Name _____

Physics 104 - Exam 1

March 4, 1999

Instructions

- *Put your name on every page first! (5 points will be deducted if your name is not on every page).*
- *Please answer all questions in the space provided on these pages. (If you need more room use the back of the page and say (OVER)).*
- *Read all the questions first. Then start on the ones you find easiest..*
- *If you don't understand what a question is asking raise your hand and ask.*
- *Write clearly and make drawings whenever it will help explain what you mean. Partial credit will be given only if we can figure out what you are trying to do or say.*

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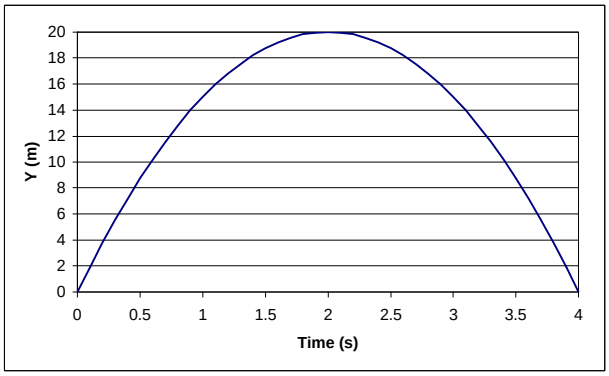
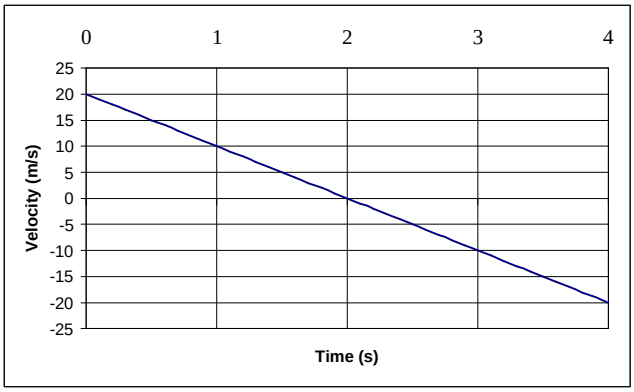
1) A ball is thrown straight up with a speed of 20m/s. The graph of its motion is shown below: (Air resistance is assumed to be negligible).





a) (5 points) What force(s) act on the ball just after it is released?

Gravity acts downward on the ball

b) (5 points) On the blank graph sketch a graph of this ball's velocity versus time (Assume g= -10m/s^2).

b) (5 points) Just after the ball is released at t=0 it has kinetic energy, but no potential energy. Explain what happens to the energy (kinetic, potential and total) of the ball at t=1s (while its going up), t=2s (at the top of its motion) and t=4s (just before it hits the ground).

At t=1s the ball has both potential and kinetic (note that it has more potential than kinetic because its higher than half way up). At 2s its all potential energy. At t=4s its back down and its all kinetic again. The total energy remains the same at all times.

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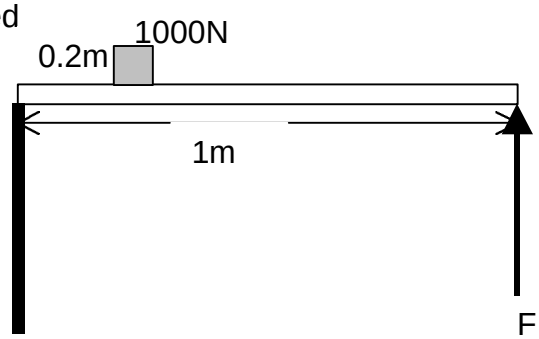
2) In the sketch shown below a 1 m long board (of negligible weight) is support on the left by pivot. A mass weighing 1000N is 0.2m from the left edge.

a) (5 points) How much force, F, must be applied at the right end of the board to hold it up?

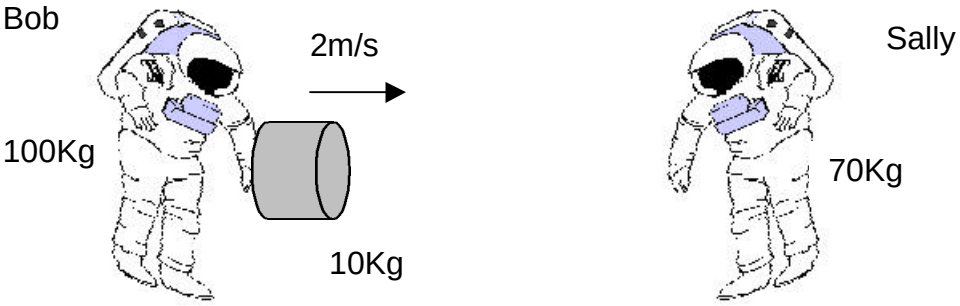


The torque must balance (or the sum=0)so:
$\tau_1 = F_1 \text{ X } R_1 = -1000 \text{ X } 0.2 = -200Nm$
$\tau_2 = F_2\ \tau_1 \text{ X } R_2 = F_2*1.0m$
$0 = \tau_1 + \tau_2 = -200Nm + F_2*1.0m$
$F_2 = 200N$

b) (5 points) If we raise the right end of the board up 10cm, how much work is done?

