebooks.

Explain:

- Students will compare their summaries with their table mates and make changes, if necessary.

Elaborate:

- Students will watch Basics of Physics: Exploring the Law's of Motion (found at http://streaming.discoveryeducation.com/) while answering questions on their worksheet - The Basics of Physics: Exploring the Laws of Motion (attached).

Evaluate:

- Students will complete the worksheet identifying Newton's laws of Motion for homework (attached).

Lesson 5: Crash Test (2- 60 minute classes)

Engage:

- Students will watch a commercial for Incredible Crash Dummies toys: http://www.youtube.com/watch?v=yWgOtNMEQGM
- Ask students to jot down a brief description of the motion of the dummies in the car.
- Share their descriptions with their partners.
- Ask students, how do Newton's laws apply to the video?
- Let students brainstorm ideas and answers.

Explore:

- Introduce the Crash Test Dummies lab and show students the materials available.
- Pass out copies of the Guided Inquiry Rubric (attached) and read together as a class.
- Allow students ample time to ask questions.
- Students will work with a partner to complete the Crash Dummies Lab.

Explain:

- Students will plan and conduct an experiment while the teacher circulates around the room and ask questions to ensure that the students are on task and have clearly identified the variables.
- After collecting data, students will explain the relationship between the variables.

Elaborate:

- As a part of the conclusion and data analysis, students will predict possible outcome on future experiments based on their data.
- Students will also apply their findings to other situations in life.

Evaluate:

- Labs will be graded using the Guided Inquiry rubric.

Lesson 6: Putting It To The Test (2- 60 minute classes)

Engage:

- Students will begin class by writing five questions that could be used on a Forces and Motion test. Questions may be a mix of multiple choice, short answer, and fill in the blank.

Explore:

- Students will play Password (attached), vocabulary review game.

Explain:

- Students will be given time to ask questions about the format of the test and any last minutes clarifications.

Elaborate:

- Students will answer the questions written at the beginning of class on white boards with their table partners.

Evaluate:

- Students will complete a Forces and Motion Test (attached).

Physics Internet Scavenger Hunt (Lesson 1) Name ________________________

To begin your hunt for information, go to http://guest.portaportal.com/coolestscienceteacher. Click on the Physical Science tab, and then the Physics tab. All of the websites you need are located on this page. Once you are done, you can go back and explore any of the sites in greater detail! Enjoy!

Amusement Park Physics (Click on Park Physics Flashed)

1. What drives a roller coaster?

2. Create a roller coaster until you are able to create one in which you make it alive until the very end. Sketch and label your roller coaster below.

3. Which horses on a carousel are moving the fastest: the ones on the inside or the ones on the outside? Explain your choice.

4. Which Law of Motion explains what happens during a ride on the bumper cars? Give an example.

5. Where do riders have a feeling of "weightlessness" on a pendulum-type ride? At what point on the pendulum-type rides do riders feel the highest g-forces?

6. Explain the "weightless water" trick. Hint: Go to the Free Fall section.

7. Out of the 270 million people who visit amusement parks annually, how many require a trip to the emergency room?

Speed Machines

8. How long can the SR-71 operate (at top speed) before it needs refueling?

9. Who devised the unit of power called the horsepower?

10. What type of vehicle is the Spirit of America?__________What is its top speed? ____________

Newton's Laws of Motion Interactive

11. What does Newton's 1st law of motion state?

12. Give an example of Newton's 1st Law of Motion.

13. What word is used to describe Newton's 1st law

14. What does Newton's 2nd law of motion state?

15. What formula is used to show Newton's 2nd Law of Motion?

16. In Newton's 3rd Law, how many forces always act at once? Give an example of how this works.

17. Take the Quiz, How many questions did you get right? (Be honest!) ___________
What kind of worm were you? _________________________

Which of the websites did you find most interesting? Why?

List three things you learned about physics through this activity:

1.

2.

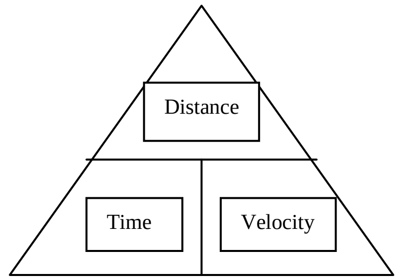
3.

Which website(s) do you want to further explore? Why?

Speed Worksheet (Lesson 1)

Name __________________________ Period _____

Use the following equations to answer the following speed questions.



Distance = Time X Velocity
Time = Distance/Velocity
Velocity = Distance/Time

1. If Steve throws the football 50 meters in 3 seconds, what is the average speed (velocity) of the football?

2. If it takes Ashley 3 seconds to run from the batters box to first base at an average speed (velocity) of 6.5 meters per second, what is the distance she covers in that time?

3. Bart ran 5000 meters from the cops and an average speed (velocity) of 6 meters/second before he got caught. How long did he run?

4. If Justin races his Chevy S-10 down Highway 37 for 2560 meters in 60 seconds, what is his average speed (velocity)?

5. Mike rides his motorcycle at an average speed (velocity) of 20 meters/second for 500 seconds, how far did he ride?

6. Sarah backstrokes at an average speed of 8 meters per second, how long will it take her to complete the race of 200 meters length?

7. Lauren's SUV was detected exceeding the posted speed limit of 60 kilometers per hour, how many kilometers per hour would she have been traveling over the limit if she had covered the a distance of 10 kilometers in 5 minutes?

8. Tina's calculations of the tarantula found that the spider was able to cover 20 centimeters in 5 seconds, what was the average speed of the spider?

DETERMINING SPEED (VELOCITY)

Name ____________________

(Lesson 1)

Speed is a measure of how fast an object is moving or traveling. Velocity is a measure of how fast an object is traveling in a certain direction. Both speed and velocity include the distance traveled compared to the amount of time taken to cover this distance.

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

Answer the following questions.

1. What is the velocity of a car that traveled a total of 75 kilometers north in 1.5 hours?

   ____

2. What is the velocity of a plane that traveled 3,000 miles from New York to California in 5.0 hours? ____________

3. John took 45 minutes to bicycle to his grandmother's house, a total of four kilometers. What was his velocity in km/hr? ____________

4. It took 3.5 hours for a train to travel the distance between two cities at a velocity of 120 miles/hr. How many miles lie between the two cities? ____________

5. How long would it take for a car to travel a distance of 200 kilometers if it is traveling at a velocity of 55 km/hr? ____________

6. A car is traveling at 100 km/hr. How many hours will it take to cover a distance of 750 km? ____________

7. A plane traveled for about 2.5 hours at a velocity of 1200 km/hr. What distance did it travel? ____________

8. A girl is pedaling her bicycle at a velocity of 0.10 km/min. How far will she travel in two hours? ____________

9. An ant carries food at a speed of 1 cm/s. How long will it take the ant to carry a cookie crumb from the kitchen table to the ant hill, a distance of 50 m? Express your answer in seconds, minutes and hours. ______________________________

10. The water in the Buffalo River flows at an average speed of 5 km/hr. If you and a friend decide to canoe down the river a distance of 16 kilometers, how many hours and minutes will it take? ______________________________

Speed and Velocity Practice Problems (Lesson 2)

1. What is the velocity of a car that traveled a total of 75 kilometers north in 1.5 hours?

2. A car is traveling at 100 km/hr. How many hours will it take to cover a distance of 750 km?

3. A plane traveled for about 2.5 hours at a speed of 1200 km/hr. What distance did it travel?

Student Directions for *Moving Man* Simulation Activity (Lesson 2)

Name____________________

http://www.colorado.edu/physics/phet

Play around with *Moving Man* by using the mouse to move him around. Use the playback features to look at and record the graphs. Once you think you have a basic understanding, of how it works, begin scenario #1.

