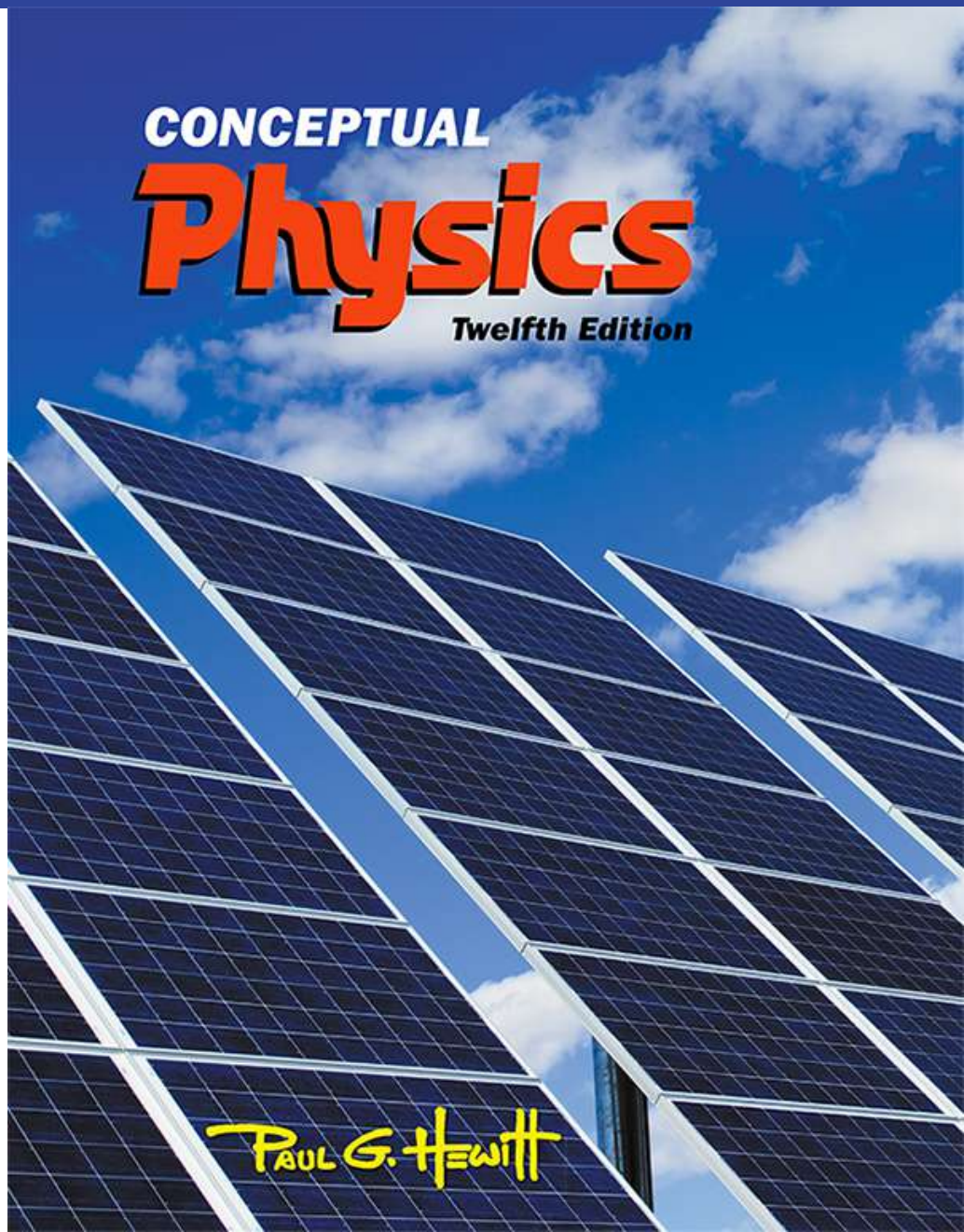
Lecture Outline

Chapter 7: Energy



This lecture will help you understand:

