WORK

POWER

ENERGY

AP Physics – Work and Energy – 1

Identify yourself in this space____Per __

Courage is doing what you're afraid to do. There can be no courage unless you are scared. --Eddie Rickenbacker

1. How much work is done on a 55 N package you carry horizontally for a distance of 12 m?

2. How much work is done on a 625 N rock that you lift 0.85 m?

3. You apply a 225 N force to a heavy crate with a rope that makes a 27.0° angle with the horizontal, if you pull the crate a distance of 3.50 m, how much work was done?

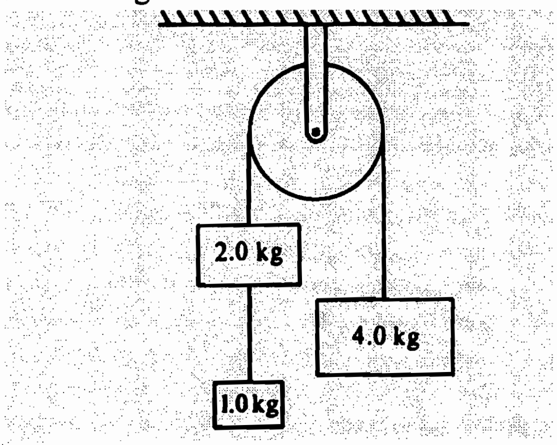
4. You pull a 55.5 kg wooden box with a rope that makes a 28.0° angle with the horizontal at a constant speed. The coefficient of kinetic friction between the box and the deck is 0.330. You pull the crate a distance of 2.25 m. How much work was done?

5. A bear with a mass of 218 kg runs up a hill. At the top of the hill, she has gained 23.5 kJ of potential energy. How high was the hill?

6. A 1.25 kg rock is thrown with a velocity of 12.5 m/s at an angle of 43.0° to the horizontal. (a) How much kinetic energy does it have when it is initially released? (b) What is its kinetic energy at the highest point in its trajectory? (c) How far does it travel in the horizontal direction?

7. A 15.0 kg bullet leaves the barrel of a gun at a speed of 240.0 m/s. (a) Find the bullet's kinetic energy, (b) find the average force exerted on the bullet by the expanding gases as the bullet moves through the length of the 50.0 cm barrel.

8. Three blocks of masses 1.0, 2.0, and 4.0 kilograms are connected by massless strings, one of which passes over a frictionless pulley of negligible mass, as shown below. Calculate each of the following.



a. The acceleration of the 4.0 kilogram block.

b. The tension in the string supporting the 4.0 kilogram block.

c. The tension in the string connected to the 1.0 kilogram block.

AP Physics – Work/Energy - 2

You, Identify, Now!____Per __

He that would make his own liberty secure must guard even his enemy from oppression; for if he violates this duty he establishes a precedent that will reach to himself. --Thomas Paine

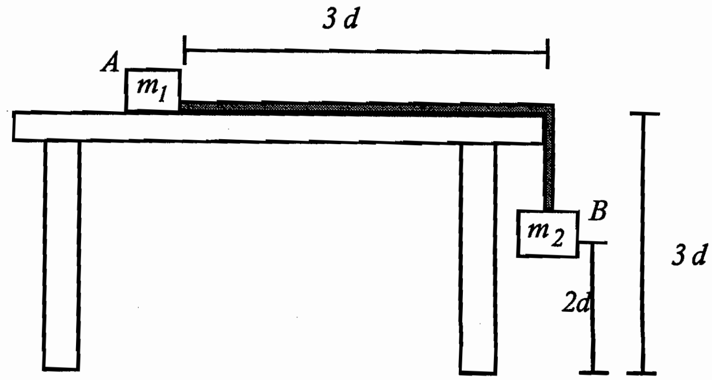
1. A 2.45 kg rock is dropped from the top of a 15.5 m vertical cliff. (a) What is the potential energy of the rock relative to the base of the cliff before it is dropped? (b) What is the kinetic energy of the rock just before it hits the ground below? (c) What is the velocity of the rock at a point 5.00 m above the base of the cliff? (d) How much total energy does the rock have half way down?

2. A roller coaster is at the top of a 75.0 m hill. It rolls down the hill on very low friction wheels and climbs up to the top of a 45.0 m hill. Find (a) the speed of the thing at the bottom of the first hill and (b) its speed at the top of the second hill.

