TEACHER NOTES For Science Bowl 2023

Topics for this competition include:

Work (Moving a force through a distance) W = F x D
Work is measured in Newton-Meters which is also the unit of a Joule (J)

Power (The time rate of doing work, or energy consumption) P = W/time
Power is measured in Watts which are Joules/second.
It can also be measured in Kilowatts which are 1000 Watts.

Energy (The ability to do work) KE = ½ mv^2 PE = W x height off ground as reference
Energy is also measured in Joules

There will be questions involving all of these terms and calculations.

The two basic types of energy which will be considered are Potential Energy (PE) and Kinetic Energy (KE). Whether energy is kinetic or potential depends on the motion, position and shape of the object. An object can have both potential and kinetic energy at the same time.

Energy of motion is Kinetic Energy—It depends on the size of the object (mass) and how fast it is moving. KE = ½ mv^2 Two objects of different masses moving at the same speed will have different amounts of KE. The larger object will have more KE.

For example: A girl with a mass of 60 kg is jogging with her dog with a mass of 30 kg. If they are running at 2 m/s, then their KE are ½ (60kg)$(2m/s)^2$ = 120 Joules for the girl and ½(30kg) $2m/s)^2$ = 60 Joules for the dog. (Note: kg-m/s^2 = 1 N and a N-m = Joule) Because the girl has twice the mass, she has twice the KE.

However, if the dog is running ahead of her and has a velocity twice her velocity (4m/s) the energy of the dog will be ½ (30kg)$(4m/s)^2$ = 240 Joules. By doubling the velocity, the kinetic energy of the dog increased by a factor of 4 times!

The primary concern with energy is the conservation of energy when kinetic energy is transferred or when potential energy is converted to kinetic energy. The motion of a pendulum shows the continual conversion from potential to kinetic back to potential.

The motion of a body on a spring going up and down also shows the conversion of potential energy to kinetic and back again.

If the pendulum bob is allowed to hit an object when the bob gets to its lowest point, it can transfer its kinetic energy to the stationery object and cause it to move. That might be another experiment the students perform with an empty box and different size bobs. Although the length of the string

determines the period of the pendulum, the mass of the bob determines the kinetic energy. All of those can be calculated, but it is beyond the scope of this contest to calculate the velocity because it involves mathematics of square roots. It is sufficient to say that at the bottom of the swing, the bob is moving the fastest, and has the most kinetic energy. At the end point of the swing where it changes the direction, the bob has NO kinetic energy, but all its energy is potential energy because it is as high as it goes and its velocity is zero because it has to stop to change directions. The potential energy can be calculated from knowing the weight of the object in Newtons and the height of the object from a reference point (ground) in meters.

In between the highest point of the swing and the lowest point of the swing, the bob has both KE and PE. The total energy remains the same. The mechanical energy is the sum of the potential energy and kinetic energy of an object.

The **other forms of energy** will also be considered; sound energy, nuclear energy, thermal energy, electrical energy, electromagnetic energy (usually considered as light energy) and chemical energy. There will be no calculations of the above, but students should be able to recognize what types of energy an object might have: a piece of cake (chemical), a burning candle (thermal-Heat and light and chemical)

Energy transformations will also be included. Students should be able to consider which transformations occur in various processes: Using a curling iron—electrical to heat; using a battery to operate a cell phone—chemical to electrical.

How fast energy is used will be considered. If two people of the same weight climb straight up a ladder, the one who gets to the top in the least amount of time has the most power. Watts = weight in Newtons x height climbed in meters divided by time in seconds.

Lastly there will be a reading portion of the contest which will be about energy.