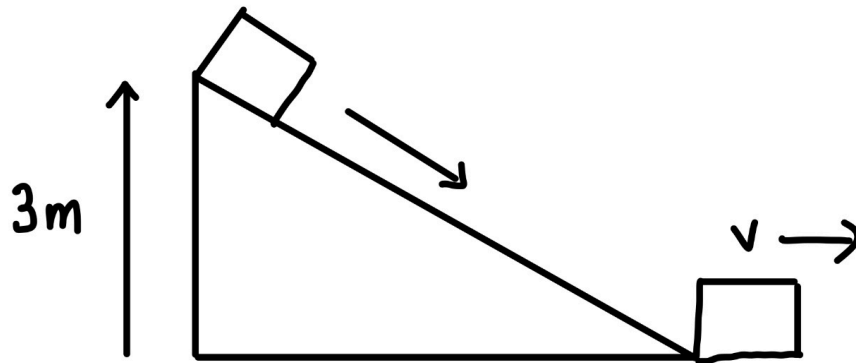


## Everything combined (Energy)

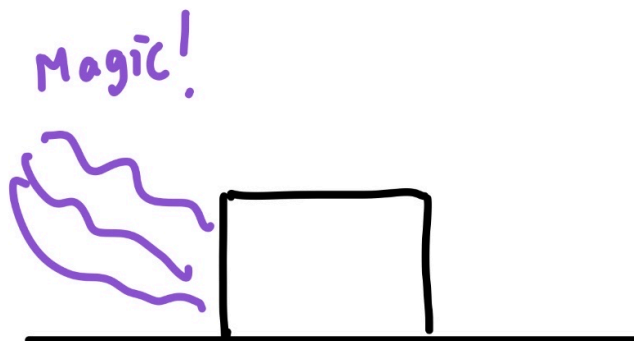
1. A 2 kg box from rest slides down a ramp of height 3m. The box has a velocity of 6 m/s at the bottom of the ramp.



- a) What is the total energy of the box at the beginning?
- b) What is the total energy of the box at the end?
- c) Where did the remaining energy go?
- d) If the box started at  $24^{\circ}\text{C}$  at the top and was  $24.1^{\circ}\text{C}$  at the bottom, find the specific heat capacity of this object.

2. A 5 kg box with an initial velocity of 10m/s slides down a ramp of height 3m. The box has a specific heat capacity of  $200\text{J/kg}^{\circ}\text{C}$ . While going down the ramp, if the box gains a temperature of  $0.1^{\circ}\text{C}$ , what is the velocity of the box at the bottom?

3. A weak magic beam is shot at a 5 kg box ( $c=300\text{J/kg}^{\circ}\text{C}$ ) at rest with the intention to accelerate it. The box accelerates to 10m/s, but also goes from  $25^{\circ}\text{C}$  to  $30^{\circ}\text{C}$ . What is the efficiency of the magic beam?



4. A box ( $c = 300 \text{ J/kg}^\circ\text{C}$ ) slides down from the top of a ramp. If the box is travelling at  $3.5 \text{ m/s}$  at the bottom of the ramp and its temperature changed from  $22.1^\circ\text{C}$  to  $22.3^\circ\text{C}$ , what is the height of the ramp?

5. An electric lift is powered by a motor to lift a  $15 \text{ kg}$  crate. The motor consumes  $4000 \text{ Joules}$  of electrical energy to lift the crate  $20 \text{ meters}$  vertically into the air. During this process, the  $4 \text{ kg}$  motor ( $c = 500 \text{ J/kg}^\circ\text{C}$ ) heats up from  $22^\circ\text{C}$  to  $25^\circ\text{C}$ .

What is the overall efficiency of the motor and winch system?

6. A powerful crossbow is used to launch a  $0.4 \text{ kg}$  steel bolt. When the crossbow is fired, it releases  $6,000 \text{ Joules}$  of stored potential energy. The transfer of energy is  $90\%$  efficient, with the rest of the energy being converted into heat that is absorbed by the steel bolt.

If the steel bolt has a specific heat capacity of  $450 \text{ J/kg}^\circ\text{C}$  and an initial temperature of  $20.0^\circ\text{C}$ , what is its final temperature immediately after being fired?

