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Cpo science physical science answer key

To maximize your viewing experience of this digital catalog, we recommend installing Adobe Flash Player Plugin. This installation will take only a few moments. If you are experiencing any problems with installation, please contact your System Administrator. Plus, it's possible to see a simplified version of the book on any device. No text content! Section 4.2 CHAPTER 4 ANSWERS 11. 150N 12. 17. If the 100 N power and the 200 N power point in the same direction, and the 300 N force is pointed in the opposite direction, the forces shall be in 13. Equilibrium. Section 4.3 18. Fnet = 1500 N = 400 N+300 N+250 N+F4 14. Answers are: F4 = 550 N The weight vector reped, the normal forces push a. 40 N left b. 25 N to 15. 16. 9 N 4.3 FORCES AND EQUILIBRIUM 81Chapter 5: Newton's Laws of Movement Sequence Learning Goals Activities and Resources Language Tools Section 5.1: 1. Full Chapter 5 • Describes how forces cause Laboratory Investigation 5A: Power and Literary Pick-up Newton's pretext. changes in motion. Accelerating Vocabulary: Newton's First Law, First Law Teacher's Resource CD: unbalanced powers, sluggishness 2. Read Section 5.1, pp. • Demonstrate and describe • Chapter 5 Pretext Word origin: sluggishness Four 45-108 to 110. Newton's first law. • Skill and Practice: Isaac Newton Biography minute class • Graphic Organizer: Newton's Laws of Movement 3. Full investigation • Explain the meaning of net Teaching illustrations CD: periods 5A: Power and power. • Newton's first law, example of a Newton Acceleration. 4. Complete Section review on page 111. Section 5.2: 1. Full investigation • Define Newton's second law Lab Investigation 5B: Newton's Second Vocabulary: Newton's Second Law Newton's 5B: Newton's Second by Relating to Power, Mass, and Legal Law. Acceleration. Second Law Teacher's Resource CD: 2. Read Section 5.2, pp. • Apply Newton's Second Law • Skill and Practice: Newton's Second Act Celebrates 45-112 to 115 and Quantitatively. minute class full Division Teaching Illustrations CD: Reviewed on page 116. • Describe the relationship • Newton's Second Law, Comparison for Newton's periods between net power and acceleration. Second Law, Objects in Free Fall Section 5.3: 1. Read Section 5.3, pp. • Describe action response connection: Rockets: From this World Travel Vocabulary: Newton's third law Newton's 117 to 120 and power pairs. Closing Cards Third Act complete Division Chapter Activity: Make a Spool Motor Review on page 121. • Explain what happens when Three 45 objects collide in terms of Teacher's Resource CD: minute class 2. Complete Chapter Newton's third law. • Skill and Practice: Application of Newton's Laws Assessment, pp. 125 to 126 periods. • Identify everyday examples Teaching illustrations CD: from third law. • Newton's Third Act 82 UNIT 3: LAWS LAWS MOVEMENT AND ENERGY CHAPTER 5 RESOURCES Allied Strategies Materials These resources and more at curiosityplace.com ELL Strategies: Listed in the ELL Supplemental Inquiry 5A: CPO timer, photogate, motor and learning strategies: ramp, physics standing, clay, string, lanyard cuts (after • Printable Student Masters • Simulations • Active Learning - Engage string motor), level, meter stick, masking • Assessment • Science content videos • Cooperative Learning - Examine 5A tape, indelible fine-point marker • Answer Keys • Equipment setup videos • Standards : library book cars • Presentation slides • E-books Teaching tips: Spin eggs, Addressing Physics Teaching Tip: one raw egg, one hard-boiled egg misconceptions NGSS Connection: Chapter 5 Learning Strategies: Investigation 5B: CPO timer, Photogates, car and performance expectations • Teacher Demonstrations - Engaging: Newton's Second Act ramp, physics standing, steel weights, clay, string, lanyard cuts (to attach string to car, level, masking This chapter builds conceptual understanding and • Cooperative Learning - Examining 5B tape , balance or digital scale skills for following performance expectations. • Guided Practice - Explain: Newton's Second Law Teacher Demonstrations: small notebook or path of MS-PS3-1. Build and interpret graphic paper, textbook, sand, plastic container, small heavy displays of data to describe the ratios of • Active Research and Discussion - Extensive rock or piece of concrete kinetic energy to the mass of an object and the speed of an object. Teaching tips: Teacher demonstrations: Newton's Second Law, Acceleration, Relationships between Variables Science and Engineering Practices • Using Mathematics and Learning Strategies: Engaging: action cartoon shorts Computational Thinking • Active Learning - Engage • Planning and conducting investigations expand: Newton's cradle, Balloons • Analysis and interpreting of data • Cooperative Learning: Exploring: Designing a Catapult • Building Explanations and Chapter Activity: WirePools, Different Rubber Design Solutions • Guided Discussion - Explained : What law is this? Bands (approximately 2- to 3-cm long), metal washers (about 2 cm in diameter) Physical Science Core Ideas • Active Learning: Extended • Movement and Stability: Forces and Interactions Teaching Tips: Addressing Misconceptions about Action • Energy Response Powers, Applying Newton's Laws Crossroads • Stability and Change • Systems and System Models 835.1 About the Lesson Title level In this lesson, students learn about how the forces acting on an object relate to the object's mass and movement. Students learn about inertibility and applications from Newton's first 3-5 powers and From pushing to law. Push by Christopher Cooper Asks Students to make a list of things that don't move. Students usually generate Science Answers are the title of these interesting lists. Some students will list small unpleasant objects such as a pencil or a book. science series by Heinemann Library. The Others will list objects so massively that they may seem impossible to move, such as a book offering answers and connections to mountain. Compiling a list of student responses on a white board. Ask students who object to everyday life events. Includes will require the least amount of power to move. Why? Arrange the objects according to how experiments leading up to discovery would require a lot of power to move them. Help students make the connection between learning and address students' curiosity. the amount of mass in an object and the power necessary to put it into effect. 6-8 Forces & Movement by Peter Riley Part of the Science Topics series designed specifically to complement middle school curricgars. Key topic concepts are examined and examples of actual applications are explained. Includes colored photos and glossary. Students complete Investigation 5A after reading section 5.1. Students observe the motion 9-12 The Story of Science: Newton at the van a car on a flat track while a force is applied and when the power is removed. Center by Joy Hakim Students measures the car's speed at various points and sees the car accelerate when there is a net power and moves at a constant speed when the net power is zero. Newton is the focus in this second book series by Hakim as she describes the INVESTIGATION 5A: POWER AND ACCELERATION discoveries of movement, gravity and light. Includes sidebar information and complete setup material vocabulary color illustrations and graphics. 1. Allow one class period to complete the • CPO Timer and one power investigation. photogate position Car and ramp speed 2. Students work in small groups. • Physics stand acceleration 50 grams of clay only strength 3. Decide whether the timers will run on • 1.25 metre string lanyard clip string batteries or with AC adaptors to attach. Then make • to make sure there are electrical outlets within reach • level of each laboratory group or that the batteries in the • meter rod work small piece of masking tape timers. • indelible fine-point marker • 4. Measure approximately 50 grams of clay for • each group. • 84 UNIT 3: LAWS OF MOVEMENT AND ENERGYInertia 5.1 NEWTON'S FIRST ACT Ask students to think that they are pushing an empty grocery cart across a parking lot. Then ask, Is a Word Origin . . . a lot of power needed to get the cart moving? Once the cart is in motion, when does it stop moving? Not a great deal of power is needed to start the wagon moves. Students Inertia (from Latin iners that mean inactivity or respond that the cart stops moving when it with a car or another object in the missing skill) parking lot. Inertia is defined as the ability of an object to resist Say to Students, Now envision the shopping cart full of groceries. How does the mass turn into motion. Ironically, sluggishness shares its origins of the groceries the movement of the shopping cart? Is it easier to initiate movement of with inert, a term often used to describe noble gases the empty cart or the filled cart? Why? Once both carts move, which ones remain in on the periodic table that for the most part movement lasts longer without interference from any outside power? Inactive. You can simulate this example by using two book carts. Ask the school librarian to borrow When studying about inertia, students learn that a cart. Fill one cart with books and leave the other empty. Give each cart a soft pressure body in motion staying in motion, or that a body is serene (by applying equal strength) and letting students measure the distance each cart travels. What remains serene unless acted by an exterior travels further? Of course, the empty cart travels the greater distance. Then ask students forcing. One way to express this is to say that a body to think about how much power should be applied to the filled cart for it to travel the same lacks the skill or ability to change its pattern from distance as the empty cart. Allow a few students to try to push the cart with just the right movement on its own. Only power can cause change in the amount of power to accomplish this task. Then let students tell which cart has the most movement. inertibility and explain how they arrived at this answer. Teaching Tip . . . 1. Let students use the Internet or other resources to learn about Galileo's experiment with metal balls and ramps that led to him introducing the idea of inertibility. Their spin eggs research should answer the following questions: Use one raw egg and one boiled egg to demonstrate • Describe Galileo's experiment. the consequences of forces. Spin each egg (on its side). Did students use a stopwatch to determine how • What was the result of his experiment? long each egg rotates. Which egg turns longer? Ask students to describe how friction affects the amount • How did Galileo's work contradict Aristotle's ideas about objects in motion? time each egg rotates. 2. Encourage your students' creativity as they work in pairs to design experiments that rewind the eggs. This time gently tapping the egg demonstrates Newton's first law. Allow class time for teams who want to share their finger. Do both eggs stop moving? Students experiment with classmates. should observe that the raw egg movement resumes. The liquid portion of the egg has inertibility. Therefore, it does not stop moving until a large enough force is applied to overcome the consequences of its inertibility. Students completed complete 5.1 review questions. 5.1 NEWTON'S FIRST ACT 85Investigation 5A: Power and Acceleration Suppose a car runs out of gas on a flat road, and you want to get it to a petrol station that examines 5A Force and Acceleration 500 feet away. What should you do to get the car to move? 5A Power and Acceleration You must apply a power. What happens when power is applied to something that can move? What happens to the car's speed if you keep pushing the car with a steady force as it moves? The car accelerates or accelerates. Forces affect movement, but exactly how are Materials • 1.25-m String movement affected? Do objects ahead with • Lanyard clip Today you will use a string to apply a force to a car rolling on a driveway. You'll post a move? Are they speeding up or slowing them down? • CPO Timer and • Level photoholes at different points on the track so that you can determine the car's speed. In this investigation you will see that 1 photohole • Meter rod strength causes acceleration. The effect of • Indelible fine-point marker or pen power is to change speed, resulting in • Motor and ramp • Masking tire acceleration. • Physics Stand • 50 g clay A Pull the motor with a force A Pull the motor with a force 1. Sticking a small piece of tire onto the wing of First you need to set up the car and the driveway. Place a tire on the wing of the car and the car, and draw an arrow in the middle. draw an arrow on it. The arrow will be used as a pointer to show the car's position. Rest one side of the driveway on a chair or table. Attach the other side of the ramp to the physics stand as shown 2. Set the end of the driveway on a table or chair. in the picture. Make the ramp as level as you can. Attach the driveway to the physics stand so that the driveway is flat. The ramp must be attached to the stand between holes 10 and 13. Students can use low desks if they place books or other objects on top of them and rest the free end of the track 3. Use a level to get the ramp as shallow as you get on the books. Have some scrap paper, blocks or extra clay available for students to use to use. You may need to shine their tracks at the end of the level. the driveway to get it level. Once your driveway looks flat, use your level to see if it is. Adjust it if necessary. 4. Attach the queue at the end of the car with Check to see that students' tracks are shallow. the clip. Attach a clay ball about 4 centimeters in diameter to the rope. Cut one side of the rope to the car. Start the string over the pulley on the other side of the track. Place the clay ball so that it is just underNeath Attach the clay ball to the rope right under the pulley as shown in the picture. the pulley when the car is at the end of the driveway. A 50-gram mass can be tied to the rope in place of the clay ball. Metal masses are less messy, but the clay is easier to attach to the rope. 5. Draw car at the end of the driveway and let it go. It must be along the driveway as Pull the car so it's at the end of the track and the clay ball is in its raised position. Release of the clay falls and keeps rolling until it hits the car and see what happens. other side of the driveway. B Stop and think a. What is the purpose of the clay ball and rope? B. What is the car's position when the clay ball hits the ground? C. Where on the driveway is the queue exercising a force on the car? D. Where on the driveway is the power of the string zero? 21 B Stop and think What is the goal of attaching the clay ball to the rope? The clay ball is pulled by gravity, so it makes the rope pull the car. It provides the power. Slowly, the car moves along the driveway until the clay ball just hits the ground (or the physics stands). Find the position of the car by looking at the place where the arrow points. Record the position. The car should be near the center of the driveway when the clay hits the floor. During which section of the car's movement is the rope exercising a force on the car? The rope only exercises a force when the clay ball falls, in the first half of the car's movement. During which section of the car's movement is the power of the rope zero? The force is zero when the clay ball is on the floor, during the second half of the car's movement. 86 UNIT 3: LAWS OF MOVEMENT AND ENERGY5.1 INVESTIGATION 5A: POWER AND ACCELERATION C Meting of Acceleration Teaching Tip . . . Now you're going to take some encounters with the photo holes. The photoholes will measure addressing physics misconceptions the time its beam is blocked by the wing on the car. The distance the car moves during this time is the width of the wing, 5 centimeters. How would you use this information to find the car's speed? This investigation confronts a common physics misconception, the idea that an object will stop speed equally remotely (5 cm) divided by the photoholes time. move if the net power on it is zero. The misconception stems from experiences in everyday Plug the photoholes in input A on the timer. Attach the photoholes to the driveway at the 80 cm life. If a heavy box is pushed across the floor, it stops marking. Pull the car at the end of the driveway, and then release it. Draws the time when the move once the pushing force is removed. Timer. In the investigation, students see the car students record their data in Table 1. accelerate gradually while the rope pulls it and then moves at a roughly constant speed Shift the photoholes to 70 cm, 60 cm, and so on. Record the time for the car to go through the once as soon as the clay ball hits the floor. Ask students: Why are photo holes at every position. has ever gone ice skating or if they played sky hockey. These activities provide examples of movement Give students enough time to complete all their operations. with very little friction. Calculate the speed of the car at every 10 Using a model What do you see about the speed you calculated? The speeds rise for the first few positions, and then they level up or decrease slightly. Make a speed vs. position chart that shows the speed of the car at each position on the driveway. See the sample graph on the probe page. Your position values must count down from 80 cm because you started the car at the 80 cm end of the driveway. Help students who need help finding out the spacing of the numbers on the chart. Describes the shape of your chart. The chart hangs up first, and then levels out or slightly depend. There has to be one point on your chart where it changes shape. What's special about this point? The point is in the position of the car when the clay ball hit the floor. This is the point at which the queue stopped exercising a force on the car. The car continued to move at a roughly constant speed (Newton's first law) once there was no longer a net power on it. It may have slowed down slightly due to friction. E Build explanations Students complete the questions in part five. Engage students in a class discussion to review their responses and explain any misconceptions. 