Physics G

Work and Energy
(Chapter 5 Syllabus)

A/B	In Class	Due on this class
1 Mar 3/4	**GW**-It's All Uphill Lab **GW**-Jambalaya QL (5.1) **DI**-It's All Uphill recap	**VF 5A, 5B, 5C, 5D**
2 Mar 5/6	**GW**-Jambalaya QL (5.1) Group Quiz 5.1 **GW**-FA5.1	Turn in QL 5.1-Jambalaya
3 Mar 9/10	**SA5.1-Work and Power (first 30 minutes)** **VF**-5E, 5F, 5G	Turn in FA5.1
4 Mar 11/12	**GW**-P5.0 #1-3, 7, 9, 11, 13-15 **GW**-FA5.0	**VF 5E, 5F, 5G** Turn in P5.0 #1-3, 7, 9, 11, 13-15
5 Mar 13/16	**SA5.0-Work and Energy (first 30 minutes)** **VF**-5K **DI**-Conservation of Energy	**VF 5K** Turn in FA5.0
6 Mar 17/18	**DI**-Conservation of Energy **GW**-Conservation of Energy QL	Turn in QL5.2.1 - Pictures
7 Mar 19/20	**DI**-Rollercoasters/PHET Energy Skate Park Group Quiz 5.2 **GW**-Human Power Output Lab **GW**-Conservation of Energy QL	**VF Human Power Output Lab**
SpringBreakYaySpringBreakYaySpringBreakYaySpringBreakYaySpringBreakYaySpringBreakYaySpring		
8 Mar31/ Apr 1	**GW**-Human Power Output Lab **GW**-Conservation of Energy QL **GW**-Rollercoasters/Energy Skate Park	Turn in QL5.2.2 - Word Problems Turn in Human Power Output Lab
9 Apr 2/3	**SA5.2-Conservation of Energy (first 30 minutes)** **VF**-6A, 6B, 6C	Turn in FA5.2
1 Apr 6/7	**Momentum and Rocket Science!**	**VF 6D-Rocket Science**

Assignments:

- 2 Labs:
  - It's All Uphill/15 pts
  - *Human Power Output lab*/30 pts
- 3 Formative/Summative Assessments:
  - 5.0 - Work and Energy
  - 5.1 - Efficiency and Power
  - 5.2 - Conservation of Energy

Handouts:

- _Syllabus-WorkAndEnergy2019
- 5
- FA05.0
- FA05.1
- FA05.2
- Lab-HumanPowerOutput
- Noteguide5A-Work
- Noteguide5B-Power
- Noteguide5C-WorkAndPower
- Noteguide5D-Efficiency
- Noteguide5E-Energy
- Noteguide5F-GravitationalPotentialEnergy
- Noteguide5G-KineticEnergy
- Noteguide5K-ConservationOfEnergy
- Quizlette-5.1Jambalaya
- Quizlette-5.2ConservationOfEnergyWords
- Quizlette-5.2ConservationOfEnergyPictur...
- WarmupQuiz5.1
- WarmupQuiz5.2
- Worksheet5.0-WorkAndEnergy
- Worksheet5.1-EfficiencyAndPower
- Worksheet5.2-ConservationOfEnergy

Noteguide for Energy - Videos 5E **Name**___________________________

Energy - the ability to do work.

1.
2.
3.
4.

(Come up with a type of energy that you feel is not nuclear, and I will try to show that it is in class...)

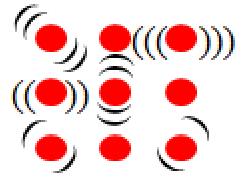
Your example:____

<u>Electromagnetic</u> – Energy of photons. (Einstein, big bang)

<u>Potential</u> - Energy of position. Stored energy.
Examples: Gravitational, chemical, springs

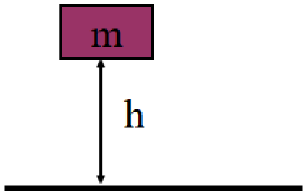
<u>Kinetic</u> - Energy of motion.
Examples: Baseballs, hammers