3. You push a 45.0 kg wooden crate up a ramp that makes an angle of 22.0° to the horizontal at a constant speed. The coefficient of kinetic friction for the crate and ramp is 0.385 (a) How much work have you done if you push it a distance of 10.5 m up the ramp? (b) What is the change in potential energy for the crate relative to the base of the ramp?

4. A 2.5 kg ball hangs from the overhead by a string that is 75 cm long. The height of the room is 3.0 m. What is the potential energy of the ball (a) relative to the deck? (b) Relative to the top of an 88 cm tall tabletop? (c) Relative to the overhead?

5. A block ***A*** of mass m_1 rests on a very smooth table and is attached to block ***B*** of mass m_2 that hangs over the table as shown. Block ***A*** is distance 3 d from the end of the table. Block ***B*** is distance 2d from the deck and distance d from the tabletop. (a) What is the potential energy of block ***B*** relative to the deck? (b) What is the acceleration of the system when block A is released? (c) What is the kinetic energy of block ***B*** just before it hits the deck? (d) What is the kinetic energy of block ***A*** at the moment it reaches the edge of the table (e) What is the potential energy of block ***A*** at the same point? (d) What is the kinetic energy of block ***A*** just before it hits the deck?



AP Physics – Work on This - 3

Identifier ____ Per ___

You can tell whether a man is clever by his answers. You can tell whether a man is wise by his questions. -- Mahfouz Naguib

1. A spring has a spring constant of k = 55.0 N/m. The spring is compressed a distance of 3.50 cm. What is the potential energy stored in the spring?

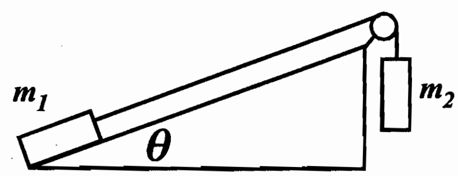
2. An 85 g wooden block is set up against a spring. The block rests on a smooth surface. The block is pushed into the spring, compressing it a distance of 2.0 cm and then released. The spring constant is k = 78 N/m. What is the speed of the block when it reaches its initial position (where the spring was not compressed)?

3. A roller coaster starts at some height that you do not know. It goes down this hill and then goes up a second hill that is 28.5 m above the first drop at a speed of 22.5 m/s. So how high was the initial hill?

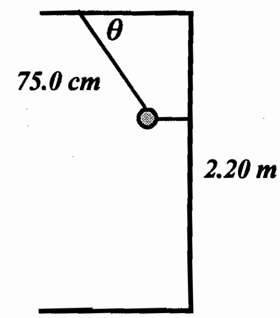
4. A 5.0 kg crate slides down a smooth ramp that is elevated at an angle of 38°. The length of the ramp is 2.0 m. What will be the speed of the crate at the bottom of the ramp?

5. A fireman runs up a 7.5 m ladder. The fireman has a mass of 52 kg and is carrying 15 kg of firefightin' gear. If the fireman developed 685 watts, how much time did it take to reach the top of the ladder?

6. A 3.00 kg mass, m_1, slides up a ramp. The angle for the ramp is 28.0°. The 3.00 kg mass is connected to a second mass, m_2, of 3.25 kg as shown by a light string with a frictionless pulley, &c. Coefficient of kinetic friction is 0.285. Find (a) the acceleration of m_1, (b) the kinetic energy of m_1 after it has traveled 25.0 cm up the ramp, and (c) the work done on m_1 to move it the 25.0 cm.



7. A 3.12 kg iron ball is suspended from the ceiling of a room by two cords as shown in the drawing. The ceiling is 2.20 m above the deck. The angle θ is 61.0°. The other cord is perfectly horizontal. Find (a) The tension in both strings. (b) The potential energy of the ball relative to the deck. (c) if the horizontal spring were to break, what would be the velocity of the ball when the other cord is vertical?



8. A 47.0 kg projectile is launched with an initial speed of 72.0 m/s and an angle of 39.8° above the horizontal. The projectile lands on a hillside 7.15 s later. Neglect air friction. (a) What is the projectile's kinetic energy at the highest point of its trajectory? (b) What is the height of the impact point? (c) What is its total energy just before it hits the hillside?

