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الجامعة اللبنانية
كلية العلوم، الفرع 3
طرابلس – لبنان

Course : Classical Mechanics (P1100)

Tutorial Chap 3: Work and Energy

Exercise 1:

A 70 kg man descends in an elevator with an acceleration of 4 m/s^2 . The elevator starts from rest and travels a distance of 6 m. Calculate the work done by the weight of the man and the normal reaction force exerted by the floor on the man. What can be concluded? Why?

Exercise 2 :

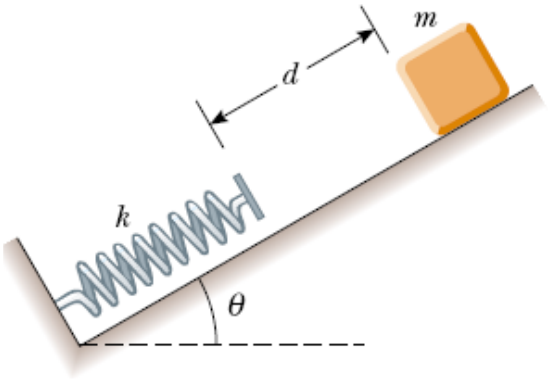
When a truck traveling at 40 km/h is braked, it comes to a stop after 3 m. Over what distance will it stop if its speed is 80 km/h?

Exercise 3 :

A box with a mass of m=1 kg is pulled on a horizontal surface by a force F=500 N at an angle θ=10x with the horizontal. Using the work-kinetic energy theorem, calculate the speed of the box after it travels a distance of x=3 m starting from rest. The coefficient of kinetic friction is μ_c=0.3.

Exercise 4 :

An object with a mass of m=1 kg, initially at rest, slides without friction on an inclined plane at an angle θ = 30°.
a) Calculate the velocity just before it touches the spring, using the conservation of mechanical energy. Given d=1 m.
b) Calculate the maximum compression distance of the spring, using the conservation of mechanical energy. The spring constant is given as K=50 N/m.

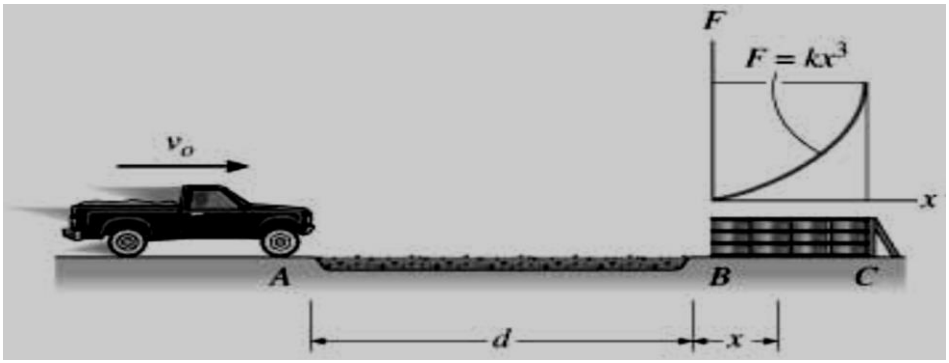


c) Practically, we found that the maximum compression is 0.36 m, so we deduced that friction is not negligible. Find the coefficient of friction.

Exercise 5 :

In an accident experiment, a truck with a mass of m=2250 kg arrives at point A with an initial speed of $v_0 = 12\,m/s$. It crosses a sand layer of length d=10 m, where the sand exerts a frictional force of 800N on each wheel. Afterward, it strikes water tanks, which exert a resistive force given by $f = 1.25 \times 10^6 x^3$.

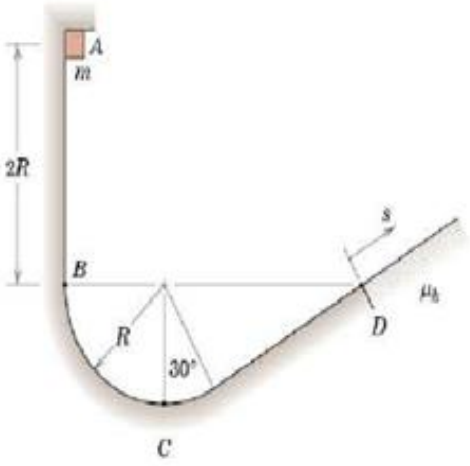
Determine the distance x required to bring the truck to a complete stop.



Exercise 6 :

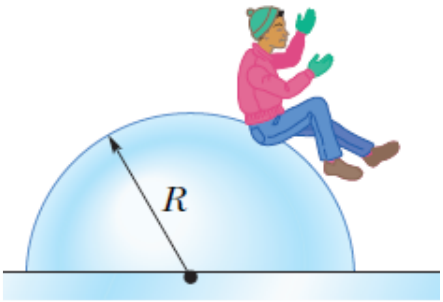
A small block of mass *m* is released from rest while in position *A* and then slides along the vertical-plane track as in the figure. The track is smooth from *A* to *D* and rough from point *D* on.

a) Determine the normal force N_B exerted by the track on the block just after it passes point *B*.
b) Determine the normal force N_C exerted by the track on the block as it passes the bottom point *C*.
c) Calculate the distance *s* traveled along the incline past point *D* before the block stops.

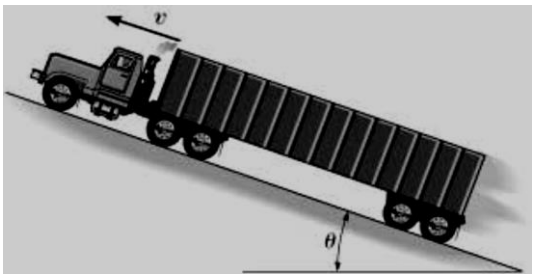


Exercice 7 :

A boy is initially seated on the top of a hemispherical ice mound of radius R = 13.8 m. He begins to slide down the ice, with a negligible initial speed (See the figure). Approximate the ice as being frictionless. At what height does the boy lose contact with the ice?



Exercice 8 :



It is assumed that the engine of a truck with a mass of m=15 tonnes develops a power of 250 kW. Determine the angle θ of a road on which the truck can climb at a speed of v =15m/s.

Exercise 9 :

A commonly used potential energy function to describe the interaction between two atoms is the Lennard-Jones potential:

$$E_p(r) = E_0\left[\left(\frac{r_0}{r}\right)^{12} - 2\left(\frac{r_0}{r}\right)^{6}\right] ; r > 0$$

Where r is the distance between the atoms; E_0 and r_0 are positive constant.

a) Find the force associated to this potential.
b) What is the equilibrium position, and explain whether the equilibrium is stable or not?
c) Determine the corresponding potential energy.

Exercise 10 :

In the figure below ABCDEF is a track described by a small ball M without friction. The circular part has a radius r = 10 m, while the heights h_A and h_F have the values 10 m and 15 m respectively.
a) Show that the ball completes the entire loop while staying in contact with the track, if it is launched at A with a minimum speed $V > V_0 = 17.32\, m/s$.
b) In this case what is the minimum speed of the ball at F?