Energy -- Conceptual Questions

1.) A net force accelerates a body. If you multiply that force by the distance over which it is applied, what will that quantity tell you?

2.) A net force F stops a car in distance d. In terms of F, how much force must be applied to stop the car in the same distance if its velocity is tripled?

3.) An object of mass m moving with speed v comes to rest over a given distance d due to the effects of friction. What do you know about the average frictional force involved (i.e., how large must it have been)?

4.) Two masses, m and 2m, both freefall from rest. Ignoring friction, which has the greater speed after falling a given distance? Which has more work done to it by gravity over that distance? Is there something to explain here? If so, do so.

5.) A car slows from 40 m/s to 20 m/s, then from 20 m/s to 0 m/s. In which instance (if any) was more energy pulled out of the system? Reversing the question, going from zero to 20 m/s requires more, the same, or less energy than is required to go from 20 m/s to 40 m/s? Explain.

6.) A force is applied to an object initially at rest. The force acts over a distance d taking the object up to a speed v.

- a.) If the force had been halved but the distance remained the same, how would the final velocity have changed (if at all)?
- b.) If, instead, the distance had been halved with the force remaining unchanged, how would the final velocity have changed (if at all)?

7.) What is the ONE AND ONLY thing potential energy functions do for you?

8.) An ideal spring is compressed a distance x. How much more force would be required to compress it a distance 2x? How much more energy would be required to execute this compression?

9.) A mass moving with speed v strikes an ideal spring, compressing the spring a distance x before coming to rest. In terms of v, how fast would the mass have to be moving to compress the spring a distance 2x?

10.) A simple pendulum (a mass attached to a swinging string) is pulled back to an angle θ and released. Ignore friction.

- a.) If the mass is doubled, what will happen to the velocity at the bottom of the arc?
- b.) If the length of the pendulum arm is doubled, how will the velocity at the bottom of the arc change?

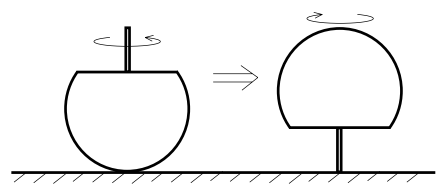
c.) Is there any acceleration at the bottom of the arc? If so, how much and in what direction?

d.) How much work does tension do as the bob moves from the initial point to the bottom of the arc?

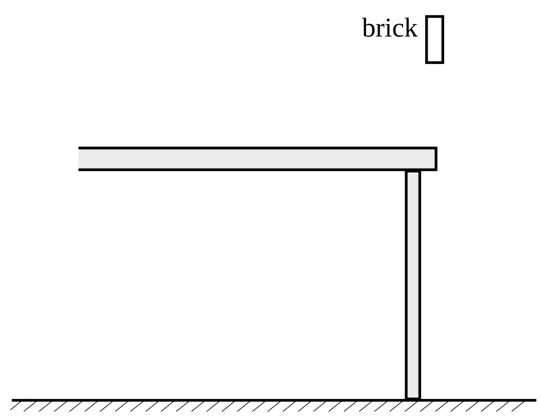
e.) How much work does gravity do as the bob moves from the initial point to the bottom of the arc?

11.) There is a toy on the market--a top--that, when spun, flips itself over (see sketch). What is the top really doing as it moves from the one state to the other state?

top flips when rotated



12.) A brick is held above the edge of a table. Suzy Q looks at the brick, deduces that if it were to fall it would land ON the table, and calculates the brick's gravitational potential energy with that in mind. In doing so, she comes up with a number N_1. Big Jack, who happens to have terrible eyesight and has left his glasses at home, looks at the brick and decides that if it falls, it will land on the ground. He keeps that in mind as he calculates the brick's gravitational potential energy coming up with a number N_2. Which potential energy quantity is correct? Explain.



13.) For a spring system, it is very obvious when there is no potential energy wrapped up in the position of the spring. For a gravitational situation near the surface of the earth, that isn't the case. What is the telltale difference between the two situations?

14.) Is it possible for:

a.) Potential energy to be negative? If yes, give an everyday example.

b.) Kinetic energy to be negative? If yes, give an everyday example.

c.) Work quantity to be negative? If yes, give an everyday example.

d.) Power to be negative? If yes, give an everyday example.

15.) The units of power could be which of the following (more than one are possible)?

a.) Joules/sec.

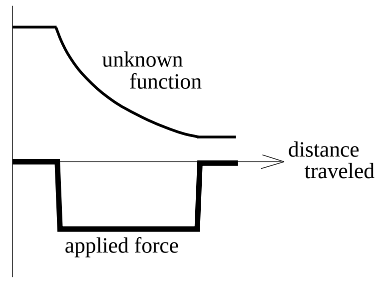
b.) Watts/sec.

c.) $Kg \cdot m^2/s^3$.

d.) Nt·m/s.

16.) Work is to energy as force is to <u>(velocity)</u>. How so?

17.) The potential energy function associated with a spring force of -kx is $.5kx^2$. What would you expect the potential energy function for a force of $-kx^5$ to be? How would you derive such a function?



18.) A vehicle moves in the +x direction. The net force applied to the vehicle is shown to the right along with a second graph. What might that second graph depict?

19.) A force is applied to an object for some period of time t. During that time it does W's worth of work. If the time of contact remains the same but the force is doubled, what will the ratio of the work quantities be?

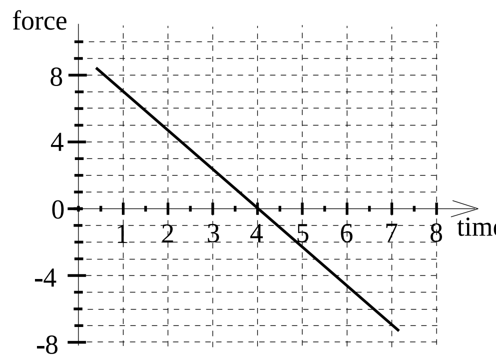
20.) Assume you have a constant force F = (12 newtons)i that does work on a moving object as the object travels a distance d = (2 meters)i in time t = 3 seconds.

a.) At what rate is energy being pumped into the system?

b.) What is the name given to the quantity you derived in Part a?

c.) Come up with four different ways to express the quantity named in Part b.

d.) In the MKS system, what are the units for this quantity and what are the units called?



21.) The graph shows the force F applied to an object that moves with a constant velocity of .5 m/s in the -i direction. Assuming F is oriented along the x axis:

a.) What can you say about the other forces that act in the system?

b.) How much power does F provide to the object between t = 1 second and t = 7 seconds?

c.) After t = 4 seconds, F's direction changes. What does that say about the power associated with F from then on?

d.). How much power, on average, does F provide between t = 1 second and t = 4 seconds?

e.) As an interesting twist, given that the average power provided to the system between t = 4 seconds and t = 7 seconds is 1.75 watts, how much work does the force do during that period of time.

22.) Let's assume that a car engine provides a constant amount of power. The car accelerates from zero to 30 m/s. Is the car's acceleration constant?

23.) A group of students were asked the following question: "In the real world, what does the power requirement do as you double a car's velocity?" Assuming a reasonable answer was expected, what information is missing in the set-up? That is, what additional information would the students have needed to answer sensibly?

24.) In his younger days, George boasted he could do a million joules of work. Gertrude, his betrothed, wasn't impressed. Why do you suppose she wasn't moved?

25.) Three identical springs are attached at the ceiling. A bar of mass m is hooked to the group. If the new system's equilibrium position is d units below the springs' unstretched lengths, what must the spring constant be for each spring? Use energy considerations to dismantle this problem.