AP Physics - Work is Still a Four Letter Word – 4

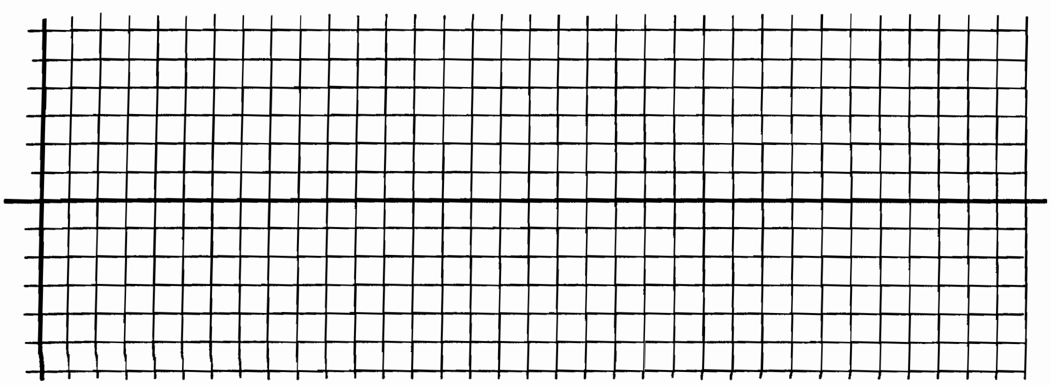
Be You Somebody? ____ Per__

Peanuts

We sleep safely in our beds because rough men stand ready in the night to do violence to those who would do us harm.
-- George Orwell

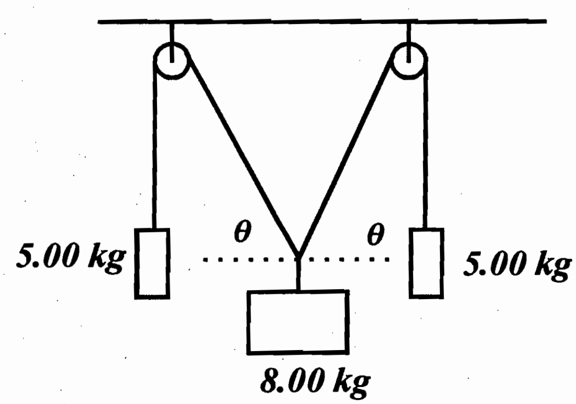
1. A 0.44 kg ball is thrown straight down from a bridge with an initial velocity of 12.5 m/s. It travels for 1.5 seconds. Find: (a) The height of the bridge, (b) the potential energy of the ball before it is thrown, and (c) the total energy of the ball 2.50 m above the water below.

2. You travel down the highway, starting from rest. You travel for 0.30 hours at a speed of 70 mi/h. Then you stop and eat your lunch for 30.0 min. Then you travel for 0.25 hours at 70 mi/h. Then you are forced to wait for 15 minutes for roadwork. Then you travel for 15 minutes at only 35 mi/h. Make a velocity vs time graph of this motion.

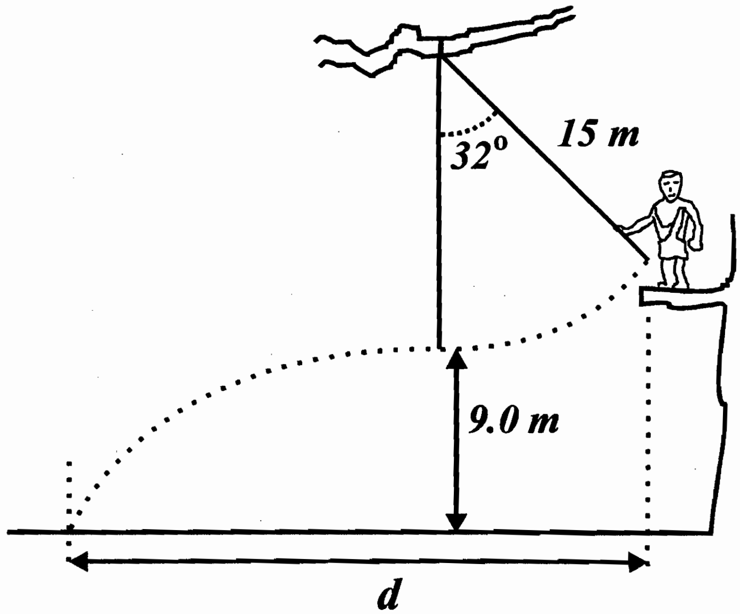


3. A 2.5 kg box slides across the flat surface of a table. The coefficient of kinetic friction for the table/box is 0.295. The box is attached to a light string that passes over a low friction pulley and is connected to a 3.0 kg mass that is hanging vertically. (a) find the acceleration of the system (b) find the velocity of the 2.5 kg box after it has been dragged 0.25 m if its initial velocity was 0.25 m/s, and (c) find the kinetic energy of the box at this point.

