Activity 5: Kinetic energy. Math and relationships

Learning intentions

Students will learn what kinetic energy is and the mathematical relationships that describe it.

Materials

- Imagination and problem solving

Teacher Notes	Student activities
This Activity sheet contains thinking-based activities for different year levels, so you can be selective in what you choose to do. See Activity 5, 6 and 7 for some hands on-experiments that enable students to test out the ideas/concepts explored in this Activity. **Forms of energy** The two main forms of energy are potential and kinetic and each have different types. Others energy forms include light, sound and thermal energy. See Activity 4 for an exploration of potential energy. For an in-depth-look at light, See FLEET Schools teacher resource, Light: reflection, refraction, diffraction **Kinetic energy:** Kinetic energy is movement, or the energy of a moving object. To get an object to move we must apply a force. The amount of kinetic energy something has is dependent on its mass and velocity (how fast it is moving). The greater the mass and velocity, the greater the kinetic energy. If something is not moving then it has no kinetic energy (but it will have potential energy). We can express this relationship between energy, mass and velocity mathematically: Kinetic energy = $\frac{1}{2}mv^2$ Where m=mass (kilograms) and v=velocity (m/sec). For example, if your speed (velocity) doubles, your kinetic energy will increase four-fold; if your speed increases five-fold, your kinetic energy will increase by a factor of 25. Mass also affects kinetic energy. What would happen to the amount of kinetic energy if you doubled only the	Question 1: Let's take two skateboarders that each weigh 70kg (mass). And this time they are on electric-powered skateboards. One travels at 20km/hour; the other at 40km/hour. Which skateboarder will have the most kinetic energy? Try to explain your answer. **For year 7-9** Calculate the kinetic energy of each skateboarder using our understanding of the relationship, Kinetic energy = $\frac{1}{2}mv^2$ Where m=mass and v=velocity (m/sec). Let us look at Question 1 again, this time we will use the above relationship to quantify the answer. Consider our above two skateboarders again that each weigh 70kg (mass). One travels at 20km/hour; the other at 40km/hour. Use the relationship, Kinetic energy = $\frac{1}{2}mv^2$ to determine the kinetic energy (joules) of each skateboarder. What did doubling the velocity of the skateboarder do to the amount of kinetic energy? Here is something to consider when students get their driver's licence. Which car will be harder to stop (using the car's brakes). A car weighing 1 ton travelling at a speed of 100km/hour and carrying nothing except the driver, or the same car (and driver) travelling at the same speed, but with 1 ton of bricks in the back?

mass (speed stays the same)? Answer: you would double the kinetic energy Students can check all this for themselves. Plug in some numbers to the equation (relationship) and see what happens to kinetic energy when you double the mass, or velocity. Speed, mass, energy…Does this sound familiar? See below. Answers to Question 1. For the skateboarders, hopefully students will intuitively understand that if you go faster or have more mass you will have more kinetic energy. Quantification Effect of change in velocity Skateborder 1 travelling at 20km/hour (remember to convert units) $KE = ½\ 70 \times 5.56 m/sec^2$ KE= 35 × 30.9m/sec KE= 1081.5 joules Skateboarder travelling at 40km/hour $KE = ½\ 70 \times 11.12 m/sec^2$ KE= 35 × 123.5m/sec KE= 4320.1 joules (Or 4 times more energy than when travelling at half the speed.) Effect of changing mass Ute without bricks $KE = ½\ 1000kg \times 27.7778 m/sec^2$ KE = 500kg × 771.6 m/sec KE = 385,802.5 Joules Ute with bricks $KE = ½\ 2000kg \times 2.77778 m/sec^2$ KE = 1000kg × 7.716 m/sec KE = 771605 Joules (or double the energy of the ute without bricks – half the mass) Question 2. Question: What other famous equation describes a relationship between energy, mass and speed?	**For years 7-9** Calculate the kinetic of each vehicle. How did the level of kinetic energy change? What do you need to consider to make sure you stop in time? How does this compare to the kinetic energy with the skateboarders where you only changed the velocity? What can you say about the relationship of mass and kinetic energy? Question 2. Question: What other famous equation describes a relationship between energy, mass and speed? (Hint, he is a Nobel prize winner where the speed refers to the speed of light.)

[$E=mc^2$]. Way back in 1907, Einstein developed the now famous equation to describe the relationship between energy, mass and light, which has changed how we think of energy and inertia. We will examine this and another not so famous equation in Activity 10. **Simulation** Check the Phet simulations and specficially the Skate Park demo that measures kinetic and potential energy and includes the effects of mass and friction. https://phet.colorado.edu/sims/html/energy-skate-park/latest/energy-skate-park_en.html	