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1-First Exercise (4 pts) :

From a point A of altitude ZA = 10 m, a stone of mass m = 200 g is launched vertically upward with a speed will equal to 36 km/h . The friction of the air are neglected.

1) Calculate the mechanical energy of the stone at point A, in recital that its potential energy is zero at point B of altitude ZB = 0.

2) Determine the maximum altitude Zmax which can be reached by the stone.

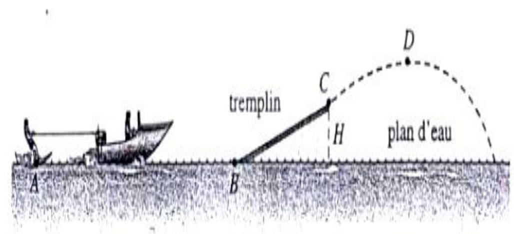
3) Calculate the speed of the stone when it reaches point B of altitude ZB = 0.

2- Second Exercise (6pts):

We studied the movement of a water-skier during a jump in the springboard.

The skier, of mass 70 kg starting without initial speed of point A is towed by a canoe through a cable taut, parallel to the plane of water which transmits a driving force of 250 N.

After a course of 200 m, the skier reaches the speed of 72km/h at point B



1. Calculate the variation of kinetic energy of the skier on the route AB.
2. a) Sketch the situation and represent the forces vectors.

b) Express the work of each of the forces which influence the skier on the course.

c) Deduct the work of the force of friction of the water on the skis and then its value.

3. The skier loose cable and addressed a springboard of length BC = 10 m and height CH = 5 m above the water level. The friction means along the springboard are equivalent has a constant force of 500 N.

a) Diagramming the situation and represent the vectors forces.

b) Calculate the work done by each of the forces.

c) Apply work- energy theorem to calculate the speed in C summit of the springboard.

4. The skier performs the jump. We neglected the friction in the air. The speed at the summit D of the trajectory of the skier is v = 9.0 m/s. The origin of the potential energy of gravity is taken at the level of the water.

a) Calculate the mechanical energy of the skier in the beginning of the jump.

This energy is conserved in the course of the jump? Why?

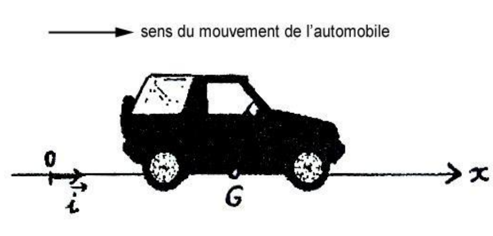
B) What is the altitude of the point D, summit of the trajectory?

C) With what speed, the skier drops it on the water?

Given: $g = 10\ m/s^2$

3 - Third Exercise (4 pts) :

An automobile engine failure , comparable to a solid



at translation , has a mass m = 1200 kg . It is pushed
by an emergency vehicle.

Figure 1

A) The car starts the motion on a horizontal road Fig1 GF

At the first time the car moves with an acceleration phase during which the vehicle exerts the pushing constant force F parallel to the displacement and forwardly directed. In this question, it will be assumed that the friction is negligible. We propose to study the movement of the center of inertia G of the automobile.

At time t = 0, start time, G is the origin O of the Ox axis with zero velocity (Figure 1).

1) Represent the external forces acting on the car .

2) The car reaches the speed v = 60 km / h after a course of 600 m.

a) Justify the variation of the speed of the motor .

b) State the theorem of kinetic energy for a solid translation.

c) After you apply this theorem to the automobile, determine the value of F.

B) After reaching the speed of 60 km / h , the car is released from the pushing action at a point noted A. She arrives on a stretch of road schematically in Figure 2 (the drawing is not to scale) :

- AB is perfectly straight horizontal of length L_1
- BC is circular with center O and radius r = 100 m.
- OC makes an angle $\alpha = 15°$ with the vertical .
- CD is straight of length L_2 making an angle $\alpha = 15°$ with the horizontal.

on the ABC part, the friction is neglected. On the CD part , they are equivalent to a t constant force of value f .

The motor comes into B with a speed V_B = 60 km / h .

