Physics 100
Unit 4: Energy (Stapleton)

Name: A1/2

Btu Kwh Calories → Joules (J)

1. What is energy? What are its units?

the ability to do work.

2. Provide a physics definition (formula) of work? What are the units for work?

work → $W = Fd$ Units ⇒ J

a force exerted over a distance

3. Give some examples of work.

- Push ups
- Jumping Jacks
- Dragging Sleds

Not: Standing Planks ↑ No distance

4. What is kinetic energy? What is its formula? Symbol?

Energy of motion

$KE = \frac{1}{2}mv^2$ ← speed, mass

5. Calculate kinetic energy of a 30kg student running at a speed of 4m/s.

$KE = \frac{1}{2}(30kg)(4m/s)^2 = 240\ J$

6. What is potential energy? What is its symbol?

Stored Energy PE

→ Chemical Energy
→ gravitational
→ spring energy

7. What is the formula for gravitational potential energy?

$PE = mgh$ ← height

8. Calculate the potential energy of a 50kg student who is standing at the top of a 7m tall waterslide.

$PE = (50kg)(10m/s^2)(7m) = 3500\ J$

9. What is thermal energy? What is its symbol?

"heat" energy Q

Formulas For This Unit:

$\bar{v} = \frac{\Delta x}{\Delta t}$ $a = \frac{\Delta v}{\Delta t}$ $a = \frac{2\Delta x}{t^2}$ $F_g = mg$ ← W

$W = Fd$ $P = \frac{W}{t}$ $1\ hp = 746\ W$

$KE = \frac{1}{2}mv^2$ $PE = mgh$

$PE_0 + KE_0 = PE + KE$

$PE_0 + KE_0 + W_{NC} = PE + KE$

$PE_0 + KE_0 + Q_0 + W_{NC} = PE + KE + Q$

$\Sigma W = \Delta KE$ $\Sigma W = \Sigma F(d)$

$\Delta KE = KE - KE_0$

10. Use a formula to explain the law of conservation of energy.

This goes away when there's no friction

$$PE_0 + KE_0 + W_{NC} = PE + KE$$

Total energy we start with

Work that adds or takes away energy from the system

Total Energy we end with.

11. What is power?

The rate of doing work (how fast work is done)

What is its symbol?

P

What are the units for Power?

Watts, Horsepower

What are some other units?

$1hp = 746\,W$

(1)

12. What is the formula for power?

$P = \frac{W}{t}$ ← work

Weight $= F_g$

work $= W$

13. Calculate the power output of a student who applies a force of 200N over a distance of 6m, in a time of 3 seconds?

$P = \frac{W}{t} = \frac{1200J}{3s} = 400W$

$W = Fd = 200N(6m) = 1200J$

Convert this to horsepower.

(1)

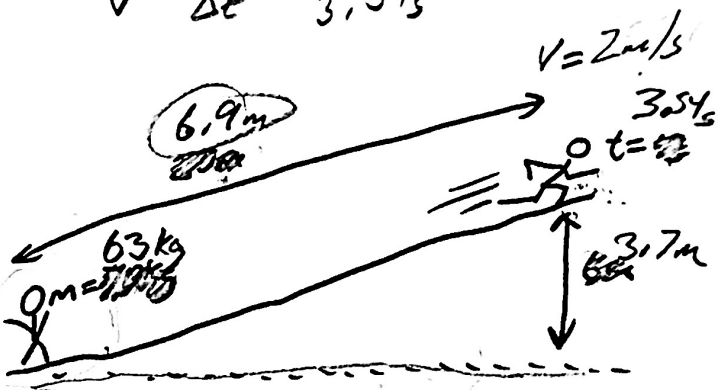
$$400\,W\left(\frac{1\,hp}{746\,W}\right) = 0.53hp$$

$PE = mgh$

$KE = \frac{1}{2}mv^2$

$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{6.9m}{3.54s} = 1.95$

14. Starting from rest, a 70kg student runs a distance of 20m in a time of 4s, finishing at a height 6m above the starting point, and having a final velocity of 5m/s. Calculate the student's average force and average power output. Convert the power output to horsepower.



- Step 1: Find the student's starting and ending KE and PE.

$KE_0 = \frac{1}{2}(63kg)(0^2) = 0$

$PE_0 = 63kg(10m/s^2)(0) = 0$

$KE = \frac{1}{2}(63kg)(2m/s)^2 = 126J$

$PE = (63kg)(9.8m/s^2)(3.7m) = 2,284J$

- Step 2: use the law of conservation of energy to find the work that was done by the student.

$PE_0 + KE_0 + W_{NC} = PE + KE$

$0 + 0 + W_{NC} = 2,284J + 126J$

$W_{NC} = 2,410J$

- Step 3: use the work formula (and the distance) to calculate force.

$W = Fd$

$F = \frac{W}{d} = \frac{2410J}{6.9m} = 349N = 78.4 pounds$

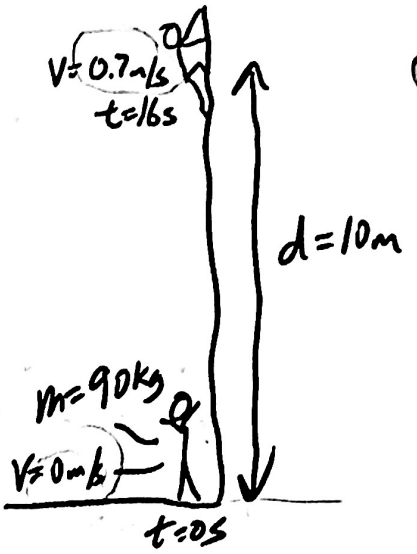
- Step 4: use the power formula to calculate power in Watts.

$P = \frac{Work}{t} = \frac{2410J}{3.54s} = 681W$

- Step 5: convert from Watts to horsepower. Google it if you need to.

$681W\left(\frac{1hp}{746W}\right) = 0.91hp$

15. Starting from rest, a 90kg student climbs a vertical distance of 10m in a time of 16s, ending with a final velocity of 0.7m/s. Calculate the student's average force and average power output. Convert the power output to horsepower.



- Step 1: Find the student's starting and ending KE and PE.

$KE_0 = 0$

$PE_0 = 0$

$KE = \frac{1}{2}(90kg)(0.7m/s) = 31.5J$

$PE = 90kg(10m/s^2)(10m) = 9{,}000J$

- Step 2: use the law of conservation of energy to find the work that was done by the student.

$0 + 0 + W_{NC} = 31.5J + 9{,}000J$

$W_{NC} = 9031.5J$

- Step 3: use the work formula (and the distance) to calculate force.

$W = Fd \Rightarrow F = \frac{W}{d} = \frac{9031.5J}{10m}$

$= 903N$

- Step 4: use the power formula to calculate power in Watts.

$P = \frac{W}{t} = \frac{9031.5J}{16s} = 564W$

- Step 5: convert from Watts to horsepower.

$564W\left(\frac{1hp}{746W}\right) = 0.76hp$