Scenario #1: The man starts at the tree and moves toward the house with constant velocity	
Position - time graph	Explain your reasoning for the graph's appearance
Velocity - time graph	Explain your reasoning for the graph's appearance

For numbers 2 & 3, ***predict*** what you think the graphs will look like and give reasons for your prediction. After making your predictions, use the *Moving man* simulation to test their validity. Use a different colored pen to verify or correct your graphs and the reasons for the differences.

Scenario #2: The man stands still while he talks on his cell phone at the middle of the sidewalk, then walks toward the house at a constant rate trying to get better cell reception. He comes to a sudden stop when the coverage is good (about a meter before the house) and stands still to finish his conversation.	
Position - time graph	Explain your reasoning for the graph's appearance
Velocity - time graph	Explain your reasoning for the graph's appearance

Scenario #3: The man starts close to the house, stands still for a little while, then walks toward the tree at a constant rate for a while, then the slows to a stop.	
Position - time graph	Explain your reasoning for the graph's appearance
Velocity - time graph	Explain your reasoning for the graph's appearance

4. With your lab partner, write a motion scenario that you could test. Test it, and then write a description of how you used the program to generate the graphs. Sketch the graphs.

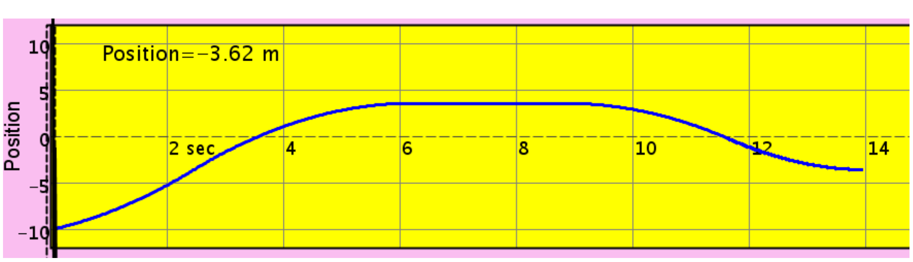
Position - time graph	Velocity - time graph

5. Without the assistance of *Moving Man,* sketch the position and velocity graphs for the following scenario:

A man wakes up from his nap under the tree and speeds up toward the house. He stops because he is worried that he dropped his keys. He stands still as he searches his pockets for his keys. Once he finds them, he continues calmly to walk toward the house and then slows to a stop as he nears the door.

Position - time graph	Velocity - time graph

6. Individually write a possible scenario for the following position- time graph. Then compare your scenario with your lab partners to check if it's reasonable.



Moving Man Teacher Instructions (Lesson 2)

1. Open the website http://guest.portaportal.com/coolestscienceteacher on a projector and have students log onto laptops and go to the same website.

2. Students will then click on Moving Man under the Physical Science tab. Once the simulation has started, have students click on the charts tab at the top. You should see the moving man in the middle of the screen with three graphs below.

3. While demonstrating on the projector, click on the red minus sign in the top- right corner of the bottom graph to close the acceleration graph so that just the position and velocity graphs are visible. Have the students do the same on their laptops. Circulate around the room to ensure that students have the correct view.

4. Place the pointer on the man to show students how to make the man move. Show them how to pause the recording, reposition the man, reset the graphs, and playback the recording.

5. After answering any questions, allow students necessary time to explore and to complete number one on their worksheet. Circulate around the room and help students to predict what the velocity- time graph should look like if the man was truly moving at a constant velocity.

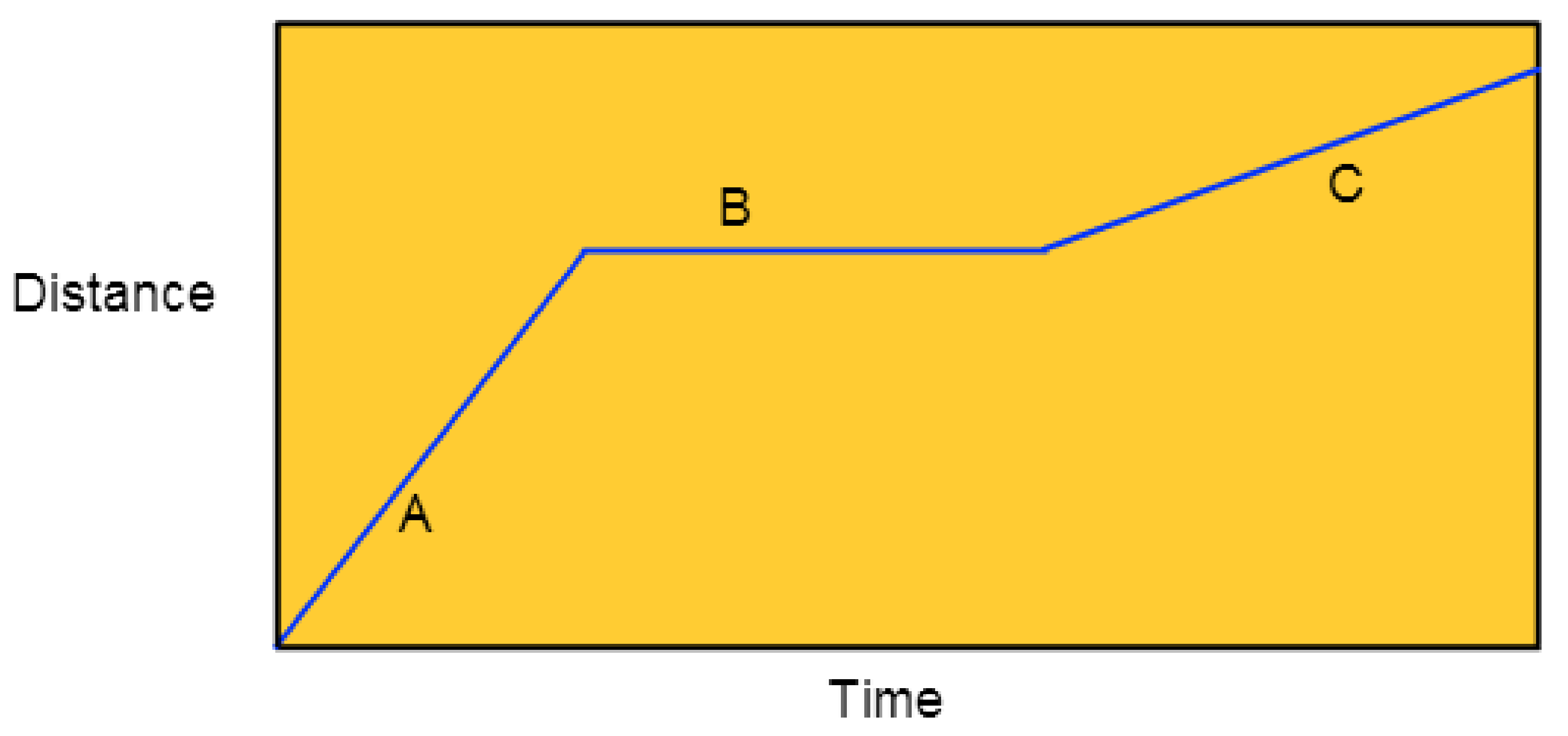
6. Remind students that for scenarios two and three on the worksheet, they need to draw graphs and give reasons for the appearance of the graph before test it using the simulation. You may need to reassure some students by telling them that will not lose points if their prediction does not match the actual graph.

