GreatHearts Irving

Physics Remote Learning Packet

Please submit scans of written work in Google Classroom at the end of the week.

Week 8: May 18-22, 2020

Course: 11 Physics
Teacher: Miss Weisse natalie.weisse@greatheartsirving.org
Resource: *Miss Weisse's Own Physics Textbook* — new pages found at the end of this packet

Weekly Plan:

Monday, May 11
- ☐ Read *Unit 8 Part 8 - Power* of *Miss Weisse's Own Physics Textbook*
- ☐ Complete Worksheet 5 #1-3
- ☐ Email Miss Weisse with Questions and to Ask for Solutions
- ☐ Spend 10 Minutes Reviewing All of *Unit 8 – Energy* for an Assessment on Wednesday

Tuesday, May 12
- ☐ Review *Unit 8 Part 8 - Power* of *Miss Weisse's Own Physics Textbook*
- ☐ Complete Worksheet 5 #4-5
- ☐ Email Miss Weisse with Questions and to Ask for Solutions
- ☐ Spend 10 Minutes Reviewing All of *Unit 8 – Energy* for an Assessment on Wednesday

Wednesday, May 13
- ☐ Complete *Unit 8 – Energy* Assessment on Google Classroom

Thursday, May 14
- ☐ Complete Review Diagram
- ☐ Email Miss Weisse with Questions

Friday, May 15
- ☐ Attend Office Hours at 9:30 AM!
- ☐ Turn in your assignments on Google Classroom by the end of the day Sunday May 17.

Please turn in all items in green!

Statement of Academic Honesty

I affirm that the work completed from the packet is mine and that I completed it independently.

____
Student Signature

I affirm that, to the best of my knowledge, my child completed this work independently

____
Parent Signature

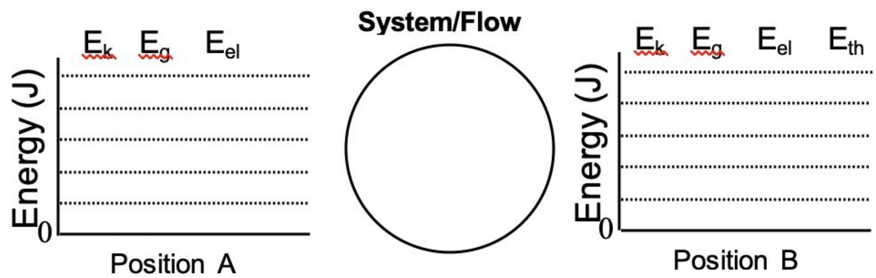
Monday, May 18

- ➔ Read *Unit 8 Part 8 - Power* of *Miss Weisse's Own Physics Textbook*
- ➔ Complete Worksheet 5 #1-3
- ➔ Email Miss Weisse with Questions and to Ask for Solutions
- ➔ Spend 10 Minutes Reviewing All of *Unit 8 – Energy* for an Assessment on Wednesday

Energy Storage and Transfer Model Worksheet 5 #1-3: Energy Transfer and Power

1. Jill pulls on a rope to lift a 12 kg pail out of a well, while the clumsy Jack watches. For a 10.0 meter segment of the lift, she lifts the bucket straight up at constant speed.
   a. How much power is required to complete this task in 5.0 seconds?

   b. Complete the energy bar graph as part of your solution.

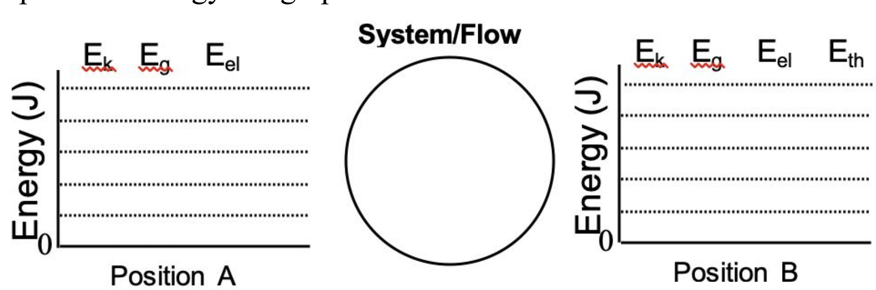


Conservation of Energy Equation:

2. Hulky and Bulky are two workers being considered for a job at the UPS loading dock. Hulky boasts that he can lift a 100 kg box 2.0 meters vertically, in 3.0 seconds. Bulky counters with his claim of lifting a 200 kg box 5.0 meters vertically, in 20 seconds. Which worker is more powerful?