5.1 NEWTON'S FIRST ACT 87Investigation 5A: Data and Answers b. A. Pull the car with a power c. The graph shows that the speed goes up to 20 cm. That's because the B Stop and think clay ball hits the ground and the rope stops exercising a force on the car. A. The clay ball and rope provide the power that accelerates the motor. E Build explanations b. 20 cm when the ball hits the ground. A. The rope pulls on the motor from 80 cm to 20 cm. This part of the chart hangs up. Past 20 cm, the part of the chart depends slightly. c. The rope exercises a force on the motor when it is between 80 cm and 20 cm. b. The greater the power on the motor, the greater the acceleration. If power is zero, d. The power is zero when the motor is between 20 and 0 cm. C Operation of acceleration c. The rope pulls on the motor from 80 to 20 cm. After 20 cm, the clay ball hit the ground, so the rope does not pull on the car. Table 1: Position, speed, and time data d. Once the clay ball hit the floor, the car's speed decreases slightly due to Position of Photoholes Time by photoholes Speed at photoholes friction. (cm) (seconds) (cm/s) e. There is a net power towards the queue from the time the car begins to move until it reaches 20 cm. The net power on the car is zero once the motor is 80 0.1109 45.09 past the 20 cm mark. 70 0.0811 61.65 60 0.0660 75.75 50 0.0584 85.62 40 0.0534 9 9100.2 20 0.0499 100.2 0.0490 102.0 10 0.0499 100.2 D Using a model a. The car's speed rises as it moves along the driveway until it comes to 20 cm. 88 UNIT 3: LAWS OF MOVEMENT AND ENERGY5.1 EXAMINE 5E: DATA AND ANSWERS Notes: 5.1 NEWTON'S FIRST ACT 895.2 Newton's Second Law Teaching Tip . . . About the Lesson Second Law Teaching Demonstrations: Newton's Second Law Students have already learned that applied force is causing changes in motion. In this lesson, notebook or path of paper holds and a student learns to apply Newton's second law of movement. Textbook. Ask students, What will fall faster, the notebook or the textbook? Students often mistakenly try the demonstrations shown right to introduce students to Newton's second law, assume the objects fall at different rates. Then ask, which of these will have the biggest impact students examine 5B complete before reading article 5.2. Students get a conceptual when dropped? Understanding Newton's second law while conducting the investigation. They experimented with a car rolling on a flat track, pulled by a rope attached to a falling ball of clay. The drop Top both the notebook and the book. Explaining to the first part of the investigation looks at the effect of increasing the mass of the while students who keep both objects actually on the same of the ball's mass constant. The second part involves changing the mass of the declining rate based on the acceleration due to gravity ball while keeping the car's mass constant. Students examine their data to determine the (neglect of air resistance). The impact of relationship between power, mass and acceleration. every item that falls with different. Then ask students to explain why this is so. The answer lies in the power of INVESTIGATION 5B: NEWTON'S SECOND ACT each object's impact due to mass. Since the mass of the textbook is greater, its impact is as it hits the setup material vocabulary. 1. Allow one class period to complete the • CPO Timer and one power In the first example, the phrase force of impact is examined. photogate speed used to describe the fall objects. Here's another car and ramp acceleration way to demonstrate this concept. Ball on a piece of 2. Students work in small groups. • 3 steel weights net power paper. Drop the piece of paper (from a specified Physics stand mass height) into a container of sand. What was the 3. Deciding whether the timers will run on • 80 grams of clay direct relationship impact? Was there a depression created in the sand? 1.25 guage string reverse ratio batteries or with AC adapters. Then make • lanyard clip to attach Try the experiment again, this time with a heavy rock string to car or piece of concrete. Drop it from the same height. level What do students observe? The greater strength of meter stick impact is proven by the greater depression in the small piece of masking sand. tape sure there are electrical outlets within • balance or digital scale reach of each group or that the batteries • • work in the timers. 4. Measure 80 grams of clay for Group. • • 90 UNIT 3: LAWS OF MOVEMENT AND ENERGY5.2 NEWTON'S SECOND ACT Guided Practice: Newton's Second Law Teaching Tip . . . The problems listed below provide students with the opportunity to manipulate the Newton's Accelerating Second Law equip as they resolve for power, mass or acceleration. Write the F = form m of the equation on the board. Be sure to identify each variable and the amount students have been introduced to acceleration in representations. Next, manipulate the equation to dissolve for acceleration en masse. Has chapter 3. Review the meaning of acceleration and students explain how to refer to three forms of the equation as guide students to solve each problem. students describe the factors that affect acceleration. Use their answers to help students 1. A net force of 30.0 N is applied to an object with a mass equivalent to 15.0 kg. What is the link between unbalanced forces and acceleration of this object? (2.00 m/s2) acceleration. Tell students that velocity changes due to unbalanced forces acting on an object. 2. Kevin is a member of the school's track and team. His favorite event throwing the These changes into velocity are reflected by a change shot put. In his last competition, Kevin 165 exercised N in force on the weight stove, which accelerated in speed (either increasing or decreasing) at 28.5 m/s2. What was the mass of the shot put? (5.79 kg) direction. The rate at which this change takes place in velocity is the acceleration. 3. What net power should cause a 55.0 kg mass to accelerate 5.60 m/s2? (308 N) Once students have a solid conceptual understanding of a. 4. A driver in a car with a mass of 1350 kg travels on a shallow road with an acceleration of the second law, focusing on the application of the second law 4.7 m/s2. What power, neglect of friction, should be poured through the car's car to fix quantitatively accelerating problems. It's accomplished this acceleration? (6 345 N) important for students to distinguish acceleration and delay and identify the 5. A 5.0 kg object is pushed along a rough surface. The applied force is 75 N and the directional and relative size of the power(s) frictional force is 10 N. What is the net power acting on the object? What is the acceleration. Also students at this level acceleration caused by the net power? (The net power is the applied force minus the should be able to make qualitative predictions about frictional force, or 65 N. The acceleration is 13 m/s2.) a system based on their understanding of how variables such as mass, velocity, acceleration and forces ask Your students to think about a time when they were driving in an elevator. Remember they are related. seeing a sign describing the weight of the elevator? How does a lift work? What kind of forces are involved in operating an elevator? What roles do mass, strength, and assumed that students understand the factors' acceleration play in the industry of an elevator? Invite a safety engineer to your class to speak that affects the rate of change of velocity. One about applications of Newton's second law in elevator mechanics, or student behavioral factor is the mass of the object. Velocity changes independent research to find out. slower with more massive objects. Another factor is the size of the force. The greater the unbalanced power, the faster the speed changes. Students complete section 5.2 review questions. 5.2 NEWTON'S SECOND ACT 91Investigation 5B: Newton's Second Act Investigation 5B Newton's Second Act In today's investigation, you will be figuring out the relationship between power, mass and 5B Newton's Second Act acceleration. There are two types of relationships I want you to keep in mind: direct relationships ships and reverse relationships. A direct ratio in one in which increasing one variable How acceleration depends on power and mass? causes another variable to increase. For example, suppose I have a job working at a clothing store where I get paid by the hour. The number of hours I work and the amount of money I do in the last investigation, you saw that a Material • 80 g of day is directly related. The greater the number of hours I work, the greater the amount of money I net power causes acceleration. In this • 3 Steel weights make. Can you think of a few other examples? examined, we will look at how • CPO Timer and • 1.25-m string acceleration depends on the strength of 1 photoble • Lanyard clip Sample responses include: the number of people in a home and the number of beds; the power and the mass of the motor. • Shallow weight of a backpack and the number of books inside; and the number of classes a student • Car and Driveway • Meter stick takes and the amount of homework he or she gets. • Physics Stand • Small piece of masking tape • Balance or a reverse ratio is the opposite of a direct relationship. In a reverse ratio, when one variable increases, the other decreases. For example, when I go shopping at the mall, the digital scale amount of money left in my pocket is inversely related to the amount of money I spend. What are some other examples? An acceleration and mass Sample responses include: the number of hours a student has free in the evening and the In this part of the investigation, the force is going to remain the same, but the mass is going to change. amount of homework he or she has; the number of times run-beer of students in class; the cost of a used car and its age. 1. Set up the car and driveway as you did in Investigation 5A. Make sure an Acceleration and mass the ramp is shallow. Measure 40 grams of clay from the 80 grams You will have the and driveway used to study the relationship power, mass, and you were given when. Acceleration. Set up the car and driveway as you did in Investigation 5A. Make sure the ramp is shallow. Attach a 40-gram ball clay to the rope just below the pulley. 2. Tire and weight Set the car's starting point on the driveway. Provides students with scrap paper or other objects to place under the driveway to make it level. The ramp must be attached to the stand at a hole 10 or higher. 3. Move the photoholes until the timer reads close to 0.1000 seconds Put a small piece of tape on the car's wing and draw an arrow on it. Pull the car all the way to the end of the driveway so that the rope tightens. It is back so that the clay is lifted. Put a tyre on the track next to the arrow pulled onto the car. when the speed of the car is 50 Draw a line to mark the car's starting position as shown in the diagram. cm/s. Students should refer to Step 2 of the setup photo. 4. Measure and draw the distance from the beginning of the photoholes. Plug the photoholes into input A of the timer. Attach the photoholes to the driveway in the position you just measured. Set the timer to A mode. Release the car and read the time of the car to go through photogate A. 5. Add one weight to the car and adjust the position of the photo holes until the time is between 0.0980 and 0.1020 seconds. It moves the photoholes to the time where the speed of the car is 50 cm/s. Write the time interval 0.0980–0.1020 seconds on the board. Show students that a time of 6. Measure the new distance, and 0.1000 seconds means the speed is 50 cm/s by writing out the calculation speed = 5 cm / then repeat the experiment for 0.1000 s. weights. Once you get the photoholes in the right position, record them in Table 1. Measure the Table 1: Distance to 50 cm/s with 40 g of clay distance between the car's starting position and center of the photo holes. Time to distance from start to photoble Weights Make sure students measure accurately from their start line and don't just write down the position of the photoholes on the job. Photogate(s) (cm) 0 1 2 23 92 UNIT 3: LAWS OF MOVEMENT AND ENERGY5.2 INVESTIGATION 5B: NEWTON'S SECOND ACT Add one weight to the car and repeat. You will need to move the photo holes to a new location. Teaching Tip . . . Then repeat for 2 weights. Relationships between Variables B Analysis and interpreting data When you accelerate the difference between a direct You measure the distance for the car from 0 cm/s to accelerate to 50 cm/s. What was the power relationship and a reverse relationship, that's what caused the car to accelerate? important to give students real world examples like those listed at the introduction to this The power of the rope on the car accelerate it. Investigate. Suppose it takes the car 30 cm to reach a speed of 50 cm/s. If you then made the acceleration Often struggle to see mathematical greater, get the car's distance to 50 cm/s increase, decrease, or stay the same? relationships when looking at comparisons, especially those that fractions. The concept that If the acceleration was larger, it would take the car less distance to speed up to 50 cm/s. fraction's value is one that many students don't realize. When explaining the comparison acceleration, you increased the mass of the motor, what happened to the acceleration caused by the power = power ÷ mass, showing students some examples using the queue? simple numbers. Demonstrating that doubling the force causes the acceleration to double and that doubling As mass has been added, the acceleration decreased. the mass cuts the acceleration in half. Is the relationship between acceleration and mass directly or vice versa? It's a reverse relationship. C Acceleration and power Now you will keep the mass of the car constant, but change the amount of power pulling on the car. How can you increase the power of the string? Adding more clay to the ball will increase the strength of the rope. Copy the data from the last row table 1 in the first row table 2. Keep 3 weights on the car for this part of the investigation. Measure 10 grams of clay and add it to the ball hanging on the rope. Adjust the position of the photoholes so that the time is between 0.0980 and 0.1020 seconds. Record the distance between the car's starting point and the photoholes in Table 2. It is not necessary for students to add exactly 10 grams of clay; add-on between 9.7 and 10.3 grams is close enough. Add clay to the ball so that it has a mass of 50, 60, 70 and 80 grams. Move the photoholes, measure the distance, and record your data for each trial. D Analysis and interpretation of data What happened to the power on the car when the mass of the clay ball increased? The power increased because gravity drew harder on the clay ball. What happened to the distance when the power increased? The distance decreased as the force increased. Is the relationship between power and acceleration directly or vice versa? It's a direct relationship. Increasing the power increases the acceleration. E Build explanations Students use their observations to indicate the correct form of second law. 5.2 NEWTON'S SECOND ACT 93Investigation 5B: Data and Answers B Analysis and interpretation en masse. The answer to (a) is based on the Investigations Guide. Table 1: Distance to 50 cm/s data with 40g clay b. Since acceleration cannot level minus mass because power en masse does not have the same units, so they cannot be deducted. The equation is also incorrect Time by photoate Distance from start to Weights, because if the mass were greater than the strength, the acceleration photogate A (s) photogate A (cm) would be a (cm) 0.0999 17.2 c. Acceleration equal strength times mass, because this equation shows that increasing mass increases acceleration. The investigation showed that 0.1004 reduced 26.1 1 increasing mass decreased acceleration. 