



Problem solving in Physics

Energy

Budapest, 2024 October 10

$$\text{Work} = \text{Force} \times \text{distance}$$

Energy is the ability to do work

Gravitational force has potential energy associated with it. Can simplify calculation.

I am moving a book of mass m up with a constant velocity v , for time t . I am exerting a force F on the book with my hand during that time. What is the amount of work I am doing?

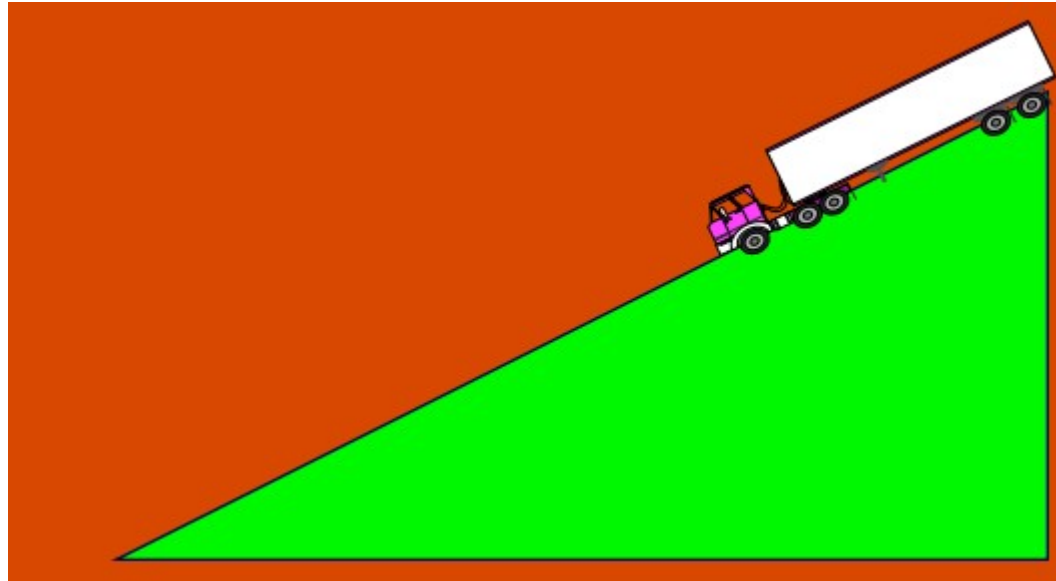
A) $mgvt$

B) $(F+mg)vt$

C) no work is done

D) Neither of the above

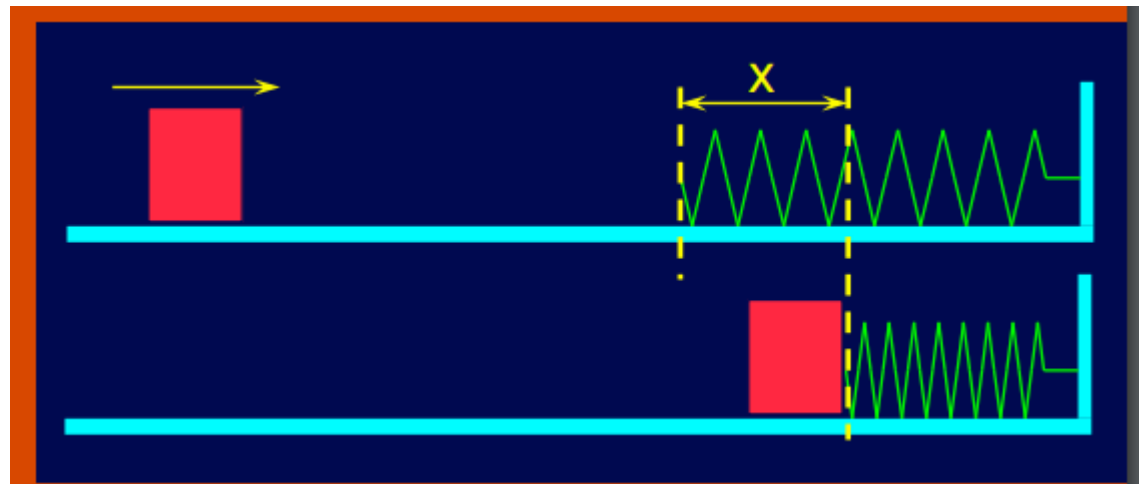
A truck, initially at rest, rolls down a frictionless hill and attains a speed of 20 m/s at the bottom. To achieve a speed of 40 m/s at the bottom, how many times higher must the hill be?



- A) 50 % higher
- B) $\sqrt{2}$ times higher
- C) twice higher
- D) 4 times higher

**Elasticity is an example for a force with
potential energy**

A box sliding on a frictionless flat surface runs into a fixed spring, which compresses a distance x to stop the box. If the initial speed of the box were doubled, how much would the spring compress in this case?



- A) 50 % more
- B) $\sqrt{2}$ times more
- C) twice as much
- D) 4 times as much

Because of dissipative forces, like kinetic friction, energy can be lost to the environment.

Static friction can also do work, e.g.,
accelerating a car

Coin is sitting on a uniformly rotating record player, held in place by static friction.
The work done by the friction force on the coin is...

A) positive

B) negative

C) zero

D) depends on the direction of rotation (clockwise vs counterclockwise)

Power = work / time

I am holding a heavy weight with a force 300 N above my head for 10 seconds. The power I am outputting here is...

A) 3000 J

B) 3000 W

C) 30 W

D) 0 W

Can static friction force do positive work? And kinetic friction?

- A) Static yes, kinetic no
- B) Static no, kinetic yes
- C) Both yes
- D) Both no

Summary

- Work and energy are scalar quantities.
- Power is the rate at which work is done.
- Gravitational potential energy is the energy stored in a mass based on its separation from the surface of Earth.
- Kinetic energy is the energy of a mass because of its motion.
- Elastic potential energy is stored in a spring that has been either compressed or stretched.
- The law of conservation of energy states that the total energy of a system remains the same.
- Mechanical energy refers to the sum total of potential energy and kinetic energy.
- Work done by friction converts mechanical energy into heat energy.

A car going with 130 km/h is watched by Alice, sitting in an Austrian train going with 160 km/h. What velocity does she assign to the car = what is the car's velocity in Alice's reference frame?

A) 30 km/h

B) -30 km/h

C) 290 km/h

D) none of the above

A car going with 130 km/h is watched by Alice, sitting in an Hungarian train going with 100 km/h. What velocity does she assign to the car = what is the car's velocity in Alice's reference frame?

A) 30 km/h

B) -30 km/h

C) 290 km/h

D) none of the above

Potential energy depends on the reference frame (0 of height). Kinetik

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C) 290 km/h

D) none of the above

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