3. The trains on the Boss roller coaster are raised from 10.0 m above ground at the loading platform to a height of 60.0 m at the top of the first hill in 45 s. Assume that the train (including passengers) has a mass of 2500 kg.
   a. Ignoring frictional losses, how powerful should the motor be to accomplish this task?

   b. Complete the energy bar graphs below.



Conservation of Energy Equation:

Tuesday, May 19

- ➔ Review *Unit 8 Part 8 - Power* of *Miss Weisse's Own Physics Textbook*
- ➔ Complete Worksheet 5 #4-5
- ➔ Email Miss Weisse with Questions and to Ask for Solutions
- ➔ pend 10 Minutes Reviewing All of *Unit 8 – Energy* for an Assessment on Wednesday

Energy Storage and Transfer Model Worksheet 5 #4-5:
Energy Transfer and Power

1. An aerodynamic 1,000 kg car takes about 270 newtons of force to maintain a speed of 25 m/s.
   a. How much horsepower (hp) is required from the engine to maintain this speed? (1 hp = 746 W) *Hint! Review page 81 carefully!*

   b. How much horsepower is required for the same car to accelerate from 0-25 m/s in 6.0 seconds?

2. Your electric utility company sends you a monthly bill informing you of the number of kilowatt-hours of energy you have used that month.
   a. What is a kilowatt-hour (kilowatt x hour, or kWh)? Determine how many Joules equal one kilowatt-hour.

   b. A refrigerator-freezer uses energy at a rate of 500. watts when you hear the compressor running. If the fridge runs for 200. hours per month, how many kilowatt-hours of energy does the refrigerator use each month?

   c. In the Dallas area, electricity rates range from 8.0 cents per kilowatt-hour (winter) to11.5 cents per kWh (summer). How much does the energy cost each month to run the refrigerator?

Wednesday, May 20

- ➔ Complete *Unit 8 – Energy* Assessment on Google Classroom
  - ◆ This assessment is open notes. Use *Miss Weisse's Own Textbook*, use assignments, use *your brain! Just don't use another person.* This must be your own work.

Thursday, May 21

- ➔ Complete Review Diagram found on the next page
  - ◆ We have learned two descriptive measurements of motion and two causal measurements of motion since September. Identify these four measurements (don't include momentum). Then, in the four boxes, show how we pictorially represent the measurement, how we use words to explain the measurement, what changes in the measurement, and the equation *and units* of the measurement.
  - ◆ If you do not have a printed copy, recreate the diagram on your own paper.

You have made it to the end of the last full week of school!
We are so close to summer!
Thank you for working so diligently
in these strange, strange times.

