EASTERN MEDITERRANEAN UNIVERSITY
FACULTY OF ARTS AND SCIENCES
DEPARTMENT OF PHYSICS

PHYS 101 –Interm EXAM Solution Set, 2019-2020 Summer (09.12.2019)

Duration: 60+30(LAB) minutes

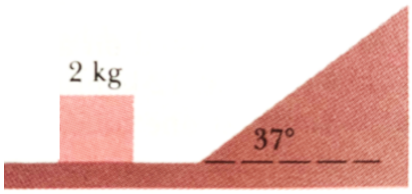
Student Number	Name	Surname	Group	Signature

$W = \vec{F}\cdot\Delta\vec{r} = \lvert\vec{F}\rvert\lvert\Delta\vec{r}\rvert cos\theta$	$W_f = -fd$	$P = \frac{\sum W}{t}$	$K = \frac{1}{2}mv^2$	$U_g = mgh$	$U_e = \frac{1}{2}k(\Delta x)^2$
$E_{mech} = K + U$	$\left(\sum E_{mech}\right)_i + \left(\sum W_{ext}\right)_{i\to f} = \left(\sum E_{mech}\right)_f$		$\vec{p} = m\vec{v}$	$\Delta\vec{p} = \vec{I}$	$g = 9.8\, {}^{m}/_{s^2}$
$\vec{I} = \int_{t_i}^{t_f}\vec{F}dt$ *(Impulse)*	*Impulse of constant Force,* $\vec{I} = \vec{F}_{ort}\Delta t$	$\left(\sum_{i=1}^{n} m_i\vec{v}_i\right)_{before} = \left(\sum_{i=1}^{n} m_i\vec{v}_i\right)_{after}$			

The solution methods for the problems of this exam are limited to the formulae given in the above table. Thus, using any other formula different than formulae given above will cause to losing points, even if your answers are correct!

P1 (5P)	P2 (5P)	P3 (7P)	TOTAL (17 P)

1. A block of mass $m = 2kg$ is moving on a horizontal frictionless surface with a speed of $5\, {}^{m}/_{s}$. The block approaches a frictionless incline of angle $\theta = 37°$ and continues its way up the incline. Determine the maximum height the block can reach on the incline.



Solution:

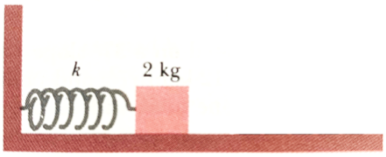
$$\Delta K + \Delta U = 0 \Longrightarrow K_f - K_i + U_{g_f} - U_{g_i} = 0 \Leftrightarrow \frac{1}{2}mv_f^2 - \frac{1}{2}m\,v_i^2 + m\,g\,y_f - m\,g\,y_i = 0$$

$$mg(y_f - y_i) = \frac{1}{2}m(v_i^2 - v_f^2) \Longrightarrow y_f - y_i = h = \frac{v_i^2 - v_f^2}{2\,g} = \frac{\left(5\frac{m}{s}\right)^2 - 0}{2\cdot 9.8\frac{m}{s^2}} = 1.28m$$

$$d = \frac{h}{\sin\theta} = \frac{1.28\,m}{\sin 37°} = 2.12m$$

We can conclude the maximum height is $h_m = 1.28m$, and the box slides 2.12 m up the incline.

2. A block of mass $m = 2kg$ is pushed against a spring of force constant $k = 400\frac{N}{m}$, compressing it 0.3 m from its equilibrium position. When the block is released it moves along a rough horizontal surface with a coefficient of kinetic friction of $\mu_k = 0.1$. Determine the distance the block will take before brought to rest by friction.



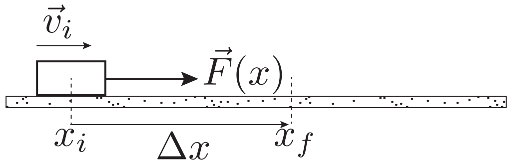
Solution:

$$\Delta K + \Delta U_S = -f_k d$$

As the block moves from rest to rest $\Delta K = K_f - K_i = 0$.

$$U_{S_f} - U_{S_i} = -\mu_k F_N d \Longrightarrow 0 - \frac{1}{2}k\,x^2 = -\mu_k F_N d \Longrightarrow d = \frac{\frac{1}{2}k\,x^2}{\mu_k F_N} = \frac{\frac{1}{2}400\frac{N}{m}\,(0.3m)^2}{0.1\cdot 2kg\cdot 9.8\frac{m}{s^2}} = 9.18m$$

Consider a box of mass $m = 1kg$ moving on a rough surface with a coefficient of kinetic friction $\mu_k = 0.4$. At $x_i = 2m$ the box has a velocity of $\vec{v}_i = 2\,\hat{\imath}\,\frac{m}{s}$ and a variable force of $\vec{F}(x) = (2x+3)\,\hat{\imath}$, where $\vec{F}$ is in Newtons and x in meters, starts acting on it at this point.



a) What is the work done by the variable applied force $\vec{F}(x)$ along the straight path from $x_i = 2\,m$ to $x_f = 5m$?
Solution:

$$W_{app} = \int_{x_i}^{x_f} F(x)dx = \int_2^5 (2x+3)dx = (x^2+3x)|_2^5 = (25+15)J - (4+6)J = 30J$$

b) What is the work done by the kinetic friction force $\vec{f}_k$ along the straight path from $x_i = 2\,m$ to $x_f = 5m$?
Solution:

$$W_{fr} = -f_k d = -\mu_k F_N d = -0.4\cdot 1kg\cdot 9.8\frac{m}{s^2}\,3m = -11.76J$$

c) What is the total work done on the box from $x_i = 2\,m$ to $x_f = 5m$?
Solution:

$$W_{total} = W_{app} + W_{fr} = 30J - 11.76J = 18.24J$$

d) What is the change in the kinetic energy of the box from $x_i = 2m$ to $x_f = 5m$?
Solution:
According to the work kinetic energy theorem $\Delta K = W_{total} = 18.24J$

e) What is the final speed v_f of the box at $x_f = 5m$?
Solution:

$$\Delta K = W_{total} \Longrightarrow \frac{1}{2}mv_f^2 - \frac{1}{2}m\,v_i^2 = W_{total}$$

$$\Longrightarrow v_f = \sqrt{\frac{2}{m}\left(W_{total} + \frac{1}{2}m\,v_i^2\right)} = \sqrt{\frac{2}{1\,kg}\left(18.24J + \frac{1}{2}\cdot 1kg\cdot\left(2\frac{m}{s}\right)^2\right)} = 6.36\frac{m}{s}$$