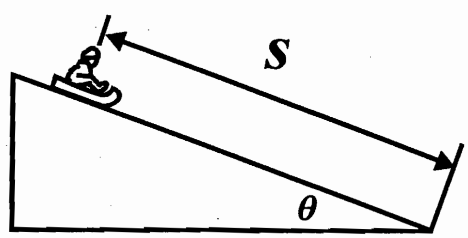
4. Find the two angles if the system is at rest.



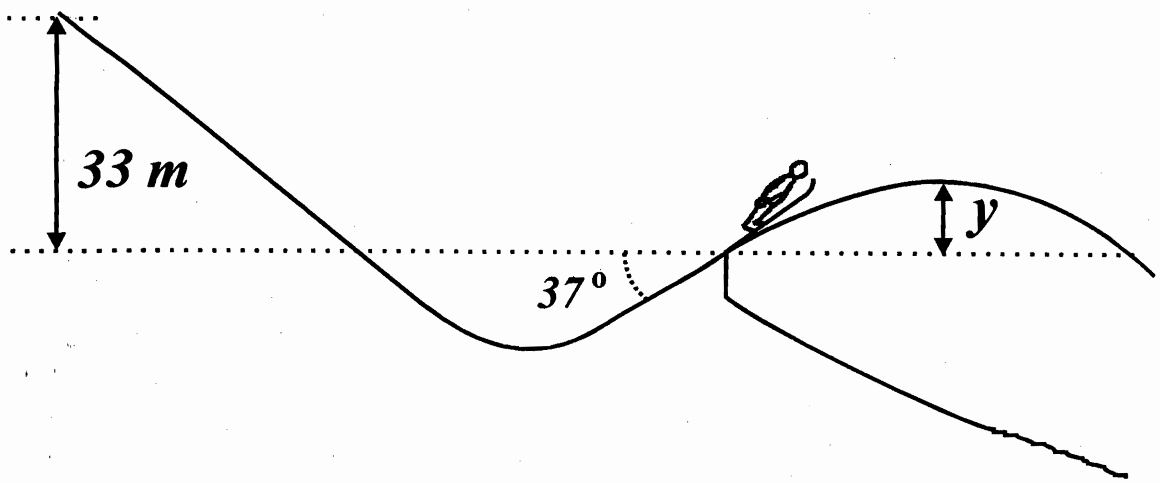
5. Okay, here's a wonderful Tarzan swing problem. Tarzan is above the floor of the jungle on a limb. He swings out on a vine and lets go of the thing when he is at the lowest point of the swing. At this point, he is 9.0 m above the ground. How far horizontally did he travel from when he first started his swing?



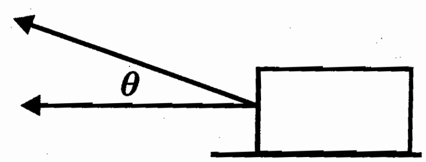
6. A sled coasts down a hill as shown. The angle the slope makes with the horizontal is 41°. The distance *s* is 35 m. Find the speed of the sled at the bottom of the hill.



7. A ski jumper sails down a slope as shown. Find the vertical distance that the skier travels from the edge of the bottom of the ski jump.



8. You pull a box across the floor with a force of 425 N. The coefficient of kinetic friction is 0.305. The mass of the crate is 125 kg. Angle $\theta = 35.0°$. Find: (a) the acceleration of the box and (b) the amount of work done in moving the crate a distance of 3.50 m.



AP Physics – Work/Energy – 5

Who you think you are ____ Per___

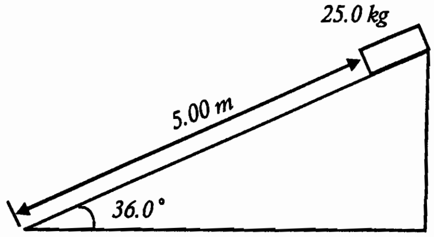
The difference between stupidity and ignorance is that ignorance is curable. – Robert Heinlein

1. A spring with a spring constant value of 125 N/m is compressed 12.2 cm by pushing on it with a 215 g block. When the block is released, what velocity will the block have when it leaves the spring (we're ignoring friction here)?

