

Work and Energy

unit [Sols – PH. 5g, 6a,b, 8a,b, 14f]

Objectives

TSW calc and apply work, efficiency, kinetic E, potential E, nuclear, and electrical E.

TSW be able to explain the current energy crisis, perpetual motion machines, and energy transformation, especially electricity production.

TSW calc law of conservation of Mo and Energy collectively with elastic and inelastic collisions.

TSW be aware the heat, light, and chemical are other forms of energy.

$$\text{Work} = \text{Force}_{||} \times \text{distance}$$

- Force must be parallel to the distance
- SI units: Joule “J”= kgm^2/s^2
- student hold weight above head –no work,
lift +work, lower –work

Power =work/time

- -it's the rate that work is done. [SI units: Watts =J/s]
- Example: A 20hp tractor, can plow the same field as a 35 hp tractor, it just takes longer.

- What is the fastest a 10hp or 7450w tractor could pull with 11,000N of force a plow 100m?

$$\text{Efficiency} = W_o / W_i$$

- The internal combustion gasoline engine is only about 33% efficient.

We assume 100% unless told otherwise.

- Nothing can be 100% efficient, (2nd law thermo)
- Easily applied to simple machines (levers, gears, etc.)

Energy is the ability to do work

- Work is the product of a force applied over a distance parallel to the force.
- [SI unit is Joule “J”] same as work.
- Other Units Cal, KWH, BTU
- 1 Cal = 4180 J
- Law of conservation of Energy ($E_b = E_a$)

Kinetic energy –energy of motion

- $KE = \frac{1}{2} mv^2$ $\Delta K = W$
- Double velocity you get 4x the energy.
Hence, if you double your driving speed, you'll need 4x stopping distance; Also, to go twice as fast, you will need 4x the energy from the engine.

Elastic and Inelastic collisions

- In Elastic collisions both momentum and Kinetic energy are conserved.
- In Inelastic collisions momentum, but **not** KE is conserved, some energy goes into noise (kinetic of sound) and heat.

Other forms of energy

Potential

- Stored energy, it has the ability to do work, but is not doing it.
- Two types. Spring and gravitational
- “U” $PE=mgh$