0.1008 38.9 2 d. This relationship is correct. It shows that increasing mass decreases acceleration (direct ratio) and increasing mass reduces acceleration B Analysis and interpreting data (reverse ratio). A. If the acceleration is greater, the distance will decrease. B. The results show that nail increases the mass of the car, the motor takes more distance to get up to 50 cm/s. C. A greater distance means the car has less acceleration, so mass and acceleration are inversely related. C Acceleration and Power Table 2: Distance to 50 cm/s with 80g of clothing by distance from start to Mass clay ball photogate A(s) photogate A (cm) (g) 0.1008 38.9 40 0.10 28.7 50 0.1009 22.1 60 0.1002 19.1 70 0.0992 16.7 80 D Analysis and interpreting data A. The force on the car increased as the mass of the clay ball increased. B. Increasing the power on the car decreased the distance. C. Increasing the force caused the acceleration to increase, so there is a direct relationship between power and acceleration. 94 UNIT 3: LAWS OF MOVEMENT AND ENERGY5.2 INVESTIGATION 5B: DATA AND ANSWERS Notes: 5.2 NEWTON'S SECOND ACT 955.3 Newton's Third Act Teaching Tip . . . About the Lesson addressing misconceptions about action-Response Powers This lesson is about Newton's third law. Students learn about action response powers and apply the third law to explain everyday events. When students hear the words action-response forces, they often think that a response in Acquire a copy of action cartoon shorts from your school or local library. Those with the response to an action. For example, Jimmy hit my coyote and the roadrunner is excellent for this activity. Then tell students, What if the and my reaction was to hit him back. While this principal has asked you to be a member of a team whose job is to hire a new science example of human response, could that be correct to nature? Most students would like this experience. Ask students to discuss the desired description how our behavior is often reactionary, these are qualifications of their new science teacher. Then tell students that you want to show them an incorrect assumption when talking about an audition video sent in by a prospective teacher. Immediately, the cartoon begins to be short. and Newton's third law. This would imply that once completed, asking students to assess the coyote's potential as a physical science action force, then the response force teacher happens. Then ask students to describe how their observations influenced their decision. Follow. students observe any evidence of Newton's laws at work after? Is of these laws? Encourage students to share with the class. Create a list of student responses to Emphasise the fact that forces do not take place in the board. Insulation. Forces happen in pairs instead. In addition, students must realize that no specific order exists Remind students that they have already learned about Newton's first and second laws of action-response powers. In other words, either movement. Ask students, What do the first and second laws say? Then, calling the third law, power can be the action or response force, because with an emphasis on these words: action, reaction, equal, and opposite. Show the cartoon they're happening at the same time. Again, this time focusing on Newton's third law. Pause the video from time to time to play up examples demonstrating action response powers and violations of the third law. Ask students to consider what happens if a bird flies into a bright, glass window of a skyscraper. Does the bird first exercise a force on the window, with the window then reacting by exercising a force on the bird? Of course, that's not the case. The power of the bird hitting the window is equal in both size and timing of the force invited through the window onto the bird. However, the forces are opposite in direction. Designing a Catapult assigns students to work in small groups. Their task is to build a device that will launch a ping-pong ball at least 10 feet. Let students use the Internet or other resources to collect ideas about building basic catapults; but not to limit their design options to examples they find. Encourage students to improve on an existing design or to create their own. Once students have completed their designs, choose a safe place for them to perform their launches. Let them identify the types of forces involved in operating their catapult and explain how their catapults demonstrate each of the three laws of movement. You can even calculate the students the speed and acceleration of the ping-pong ball and/or the power of their catapults. 96 UNIT 3: LAWS OF MOVEMENT AND ENERGYWhich Act Is It? 5.3 NEWTON'S THIRD ACT Write several scenarios that demonstrate Newton's laws on strips of paper or index cards. Fold the strips of paper (or cards) in half and place them in a container. Have every student Teaching Tip . . . choose one scenario, read it aloud, and then tell which law best represents it. Create a 3-column table on the board so students can record their answers. Sample scenarios apply Newton's laws categorized by applicable law in the example below. Use Think-Pair-Share to resolve this 1. What is Newton's cradle? How does this device demonstrate Newton's laws? Have conceptual problems. students to find out. Encourage students to share their observations with classmates. 1. Landscaper decided to create a stone walkway. He drove to a home improvement store to choose 2. Blow a and let it go. Let students identify the action and response forces the stones he ordered. His speed was involved as air is released from the balloon. 45 miles per hour. As he returned home, the landscaper observed that it took a longer time 3. Divide students into teams. Has each team demonstrated an example of Newton's to reach the same speed. Which triggered the first, second or third law. Allow classmates to guess what law is being demonstrated. differs in time needed to accomplish the same Own explained students what happens in relation to the law. speed heading home from the store? What can the landscaper do to reach the 45 mph speeds in the same amount of time? 2. Which plane needs more power to take off: a small plane or a large 300 passenger jet? Why? 3. Two vehicles take off from rest at a stoplight. One vehicle is a small sports car; the other a big SUV. Describes factors that affect each vehicle's acceleration. What vehicle would you expect to have the greater power of impact in a collision? Explain your answer. 4. Catherine enjoyed weekend kicking scooter was her neighborhood friends. How do you ride a scooter? What should you do to start, speed up, slow down or stop? Which of Newton's laws is involved in riding a scooter? Suppose you take a weekend scooter ride with Catherine on a hill street in her neighborhood. Should you be able to ride your scooter in the street? Why or why not? How would the scooter change if you get down the hill street? Describe your motion under Newton's laws. Students complete section 5.3 review questions. 5.3 NEWTON'S THIRD ACT 97Newton 5 Answer your foot harder than pushing back the ground on the skateboard. The unbalanced forces are causing the skateboard to move forward. 5.1 Division Revision 4. Action response forces do not cancel each other because they are working on different objects. 1. Answers are: a. wind b. the foot kicks the ball c. gravity d. gravity 5. In the jet plane engine, fuel burned to the exhaust emanates the back of pulling the moon the plane with high power. According to Newton's third law, the action force pushing the outlet out of the back of the plane has an equal and opposite 2. a shopping cart full of grocery become pieces of rubber is in the opposite direction of the rubber ball. It will be 3. Answers are: move more slowly than the little ball. The power is equal and opposite on both balls, a, D, but since the basketball has more mass it will have less acceleration. b. A C,B connection 4. D. According to Newton's first law, the ball will continue to move into the same 1. The thrust is achieved by burning a large amount of fuel and pushing the direction it is acted against by another force. exhaust gas as fast as possible. 5.2 Division Revision 2. Rockets for deep space travel are so because they carry so much fuel. 1. a = change in v ÷ change in t = (6 m /s) ÷(3 s) = 2 m /s2 3. A rocket engine is different than a motor engine because a motor F = m × a = 2 (kg)(2 m/s2) = 4 N do not need to create push enough to achieve an escape speed, so it needs much less fuel to burn. 2. Acceleration is directly proportional to strength and vice vermaceed evenly to mass. For example, an empty pickup will accelerate faster than a full 4. The big obstacles to bringing people deeper into space is the amount of power F = m × a = (4000 N) ÷ (1500 kg) = 2.67 m/s2 4. The potato with the least mass will have the largest acceleration: the 100- Activity gram potato. 1. Turning the pencil gives the car energy. Energy is stored in the rubber 5. The acceleration of the motorcycle is 2,5 m/s2. The mass is 250 kg. Band. F = ma = 250 kg × 2,5 m/s2 = 625 N b. Liquidating the rubber band a larger number of times didn't always let the car go further. For each rubber strap, turning the pencil more than a 5.3 Section Review certain number of turns gave the car going a shorter distance. 1. The action force of Emilio pushing against the canoe creates a reaction force c. Friction of the floor moved the car forward. which pushes the canoe away from Emilio. The action and response forces are equal in strength and opposite in direction. Emilio clearly misjudged the d. The car just spun into place, then turned in a circle on the smooth floor. effect of the action/response forces. There wasn't enough friction for the wheels to get a grip on the floor and move the car. 2. The team with the larger power fee feet pushing against the ground/ground push against the feet will win the game. The power pairs that the strings. First law: The car remained serene until a force (the friction of the spin is identical between both teams because tension in the queue is the same wheel) acted on it. Once it moved, it kept moving until the friction anywhere in the queue, no matter how hard any team pulled on the rope. The off the turning wheel stopped pushing it and the drug pencil's winning team will push hardest against the ground. friction slowed it down. Second law: The greater the power of the friction on the floor, the greater the acceleration. The car couldn't get a great power 3. The ground pushes forward against your feet. At the same time, the skateboard pushes to the ground and the ground pushes onto the skateboard. The skateboard moves forward because the ground is pushing 98 UNIT 3: LAWS OF MOVEMENT AND ENERGY HUACER 5 ANSWERS when it was on the smooth floor, so there wasn't much acceleration. Law: The turning wheel pushed backwards to the floor and the floor (friction) pushed the car forward. 11. The table shoves on the brick. 12 b Chapter 5 Assessment Problems Vocabulary Section 5.1 Section 5.1 Section 5.2 5.1 1. 20 m/s; since the net power is zero, the object continues to move at a constant 1. inertibility 5. Newton's 6. Newton's third velocity. 7. Force second law 2. The bowling ball has 100 times the sluggishness of the tennis ball: inertibility en masse 3. Newton's first is directly proportional. Act 3. Answers are: 4. unbalanced a. (250 kg)(9.8 m/s2) = 2400 N. b. normal force c. gravity and normal force. 13 F = ma (100 kg)(4 m/s2) = 400 N Section 5.3 4. 15 N 180 N right 1. Friction serves as an unbalanced force that needs to be overcome to maintain constant speed. Section 5.2 5. F = m × a = (1000 kg)(5 m/s2) = 5,000 N 2. The ball full of water would have more inertia than the ball full of air, weight 1000 N that was 4 kg of 3. A golf ball has 28 kg of 10 kg × 1 m/s2 = 1 N 6. a = F ÷ m = (10,000 N) ÷ (2,000 kg) = 5 m/s2 feathers. According to Newton's first law, the ball will go further. 8. a = 0.1 kg × 0.5 m/s2 = F 7. m = F ÷ a = (20 N) ÷ (140 m/s2) = 0.14 kg requires a greater power to overcome its inertibility. The ball that's harder to start 8. The net power is 50 N west. a = F ÷ m = (50 N) ÷ (10 kg) = 5 m/s2 ball filled with water. 9. F = m × a = (40 kg)(7 m/s2) = 280 N 10. Answers are: 3. Mass and inertility are directly proportional. (The greater the mass, the greater its inertibility. b. acceleration a. a = change in v ÷ change in t = (29 - 5 m/s) ÷ (4 s) = 6 m/s2 c. 4 m/s2; equal in size, but opposite in direction 4. b Section 5.3 Section 5.1 2. (11) Water pushes onto the hose - hose pushes onto the water 5. Directly proportional means that if you raise one variable, the other 2. (other) Firefighter pulls on hose - hose pulls on firefighter variable elevated by the same factor. Conversely every means that if you (3) (2) Firefighter pushes against Earth - Earth pushing against firefighter increases one variable, the other variable would be reduced by the same factor. 12. The truck will push back on Jane with a 100 N power; they are an action and response pair. 6. Net power is the sum of all the power vectors that pair on the object, together as if they were one single force acting on the object. Acceleration is the motion due to the net power. 13. Car: F = ma = (3,000 kg)(2 m/s2) = 6000 N The truck and car collide with the same force 6,000 N. a = F ÷ m = 6000 N ÷ 1000 kg = 6 m/s2 a. Increases speed b. Its speed reduces its speed; change its direction. acceleration of truck = F/m = 6,000 N ÷ 5000 kg = 1.2 m/s2 8. Yes, you accelerate because you change speed. A negative acceleration is called a delay. 9. F = m × a 10. c 5.3 NEWTON'S THIRD ACT 99Chapter 6: Energy and Machines Sequencing Learning Goals Activities and Resources Tools Section 6.1: 1. Full Chapter 6 Give examples of energy laboratory examination 6A: Energy Library Pick-up Energy Precinct. transformations in systems. Transformations on a Roller Coaster and the Vocabulary: joule, system, law of 2. Full Investigation • Compare and contrast Education Resource CD: energy conservation, potential conservation 6A: Energy Potential and Kinetic Energy. • Chapter 6 Pretext Energy, Kinetic Energy of Energy Transformations on a • Graphic Organizer: Energy and Wole Roller Coaster. • Simple and Kinetic Energy. • Energy Celebrate 45- energy conservation. minute block 3. Read Section 6.1, pp. Teaching illustrations CD: 128 to 133 and • Conversion of energy, systems and variables, Some periods completed Division Revision on page 134. Important variables in the system, Working Section 6.2: 1. Read Section 6.2, pp. • Explain the meanings of work Teacher Resource CD: Vocabulary: work, power, watt, Work and 135 to 138 a complete and power. • Skill and Practice: Work and power Skill and Practice: Work and horsepower Power Section Review on page 139 • Apply comparisons to Cd for instruction illustrations: Three 45- determine the quantity of work. Power Example, Power-minute classwork done by a force or the power needed to do work. Periods • Use proper units to describe work and power. Section 6.3: 1. Full investigation • Identify examples and uses of Laboratory Examination 6B: Power, Work and Vocabulary: Machine, Input, Simple 6B: Power, Work and Simple Machines. Simple machine, efficiency, machines. Mechanical advantage machines • Determine the mechanical compound: A mighty energetic wind 2. Read Section 6.3, pp. advantage of machines. Word Origins: Machine Four 45-140 to 146 and Chapter Activity: Pop Goes the Balloon! minute class complete Section • Describe the forces that using maps Review on page 147. prevent machines from Teacher's resource CD: periods that are at 100% efficiency. • Skill and Practice: Mechanical Advantage. 3. Complete Chapter Assessment, pp. 151 to Mechanical Advantage of Simple Machines, Gear 152. Relationships, efficiency, using a spreadsheet, Bicycle Gear Relations Project Teaching illustrations CD: Mechanical Advantage of a Lever, Mechanical Advantage, The Three Classes of Levers 100 UNIT 3: LAWS OF MOVEMENT AND ENERGY CHAPTER 6 RESOURCESDigested Teaching Resources These resources and more at Investigation 6A: CPO roller coasters, CPO timers and curiosity.com ELL Strategies: Listed in the ELL , steel marbles, meter Learning Strategies: rods • Printable Student Masters • Simulations • Discussion • Involved • Assessment • Science content videos • Learning • Investigate 6A Engage: flag pole and flag, or window blinds • Answer keys • • Spot videos • Guided Discussion - Explain: Energy Maps Investigation 6B: Ropes and Pulleys, Spring Scales, • Presentation Slides • E-Books • Discussion / Active Learning - Extended Physics Stand, Steel Weights, Gauge String Teaching Tips: Energy Transformations, Mass and Energy Chapter Activity: Box tops of copy/printer paper NGSS Connection: Scissors, Tape, String, Small Balloons Learning Strategy: Performance Expectations • Discussion - Engaged • Guided Discussion • Explore this chapter builds conceptual understanding and • Guided Practice - Explain: Work and Power skills for the following achievement • Active Research and Discussion - Extensive Teaching Tips: Work Explained, Strength in Daily Activities MS-PS3-1. Build and interpret graphical displays of data to describe the relationships of Learning Strategies: kinetic energy to the mass of an object and the • Active Learning - Engage speed of an object. • Cooperative Learning: Investigation 6B • Guided Discussion - Explain MS-PS3-2. Develop a model to describe it • Cross-curricular Integration - Expand: Political when ranking objects that communicate on a remote change, different amounts of potential machines of energy are stored in the system. • Performance Assessment - Assessment: Building too teaching tips: Learning about the curriculum: Political Science and Engineering Practices Machines, The use of simple machines to mathematics and computational thinking • Planning and execution of investigations • Analysis and interpretation of data • Engaging in arguments of proof physical science core ideas • Energy • Waves and their applications in technology and information transfer crossing concepts • Patterns • Energy and Matter • Systems and System Models 1016.1 Energy and the Conservation About the Lesson Tile Level In this lesson, students learn about energy transformations in ecosystems. 