Name Exam 2 solutions Section ____________

Physics 1210 Exam 2

10 March 2011

This test is closed-note and closed-book. No written, printed, or recorded material is permitted. Calculators are permitted but computers are not. No collaboration, consultation, or communication with other people (other than the administrator) is allowed by any means, including but not limited to verbal, written, or electronic methods. Sharing of calculators is prohibited. If you have a question about the test, please raise your hand. For multiple choice, you may choose two answers, and if one is correct, receive half credit, etc. For full credit on written problems, show the full thought process from basic equations to final results.

$V_{avg}=\frac{x_2-x_1}{t_2-t_1}=\frac{\Delta x}{\Delta t}$ $a_{avg}=\frac{v_2-v_1}{t_2-t_1}=\frac{\Delta v}{\Delta t}$ $a_{rad}=\frac{v^2}{R}=\frac{4\pi R^2}{T^2}$ For

$2.2\,lbs=1\,kg$

$1\,mi=5280\,ft=1760\,m$

$1\,Calorie=4200\,J$

$1\,Ton=2000\,lbs$

$x_1=x_0+v_0 t+\frac{1}{2}at^2$ $v_1=v_0+at$ $v_1^2=v_0^2+2a(x_1-x_0)$

$\Sigma \bar{F}=m\bar{a}$ $F_{spring}=-kx$ $F_f=\mu F_n$

$W=\bar{F}\cdot\bar{s}$ $W=\Delta K$ $U_s=\frac{1}{2}kx^2$ $U_g=mgy$ $P=\frac{\Delta W}{\Delta t}=Fv$ $W_{grav}=-\Delta U$

$p=mv$ $J=\Delta(mv)=Ft$ $X_{cm}=\frac{\Sigma m_i x_i}{\Sigma m_i}$

the first time

1. (7 pts) A box of mass M falls from a height H onto a spring and comes to a halt when compressed a distance X. A second box of mass M falls from height 2 H onto a different but identical spring. Assume that H is much larger than the size of a spring. Compared to the first case, the second spring compression distance when the box comes to a rest will be the first time

c

A. ½ X B. X C. 1.4X D. 2X E. 4X

2. (7 pts) The elastic energy stored in an unusual compound spring (a spring consisting of two separate springs) is given by $U(x)=2x^2 - 4x$. When x=2 m, the force that the spring exerts is

b

A. Zero B. Negative C. Positive D. Infinity E. Cannot be determined from given information

3. (7 pts) When you turn a corner in your car on a normal day on a normal road, what is it that is responsible for your car turning rather than going straight?

c

A. The centrifugal force of your car's motion
B. The coefficient of kinetic friction
C. The coefficient of static friction
D. The coefficient of rolling friction
E. Both A and D.

4. (7 pts) A pendulum bob is hanging by a massless wire and is swing back and forth in a vertical plane. Which of the following statement is correct?

c

A. the centripetal force is provided by the gravity only.
B. the centripetal force is provided by the tension force only.
C. the centripetal force is provided by the net of the gravity and tension forces.
D. there is no centripetal force involved in the situation.

5. (4 pts each) In a sentence or two, give one example for each of the following situations. (You might want to use diagrams to better explain your answers)

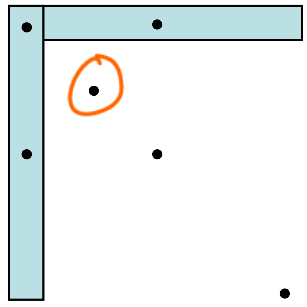
A. A normal force does negative work

The elevator floor on you when you are descending

B. A tension force does positive work

The cable that lifts your elevator car upward.

6. (7 pts) Two geometrically identical bars with the same mass are put together according to the following figure. Circle the correct location of the center of mass of this two-bar system.



7. (7 pts) A heavy truck and a small car are traveling at speed V on the same road. They both slam on their brakes and skid to a halt. They both have the same tires, so the coefficient of friction is the same.