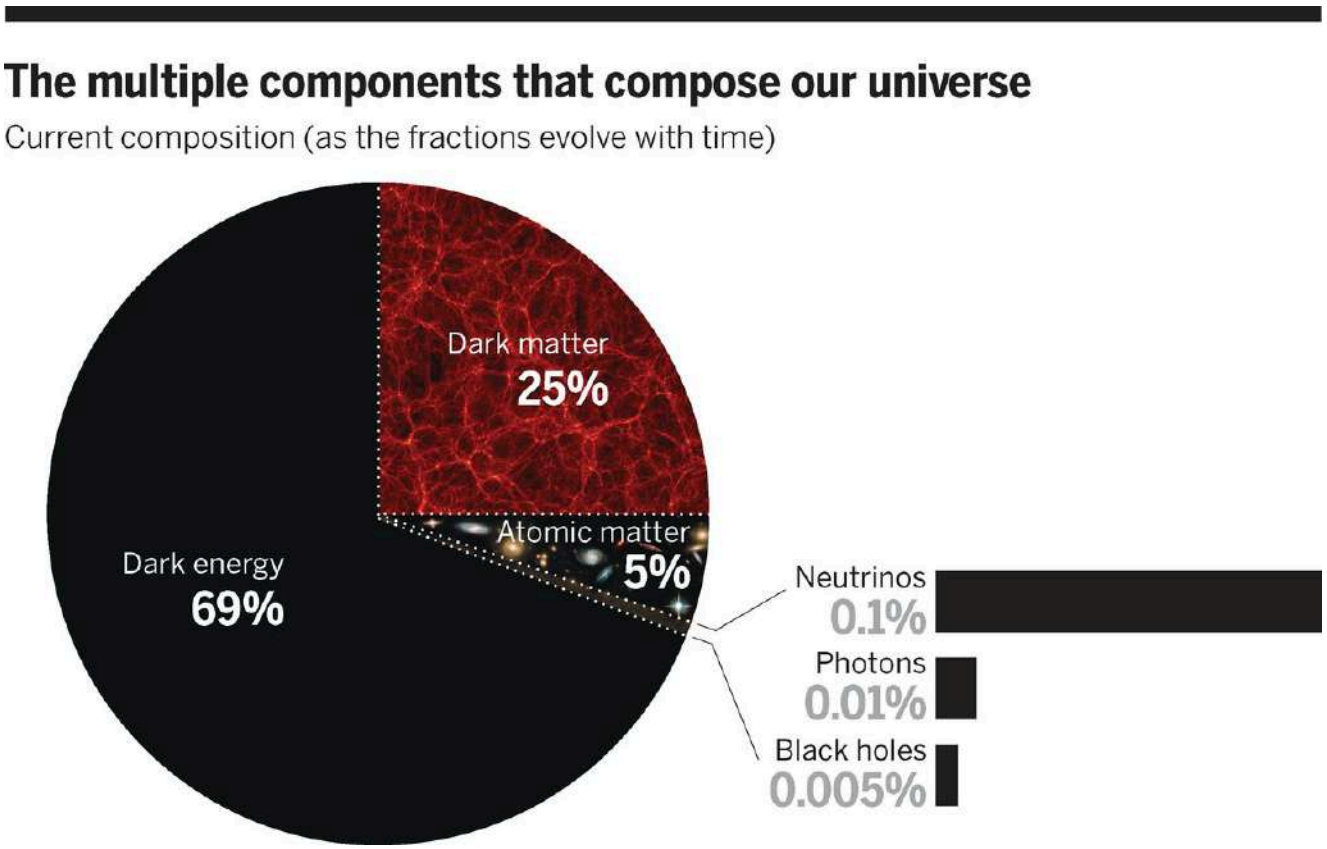
- Energy
- Work
- Power

Energy

- A combination of *energy* and *matter* **make up the universe.**
- **Energy**
  - Both a thing and a process:
  - You can both have energy and transfer it to other objects.
  - Most easily observed *when it is being transferred or being transformed*
  - *Think! Pushing a swing shows that you have energy and can transfer it to a swing.*
  - Property of a system that enables it to do *work*

Matter:

- Occupies space
- Has mass—made up of particles



Work

- Work
  - involves force and distance.
  - is force x distance.
  - in equation form: $W = Fd$.