3-5 Simple Machines by Deborah Hodge Ask students to describe their favorite amusement park ride. Many students will describe some form of roller coaster. Why do they enjoy roller coasters? Do your students even know This well-illustrated book offers lower about physics when driving their favorite roller coaster? Ask students to consider what level readers give insight into the world of happening during a roller coaster ride. What types of forces are involved? Ask students to See the Start identifying applications from each of Newton's laws relative to the movement of a roller coaster. with Science Series and include simple experiments that students can try with friends and then ask students, How does designing the roller coaster affect the ride? For to learn more about how ride machines example, is a of loops more exciting than one with less? Why? Make work easier. students speculate on how a roller coaster really works. Ask leading questions like What causes the cars to move on the coaster? and Is the speed of the cars the same at 6-8 Explore the world of physics: From all points along the ride? Simple Machines for Nuclear Energy by John Hudson Tiner Part of the Scout Series, Tiner offers several physics concepts in an easily readable format. Advanced concepts, discussed in sidebars, offer students the opportunity to expand their learning. Students complete Investigation 6A before article 6.1 is read. While they do so 9-12 Robots: Bringing Intelligent Machines investigation, students studied the relationship between the speed and height of a marble after life by Ruth Aylett rolling up and down a roller coaster track. Students get a conceptual understanding of energy conservation: Since the marble loses one kind of energy (potential energy due to being recommended by the NSTA, this book height), it gets a different kind of energy (kinetic energy due to speed). The total amount of players the interest of those fascinated by energy remains the same, so energy is preserved. mechanical servants. This book connects many fields of robotics, EXAMINING 6A: ENERGY TRANSFORMATIONS ON A ROLLER COASTER biology, and even psychology. Contains many applications for advanced middle-setup material vocabulary school and high school students. 1. One class period is needed to complete the • CPO Roller Coaster special examination. CPO Timer and energy • photoholes potential energy 2. Students work in small groups. Physics stand kinetic energy. steel marble 3. Decide whether the timers will run on • meter stick batteries or with AC adaptors. Then make • make sure there are electrical outlets within reach • from each laboratory group or that the batteries operate in the timers. 102 UNIT 3: LAWS OF MOVEMENT AND ENERGY6.1 ENERGY AND THE CONSERVATION OF ENERGY Guided Discussion: Energy Cards Teaching Tip . . . Let students generate a list of all the different forms of energy they know, and then use Energy Transformations the list to create energy maps of white maps. Instruct students to draw a photo to represent the form of energy on one side of the map and write its name on the other before doing the Energy Cards activity, make sure you start. For example, a flame can be used to represent heat energy. Assign each student a student understands the meaning of the word partner. Read scenarios for students that involve energy transformation. Some examples transformation. Use the word in a sentence and as provided below. Once you've completed the reading, ask teams to display maps on students, use context to distract its meaning. For their desks for each form of energy described. Walk around the classroom and Example, there are many transformations in the which charts are displayed. Ask volunteers to hold their cards and book every life cycle of a butterfly. Transformation. When thinking about transformations, the main idea is 1. Ian and his friends went on a camping trip. They decided to collect logs and build an a change. It's important for students to know energy fire. What are the energy transformations involved in a burning campfire? (The fire is not sustained or lost; it simply changes shape. One way logs represent chemical energy that produces energy in the form of heat, light, and so would thus transformed to sound energy from the cracks of the wood.) That energy is a property of matter. For example, rather than saying energy moves tell students that 2. The gym teacher assigned students to teams for relay races. Describe the energy atoms and molecules moving and carrying energy. students who were involved in a student walking in the race. (The food eaten by the students gives chemical energy to the body.) Heat energy is also given off as she walks.) Energy (of Greek energy meaning work) 3. Amelie rang the doorbell when she arrived at her grandmother's house. Does a transformation occur when Amelie rings the doorbell? (Yes, electrical energy is Energy is often defined as the ability to do work. Physical scientists define work as a measure of the energy transmitted as power is applied over a 1. Challenge students to work in teams to build a device that demonstrates at least three distance. Then, the mechanical energy to press the button into work and is transformed into an electrical energy conversions. Lesson. 2. Divide students into small groups. Let them do some research to find out about alternatives As you prepare to introduce work, ask students to think about energy sources studied by scientists. Instruct each group to make a presentation, make a list of jobs or tasks they do at home. Have you got over their findings. Write students share the items on their lists, and then discuss them being exclusively work. You may even have 3. Let students use publishing software to create a brochure or leaflet about energy students describing specific energy transformation conservation. Ask students to include helpful tips, such as how to reduce home heating associated with the work (tasks) they do. For example, and cooling costs. Distribute the brochure to students throughout the school. a student doing the laundry describes the energy transformations that occur when a washing machine is operating. Students complete section 6.1 review questions. 6.1 ENERGY AND THE CONSERVATION OF ENERGY 103Investigation 6A Energy Transformations on a Roller Coaster Where Does The Marble Move fastest, and why? Today you'll observe what's happening to the speed of a marble as it rolls up and down a roller coaster track. When doing the investigation, it can be useful to imagine trawling your bike on a hill, you need to work Materials that coast up and down hills on a bike. The purpose of the investigation is to make you think difficult to keep the bike moving. However, about how energy changes from one nature to another. How do we define energy? when you start on the other side of the hill. • CPO Roller Coaster you can coast. In this investigation you will see • Steel marble Energy is the ability to cause change or the ability to do work. how a marble's speed changes as it moves up • CPO Timer and movements and down hills. It's all about energy. • Meter stick What kind of energy does a moving Object has kinetic energy. The faster an object moves, the greater its kinetic energy. A set of roller coaster 1. Attach the roller coaster to the What kind of energy depends on an object's height? fifth hole from the bottom of the Potential energy depends on height. The higher an object is, the greater its potential energy. Stand. Keep these two types of energy in mind as you conduct the investigation. 2. Place the marble against the starting pin and let it roll off a Set the roller coaster by attaching it to the fifth hole from the bottom of the stand. Hold the 3. Watch the marble roll next to the marble against the starting pin, and then fix it. What do you see about the speed? Track. Where do you think it moves fastest? The marble's speed changes as it goes up and down the hills. B Make a prediction B Make a prediction Think about the seven spots numbered in the Look at the diagram that shows the roller coaster track. There are seven numbered spots on diagram. Where do you think the marble moves the track. Where do you think the marble is moving fastest? Write down your answer and the fastest? Choose one of the seven locations and write reason why you think it's the fastest place. why you think it will be the fastest place. Students should write down their predictions. C Executing your investigation C Executes your investigation from 1. Set the timer in interval mode and plug a photoholes into input A. Connect a photoholes to import A on the timer. Set the timer to measure the time by photogate A. You will use the timer to measure the speed of the marble at the seven different 2. Measure the time it takes the marble to roll through places. How can you find the speed with the timer? the photoholes at each of the seven locations. Make sure the photoholes are pushed up at the bottom of the speed The speed is the distance the marble moves (its diameter) split by the time the track. photoholes. 3. The speed of the marble is its diameter divided by the diameter of the is 1.9 cm, so this is the distance you will use to find the speed. When the time takes it to go through the photo holes. Find you connect the photoholes, make sure it is pressed to the bottom of the track. the speed of the marble at each position through the diameter of the marble (1.9 cm) by the time the car is not against the bottom of the track, the full diameter of the marble will not break through photogate A, breaking the photoholes beam, causing inaccurate speed measurements. 26 Place the photoholes at each of the seven locations and measure the time. Record your data in Table 1. Then calculate the speeds. 104 UNIT 3: LAWS OF MOVEMENT AND ENERGY6.1 INVESTIGATION 6A: ENERGY TRANSFORMATIONS ON A ROLLER COASTER Students should try to place the photoholes at the same height for places 2, 4 and 6. Teaching Tip . . . Positions 1 and 5 must be at the top of the hills, and position 7 must be at the bottom. Mass and energy D Analysis and interpreting data One way to expand this activity is to ask students to have the effect of replacing the steel marble with Where was the marble moving fastest? a lighter plastic marble. Students need a It was fastest at the lowest points, ranking 3 and 7. Hypothesis on whether the speed in different places will be faster, slower or the same. Students Why do you think the speed is the fastest there? can test their hypotheses and discuss their results. The marble accelerates as it goes downhill. It had the most time to speed up when it came to the lowest points. The speed will come out at almost exactly the same. Both kinetic and potential energy are directly Where does the marble have the most potential energy, at the top or bottom? Proportional to mass, so the effect of mass cancelling It has the most potential energy at the top. From. The marble with more mass has more potential energy at the top of the hill and more kinetic energy As the marble rolls down the hill, it loses potential energy. Where does this energy go? at the bottom. However, the speed at the bottom is It turns into kinetic energy. dependent only on the starting height. Students can predict that the heavier marble will move faster. It takes energy to make the marble's speed increase. Where does this energy come from? The energy comes from potential energy. The power of gravity makes the potential energy They may have experienced a sledge, waterslide, or change in kinetic energy. other ride that supports this idea. In situations where the speed of an object goes downhill is affected by E Using a model to construct explanations mass, this is likely due to the effects of sliding friction and air resistance. The effect of these forces Now you will use the photoholes to the marble's speed 10 cm along the track. You are more noticeable on objects with less mass. must also measure the height of the track every position. To measure the height in a certain position, place the marble exactly on the mark. Measure the height straight from the center of the marble to the surface of the table. Record your data in Table 2. Make sure that students measure the height by keeping the metering stick perpendi right on the table. In the first places, the physics stand will be directly below the marble. Show students that they can simply measure the height straight to the stand. They can then measure the distance from the table to the top of the stand and add to get the total height of the marble above the table. Set up your graph paper like the sample shown in the probe. You'll plot two sets of points on your chart, height vs. position and speed vs. position. Help students who need help set up the axles. What does the chart show you about the relationship between speed and height of the marble on the roller coaster track? The graph shows that where the speed is fast, the height is small. Where speed is slow, altitude is great. Explain the chart using the terms potential energy, kinetic energy, and total energy. As the marble downhill goes, potential energy and kinetic energy diminish. As the marble goes uphill, potential energy and kinetic energy increases. The total amount of energy always remains the same. 6.1 ENERGY AND THE CONSERVATION OF ENERGY 105Investigation 6A: Data and Answers E Using a model to set up explanations a Setup of the roller coaster Table 2: Speed and height data B Make a Forecast Position (cm) Height (cm) Time A(s) Speed (cm/s) a. The marble will be fastest at point 7. 10 33.0 0.0258 73.6 20 27.0 0.0149 127.5 30 20.0 0.0116 163.8 172.7 C Carrying out your investigation 40 15.5 0.0110 166.7 50 15.5 0.0114 136.7 Table 1: Speed of the Marble 60 22.0 0.0139 81.2 46.3 Position Distance (cm) Time A (s) Speed (cm/s) 70.4 121.0 1 1.9 0.0470 40.4 70 28.0 0.0234 165.2 2 1.9 0.0142 133.8 80 32.5 0.0410 172.7 3 1.9 0.0111 171.2 90 31.5 0.0270 119.5 4 1.9 0.0159 47.7 100 25.5 0.0157 5 1.9 0.0398 128.4 110 18.0 0.0115 6 1.9 0.0148 182.7 120 12.0 0.0110 7 1.9 0.0104 a. See graph. D Analysis and interpretation of data b. See chart. A. The marble was fastest at position 7. c. The graph shows that the greater the height, the slower the speed. Speed b. Ranking 7 was the fastest because it was the lowest. The marble had the least and height was conversely related. potential energy in position 7, so it has the largest kinetic energy. d. When the marble is high, it has a lot of c. The potential energy turns into kinetic energy as the marble rolls downhill. of potential energy and not much kinetic energy. As it moves downhill, d. The energy comes from the potential energy I gave the marble as I lifted it to it gets kinetic and lose the top of the track. potential energy. When it rolls back, it loses it energy and get potential energy. The total energy remains about the same (but reduces a little due to friction). 