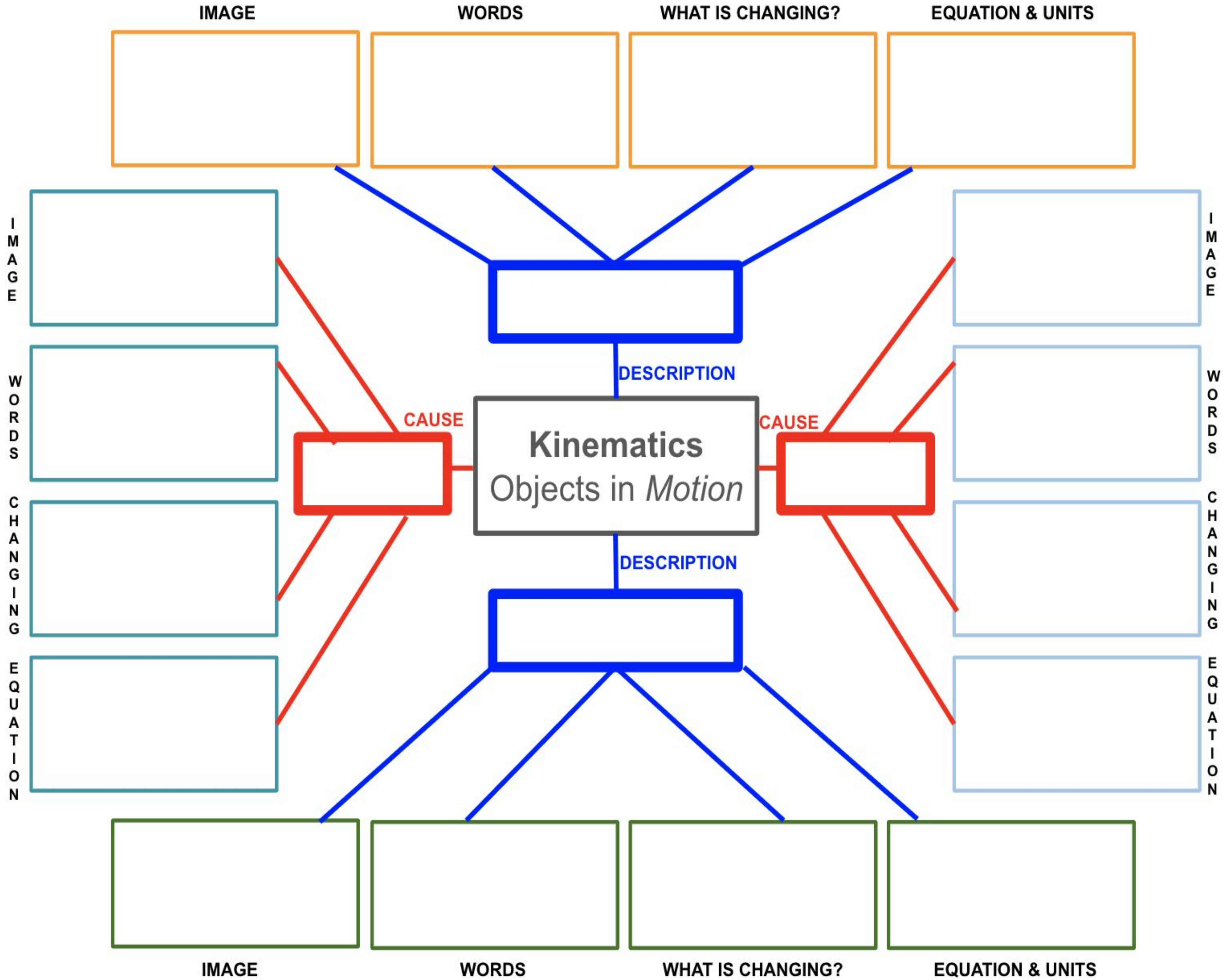


IMAGE
WORDS
WHAT IS CHANGING?
EQUATION & UNITS
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DESCRIPTION
CAUSE
Kinematics
Objects in *Motion*
CAUSE
IMAGE
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CHANGING
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WHAT IS CHANGING?
EQUATION & UNITS

Unit 8 - Energy
Part 8
Power

The last new concept we will discuss this school year is POWER. Before reading on, try to write down or say outloud (or even email me!) how you would define power (the concept of power, not its physics-y meaning).

...

Maybe your thoughts tended toward political power like a president, king, or dictator. Or possibly something like the power of words in an argument, book, or movie. Maybe your mind stuck to the physical world and physical properties like the powerful engine of a car or truck that can pull a heavy load, a powerful storm with damaging winds, or a powerful tackle in a rugby match.

All these ideas of power are on the right track.

POWER, in a general sense, is the quickness with which you get things done. It is not merely strength, but how effectively you use that strength. As an equation we see this as

$$P = \frac{\Delta E}{t}$$

$$P = \frac{W}{t}$$

In words, we would say POWER is the amount of energy transferred in some unit of time. Or, POWER is the amount of WORK done in some unit of time.

Let's consider units —

$$P = \frac{W}{t} = \frac{\Delta E}{t} \left(\frac{J}{s}\right)$$

$$\text{WATT} = W = \frac{J}{s} = \frac{N \cdot m}{s} = N\left(\frac{m}{s}\right) = \frac{kg \cdot m}{s^2}\left(\frac{m}{s}\right) = \frac{kg \cdot m^2}{s^3}$$

↑ The Watt is the Unit of Power

↑ This is also interesting: These units suggest that $\boxed{P = F \cdot \vec{v}}$ is another possible calculation of Power.

Now we have equations and units for POWER. Next step is to figure out what it means. Think about your 4-year-old self. You want a cup of milk and you want to poor it yourself. It takes the same amount of energy for you or your parent to lift the gallon and poor the milk, but it looks like you are putting in much more effort than your parent has to. WHY? Because you are lifting the gallon with less power as you slowly struggle to lift the milk high enough to to poor it. Let's look at it mathematically. A gallon of milk has a weight of ~8.4 pounds, which is ~3.8 kg. 4-year-old you can lift the gallon 20cm above the table in (a very focused) 4s (because, of course, you're 4). Your parent can lift the gallon the same height in half a second. We can show your parent (though transferring the same amount of energy) is more powerful.

