Teacher notes

Energy transformation

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Aim

These experiments are designed to help students understand the meaning of energy transformation and transfer. They will also appreciate the meaning of energy conservation.

Students from years 7 to 10 are expected to classify different forms of energy and apply models, theories and laws to explain situations involving energy transfer and transformation. They are also introduced to the concept of conservation of energy.

Students will be able to represent energy transformations in different systems using a Sankey diagram and are encouraged to design their own way to represent the transformations.

Plan

The experiment is planned for the students; however they have to conduct an internet search to understand the types of energies involved in the process of energy transformation and transfer. The role of the teacher is to organize the class discussions and to amend any misconception or misinterpretation of events.

Safety precautions should be taken and students should be informed of the potential hazards accompanying hitting with a hammer. The experiment also involves the use of bouncy balls and toys which could possibly cause damage if students are not considerate while using them.

Conduct

This activity is at a guided inquiry level. Students are given the question but it is their responsibility to conduct the experiment and find suitable meaning to their observations. The experiment requires the collaboration of team members and involves a lot of discussion. Encourage students to ask questions and to openly express their thoughts of what could be happening.

The experiment is composed of three activities which involve energy transfer and transformation, make sure students understand the difference between the two terms. Energy transfer means that energy is transferred from one place to the other; an example is the transfer of heat from a hotter object or medium to a cooler one. On the other hand, energy transformation is the transformation from one form to another; such as when potential energy transforms to kinetic energy. In all cases, students should be

aware that the total energy is conserved, that is it remains the same. It is useful to allow students to watch a video about energy transformation and transfer before the start of the experiment to engage them and give them a solid idea about energy. A link to a useful video is https://www.youtube.com/watch?v=SYpJS3D6vo0

In the first activity, students will watch a hammer hit a nail into wood. Make sure students understand the different forms of energies including chemical energy which is stored in materials, kinetic energy which is the energy of motion, gravitational potential energy which is acquired by bodies raised to a height against the force of gravity, thermal or heat energy and sound energy. Encourage students to identify types of energies involved in hitting the hammer.

In the second activity, students will drop a ball and identify the energy transformations. This activity can be extended for higher classes, where students will be asked to calculate the potential energy and kinetic energy of the bouncing balls using equations as shown below to check if the energy is conserved.

This can be done by using a ruler to measure the height from which the ball is released and weighing the mass of the ball. For more advanced classes, successive bouncing heights are recorded to see how the height gets less and to explain what happened to the energy.

For advanced classes and years 11-12 this investigation can be extended by looking into the formulas for gravitational potential energy and kinetic energy.

Equations used in calculating kinetic and potential energies:

$$P.E. = mgh$$

Where, P.E. = gravitational potential energy in (J),

m = mass in (kg)

g = acceleration due to gravity in (ms^{-2})

h = height from which ball is dropped in (m)

$$K.E. = \frac{1}{2}mv^2$$

Where K.E. = kinetic energy in (J)

m = mass in (kg)

v = velocity with which the ball hits the ground in (ms^{-1})

$$v = \sqrt{2gh}$$

Where v = velocity with which the ball hits the ground in (ms^{-1})

g = acceleration due to gravity in (9.8 ms^{-2})

h = height from which the ball is dropped in (m)

In the third activity, students will explore a toy and will explain the energy transformations and/or transfer used by it.

Analyse

The sequence of events in the process of hitting the nail with a hammer is depicted using a Sankey diagram; students are given the diagram to help them to understand the process and to prepare them to do their own diagrams for the following activities.

Then students will do the ball experiment, for younger classes they are required to explain which energies are involved and to draw their own Sankey diagram and answer the questions provided in their worksheet.

For more advanced students and years 11-12; students will do some measurement as explained above. It is a good idea to tabulate their measurements as follows

Height from which ball is dropped (m)	
Mass of ball (kg)	
Acceleration due to gravity (ms^{-2})	
P.E. (J)	
Velocity when hitting the ground (ms^{-1})	
K.E. (J)	
Is energy conserved	

This is followed by measuring the bouncing heights and repeating the same table for each bouncing height.

In the third activity, students will be given different toys. According to the type of toy, they will explain the route of energy transformations and transfers.

Problem solving and discussion

Encourage students to come up with their own diagrams to explain their understandings of energy transformation and transfer in the activities they undertook.

This experiment is a hand on activity to observe different forms of energy and to understand how energy can be transformed from one form to another whilst maintaining the total energy constant. Make sure they understand that energy is the capacity to do work, so whilst work is done energy is transferred from one body to another and transformed to different types of energies.

This is very clear in the process of hitting the hammer where chemical energy in the arm is transformed to gravitational potential energy while raising the arm. This in turn is transferred to gravitational potential energy in the hammer. The lowering of the arm and hammer, transforms the gravitational potential energy to kinetic energy. Once it hits the nail a sequence of energy transformations and transfers can be seen. First kinetic energy is transferred to the nail which starts to move, it is also transformed to thermal energy and encourage students to touch the nail after hitting it to feel the heat and at the same time students will clearly hear the sound and this is another transformation. The kinetic energy transferred to the nail will again undergo a number of transformations and transfer where it is transferred to the wood and transformed into sound energy and thermal energy in the wood.

For the bouncing ball, it is expected to find that both the kinetic energy and potential energy is getting less for each successive bounce. Students should explain that while the total energy is conserved yet some of this energy has transformed to heat energy and sound energy when the ball hits the ground. This is why the bouncing height decreases for each successive bounce. The potential energy should be exactly equal to the kinetic energy for each individual bounce.

Conclusion

By the end of this experiment, students should have comprehended the meaning of energy transformation and energy transfer. They can represent their experiment as a video and explain their results. They can also take pictures of the experiment and draw the Sankey diagrams in a poster format to be hung in their school.

Link to photo: