Force and Motion: Give it a Push

Grade Level or Special Area: 8th grade Science and Technology
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Length of Unit: Four lessons (approximately 2-3 weeks (12-18 days); 1 day= 45 minutes)

I. ABSTRACT

The focus of this 8th grade Science and Technology Unit is a systematic approach to understanding the topics of Force and Motion within Physical Science. In addition, Technology components are included to enhance the understanding of the topics and fulfill the National Standards for Technology Literate Students. Hands-on activities, Labs and Tricks-of-the-trade will enhance Force and Motion: Give it a Push.

II. OVERVIEW

A. Concept Objectives (Colorado Model Content Standards for Science and National Performance Indicators for Technology-Literate Students)
   1. Students will understand the processes of scientific investigation and design, conduct, communicate about and evaluate such investigations. (CS1)
   2. Students understand the interactions between forces and matter. (CS2)
   3. Students exhibit legal and ethical behaviors when using information and technology, and discuss consequences of misuse. (NPIT3)
   4. Students design, develop, publish and present products using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom. (NPIT6)

B. Content from the *Core Knowledge Sequence* – Science, 8th grade, p. 198
   1. Motion
      a. Velocity and speed
         i. The velocity of an object is the rate of change of its position in a particular direction.
         ii. Speed is the magnitude of velocity expressed in distance covered per unit of time.
         iii. Changes in velocity can involve changes in speed or direction or both.
      b. Average speed= total distance traveled divided by the total time elapsed
         i. Formula: Speed=Distance/Time (S=D/T)
         ii. Familiar units for measuring speed: miles or kilometers per hour
   2. Forces
      a. The concept of force: force as a push or pull that produces a change in the state of motion of an object
         i. Examples of familiar forces (such as gravity, magnetic force)
         ii. A force has both direction and magnitude.
         iii. Measuring force: expressed in units of mass, pounds in English system, Newtons in metric system
      b. Unbalanced forces cause changes in velocity.
         i. If an object is subject to two or more forces at once, the effect is the net effect of all forces.
         ii. The motion of an object does not change if all the forces on it are in balance, having net effect zero.
         iii. The motion of an object changes in speed or direction if the forces on it are unbalanced, having net effect other than zero.

C. Skill Objectives

1. Students will realize that force causes motion.
2. Students will take notes on class discussions.
3. Students will observe and analyze observations.
4. Students will use problem-solving skills to invent solutions.
5. Students will participate in discussions.
6. Students will make connections between forces and the field of Physics.
7. Students will formulate conclusions based on experimentation.
8. Students will make hypotheses based on prior knowledge.
9. Students will use the scientific method to test hypotheses.
10. Students will use gross and fine motor skills to perform experiments.
11. Students will make connections between content learned in this lesson and daily life.
12. Students will operationally define speed, velocity, scalar quantity, vector quantity, distance and displacement.
13. Students will apply these lessons to life situations.
14. Students will hypothesize possible outcomes.
15. Students will record and analyze data and observations.
16. Students will graph data.
17. Students will write experimental conclusions in paragraph form.
18. Students will experiment with different forces and vectors.
19. Students will practice using head-to-tail vector addition.
20. Students will make connections between mass and force.
21. Students will use Microsoft Word to produce neat, complete final products.
22. Students will use the Paint program to illustrate concepts.
23. Students will use interactive web sites to gain information.
24. Students will manipulate objects on the computer using the mouse.
25. Students will record, graph and analyze data and observations using the Excel spreadsheet program.

III. BACKGROUND KNOWLEDGE

A. For Teachers

1. Adams, Richard C. and Goodwin, Peter H. *Physics Projects for Young Scientists*
2. Kuhn, Karl F. *Basic Physics: A Self-teaching Guide*
3. The Physics Classroom Physics Tutorial website: http://www.glenbrook.k12.il.us/gbssci/phys/Class/Bboard.html
4. Familiarity with Netscape Composer, Microsoft Publisher, Microsoft Office Suite, Paint program, and Internet searches

B. For Students

1. Energy, Heat and Energy transfer: *Core Knowledge Sequence*, grade 6
2. Atomic Structure: *Core Knowledge Sequence*, grade 7
3. Familiarity with Netscape Composer, Microsoft Publisher, Microsoft Office Suite, and Paint program

IV. RESOURCES

A. The internet (Lessons Two and Three)

B. Toy car or ball- anything that will move and continue to move along a surface with a small push. (Lesson One)

C. Chunk of wood- size does not matter (Lesson One)

D. Nails (at least two – more if they get bent or can't be reused for any other reason) (Lesson One)

E. Hammer (Lesson One)
F. Chalkboard eraser or object of similar mass and aerodynamic qualities (Lesson One)
G. String ~ 1.5 meters long (Lesson One)
H. Serving bowls – one per lab group or one for teacher demo (Lesson One)
I. Marbles – one per lab group or one for teacher demo (Lesson One)
J. Cardboard squares ~20cm^2 – one per lab group (Lesson One)
K. Cardboard scraps (Lesson One)
L. Masking tape (Lesson One and Two)
M. Various materials around the classroom (Lesson One)
N. Meter stick or metric tape measure (Lesson Two)
O. Stopwatch (Lesson Two)
P. Ticker tape timer (Lesson Four)
Q. Ticker tape (Lesson Four)
R. Transparent tape (Lesson Four)
S. "HotWheels" track (usually orange with purple connectors) – one for each lab group (Lesson Four)
T. Car to fit track – one for each lab group (Lesson Four)
U. Ruler-one for each student/lab group (student supplied?) (Lesson Four)
V. Graph paper (Lesson Four)
W. Rope for tug of war – large enough for entire class (alternate: two or more skateboards and helmets) (Lesson Three)
X. Wheeled cart strong enough to hold a person (optional) (Lesson Three)
Y. Student supplied calculators (Lesson Two and Four)
Z. Computer (All Lessons)
AA. Printer (All Lessons)
BB. Internet Connection (All Lessons)
CC. Microsoft Office Suite (All Lessons)
DD. Paint Program (All Lessons)
EE. Storage media (floppy disk, CD Rom, network storage, etc) (All Lessons)