<u>Thermal</u> - Random potential and kinetic energy of molecules and atoms.
Examples: Hot stuff



Noteguide for Gravitational Potential Energy - Videos 5F **Name**____________________________

Gravitational Potential Energy



PE=mgh
- PE- gravitational potential energy
- h - Change in height
- m - Mass
- g - 9.8 N/kg on Earth

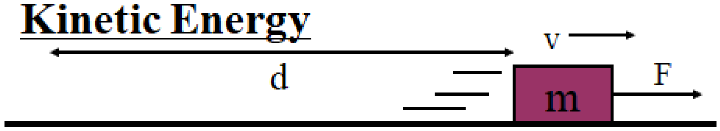
Example: What is the Potential Energy of a 5.0 kg mass 2.1 m from the ground?

Whiteboards:

<table>
<tr><td>1. What is the potential energy of a 4.5 kg bowling ball, 13.5 cm above the ground? (5.953 J)</td><td>2. Toby Continued lifts a 75.0 kg box doing 1573 J of work. What is the change in height of the box? (2.14 m)</td></tr>
<tr><td colspan="2">3. Colin Host lifts himself up 15 m doing 9555 J of work. What is his mass? (65 kg)</td></tr>
</table>

Noteguide for Kinetic Energy - Videos 5G **Name**_________________________

Kinetic Energy



$KE = {}^{1}/_{2}mv^2$

KE - Kinetic energy
V - velocity
m - mass

Example: What is the kinetic energy of a 4.20 g bullet going 965 m/s? (units?)

Whiteboards:

1. Ex1 - What speed must a .563 kg hammer move to store 34 J of energy? (11 m/s)	2. Ex2 - A European swallow has 2.055 J of kinetic energy when it is flying at 14.23 m/s. What is its mass in grams? (0.020297 kg, 20.3 g)
3. Ex3 - A 4.0 kg shot is sped up from 6.0 m/s to 9.0 m/s. What is the change in kinetic energy? (90 J) - (calculate two KEs and subtract)	

Efficiency and Power Questions from A5.1

0.856, 380. J 45.0 W, 2700 J 9.32 m 282 s	1. a. A heater consumes 125 J of fuel and produces 107 J of useful heat. What is its efficiency? How much fuel would it consume to produce 325 J of useful heat? b. A motor does 585 J of work in 13.0 seconds. What is its power output? What work could it do in 60.0 seconds? c. You do 412 J of work dragging a 26.5 kg box over a level floor (at a constant low speed) where the coefficient of dynamic friction is 0.170. What distance did you drag it? d. What is the minimum time a 540. W motor can lift a 3450 kg land rover 4.50 m?
567 J, 408 J 80.4 W, 19.0 s 3.21 m 405 W	2. a. A heater is 91.0% efficient. How much useful heat would it produce from 623 J of fuel energy? How much fuel would it consume to produce 371 J of useful heat? b. A motor does 965 J of work in 12.0 seconds. What is its power output? In what time could it do 1530 J of work? c. You do 371 J of work lifting a 11.8 kg box. What height did you lift it? d. What is your power output if you drag a 87.0 kg sled a level distance of 43.0 m in 19.0 s where the coefficient of dynamic friction is 0.210?
0.916, 591 J 5040 J, 1.80 s 9.97 kg 43.8 s	3. a. A heater consumes 215 J of fuel and produces 197 J of useful heat. What is its efficiency? How much useful heat would it produce from 645 J of fuel energy? b. What work does a 420. W motor do in 12.0 seconds? What time would it take the motor to do 758 J of work? c. You do 850. J of work raising what mass a vertical distance of 8.70 m? d. A sled dog has a power output of 310. W. In what time can it drag a 112 kg sled 95.0 m across a frozen lake where the coefficient of friction is 0.130?
204 J, 584 J 51.6 W, 6970 J 15.0 kg 674 W	4. a. A heater is 82.0% efficient. How much fuel would it consume to produce 167 J of useful heat? How much useful heat would it produce from 712 J of fuel energy? b. A motor does 568 J of work in 11.0 seconds. What is its power output? What work could it do in 135. seconds? c. You do 381 J of work dragging a box 23.5 m over a level floor (at a constant low speed) where the coefficient of dynamic friction is 0.110. What is the mass of the box? d. What is the minimum power rating a motor can have if it needs to lift a 2350 kg SUV a vertical distance of 4.50 m in 154 s?
0.945, 912 J 1890 J, 7.00 s 0.137 135 s	5. a. A heater consumes 618 J of fuel and produces 584 J of useful heat. What is its efficiency? How much fuel would it consume to produce 862. J of useful heat? b. What work does a 118 W motor do in 16.0 seconds? What time would it take the motor to do 826 J of work? c. You do 645 J of work dragging a 15.0 kg box over a level floor (at a constant low speed) a distance of 32.0 m. What was the dynamic coefficient of friction? d. What is the minimum time a 746. W motor can lift a 2770 kg land rover 3.70 m?
	More Jambalaya: (All possible Jambalaya problems) Lifting: d. What time can a 12.5 W motor lift a 15.0 kg mass 65.0 m? d. What is the mass of an elevator if a 150. W motor takes 14.0 s to lift it 5.20 m? d. What distance would a 63.0 W motor lift 78.0 kg in 57.0 s? d. What power motor can lift 890. kg 45.0 m in 140. s? Dragging: d. A 854 W tractor can drag a 780. kg mass 180. m in what time if the coefficient of friction is 0.160? d. A 720. W winch drags a 1340 kg car with a coefficient of friction of 0.850 how far in 45.0 s? d. A team of dogs can put out 1350 W of power. If the coefficient of friction between the sled and the ice is 0.120, what mass can they drag 50.0 m in 120. s? d. A conveyor belt is operated by a 420. W motor. If it is supposed to move a 15.0 kg box 21.0 m in 17.0 s, what must be the coefficient of friction between it and the underlying surface? d. A tractor must be able to drag 1520 kg of logs 460. m across the ground where the coefficient of friction is 0.650 in 63.0 s. What must be the power minimum power output of the tractor?

Practice 5.0 - Work and Energy

Work: W = Fd

1. How much work does Fred do exerting 45.0 N to lift a box 3.20 m? (144 J)
2. How much work does Adair lifting a 12.0 N box up 5.00 m? (60.0 J)
3. An alkaline AA battery contains 9360 J of energy. If it takes 68.0 N of force to drag a heavy box across the floor, how far could the energy in a AA battery drag the box? (138 m)
4. What vertical distance will 64.0 J of work lift a box that weighs 41.0 N? (1.56 m)
5. Katherine moves a box 7.20 m doing 5.00 J of work. What is the frictional force? (0.694 N)
6. What force exerted for 4.10 m does 117 J of work? (28.5 N)

Potential Energy: PE = mgh

7. What is the potential energy of a 5.40 Kg shot put that is 12.0 m in the air? (635 J)
8. What is the potential energy of a 3.20 kg clock weight that has been wound up to a height of 0.680 m? (21.3 J)
9. What is the mass of a pile driver if it has 13,200 J of PE when it is 8.30 m in the air? (162 Kg)
10. What mass has a PE of 140. J when it is at an elevation of 0.210 m? (68.0 kg)
11. An alkaline AA battery contains 9360 J of energy. If I connected it to a 100% efficient winch, how high could it lift a 72.0 kg person? (13.3 m, 43.5 feet)
12. To what height must a 0.145 Kg baseball rise to get a potential energy of 27.0 J? (19.0 m)

