Your Name: ______________________

PHY203

Exam #2
Chapters 5-8
Fri., March 25, 2022

Solutions

Exam2S22

1. A 4.00 kg object is at rest at the origin. At t=0, it is subjected to two forces, $\vec{F}_1 = 2.00\text{ N }\hat{\imath} - 18.0\text{ N }\hat{\jmath}$ and $\vec{F}_2 = 20.0\text{ N }\hat{\imath} - 11.0\text{ N }\hat{\jmath}$.

a. Find the acceleration of the object in vector notation. **10**

$$\vec{F}_{tot} = \vec{F}_1 + \vec{F}_2 = (22.0\,\hat{\imath} - 29.0\,\hat{\jmath})\text{ N}$$

$$\vec{a} = \frac{\vec{F}}{m} = \frac{(22.0\,\hat{\imath} - 29.0\,\hat{\jmath})}{4.00}$$

$$= (5.50\,\hat{\imath} - 7.25\,\hat{\jmath})\text{ m/s}^2$$

b. Find the velocity of the object in vector notation after it has been moving for 13.0 s. **5**

$$\vec{v} = \vec{v}_0 + \vec{a}t$$

$$= 0 + (5.50\,\hat{\imath} - 7.25\,\hat{\jmath})(13.0)$$

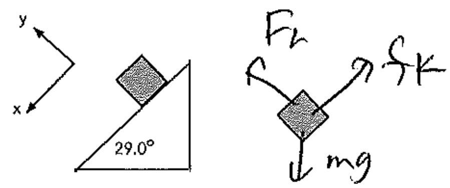
$$= (71.5\,\hat{\imath} - 94.2\,\hat{\jmath})\text{ m/s}$$

c. Find the position of the object in vector notation after it has been moving for 13.0 s. **5**

$$\vec{r} = \vec{r}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$$

$$= 0 + 0 + \frac{1}{2}(5.50\,\hat{\imath} - 7.25\,\hat{\jmath})(13.0)^2$$

$$= (465\,\hat{\imath} - 613\,\hat{\jmath})\text{ m}$$



2. A 4.60 kg block slides down a rough inclined plane that makes an angle of 29.0° with the horizontal. Starting from rest, the block slides a distance of 2.20 m in 1.80 s.
a. Draw a free body diagram on the figure above and to the right of the block as it is sliding on the incline. **5**

b. Write out Newton's 2nd Law for the block in the x- and y-directions. **15**

x: $mg\sin\theta - \mu_k F_n = ma$

y: $F_n - mg\cos\theta = 0$

c. Find the magnitude of the normal force on the block. **5**

$F_r = (4.60)\, g \cos(29.0) = 39.5\,N$

d. Find the magnitude of the acceleration of the block. **10**

$x = x_0 + v_0 t + \frac{1}{2} a t^2$

$2.20 = 0 + 0 + \frac{1}{2} a (1.80)^2$

$a = 1.36\ m/s^2$

e. Find the coefficient of kinetic friction between block and ramp. **10**

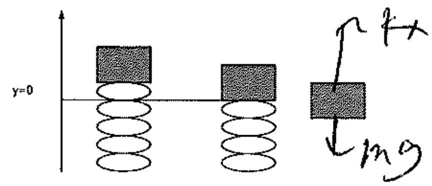
x: $\cancel{m} g \sin\theta - \mu_k \cancel{m} g \cos\theta = \cancel{m} a$

$\sin\theta - \mu_k \cos\theta = \frac{a}{g} = \frac{1.36}{g} = 0.139$

$\sin(29.0) - 0.139 = \mu_k \cos(29.0)$

$\mu_k = \frac{0.485 - 0.139}{\cos(29.0)}$

$\mu_k = 0.395$



3. A 2.75 kg block is slowly lowered onto a spring until it stops moving. At that point the spring has been compressed by 0.200 m.

a. Draw a free body diagram on the block above and to the right. **5**

b. Write out Newton's 2nd Law in the y-direction and find the spring constant. **10**

$$kx - mg = 0$$

$$k = \frac{mg}{x} = \frac{(2.75)g}{.200} = 135\ \frac{N}{m}$$

c. The block is then forced down by an additional 50.0 cm. Take y=0 at this point. (Ignore the size of the block.) Find the energy of the spring/block system. **10**

$$E = \frac{1}{2}kx^2 = \frac{1}{2}(135)(0.700)^2$$

$$= 33.1\ J$$

d. Find the highest y value the block reaches after it has been released. **10**

$$33.1 = mgh$$

$$h = \frac{33.1}{2.75\ g} = 1.23\ m$$

Exam2S22alt

1. A 5.00 kg object is at rest at the origin. At t=0, it is subjected to two forces, $\vec{F}_1 = 3.00\text{ N }\hat{\imath} - 16.0\text{ N }\hat{\jmath}$ and $\vec{F}_2 = 18.0\text{ N }\hat{\imath} - 11.0\text{ N }\hat{\jmath}$.