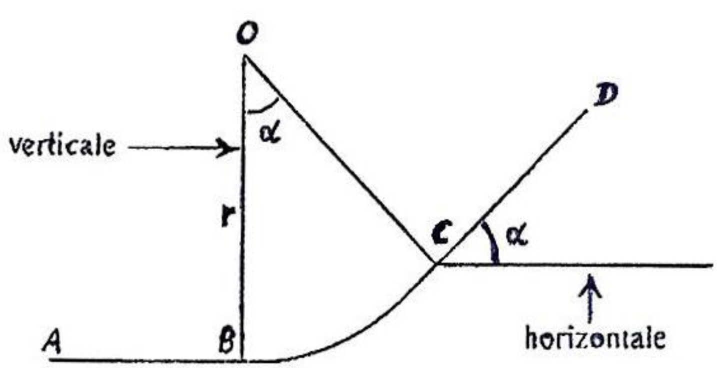
1)

a) Review the external forces acting on the car between B and C and represent it on G.

b) Applying the theorem of kinetic energy to the vehicle on the segment BC , to establish the expression of V_C according to V_B, r , g and α .

c) Calculate and verify that V_C = 52 km / h

2) The car stops on the CD stretch after traveling a distance of 35 m. By using the theorem of kinetic energy , calculating the value of the frictional force acting on the segment CD .



4 - Fourth Exercise (6 pts) :

A simple pendulum (P) ,of an inextensible wire of length L = 40cm, and a small sphere S of mass m = 50 g , it touch at equilibrium the surface of an horizontal table perfectly smooth. It differs (P) $\alpha = 60°$ from its equilibrium position and then released without speed. Upon its passage through the vertical, S1 takes a velocity V1.

choosing the horizontal table as the reference level of the gravitational potential energy.

On the table is a second sphere S2 of mass m2 = 200g, initially at rest , S1 became to collides S2 with a perfectly elastic collision. (All friction is neglected) .

1) Calculate the speed v1 ..

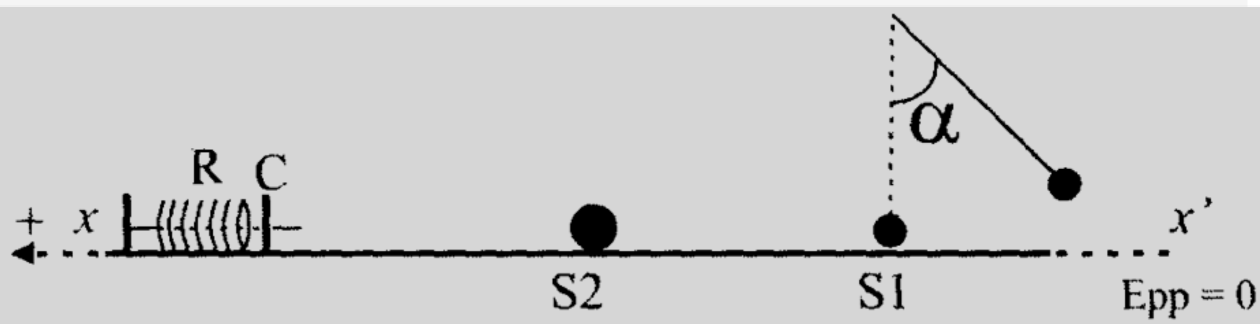
2) Determine the speed v'1, v'2 respectively of S1 and S2 just after impact. (Assuming that the velocity vectors before and after the shock are collinear) .

3) Determine α'm the maximum angle of the wire with the vertical after the collision ..

4) S2 has the speed v2 continues its movement and strikes, has now taken as the origin of dates (t = 0) , the solid (C) of an elastic pendulum and clings to him to form a single body (A) of mass M = 250g.the spring is then compressed 10 cm .. the spring with constant K and its axis is assumed confused with the right path of S2 after the shock :

a- Calculate the velocity V ' (A) immediately after the clinging

b- Calculate K .



The Correction:

1-First Exercise (4 pts) :

Z_A = 10m ; m=200g ; v_A = 36 km/h = 10 m/s ;ise

1) $E_{m(A)} = E_{c(A)} + E_{pp(A)} = \frac{1}{2} m.v_A^2 + mgz_A = \frac{1}{2}(0,2).(10)^2 + (0.2)(10)(10) = 30$ J .