V. LESSONS

Lesson One: Forces (three to four 45-minute class periods)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Students will understand the processes of scientific investigation and design, conduct, communicate about and evaluate such investigations. (CS1)
   b. Students understand the interactions between forces and matter. (CS2)
   c. Students exhibit legal and ethical behaviors when using information and technology, and discuss consequences of misuse. (NPIT3)
   d. Students design, develop, publish and present products using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom. (NPIT6)
2. Lesson Content
   a. The concept of force: force as a push or pull that produces a change in the state of motion of an object
      i. Examples of familiar forces (such as gravity, magnetic force)
      ii. A force has both direction and magnitude.
      iii. Measuring force: expressed in units of mass, pounds in English system, Newtons in metric system

3. Skill Objective(s)
    a. Students will realize that force causes motion.
    b. Students will take notes on class discussions.
    c. Students will observe and analyze observations.
    d. Students will use problem-solving skills to invent solutions.
    e. Students will participate in discussions.
    f. Students will make connections between forces and the field of Physics.
    g. Students will formulate conclusions based on experimentation.
    h. Students will make hypotheses based on prior knowledge.
    i. Students will use the scientific method to test hypotheses.
    j. Students will use gross and fine motor skills to perform experiments.
    k. Students will make connections between content learned in this lesson and daily life.
    l. Students will use Microsoft Word to produce neat, complete final products.
    m. Students will use the Paint program to illustrate concepts.

B. *Materials*
1. Appendices A, B, D, E and F photocopied for students, C for teacher prep
2. Toy car or ball- anything that will move and continue to move along a surface with a small push
3. Chunk of wood
4. Nails (at least two – more if they get bent or can't be reused for any other reason)
5. Hammer
6. Chalkboard eraser or object of similar mass and aerodynamic qualities
7. String ~ 1.5 meters long
8. Serving bowls – one per lab group or one for teacher demo
9. Marbles – one per lab group or one for teacher demo
10. Cardboard squares ~20cm^2 – one per lab group
11. Cardboard scraps
12. Masking tape
13. Various materials around the classroom
14. Computer
15. Printer
16. Storage media (floppy disk, CD Rom, network storage, etc)

C. *Key Vocabulary*
1. Physics: a major science dealing with the fundamental constituents of the universe, the forces they exert on one another, and the results produced by these forces
2. Force: a push or pull on an object or substance that may or may not produce a change in motion
3. Centripetal Force: a center seeking force that causes an object to move in a circular path
4. Template: a document or file having a preset format
5. Portfolio: materials collected representative of a person's work
6. Click: an instance of pressing down and releasing a button on a pointing device, such as a mouse
7. Open: gaining access to a file on the computer or floppy disk
8. Save: to copy a file from the computer's main memory to a disk or other storage medium
9. Save As: to copy a file from the computer's main memory to a disk or other storage medium as a specific name and/or file type

10. Drop Down Menu: to click on a word or icon and have a list of options below it
11. Icon: a small picture or graphic that will take the user to another location

D. *Procedures/Activities*

1. Set a small toy car or ball on a table or floor and give it a gentle push to get it moving. Ask students why it moved. Help generate discussion by asking for more ideas of how to get your object moving (blow on it, pull it with two magnets, hit it with a stick, etc.)
2. Discuss and have students take notes on Appendix A as the lesson progresses. Rubric for grading notes is included in Appendix B.
3. Define force for students and have them write down the definition.
4. Have a student hammer a nail most of the way into a board (do this yourself if you like). Wear safety goggles!
5. Ask students if a force was applied to the nail, and how they can tell. (yes, because the nail moved)
6. Now push on another nail with your thumb. Better yet, get the biggest, strongest student in class to do it. It probably won't even stick into the wood.
7. Ask students if a force was applied to the nail. (yes, even though the nail didn't move)
8. Refer back to the part of the definition of a force where it says that movement may or may not occur.
9. Discuss further by giving examples such as the teacher trying to move the wall of the classroom, or a student trying to push a car with the emergency brake on, etc.
10. Discuss other ways that forces can change the movement of objects: speeding up, slowing down, starting, stopping, changing direction.
11. Discuss examples of forces in action in everyday life.
12. Introduce the Newton as the unit of force.
13. Talk about the definition of Physics and introduce this branch of science.
14. Tie an eraser or other object of about that mass to a string 1.5 meters long.
15. Swing the string and eraser around in a circle over your head, like a lasso.
16. Ask the students why the eraser is going in a circle. (the string is limiting its motion)
17. Have the students hypothesize what might happen if you let go of the string.
18. Go ahead and let go of the string. (you might want to do this multiple times. The students think it's quite entertaining)
19. Discuss why the eraser didn't keep going in an arc -- why it went in a straight line. (the eraser keeps going in the exact direction it was going at the exact instant it was released -- there is no longer anything to MAKE its path curved)
20. Talk about how Centripetal force affects us: the centripetal force of gravity keeps the earth moving in a circle around the sun, and the earth does the same to the moon. See this website for a very good explanation of Centripetal force: www.glenbrook.k12.il.us/gbssci/phys/Class/circles/u6l1c.html
This site is also great for explaining centrifugal "phantom force": http://www.glenbrook.k12.il.us/gbssci/phys/Class/circles/u6l1d.html
21. Have the students perform the experiments in Appendix D and E, or do them as demonstrations. Appendix E is adapted from the animation shown here: http://www.glenbrook.k12.il.us/gbssci/phys/mmedia/circmot/cf.html
22. One possible solution to the cardboard and marble experiment (Appendix E): build a small wall on the cardboard that the marble can rest against while traveling through the arc.
23. Have students use Word template (Appendix C gives instructions on how to make templates; hard copies of labs are Appendices D and E) to type up a final

lab write-up and turn it in electronically. See Rubric for grading Lab write ups. Make sure that students save this template correctly as this will be included in their science portfolio.

24. Using the Paint program, students will draw trial solutions and final solutions to include in lab write up.
25. *Note: If you have enough computers for each student to use daily, have them complete all labs directly on the computer, without ever printing and photocopying the appendices. If you have no computers, do everything in print.

E. *Assessment/Evaluation*

1. Teacher will use Rubrics in Appendix B and Appendix F to determine application of skills evaluated. The grade will be determined from the rubric.

