PHYS 1441 – Section 002
Lecture #17

Monday, Mar. 31, 2008
Dr. Jaehoon Yu

- Power
- 2nd term exam solutions

Today's homework is homework #9, due 9pm, Monday, Apr. 6!!

Announcements

- Term exam results
  - Average score: 41.9/94
    - Equivalent to 44.6/100
  - Top score: 70/94
- Evaluation criteria
  - Two best of the three term exams: 12.5% each
  - Final exam: 25%
  - Homework: 25%
  - Lab: 15%
  - Quizzes: 10%
  - Extra Credit: 10%
  - Final grading done on a sliding scale, after taking into account the fluctuation in exam difficulties
- Mid-term grade discussion this Wednesday
  - Do not miss this

Power

- Rate at which the work is done or the energy is transferred
  - What is the difference for the same car with two different engines (4 cylinder and 8 cylinder) climbing the same hill?
  - ➔ The time… 8 cylinder car climbs up the hill faster!

Is the total amount of work done by the engines different? NO

Then what is different? The rate at which the same amount of work performed is higher for 8 cylinders than 4.

Average power $\boxed{\overline{P} \equiv \frac{\Delta W}{\Delta t} = \frac{Fs}{\Delta t} = F\frac{s}{\Delta t} = F\,\overline{v}}$ Scalar quantity

Unit? $\boxed{J/s = Watts}$ $\boxed{1HP \equiv 746Watts}$

What do power companies sell? $1kWH = 1000Watts \times 3600s = 3.6 \times 10^{6}\,J$

Energy

Energy Loss in Automobile

Automobile uses only 13% of its fuel to propel the vehicle.

Why?

67% in the engine:
- Incomplete burning
- Heat
- Sound

16% in friction in mechanical parts

4% in operating other crucial parts such as oil and fuel pumps, etc

13% used for balancing energy loss related to moving vehicle, like air resistance and road friction to tire, etc

Two frictional forces involved in moving vehicles

$$m_{car} = 1450kg \quad Weight = mg = 14200N$$

Coefficient of Rolling Friction; μ=0.016

$$\mu n = \mu mg = 227\,N$$

Air Drag

$$f_a = \frac{1}{2}D\rho Av^2 = \frac{1}{2}\times 0.5\times 1.293\times 2v^2 = 0.647v^2$$

Total Resistance

$$f_t = f_r + f_a$$

Total power to keep speed v=26.8m/s=60mi/h

$$P = f_t v = (691N)\cdot 26.8 = 18.5kW$$

Power to overcome each component of resistance

$$P_r = f_r v = (227)\cdot 26.8 = 6.08kW$$

$$P_a = f_a v = (464.7)\cdot 26.8 = 12.5kW$$

Human Metabolic Rates

Activity	Rate (watts)
Running (15 km/h)	1340 W
Skiing	1050 W
Biking	530 W
Walking (5 km/h)	280 W
Sleeping	77 W

[a]For a young 70-kg male.

Ex. 13 The Power to Accelerate a Car

A 1.10×10^3kg car, starting from rest, accelerates for 5.00s. The magnitude of the acceleration is $a=4.60m/s^2$. Determine the average power generated by the net force that accelerates the vehicle.

What is the force that accelerates the car?

$$F = ma = \left(1.10\times10^3\right)\cdot\left(4.60\,m/s^2\right) = 5060\,N$$

Since the acceleration is constant, we obtain

$$\bar{v} = \frac{v_0 + v_f}{2} = \frac{0 + v_f}{2} = \frac{v_f}{2}$$

From the kinematic formula

$$v_f = v_0 + at = 0 + \left(4.60\,m/s^2\right)\cdot\left(5.00s\right) = 23.0\,m/s$$

Thus, the average speed is

$$\frac{v_f}{2} = \frac{23.0}{2} = 11.5\,m/s$$

And, the average power is

$$\bar{P} = F\bar{v} = \left(5060\,N\right)\cdot\left(11.5\,m/s\right) = 5.82\times10^4 W$$
$$= 78.0hp$$