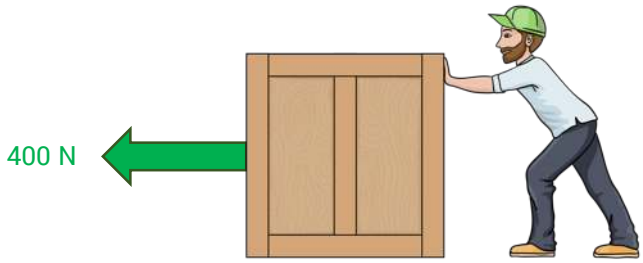
0 1

George is pushing the below box at a **constant speed** along a level surface. He applies a force of 400 N to the box.



0 1 . 1

State the value of the total frictional force acting on the box.
You may assume that the force of air resistance is negligible.

Frictional force = **400 N**

0 1 . 2

Calculate the amount of work George does against friction when he pushes the box through a distance of 50 cm.

Work done (W) = force (F) × distance (s) = 400 × 0.5 = **200 J**

0 1 . 3

As George pushes the box, the amount of chemical energy stored in his body decreases. Into which *object* (or objects), and into which *type of energy store*, is this energy transferred?

Into the internal (thermal) energy store [1] of the box and ground [1].

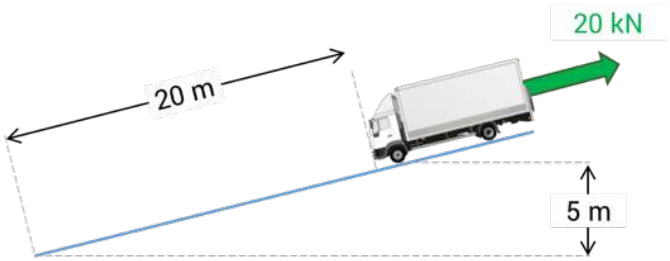
0 1 . 4

When taking a well-deserved break, George lifts a bottle of water which is sitting on the ground through a height of 1.5 m so that he can have a drink. In doing so, he does 7.35 J of work against gravity. Calculate the mass of the bottle. Take the value of g to be 9.8 N/kg.

W = F s
7.35 = F × 1.5
F = 7.35 ÷ 1.5 = 4.9 N

m = F ÷ g = 4.9 ÷ 9.8 = **0.5 kg**

0 2 A lorry is travelling at a **steady speed** down a hill, as shown in the below diagram.



The total resistive force (from both friction and air resistance) acting on the lorry is 20 kN, and its mass is 10,000 kg.

0 2 . 1 Show that the lorry does 400 kJ of work against the resistive forces which are acting on it on this section of hill.

W = F × s = 20,000 × 20 = 400,000 J = **400 kJ**

0 2 . 2 Calculate the weight of the lorry. Take g = 9.8 N/kg.

Weight = m × g = 10,000 × 9.8 = **98,000 N**

0 2 . 3 Calculate the amount of work done on the lorry by gravity.
Write your answer in kilojoules.

W = F × s = 98,000 × 5 = 490,000 J = **490 kJ**

OR E_p = m g h = 10,000 × 9.8 × 5 = 490 kJ

0 2 . 4 Hence calculate the amount of energy which is transferred to the internal energy store of the brakes as the lorry travels down this section of hill.

In this question, we know that, because the lorry is travelling at a *steady speed*, its *kinetic energy* isn't changing. This allows us to write the following equation:

- Amount of work done ON lorry = amount of work done BY lorry
- Work done by gravity = work done against resistive forces + energy transferred to internal energy in brakes

490 kJ = 400 kJ + kinetic energy transferred to internal energy in brakes
Kinetic energy transferred to internal energy in brakes = **90 kJ**