Lesson Two: Speed and Velocity (three to four 45-minute class periods)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Students will understand the processes of scientific investigation and design, conduct, communicate about and evaluate such investigations. (CS1)
   b. Students exhibit legal and ethical behaviors when using information and technology, and discuss consequences of misuse. (NPIT3)
   c. Students design, develop, publish and present products using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom. (NPIT6)
2. Lesson Content
   a. Velocity and speed
      i. The velocity of an object is the rate of change of its position in a particular direction.
      ii. Speed is the magnitude of velocity expressed in distance covered per unit of time.
      iii. Changes in velocity can involve changes in speed or direction or both.
      iv. Average speed= total distance traveled divided by the total time elapsed
      v. Formula: Speed=Distance/Time (S=D/T)
      vi. Familiar units for measuring speed: miles or kilometers per hour
   b. Vectors and scalars
   c. Distance and displacement
3. Skill Objective(s)
   a. Students will operationally define speed, velocity, scalar quantity, vector quantity, distance and displacement.
   b. Students will apply the lesson to life situations.
   c. Students will hypothesize possible outcomes.
   d. Students will record and analyze data and observations.
   e. Students will graph data.
   f. Students will write experimental conclusions in paragraph form using Microsoft Word.
   g. Students will use interactive web site to gain information.

B. *Materials*

1. Appendices G and I photocopied for students, Appendix H is teacher key
2. Masking tape
3. Meter stick or metric tape measure

4. Stopwatch
5. Student calculators
6. Computer
7. Printer
8. Internet connection
9. Storage media for computer data

C. *Key Vocabulary*
1. Speed: the rate of change in the position of an object or how fast an object is moving
2. Velocity: speed with direction of movement specified or the rate at which an object changes its position
3. Scalar quantity: a quantity that describes magnitude alone
4. Vector quantity: a quantity that tells both magnitude and direction
5. Distance: scalar quantity which refers to how much ground an object has covered during its motion
6. Displacement: a vector quantity that refers to how far out of place an object ends up; it is the object's change in position
7. Web browser: enables you to view documents on the World Wide Web and navigate through them

D. *Procedures/Activities*
1. Have students complete the web-based worksheet in Appendix G if you have internet access for the students. They may work alone, in pairs or in groups depending on your needs. Use the note-taking rubric for grading.
2. If internet access is not available, the worksheet answers can be found in most textbooks, and a key is also provided in Appendix H for your use however you see fit.
3. Lead a class discussion over the subjects in this section. Check for understanding both during this discussion and while students are completing Appendix G.
4. Have students complete the Lab activity from Appendix I and use the lab templates included to turn in their final write up. Make sure that students save this template correctly as this will be included in their science portfolio.
5. Refer to Appendix C for directions on how to make a template.

E. *Assessment/Evaluation*
1. Teacher will use Rubric, Appendix B and Appendix F to determine application of skills evaluated. The grade will be determined from the Rubric.

Lesson Three: Balanced and unbalanced forces (two to three 45-minute class periods)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Students will understand the processes of scientific investigation and design, conduct, communicate about and evaluate such investigations. (CS1)
   b. Students understand the interactions between forces and matter. (CS2)
   c. Students exhibit legal and ethical behaviors when using information and technology, and discuss consequences of misuse. (NPIT3)
   d. Students design, develop, publish and present products using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom. (NPIT6)
2. Lesson Content
   a. Unbalanced forces cause changes in velocity.

i. If an object is subject to two or more forces at once, the effect is the net effect of all forces.
ii. The motion of an object does not change if all the forces on it are in balance, having net effect zero.
iii. The motion of an object changes in speed or direction if the forces on it are unbalanced, having net effect other than zero.

3. Skill Objective(s)
   a. Students will experiment with different forces and vectors.
   b. Students will practice using head-to-tail vector addition.
   c. Students will make connections between mass and force.
   d. Students will manipulate objects on the computer using the mouse.
   e. Students will use Microsoft Word to write up lab.

B. *Materials*
1. Appendix J photocopied for students
2. Rope for tug of war – large enough for entire class (alternate: two or more skateboards and helmets)
3. Wheeled cart strong enough to hold a person (optional)
4. Rulers (optional)
5. Graph paper (optional)
6. Computer
7. Printer
8. Internet connection
9. Storage media for computer data

C. *Key Vocabulary*
1. Net force: all the forces on an object added together
2. Unbalanced forces: when there is a net force other than zero – movement takes place
3. Balanced forces: when the net force is zero – no movement takes place
4. Click and Drag: to click on a word, icon or picture and while depressing the mouse button drag it to another location

D. *Procedures/Activities*
1. Pre-Lesson Preparation: the day before beginning this lesson, find out the weight of each student and come up with a way to divide the class into two teams with as nearly as possible equal total weight.
2. Bring up two students of nearly equal weight and strength. Have them pull on opposite ends of a chunk of rope (it is best if neither one actually moves, so have them pull as equally as possible). Have them tell the class how hard they pulled and discuss with the class why there was little or no movement between the two. This is balanced force. This also introduces the concept of net force. Both students are pulling in opposite directions and canceling out each other's forces.
3. Tie a second rope onto the middle of the first and have a third student pull to the side while the other two are pulling. Have them change their angles of pulling or the force with which they are pulling to see the different net forces. An interesting variation on this is to have a student (or an unsuspecting adult) lay on a wheeled cart with ropes tied to arms and legs and have different students pull on different ropes to see the resultant (net) forces on the now taller experimental subject.
4. As a final physical activity, take the class outside and have them divide themselves up into two tug of war teams, however they want (e.g. boys against girls, football players against everyone else, etc.) and play tug of war to see if

there is a net force – balanced or unbalanced. Make sure they tug evenly with no jerking, as the jerking messes up the vectors.

5. Now divide up the teams as you have devised according to weights and see if the forces are balanced or unbalanced. Discuss the concepts of balanced and unbalanced forces.
6. An alternative to the tug of war is to have two or more skateboards in your room and have students push slowly and gently on one another while standing on skateboards. This works quite well if your floor is level and not bumpy. Make sure the kids wear helmets, as there will be someone falling at least once.
7. Have the students read and participate in these three websites. They are very helpful for explaining the math and graphic relationships of vectors and vector addition. The first site explains, then the other two are interactive ways to practice vector addition and check for understanding. If you have no internet access, these concepts can easily be taught with number lines, rulers and graph paper. http://www.glenbrook.k12.il.us/gbssci/phys/Class/vectors/u3l1b.html http://home.acity.de/walter.fendt/physengl/resultant.htm http://www.explorescience.com/activities/Activity_page.cfm?ActivityID=15
8. Check for understanding while the students are working on these sites. Have them demonstrate operations individually to you.