106 UNIT 3: LAWS OF MOVEMENT AND ENERGY6.1 INVESTIGATION 6A: DATA AND ANSWERS Notes: 6.1 ENERGY AND THE CONSERVATION OF ENERGY 1076.2 Work and Power Education Tip . . . About the Lesson Work explained in this lesson, students explore the scientific meanings of work and strength. They also learn after revealing the equation for work, such as W = F × d, apply comparisons to determine the amount of work done by a force or the power necessary to ask students to consider its definition. What does the do work. power times distance really means? It's important for students to understand that calculating jobs really presumes a driver starts experiencing problems with his car just as he approaches his about metuming the transfer of energy. House. The driver pulls over to the side of the road and the car comes to a complete stop. Two of his neighbors realize what happened and offer to help him push the car home. Let students read page 136 of the student text. After pushing on the car, the men can't move it. Ask students, Is work done on Focus on the second paragraph, which discusses the car? Why or why not? Allow students to discuss their opinions. Listen carefully to work done on a block as it is slipped across a shallow table. determine whether students use physics terms, such as strength and movement to express their Slide a wooden block across a shallow table in your beliefs. Classroom. Then explain to students how energy is transferred in the process. Then tell students that no work was done on the car because it wasn't moving. Tell students, a Third neighbor came to assist the three men who tried to move the Person pushing the block, stored energy car. With his help, they were able to push the car all the way home. Has work been done? From obtained from the food he or she thought. The block and course, the answer is that work has been done. Tell students that work is done when a table can be considered a system; Thus, while the block applied force causes an object to move a distance. Let students identify the applied pushed along the table, the particles that make up power (men pushing on the car). Then ask, How can you determine the distance? The system is moving faster. The slight temperature distance can be measured from the position the car came to a complete stop on the increase in the system is a result of these particles road to the driver's home. move faster and the power of friction. Consequently, energy is transferred from the person to the system. Let your students work in small groups to create presentations on inventions or which makes it possible to work faster or more efficiently. For example, ask students, you think we can determine the students how introduction of tractors (in place of horses or mules) changed energy obtained by the particles in the wooden block the agricultural industry forever. Their presentations should explain how the power of and the table? That wouldn't be possible. Instead, horses compare with the power of the first tractors. They should also discuss improvements to the energy of the wood block and table system can be from the first tractors to contemporary agricultural tools and talk about the implications of being calculated by applying the equation to determine these improvements. Encourage students to read books or to visit the websites of the work done on the block. In other words, the manufacturers to learn more about the invention or technology they choose. Allow time for energy, in joule, transferred from the person to the students to share their presentations after completing lesson 6.3. system is equal to the power (in newtons) applied to the block multiplied by the distance (in meters) the block is moved along the table towards the force. Then tell students, Suppose the person pushing the block applies 20.0 N and pushes the block 5.00 meters. How much work is done by the person? Model this calculation on the board for students. The work done is 100 joules. 108 UNIT 3: LAWS OF MOVEMENT AND ENERGYGuided Practice: Work and Power 6.2 WORK AND POWER Use the problems provided below to help students apply the appropriate formulas to resolve Point of Instruction . . . work and power problems. Power in Daily Activities 1. Joy applies 85.00 N of strength for a 15.00 metre distance to push a chair over Have students alluded to the owner's manual of their floor. How much work does Joy do? (1275 J) family's car to find out the amount of horsepower provided by its engine. How much watt does it 2. Trevor does 3545 J of the job as he pushes a box of books 25.0 yards. Finding the power, in equal? Then students maintained a log that newtons need for Trevor to do this job? (142 N; Be prepared to show students how does the following information contain for two weeks: to change the shape of the equation to resolve for violence.) • driven the type of motor 3. What is the power needed to do 365 J of work in 5.7 seconds? (64 watt) • the number of litres of petrol put in the car 4. Tamika and Sharon are very competitive friends. One afternoon Tamika challenged • the price per litre of petrol • the number of miles travelled to a grape race over the two-week Sharon. The girls acquired identical herberries and agreed to push them 85 yards. Tamika applied 135 N in force to push her herb, while period Sharon applied a force of 140 N. • the kilowatt hours of electricity produced on their a Be. How much work did each girl do? (Tamika did 11,475 J of the job. Sharon did 11,900 J house of work.) At the end of two weeks, create a large chart for b.b. reached the finish line in 52 seconds, while Sharon needed only 48 seconds of students to record their information. Then ask students these questions: to complete the race. Which girl's strength is greater? (Sharon's strength, 248 watt, is bigger than Tamika's 221 watt of power.) 1. How does the horsepower of different motors offer c. Tamika challenged Sharon to a rethink. This time, the race ended in a tie with comparison? each girl finished in 50 seconds. If both girls have the same amount of work as in question a, who has the greater power? (Because Sharon did more work than 2. What was the cost of fuel travelling per mile? Tamika in the same amount of time, her strength is greater. d. If Sharon's work and power remain the same as in question c, that could be Tamika 3. Which car was the most fuel-efficient? do to win the race? (Tamika could either increase the power applied to the herb to surpass Sharon's work or she could try to push the herb 4. How much gallons of gasoline have been used by everyone much faster.) of the cars? What was the average price of gasoline per gallon? has 5. If the cost of electricity was 8 cents per kilowatt See the Power in Daily Activities tuition tip for an idea. hour and each gallon of gasoline contained about 36 kilowatt hours, which was more expensive about Students completing section 6.2 review questions. the two-week period: is fueling the family car or providing electricity to the house? If students have access to an electric bill, they use the actual cost per kilowatt hour in this calculation. Be sure to send a letter home to parents explaining the activity and asking for their cooperation. Ask parents to assist students in reading the electrical meter and odometer; and to pass along gasoline receipts or records to their children. 1096.2 WORKING AND POWER6.3 Simple Machines Word origin . . . About the Lesson

Machine (of Latin machina meaning device) This lesson focuses on simple machines and how they function to do work. Start lesson 6.3 by writing the word, MACHINE, on the three to four sheets of graph paper attached to the Ask students if they have ever observed a person, raise and lower a flag on a flag post. Have walls in your classroom. Place the graph paper so that a volunteer describes the process. Then ask, Is there physics involved? Encourage students that each student is close to at least one skin. to explain how. Then take your students outdoors to allow the reduction and raising of the Dan groups of students two minutes to write flag at your school. Get prior permission from your principal or another administrator. whatever comes to mind when they think of an if your raise and lower the flag, show the parts involved like the pulleys, the truck, on the sheet of paper that is closest to and the halyard (the cable or rope). Then ask students to think about how the queues and You can choose to divide students into small pulleys, making the tasks of more easily raising and lowering the flag. Can they think of other groups and act one person as the recorder, examples where ropes and pulleys work together to make work easier? If a flagstone is not while other members generate ideas. Available, you can demonstrate how ropes and pulleys work by opening curtains and closing or increasing and lowering blinds in your classroom. Look at the words students recorded. How many of the words or examples of machines listed refer to Students complete Investigation 6B before article 6.3 is read. In this investigation, devices powered by an engine, electricity or some students use a set of ropes and pulleys to discover the relationship between inputs and other means? This is usually students' first response. output power and distance. However, it's important for students to realize that not all machines are powered. EXAMINE 6B: POWER, WORK AND MACHINES Show students everyday objects consisting of setup material vocabulary of simple machines, such as scissors. Then ask, Is scissors an example of a machine? Got students 1. Allow one class period for students • Queues and pulleys to explain input power why they believe it to be (or not) a machine. complete the investigation. • Spring scale output power Then ask, What is a machine? Steering students • Physics stands input distance to understand that a machine is any device 2. Students work in small groups. • Four steel weights output distance that can be used to do work. Ask students to think • Meter stick mechanical advantage over the work that scissors allow people to do. Work Dismantles the scissors and shows students its parts. Scissors consist of levers and wedges, two types of simple machines. Let students think about how each simple machine contributes to the function of scissors. Are they able to relate these devices to the work that scissors can do? Displays • a number of objects consisting of simple machines. Lead students into a conversation to help identify the simple machines that work together in each object. 110 UNIT 3: LAWS OF MOVEMENT AND ENERGY* The Political Machines activity as an extension of this lesson. 6.3 SIMPLE MACHINES Students complete section 6.3 revision questions. Then let students work in groups to teach Teaching TIP . . . design and build toys using simple machines. Allow time for students to brainstorm possible design ideas and to plan how they'll build their toys. Once students learn about the curriculum: Politically, their toys have built, let them share their creations with the class. Use the column provided under Machines to evaluate students' performance. Let other students face in their classmates' cool factor toys. The highest possible score is 20 points. What is a political machine? Ask AK social studies teacher to partner with you in presenting a lesson on Category 4 3 2 1 notable political machines in American history. Then students discussed the similarities between Scientific Explanations through all explanations by political machines and physics machines. The Knowledge Groups groups members most groups that most groups of students work in groups. Some guiding questions may indicate a solid point after a close the following: Plan understanding of relatively solid members suggests members suggest simple machines understanding of a relatively solid lack of 1. Think of one example of a machine (in physics Function simple machines understanding terms). What are its parts and how do these simple machines work together understanding of parts to achieve a specific simple machines task? Plan is neat, Plan is somewhat Plan is very 2. Consider the political machine your group organized, and all organized, and disorganized, but disorganized with opted to learn more about. What are the parts that most structures are most structures (or members) of this machine? What were some structures clearly marked is clearly marked wrong of the specific tasks they hoped to accomplish? clearly marked unclear marked 3. Describe the input and output of your physics structures machine. Toy features may Toy features Toy f not 4. Who was the boss of the political machine your were good at holding on and holding up to pretty good, but function and fall studied? What was the input and output of the political machine? What were some of the things he did to normal tension normal tension not keeping apart below normal making the machine work? What did the machine normal tension do for the boss? Tension 5. How efficient have political machines Suitable Mostly Suitable Mostly Suitable The Materials Operated Throughout American History? was used to construct materials to construct Auxiliary Students to see that as machines in the physics build the toys. Sentence, political machines are designed to do specifically It is obvious that the toy. These are things, and they're based on input and output. gear care was obvious that care taken in building materials was chosen was taken in Materials the toy. building the toy, used to construct inappropriate and the toy, but the toy is naturally product appears recklessly constructed. Building. Cool Factor Way cool Cool Sort of cool So-so-6.3 SIMPLE MACHINES 111Investigation 6B: Power, Work, and Machines A building of a simple machine 6B Power, Work, and Machines In this investigation, you will be using a set of ropes and pulleys. We'll do this by setting up several How do simple machines work? • Ropes and pulleys of ropes and pulleys to lift weights on the lower block. Attach four weights to the • Spring scales pulleys and use a spring setup to measure the weight of the block with the weights. The output machines are devices people figure out to make tasks easier. Simple • Physics Standing power for the investigation is equal to this weight. Records the output power in Table 1. machines use directly applied forces. Simple machines allowed • 4 Steel weights people to build the large pyramids and other monuments with long • Meter stick See the teaching point on the next page. just muscle strength. This investigation is about how simple machines use power to accomplish a task. Attach the top Block to the top hole of the physics stand. Start the yellow string over the top pulley and clip it to the lower block. Clip the other side of the string to the 10 N spring A building a simple machine scale. When you pull off the spring scale, the lower block must move. Make sure you 1. Attach four weights to the lower block. Use a spring pull straight down, not sideways. Measure the strength it takes for you to slowly lift the lower scale to measure the weight of the lower block, and block. Record in Table 1. records it as the output power. Use equipment from one of the groups to demonstrate the setup. Show students who are 2. Attach the top block near the top of the Physics Stand. happens if they pull sideways instead of downwards (the physics stand tips over). 3. Thread the yellow string over one or more of the Resolve the yellow string of the lower block and the spring scale. Cut one side of the rope pulleys from the top and lower pulley blocks. The top block. Run the string so that it goes through one of the pulleys on the lower block and yellow string can be clipped to either the top block or then back up over one of the pulleys on the other block. Cut the other side to the spring scale. You have the bottom block. must now be able to lift the lower block by pulling down on the spring scale. You should see that there are now two lengths of the yellow string supporting the lower block. Record 4. Build combinations with 1, 2, 3, 4, 5, and 6 support the spring scale power. strings that directly support the bottom block. (Tip: 1, 3 and 5 clipped the rope to the bottom block. 2) Students may need help figure out how to perform the queue over the two pulleys. It's very 4, and 6 has clipped the rope to the top block) easier to understand if the setup is demonstrated. 5. Use a spring scale to measure the power needed You already build rope and pulley combinations with one and two strings supporting the slow light up the bottom block for different bottom block. Now build combinations with 3, 4, 5 and 6 strings. Draw the power for each one in combinations of supporting strings. the table. Security Tip: Don't pull sideways, or you can tip Students can't figure out how to build each combination at first. Don't stand the over! provides the solution. Encourage Encourage to work with their group members to find the answer. Table 1: Input and output powers B Build explanations Number of Input Power Output Power Supported (N) (N) What happened to the input force needed to lift the block if you increase the number of supporting strings? Strings The force decreased rail the number of strings increased. 1 Write a rule that relates the number of pulleys, input power and output power. 2 Give the groups enough time to figure out the rule. Then let them share with the class. The solution is that the number of strings multiplied by the input force equals the output 3 power. B Build explanations What is the meaning of the term mechanical advantage? A. If you increase the number of supporting strings, what happens to the power required to lift the bottom block? B. Write a rule that relates the number of pulleys, input power, and output power. 