7. After all students have finished the worksheet, plug the motion detector into the laptop with projector and open the Logger Lite software. Have students volunteer to try to match the graph on the computer screen based on what they learned on the Moving Man simulation. Allow “audience members” to make suggestions as to how the “moving students” should move (i.e. walk towards the screen, begin at the trash can, walk fast, etc.)

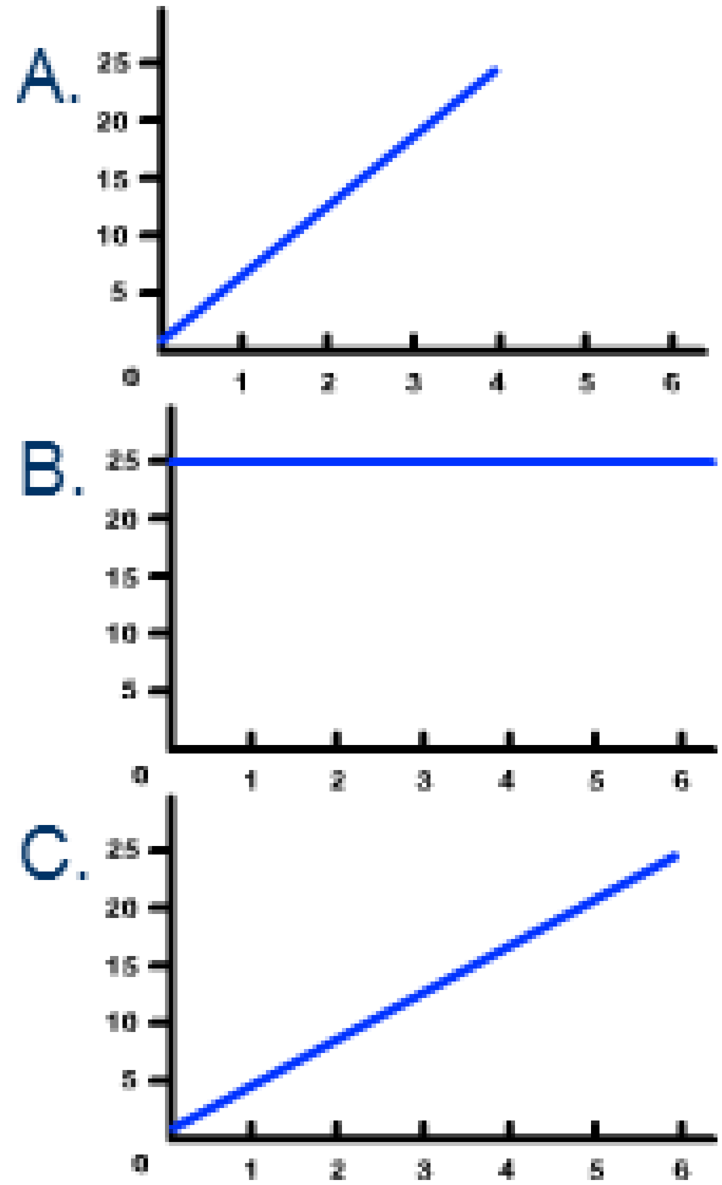
Moving Man follow-up questions (Lesson 2)

Answer the following questions on notebook paper.
You will turn them in as you leave.

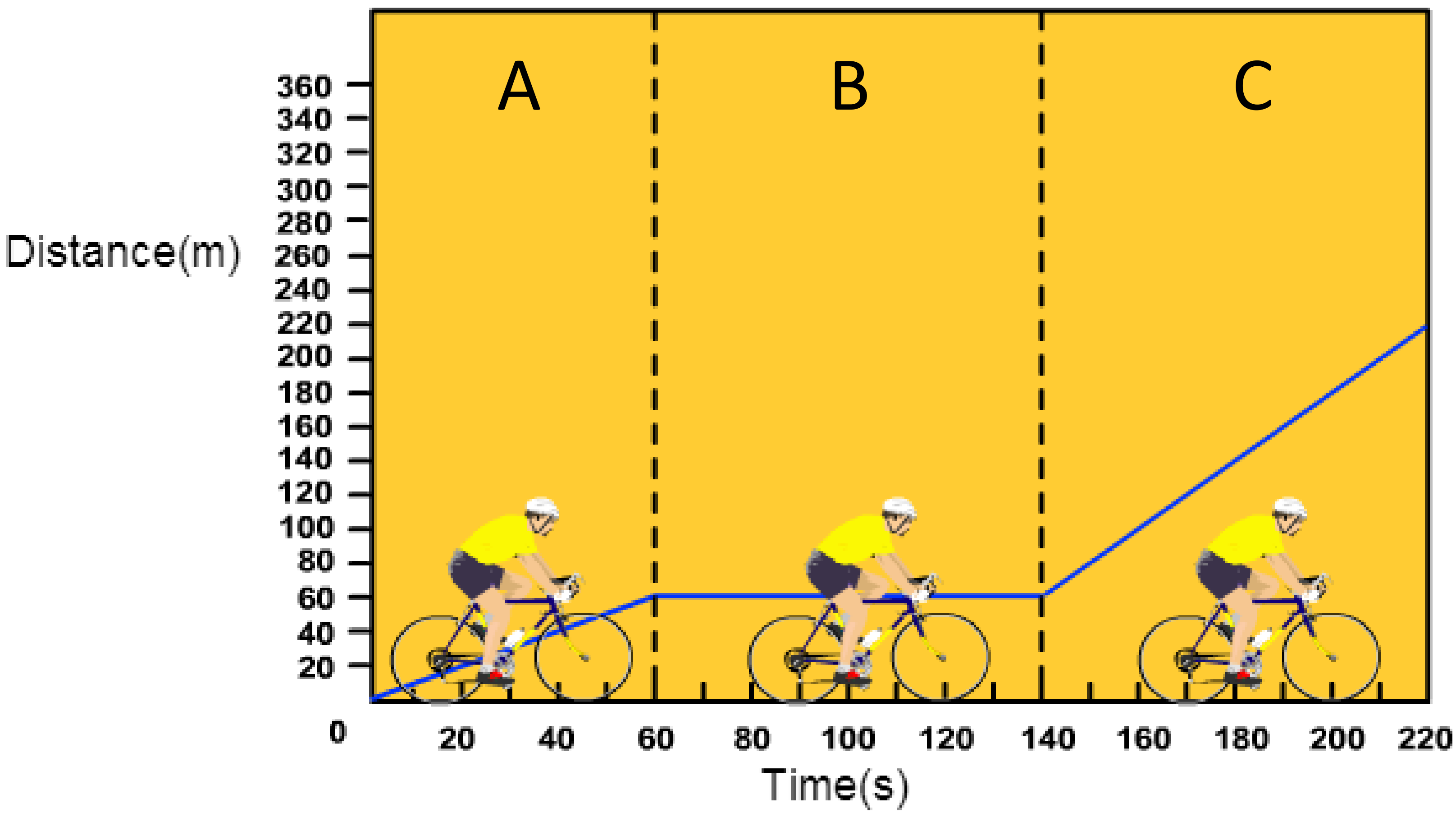
At which of the following three points is the object not moving?