E. *Assessment/Evaluation*

1. Student demonstrations of vector manipulation on websites.
2. Teacher will use Rubric in Appendix J to determine application of skills evaluated. The grade will be determined from the rubric.

Lesson Four: Acceleration (three to four 45-minute class periods)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Students will understand the processes of scientific investigation and design, conduct, communicate about and evaluate such investigations. (CS1)
   b. Students understand the interactions between forces and matter. (CS2)
   c. Students exhibit legal and ethical behaviors when using information and technology, and discuss consequences of misuse. (NPIT3)
   d. Students design, develop, publish and present products using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom. (NPIT6)
2. Lesson Content
   a. Positive and Negative Acceleration
   b. Circular motion
   c. Formula for acceleration
   d. Units for acceleration
3. Skill Objective(s)
   a. Students will brainstorm past experiences.
   b. Students will apply the lesson to life situations.
   c. Students will hypothesize possible outcomes.
   d. Students will record, graph and analyze data and observations using the Excel spreadsheet program.
   e. Students will use the Word program to write experimental conclusions in paragraph form.
   f. Students will know how to use key vocabulary from lessons.
   g. Students will take notes from class discussion.

B. *Materials*
   1. Appendices K, M and N photocopied for students, Appendix L is teacher key
   2. Ticker tape timer
   3. Ticker tape
   4. Transparent tape
   5. "HotWheels" track – one for each lab group
   6. Car to fit track – one for each lab group
   7. Ruler
   8. Graph paper
   9. Student calculators
   10. Computer
   11. Printer
   12. Internet connection
   13. Microsoft Office Suite
   14. Storage media for computer data

C. *Key Vocabulary*
   1. Acceleration: a change in velocity over a period of time
   2. Positive acceleration: speed up
   3. Negative acceleration: deceleration, slow down
   4. Spreadsheet: a computer program that displays data in rows and columns on a screen; this data can be used for comparative analysis

D. *Procedures/Activities*
   1. Have the class brainstorm about what they have experienced in the past about acceleration. Ask for concrete examples. Lead the class into differentiating between the different types of acceleration.
   2. After the discussion, lead the class in filling out the notes on acceleration from Appendix K.
   3. Pre-lab prep: build a track for each group with different heights of at least one secondary hill on each track. Mark off sections of each track and label the track with an erasable marker.
      Example of side view of possible track:

   4. Do the lab activity from Appendix M in groups of two to four.
   5. Have the students do final lab write up using template. Make sure that students save this template correctly as this will be included in their science portfolios.

E. *Assessment/Evaluation*
   1. Teacher will use Rubric, Appendix F, to determine application of skills evaluated. The grade will be determined from the rubric.

VI. CULMINATING ACTIVITY

A. The students will create a PowerPoint presentation, Newsletter, Brochure, or website to bring together all of the concepts, vocabulary and applications from the unit. This will also be used as the review for the unit test. See Appendices O-S.

B. Unit Test Appendix T

VII. HANDOUTS/WORKSHEETS

A. Appendix A: Forces student notes

B. Appendix B: Rubric for notes in science notebook
C. Appendix C: Making a Template
D. Appendix D: Student Lab: Centripetal Force on a Marble
E. Appendix E: Student Lab: Centripetal Force II
F. Appendix F: Rubric for Lab Write up
G. Appendix G: Speed and Velocity Internet worksheet
H. Appendix H: Key for Appendix G
I. Appendix I: Student Lab: Speed and Velocity
J. Appendix J: Rubric for Evaluation of Vector Addition
K. Appendix K: Acceleration Student notes
L. Appendix L: Acceleration notes Key
M. Appendix M: Student Lab: Acceleration
N. Appendix N: Creating a Graph using Excel
O. Appendix O: Website procedures
P. Appendix P: Newsletter/Brochure Procedures
Q. Appendix Q: PowerPoint procedures
R. Appendix R: Storyboard
S. Appendix S: Rubric for culminating activity
T. Appendix T: Test: Force and Motion
U. Appendix U: Test Key

VIII. BIBLIOGRAPHY

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Appendix A

FORCES

1. Why does the toy car move?

2. Name some other ways to make a toy car move:

3. Define Force:

4. Give several examples of when forces produce motion:

5. Give several examples of when forces do NOT produce motion:

6. Discuss other changes in motion:

7. Everyday life examples of forces:

8. What is Physics?

9. Why does the eraser go around in a circle?

Appendix A, page 2

10. Write down your hypothesis – what exactly will happen when the teacher lets go of the string. Give details, and explain why you think so (make a COMPLETE hypothesis)

11. What actually happened to the eraser, and why?

12. What is Centripetal force?

13. Give some examples of centripetal force:

Appendix B

RUBRIC FOR NOTES IN SCIENCE NOTEBOOK

Category	Outstanding	Accomplished	Developing	Beginning	Total Points	Teacher's Score
CONTENT	Contains all content given in class	Contains most content given in class	Contains some content given in class	Contains little or no content given in class	**10**	
NEATNESS	Neat and easy to read and follow	Neat	Somewhat messy	Messy and unable to follow	**5**	
APPLICATION	Demonstrates understanding by including additional information whenever possible	Demonstrates understanding by including some information	Very little information included	No additional information included	**8**	
				TOTALS	**23**	

Appendix C

MAKING A TEMPLATE

1. Open document that you want to make a template for.
2. Open **File**.
3. Click **Save As**.
4. Name your document.
5. Under the **File Name** box is a box that says **Save As** Type. Click on the arrow on the right and find **Document Template**.
6. **Remember this!!** The **Document Template** automatically wants to save your document in the **Office Templates Folder**. This is OK, but it makes it hard for you to find specific templates. Every time you open up a new document you would have this template to chose from in the template folder. It is better to save this template someplace that is easy for you to find. Therefore, up at the top again, where it says **Save In**, find the place you want the template to be saved.

When you open up this template from the folder where you saved it, the information you had will be there. Add new information to this template. The name of the document on the top left will say Document 1 until you save it with a new name. When you save this time, you will be saving your document under a new name, and it won't be a template unless you specify this. After closing, your original template will still be there without any changes.

