

9 Work and energy

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Question box 9.1

F1 The street in fig. 9.1 is exactly 100 m long. Since it is so steep, you ride your bike 200 m up the hill in a zigzag course. Does this change the amount of force necessary? Does it change the amount of work done?

F2 You have to load kegs onto a truck. What takes more force: rolling the kegs up a ramp (a), or lifting them directly onto the truck (b)? Does either one of these variations require less work?

key words excerpt

work – die Arbeit

energy – die Energie

conservation of energy – die Energieerhaltung

force applied in direction of displacement/motion – Kraft, die in die Richtung der Verschiebung wirkt

weight – das Gewicht

to lift - heben

to convert - umwandeln

conversion – die Umwandlung

potential energy – die potenzielle Energie

opposite to motion of object – in die Gegenrichtung der Bewegung

Question box 9.2

F3 In Austria there are more than 20 storage power plants. They are reservoirs into which water is pumped at certain times. Why is this done? What times is the water pumped and why at these specific times?

F4 The 137 m high Cheops pyramid is the last of the 7 wonders of the world still intact. In it a lot of lifting power of very many people is saved. Assuming you could convert this energy into electricity without any loss, how long do you think Austria could be supplied with electric power? a) about 5 years, b) about 5 weeks, c) about 5 days or d) about 5 minutes.

key words excerpt

storage power plants – das Speicherkraftwerk

electricity – die Elektrizität

Question box 9.3

F5 A roofer drops a hammer. After one second it has fallen down 5 m. How far will it have fallen in 2 seconds? At which speed will it fall after one second and after 2 seconds? How much energy is released in the first and second seconds?

F6 A car takes a certain amount of gasoline to accelerate up to 50 km/h. How much energy will the car need to accelerate from 50 to 100 km/h?

a) same, b) less, c) more. Leave out friction of your calculations.

F7 What has more kinetic energy, a car (1500 kg) at moving at walking pace, or a fired bullet (0,02 kg)?

key words excerpt

kinetic energy – die kinetische Energie

potential energy – die potenzielle Energie

to convert - umwandeln

to release – freisetzen

gasoline – das Benzin

friction – die Reibung

bullet – das Geschoss

Question box 9.4

F8 Stretch your arm out and look at your thumb. Slowly bring your thumb to your eyes. At which distance can you no longer see your thumb clearly? Why does this happen?

F9 The amount of energy always stays the same, but its form can change. Where does the kinetic energy go when a clump of clay hits a wall?

key words excerpt

to deform – sich verformen
 deformation – die Verformung
 elastic - elastisch
 elasticity – die Elastizität
 plastic – plastisch
 plasticity - Plastizität
 old age farsightedness – Altersweitsichtigkeit
 clump of clay – der Tonklumpen

Question box 9.5

F10 Two people load a truck with an equal number of kegs. One finishes faster than the other. Who used more power (be careful not to mix up power and force!!!)? Who worked more?

F11 This question might sound dumb, but how much horse power does one horse have?

F12 Most electrical appliances indicate their power (in watts). A bright light bulb has, for example 100 watts, a toaster 800 watts, a hair dryer 1300 watts und an electric oven 3000 watts. In comparison, what do you think the short term and long term power output of human beings are?

key words excerpt

power – die Leistung
 work – die Arbeit
 time – die Zeit
 horse power – die Pferdestärke
 kilowatts – das Kilowatt

Question box 9.6

F13 ►L In the film “Flubber”, a crazy professor discovers an ultra elastic material that bounces higher after each collision (as in fig. 9.19, but from right to left). What does physics have to say about that concept?

F14 ►L Below left you see the oldest form of a perpetual mobile with water filled compartments (India, around 1150), and below right a later model with balls. The idea: the wheel should turn forever due to the heavier weight on one side, but neither worked. What is the conceptual problem here?

F15 ►L Is the picture sequence below possible? Does it violate the Conservation of Energy Law?

key words excerpt

perpetual mobile – das Perpetuum mobile
 venous blood – das venöse Blut
 arterial blood – das arterielle Blut
 oxygen-rich - sauerstoffreich
 energy needs – der Energiebedarf
 entropy – die Entropie
 Conservation of Energy – die Energieerhaltung

Question box 9.7

F16 A roller coaster is 20 m high and the cars reach speeds at the bottom of 20 m/s. That is not fast enough. How high does the roller coaster have to be to double the speed? Does the mass of each car have any relevance?

F17 Can you predict the potential jump height in pole vaulting using the Conservation of Energy Law? Try it assuming an initial speed of 10 m/s.

F18 At which angle will two pool balls rebound if they are hit off-center? Use Conservation of Energy.

F19 Breaking distance increases by the square of the velocity (chapter 6.4.2) Can you explain it using the Conservation of Energy Law?

key words excerpt

roller coaster – die Achterbahn
 Conservation of Energy Law - Energieerhaltungssatz
 braking distance – der Bremsweg
 center of gravity - Körperschwerpunkt

Question box 9.8

F20 Hold a really heavy object in steadily your hand for a while. From a purely physical standpoint, no work is being done. Why is it then so difficult? Doesn't the Conservation of Energy Law apply here?

F21 Why do we get warm when doing sports?

F22 A person who weighs 100 kg climbs a 10 m staircase. How much lifting does this person do?

F23 How many days do you have to do starvation diet to loose one kilogram fat? How far would you have to run to loose it? Guess.

key words excerpt

lifting – die Hebearbeit

to fast - fasten

daily energy consumption – der tägliche Energiebedarf

weight gain – die Gewichtszunahme

weight loss – die Gewichtsabnahme

carbohydrate – die Kohlenhydrate

Tool box

F24 ►L A runner starts running from a stationary position. Does he put more E_k into the floor or into himself? A swimmer starts swimming from a stationary position. Does she invest more E_k into himself or into the water?

F25 ►L The "drinking bird" doesn't seem to have any power source and swings back and forth despite this. Is this a Perpetual mobile?

F26 ►L A skier slides down the hill starting from a stationary position and reaches a speed of 8 m/s at the bottom. The second time he starts with an initial speed of 6 m/s. How fast will he be at the bottom?

F27 ►L Does this Pendulum violate the Conservation of Energy law if it doesn't attain the exact same height with every swing?

F28 ►L You drop a stone from a height of 80 m. How fast is it when it reaches the ground? Calculate this in two different ways.

F29 ►L Which efficiency does a perpetual mobile have?

F30 ►L You cycle one hour long using 100 W on a bicycle. How much energy do you need to accomplish this? How long do you have to cycle to lose 1 kg of fat?

F31 ►L How much will a person with a mass of 75 kg lose in one year if they climb five flights of stairs (15 m) twice each day without any other changes in their diet?