Which of the following distance-time graphs shows the object moving with the fastest speed?



Write a scenario for the graph below, including explanations for the graph's appearance in each segment.



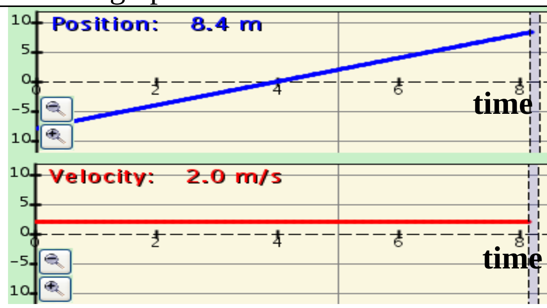
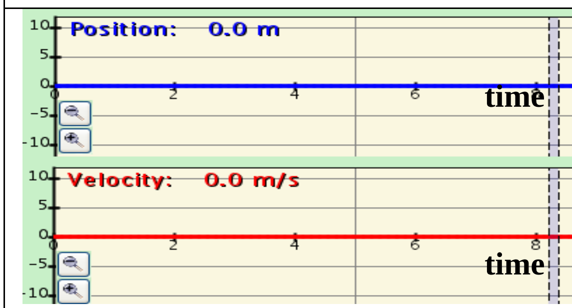
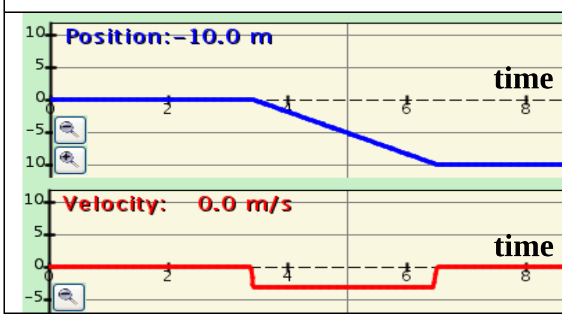
Draw a ***position-time*** graph would best depict the following scenario.

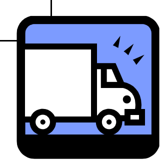
A man starts at the origin, walks back slowly and steadily for 6 seconds. Then he stands still for 6 seconds, then walks forward steadily about twice as fast for 6 seconds.

Name ____________________________

Motion Graphs Warm-Up (Lesson 3)

A policeman is tracking the motion of cars near a stoplight. His radar detector recorded their motion in these graphs, and he needs your help interpreting the graphs. Tell him how the car was moving. The stoplight is at position 0 meters.

	Motion graphs	Description of car's motion:
Car #1 		
Car #2 		
Car #3 		



The policeman also watched a truck that was sitting at the red light. **When the light turned green, the truck slowly started moving, getting faster and faster until it was going a constant velocity**. What do you think the motion graphs looked like? Explain why you think they look this way.

Position-time	Velocity-time	Why do you think they will look like this?

What is the pedal called that the truck driver pushes on to go faster and faster?______________________

Name________________________________

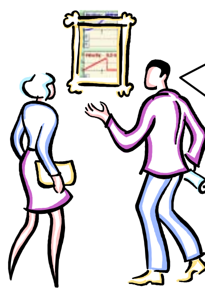
Moving Man Graphs: Accelerating and Decelerating (Lesson 3)

1. Joe is training for the “Race for the Cure” run. His coach wants him to get better at starting. He practices speeding up **from the start** to **a running speed of 10 m/s**. His coach records his motion using a motion detector. After his run, Joe and his coach will use the graphs to analyze his starts. Sketch what you think the motion graphs will look like.

Motion graphs	Why do you think they will look like this?
position time velocity time acceleration time	

2. Open Moving Man. Check your understanding by using the acceleration slider.
3. Make any changes to your graphs using a different color pen or pencil.
4. After practice, Joe and his coach look at the graphs and notice that it shows Joe speeding up. Finish their comments.

Look, Joe – the velocity graph is …



You’re right, Coach. Also, the position graph shows that I’m speeding up because it …

5. The coach tells Joe to run again, and to accelerate more this time. That is, she wants him to try to speed up more quickly this time.

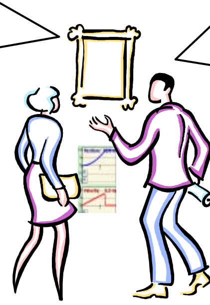
- Sketch what you predict the graphs will look like.
- Check your prediction using the Moving Man.
- Make any changes to your graphs using a different color pen or pencil.

Motion Graphs
position time velocity time acceleration time

6. The coach explains to Joe why the graphs above look different than the first set. Finish their conversation.

Look, Joe – the position graph…

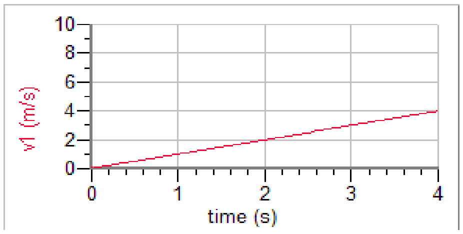
because…

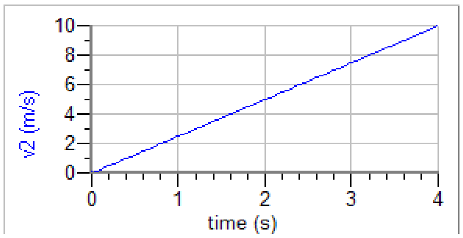


Yes, and the velocity graph…

because…

7. These graphs show the velocity of two different people. Draw a picture to go along with the graph. Then write a story that describes their different motions.

