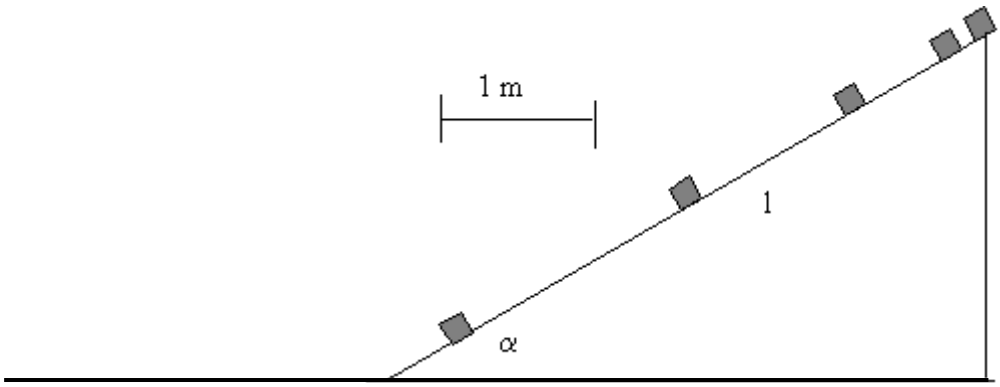
Form 11

1. Problem

At the top of inclined plane small box is released. Mass of the box is 2 kg. Positions of the box after each $t_o = 0{,}5$ s since release are shown in the picture. g can be assumed equal to 10 m/s^2



A. By doing measurements, determine the length of the plane and angle α.
B. Determine acceleration of the box.
C. What is the time in which the box reaches the end of the plane and what is final speed?
D. What is the ratio of mechanical energies at the beginning of the motion and at the end of the inclined plane (use the lower end of the plane as the reference point)?
E. What is coefficient of dynamic friction between box and plane surface.
F. What is the distance made by box on horizontal surface if the coefficient of friction between box and horizontal surface $\mu_2 = 0{,}2$?

2. *Problem*

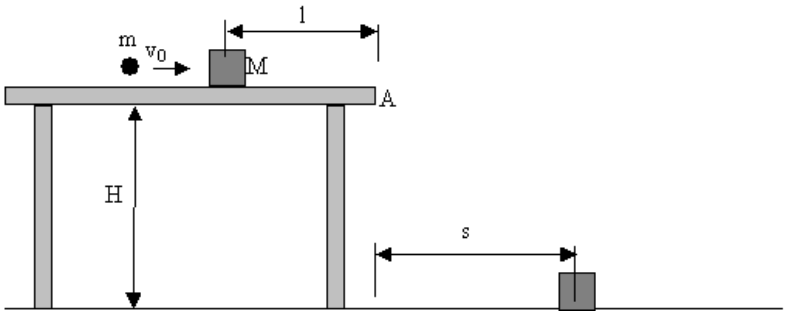
Cylinder with piston with cross section area of 50 cm^2 contains 44g of air at temperature of 300 K. If piston is moving, constant friction force of 30N between it and cylinder walls appears. At the beginning distance between the end of the cylinder and piston L=0,80 m. Molar mass of the air is 29 g/mol, universal gas constant R=8,31 J/(K·mol) and atmospheric pressure is $1 \cdot 10^5$ Pa!

A. What is the friction force at the initial state and what is its direction (with respect to x axis)?
B. Gas is slowly heated up from 300 K to 400 K. At what temperature the piston starts to move?
C. Draw plot of friction force along X axis versus temperature, if gas is heated up from 300 K to 400 K.
D. Draw the process in p,V coordinates if temperature is increasing from 300 K to 400 K!
E. Calculate the work done by air inside the piston if temperature increases from 300 K to 400 K?
F. Calculate the amount of heat delivered to the air to heat it up from 300 K to 400 K?

Heat capacity of cylinder and piston can be neglected.

3. Problem

The box with mass M=390g is on the horizontal table with height H = 0,8 m. Distance from the side of the table to the box l=0,25 m. Bullet with mass m=10 g and speed v_o = 80 m/s is shot in the box. Bullet remains in the box after collision. Coefficient of friction between box and table surface μ = 0,2. Air resistance can be neglected and g = 10 m/s^2.



A. Calculate the initial speed of the box just after collision?

B. How much heat has been released during collision?

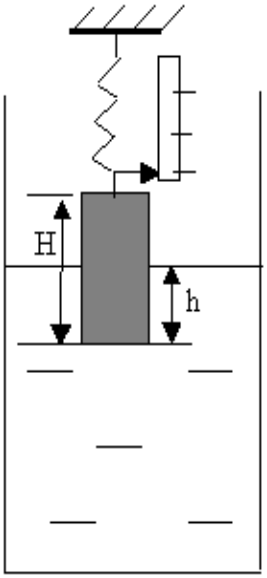
C. After how long time the box reaches the side of the table A and what is the speed of the box in this moment?

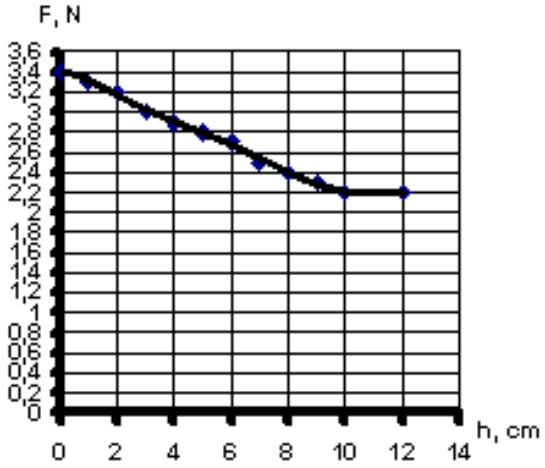
D. What is the distance s where the box will hit the floor?

E. What is the speed of the box when it hits the floor? What is the direction of the speed at this moment (angle of speed vector against horizon)?

4. Problem

Cylindrical body is attached to dynamometer. Radius of the cylinder is R, but height is H = (10,0 ±0,1) cm. Cylinder is partly immersed in the water. h-distance from the bottom of the cylinder to the water surface. Force measured by dynamometer versus immersion depth is shown in the plot. It can be assumed g = 10 m/s^2.





A. Draw the forces acting on the cylinder when it is immersed in the water. Calculate the mass of the cylinder.

B. Draw the plot of Archimedes force F_A versus immersion depth *h*.

C. Determine the volume of the cylinder and its density if density of water is 1000 kg/m^3.

D. Cylinder immersed in depth h=10 cm is slowly pulled out of the water. What is the work required to do it?

E. Cylinder is fully immersed in the water and then released. Calculate the acceleration of the cylinder while it sinks. Water resistance and surface tension can be neglected.