Pre-Semester Physics - Exercises **Summer 2010**

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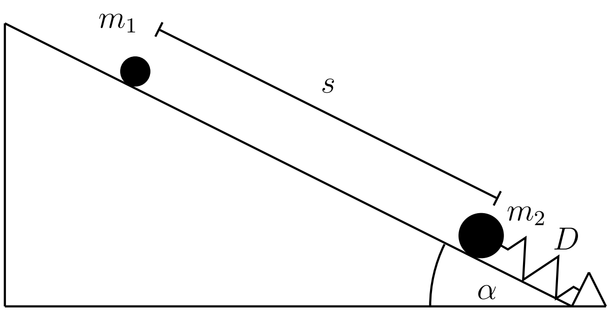
Extra Sheet III
8.9.2010

1. Exercise:



Consider two masses $m_1 = 1.0\,\text{kg}$ and $m_2 > m_1$ at distance $s = 12\,\text{m}$ on a frictionless inclined plane with angle $\alpha = 45°$. Both masses are initially at rest but are subject to gravity ($g = 10\,\frac{\text{m}}{\text{s}^2}$). The position of the second mass m_2 is fixed by a spring with constant D. The goal is to find the maximum height h_1 of the mass m_1 and the maximum compression s_2 of the spring after a total elastic collision.

(a) What would be the downward force acting on the mass m_1?

$F_D =$

(b) From Newton's 2$^{\text{nd}}$ axiom state the acceleration of the mass m_1

$a =$

(c) This means that the first mass performs a

☐ uniform motion ☐ motion with constant acceleration ☐ circular motion

(d) How depends the position of the first mass in general?

$x(t) =$

(e) Specify the integration variables.

$v_0 =$

$x_0 =$

(f) What would be the position of the mass m_1 at the collision for this choice?

$x(t) =$

(g) Solve the equation for the position for this value to the time in order to determine the time t when both masses collide.

$t =$

(h) Find the velocity v before the collision by taking the time derivative of the position function and put the last value in.

$v =$

(i) State the laws of momentum and energy conservation for the elastic collision in the case that the second mass is at initially at rest.

$=$

$=$

(j) Solve the law of momentum conservation to v_2', the velocity of the second mass m_2 after the collision.

$v_2' =$

(k) Put this expression into the law of energy conversion and simplify it to a quadratic expression for v_1', the velocity of the mass m_1 after the collision.

$0 =$

(l) Use the solution formula of quadratic expressions to obtain two solutions. Simplify them!

(1) : $v'_{1,1} =$

(2) : $v'_{1,2} =$

(m) Which solution describes the situation before the collision?

(n) Take the other expression and evaluate it for $m_2 = 2\,\mathrm{kg}$ and the given values.

$v'_1 =$

(o) Put this value in the formula for v'_2 in order to determine the velocity of the second mass after the collision.

$v'_2 =$

(p) Now state the law of energy conversion which determines the maximum height h_1 of the first mass if it has a velocity v'_1. Take as zero point of the potential energy the one at the position of the collision.

$=$

(q) Solve this equation to h_1.

$h_1 =$

(r) Put in the values calculated for v'_1.

$\underline{\underline{h_1 =}}$

(s) Write down the law of energy conversion for the second mass when hitting the spring on the inclined plane if it has the velocity v'_2. Do not forget the potential energy caused by the difference in height h_2.

$=$

(t) Express therein the difference in height by the compression of the spring.

$=$

(u) Rewrite this equation to a quadratic expression for the compression s_2.

$0 =$

(v) Solve the equation to the two mathematical solutions.

(I) : $s_{2,1} =$

(II) : $s_{2,2} =$

(w) Which solution is the physical solution?

(x) Put in this expression the spring constant $D = 10^2\,\frac{\mathrm{N}}{\mathrm{m}}$ and the values determined above.

$s_2 =$