2. A woman lifts a 12.5 kg bucket up a well. She does 5.50 kJ of work. How deep is the well?

3. A 48.0 kg telephone repairperson climbs up one of them power pole deals. She is carrying 7.85 kg of tools and things. If she generates 0.765 hp, how much time does it take her to climb the 3.20 m tall pole?

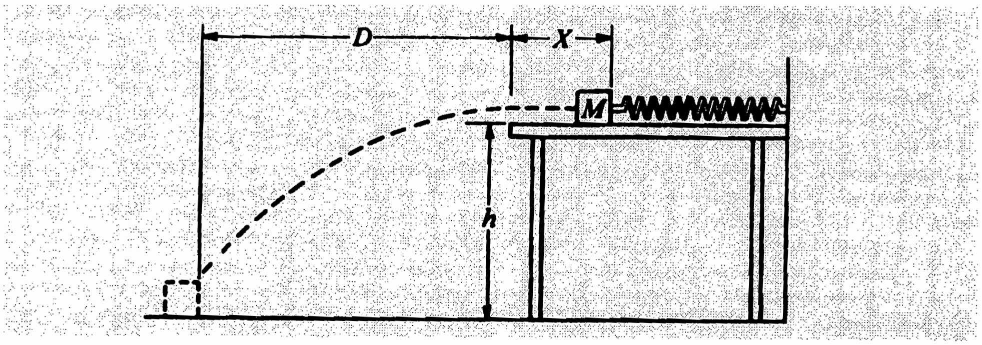
4. A 25.0 kg block slides down a ramp that is elevated at 36.0° a distance of 5.00 m. The coefficient of kinetic friction is 0.220. (a) What is the potential energy of the block before it begins to slide? (b) What is the work done by friction as the block slides down the ramp (said energy being converted into heat)? (c) What is the speed of the block when it reaches the bottom?



5. A 12.6 kg monkey sitting on a branch grabs a 25.0 m long vine and swings outward. Initially the vine made an angle of 28.0° to the vertical. How fast will the monkey be traveling when she reaches the bottom of her swing?

6. A dart gun consists of a spring (k = 367 N/m) and a 25.0 g dart. When the dart is loaded into the gun, the spring is compressed 7.0 cm. The gun is aimed straight up and fired. How high does the dart go, ignoring air resistance of course?

7. One end of a spring is attached to a solid wall while the other end just reaches to the edge of a horizontal, frictionless tabletop, which is a distance ***h*** = 0.89 m above the floor. A 3.5 kg block is placed against the end of the spring and pushed toward the wall until the spring has been compressed a distance of 18 cm, as shown below. The block is released, follows the trajectory shown, and strikes the floor a horizontal distance of 1.2 m from the edge of the table. Air resistance is negligible.



Determine the following :

a. The time elapsed from the instant the block leaves the table to the instant it strikes the floor.

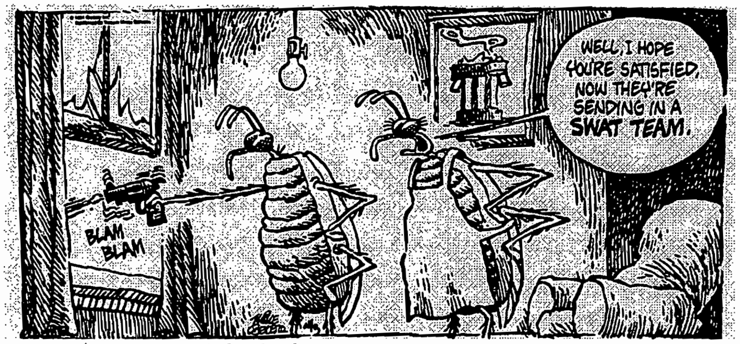
b. The horizontal component of the velocity of the block just before it hits the floor.

c. The work done on the block by the spring.

d. The spring constant.