- It takes energy to do work.
- Two things occur whenever work is done:
  - application of force
  - movement of something by that force

Work
CHECK YOUR NEIGHBOR

If you push against a stationary brick wall for several minutes, you do no work

A. on the wall.
B. at all.
C. Both of the above.
D. None of the above.

Work
CHECK YOUR ANSWER

If you push against a stationary brick wall for several minutes, you do no work

A. on the wall.

Explanation:

You may do work on your muscles, but not on the wall.

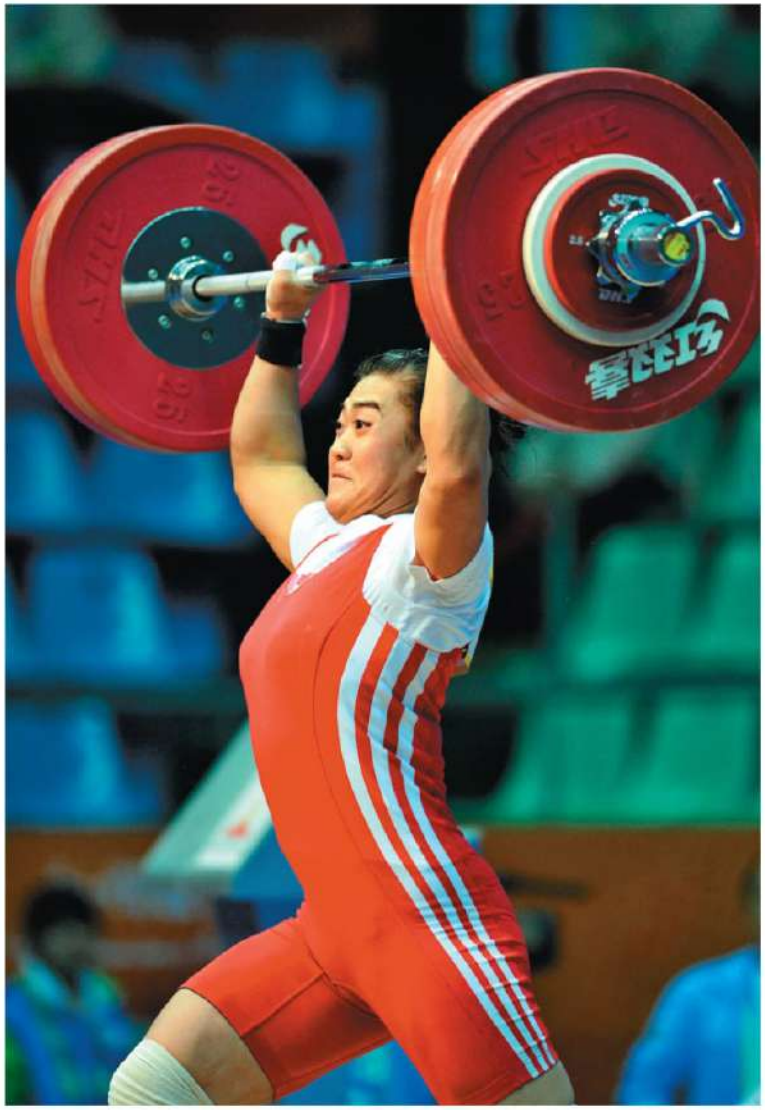
Work is F x d:

- Examples:
  - Twice as much work is done in lifting 2 loads 1 story high versus lifting 1 load the same vertical distance.
    - Reason: force needed to lift twice the load is twice as much.
  - Twice as much work is done in lifting a load 2 stories instead of 1 story.
    - Reason: distance is twice as great.