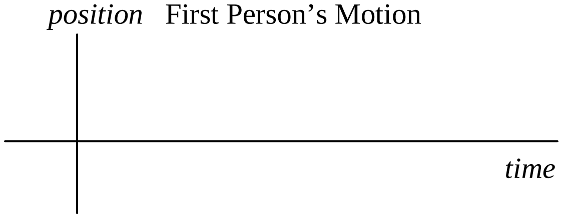




Picture	Story

8. Draw what you think the position-time graphs would look like for the story you just wrote.

position First Person's Motion



position Second Person's Motion

9. At the end of the race, Joe gradually slows down to a stop. Draw what you think the graphs will look like. Explain why you think they will look that way.

Position graph	Velocity Graph	Acceleration Graph
position time	velocity time	acceleration time
Why do you think it will look like this?	Why do you think it will look like this?	Why do you think it will look like this?

10. Now use *Moving Man.* Were your graphs both correct? ____ If not, go back, and draw the correct curve in a different color pencil or pen.

11. Take out your Warm-Up activity for today and check your answer to the last problem. Now that you've studied graphs of "speeding up", do you need to change your answer?_____.
Change it in a different color pencil or pen, if you need to.

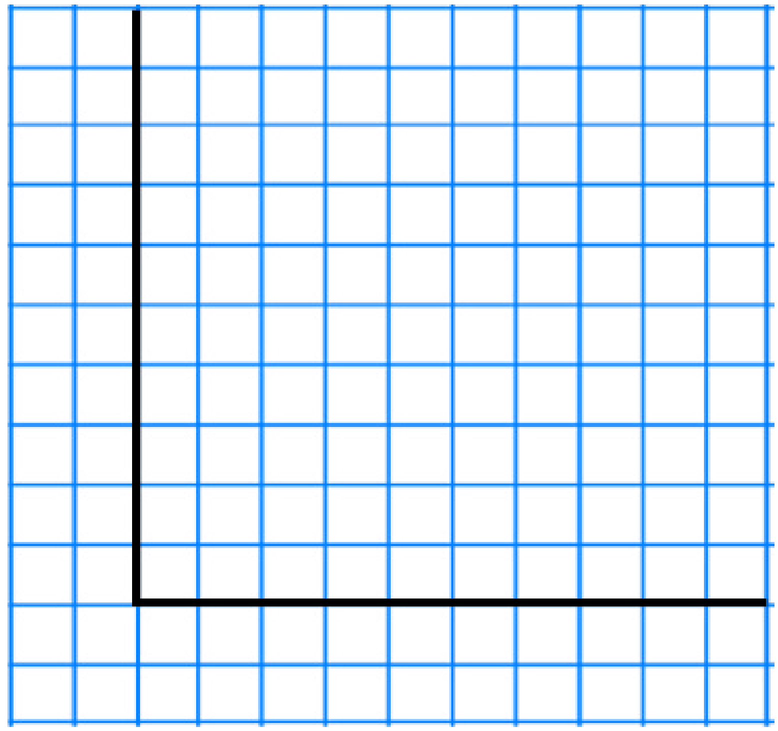
Name:________________________

Velocity/Acceleration Worksheets (Lesson 3)

Calculating Average Speed

Graph the following data on the grid below and answer the questions at the bottom of the page.

Time (sec)	Distance (m)
0	0
1	50
2	75
3	90
4	110
5	125



SHOW YOUR WORK!

1. What is the average speed after two seconds?
2. After three seconds?
3. After 5 seconds?
4. What is the average speed between two and four minutes?
5. What is the average speed between four and five minutes?

Acceleration Calculations

Acceleration means a change in speed or direction. It can also be defined as a change in velocity per unit time.

Calculate the acceleration for the following data. SHOW WORK!

	Initial Velocity	Final Velocity	Time	Acceleration
1.	0m/s	24 m/s	3 s	______________________
2.	0 m/s	35 m/s	5 s	______________________
3.	20 m/s	60 m/s	10 s	______________________
4.	50 m/s	150 m/s	5 s	______________________
5.	25 m/s	1200 m/s	3600 s	______________________

6. A car accelerates from a standstill to 60 m/s in 10 seconds. What is the acceleration?

7. A car accelerates from 25 km/hr to 55 km/hr in 30 seconds. What is its acceleration?

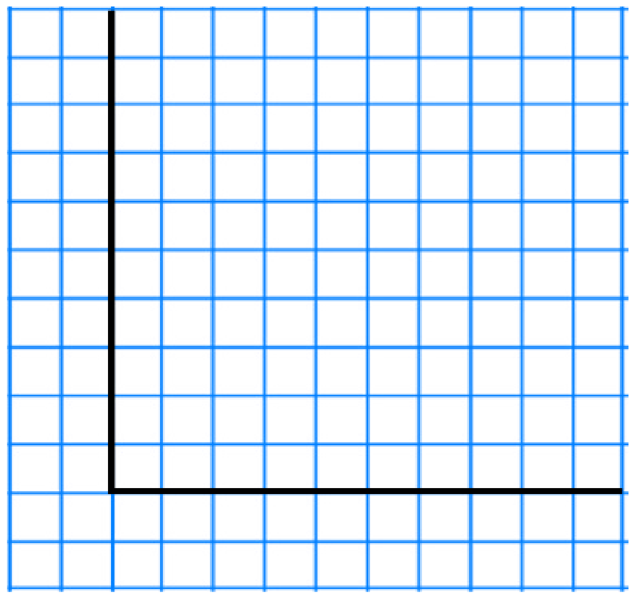
8. A train is accelerating at a rate of 2 m/s. If its initial velocity is 20 m/s, what is its velocity after 30 seconds?

9. A runner achieves a velocity of 11.1 m/s, 9 sec after he begins. What is his acceleration? What distance did he cover?

Graphing Velocity vs Time

Plot the following data on the graph and answer the questions below. SHOW WORK IF APPLIES!