1) A with max alt Z_{max} : V=0m/s

$E_{m(M)} = E_{c(M)} + E_{pp(M)} = \frac{1}{2} m.v_M^2 + mgz_{max} = 0 + mgz_{max} \Rightarrow Z_{max} = \frac{E_m}{m.g} = \frac{30}{0,2\times10} = 15$m

2) At point B : E_{pp} =0

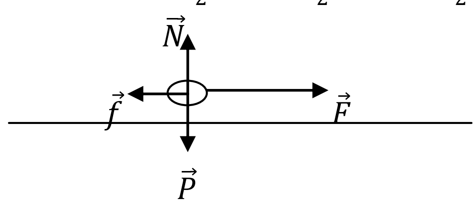
$E_{m(B)} = E_{c(B)} + E_{pp(B)} = \frac{1}{2} m.v_B^2 \Rightarrow V_B = \sqrt{\frac{2E_m}{m}} = 17,32$ m/s .

2- Second Exercise (6pts) :

M= 70 kg ; f = 250 N ; V_A =0 m/s ; V_B = 72 km/h = 20 m/s ; AB = 200m .

1- $\Delta E_c = E_{c(B)} - E_{c(A)} = \frac{1}{2} m.v_B^2 - \frac{1}{2} m.v_A^2 = \frac{1}{2}(70)(20)^2 - 0 = 1400$ J .

2- a)



b) $W_p = W_N = 0$ ($\vec{P}$ et $\vec{N}$ sont ⊥ au déplacement)

W_F = F .AB = (250).(200) = 50000 J .

$\Delta E_c \neq W_F + W_p + W_N$ then we have friction .

c) W_f = ? f= ?

$\Delta E_c = \Sigma W_{Fext} = W_F + W_f + W_P + W_N = W_F + W_f \Rightarrow W_f = \Delta E_c - W_F$ = 14000 J -50000 J = -36000 J .

$W_f = -$ f.AB $\Rightarrow f = \frac{W_f}{AB} = \frac{36000}{200} = 180$ N

3) BC = 10 m ; CH = 5 m ; f = 500 N ;

a) Representation of vectors forces

b) $W_N = 0$

W_P = -m.g.CH= -(70)(10)(5) = -3500 J .

W_f = - f.BC = -(500)(10) = -5000 J .

c) T.E.C : $\Delta E_c = \Sigma W_{Fext}$; $\Delta E_c = E_{c(C)} - E_{c(B)} = \Sigma W_{Fext}$ => $E_{c(C)} = E_{c(B)} + \Sigma W_{Fext}$ = 14000 + (-8500) =5500 J

$E_{c(C)} = \frac{1}{2} m.v_C{}^2$ => $V_C = \sqrt{\frac{2E_c}{m}} = \sqrt{\frac{2.5500}{70}}$ = 12,53 m/s .

4) V_D = 9 m/s .

a) $E_{m(c)} = E_{c(c)} + E_{pp(c)} = \frac{1}{2} m.v_c{}^2 + mgz_c$ = 5500 + 70.10.5 = 9000 J .

Yes it conserved since friction is null .

b) $E_{m(D)} = E_{m(c)}$ = 9000 J

$E_{m(D)} = E_{c(D)} + E_{pp(D)}$ => $E_{pp(D)} = E_{m(D)} - E_{c(D)} = 9000-0{,}5.70.9^2$ = 9000 -2835 = 6265 J .

$E_{PP(D)} = mgz_D$ => $z_D = \frac{EPP\,(D)}{m.g} = \frac{6165}{70.10}$ = 8,807 m .

c) At the surface of water $E_{pp} = 0$ $E_m = E_{pp} + E_c = 0 + \frac{1}{2} mv^2$ => $V = \sqrt{\frac{2E_m}{m}} = \sqrt{\frac{2.9000}{70}}$ = 16,03 m/s.