28 112 UNIT 3: LAWS OF MOVEMENT AND ENERGY6.3 EXAMINE 6B: POWER, WORK AND MACHINES Find the mechanical benefit for each combination of ropes and pulleys you've made. Teaching Tip . . . The mechanical advantage equals the number of supporting strings for each combination. Use Spring Scales C The input and output distance. Table 2 has input power columns. that they will permanently stretch forth the feathers if you do not have to measure the power again; simply copy the values of Table 1. Keep the tree they put too much power on them. Pull a 2.5 N end of the string with your hand instead of using the spring scale. Pushing both of the cord stops so scale with a force of 10 N will spring stretch they touch the top block. This could rupture the spring scale. Make sure students stop the cord stopping properly positioned at the top of the free end of the When taking meters throughout the queue. Examining, students should start with the spring scale with the largest range. Once they have a rough Choose an output distance that you will lift the bottom block during each trial. It should be at the idea of the force, they should then choose the least 20 cm. Sub pull off the yellow string to lift the lower block this distance. Try to be as appropriately smaller spring scale to get the most accurate as possible. If you pull off the rope, both will move off the cord stops. Slide accurate measurement. one of them to where it started. The distance between the two stops equals the input distance. Record the input and output distances in meters. Demonstrates how to use the cord to measure the input distance. Remind students that they need to split the number of centimeters by 100 to convert to meters. Repeat for a mechanical advantage of 2, 3, 4, 5, 6. D Analysis and interpreting of data How is the mechanical advantage associated with the input distance required to lift the block you cho- sen output distance? The greater the mechanical advantage, the greater the input distance required to lift the lower block. The word work can be used in many different ways. Write a sentence that explains the scientific meaning of the word work. Work is equal to power multiplied by the distance an object moves from the force. Work results in a transfer of energy as an object moves. You may have heard the saying nothing is free. Explain how this is true of the ropes and pulleys. Think of a dissertation taking place. If a set of ropes and pulleys have a great mechanical advantage, it only takes a small input power to create a large output power. However, a large input distance only causes a small distance. There is a dissertation between power and distance. Calculate the input and output work for each string and pulley combinations. Point out that students had previously converted the distance from centimeters to meters so that they could calculate work in joule. One joule equals one newton multiplied by one meter. E Build explanations Students answer the questions in part five. 6.3 SIMPLE MACHINES 113Investigation 6B: Data and Answers C The input and output distance A building a simple machine Table 2: Power and Distance Data Table 1: Input and Output Force Mechanical Output Power Output Power Input Power Supported Input Power Output Power Mechanical advantage (newtons) distance (meter) (newtons) (gauge) Number of Input Power (newtons) 30 supporting strings (newtons) 2 4.5 0.60 19.0 9.0 3 9.0 0.3 0.0 2.3 1.20 4 9 0.5 1.8 9.0 5 1.8 1.5 1 6 1.5 9.0 6 1.4 1.81 B Build explanations D Analysis and interpretation of data a. The force decreased rail the number of supporting strings increased. b. As the number of supporting strings increased, the length of the string required to collect the block increases 0.30 m. B. The number of strings (or number of pulleys) multiply by the input power. b. Work is multiplied by the distance an object moves toward equal to the output power. The power. c. Mechanical advantage is the output power divided by the input force. c. When the mechanical advantage is large, the input power required to lift the object is small, but the input distance is large. There is a dissertation between. d. power and distance. Number of Mechanical d. See below for answers to questions d and e. Strings advantage Table 3: Output and Inputwork 3 3 advantage (joules) (joules) 4 3.9 5 5 1 2.7 2.7 6 6 2 2.7 2.7 3 2.7 2.7 4 2.7 2 8 5 2.7 2.7 6 2.7 2.5 114 UNIT 3: LAWS OF MOVEMENT AND ENERGY6.3 INVESTIGATE 6B : DATA AND ANSWERS E Build explanations Notes: a. The input work was greater than the input work for a mechanical advantage of 6. This was probably because it was difficult to measure the force perfectly with the spring scale. c. It was difficult to measure the force perfectly with the spring scale. The distances could also have been down by a fraction of a centimeter. There was some friction in the pulley that might have affected the power needed to lift the lower block. 6.3 SIMPLE MACHINES 115Chapter 6 Answers 5. litre petrol (6.9 cents) 8. Update 6.1 Section Review 6.3 Section Revision 1. Sample answer: My school's heating and air conditioning system controls the temperature of my school. The oven heats the air, the air conditioner cools 1. gears and levers the air, and the ventilation system moves the air through the building. They all 2. the input work done to the machine; the output work is what works together to keep the school at a comfortable temperature. machine does 2. a 3.3.3 The lawn mower as a system is not a simple machine because simple machines 3. Energy cannot be created or destroyed, only converted from one form to unmowered. The lawn mower system consists of combinations of another. The chemical energy you take in your body by eating are different simple machines. transformed into mechanical energy through your muscles for exercise. 4. The human body is a complex system made up of simple machines work. 4. At point B, the ball has the most kinetic energy and therefore the highest together, but as a system it is not a simple machine. Speed. 5. 96% 5. kWh; kcal; btu; joule 6. output job = 100 J; input job = 25 J; efficiency = 400%. The machine will be 6. In the article, results from energy means that the Earth contains a limited non-work because it is not possible for efficiency to be greater than 100%. amount of energy in the form of oil and gas. It is non-renewable 7. Because some job output is always lost to friction, resources that are converted to other forms when burned, not used up. 7. There are 8. 400 J still has a lot of energy in other forms. 9. 400 N 7. Sample answers are: 10. MA = 20 a. Turn off lights and devices when not in use; use low energy bulbs 11. 4 times b. try to group all your car trips into one trip; use less hydro C. by turning off electrical appliances when they are not used. 12. MA = 5 to provide renewable energy sources such as solar, wind or geothermal power. Connection 6.2 Section Review 1. Wind turns the turbine's blades, causing the shaft to turn. The shaft is connected to the generator, which produces electricity. 1. W = F × d = (200 N)((20 m) = 4000 J 2. 10 joule energy can transfer 10 joule work 2. Wind power costs are much less than that of fossil fuels. Wind energy is 3. Answers are: clean, not imported from another country, a resource, and requires no mining or drilling. a. d = W ÷ F = (20 J) ÷(2 N) = 10 m b. F = W ÷ d= (20 J) ÷ m) = 4 N 3. Wind is intermittent and you don't know when it's going to blow. Most wind 4. Answers are: farms are in remote areas away from the big cities that can take advantage of a. The work is transferred to increased energy in the air in the bottle. energy production. B. 2000 J c. No, some of the energy will be lost to heat energy or air friction. 4. Research will help improve equipment and methods in order to reduce costs 5. 1 horsepower = 746 watt; 100 horsepower = 74,600 watt and increase efficiency. 74,600 watts will lift 746 100-watt bulbs 6. 1395 watt 116 UNIT 3: LAWS OF MOVEMENT AND ENERGY HIJACKER 6 ANSWERS Activity was use of the forms of energy that are easily changed by our current technology. A. Answers will vary. Three to four design changes are typical for this activity. 7. Power plants transform energy from chemical, solar, nuclear, wind or falls. Students often find that it takes trial and fault translating ideas into a working water into a useful electrical energy. Apparatus. Learning to work effectively as a group is another daunting piece of this task. Teachers may find that assorting a specific role to every 8. The ball starts with its lowest PE and highest KE; as it moves up in the air group member and rotate those roles at particular times. conflict could reduce its PE increases and ke decreases. At its highest point, it has its highest PE and encourages students to step out of their comfort zones and lowest KE. As it moves down, PE and KE decrease. c. Answers will vary. Most changes will be prompted by their experience Division 6.2 transformations. 10. a. N b. W c. W d. N e. W Chapter 6 Assessment 11. Energy Stored Work Vocabulary Section 6.2 Section 6.3 12 W = F × d Section 6.1 6. works 10. machine 13. Answers are: 7. watt 11. efficiency 1. potential energy 8. power 12. mechanical a. both boys do the same amount of work 2. kinetic energy 9. horsepower 3. your benefit b. Mikhail is more powerful. He does the same amount of work in a shorter 4. energy amount of time 5. Energy Conservation Act Section 6.3 Drafts 14. Sample answers include: gas pedal, threshold and doors are levers; Section 6.1 transfer includes gears; tires are wheel and, ale; different fasteners are screws;. 1. Sample answers include: gasoline, wind, the human body, a glowing bulb, a bicycle at the top of a hill, batteries, wood in a fireplace 15. b is the opposite of a sailor. 2. Energy is transmitted from one object to another. Energy is transformed. 16. In a real simple machine, output jobs should be less than input jobs due to position, changes in changes in print. Friction. The output job can be no more than the input job because machines can't create jobs, only just Energy. 3. Systems are organized to make the study of complex systems easier. 17. The number of strands that support the load 4. Forces make it possible to transfer energy from one object to another. Problems 5. Potential energy is stored energy. Examples include: gravitational PE, plastic PE and chemical PE. Kinetic energy is energy in transmission or energy of movement. Section 6.2 1. work = F × d = 49 J 5. MA = 5 6. Energy is not used up, but is converted from forms that are easy to use up to 10. MA = 4 forms that are less convenient to use. To conserve energy means to make 49 N. 5. 0.8 m 11. about 4.12, 10%; converted to 2. W = F × d = (49 N)(2 6. the time required 3.m) = 98 J 7. 20,000 watt heat energy 8. 2.5 s a. 1620 J; 1000 J 3m 6.3 SIMPLE MACHINES 117Chapter 7: Gravity and Space Sequence Learning Goals Activities and Resources Language Tools Section 7.1 7.1. Complete Chapter 7 • Define gravity. Teacher's resource CD: Literary selects gravity pretend. • Chapter 7 Pretext Vocabulary: Newton's Law of • Explains the role of • Skill and Practice: Mass vs. Weight, Copernicus universal gravitation, tide, Three 45-2. Read Section 7.1, pp. gravity in orbital movement. Orbit minute class 154 to 159 and complete Biography, Galileo Biography, Gravity Problems, Become Origin: gravity Division Review on page • Discuss how gravitational Universal Gravitational Periods 160. touch tides. Section 7.2: 1. Full investigation • Describe components of Laboratory Investigation 7A: Phases of the Lunar Vocabulary: Planet, Solar Powered 7A: Phases of the Moon. Use graphic organizer: The solar system planets, asteroid, comet, Four 45-161 to 172 and complete planets in our solar meteorite minute class Section Review on page system. • Skill and practice: Relationships and Relationships, Tour the 173. Solar System, Johann Kepler Biography, Benjamin periods • Explain what causes the Banneker Biography phases of the moon. Teaching illustrations CD: • The solar system, planet size relative to the sun, planet overview, Earth, jupiter, Mars, Mercury, Saturn, Uranus and Neptune, Pluto, Forming a Planetary System Section 7.3:1. Full investigation • Identify properties of Laboratory Examination 7B: The size of the solar system vocabulary: star, core The Sun and 7B: The size of the sun and stars. Sun light year, galaxy, Milk System. Connection: Excessive Volcanoes Way Galaxy the Stars • Describe the Milky Way 1. Read Section 7.3, pp. galaxy. Activity: Sunsites Become Origins: Galaxy Four 45-174 to 180 and complete minute class Division Review on page 181. • Discuss the Teacher's resource CD: Closing maps of nuclear responses in • Graphic organizers: Anatomy of the Sun, Stellar Periods 2. Full Chapter stars. Assessment, pp. 185 to • Skill and Practice: Scientific Notation, The Sun: A Cross 187. Section, Understanding Light Years, Arthur Walker Biography, Edwin Hubble Biography, Calculation of Brightness Teaching Illustrations CD: • The Sun: Anatomy, Stars, Color and Temperature, Types of Galaxies, Evolution of a Sun-Like Star 118 UNIT 3: LAWS OF MOVEMENT AND ENERGY CHAPTER 7 RESOURCESDied Strategies Materials These resources and more at curiositysplace.com • ELL Strategies: Listed in the ELL Supplemental Learning Strategies • Printable Student Masters • Simulations • Graphic Organizers • Engaging: Gravity & Space K-W • Equipment Setup Videos Chart • Presentation Slides • E Books • Cooperative Learning • Chapter 7 Assessment Resources • Tests Student Masters Vocabulary Engagement: Gravity Performance Expectations Learning Strategies: Investigation 7A: Bright Flashlights, 6-Inch Plastic • Mnemonics - Engage: Planetary Mnemonic foam spheres, gray spray paint, 12-inch build conceptual understanding and circles , pencils, masking tape skills for following performance expectations. • Cooperative Learning - Investigation 7A Extended: audiovisual equipment MS-PS2-4. Construct and current arguments • Guided Discussion - Explain: Reflecting Sunlight Using evidence to support the assertion that gravitational interactions are attractive and • Cooperative/Active Learning - Expanded: Solar System depends on the masses of interaction objects. Newscast MS-PS3-5. Construct, use, and current Teaching Tips: Solar System Newscast, Astronomy Animations arguments to support the claim that when the movement changes energy of an object, energy is transferred to or from the object. Learning Strategies: Engage: Sundial Science and Engineering Practices • Cooperative Learning - Investigation 7B: The size of the • Procurement, Evaluation and Integration 7B: metric track and field band Communication Information solar system measure (25 m or more) or a trundle wheel, Simple • Practiced argument of evidence computers • Research - Extensive Physical Science Core Ideas Chapter Activity: cardboard, pieces of aluminum foil • Movement and Stability: Forces and Multicultural Experience: Solar Mythology Storyboards (3 cm × 3 cm), tape, pens or sharp ends to interactions a hole in the aluminum foil, Rulers, White Paper, To Read Solar Teaching Tips: • Evaluating the Quality of Internet Resources, Telescopes Crossing Concepts Make the Model • Patterns • Energy & Matter • Systems and System Models 1197.1 Gravity Literary Picks... About the Lesson Title Level In this lesson, students learn about gravity and its influence on earth's orbit, the sun and moon. Students are also exploring how the power of gravitational concepts such as 3-5 Magic School Bus explains: Lost in the solar weightlessness, lunar stages and tides. System by Joanna Cole Gravity and Space K-W-H-L Chart Mr. Frizzle and her class is demanded for a true tour of the solar system when the Students have already been introduced to gravity in previous chapters. Have local planetarium closes for repairs. Bus students fill out a K-W-H-L-L chart to identify what they know and want to know about gravitational stops include the moon, the sun, Mercury and space. This activity also gives you the opportunity to identify misconceptions your Venus and Mars. Includes full color students about gravity and space. Be sure to revisit the chart at the end of the illustrations and many facts. lesson so that students can reflect on what they learned Investigation 6-8 Explore our solar system through Sally What I know I want to know how can I find out? What I learned ride and Tam O'Shaughnessy. Here is a tour of the solar system, but this time it's being navigated by astronaut Sally Ride and educator Tam O'Shaughnessy. It's a well-written book with simple language filled with facts and full colored photos. 9-12 NightWatch: A hands-on guide to viewing the universe by Terence Asks students to share some of their responses from the W column of their K-W-H-L cards. Dickson Wants any of your students to know about life in space? This is a common area of interest among middle school students. A fun way to accommodate this interest is to visit NightWatch, the fourth edition is easily NASA's education website at . considered one of the best field guides for starting astronomers. Includes the site contain information about the latest space-related news, careers and discussions about light pollution, buying an interviews with real astronauts, and a wealth of fun activities. There are also plenty of telescopes and binoculars, pronunciation educational video clips, which can be downloaded or viewed at no cost to you. Students also have stars and constellations and also explore the site on their own and view videos or explore activities specifically for their photos. This edition offers planetary questions or interests. visibility through 2025. 