Speed (m/s)	Time (sec)
0	0
10	2
20	4
30	6
40	8
50	10



1. As time increases, what happens to the speed? ________________________________

2. What is the speed at 5 seconds? ______________________________

3. Assuming constant acceleration, what would be the speed at 14 seconds? __________

4. At what time would the object reach a speed of 45 m/s? ____________________

5. What is the object's acceleration? ____________________

6. What would the shape of the graph be if a speed of 50 m/s is maintained from 10s to 20 s?

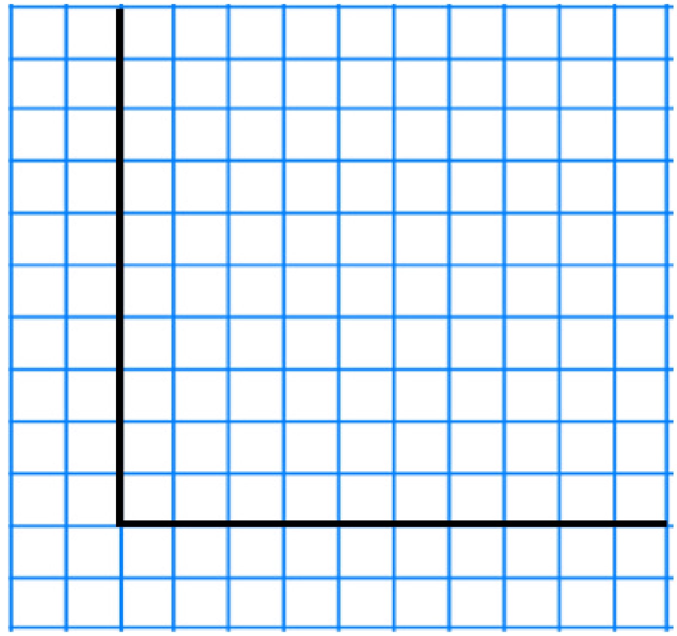
7. Based on the information in Problem 6, calculate the acceleration from 10 s to 20 s.

8. What would the shape of the graph b if the speed of the object decreased from 50 m/s at 20 s to 30 m/s at 40s?

Graphing Distance vs. Time

Plot the following data on the graph and answer the following questions below. SHOW WORK IF APPLIES!

Distance (m/s)	Time (s)
0	0
5	10
12	20
20	30
30	40
42	50
56	60



1. What is the average speed at 20 s? ______________________________
2. What is the average speed at 30 s? ________________________________
3. What is the acceleration between 20 and 30 s? ________________________
4. What is the average speed at 40 s? ______________________________
5. What is the average speed at 60 s? ______________________________
6. What is the acceleration between 40 and 60 s? _______________________
7. Is the object accelerating at a constant rate? __________

Name:__________________

The Basics of Physics: Exploring the Laws of Motion (Lesson 4)

Directions: Answer the following questions based on information from the program.

1. Newton's first law of motion is also referred to as inertia. What is inertia?

2. Newton's second law of motion talks about changing the acceleration of an object by adding or applying a force. The greater the _________ the greater the acceleration. The larger the ______ of the object the greater the force required to accelerate or slow down the object.

3. What is Newton's third law of motion?

4. What force makes us move forward when a car stops suddenly?

5. Name some ways that friction can be helpful and some ways it is harmful.

6. What force holds an object in a circular orbit?

7. Why is it harder to stop a train than a car even when the car is moving faster?

8. Describe how mass and weight are different.

9. A spacecraft traveling in space can travel at a constant speed and in a straight path without using engines. Why?

10. How is momentum calculated?

Lesson 4

WHICH LAW?

We're told that Sir Isaac Newton discovered some things about motion when an apple dropped on his head. Whatever "force" was behind his discoveries, we have benefited from his discoveries.
Here are his three laws of motion. You should be familiar with them. Fill in the missing words in each of the three laws. Then tell which law fits each example below.

Which law? First, Second, or Third?

_____ 1. A frog leaping upward off his lily pad is pulled downward by gravity and lands on another lily pad instead of continuing on in a straight line.

_____ 2. As the fuel in a rocket ignites, the force of the gas expansion and explosion pushes out the back of the rocket and pushes the rocket forward.

_____ 3. When you are standing up in a subway train, and the train suddenly stops, your body continues to go forward.

_____ 4. After you start up your motorbike, as you give it more gas, it goes faster.

_____ 5. A pitched baseball goes faster than one that is gently thrown.

_____ 6. A swimmer pushes water back with her arms, but her body moves forward.

_____ 7. As an ice skater pushes harder with his leg muscles, he begins to move faster.

_____ 8. When Bobby, age 5, and his dad are skipping pebbles on the pond, the pebbles that Bobby's dad throws go farther and faster than his.

_____ 9. When you paddle a canoe, the canoe goes forward.

_____ 10. A little girl who has been pulling a sled behind her in the snow is crying because when she stopped to tie her hat on, the sled kept moving and hit her in the back of her legs.

NEWTON'S FIRST LAW OF MOTION:

An object at _______ stays at _______ or an object that is _______ at a _______ in a straight _______ keeps moving at that _______ unless another _______ acts on it.

NEWTON'S SECOND LAW OF MOTION:

The amount of _______ needed to make an object change its _______ depends on the _______ of the object and the _______ required.

NEWTON'S THIRD LAW OF MOTION:

For every _______ (or force), there is an _______ and _______ action (or force).

Name ______________________________

Name ____ Period _______________

Guided Inquiry - Crash Dummies (Lesson 5)

Category	Excellent (100%)	Good (75%)	Needs Work (50%)	Poor (25%)
Materials List (10%)	• All materials used are included in the list	• Two to three materials are missing from the list.	• More than three materials are missing from the list	• Materials list is missing
Identification of Variables (10%)	• Only one independent variable is clearly identified. • Dependent variables are clearly identified.	• More than one independent variable is present ; or independent variable is missing or incorrect; or • Dependent variable is missing or incorrect	• More than one independent variable is present ; or independent variable is missing or incorrect; AND • Dependent variable is missing or incorrect	• Both variables are missing or are incorrect
Procedure (30%)	• Procedure is easy to follow with the steps in a logical order.	• Procedure is missing one or two steps OR is not in a logical order.	• Procedure is missing between two and four steps AND is not is a logical order.	• Procedure is impossible to follow.
Data Collection (20%)	• Data is recorded in a correctly labeled table or chart • Multiple trials are present	• Data is recorded incorrectly, in an inappropriate format; OR • Table or chart is not labeled correctly; OR • Only one trial is present	Two of the following apply: • Data is recorded incorrectly, or in an inappropriate format; OR • Table or chart is not labeled correctly; OR • Only one trial is present	More than two of the following apply or are missing: • Data is recorded incorrectly, or in an inappropriate format; OR • Table or chart is not labeled correctly; OR • Only one trial is present
Data Analysis/ Conclusion (30%)	• The relationship between the variables is clearly expressed based on the data. • Predictions are made for future experiments based on the data.	• The relationship between the variables is not clearly expressed or is not based on the data; OR • Predictions are missing or are not based on the data.	Two of the following apply: • The relationship between the variables is not clearly expressed OR • Conclusions are not based on the data; OR • Predictions are missing or are not based on the data.	More than two of the following apply or are missing: • The relationship between the variables is not clearly expressed OR • Conclusions are not based on the data; OR • Predictions are missing or are not based on the data.