W=F*d and F = 200N d= 0.1m so W= 200N*0.1m = 20J

3) In space, two astronauts are floating in the shuttle cargo bay. One astronaut, named Bob whose mass is 100Kg, pushes a 10Kg mass at 2m/s toward another astronaut Sally whose mass is 70 Kg.



a) (5 points) How does Bob move (speed and direction) after he releases the mass?

$M_1 * V_1 + M_2 * V_2 = 0$
$100Kg\ V_1 + 10kg * 2m/s = 0$
$V_1 = -0.2m/s$ (left)

b) (5 points) How do Sally and the mass move (speed and direction) after she catches the mass?

The momentum of the mass is 20Kg m/s to the right. After the catch the total momentum remains the same so the mass of Sally and the object = 70Kg +10Kg and their momentum is 20Kg m/s to the right. This gives
V=20Kg m/s /80Kg = 0.25m/s

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4) You spin a weight on string in a circle above your head at a constant speed:

a) (5 points) Is the mass accelerating? (Explain briefly).

Yes it's changing direction continuously.

b) (5 points) Are you doing work on the mass? (Explain briefly).

No - You are applying a force perpendicular to the direction of motion. Work is F (dot) V or Force times the motion along the force.

c) (5 points) If you let the string go, describe the motion of the mass.

It moves in a straight line since no force acts on it. (Yes it may fall as well).

5) **Answer briefly <u>10 out of the following 13</u> questions.** Use complete sentences and include physics terms like energy, torque, convection… etc. and/or a sketch where appropriate. (5 points each. If you answer more than 10 we will only count the first 10 unless you cross out the ones that you don't want to count).

a) Why do you use a wrench to tighten a bolt?

The wrench gives you a longer lever arm so less force is required to give a large torque.

b) Explain how you are transforming one type of energy to another when you ski down a hill at a constant speed.

You are moving a constant speed as you lose potential energy so you are transforming potential energy into thermal energy with friction on the snow.

c) Explain why, even though air is a poor conductor of heat, a big air space in the attic of a house still causes the house to loose a lot of heat if the attic is not insulated.

Convection currents are set up which take heat from the floor of the attic and transport it to the roof where it conducts out.

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d) Explain why fiberglass insulation reduces heat loss in the attic of a house.

Fiberglass is a poor conductor and it traps air which is also a poor conductor. This prevents the floor of the attic (the ceiling of the inside of the house) from conducting heat to the attic. Hence no convection. (see question c).

e) Explain the wind chill effect.

Your body warms the air near your skin and if the air stays there you don't lose much heat to it. If its windy this air is blown away and replaced by cold air so you lose heat quickly. This makes a windy day seem colder since you measure temperature by the rate at which you lose heat.

f) Explain how a thermostat works.

A bimetal strip which is made of two metals with different expansion coeffiecients is coiled up. As the temperature changes, the coil winds further or unwinds. A switch (typically mercury) is at the end of the coil. It either turns on or off as the coil winds or unwinds, turning on or off the heat or airconditioning.

g) Explain why you can't make a truly "white" light bulb (one with the same spectrum as the sun).

The Sun's temperature is 5800K no material can be heated that high without melting.

h) Explain how double pane windows reduce heat loss.

The double pane window has a thin layer of air or gas between the panes of glass. This gas is a poor conductor of heat. Since it is tall and thin, no convection cell is set up so it is a very good insulator and reduces heat loss over a single pane of glass.

i) Explain why on a clear night objects cool faster than on a cloudy night.

On a clear night you radiate to the 3K temperature of space. On a cloudy night you radiate to clouds which are close to your temperature. (Actually it’s the rate at which space or the clouds radiate to you).

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j) Explain why when a light car and heavy truck collide, even though according to Newton's third law the force on both is equal and opposite, it is better to be in the truck.

F=ma and the force on both vehicles is the same. So the car which has the small mass has a big acceleration while the truck has a much smaller accleration. The acceleration is the problem. If you accelerate rapidly you can be hurt.

k) Explain why, when you use a dimmer to reduce the light from a bulb, you are getting a smaller fraction of the power as light.

As the bulb is run a lower temperature it radiates a larger fraction of its energy in the infrared where its invisible.

l) Why wrap a potato in aluminum foil after you remove it from the oven?

The aluminum foil reflects the radiation back into the potato and even though it gets warm it itself is a poor radiator. This keeps the heat in the potato and lets it cook all the way through.

m) Explain why a rolling wheel does no work.
The point of contact changes continually, so there is only static friction. If there is no movement there is no force times distance - therefore no work. You only get work from sliding friction.