PHYS101 Quiz — *Solution Set*

Department of Physics

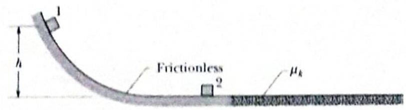
Fall 2016/17 - December 22, 2016

Student Number:	Name and Surname:	Group:	Signature:	Total (12 P)	

Some useful formulae: **Exam Duration: 30 min**

$\vec{r}(t) = \vec{r}_i + \vec{v}_i t + \frac{1}{2}\vec{a}t^2$, $\vec{v}(t) = \vec{v}_i + \vec{a}t$, $\vec{v}(t) = \frac{d\vec{r}(t)}{dt}$, $\vec{a}(t) = \frac{d\vec{v}(t)}{dt} = \frac{d^2\vec{r}(t)}{dt^2}$ $g = 9.80\frac{m}{s^2}$,
$\vec{F} = m\vec{a}$, $\vec{F}_k = \mu_k \vec{F}_N$
linear momentum: $\vec{\mathbf{p}} = m\vec{\mathbf{v}}$, Work: $W = \int_{x_i}^{x_f} \vec{\mathbf{F}} \cdot d\vec{\mathbf{r}}$, Kinetic Energy: $K = \frac{1}{2}mv^2$,
gravitational potential Energy: $U = mgh$, potential Energy of a spring: $U = \frac{1}{2}kx^2$,
conservation of Energy: $(\sum E_{mech})_i + (\sum W_{ext})_{i\to j} = (\sum E_{mech})_f$,
conservation of linear momentum: $\vec{\mathbf{p}}_i = \vec{\mathbf{p}}_f$. Work-Kinetic Energy Theorem: $\sum W_{ext} = \Delta K$

Question:
The Block 1 of mass $m_1 = 1kg$ slides from rest along a frictionless ramp from height $h = 2.50m$ and then collides with stationary block 2, which has mass $m_2 = 2kg$. After the collision, block 1 and block 2 **stick to each other and slide together** into a region where the coefficient of kinetic friction $\mu_k = 0.4$ and comes to a stop in distance d within that region.



(a) Calculate the the speed of block 1 just before the collision with block 2. (3 P)

(b) Calculate the speed of the system $(m_1 + m_2)$ just after the collision, before entering the region with friction. (3 P)

(c) Calculate the change in the total kinetic energy due to the collision. (3 P)

(d) Calculate the distance d, when the system comes to rest. (3 P)

a) $\Delta E_{mech\,1} = \Delta K_1 + \Delta U_1 = 0 \Leftrightarrow \left(\frac{1}{2}m_1 v_{1f}^2 - \frac{1}{2}m_1 v_{1i}^2\right) + \left(m_1 g h_{1f} - m_1 g h_{1i}\right) = 0$ (with $v_{1i} = 0$, $h_{1f} = 0$)

$\Rightarrow \frac{1}{2}m_1 v_{1f}^2 - m_1 g h_{1i} = 0 \Rightarrow v_{1f} = \sqrt{2 g h_{1i}} = \sqrt{2 \cdot 9.8\,m/s^2 \cdot 2.5\,m} = 7\,m/s$

b) $p_{1i} + p_{2i} = (m_1 + m_2) v_f \Rightarrow v = \frac{m_1 v_{1f} + m_2 v_{2i}}{m_1 + m_2} = \frac{1kg \cdot 7\,m/s + 0}{1kg + 2kg} = \frac{7}{3}\,m/s = 2{,}33\,m/s$

c) $\Delta K = K_f - K_i = \frac{1}{2}(m_1 + m_2)v^2 - \frac{1}{2}m_1 v_{1f}^2 = \frac{1}{2}(1kg + 2kg)\cdot(2{,}33\,m/s)^2 - \frac{1}{2}1kg\cdot(7\,m/s)^2$
$= -11.33\,J$

d) $\Delta K = -f_k d \Rightarrow d = -\frac{\Delta K}{f_k} = -\frac{0 - \frac{1}{2}(m_1 + m_2)v^2}{\mu_k \cdot (m_1 + m_2) g} = \frac{v^2}{2\mu_k g} = \frac{(2.33\,m/s)^2}{2 \cdot 0.4 \cdot 9.8\,m/s^2}$
$= 0.69\,m$