A. The car stops in less distance, but they both stop in the same time.

E

B. The truck stops in less distance, but they both stop in the same time

C. The truck stops in the least distance and in the least time

D. The car stops in the least distance and in the least time.

E. They both come to a stop in the same distance and same time.

8. (7 pts) A feather falls to the surface of the moon and experiences no air resistance. As it falls, which one of these statements is true?

A. The feather's mechanical energy is constant.

A

B. The feather's kinetic energy is constant.

C. The feather's gravitational potential energy is constant.

D. The feather's momentum is constant.

E. None of the above

9. (7 pts) Cart 1, with mass m_1, collides perfectly elastically on a frictionless track with cart 2, which has mass m_2. Before the collision, cart 1 travels with velocity v_{1i} and cart 2 is at rest but free to move. Which condition is necessary to ensure that v_{1f}, the velocity of cart 1 after the elastic collision, is in the direction opposite to the direction of its initial velocity v_{1i}?

E

A. $m_1 > m_2$.

B. $m_1 = 0$.

C. $m_2 = 0$.

D. $m_1 = \infty$.

E. $m_1 < m_2$.

F. $m_1 = m_2$.

10. (7 pts) A solid, rigid sphere is wedged in a joint between two rigid, frictionless plates. One plate is vertical and the other is inclined at an angle 45° above horizontal. The magnitude of the normal force exerted by the vertical wall on the ball is:

A. greater than the sphere's weight.

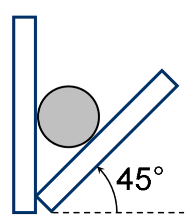
B

B. equal to the sphere's weight.

C. less than the sphere's weight but greater than zero.

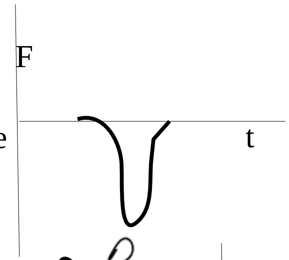
D. zero.

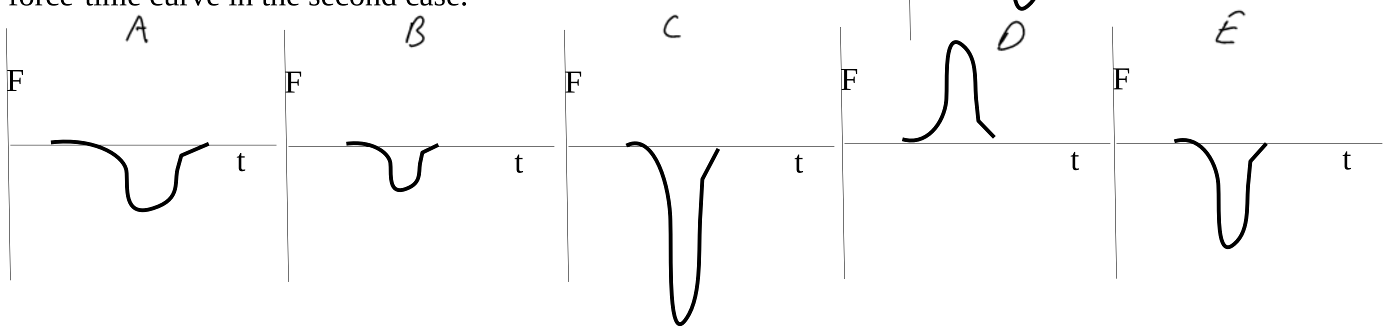
E. impossible to determine.



A

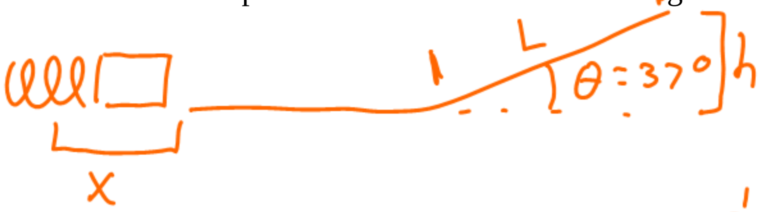
11. (7 pts) Your rich uncle buys you a new Porche automobile and you sadly crash it head-on into a concrete wall. The graph of the force versus time in the impact looks like the following (at right). Luckily your uncle is nice and buys you an identical car and you cover the front of the car in (lots of) pillows before running it into the same wall at the same speed. Circle the graph that best describes the force-time curve in the second case.