a. Find the acceleration of the object in vector notation. **10**

$$\vec{F}_{tot} = \vec{F}_1 + \vec{F}_2 = (21.0\,\hat{\imath} - 27.0\,\hat{\jmath})\text{ N}$$

$$\vec{a} = \frac{\vec{F}}{m} = \frac{(21.0\,\hat{\imath} - 27.0\,\hat{\jmath})}{5.00}$$

$$= (4.20\,\hat{\imath} - 5.40\,\hat{\jmath})\text{ m/s}^2$$

b. Find the velocity of the object in vector notation after it has been moving for 14.0 s. **5**

$$\vec{v} = \vec{v_0} + \vec{a}\,t$$

$$= 0 + (4.20\,\hat{\imath} - 5.40\,\hat{\jmath})(14.0)$$

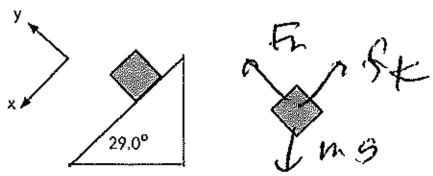
$$= (58.8\,\hat{\imath} - 75.6\,\hat{\jmath})\text{ m/s}$$

c. Find the position of the object in vector notation after it has been moving for 14.0 s. **5**

$$\vec{r} = \vec{r_0} + \vec{v_0}\,t + \frac{1}{2}\vec{a}\,t^2$$

$$= 0 + 0 + \frac{1}{2}(4.20\,\hat{\imath} - 5.40\,\hat{\jmath})(14.0)^2$$

$$= (412\,\hat{\imath} - 529\,\hat{\jmath})\text{ m}$$



2. A 5.60 kg block slides down a rough inclined plane that makes an angle of 29.0° with the horizontal. Starting from rest, the block slides a distance of 3.20 m in 1.80 s.
a. Draw a free body diagram on the figure above and to the right of the block as it is sliding on the incline. **5**

b. Write out Newton's 2nd Law for the block in the x- and y-directions. **15**

$x: \quad mg\sin\theta - \mu_k F_n = ma$

$y: \quad F_n - mg\cos\theta = 0$

c. Find the magnitude of the normal force on the block. **5**

$F_n = (5.60)\,g\cos(29.0) = 48.0\,N$

d. Find the magnitude of the acceleration of the block. **10**

$x = x_0 + v_0 t + \frac{1}{2}at^2$

$3.20 = 0 + 0 + \frac{1}{2}a(1.80)^2$

$a = 1.98\ m/s^2$

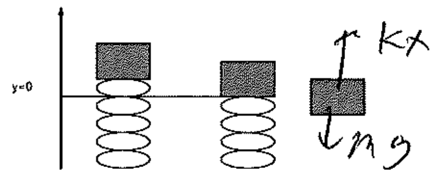
e. Find the coefficient of kinetic friction between block and ramp. **10**

$x: \quad mg\sin\theta - \mu_k mg\cos\theta = ma$

$\sin(29.0) - \mu_k \cos(29.0) = \frac{1.98}{g} = 0.201$

$\sin(29.0) - 0.201 = \mu_k \cos(29.0)$

$\mu_k = 0.324$



3. A 3.75 kg block is slowly lowered onto a spring until it stops moving. At that point the spring has been compressed by 0.15 m.

a. Draw a free body diagram on the block above and to the right. **5**

b. Write out Newton's 2nd Law in the y-direction and find the spring constant. **10**

$$kx - mg = 0$$

$$k = \frac{3.75g}{0.15} = 245 \frac{N}{m}$$

c. The block is then forced down by an additional 60.0 cm. Take y=0 at this point. (Ignore the size of the block.) Find the energy of the spring/block system. **10**

$$E = \frac{1}{2}kx^2 = \frac{1}{2}(245)(.750)^2$$

$$= 68.9\ J$$

d. Find the highest y value the block reaches after it has been released. **10**

$$68.9 = mgh$$

$$h = \frac{68.9}{3.75g} = 1.87\ m$$