AP Physics – Work/Energy – 6

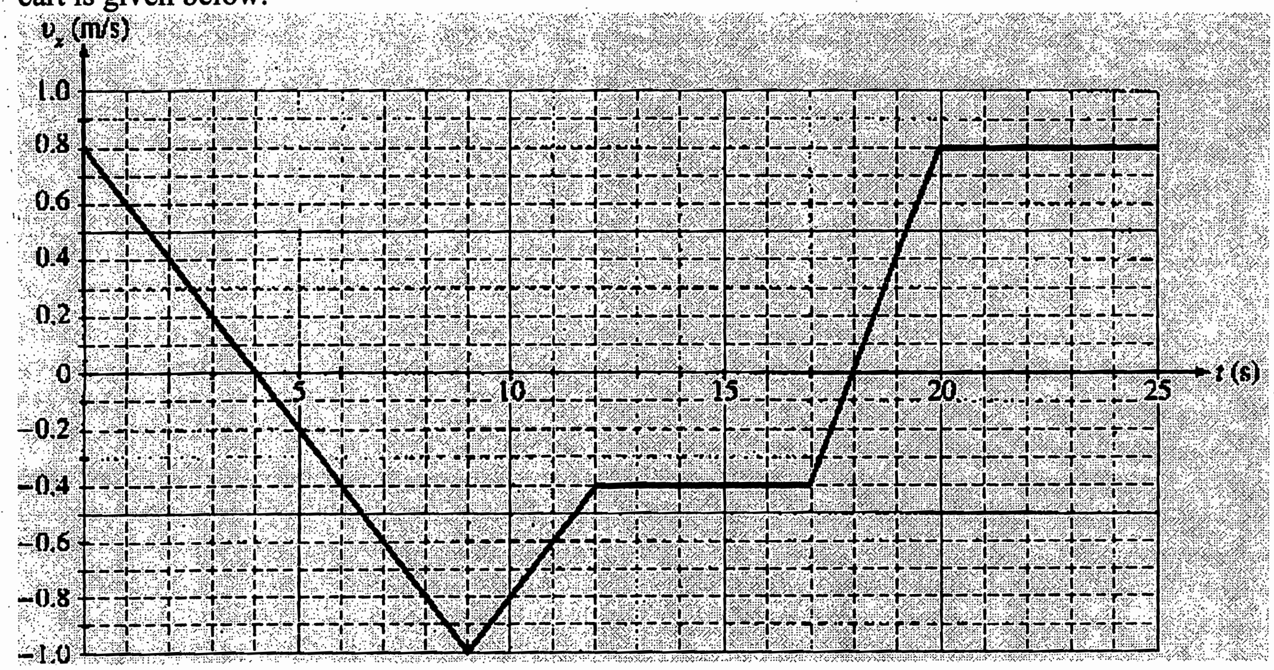
Who you may be ____ Per___



I think, therefore I am. -- Rene Descartes

I think, therefore I thtay away from water becauth I can't thwim.. -- Babette Bingo

1. A 0.50 kg cart moves on a straight horizontal track. The graph of velocity $\mathbf{V_x}$ versus time t for the cart is given below.

