FLEET ARC CENTRE OF EXCELLENCE IN FUTURE LOW-ENERGY ELECTRONICS TECHNOLOGIES

FLEET Schools. Activity 4: Potential energy

Learning intentions

Students will learn what potential energy is and how to calculate how much potential energy something has – and how much potential work you can do with that energy.

Materials

- Imagination – and possibly the desire to get out a skateboard and design an experiment to test the math.

Teacher Notes	Teaching Notes: Running the activity
This Activity sheet contains a mix of activities with one activity targeted at year 7-9, depending on their ability. **Forms of energy** The two main forms of energy are potential and kinetic and each have different types. Other energy forms include light, sound and thermal energy. See Activity 5 for an exploration of kinetic energy. For an in-depth look at light, see FLEET Schools teacher resource, Light: reflection, refraction, diffraction **Potential energy**: This is the energy associated with either the position of an object and the forces being exerted on it (e.g., a skateboarder stationary at the top of a ramp where the force acting on the skateboarder is gravity), or its structure (e.g., the chemical bonds in different molecules). The many types of potential energy include gravitational, chemical and elastic. Each can be defined in different ways. Collectively, however, potential energy represents the potential that something has to do work. The skateboarder positioned at the top of the ramp (stationary) has potential gravitational energy. When they lean forward, however, and start hurtling down the ramp, that potential energy is transformed into kinetic energy – movement.	**Method** Question 1. Before applying the math, get students to develop a hypothesis (prediction) for the following question: Assume the two skateboarders weigh the same. Does a skateboarder stationary at the top of a high ramp have more or less potential gravitational energy than a skateboarder stationary on a lower ramp? Question 2. Another example is holding a heavy weight above your head. The weight has potential gravitational energy. This is potentially dangerous, but if you want to express your concern and sound smart (or annoying) you could tell the person holding the weight above their head that you are worried about the potential gravitational energy above them transforming into kinetic energy (more about transfer of energy later). What could you suggest to the person holding the weight above their head to reduce the potential gravitational energy and the risk of serious injury? Test your answer to the above questions with some math.

Question 1. Answer (non-math version): The higher the ramp they start from, the more potential gravitational energy a skateboarder will have, and therefore the more kinetic energy they have once they start moving downward.

Question 2. What could you suggest to the person holding the weight above their head to reduce the gravitational potential energy?
Answer: lower the weight so that it is closer to your head, or even better place it on the ground. Alternatively, they could reduce the mass of the weight.

Math: Potential energy (PE)= Gravitational force × height.

And the units for energy = Joules

Question 3. Skateboarder potential energy = Gravitational force × height
We know the height of the ramp is 10 metres
The gravitational force = mass × gravity, and gravity we know on Earth =9.8 metres / s^2 – or how fast you fall.

[Note: make sure you have your units correct: where m is the mass in kilograms, g is the acceleration due to gravity (9.8 m / s^2 at the surface of the earth) and h is the height in meters.]

For simplicity here, let us call gravity 10m / sec^2

Therefore, we can calculate the potential energy of the skateboarder as follows
Potential (gravitational) energy = Force of gravity (10m/sec^2) × mass × height

Question 3. We can calculate the potential gravitational energy of someone or something if we know the force of gravity, its mass and its height above the ground. Here we are talking about skateboarders at the top of a 10 metre ramp. We weigh the skateboarders and they weigh 70kg. We know the force of gravity for our purposes is 10 m/sec^2

Calculate the potential energy of the skateboarder at the top of the ramp?

What if there was a second skateboarder hanging at the top of the 10 metre ramp that weighed 50kg? Which skateboarder has the greatest potential energy? Use the mathematical relationship to work it out.

What if the skateboarders took their ramp to the moon where there is less gravity (gravitational force is lower)? Compared to being on their Earth ramp, would they have more or less potential energy at the top of their ramp when on the moon?

Skateboarder 70kg Potential Energy (Joules) = 10m/sec^2 × 70kg × 10 metres = 7000 Joules (J) Skateboarder 50kg Potential Energy (Joules) = 10m/sec^2 × 50kg × 10 metres = 5000 Joules (J) And if the skateboarders took their ramp to the moon, they would have less potential energy at any position on the ramp because gravity, which applies a downward force, is reduced.	