Kinetic energy: KE = 1/2mv^2

13. What is the kinetic energy of a 0.145 Kg baseball going 40.0 m/s? (116 J) (about 90 mph)
14. What is the kinetic energy of a 4.20 g (0.0042 kg) bullet going 1120 m/s? (2634 J)
15. An alkaline AA battery contains 9360 J of energy. If I connected it to a 100% efficient pitching machine, how fast could it pitch a 0.145 kg baseball? (359 m/s or mach 1.05)
16. What speed must a 0.450 Kg hammer have to have a kinetic energy of 57.0. J? (15.9 m/s)
17. A pile driver must develop 14,500 J of kinetic energy when it is going 13.0 m/s. What does its mass have to be? (172 kg)
18. A bullet with a speed of 892 m/s has a kinetic energy of 2740 J. What is its mass? (0.00689 Kg or 6.89 g)

Conservation of Energy Questions from A5.2

24.7 m 27.6 N 11.3 m/s 7.10 m/s	1. a. A 0.145 kg baseball going 22.0 m/s straight up goes how high before stopping? b. A baseball pitcher speeds a 0.145 kg ball from rest to 38.0 m/s over a distance of 3.80 m. What must be the average force exerted on the ball? (Neglect friction or any change in elevation) c. A 1340 kg car is moving at some speed at an elevation of 5.50 m partway up a hill, and then coasts to a stop at an elevation of 12.0 m. How fast was it going at 5.50 m elevation? (Neglect friction) d. A 150. kg sled is going 3.40 m/s at the top of a 2.50 m tall hill. At the bottom it hits a patch of dirt that exerts a slowing force of 180. N for 4.20 m. How fast is the sled going after the dirt patch? (Neglect friction)
89.7 N 9.44 m 178 N 2.41 m	2. a. A 0.320 kg hammer is going 8.20 m/s. What force would stop it in 0.120 m? b. A 1530 kg car starts at rest and rolls down a hill. At the bottom it is going 13.6 m/s. How high was the hill? (Neglect friction) c. Mom gives 55.0 kg Tamara a push from rest on her massless sled for a distance of 7.20 m at the top of a 3.80 m tall hill. If she is going 11.0 m/s at the bottom of the hill, what force did Mom exert at the top to speed her up? (Neglect friction) d. A 410. kg rollercoaster car going 3.40 m/s hits an accelerator that exerts a force of 780. N to speed up the car over a distance of 14.0 m. The car then rolls up a hill where it is going 4.20 m/s. What is the height of the hill? (Neglect friction)
1.71 m/s 10.5 m 9.40 m/s 3.99 m	3. a. A 5.00 kg pendulum starts from rest 0.150 m above the lowest point. What is its speed when it reaches the lowest point? b. A 0.170 kg ball is sped up with a 5.00 N force straight up from rest a vertical distance of 3.50 m. To what height does it rise above its lowest point before stopping? (Neglect air friction) c. A 0.170 kg ball is sped up with a 5.00 N force straight up from rest a vertical distance of 3.50 m. What is the velocity of the ball when it is a height of 6.00 m above its lowest point? (Neglect friction) d. A 784 kg rollercoaster car is going 7.50 m/s at the top of a 2.15 m tall hill. At what height is it when it is going 4.50 m/s? (Neglect friction)
1.40 N 25.6 m 8.91 m/s 1.81 m	4. a. What force over 0.180 m exerted on a 0.345 kg air track glider speeds it from rest to 1.21 m/s? b. A 0.145 kg baseball is popped straight up, and goes 33.5 m in the air before coming back down. What was its initial velocity? (Neglect friction) c. A 1370 kg car going 14.7 m/s on a level road strikes a puddle that exerts a retarding force of 5200. N What is the velocity of the car when it has gone 18.0 m into the puddle? d. A 680. kg Rollercoaster car at rest on top of a 3.50 m tall hill is sped up by a force of 7780 N for a distance of 2.50 m. What is the height of the car when it is going 9.50 m/s? (Neglect friction)
9.29 m/s 0.219 m 0.592 m 5.07 m/s	5. a. A 65.0 kg sled starts from rest at the top of a 4.40 m tall hill. What is its speed at the bottom of the hill? (Neglect friction) b. Ferdinand exerts a force of 168 N for a distance of 18.5 m on the level speeding up a 1450 kg car initially at rest. The car then rolls up an incline. How much elevation will the car gain before it stops? (Neglect friction) c. Reginald exerts a force of 195 N for a distance of 35.0 m on the level speeding up a 985 kg car from rest. The car then rolls up an incline. What elevation has the car gained when it has a velocity of 1.50 m/s? (Neglect friction) d. A 450. kg roller coaster car initially at rest is launched from the top of a 2.30 m tall hill by a 4890 N force exerted over a distance of 3.80 m. What is the speed of the car when it is at the top of a 5.20 m tall hill? (Neglect friction)