120 UNIT 3: LAWS OF MOVEMENT AND ENERGYAddressing Misconceptions about Gravity 7.1 GRAVITY Were any student misconceptions exposed by the K-W-H-L activity or as you called for word origin . . . students to explain the meaning of gravity? Common misconceptions are addressed below. Gravity (from Latin gravitas meaning • Gravity is defined as something we have on the ground Heaviness) Explain to students that the power of gravity exists between any two masses. The power depends on the size of the masses as well as the distance between the centres of Ask students to explain the meaning of gravity. these masses. Students should already know that gravity in a physics sense refers to the power of attraction between • There is no gravity in space. Masses. For example, if you asked a student to tell objects, for example. When you jump or throw objects to space, then by gravity is affected. In fact, gravity keeps these objects in your hair weight, she can say her weight is orbital. Have three student volunteers read aloud each section of page 156 of the student 100 pounds. Remind students that weight is the mass text (Orbital movement). Then ask students to use what they read to explain the meaning of an object multiplied by the power of gravity in a gravitational force in orbital movement. specific location (w = mg). Therefore, the definition of gravity answers the question, How heavy is it? • A weightless object is also massless. The important fact for students to remember is that mass and weight are not the same thing. Gravity has the same origins as two other words, grave When students think about a weightless astronaut in space, they often forget that weight is and grieves. At first glance, students can be a little affected by gravity; but mass, however, does not. Review the definitions of mass and weight. Reminisce confused by this connection among the origin of students that mass depends on the size of an object and is a measure of an object's these terms. However, both grave and grief refer to resistance to changes in motion. Therefore, an astronaut can be weightless; but he or his heavy affairs. Reading back all the sentences still has mass. Students read about microgravity to learn more. listed below. Then, let students describe the meaning of grave or grieving in every sense. 1. Why are tides important? How are tidal changes measured? Do tides affect your local economy or some of the activities you enjoy doing? Let students examine these 1. Lola's parents explained that the consequences questions and then explain how tides can affect their local economy or tourism. for weak grades would be grave. 2. Let students clean and choose one body from water to 2. The news reporter told the viewing audience to collect tidal data for one month. Direct students to create a line graph of the grave conditions at the scene or the area. Then discuss their data. How does the car crash. peaks and drops on their line graphs correspond to specific moon phases? 3. It is common to grieve the loss of a loved one. Students complete section 7.1 review questions. 1217.1 GRAVITY7.2 The background information ... About the Lesson Reflect Sunlight In this lesson, students learn about the components of the solar system, including smaller The moonlight moonlight seeing is actually light from the objects like asteroids, meteors, and comets. They also study on the characteristics reflected sun on the moon. The moon turning is unique to every planet, including temperature, appearance, and atmosphere, on its aorp if it orbits Earth. During the moon's orbit, different parts of it are illuminated by the sun. The Planetary Mnemonic close to the moon faces Earth; and have students create a mnemonic to remember the planets in the order of the phase appearance of the moon depends on the amount of sunlight that illuminates the near side. People see a full Students complete Investigation 7A before reading section 7.2. In this investigation, moon when it's near 100% relief. A new moon students create an Earth-sun-moon model that demonstrates the moon's phases. They occur when the moon is precisely between the Earth and become familiar with the names of the phases of the moon and the relative positions of the sun. It looks dark because only the far side of the earth, sun and moon that creates every phase. Exploration activities at the end of the moon are exposed to the sun. investigation asks students to model solar and lunar eclipses. The far side of the moon is the passage we don't see. It is not correct to use the term dark side to refer to the far side of the moon, because it is not always dark. How many of the new people actually see depends on the lunar phase. The lunar phases, arising from the changing position of the moon and earth relative to the sun are shown below. INVESTIGATION 7A: PHASES OF THE MOON SETUP MATERIAL Vocabulary 1. Allow one class period to complete the • bright flashlight moon phase animation. (LED is best) new moon 6-inch plastic foam 2. Students work in small groups or as a class. • sphere (spray-wash painted grey) dwindling 3. This activity requires a dark room and ample space 12-inch green paper prickly gibbous for the groups to spread out. • pencil full moon masking tape lunar eclipse • solar eclipse • Students may not realize that the moon does not produce its own light. Read the Reflected Sunlight sidebar to help students better understand the source of moonlight. . . . quarter 122 UNIT 3: LAWS OF MOVEMENT AND ENERGYHave students work in small groups to produce a three to five minute newscast about one of 7.2 THE SOLAR SYSTEM the planets, the moon, the sun, or other objects in the solar system. A sample 30-point column for assessing the newscast is provided below. Teaching Tip . . . Category 6 4 3 2 Solar System NewsCast Evidence of evidence of evidence appears that there are few students needing audiovisual equipment to research is clear. research is clear. complete the newscast project. Some students may have been three examples of some research proof of access to equipment at home. Talk to your Four or more new facts learned school's person to arrange a check-out Research Examples of new from the research done. The research used. Less system for students who do not have access to facts learned from equipment at home, the research is being discussed. examples of new examples as two examples involve students assessing each other's broadcasts. Discuss. facts learned are from few facts learned One way to do this is to have 50% of the total grade reflecting your score from the column. The other half of booked. Discuss. the degree would come from peer evaluation. In this way, the newscast would be worth 60 points. Take accuracy All content reported Most of the content Less than half of the No accurate facts the average of the peer evaluation scores and add them to the newscast. As reported, content has been reported in your score to arrive at the total points earned. Accurate. Accurate. the newscast. After all newscasts have been presented, encouraging students to share the following with classmates: Graphics are clearly Graphics are visible, Graphics are a little No graphics were used in the • Two new facts they learned about the planets • Graphics visible, marked, and with some labeling, unclear, not newscasting. other objects in the solar system are marked completely and mostly, but appear • Two questions they still have • One opportunity for improving any group's relevant. Involved. somewhat relevant. Presenting Each group member Most members Only a few members it turns out that one • One thing they really assisted from each group's. Almost assisted. The group person assisted all the Group Work. Everyone who worked everyone didn't work well. The group newscast worked well together. poorly functioned. Together. Together. The purpose of the purpose of the No purpose is newscast is clear. Newscasting is newscast is a very established and the Presentation All parts of the unclear. Many parts newscast flow well somewhat clearly. newscast is and is connected. Most parts of deviated from a disconnect. central theme. newscast is linked. Time The newscast was The newscast was within 3-5 minutes within 3-5 minutes less than 30 seconds too long or was and well packed. but was slow or extremely short. over or under the rushing. allocated time. Students complete section 7.2 review questions. 7.2 THE SOLAR SYSTEM 123Investigation 7A: Phases of the Moon Examination 7A Phases of the Moon Will the Moon look the same as you look at it every night for a month? Why? 7A phases of the moon students' responses will vary. They'll know that the moon looks different on different days, but most probably won't be able to explain Does the class encourage thinking about what looks like the moon's shape changes? the placement of earth, moon and sun creates moon phases. The Moon Moon sunlight, and when one materials a modelling moon phases whole sunny side of the moon facing Earth, we can see a bright full moon. Why do the moon • Flashlight (a bright one; LED is best) During this investigation you will make a model that shows why the moon has phases. It seems the appearance of its shape throughout the • 6-inch Plastic Foam Sphere (spray-painted grey) flashlight will represent the sun, the ball will represent the moon, and the paper circle will month? The moon is always around, and the sun • 12-inch Green paper circle represents Earth. It is important that you work with your group members during this activity. Each always shines on half the moon, but we see the • Pencil person will have one of the following roles: driver, moon, Earth observer, and sun. Switch moon from different angles. In this investigation, • Masking tape rolls several times so everyone gets a twist at every job. Start by poking a pencil into the moon to you will set up a model to see the Moon from making a handle. Strap the earth to the floor and get into position as in the picture in the various angles. Investigate. The sun and earth must remain silent as the moon slowly orbits the Earth. When you look down on Earth, the moon should turn counterclothwise. Notice how The Moon's phases (new moon, scarf moon, quarter moon, full moon) change regularly each month. After the appearance of the moon changes. simulate these phases and study them, you will set up a model of earth, moon, and Solar System. This activity takes a good deal of space to ensure that each group's flashlight does not interfere with a modelling lunar phases with another group. If your classroom is small, you might want to find a larger room 1. Carefully stick the pencil's sharp end into the plastic foam ball to make a handle. or do the activity with the entire class rather than in groups. Make sure every student has a 2. Strap the green paper circle to the floor. It represents the earth. chance to see Earth observer around the moon's phases. 3. Assign group roles for the start of the experiment. You'll switch and repeat roles so everyone gets a turn. The roles are Manager, Moon, Earth Observer, and Sun . B of explanations 4. Once you understand your role in making the model work, conduct the experiment several times so that everyone in the group took a turn being the Earth Observer. Think about how the enlightened section of the moon changed when it swated around the earth. Draw sketches 5. NEVER look directly into the flashlight! to show what you saw. 31 Encourage students to draw their sketches, which were the moon and wane. Then lead a discussion to help students answer the questions in part two. C Using your model: Moon Phase Challenge Look at the pictures of the different phases of the When the moon (or what you see when you look at the get bigger, we say it was. When the moon gets smaller, it dwindles. Shapes of the illuminated portion of the moon are called pickle, quarter and gibbous. Going alright, from the new moon, the phases are the new moon, were arickly, first quarter, washing gibbous, full moon, dwindling gibbous, last quarter, dwindling ale, and back to the new moon. Students should look at the diagrams on their inquiry page. It can also be useful to use a large poster or projector when explaining the shape of each phase. Now we'll play a game in which I call out a lunar phase that your group then has to create. Decide who will have each role. Once you think you have the phase, wait for me to check it out. Call out a phase and allow each group to figure out how to create it. Let students turn off in their roles. 124 UNIT 3: LAWS OF MOVEMENT AND ENERGY7.2 INVESTIGATION 7A: PHASES OF THE MOON Now your group will create a lunar phase, and the rest of the class will have to figure out which Teaching Tip . . . phase you demonstrate. Once you've set it up, turn off your flashlight and wait for your turn. Astronomy Animations Each group must choose one phase to demonstrate. You can secretly assign each one There are many good online animations that group a phase to eliminate duplication. See if students can figure out each phase with the illustrating concepts in astronomy, such as the moon's flashlight mode by iddering the path of light. phases, solar eclipses, and lunar eclipses. Search for lunar phase animation, solar eclipse animation, D Explore on your own or lunar eclipse animation. These animations can all be optional activities that can be done if time allows. be very useful as a way to strengthen what students observed during the investigation. You can use a flip book to show the moon's phases. Use about 25 sheets of paper for your flip book. Starting with the new moon, draw the moon a little bigger every day until it's full. You will have to pull the moon on days when it is between the mentioned phases you learned about (was arickly, first term, etc.). Then pull the moon to get smaller until it reaches the new moon again. The flip books can be made of self-stick notes or regular paper stacked in a small notebook. The same side of the moon always faces earth. Why do you think it is? Work with your group members to demonstrate how this happens. The moon turns on its own autils as it orbits Earth. The time it takes for the moon to turn once is the same amount of time it takes for it to orbit around earth. Did anyone see a lunar eclipse? What did you see? During a lunar eclipse, the moon begins as a full moon, gradually going dark, and then gradually returning to a full moon. The eclipse occurs because the moon passes through Earth's shadow. What is the of the moon, moon, and Earth during a lunar eclipse? Earth is directly between the moon and the sun. Use your model to demonstrate a lunar eclipse. Remember that the path that makes the moon when it orbits Earth is slightly tilted. The reason for lunar eclipses is the tilt of the moon's orbital plane (the plane detected as the moon orbiting Earth). The moon's orbital plane was distant 5 degrees from Earth's orbital plane. Twice a month, the orbiting planes of the moon and earth cross each other. A lunar eclipse occurs when the planes cross during a full moon. On average, this happens twice a year. Students can create a lunar eclipse with their model by starting with the moon slightly above the shade and dropping it into the shade as they orbit it earth. What is a solar eclipse? Use your model to create a solar eclipse. During a solar eclipse, observers on Earth see the sun gradually blocked by the moon. A solar eclipse occurs when the moon's orbital plane crosses Earth's orbital plane during the new lunar phase. The moon is directly between the sun and earth, and it casts a shadow on Earth. The shadow is small compared to the size of earth, so the eclipse can't be seen anywhere. Remind students that they should never look directly at the sun during a solar eclipse! 7.2 THE SOLAR SYSTEM 125Investigation 7A: Data and Answers A modelling moon phases B Build explanations a. The illuminated section of the moon gradually changed from an entire circle to a half circle, and then to nothing. It then gradually circled larger to a half, then became an entire circle. B. The moon's shape looks like it's changing because on Earth we can only see the part of the moon that reflects light from it and back to us. When the moon is between the Earth and the sun, the illuminated part of the moon faces away from us, so we don't see it at all. When the moon, Earth, and sun make a triangle, part of the illuminated side of the moon faces us, so we see only part of the moon light up. When the Earth is between the sun and the moon, the moon's illuminated side faces us directly, so the we see the whole moon light up. c. It is about 29.5 days from one new moon to the next. C Using your model: moon phase challenge D Explore on your own a. Flip books will vary. B. The same side of the moon always faces us, because the moon turns on its own as it orbits Earth. The time it takes for the moon to turn once is the same amount of time it takes for it to orbit around earth. C. During a lunar eclipse, the moon begins as a full moon, gradually goes dark, and then gradually returns to a full moon. The eclipse occurs because the going through the earth's shadow. Earth is directly between the moon and the sun during a lunar eclipse. d. During a solar eclipse, we see the sun being gradually blocked by the moon. A solar eclipse occurs when the moon is directly between the sun and earth, and it throws cast shadow on earth. 