Phys 2107 Physics for Engineers I

Test II 5/11/2007 17:00-18:00

Grading

Q1	Q2	Q3	Q4
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ID:	Name:	Sec:	Score:

Please check that you have 4 pages. Take $g = 10 m/s^2$. You have 5 multiple-choice questions and 3 classical problem-type questions.

1. Multiple-Choice Questions **(10 points)**

Points

1a. A car is traveling at 15 m/s on a horizontal road. The brakes are applied and the car skids to a stop in 4.0 s. The coefficient of kinetic friction between the tires and road is: (2)

(A) 0.38 B) 0.69 C) 0.76 D) 0.92 E) 1.11

$V = at$, $a = \frac{15}{4}\ m/s^2$ $\mu mg = ma$ $\mu = \frac{a}{g} = \frac{15}{40} = 0.375$

1b. A force of 10 N holds an ideal spring with a 20-N/m spring constant in compression. The potential energy stored in the spring is: (2)

A) 0.5 J (B) 2.5 J C) 5 J D) 10 J E) 200 J

$x = \frac{F}{k} = \frac{10}{20} = 0.5\ m$, $U = \frac{1}{2}kx^2 = \frac{1}{2}\,20\,(0.5)^2 = 2.5\ J$

1c. A 2-kg object is moving at 3 m/s. A 4-N force is applied in the direction of motion and then removed after the object has traveled an additional 5 m. The work done by this force is: (2)

A) 12 J B) 15 J C) 18 J (D) 20 J E) 38 J

$W = Fd = 4 \times 5 = 20\ J$

1d. A projectile of mass 0.50 kg is fired with an initial speed of 10 m/s at an angle of 60° above the horizontal. The potential energy (relative to ground level) of the projectile at its highest point is: (2)

A) 25 J (B) 18.75 J C) 12.5 J D) 6.25 J E) none of these

$mgh_{max} = mg\frac{v_{0y}^2}{2g} = \frac{1}{2}(0.5)(10\sin 60)^2 = \frac{100}{4} \cdot \frac{3}{4} = 18.75\ J$

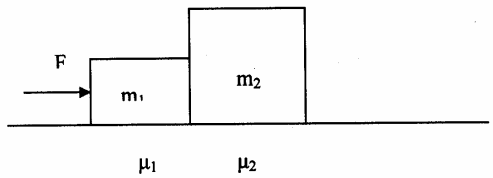
1e. Block A, with a mass of 4 kg, is stationary while block B, with a mass of 8 kg, is moving at 3 m/s. The center of mass of the ~~two-block~~ system has a speed of: (2)

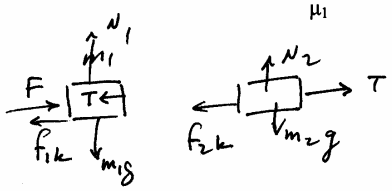
A) 0 B) 1.5 m/s (C) 2 m/s D) 3 m/s E) 12 m/s

$V_{com} = \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2} = \frac{4(0) + 8 \times 3}{12} = 2\ m/s$

Classical Problems

2. Two boxes of mass $m_1 = 1.0kg$ and $m_2 = 3.0kg$ which are in contact are accelerated across a horizontal surface by a horizontal force $\vec{F}$ of magnitude $20N$ applied on the first box as shown in the figure. The coefficients of kinetic friction between the box of mass m_1 and the box of mass m_2 and the surface are $\mu_1 = 0.4$ and $\mu_2 = 0.2$ respectively. Find the acceleration of the system and the contact force between the boxes. **(15 Points)**





(10) $\begin{cases} F - T - f_{1k} = m_1 a, & f_{1k} = \mu_{1k} m_1 g \\ T - f_{2k} = m_2 a & f_{2k} = \mu_{2k} m_2 g \end{cases}$

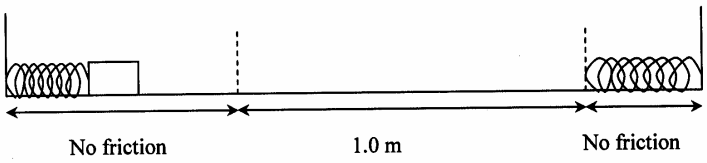
$$a = \frac{F - g(\mu_{1k} m_1 + \mu_{2k} m_2)}{m_1 + m_2} = \frac{20 - (0.4 + 0.2 \times 3)10}{4} = \frac{10}{4} = 2.5\ m/s^2$$

(3) (4) $\boxed{a = 2.5\ m/s^2}$

$$T = m_2 a + f_{2k} = 3 \times 2.5 + 0.2 \times 3 \times 10 = 7.5 + 6$$

(2) (5) $\boxed{T = 13.5\ N}$

3. As shown in the figure, a 1.0kg block is compressed $10cm$ against a spring whose spring constant is $k_1 = 1000N/m$. After leaving the spring at its relaxed length, the block travels over a horizontal surface, with a coefficient kinetic friction of $\mu_k = 0.3$, for a distance of $1.0m$ and compresses the second spring on the right a distance $20cm$. Find the spring constant of the spring on the right of the figure.
(13 Points)



$k_1 = 1000\ N/m$
$x_1 = 0.1\ m$
$x_2 = 0.2\ m$
$\mu_k = 0.3$

6 → $\Delta E_{mech} = E_{fmech} - E_{imech} = W_{fk}$

→ $= \frac{1}{2}k_2x_2^2 - \frac{1}{2}k_1x_1^2 = -\mu_k mgd$

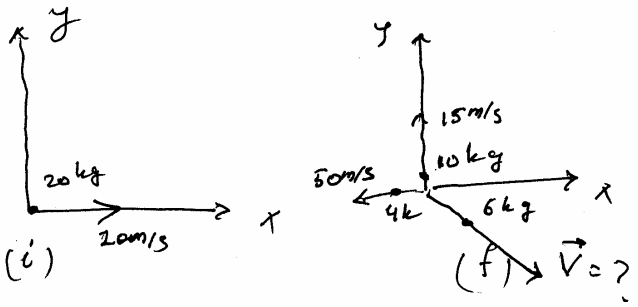
(2) ⇒ $\frac{1}{2}k_2(0.2)^2 - \frac{1}{2}1000(0.1)^2 = -0.3 \times 10 \times 1$

$2k_2 \times 10^{-2} - 5 = -3$

$2k_2 \times 10^{-2} = 2$

(5) $k_2 = \frac{1}{10^{-2}} = 100\ N/m$

4. A 20 kg body is moving in the positive x direction with a speed 20 m/s when, owing to an internal explosion, it breaks into three parts. One part, with a mass of 10 kg moves away from the point of explosion with a speed of 15 m/s in the positive y direction. A second fragment, with a mass of 4 kg, moves in the negative x direction with a speed of 50 m/s. Find the velocity of the third (6 kg) fragment in unit vector notation? **(12 Points)**



(6) $\rightarrow$ $\vec{P}_i = \vec{P}_f \Rightarrow 20\times 20\,\hat{i} = 10\times 15\,\hat{j} - 4\times 50\,\hat{i} + 6\,\vec{V}_3$

$400\,\hat{i} + 200\,\hat{i} - 150\,\hat{j} = 6\,\vec{V}_3$

(2) $\vec{V}_3 = \frac{600}{6}\,\hat{i} - \frac{150}{6}\,\hat{j}$

(4) $\vec{V}_3 = 100\,\hat{i} - 25\,\hat{j}$ m/s