If you need to change the template for any reason:

1. Instead of opening up your template from the folder you saved in, open up Word.
2. Go to **File** ® **Open** ® Find your template and open. The name at the top of the document should now read the name of your template.

Appendix D

CENTRIPETAL FORCE ON A MARBLE

Purpose: To find the effects of Centripetal force on circular motion.

Hypothesis: Do you think we can make a marble roll around in a circle inside a bowl? What happens to the marble when the rate of motion is decreased? What happens when the rate of motion is increased?

_____
_____
_____
_____
_____

Materials:

A smooth bowl about the size of a serving bowl
A marble

Procedure:

1. Put the marble in the bowl and begin to move the bowl in a circular motion, slowly at first just like when you start a hula hoop until you get it spinning around inside the bowl nicely. Make note of what forces and effort it takes to get the marble going and keep it that way.

2. Observe what happens to the motion of the marble as you increase and decrease its speed.

3. Make sure to increase the speed enough that the marble flies out of the bowl at least once. Observe the direction and path of flight.

Observations:

Analysis:

1. What path does the marble take when it flies out of the bowl? Why?

2. At what speed, slow or fast, does the marble fly out?

Conclusion:

Give details about the correctness or incorrectness of your hypothesis, then review and discuss what actually happened during the experiment.

Appendix E

CENTRIPETAL FORCE II

Purpose: To observe the effects of centripetal force.

Hypothesis: Will a marble stay sitting on a surface if the surface moves in a curved path? Why or why not, and what might we do to get it to stay on the surface?

_____

_____

_____

_____

_____

_____

Materials:

Cardboard squares, ~ 20cm^2
Cardboard scraps
Masking tape
Any other useful objects or materials available
A marble

Procedure:

1. Set the marble on the cardboard square, making sure it rests in the middle.
2. Move the cardboard square in an arc across the surface of the table. See figure 1.

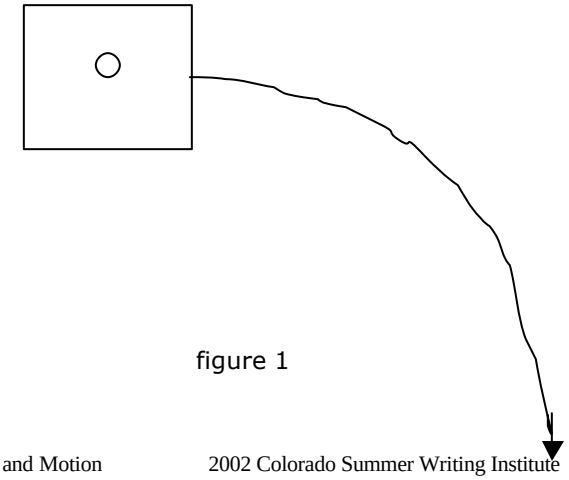

figure 1

3. Record observations about what happens to the marble.
4. See if you get the same observation when you vary the speed of the movement through the arc.
5. Using materials provided by your teacher or others of your own invention, figure out a way to make the marble stay on the cardboard as it moves WITHOUT sticking the marble to the cardboard.
6. As you experiment with methods, write down exactly what you try and what does and does not work in the data and observations section. You may sketch your inventions in the margins or another piece of paper.

Data and Observations:

Conclusions: What happens to a marble on a flat surface when the surface moves? How did you finally get the marble to stay on the cardboard?

Appendix F

RUBRIC FOR LAB WRITE UP

Category	Outstanding	Accomplished	Developing	Beginning	Total Points	Teacher's Score
Correct Use of Template	Used template	Used template with assistance	Didn't use template but typed up lab	Didn't use template	**5**	
Hypothesis	Hypothesis follows correct form and shows outstanding reasoning	Hypothesis follows correct form and shows basic reasoning	Hypothesis doesn't follow correct form and shows some reasoning	Hypothesis doesn't follow correct form and doesn't show reasoning	**10**	
Procedure	Follows procedure correctly, independently and in a timely manner	Follows procedures correctly with some assistance and in a timely manner	Follows procedures with frequent assistance	Doesn't follow procedures and turns in late	**10**	
Observations	Records data and observations while performing the procedure in the correct form	Records most data and observations while performing the procedure in the correct form	Records most data and observations after performing the procedure. Some problems with form	Records data and observations after performing the procedure. Many problems with form.	**10**	
Conclusion	Reviews hypothesis, data and observations, and states well-reasoned conclusion in paragraph form.	Reviews hypothesis, data and observations, and states a conclusion in paragraph form.	Missing a few key elements.	Does not come to a valid conclusion.	**10**	
				TOTALS	**45**	

Appendix G

SPEED AND VELOCITY

Directions:
Open Internet Explorer and type in the following address:
http://www.glenbrook.k12.il.us/gbssci/phys/Class/1Dkin/U1L1d.html
Answer the following questions based on the material.
Follow the links.
Use the **Back** button on the gray bar at the top of the screen to get back to the main text.
Remember, you may not copy and paste information. Shorten and summarize!

1. Click on the words "Distance and Displacement" in the left margin.

    a. Define Distance:

    b. Define Displacement:

2. Continue reading through this section.

Find the solutions to the examples, and answer the following questions.

One day you decide to walk to the mall. You walk 3 blocks when you realize you forgot your wallet. You have walked 2 blocks back when you realize you've got money in your pocket anyway, so who needs a wallet? You turn around a walk 4 blocks from that point towards the mall when it begins to rain. You run all the way home to get your umbrella. You cover 3 blocks towards home when the rain stops, the sun comes out, and it looks like no more rain. You turn back around towards the mall and walk 6 more blocks. It is then you realize you left the dog in the house, and you were supposed to let him out. You walk all the way back home again, but when you get there, you decide it's not worth it and to try again tomorrow.

Use what you learned from the reading to determine your total distance traveled, your displacement each time you turned towards home, and what your ending displacement is. You may want to use a number line or sketch to help you keep track

a. Total distance covered in blocks:

b. Displacement each time you turn back towards home:

c. Total displacement:

3. Click your browser's back button to return to the main lesson.

   a. Define speed:

   b. Define velocity:

   c. If you sit in your seat and wiggle violently, do you have velocity or speed? Explain:

4. Click on Scalar Quantity.

   a. What is the difference between a scalar quantity and a vector quantity?

   b. Perform the "check your understanding" activity on this page.

   b. Is the quantity "1.2 miles up Mount Evans" scalar or vector? How can you tell?