Given Info

$m = 3.8\,kg$

$h = 20\,cm = 0.20\,m$

$t_{4yoy} = 4s$

$t_p = 0.5\,s$

4-Year-Old You

$$P_{4yoy} = \frac{W}{t} = \frac{mgh}{t} = \frac{(3.8kg)(10\frac{m}{s^2})(.20m)}{4s} = \frac{7.6\,J}{4s} = 1.9\,W$$

Parent

$$P_p = \frac{W}{t} = \frac{mgh}{t} = \frac{(3.8)(10)(.20)}{0.5s} = \frac{7.6\,J}{0.5s} = 15.2\,W$$

← SAME AMOUNT OF WORK

$$8 \times P_{4yoy} = P_{parent}$$

Your parent has EIGHT TIMES AS MUCH POWER lifting the gallon as 4-year-old you has because your parent is doing the same amount of work more quickly.

Now for an example that combines the conservation of energy and power.

1. A student eats a tasty school lunch containing 700. Calories. (One food Calorie = 4186 joules.) Due to basal metabolism, the student radiates about 100. joules per second into the environment.
   a. How long would the student have to sit on a couch to radiate away all of the energy from lunch?

$E = 700.\ \text{Calories} \times \frac{4186\ J}{\text{Calorie}}$

$= 2{,}930{,}200\ J$

$P = 100\ \frac{J}{s}$

$t = ?$

First, we're confused— what do you mean by radiating?! Second, WE LOOK AT THE UNITS! $100\ \frac{J}{s}$ that is POWER!

$\frac{t}{P} \cdot P = \frac{\Delta E}{t} \cdot \frac{t}{P}$

$t = \frac{\Delta E}{P}$

$t = \frac{2{,}930{,}200\ J}{100\ \frac{J}{s}}$

$\boxed{t = 29{,}302\ s}$ → But we don't think in large numbers of seconds, let's change it into hours.

$29{,}302\ s \times \frac{1\ hr}{3600\ s} = \boxed{8.14\ hr}$ → THAT'S A LONG TIME! GET UP AND START MOVING!

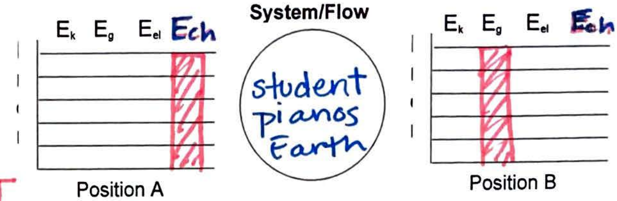
aka - not sitting on the couch!

b. If all of the energy from the student's lunch did something useful, like lifting pianos weighing 5000. newtons to the top of a 10-meter tall apartment building, how many pianos could be lifted with the energy from lunch? (Ignore the energy radiated by the student.) Complete the energy bar graph below to aid your solution.

$F_{piano} = 5000\ N$

$h = 10 m$

$E_{lunch} = 2,930,200\ J$



E_{ch} = chemical energy from your metabolism

Energy Conservation Equation: $(E_{ch})_A = (E_g \text{ of all Pianos})_B$

Let's start by calculating the E_g for one piano lifted to the top of the apartment building.

$$E_g = mgh$$
$$= (mg)h$$
$$= (F_{piano})h$$
$$= (5000 N)(10 m)$$
$$= 50,000\ J$$

We can divide the total energy by the energy it takes to lift one piano to determine how many pianos can be lifted.

$$\frac{E_{total}}{E_{1\ piano}} = \frac{2,930,200\ J}{50,000\ J} = 58.604 \text{ pianos}$$

But, of course, there can't be 0.604 of a piano so there is leftover energy: $(E_{piano})(.604)$

$$= (50,000\ J)(.604)$$
$$= 30,200\ J \text{ left over.}$$

Answer: The energy from the student's lunch is enough to lift 58 pianos to the top of an apartment building with 30,200 J left to radiate on the couch.

APPENDIX A

Miss Weisse's Musings on Power - An Analogy

For the same reason we say your parent is more powerful than your 4-year-old self because your parent can lift the gallon of milk the same height more quickly, we can also say some governments are more powerful than others. Thinking about our government in the United States, the power the government has changes every election. Let me explain — if we have a Republican president and a Senate with a Democrat majority, or vice versa, the government has less power because legislation becomes law VERY SLOWLY. If, on the other hand, the executive and legislative branches are both Republican or Democrat or whatever, the government will have more power because legislation will pass and become law more quickly... A military coup would probably have the most power, because they would cause change rapidly. This is why we have checks and balances in our Democratic Republic.

I am not advocating for any specific type of government (and especially not a coup!), but is it not interesting how this concept in physics enlightens our understanding of more than just the physical world? I am in awe.

I hope I have been able to share a little of this awe with you this year in Physics with Miss Weisse.