Force and Motion Test (Lesson 6)

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question.

____ 1. The relationship among mass, force, and acceleration is explained by ____.
A. conservation of momentum
B. Newton's first law
C. Newton's second law
D. Newton's third law

____ 2. A feather will fall through the air more slowly than a brick because of ____.
A. air resistance
B. gravity
C. inertia
D. momentum

____ 3. In the absence of air, a penny and a feather that are dropped from the same height at the same time will ____.
A. fall at different rates
B. fall at the same rate
C. float
D. not have momentum

____ 4. The acceleration due to gravity is ____.
A. 98 m/s^2
B. 9.8 m/s^2
C. 9.8 m/s
D. 0.98 m/s

____ 5. When an object moves in a circular path, it accelerates toward the center of the circle as a result of ____.
A. centripetal force
B. frictional force
C. gravitational force
D. momentum

____ 6. As you get farther from the center of Earth, your weight will ____.
A. decrease
B. increase
C. remain the same
D. can't tell from information given

____ 7. A real car moving at 10 km/h has more momentum than a toy car moving at the same speed because the real car ____.
A. generates less friction
B. has greater mass
C. has less mass
D. has greater forward motion

____ 8. The statement "to every action there is an equal and opposite reaction" is ____.
A. the law of conservation of momentum
B. Newton's first law
C. Newton's second law
D. Newton's third law

____ 9. In the equation $p = m*v$, the p represents ____.
A. friction
B. inertia
C. momentum
D. position

____ 10. The unit of momentum is ____.
A. kg * m
C. kg *m/s^2

B. kg* m/s D. m/s^2

_____ 11. Which of Newton's Laws explains why when you are riding in a car that suddenly stops, you continue forward?

A. 1st Law C. 3rd Law

B. 2nd Law

_____ 12. Which of Newton's Laws explains why when you paddle a kayak, you go forward?

A. 1st Law C. 3rd Law

B. 2nd Law

_____ 13. Which of Newton's Laws explains why a magician can pull the tablecloth off of a table and leave the dishes still in place?

A. 1st Law C. 3rd Law

B. 2nd Law

_____ 14. Which of Newton's Laws explains why a golf ball shot in a slingshot will hit harder than a pingpong ball shot from a slingshot?

A. 1st Law C. 3rd Law

B. 2nd Law

_____ 15. If you ride your bicycle down a straight road for 500 m then turn around and ride back, your distance is _____ your displacement.

A. greater than C. less than

B. equal to D. can't determine

_____ 16. The speed you read on a speedometer is _____.

A. instantaneous speed C. average speed

B. constant speed D. velocity

_____ 17. 3 m/s north is an example of a(n) _____.

A. speed C. position

B. velocity D. acceleration

_____ 18. A merry-go-round horse moves at a constant speed but at a changing _____.

A. velocity C. inertia

B. balanced force D. unbalanced force

_____ 19. Inertia varies depending on _____.

A. force C. velocity

B. mass D. motion

_____20. Newton's first law of motion is also called the law of _____.

A. mass C. force

B. inertia D. constant velocity

_____ 21. You can show the motion of an object on a line graph in which you plot distance against

A. velocity.

B. time.

C. speed.

D. direction.

_____22. In graphing motion, the steepness of the slope depends on

A. how quickly or slowly the object is moving.
B. how far the object has moved.
C. the velocity of the object.
D. the direction the object is moving.

_____23. Which of these is an example of deceleration?

A. a bird taking off for flight
B. a baseball released by a pitcher
C. a car approaching a red light
D. an airplane turning to change its course

_____24. To determine the acceleration rate of an object, you must calculate the change in velocity during each unit of

A. speed.
B. time.
C. motion.
D. deceleration.

_____25. If velocity is measured in kilometers per hour and time is measured in hours, the unit of acceleration is

A. hours.
B. kilometers per hour.
C. kilometers per hour per hour.
D. kilometers.

_____26. On a graph showing distance versus time, a horizontal line represents an object that is

A. moving at a constant speed.
B. increasing its speed.
C. decreasing its speed.
D. not moving at all.

_____27. In an acceleration graph showing speed versus time, a straight line shows the acceleration is

A. decreasing.
B. increasing.
C. changing.
D. constant.

Short Answer

28. Sally throws a ball horizontally from the top of a tall building at the same time that Pete drops a ball from the top of the same building. Which ball will hit the ground first? Explain your answer.

29. Sally and Pete do the same amount of work. Sally does the work in 2.3 hours and Pete does it in 2.5 hours. Who is more powerful? Explain.

30. How are work, time, and power related?

31. Explain why adding oil to the moving parts of a machine can increase its efficiency.

32. Explain how mass and weight are different from each other.

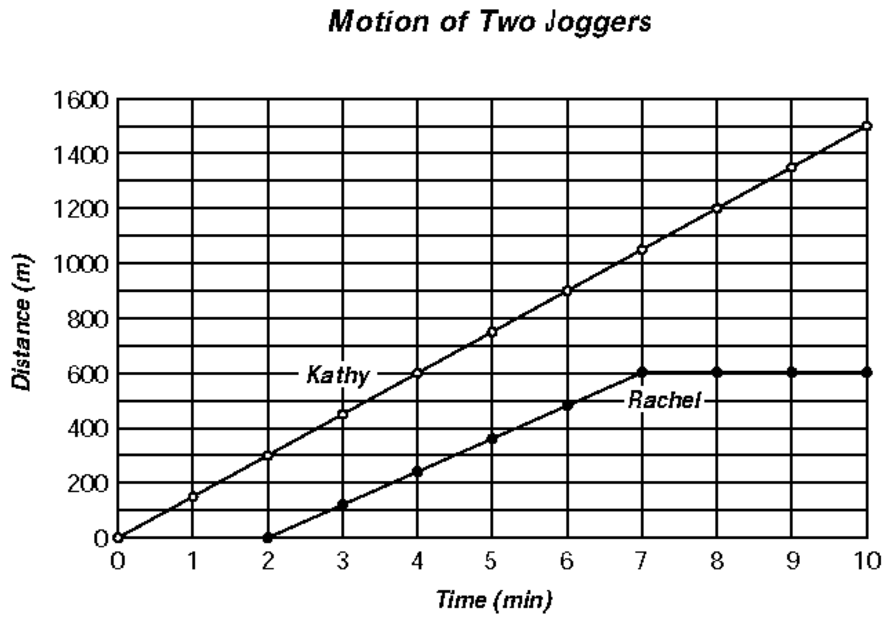
33. A truck travels to and from a stone quarry that is located 2.5 km to the east. What is its distance? What is its displacement?

34. Two cars are traveling along the same road at the same speed but at different velocities. Explain.

35. An inline skater is skating around a parking lot. Can she have constant speed and a changing velocity? Changing speed and constant velocity? Explain your answers.

