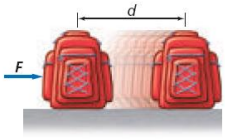
Work and Energy

Ch. 7

Objectives

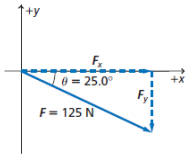
- Describe the relationship between work and energy.
- Calculate work, power, KE, PE_{grav}, $PE_{elastic}$
- Understand the work-energy theorem
- Calculate the PE and KE of a system using the law of conservation of energy

Work



- W = F d
- Measured in joules (J)
- 1 J = 1 N·m

Work



- W = F d
- Only use the force in the same direction of movement

Problem 1—Work

- A 105 g hockey puck is sliding across the ice. A player exerts a 4.50 N force over a distance of 0.150 m. How much work does the player do on the puck? (0.675 J)

Problem 2—Work

- A sailor pulls a boat a distance of 30.0 m along a dock using a rope that makes a 25° with the horizontal. How much work does the sailor do if he exerts a force of 255 N? (6930 J)

Power

- $\text{Power} = \frac{\text{Work}}{\text{time}}$
- Measured in watts (W)
- 1 W = 1 J/s

Problem 3—Power

- A motor lifts an elevator 9.0 m in 15 s by exerting a force of 12 000 N. What is the power? (7200 W)
  - What is the power in kW? (7.2 kW)

Power activity

- Walk quickly and safely up a flight of stairs
- Measure time

- Weight: 1 lb = 4.45 N
- Determine power used in watts and horsepower: 1 hp = 746 W

Kinetic Energy

- Energy = ability to do work
- Kinetic energy = movement
- $KE = \frac{1}{2}mv^2$
- Measured in J

Problem 4—Kinetic energy

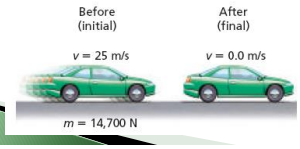
- A 1600 kg car travels at a speed of 41 km/hr.
  - Convert 40 km/hr to m/s (11 m/s)
  - Calculate the KE of the car (97 000 J)

Work-Energy Theorem

- $KE = \frac{1}{2}mv^2$
- W = F d
- When work is done, kinetic energy changes
- W = ΔKE
- $W = KE_f - KE_i$

Problem 5—Work-energy

- A 1470 kg car is traveling at 25 m/s. The brakes are applied and the car slides to a stop. The braking force is 7100 N.
  - How much work is done? (460 000 J)
  - How far will it take to stop the car? (65 m)



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Potential Energy

- Gravitational PE
- Stored energy due to gravitational force
- $PE_{gravity} = mgh$

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Problem 6—PE

- A 55 kg diver climbs to the top of the springboard 3 m above the pool. What is her gravitational potential energy? (1600 J)

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Potential Energy

- Elastic PE
- Stored energy in a pulled string, spring, pole vaulting, etc
- $PE_{elastic} = \frac{1}{2}kx^2$
- x = distance compressed

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Problem 7—PE

- When the diver jumps on the board, the board lowers by 0.80 m. If the springboard k = 833 N/m, what is the elastic PE provided by the board? (270 J)

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Conservation of Energy

- Total energy = sum of all energies
- Mechanical energy: sum of KE and PE
- E = KE + PE
- $KE_{before} + PE_{before} = KE_{after} + PE_{after}$

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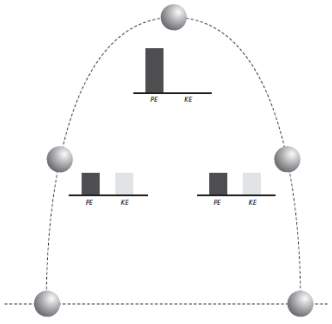
Conservation of energy

Ball tossed up in the air



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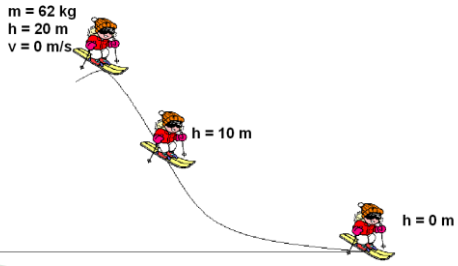
Problem 8—Calculate PE and KE for each position on the ski slope



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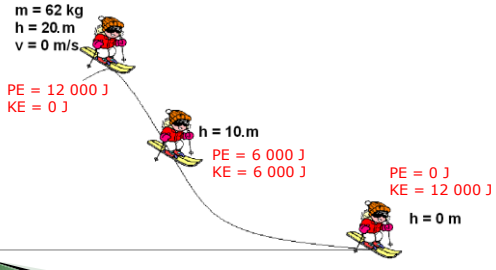

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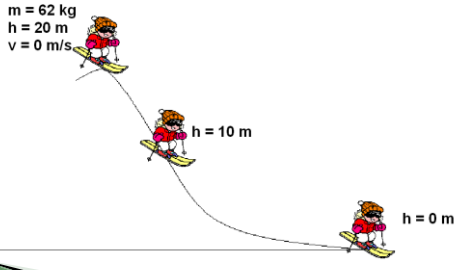
Problem 9—Calculate velocity at h = 10m and h = 0 m



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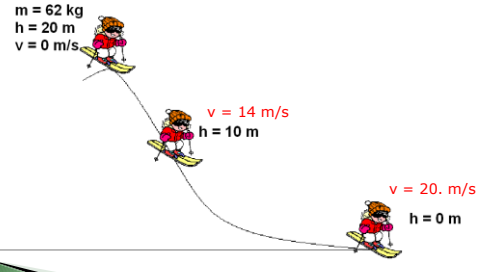

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Problem 10—Diver (again)

- For the springboard diver in problems 6 and 7, determine the velocity at which she enters the water (v_f = 8.3 m/s)

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Problem 10—Diver (again)

- For the springboard diver in problems 6 and 7, determine the velocity at which she enters the water
- Max height = 3.5 m
- Max PE = 1900 J
- v_f = 8.3 m/s