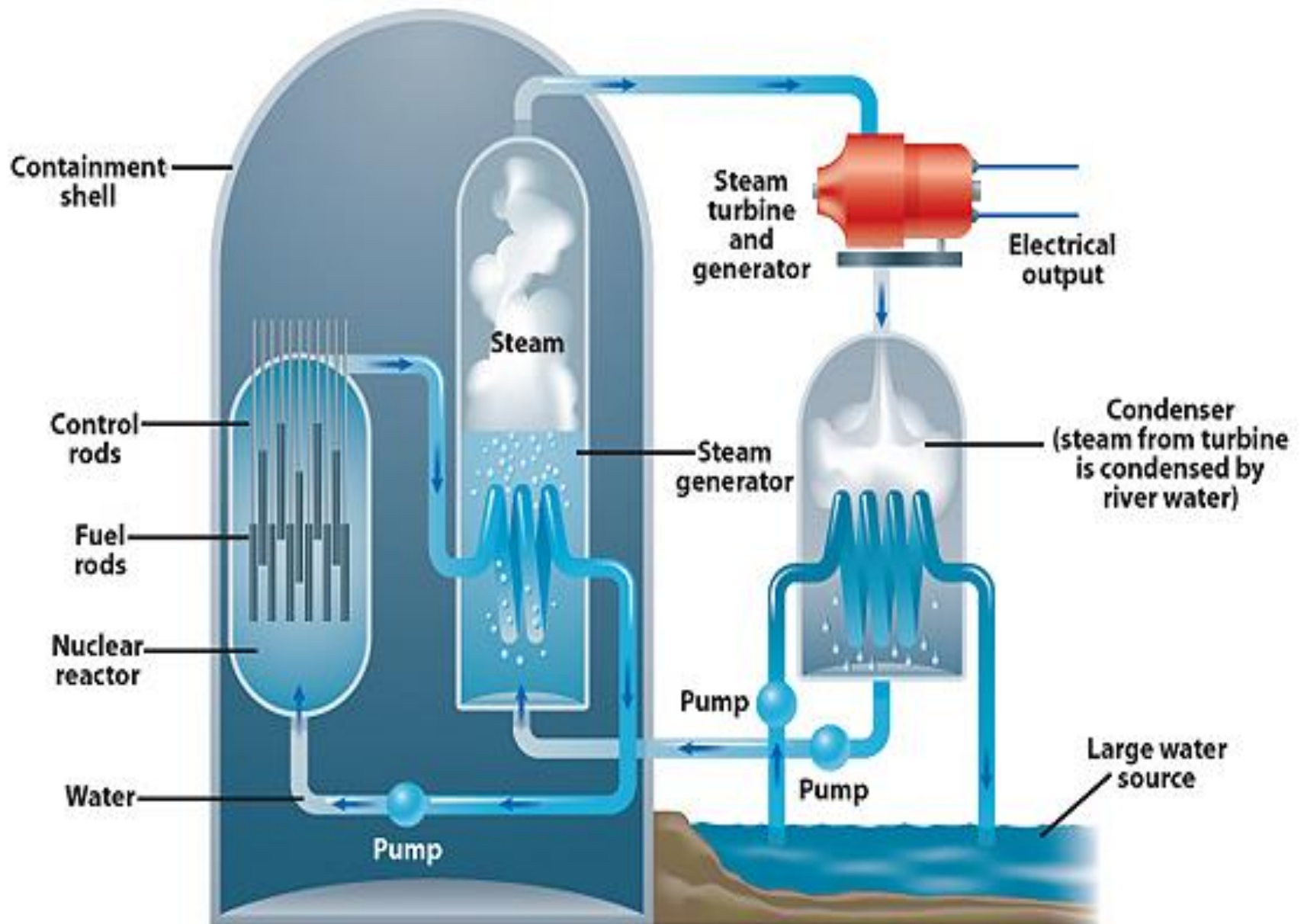
Electrical

- $E=pt=vit$
- Energy= power x time= voltage x current x time
- J=Watt x seconds= volts x amps x seconds
- KWH=kilowatt x hour
- Used in every day life

- Other Forms: Thermal, Chemical, and Radiant
- *do pendulum example
- * Gordy
- *do example probs with $E_b = EA$

EE production

- Most Electricity is produced by heating water, to make steam, the steam will then turn a turbine, which is connected to a generator that makes EE. The steam is cooled and reused.
- 56% from coal
- 20% Nuclear



Perpetual motion – not possible

- *Show letter*
- Violates $E_b = E_a$
- *Show genco gen w/ and w/o production*







Nuclear or Rest Mass Energy

- This is energy that is stored in mass.
- $E = mc^2$ $c = 3 \times 10^8 \text{ m/s}$ and is the speed of light
- Two ways to harness the energy, Fission and Fusion.

Fission – involves the splitting of a large nucleus into smaller nuclei

- - currently about 21% of EE in the US is from fission. . . France is close to 90%
- ${}^1_0n + \text{U}^{235}_{92} \rightarrow {}^{92}_{36}\text{Kr} + {}^{141}_{56}\text{Ba} + 3{}^1_0n + \text{Energy}$
- - Is used in the atomic or A-bomb. The US is the only country to use in war
- - The reactants are very radioactive. . . therefore using for EE production produces a lot of toxic waste. Currently the US is considering storing it under Yucca MTN.
- - Nuclear power plants could never blow up like a bomb. Only melt down. They produce EE in a similar manner to coal facilities the biggest difference is how the water is heated.

Fusion - involves combining nuclei.

- - Can use H found in sea water
- - is a lot more potential than fission b/c of supply
- - It is the process the sun uses to get energy
- - no toxic waste
- - Too powerful to contain. Chain reaction temp = 10,000,000 deg F, all known containers will melt.
- - Currently trying to use a plasma to make a magnetic bottle to hold the reaction. The reactor is called the Tokamak and is located at Princeton University. Also iter – pronounced “fitter”
- $${}^2_1\text{H} + {}^3_1\text{H} \rightarrow {}^4_2\text{He} + {}^1_0\text{n} + \text{Energy}$$

- - In war fare called the Hydrogen or H-bomb, it uses an A-bomb as a triggering device and has never been used in conflict. It is on about 1000x more powerful than an A-bomb.
- The reverse process says that mass could be made from energy. Currently this is done on a small scale with particle accelerators, Star Trek showed what it might be like with their replicators.