5. Use your browser's back button to go back to the main lesson.

    a. What is the main, most important difference between speed and velocity?

6. Keep reading, then click on the "animation" when you get there. Go back to the main page when you are finished perusing the animation and its content.

    a. What is instantaneous speed?

    b. What is average speed? Give the definition and the equation:

    c. How is average velocity computed?

    d. If I traveled 12 miles to school today, and it took me a total of 20 minutes, what was my average speed in miles per minute? Show your work.

    e. Did I constantly go that speed? Explain.

Appendix G, page 4

Graph the two tables shown on the page. One for constant speed and one for changing speed. Make a separate line graph for each Time vs. position graph.

Constant						Changing					

Keep reading after the tables. Figure out the examples.

If you end up where you came from, do you have an average velocity?

Explain:

Appendix H
Key for Appendix G

SPEED AND VELOCITY

Directions: Open Internet Explorer and type in the following address:

http://www.glenbrook.k12.il.us/gbssci/phys/Class/1Dkin/U1L1d.html

Answer the following questions based on the material.
Follow the links.
Use the **Back** button on the gray bar at the top of the screen to get back to the main text.

Remember, you may not copy and paste information. Shorten and summarize!

1. Click on the words "Distance and Displacement" in the left margin.
   a. Define Distance:

   A scalar quantity that says how much ground an object has covered (how far it has gone).

   b. Define Displacement:

   A vector quantity that says how far an object is from its starting point.

2. Continue reading through this section.
Find the solutions to the examples, and answer the following questions.

One day you decide to walk to the mall. You walk 3 blocks when you realize you forgot your wallet. You have walked 2 blocks back when you realize you've got money in your pocket anyway, so who needs a wallet? You turn around a walk 4 blocks from that point towards the mall when it begins to rain. You run all the way home to get your umbrella. You cover 3 blocks towards home when the rain stops, the sun comes out, and it looks like no more rain. You turn back around towards the mall and walk 6 more blocks. It is then you realize you left the dog in the house, and you were supposed to let him out. You walk all the way back home again, but when you get there, you decide it's not worth it and to try again tomorrow.

Use what you learned from the reading to determine your total distance traveled, your displacement each time you turned towards home, and what your ending displacement is.

Total distance covered in blocks:

3+2+4+3+6+8 blocks = 26 blocks total.

Displacement each time you turn back towards home:

1st time: 3 blocks, 2nd time: 5 blocks, 3rd time: 8 blocks.

Total displacement: ***0: you end up back home.***

3. Click your browser's back button to return to the main lesson.
   Define speed:

   A scalar quantity that tells how fast something is going.

   Define velocity:
   A vector quantity that shows the rate at which something changes position.

   If you sit in your seat and wiggle violently, do you have velocity or speed? Explain:
   Speed. You may be moving quickly, but you are going nowhere, so you have no velocity. Velocity requires you to move from your original position.

4. Click on Scalar Quantity.

What is the difference between a scalar quantity and a vector quantity?

Scalar quantities give only number measurements, while vector quantities tell both the measurement and the direction of motion.

Perform the "check your understanding" activity on this page.

Is the quantity "1.2 miles up Mount Evans" scalar or vector? How can you tell?

Vector: it has a distance measurement and a direction.

5. Use your browser's back button to go back to the main lesson.
What is the main, most important difference between speed and velocity?

Speed has no specific direction, while velocity requires a speed in a specific direction.

6. Keep reading, then click on the "animation" when you get there. Go back to the main page when you are finished perusing the animation and its content.

What is instantaneous speed?

A specific reading of speed at a specific moment in time.

What is average speed? Give the definition and the equation:

A measurement of the total distance traveled in a given period of time.

Ave. speed = Distance traveled/time of travel

How is average velocity computed?

Ave. velocity = displacement/time

If I traveled 12 miles to school today, and it took me a total of 20 minutes, what was my average speed in miles per minute? Show your work.

S = d/t S= 12mi/20min S= .6mi/min

Did I constantly go that speed? Explain.

Probably not, since there are places I need to speed up and slow down on the way to school.

Appendix H, page 4

Graph the two tables shown on the page, one for constant speed and one for changing speed. Make a separate line graph for each Time vs. position graph.

Constant						Changing					

Keep reading after the tables and figure out the examples.

If you end up where you came from, do you have an average velocity? Explain:

No, because you have no displacement.

Appendix I

LAB: SPEED AND VELOCITY

Purpose: To study differences in speed and velocity.

Hypothesis: Do you think your team will have the greatest speed/ velocity when running or when playing leapfrog? Explain your reasoning.

_____
_____
_____
_____

Materials:

Stopwatch
Meterstick or metric tape measure
Masking tape

Procedure:

1. Place a small piece of masking tape on the floor or ground in an open area where you can walk freely.

2. Place another small piece of tape 10 m away from the first.

3. Hold the stopwatch and stand at either piece of tape. Time yourself walking at a normal pace in a straight line from one tape to another. Record in data table A and repeat twice.

4. Repeat the procedure in number 3 while running instead of walking. Record times in data table B.

5. Find three friends (that makes four of you total) and play leapfrog from one mark to the other with one of you timing. Whoever is timing needs to start at the starting line and stop the watch when he/she actually crosses the finish line. Record times in data table C.

6. Begin from one piece of tape, ignoring the other, and walk for exactly 5 seconds. Stop immediately at 5 seconds. Have a partner measure the distance you walked. Record in data table D and repeat twice.

Appendix I, page 2

Data

Table A walking

	Distance (m)	Time (s)
Trial 1	10	
Trial 2	10	
Trial 3	10	
Average		

Table B running

	Distance (m)	Time (s)
Trial 1	10	
Trial 2	10	
Trial 3	10	
Average		

Table C leap frog team

	Distance (m)	Time (s)
Trial 1	10	
Trial 2	10	
Trial 3	10	
Average		

Table D walking

	Distance (m)	Time (s)
Trial 1		5
Trial 2		5
Trial 3		5
Average		

Analysis: Please show formulas and work in all math problems.