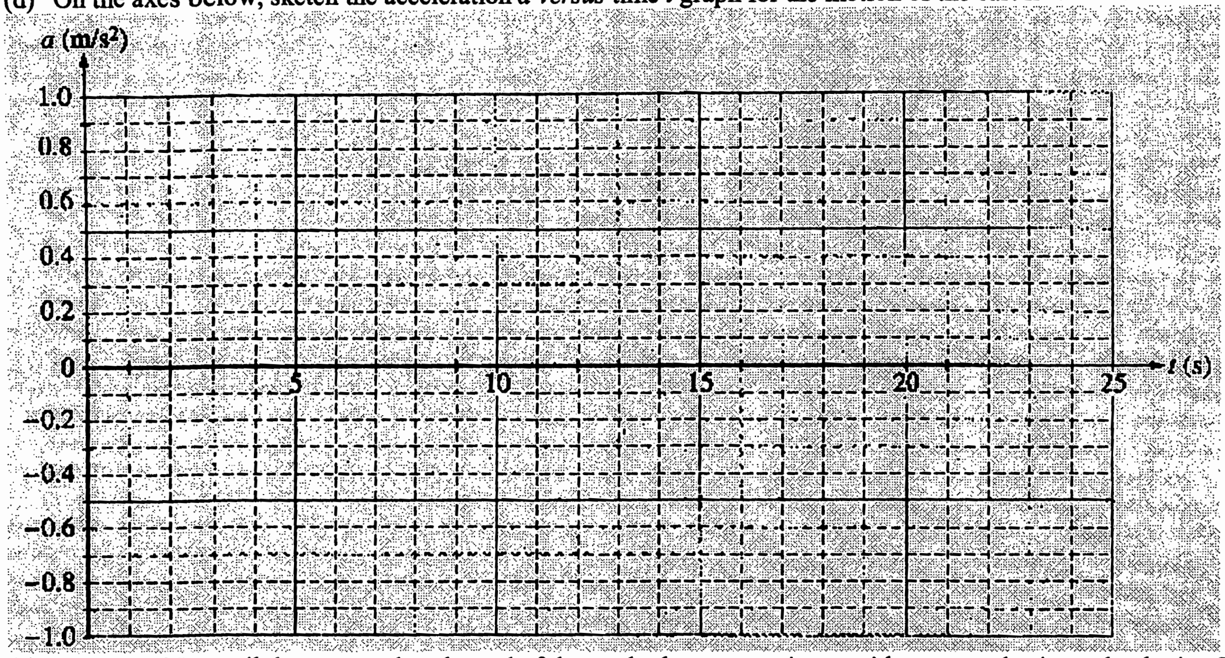


(a) Indicate every time *t* for which the cart is at rest.

(b) Indicate every time interval for which the speed (magnitude of velocity) of the cart is increasing.

(c) Determine the horizontal position x of the cart at t = 9.0 s if the cart is located at x = 2.0 m at t = 0.

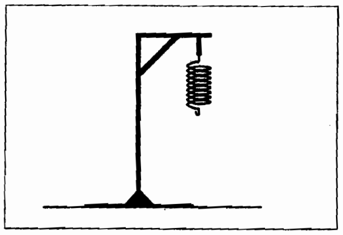
(d) On the axes below, sketch the acceleration a *versus* time t graph for the motion of the cart from $t = 0$ to $t = 25$ s



(e) From $t = 25$ s until the cart reaches the end of the track, the cart continues with constant horizontal velocity. The cart leaves the end of the track and hits the floor, which is 0.40 m below the track. Neglecting air resistance, determine each of the following.

i. The time from when the cart leaves the track until it first hits the floor
ii. The horizontal distance from the end of the track to the point at which the cart first hits the floor
iii. The kinetic energy of the cart immediately before it hits the floor

2. A spring that can be assumed to be ideal hangs from a stand, as shown.



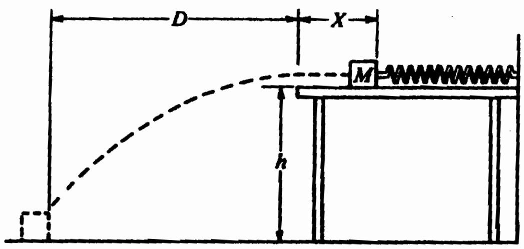
a. You wish to determine experimentally the spring constant ***k*** of the spring.
   i. What additional, commonly available equipment would you need?
   ii. What measurements would you make?
   iii. How would *k* be determined from these measurements?

3. A 154 kg bear runs up a hill that has a slope of 15.0° to the horizontal. The critter travels 1200 m in 125 seconds. (a) How much work did the bear do on itself? (b) How much power did the bear develop?

4. A spring is compressed 3.25 cm by a 105 N force. (a) What is the spring constant? (b) How much potential energy is stored in the spring?

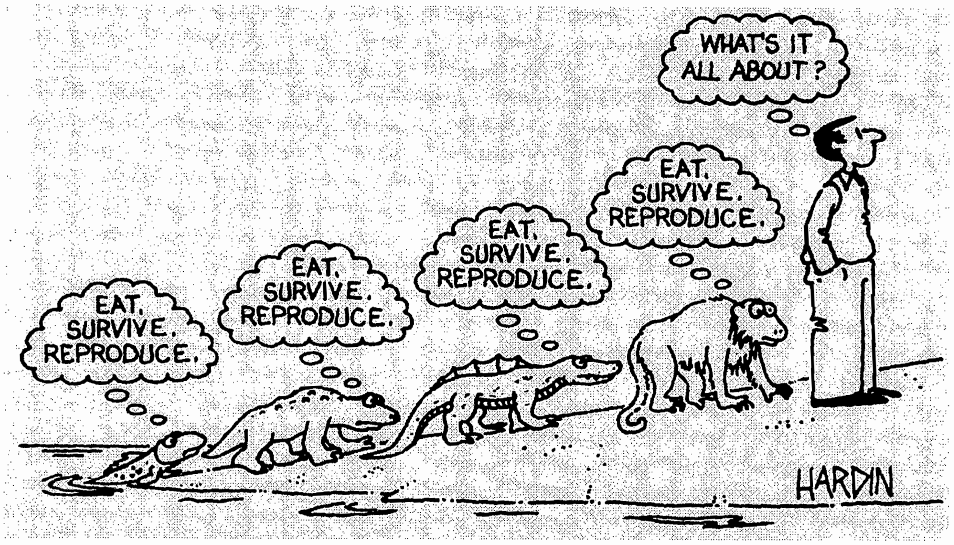
5. One end of a spring is attached to a solid wall while the other end just reaches to the edge of a horizontal, frictionless tabletop, which is a distance ***h*** above the floor. A block of mass ***M*** is placed against the end of the spring and pushed toward the wall until the spring has been compressed a distance ***X***, as shown. The block is released, follows the trajectory shown, and strikes the floor a horizontal distance ***D*** from the edge of the table. Air resistance is negligible.