Noteguide for Conservation of Energy - Videos 5K **Name_________________________**

Conservation of Energy

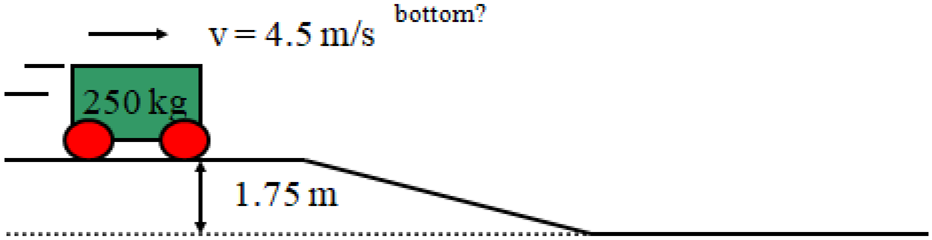
Total Energy before = Total Energy After

Comes from = Goes to

Assets = Expenditures

$Fd + mgh + \frac{1}{2}mv^2 = Fd + mgh + \frac{1}{2}mv^2$

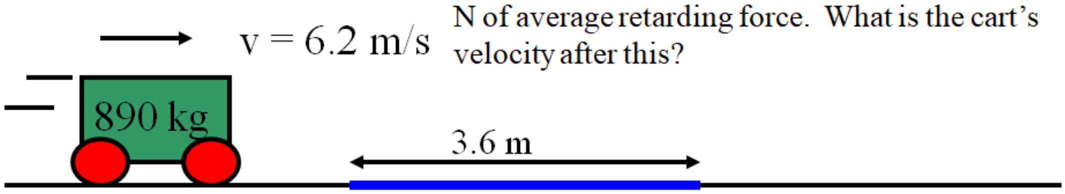
A 250 kg cart going 4.5 m/s rolls down a 1.75 m tall hill. What is the velocity of the cart at the bottom?



$Fd + mgh + \frac{1}{2}mv^2 = Fd + mgh + \frac{1}{2}mv^2$

Example 1

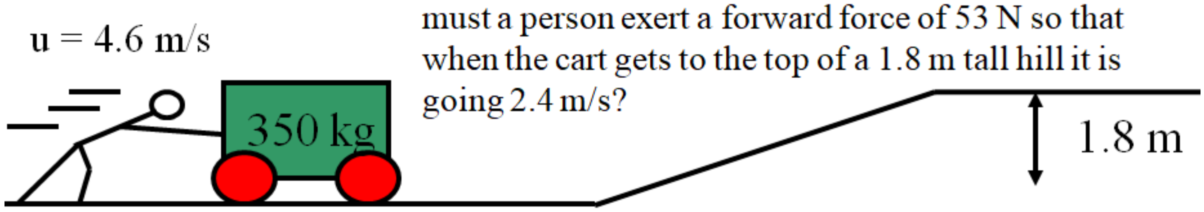
An 890 kg cart rolling 6.2 m/s along a level surface hits a 3.6 m long puddle that exerts 3200 N of average retarding force. What is the cart's velocity after this?



(Puddle - Exerts 3200 N of retarding force)

Example 2

A 350 kg cart is going 4.6 m/s. For what distance must a person exert a forward force of 53 N so that when the cart gets to the top of a 1.8 m tall hill it is going 2.4 m/s?



Example 3

A 0.124 kg pine cone falls 45.0 m from a tree. It is going 22.0 m/s when it strikes the ground. What is the average force of air friction that acts on the pine cone as it falls?