1. What was your average speed in Table A?

2. What was your average speed in Table B?

3. What was your average speed in Table C?

4. What was your average speed in Table D?

5. What was your average velocity in each table? Be creative.
   A:
   B:
   C:
   D:

Conclusion: Was your hypothesis correct or not? Give details about what actually happened (for example, you may want to rank your average speeds in order from slowest to fastest). Remember to use paragraph format.

Appendix J

RUBRIC FOR EVALUATION OF VECTOR ADDITION

Criteria	Y	N	Comments	Date
Able to demonstrate understanding of vector addition using web site				
Able to demonstrate understanding of vector addition using paper and pencil				
			GRADE	

Appendix K

ACCELERATION NOTES

I. Acceleration

A. Definition-

1. Positive acceleration-

a. Class examples-

b. Personal examples (give at least 2)-

2. Negative acceleration-

a. Class examples-

b. Personal examples (give at least 2)-

3. Centripetal (Circular) acceleration-

B. Formula-

1. Practice problem-

2. Practice problem-

3. The most common units for acceleration-

Appendix L

Acceleration Notes key

I. Acceleration

A. Definition- ***The rate of change in velocity over a period of time***

1. Positive acceleration- ***an increase in velocity (it speeds up)***

a. Class example

b. Personal examples (give at least 2)-

2. Negative acceleration- ***a decrease in velocity (it slows down)***

a. Class examples-

b. Personal examples (give at least 2)-

3. Centripetal (Circular) acceleration- ***it changes direction (turns)***

B. Formula- $\mathbf{a} = \frac{velocity(\,final) - velocity(initial)}{time}$ or $a = \frac{vf - vi}{t}$

1. Practice problem-

If a car starts out from stop and accelerates to a velocity of 3m/s in 5 seconds, what is the acceleration of the car?

$a = \frac{vf - vi}{t}$	$a = \frac{3m/s - 0m/s}{5s}$	A= o.6 m/s/s

2. Practice problem-

Susan was running to catch the bus when she slowed down from 4m/s to 1m/s to avoid being hit by a bicyclist. It took her 2 seconds to slow down. What was her acceleration?

$a = \frac{vf - vi}{t}$	$a = \frac{1m/s - 4m/s}{2s}$	A= -1.5m/s^2

3. The most common units for acceleration- ***m/s/s or m/s^2 because you have velocity over time.***

Appendix M

Lab: Acceleration

Purpose: To measure and graph the acceleration of a toy car as it rolls along a track.

Hypothesis: Look at the track assigned to you. What do you think will happen to the car's velocity as it travels through each labeled section of track?

_____

_____

_____

Materials:

Ticker tape timer
Ticker tape
Transparent tape
"HotWheels" track
Car to fit track
Ruler
Graph paper

Procedure:

1. Watch and pay attention to your teacher's demonstration on how to use the ticker tape timer.
2. Cut a piece of ticker tape the same length as your track. (You may want to measure with the ticker tape before you cut it.) Leave about 15 cm extra.
3. Securely attach the ticker tape to the back/top of your toy car with transparent tape, making sure not to impede the motion of the wheels.
4. Place the car at the top of the track and feed the free end of the ticker tape into the timer device.
5. With the car in ready position, turn the timer on. Let the car roll down the track until it stops, then turn off the timer. (**DO NOT push the car to start it or to keep it going.**)
6. You should now have a neat row of tiny dots along the ticker tape. If not, repeat the experiment until you do. Use the same tape if it's still good.
7. Lay your tape out flat on your desk. Start at the first mark (which should be the darkest), mark every fifth dot with a pencil. Measure the distance from the START to every fifth dot in cm. Record measurements in the data table as you go.
8. Calculate the velocity for each interval in cm/tick.

Appendix M, page 2

9. Calculate the acceleration for each interval in cm/tick^2.
10. Graph time versus velocity and acceleration in Excel.

Data Table

Mark	**Time=t (5 ticks per mark)**	**Displacement=d: d= distance between starting point and mark on the tape**	**Velocity =v** $v = \frac{dpresent - dprevious}{t}$ **(t=5 ticks for each)**	**Acceleration=a** $a = \frac{vpresent - vprevious}{2(t)}$ **(2(t) = 10 ticks for each)**
Start	0	0	0	0
1	5			
2	10			
3	15			
4	20			
5	25			
6	30			
7	35			
8	40			
9	45			
10	50			
11	55			
12	60			
13	65			
14	70			
15	75			
16	80			
17	85			
18	90			
19	95			
20	100			
21	105			
22	110			
23	115			
24	120			
25	125			
26	130			
27	135			
28	140			
29	145			
30	150			

Conclusions:

Using your graphs, describe the acceleration of the car down the track. Did it do what you had predicted in your hypothesis?

Just from looking at your data and graphs, how can you tell how far down the track the small hump must have been? Explain.

Appendix N

CREATING A GRAPH USING EXCEL

1. Click on **START**.
2. Click on **NEW OFFICE DOCUMENT**.
3. Click on **BLANK WORKBOOK**.
4. In cell A1 type the word **VELOCITY.**
5. In cell B1 type the word **ACCELERATION.**
6. In column A under the word **VELOCITY** input your data.
7. In column B under the word **ACCELERATION** input your data.
8. Save your chart in your H:/ drive.
9. Highlight the column headings and the data.
10. After you have input all data and saved, click on the chart wizard icon on the tool bar.
11. Click on the word **Line** in the box under Standard Types.
12. Choose a chart sub-type.
13. Click next.
14. Click next.
15. Title the chart **TIME VS. VELOCITY/ACCELERATION.**
16. Click next.
17. Click Finish.
18. Save.
19. Then open your lab.
20. Click on **Insert.**
21. Click on **Object.**
22. Click on tab **Create from File.**
23. Click on **Browse.**
24. Find you file.
25. Click **Insert**.

Appendix O

WEB SITE PROCEDURES

Students will use Netscape Composer to create a web site. This Web Site will include all concepts, all vocabulary and at least four real life examples for the Force and Motion: Give it a Push unit.

Remember this will demonstrate what you have learned and be a good review for the unit test.

1. Students will use their notes and labs as their primary resource. They may supplement with Internet resources and outside books.
2. Students will include works cited for all information used.
3. Students will have an Index page that explains what the site is about.
4. Students will have subsequent pages giving concepts, vocabulary and real life examples.
5. Students will include graphics, text, and links appropriate to the unit.