3-<u>Thirst Exercise (4 pts) :</u>

M= 1200 kg

A) V_0 = 0m/s

1) forces

2) V= 60km/h = 16,67 m/s ; MN = 600m .

a) $\sum \vec{F} = m.\vec{a}$ => $\vec{P} + \vec{N} + \vec{F} = m.\vec{a}$ => $\vec{a} = \frac{\vec{F}}{m}$; $a = \frac{F}{m} > 0$ => UVRM then V increase .

b) $\Delta E_c = \Sigma W_{Fext}$.

c) $\Delta E_c = \Sigma W_{Fext} = W_P + W_N + W_F = W_F$ => $E_{c(f)} - E_{c(i)}$ = F.MN => $F = \frac{E_{c\,f}}{MN} = \frac{1/2.1200.16{,}67^2}{600}$ = 278 N.

B) V_B = 16,67 m/s .

1) a) forces .

b) $\Delta E_c = \Sigma W_{Fext}$

$E_{c(C)} - E_{c(B)} = W_P + W_N$

$\frac{1}{2} m.v_C{}^2 - \frac{1}{2} m.v_B{}^2 = -mgz_c$ avec $z_c = r - r\cos\alpha = r(1-\cos\alpha)$

$v_C{}^2 - v_B{}^2 = -2g\,r(1-\cos\alpha)$ => $V_c = \sqrt{V_B^2 - 2g\,r(1-\cos\alpha)}$

c)$V_c = \sqrt{16{,}67^2 - 2.10.100.(1-\cos 15)}$ = 14,48 m/s = 52,136 km/h .

2) $\Delta E_c = \Sigma W_{Fext} = W_P + W_N + W_f$

$E_{c(f)} - E_{c(i)}$ = -f.CN – mg.CN.sinα

0-1/2.m.V^2 = -f.CN – mg.CN.sinα => f =488,52 N .

4-Foorth Exercise (6 pts):

1- $E_{m(\alpha=60)} = E_{m(\alpha=0)}$ => $E_{c(\alpha=0)} + E_{pp(\alpha=0)} = E_{c(\alpha m)} + E_{pp(\alpha m)}$

=> $\frac{1}{2}m.v_0^2 + mgz_0 = \frac{1}{2}m.v_1^2 + mgz_1$ => $V_1 = \sqrt{2gz_0} = \sqrt{2gl(1-\cos\alpha)}$ = 2m/s .

2- coll , the linear momentum is conserved => $\overrightarrow{P_{avant}} = \overrightarrow{P'_{après}}$

$\vec{P_1} + \vec{P_2} = \vec{P'_1} + \vec{P'_2}$ => $\overrightarrow{m_1v_1} + m_2\vec{v_2} = m_1\vec{v'_1} + m_2\vec{v'_2}$ => $\overrightarrow{m_1v_1} = m_1\vec{v'_1} + m_2\vec{v'_2}$

: $m_1v_1 = m_1v'_1 + m_2v'_2$

$m_1(v_1 - v'_1) = m_2v'_2$ (1): $E_{c(avant)} = E'_{c(après)}$

: $m_1(v_1 - v'_1) = m_2v'_2$ (2)

$\frac{(2)}{(1)}$ => $V'_2 = V_1 + V'_1$ (3) dans (1) => $m_1(v_1 - v'_1) = m_2(v_1 + v'_1)$ => $v'_1 = (\frac{m_1 - m_2}{m_1 + m_2})v_1$

Et $v'_2 = (\frac{2m_1}{m_1 + m_2})v_1$

A.N v'_1 = -1,2 (m/s) et v'_2 = 0,8 m/s .

3) E_m of the system (P,Terre , Support) is conserved : $E_m = E'_m$ => $\frac{1}{2}m_1.v'_1 = m_1gz'$

=> $\frac{1}{2}v'_1 = gl(1-\cos\alpha'_m)$ $1-\cos\alpha'_m = 0{,}18$ => $\cos\alpha'_m = 0{,}82$ => $\alpha'_m = 35^o$

4) a) Choc => the vector $\vec{P}$ is conserved => $\vec{P}_{avant} = \vec{P}'_{après}$ => $m_2.\vec{v}'_2 = (m_2 + m_c)\vec{v}'$

=> $\vec{v}' = \vec{v}'_2\,(\frac{m_2}{m_2 + m_c})$ en module : $v' = (\frac{200}{250})(0{,}8)$ = 0,64 m/s .

b) conservation of E_m => $1/2(MV'^2) = 1/2\ .k.x^2$ donc k= 10,24 N/m.