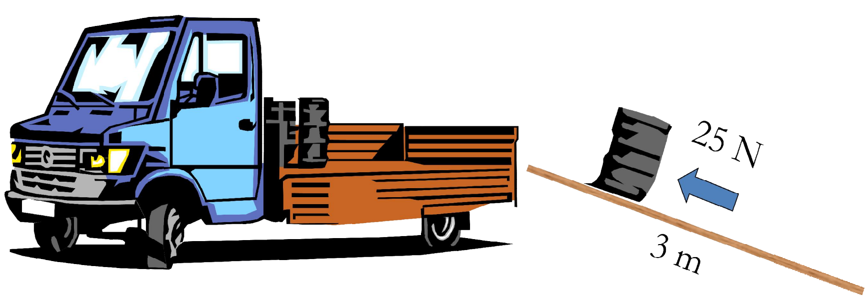
Chapter 9 (slide 1)

Work and Energy Notes Part 2

Work

- What is work? (slide 2)
- To a scientist work is done when changing motion
- Work is force applied multiplied by the distance the force acts
- W = Force x Distance
- W = F x d
- Only if the force and the direction are the same
- When an Olympic weight lifter presses a barbell over his head (slide 3)
- He is doing work
- he must hold it there until the judges say he can put it down
- He is not doing work
- Big force but no distance
- W = F x d (Units of Work) (slide 4)
- Netwons x meters = N·m
- Or $kg \cdot m^2/s^2$
- Or Joules = J
- An apple weighs about 1 N
- Lift it one meter
- That is 1 N·m of work or 1 J of work
- Use the equation W = F x d (Calculating Work) (slide 5)
- 1. How much work does it take to lift a 200 N weight 2 m off the floor?
- 2. How much work does it take to hold a 200 N weight 2 m off the floor?
- 3. How much work is done if you drop a 2.5 N book 3 meters?
- 4. What does the work?
- Running up stairs is harder than walking up stairs (Power) (slide 6)

- 5. Why? They both do the same amount of work.
- Running does the same work more quickly
- Power is the rate at which work is done.
- Power = $\frac{\text{Work}}{\text{Time}}$
- Measured in units called watts (W) (slide 7)
- 1 watt is the power to do 1 J of work in 1 s
- W = $\frac{\text{J}}{\text{s}}$
- 6. A student lifts a 12 N textbook 1.5m of the floor in 1.5 s. How much work did he do?
- 7. How much power did he use?
- 8. A 43 N force is exerted through 2.0 m distance for 3.0 s. How much work was done? (slide 8)
- 9. How much power was used?
- Machines make work easier. (slide 9)
- They multiply force or change its direction
- They multiply force by using a small force to go a long distance
- Things like ramps, levers, etc.



- W = 75 N x 1 m = 75 J (slide 10)
- W = 25 N x 3 m = 75 J
- How many time a machine multiplies the input force (Mechanical Advantage) (slide 11)
- Mechanical Advantage = $\frac{\text{output force}}{\text{input force}}$
- Mechanical Advantage = $\frac{\text{input distance}}{\text{output distance}}$
- Mechanical advantage greater than 1 multiples force
- Less than 1 it multiples distance, less force

- Energy is the ability to do work (Energy) (slide 12)
- Whenever you do work you transfer energy from one thing to another
- It can only be observed when it is transferred
- Measured in the same units as work- joules
- Stored energy (Potential Energy) (slide 13)
- Energy of position
- Stretched rubber band
- Gravitational potential energy – any time gravity supplies the force
- Most often because it is raised off the ground.
- Depends on mass and height (Gravitational Potential Energy) (slide 14)
- PE = m x g x h
- m is mass in kilograms
- g is acceleration caused by gravity 9.8 m/s^2
- h is distance it can fall in meters.
- Remember mg is weight in N so mgh is force times distance.
- 10. A 100 kg boulder is on the edge of the cliff 10 m off the ground. How much energy does it have? (slide 15)
- 11. A 0.5 kg ball is thrown 15 m into the air How much potential energy does it have at its highest point?
- The energy of motion (Kinetic Energy) (slide 16)
- Depends on two things
- Mass and velocity
- Twice the mass, twice the kinetic energy
- Twice the velocity four times the kinetic energy
- $KE = \frac{1}{2} mv^2$
- $KE = \frac{1}{2} mv^2$ (Calculating Kinetic Energy) (slide 17)
- 12. What is the kinetic energy of a 100 kg man moving 5 m/s?
- 13. What is the kinetic energy of 0.5 kg ball moving at 30 m/s?
- The sum of the potential and kinetic energy. (Mechanical Energy) (slide 18)

- Before an apple falls it has all potential energy
- Just before it hits the ground it has all kinetic energy
- In between it has some potential energy, and some kinetic energy
- Chemical energy – stored in the bonds between atoms (Other Forms of Energy) (slide 19)
- Reactions release or absorb energy
- Temperature – measures the kinetic energy of the particles
- Heat – the total kinetic energy of the particles of a substance
- Nuclear energy- energy from changing the nucleus of atoms (slide 20)
- The sun's energy comes from fusion – putting two hydrogen atoms to make helium atoms
- $E = mc^2$ mass is converted to energy
- Electricity- the energy of charged particles
- Light- energy that can travel through empty space in electromagnetic waves
- Energy can't be created or destroyed (Conservation of Energy) (slide 21)
- The total energy remains constant
- It just changes form
- Potential to kinetic (Energy is Transformed) (slide 23)
- But the pendulum will stop eventually.
- Where does the energy go
- Into moving the air
- Some energy is always changed into a form you don't want
- Friction turns motion to heat.
- Electric cords get hot
- All the energy can be accounted for (Energy is Conserved) (slide 24)
- It can be hard
- Two types of systems
- Closed system does not let energy in or out
- Used by scientists to limit variables
- Open system does let energy in or out

- Much more common
- Not all the work done is useful work (Efficiency) (slide 25)
- Some gets turned into other forms
- Often heat
- Efficiency = $\frac{\text{Useful work}}{\text{Work input}}$
- Or % Efficiency = $\frac{\text{Useful work}}{\text{Work input}} \times 100\%$
- Always less than 100% efficient
- Machines that would run forever without energy input (Perpetual Momentum Machine) (slide 26)
- Or machines that put out more energy than you put in.
- They don't exist.
- Would require a complete absence of friction.
- Or they would break the law of conservation of energy