Appendix P

NEWSLETTER/BROCHURE PROCEDURES

Students will use Microsoft Publisher's Newsletter or Brochure option to create **either** a **newsletter** or **brochure**. This newsletter or brochure will include all concepts, all vocabulary and at least four real life examples.

Remember this will demonstrate what you have learned and be a good review for the unit test.

1. Students will use their notes and labs as their primary resource. They may supplement with Internet resources and outside books.
2. Students will include works cited for all information used.

Appendix Q

POWERPOINT PROCEDURES

Students will work independently to create a multi-media presentation using Microsoft Power Point. This presentation will include all concepts, all vocabulary and at least four real life examples.

Remember this will demonstrate what you have learned and be a good review for the unit test.

1. Students will use their notes and labs as their primary resource. They may supplement with Internet sources and outside books.
2. Students will complete a storyboard.
3. Students will create the outline portion of the Power Point slide.
4. Once completed, students will enhance their presentation with graphics and other tools available in Power Point, including transitions and timing. Microsoft sound is only required for slide #1 and #15.
5. Students will save the presentation to be included in their Science Portfolio.

Appendix R

STORYBOARD OUTLINE

Sketch your ideas for each slide prior to creating the Power Point outline. Continue drawing boxes with your plan on a separate sheet.

Introduction Slide 1 **FORCE AND MOTION** **Give it a Push** **Name**	Slide 2
Slide 3	Slide 4
Slide 15 **Ending Slide**	Slide 16 **Works Cited**

Appendix S

RUBRIC FOR CULMINATING ACTIVITY

Category	Outstanding	Accomplished	Developing	Beginning	Total Points	Teacher's Score
Concepts	Included all concepts	Included most concepts	Included half of the concepts	Didn't include many concepts	20	
Vocabulary	Included all vocabulary	Included most vocabulary	Included half of the vocabulary	Didn't include much of the vocabulary	20	
Real Life Examples	Included four examples	Included three examples	Included two examples	Included one or less examples	20	
Neatness	Extremely neat	Neat	Somewhat messy	Messy	10	
Creativity	Extremely creative	Creative	Somewhat creative	Not creative	15	
Turned in on time	Yes / No				10	
Appropriate Graphics	Extremely good graphics	Good graphics	Some graphics	No graphics	15	
Text Format	Great formatting	Good formatting	Some format	No format	15	
				TOTALS	**125**	

Appendix T

8th grade Test
Force and Motion

Name _____

Date _____

Period _____

I. Fill in the blanks and then answer each question:

1. **A _____ is a push or pull that gives energy to an object, sometimes causing that object to do what?**

2. **The rate at which an object moves is called _____. Show the formula to figure this:**

3. **The distance-time graph for constant speed is a(n) _____ line. Draw a simple version of one:**

4. **Unbalanced forces always cause a _____ in motion. What is the term to describe this?**

5. **The _____ is the unit commonly used to measure force.**

6. **What is the formula to find acceleration?**

II. Multiple choice. Circle the correct answer, then explain your choice on the lines below the question. You may choose to explain why the other answers are not correct.

7. The sum of balanced forces equals

a. zero **c. two**
b. one **d. three**

Explain:

_____
_____
_____
_____

8. The distance traveled by an object divided by a unit of time is called

a. velocity **c. momentum**
b. speed **d. acceleration**

Explain:

_____
_____
_____
_____

9. Velocity is

a. the same as speed. **c. speed in a specific direction.**
b. the same as acceleration. **d. the same as momentum.**

Explain:

_____
_____
_____
_____

10. Acceleration is the

a. rate of change in momentum.
b. rate of change in speed.
c. rate of change in velocity.
e. amount of time needed for an object to reach its destination

Explain:

_____
_____
_____
_____

11. Deceleration is

a. negative velocity. **c. negative acceleration.**
b. negative speed. **d. negative density.**

Explain:

_____
_____
_____
_____

12. An object traveling at a constant 20 m/sec in a circular path is changing its

a. speed. **c. velocity.**
b. momentum. **d. mass.**

Explain:

_____
_____
_____
_____

III. True or false. Write true or false on the first line. If the answer is false, replace the underlined word(s) to make the statement true.

___ _____13. An <u>unbalanced</u> force changes the velocity of an object.
___ _____14. Balanced forces maintain motion at a constant <u>acceleration</u>.
___ _____15. Speed that does not change is called <u>average</u> speed.
___ _____16. Speed equals <u>acceleration</u> divided by time.
___ _____17. The distance-time graph for acceleration is always a <u>straight</u> line.

IV. Short (or long) answer:

18. Which is the "phantom" force? Centripetal Force **Centrifugal Force**

Explain each force:

19. Using a pencil and a ruler, figure the net force on a rock that is being pulled directly north with a force of 10N and directly east with a force of 7N. Draw the vectors here. Please circle your answer and show your work.

20. What happens to an object when the combined forces acting on it all cancel each other out?

V. Math problems: Remember to show all of the required steps and label each number with its unit.

21. Find the speed of an object that covers 400km in 5 hr.

22. What is the acceleration of an object that takes 20 sec to change from a velocity of 200m/sec to 300m/sec?

23. An object rolls toward the east at a steady speed of 12 m/sec for 3 sec. What distance does it travel?

24. If you row a boat upstream at 10 km/hr and the river has a downstream velocity of 5 km/hr, what is your actual speed?

Appendix U

Key for Unit Test

1. force, move
2. speed, s=d/t
3. straight-diagonal, check drawing
4. change, acceleration
5. Newton
6. $a=v_f-v_i/t$
7. A
8. B
9. C
10. C
11. C
12. C
13. T
14. F velocity
15. F constant
16. F distance
17. F curved
18. Circle Centrifugal force

    Centripetal force: the center seeking force that causes things to have circular motion.

    Centrifugal force: the feeling of pressing outwards when going in a circle. Actually is the object trying to go in a straight line instead of curving.
19. check drawing of head to tail vector addition. Answer should be somewhere around 12N northeast
20. its motion or lack of does not change.
21. s=d/t s=400km/5hr s= 8km/hr

22. $a=v_f-v_i/t$ a=300km/s – 200km/s / 20s a= 5km/s/s

23. s=d/t or d=st d=12m/s x 3s d= 36m

24. s= up – down s=10km/hr – 5km/hr s=5km/hr