

Working sheet – Impact of a meteorite on Earth

There are impacts of extraterrestrial bodies on Earth every day. Normally they explode and die away in the Earth's atmosphere. Seldomly it happens that a big object hits Earth like the object 65 million years ago, which probably contributed to the extinction of the dinosaurs.

Meteoride: A small object that enters Earth's atmosphere.

Meteor: If a meteoride shows a glowing appearance it is called meteor or shooting star.

Meteorite: Hits an extraterrestrial body the Earth's surface it is called a meteorite. It is composed mainly out of water ice, stone and iron or nickel.

Following tasks can be solved with the known formulas of the different forms of energy and the law of conservation of energy.

These formulas are useful: $E_{\text{kin}} = m \cdot v^2 / 2$ and $E_{\text{pot}} = m \cdot v \cdot h$ just as $\Delta E = m \cdot \Delta T \cdot c$

Tasks

1 Which value has the kinetic energy of a spherical shaped meteorite with a diameter of ten kilometers that proceeds with a speed of about 60 km s^{-1} to the Earth's surface. Inform yourself about the composition of a meteorite and estimate the density of this kind of object.

2 The explosive force of the Hiroshima-bomb had a value of 13.4 kilotons¹ (kt) TNT. One kt TNT is equivalent to $4.184 \cdot 10^{12} \text{ J}^2$. How many Hiroshima-bombs are equivalent to the kinetic energy of the above mentioned meteorite?

3 Assuming the whole amount of the impacting object's energy can be used to lift up rock and soil to a height of ten kilometers. How big is the mass that can be lifted into the air? Calculate the fraction of the meteorite's mass and the lifted mass!

4 If an object falls into the sea a huge amount of vapour is lifted into the atmosphere or the above calculated amount of dust when impacted into solid ground, respectively. Inform yourself about resulting consequences for weather and climate features!

5 Logically not one hundred percent of the kinetic energy can be transformed to lift up rock into the atmosphere. The bigger part is transformed into heat. How many kilograms of iron can be melted with 50 percent of the above calculated kinetic energy (specific heat of iron equals $0.45 \text{ kJ kg}^{-1} \text{ K}^{-1}$, to melt iron the temperature has to be raised from about 20°C to the melting point of iron). Inform yourself about the melting point of iron!

If the meteorite hits the sea's surface sea-water is vaporized. How many liters of water can be transformed to vapour by using the whole amount of the meteorite's kinetic energy (room temperature 20°C , $c = 4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$).

1 <http://de.wikipedia.org/wiki/TNT-%C3%84equivalent>

2 http://de.wikipedia.org/wiki/Little_Boy