36. A car has an acceleration of $-5\ m/s^2$. Describe the car's motion.

Use the diagram to answer each question.



37. What two variables are plotted in the graph?

38. How would you describe Kathy's motion? What does such motion mean?

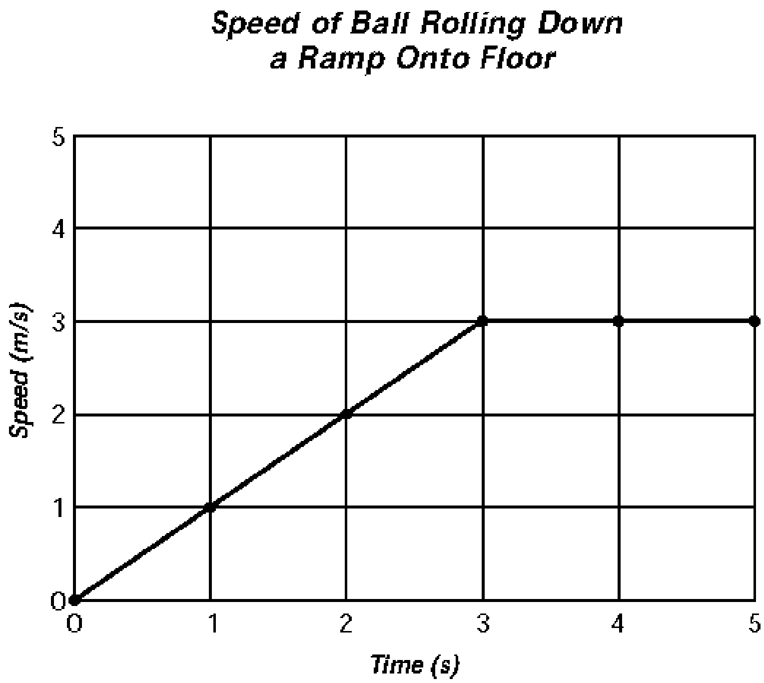
39. How far did Kathy jog in the first 4 minutes?

40. What is Kathy's average speed?

41. How long after Kathy started jogging did Rachel begin jogging?

42. Describe Rachel's motion at 9 minutes.

Use the diagram to answer each question.



43. What two variables are plotted in the graph?

44. What does the line segment on the graph from 0 to 3 seconds represent? Explain your answer.

45. What is the acceleration of the ball between 0 and 3 seconds?

46. What happened to the speed of the ball during the final two seconds?

47. Does the graph indicate that the ball decelerated? Explain your answer.

48. How far did the ball move in the final 2 seconds?

Problems

Use the following equations to answer the questions below. Write the number of the equation used in the blank beside the problem. Partial credit will be given if the information given is identified.

A. $a = V_f - V_i / \ t$

B. $p = m * v$

C. $P = w / t$

D. $s = d / t$

E. $w = F * d$

F. $F = m * a$

49. __________ A 10-kg wagon has a speed of 25 m/s. What is its momentum?

50. _________ A cross-country runner runs 10 km in 40 minutes. What is his average speed?

51. __________ A high speed train travels with an average speed of 227 km/h. The train travels for 2 h. How far does the train travel?

52. __________ Find the acceleration of a car that goes from 32 m/s to 96 m/s in 8.0 s.

53. __________ What force would be required to accelerate a 40 kg mass by 4 m/ s/ s?

54. ___________ If a marble is dropped off of a tall building, how long would it take before it reaches a speed of 49 m / s?

55. __________ A tow truck pulls a car out of a ditch in 5 seconds. If 6000w of power is used, how much work will be performed?

56. ____________ A bulldozer does work at a rate of 12,000N every minute, how much power does it have?

57. ___________ A 3000 kg car travels at a rate of 2 m/s^2. If 12,000 J of work are done, how far will it travel?

58. _____________ If Dwight races his Chevy towards Chatham and travels 2460 meters in 60 seconds. what is his velocity?

Essay

59. Two toy wind-up cars are traveling in the same direction. Car A is 5 cm ahead of car B. On a motion graph, the two straight lines that represent their motions cross. Which toy wind-up car is traveling faster? Explain.

Force and Motion Test
Answer Section

MULTIPLE CHOICE

1. C
2. A
3. B
4. B
5. A
6. A
7. B
8. D
9. C
10. B
11. A
12. C
13. A
14. B
15. A
16. A
17. B
18. A
19. B
20. B
21. B
22. A
23. C
24. B
25. C
26. D
27. D

SHORT ANSWER

28. They will hit at the same time. Vertically, they travel the same distance under the influence of the same force, gravity; horizontal motion doesn't count.
29. Sally; Sally does the same amount of work in less time, so she is more powerful.

30. Power is the measure of amount of work done per unit of time, or $P = W/t$.
31. Adding oil decreases friction, decreases work lost to heat, increases work output, and increases efficiency.
32. Mass measures the amount of matter; weight measures the force of gravity on the matter.
33. 5 km, 0 km
34. The two cars are traveling in different directions.
35. Yes, the skater could be changing directions. No, any change in speed will change the velocity.
36. The car is slowing down at the rate of 5 m/s every second.
37. distance and time
38. Kathy is jogging at a constant speed. Her speed does not change as she moves.
39. 600 m
40. *Average speed = distance/time* = 1,500 m/10 min = 150 m/min
41. 2 minutes
42. Rachel is not moving; she is at rest.
43. speed and time
44. The segment represents constant acceleration. The speed increases by the same amount during each second.
45. 1 m/s^2 (3m/s – 0 m/s)/3 s = (3 m/s)/(3 s) = (1 m/s)/s = 1 m/s^2
46. The ball's speed was constant; it did not change.
47. No, deceleration is a negative acceleration, which means an object slows down. According to the graph, the ball's velocity increased in the first three seconds and then remained the same. It did not slow down. Deceleration would be indicated by a line that slopes downward.
48. 6 m (3.0 m/s x 2 s = 6 m)

PROBLEM

49. 250 kg ´ m/s
    $p = mv$ = 10 kg ´ 25 m/s = 250 kg ´ m/s
50. $s = d/t$ = 10 km/40 min = 0.25 km/min
51. $d = s$ ´ y = 227 km/h ´ (2.00 h) = 454 km
52. $v_f - v_i/t$ = (96 m/s – 32 m/s)/ 8.0 s = 8.0 m/s^2
53. 160 N
54. 5 sec
55. 30000J
56. 60w
57. .5m
58. 41 m/s towards Chatham

ESSAY

59. Car B is traveling faster. At the point where the two lines cross, car B and car A are at the same place after traveling the same amount of time. Since the cars are traveling in the same direction, car B must travel the distance that car A moves plus the 5 cm head start. So, car B must be moving faster because it moves a greater distance in the same amount of time as car A.