   Determine expressions for the following quantities in terms of ***M, X, D, h,*** and ***g***. Note that these symbols do not include the spring constant.



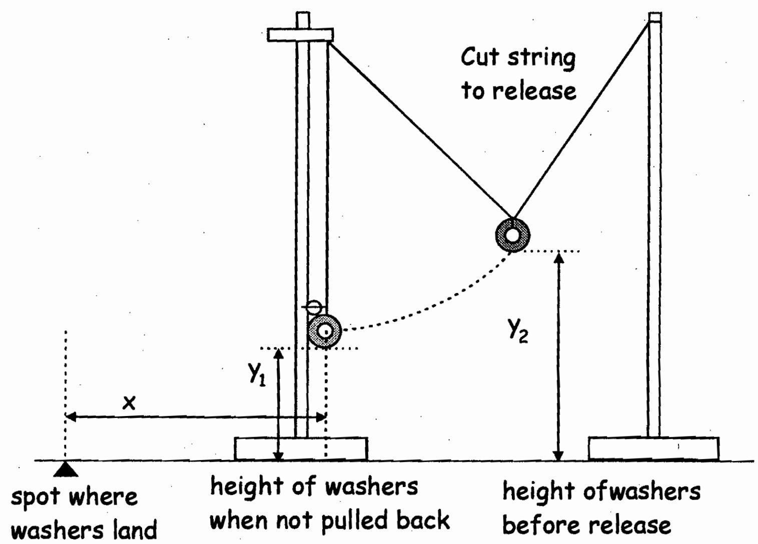
a. The time elapsed from the instant the block leaves the table to the instant it strikes the floor.
b. The horizontal component of the velocity of the block just before it hits the floor
c. The work done on the block by the spring
d. The spring constant

AP Physics - Exciting Conservation of Energy Lab



A hen is only an egg's way of making another egg. -- Samuel Butler

In this ever so loverly lab, you are going to confirm the universality of the good old law of conservation of energy.



Tie a bunch or washers (10 – 12 of them) together into a single lump kind of deal. Then, note that the washers are fit to be tied to the end of the thread. So tie them to the end of a piece of thread. The other end of the thread is tied to the ring at the top of the ring stand.

Allow the washers to hang vertically and measure the height of the washers above the tabletop. This is shown as y_1 in the drawing above. You want the razor blade to be above the washers, so the washers won't hit it, just the string. But it should be fairly close to the washers so that the string when in a straight, up-and-down position, will hit the razor blade. Fix the razor blade in a clamp below the ring. Now, does the General really have to remind you that the razor blade is sharp, so be careful that you don't cut yourself? Naw, probably not.

Do you need to measure the mass of the washers?

Tie another thread to the washers and use it to pull the washers back to some height, y_2, above the tabletop. You should measure this height also. The washers are then released – cut the string! The washers swing forward until the razor blade cuts the thread. The washers will travel some horizontal distance x before they hit the tabletop. Mark where they hit and measure the value of x.

Now, before you released the washers they had potential energy with respect to y_1. When they got to the bottom of the swing where the razor blade cut the string, they had kinetic energy. Solve the thing for v, which gives you the horizontal speed of the washers when they are released. Of course, once the razor blade cuts the string, the washers will fall. Calculate the distance they should travel and compare to what actually happened.

Hey, you could figure out an experimental error, couldn't you?

Anyway, get busy and do the lab. Stop goofing around. Turn to!