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AP PHYSICS I

Energy Lab 1 – Work

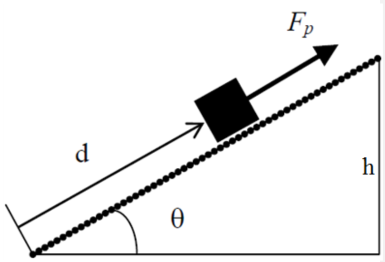
Reflective Question:

Suppose you were called upon to design a roller coaster. The first part of your design would be to move the passengers to the top of the first hill. How steep would you make the incline? How fast would you have the passengers move up the incline? What are some of the other considerations you would need to take into account?

Materials: inclined plane, meter stick, cart, spring scale

Steps:

1. You will be pulling up a cart at *constant speed* up an inclined ramp with a spring force reader.
2. You can adjust the angle of the ramp. Just make sure the cart goes to the same height every time (partway up the ramp for higher angles, full way for lower). Calculate the angle using trigonometry (sine of angle = h/d)
3. Run a couple of trials and record the data below.



Mass of Cart: _5 newtons_________

Height: _9 cm___________________

	x-variable	y-variable
Angle	**Distance (m)**	**Force (N)**
6.5	79	0.3
4.9	106	0.25
40.0	14	1.5
11.0	47?	0.5?
54.9	11	2.25

Commented [(Q1]: Outlier not included in graph

4.
5.
6.
7.
8.
9.
10. What kind of relationship exists between the *distance* up the ramp and the *force* required to pull it up? (Linear, inverse, power, root, ect.)
    There is an inverse relationship because the force require to pull it up gets larger as the distance of the ramp decreases and the force required decreases as the distance increases.

11. What do you notice about the *steepness* (angle) of the ramp and the *force* required to pull the cart up the ramp?
    There is a linear relationship the greater the angle is the greater the force needed is.

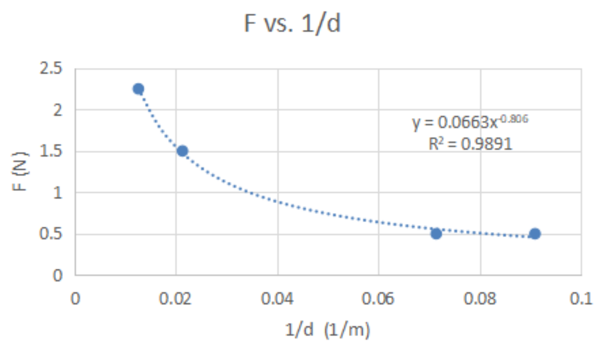
12. What do you notice about the *steepness* (angle) of the ramp and the *distance* required to pull the cart up the ramp?

    There is an inverse relationship because the steeper the ramp gets the less distance that the cart travels.

13. In the table below, please calculate the values

x-variable **Reciprocal of Distance: $1/d$**	y-variable **Force: F**	**Ratio of F to $1/d$ ($F \div 1/d$)**
1/79	0.3	23.7
1/106	0.5	26.5
1/14	1.5	21
1/47?	0.5?	23.5
1/11	2.25	24

14. Please enter your data for the graph of $F\ vs.\ 1/d$ below.



15. What do you notice about the ratio of F and $1/d$? Also, think of another mathematical way of expressing $F \div 1/d$.

The ratio of F and 1/d is not linearly proportional. Another mathematical way of expressing this is W = FD

16. This value is expressed as the ***Work*** done on an object and is expressed in units of Joules (N*m). Knowing this, write the general equation which represents the relationship between Work, Force, and Distance.

$$W = FD$$

17. Now suspend the cart on the spring scale and elevate the cart to the height of the ramp at a *constant velocity*. How much force was required to elevate the cart?

More than 2.5 N

18. Work is defined as the transfer of energy. So the energy that you placed into the object has transformed to a quantity known as gravitational potential energy: U_g or PE_g. According to you relationship in #10, what would be the mathematical equation used to evaluate the amount of gravitational potential energy change be in terms of mass, height, and physical constants?

$$\Delta U_g = 9.8mh$$

19. If this ramp were to appear somewhere in your roller coaster, what would be the minimum speed needed at the bottom part of the ramp in order to successfully reach the top of the ramp without the assistance of an outside force pulling the cart up the ramp and without considering energy lost to friction/heat? Reminder: $KE = \frac{1}{2}mv^2$. Does the angle or steepness seem to affect the speed needed to do so?

KE=1/2(0.5)v^2
23.5=1/2*(0.5)*v^2
Velocity is 9.7m/s

The angle/steepness **does** affect the speed needed to do so.