Work, Continued-1

- Example:
  - a weightlifter raising a barbell from the floor does work on the barbell.
  - The barbell has more energy as a result

- Unit of work:
  - newton-meter (Nm) or joule (J)



Work
CHECK YOUR NEIGHBOR, Continued

Work is done in lifting a barbell. How much work is done in lifting a barbell that is twice as heavy the same distance?

A. Twice as much
B. Half as much
C. The same
D. Depends on the speed of the lift

Work
CHECK YOUR ANSWER, Continued

Work is done in lifting a barbell. How much work is done in lifting a barbell that is twice as heavy the same distance?

A. Twice as much

Explanation:

This is in accord with work = force x distance. Twice the force for the same distance means twice the work done on the barbell.

Work
CHECK YOUR NEIGHBOR, Continued-1

You do work when pushing a cart with a constant force. If you push the cart twice as far, then the work you do is

A. less than twice as much.
B. twice as much.
C. more than twice as much.
D. zero.

Work
CHECK YOUR ANSWER, Continued-1

You do work when pushing a cart with a constant force. If you push the cart twice as far, then the work you do is

B. twice as much.

Example: Calculating Work

Calculate the work done when a force of 5 N moves a book 1.2 m.

Work = force x distance

$W = F \times d$

$= (5\ N) \times (1.2\ m)$

$= 6\ N \cdot m$

$= 6\ J$

Units of work: 1 Joule = 1 Newton·meter

$1\ J = 1\ N \cdot m$

Compare Work and Impulse:

- **Impulse**
  - is force x time.
  - equation: $impulse = Ft$
  - *impulse changes momentum*

- **Work**
  - is force x distance.
  - equation: $W = Fd$
  - *work changes energy*

Power

- Power:
  - Measure of *how fast work is done*
  - We say a certain power is "developed, generated, exerted, etc."
  - In equation form:
  - $$Power = \frac{work\ done}{time\ interval}$$

$$P = \frac{W}{t}$$

Example: Calculating Work

A 2000 N bag of cement is lifted 4 meters in 10 s.

Work done:

$W = F \times d$

$= (2000\ \text{N}) \times (4\ \text{m})$

$= 8000\ \text{N·m}$

$= 8000\ \text{J}$

Power exerted:

$$P = \frac{W}{t}$$

$$= \frac{8000\ J}{10\ s}$$

$= 800\ \text{J/s}$

$= 800\ \text{W}$

where the W stands for watts, the power unit.

Example: Calculating Work

A 2000 N bag of cement is lifted 4 meters in 5 s.

Work done:

$W = F \times d$

$= (2000\ \text{N}) \times (4\ \text{m})$

$= 8000\ \text{N·m}$

$= 8000\ \text{J}$

Same answer as before!

Power exerted:

$$P = \frac{W}{t}$$

$$= \frac{8000\ J}{5\ s}$$

$= 1600\ \text{J/s}$

$= 1600\ \text{W}$

Twice as much power!

- Unit of power:
  - joules per second is called the watt after James Watt, developer of the steam engine
    - 1 joule/second = 1 watt
    - 1 kilowatt = 1000 watts

Notice:

W in an equation represent work.

Power $P = \frac{W}{t} = 800\ W$

W as a unit after a number is watts.

Power, Examples

- A worker uses more power running up the stairs than climbing the same stairs slowly.

- An engine with twice as much power can do:

… twice as much work in the same amount of time,

or…

…the same work in half the time

Power
CHECK YOUR NEIGHBOR

A job can be done slowly or quickly. Both may require the same amount of work, but different amounts of

A. energy.
B. momentum.
C. power.
D. impulse.

Power
CHECK YOUR ANSWER

A job can be done slowly or quickly. Both may require the same amount of work, but different amounts of

C. power.

Comment:

Power is the rate at which work is done.

Homework: due tomorrow by 7 pm.

- On page 126:
- #2-6
- On page 127:
- #30-31 **show your work.**

Let's start #30 together:

#30: Work = Fd

= (20 N) (3.5 m)

= _____ J