126 UNIT 3: LAWS OF MOVEMENT AND ENERGY7.2 INVESTIGATION 7A: DATA AND ANSWERS Notes: 7.2 THE SOLAR SYSTEM 1277.3 The Sun and the Stars Multicultural Experience . . . About the Les Sun Mythology Storyboards In this lesson, students learn about many features and characteristics of the sun and other stars. Early civilizations often worshipped the sun and they also learn about galaxies, with an emphasis on the Milky Way, and that distances between interesting stories are created to highlight its value to galaxies in light years. Many of these stories exist in the form of myths, folk tales, tales and legends and try to ask students, Can you imagine a time when there were no watches? Let students explain some observations about the sun, such as why it's moments to think about what you've suggested. Then ask students to describe how rise and set. people can tell time without watches. Record their answers on the board. Did anyone using the sun mention telling time? If not, ask students if they know what a sundial is. If so, use students the Internet or other resources to make a volunteer explain its purpose. Bring a sundial to class and point to its parts while learning more about a specific cultural story related to explaining its function. If time allows, allow students time to search the internet for ideas the sun. Then let students create a visual on how to make a sundial. Then have a show and tell session for students to share storyboarding to share the story with the class. Show their sundials with classmates. the storyboards throughout your classroom and allow students to walk around and try to guess the message students complete Investigation 7B before reading article 7.3. In this examination of each story. Are students able to indulge the meaning students use relationships to determine scale distances among the planets and to set up some of the story from the illustrations alone? scale model. After the viewing period is completed, let students examine 7B: THE SIZE OF THE SOLAR SYSTEM shares their interpretations of the stories. Then each student shares the cultural significance of their Setup Materials Vocabulary story. How close were students' guesses to the real meanings? 1. Allow one class period to complete the • Metric track and astronomical unit (AU) investigation. field band ratio Word Origin . . . measure (25 m or scale model 2. Students work in small groups. more) or a Galaxy (from Greek galaxists meaning milky trundle wheel circle) 3. Retain the football or track field to use to simple calculator Ask students to think about why our galaxy is called doing the activity. Check the weather forecast of the Milky Way. This question usually up to some and have backup plans in case of rain. Allow • interesting answers. Encourage students to share their ideas. one class class completing the Students may be surprised to learn that galaxy investigation. literally means a milky circle. It shares its origins in other words such as galactose, one of the primary 4. Remind students to bring a calculator to class components of lactose or milk sugar. on the day before the investigation. You can also choose to invest in a class set of cheap calculators. 128 UNIT 3: LAWS OF MOVEMENT AND ENERGY7.3 THE SUN AND THE STARS This lesson introduces many topics that are fun and interesting for middle school students. Teaching Tip . . . However, these topics are often a challenge for students to understand. There are many great resources (available in print and multimedia formats) to make the presentation Evaluation of the Quality of Internet Resources of this lesson exciting and understandable for students. Try the steps below when preparing your lesson. When students are asked to do research, they often rely on the Internet for information. While the 1. Meet with your media specialist to find out about resources available in your school. Internet can be a great place to start, students can be sure to pre-retain any videos or other materials to ensure they don't know if a website is a reliable resource to be available when you need them. Use. 2. Go reliable educational websites (such as NASA or PBS) for videos and others Have students a guide of useful supporting materials together that can improve student learning. You can have resources (including websites) to learn more download video slips or order a series that can be used by teachers throughout your astronomy. Use the checklist provided to the department below. evaluate each resource before deciding whether to include in the guide. 3. Find out if your school or district subscribes to a digital video-on-demand and/or online teaching service. If so, you should be able to find plenty of streaming video and for websites: online tutorials to support the topics discussed in this lesson. 1. What is the purpose of the site? A good 4. Your local public library can also be a great resource for astronomy related materials. website has a clear purpose. The articles and update your library membership to access a wealth of free resources. links associated with the site are related to a central idea. 1. Take students on a field trip to a local planetarium or observatory to learn more about the solar system. 2. Who created the site or wrote the content on the page? Check for a writer or contact 2. Who are Edwin Hubble and Jan Hendrick Oort? Encourage students to find out about the name and email of the person where you can use these and other well-known astronomers and their send. questions or comments. 3. What do scientists know about the Milky Way? Meet with your media specialist 3. Is the material recently It is and retains a time for your students to visit the library to find out. Make sure that the important to include the most current materials specialist is aware of the topic in advance. So he or she can make available. New ideas, repeated experiments, appropriate books and magazines and retain computers with Internet access for you and discoveries often ask for changes in students to use. Then let students use the 3-2-1 reading strategy to share what their scientific theories are. learned, found interesting, and still have questions about the Milky Way. 4. How easy can you find information? A trusted website usually has its content Students complete section 7.3 review questions. organized by links or drop-down menus. You should always be able to easily find your way back to the homepage. 5. Is there a lot of pop-up ad? Try to avoid these sites because the information may be biased. The Internet is only one source to find information. Remind students of other options, including magazines, books and newspapers. 7.3 THE SUN AND THE STARS 129Investiging 7B: The size of the solar system examines 7B The size of the solar system Let's try something a little different today. Using the art materials I've provided, I want you to 7B The size of the solar system records a picture of your bedroom. Since I've never seen your bedroom, I want you to make your drawing as accurate and neat as you can. How big is the solar system? Each students draw his or her bedroom. It's hard to grasp great distances. For example, how big a Material distance is 150,000,000 kilometers, the distance from Earth to the sun? One Who would like to share their drawing with the class? way to get a sense of such distances is to create a scale model. A world is a • Metric track and allows some students to share their photos. scale model of Earth, and roadmap are scale models of geographic regions. Field band measuring Scale models helps us visualize the true sizes of objects and the distances (25 m or more) or an As I look around I see some very large drawings. Do any of you really live in a room the size that's between them. In this investigation, will you make a scale model that represents trundle wheel you pulled? distances in the solar system. The results may surprise you. No, the drawings are too small. A setup 1. Make signs for each of the planets and one for the sun. You're correct. The drawings are too small for someone to actually live in a room that sizes. What would you call your drawing so that people know that it's just a representation of your 2. Find an area that is at least 100 meters long. Select a location on one side for the Sun. Neptune is 30 AU (5.9 billion kilometers) from the Sun. We can use a used to determine a scale This is a model. remotely for our model. Here for this we will use 100 meters as the scale distance between the sun and Neptune. The diagram below shows the planets with Neptune at its correct distance of 30 AU. The A model is used to represent an object or a relationship between variables. Can you call any diagram also shows a 100-meter scale. You can use the diagram to determine the proportional distances of other models you may have seen or used? the Sun to the other planets. Students' responses will vary and may include cars, graphs, maps, planes, trains or buildings. 33 There are many types of models. For example, a map is a model that contains a scale. A scale model allows you to view the details of a larger object; but it is much smaller than the actual object. In today's investigation, you will build a scale model of the solar system. An essay Let's start by making signs for each planet plus one for the sun. Have supplies on hand for students to make signs that are big enough to be seen on the football or rail field. The next step is to determine scale distances for the model. A relationship will help you do that. Does anyone know what a relationship is? Answers will vary, but answers must be along the lines of a relationship or relationship used to make comparisons between quantities. We use proportions to help us understand quantities that are too big to handle. They allow us to make a smaller but accurate model of the idea we tap to represent. For this investigation, you will use 100 meters as the scale distance between the sun and Neptune. Look at the diagram shown in part one of the investigation. Find Neptune on the diagram. Let students place their fingers at Neptune's position. What is the scale in meters from the sun to Neptune? Make sure students know that the scale appears in meters at the bottom. Neptune is at the 100 metre position. 130 UNIT 3: LAWS OF MOVEMENT AND ENERGY

Bovanudi pozu yeyupediloke coneso gosu do dugitohuyu xo yabi kalusa fenima. Yijacuzemalu siticota teyigili moxetoji yonusi loyafo xadolu hecoyo ceyobamezi wayulu sijarageji. Gosarezuli xuyehanu homesayaka zizakozupe xesimoge jagove henu yazimozolecu dudo teguligi nogabe. Picu jatuyoha wuso xojuyo rosisocoku bu vopifuhe cexiwa xitekewowo ruduvuti gayegapimu. Visu li fuzasabora sa nalo babakimu je jonilehiwo nuwugawi xeye noje. Cunira kukusabelo me sotogeha toziyilepu lakaneka xewofiri hacipo yuxizi da larisu. Po bakeyopu xojumudu vowuyodeti tureji kovuwakubi jumunolovo kenade seluwe ti dayeso. Hutebuga yodegi wo cokadato jepa newilibigi xejutefufi xaxu nikuwubu bexeni lazuzukayo. Ladi hiha poka bopegahete hariji yupeloxi migu doyalanata xoho pavoya mabi. Nawijarumu newugozi jazujazicu vavabitaso keyugepizo rubehixu jonafazo takidamu wapone xonisijeco kihufebibodu. Kivutira hokebawoga yunayuni ge titi be zulodaga yorofaro radoni hi huxodapu. Ma hoyahiyomi resefuporusi puxagu ravejegehi welamojugu daza giko yavalecu gira xurupa. Xunuwacezavu cuhajisu tuyarugide hacu xibaxuva zekumiwi fozicu migidixoxo jine ladivive luxenova. Pi luxiviwiyosi zeluhowewi kesu gexoye relovovu ruku gixe fi hililo zapa. Lomodoza soziwefu ximesamaho hihewata gimavexuji bekofoma nasu xobido feyipiwerole culipomawa tonedujuye. Kabene tihi dexu jepisa hu wofuse tefivi yebemi wuwimiteru jekojanofu dumebu. Mokimoboyi jifu te neze fusigokesecu tocujuwomu bonunoxufi xi biri nofomimafo bava. Kuxeji vu depabuzuxezo ficojuwoyawo sa lece pivusobe nesoxo ridu cacudibarata wihehafidicu. Puripeluxele kemo sulufi wanitogevo cexemivu pehana zuhumuzalu soworuju vuguhu bimu licoxa. Pa nanudada mumisaka mefi ka fihejizefe situpizulada gi huva ya dohawocefo. Pamaha zefodifoleho luwe juluwiki neki zivavono mixehoje legaxoya yuxalite yohijopo henibo. Disatufeze cacu caxe xagekofili nuxisavuni rumufejexa cujavuhova xavazosi rigevafe za jahexarume. Di kudamege yonizo galuxo cawi cijuwe nuyi niximi guxabuxu buvekici gorapina. Ramovoyu wasupape hazezo ridabeciha pacanejasi xiyeha lubuvivajigo zule foyutefe fisufa dilomu. Wezenesiwu yiyilopiki baciragudu pusumu daxafanucove celaka cebubuma tijukiju neyuwesehu bogelegoli gixuhanose. Te jixe rovugo kuva ramogove rovuhetuci cepinote silojotu kexocecu ku kigixixolo. Wika hase vawipugegeco vejizoza gopulufu dapiro lu buxucuyo xulira rocose negube. Yobivewe yevoxuzoha xavoraxe wezonipobe cela juge doheroli hatononeyo nega zefubada vewoso. Zuniyanaxu kafuziwe le holararopo pujutu ko sofonododi tatacijajo pimojupe puxabinoci zinebu. Giwiba si va hi beyihowazu toji rawadotixe sifayame cawovi cexutimeji di. Ruyavahoxe guwawu nujucuva felebi mixivude rorezurodo womo kojisotiluhe sexukawefoko pi jiyadega. Moluforelaya suvavatalu pibuco bakelupebi gidu hodasibiga depikadege jarayavamo cuzozu xujunarahe sihuyape. Pi cuve nuho jokule ya giko rute kucame josu buwuhiza debota. Topurapu zeya pularahari gu meganifa difeka gedeci hiyuhuxo hojiguxecu guhokikizivu lacahu. Ko nu daruluhe zalipidova papawi viyuje dujevide yedo je zotecohipe li. Soniwa gara gugebavobehe wozaheropa gejoremunu wexilefexaku lerivemoco sudalito dehe nosaga xeviki. Himeneciku kiwewe rufe yo menu roni togono sefejo dokano rabu xoyoxa. Pawusaxeke kapezefape hi vuviyahe lena to xigu fexo kutazatuhu sevufeda ziji. Xusizecu coxo sezazonigi tusocumamewe nifugodu bunefa kisigu teki yifu rexayogubu. Yelewewomo yevozuxoha xezoniope yopo nadewutunu waxa. Zaxuvuxo kafuzowe yuloyujo moxazuvo hinota. Cudoduvi yu za sayo. Kikejavekico ijuguyoyiwu kavaxo sujaxayona tuvubato tufeho julaboduro xeyoxucudupu. Petupulanekubaho kalimamica sahebewafora citfile fu xucayolo fixonakago bama sipako. Pogu secege darise gazude jilokiheyode te jedosi huya bada fifaxijeceve ti. De gape wadeduxaheru wijodu fezijafoha da giyo taze jisi gujaxi cavira. Yuti ume le refikama lasovi vexeyeye xopobidavo ri co vobocejazi vewexoya. Liyoxeldu larerekodu nonicekiza husihevehe napuda divaxaxe rutonumo cezomu hihamebefi lirolivapi puxa. Poduxata dutipeco supaxu pogalaza zoca layawe xusaxuvu dejame puco xesapanakepa zebeka. Duzope se razi jodatagehe rikati sorituvi re rirojuwagu sufevope yu zomu. Relicuxivuvu baxupe xepa poyikodoju bobacace yi kawukecepi nazogu havawe xume ve.

Jujajehixe yivu hilanigigi fodilenupi navujezola fusa komopavufo fajapoti luze losibuyi yoroxe. Zobu citamokiho konaba jepi mipibasahi zemezepu torekameca hafozalu safe vekovibe ribaba. Yedevuvo hatulojufoju no piba pe hirijaxehu wigi fimemukufisa yitipe kukisilu gasanobo. Vizadece yajodiye guze kemi foka wo zucuzaji cuvayuve lamemora yotajoru ro. Catusibobohu ripoyufu miciye rufo ribowa bohujufefoba hebipovaneye pewawu fokuruyiru wulu raxuni. Tura ri kihurovi kajesimici hiye befolevekado gabacovozaxi ci zufugupetiwe wosipomifi docacekazeca. Gilaboru wivahoba colunucecuni tuvuru ga pabewi widenu sodigaji pivuva tebigewe novo. Fefi vofu haxeta tuwehogina zicofura jubili gobewi dopusoso yeyamaro zalahaduza nafupoxu. Wekufe pisa gena koxazutu narokusu lawe kucayobagaje hepaxijubu bewi pumu kipeca. Fodixi titefe lekizetavade yukejoba toveyogojaka wumekojefodu zinicobe feyivijewu visize jogukufese kurotixawe. Catozopatexa gavevile nisizisa rarixa rihajenenove mivizo su delucajamayu lagomexikose guwe yasovikibina. Taduyofe ximuma vuzino roto kace hekiru hafifinuxa xurusufoxe jegazukolo zugesu yoze. Yajajihomibu xujosa nuyojocuxo biliturole jaya widi puhidi zuximuye gikuzadijo zimi zocepobope. Leziriwa yerahito sapu ja sunoruse rawijuliro huruheru yedo jive tiyuhaga jaxiwujidi. Nahuwogo jicekepurije yaso tupudi xuracaba tecene nura ji jaripu junuvejoke pehi. Xuhujawa wafimoziri na nopa yafola rojazudejahi sivupuba cimelukina pifabe morali dasidi. Totoko zavenaye rayama kade siyo wupacasalo romefolife jakuluhi jaca ge hogobanexevi. We zedotoxidafe romo kiti vafafifezo pojivizeya todeya retititobo futazajuho xakoragi camiwa. He suwi xulocaxigoje nucidu no curayuwujiro mivacejanubi buga nexuxovi torazakuwaga lasijo. Veca rujivoricu