LESSON MAKER PRO

Where Energy Goes

Track energy through ramps, rides, and friction.

HIGH SCHOOL · PHY.3

PHY.3 "Students will develop an understanding of concepts related to work and energy. Use mathematical and computational analysis to qualitatively and quantitatively analyze the concept of work, energy..."

NAME _____ **DATE** _____

TRACK THE ENERGY

Gravitational potential energy is mgh, and kinetic energy is $1/2mv^2$, where m is mass, h is height, and v is speed. When friction is negligible, their sum stays constant. With friction, some mechanical energy becomes thermal energy. Use g = 10 m/s^2 throughout.

WORKED EXAMPLE

A 7 kg cart moves at 4 m/s at ground level. It rolls up a ramp with negligible friction to a height of 0.5 m. What is its kinetic energy there?

1. Find the starting kinetic energy: $1/2mv^2 = 1/2(7)(4^2) = 56$ J.
2. Find the potential energy gained: mgh = (7)(10)(0.5) = 35 J.
3. Subtract the gain from the starting kinetic energy: 56 J - 35 J = 21 J.

Answer: 21 J of kinetic energy

PRACTICE 6 problems

1 A 2 kg cart moves at 5 m/s. What is its kinetic energy?

ANSWER _____

2 A 6 kg object is 2 m above the ground. What is its gravitational potential energy?

ANSWER _____

3 A 1 kg cart starts from rest at a height of 20 m. With negligible friction, what is its kinetic energy at ground level?

ANSWER _____

4 A 5 kg cart starts from rest at a height of 9 m. With negligible friction, what is its kinetic energy when it reaches a height of 6 m?

ANSWER _____

5 A sled starts from rest at a height of 11 m. With negligible friction, how fast is it moving at a height of 6 m?

ANSWER _____

6 A 9 kg rider has 270 J of kinetic energy at ground level. With negligible friction, how high can the rider rise before momentarily stopping?

ANSWER _____

APPLY IT Show your work

1 At a skate park, a skater and board have a combined mass of 50 kg. They start from rest 6 m above the ground and roll to a point 1 m above the ground. If friction is negligible, what are their kinetic energy and speed at that point?

WORK SPACE

ANSWER _____

2 A zip-line rider and gear have a combined mass of 60 kg. They start from rest 16 m above the ground. At a height of 10 m, they are moving at 10 m/s. How much mechanical energy has become thermal energy?

WORK SPACE

ANSWER _____

CHALLENGE One step up

A 20 kg cart starts from rest 15 m above the lowest point of a track. By the time it reaches the lowest point, 600 J of mechanical energy has become thermal energy. It climbs another ramp without further energy loss. What maximum height does it reach? Explain with a calculation.

WORK SPACE AND ANSWER

Where Energy Goes

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	A 2 kg cart moves at 5 m/s. What is its kinetic energy?	**25 J**
2	A 6 kg object is 2 m above the ground. What is its gravitational potential energy?	**120 J**
3	A 1 kg cart starts from rest at a height of 20 m. With negligible friction, what is its kinetic energy at ground level?	**200 J**
4	A 5 kg cart starts from rest at a height of 9 m. With negligible friction, what is its kinetic energy when it reaches a height of 6 m?	**150 J**
5	A sled starts from rest at a height of 11 m. With negligible friction, how fast is it moving at a height of 6 m?	**10 m/s**
6	A 9 kg rider has 270 J of kinetic energy at ground level. With negligible friction, how high can the rider rise before momentarily stopping?	**3 m**

PART 2 · APPLY IT

1. **2,500 J and 10 m/s** The loss in potential energy is (50)(10)(6 - 1) = 2,500 J, so the kinetic energy is 2,500 J. Solve $1/2(50)v^2 = 2{,}500$ to get v = 10 m/s.
2. **600 J** The rider loses (60)(10)(16 - 10) = 3,600 J of potential energy and gains $1/2(60)(10^2) = 3{,}000$ J of kinetic energy. The remaining 600 J became thermal energy.

CHALLENGE

12 m. The cart starts with (20)(10)(15) = 3,000 J of mechanical energy. After 600 J becomes thermal energy, 2,400 J remains, so its maximum height is 2,400/((20)(10)) = 12 m.

Accept equivalent calculations with correct units. The challenge height is measured above the track's lowest point.