12. (20 pts) A 2.00 Kg block is pushed against a spring with negligible mass and force constant *k* = 400N/m, compressing it 0.220 m. When the block is released, it moves along a frictionless, horizontal surface and then up a frictionless incline with slope 37.0º.

A. What is the speed of the block as it slides along the horizontal surface after having left the spring?



use Energy conservation

$E_1 = E_2$

$U_{s_1} + U_{g_1} + K_1 = U_{s_2} + U_{g_2} + K_2$

$\frac{1}{2}kx^2 + 0 + 0 = 0 + 0 + \frac{1}{2}mv_2^2$

$v_2 = \sqrt{\frac{k}{m}x^2} = \sqrt{\frac{400}{2}(0.22)^2}$

$= 3.1\ m/s$

B. How far does the block travel up the incline before starting to slide back down?

$E_2 = E_3$

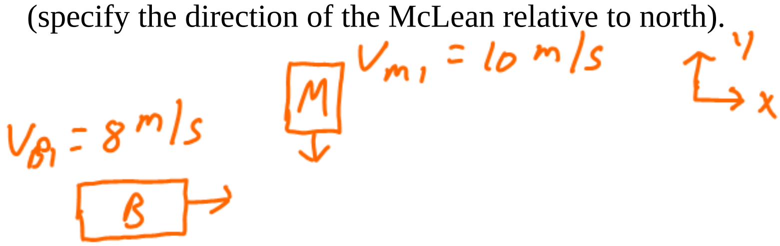
$U_{g_2} + K_2 = U_{g_3} + K_3$

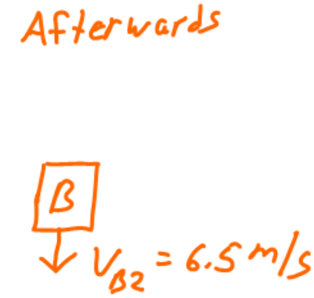
$0 + \frac{1}{2}mv_2^2 = mgh + 0$ note $h = L\sin\theta$

$\frac{1}{2}mv_2^2 = mgL\sin\theta$

$\frac{\frac{1}{2}v_2^2}{g\sin\theta} = L = \frac{\frac{1}{2}(3.1)^2}{9.8\sin 37} = 0.81\ m$

13. (25 pts) Two ships, the 30,000-ton *Josephine Baker* and the 50,000-ton *Malcolm Mclean*, collide at sea. Immediately before the collision, the *Baker* was traveling due east at 8.0 m/s, and the *Maclean* was traveling due south at 10.0 m/s. Immediately after the collision, the *Baker*'s velocity was 6.5 m/s due south. What was the velocity (speed and direction) of the *McLean* immediately after the collision? (specify the direction of the McLean relative to north).





Conserve momentum in X and Y

X

$$P_1 = P_2$$

$$m_B V_{B1x} + m_m V_{m1x} = m_B V_{B2x} + m_m V_{m2x}$$

($V_{m1x} = 0$, $V_{B2x} = 0$)

$$\frac{m_B V_{B1x}}{m_m} = V_{m2x} = \frac{3}{5} 8 = \boxed{4.8 \frac{m}{s}}$$

Y

$$P_1 = P_2$$

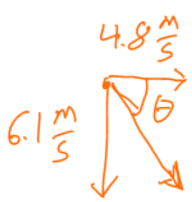
$$m_B V_{B1y} + m_m V_{m1y} = m_B V_{B2y} + m_m V_{m2y}$$

($V_{B1y} = 0$)

$$\frac{m_m V_{m1y} - m_B V_{B2y}}{m_m} = V_{m2y}$$

$$V_{m1y} - \frac{m_B}{m_m} V_{B2y} = V_{m2y}$$

$$-10 \frac{m}{s} - \frac{3}{5}\left(-6.5 \frac{m}{s}\right) = \boxed{V_{m2y} = -6.1 \frac{m}{s}}$$



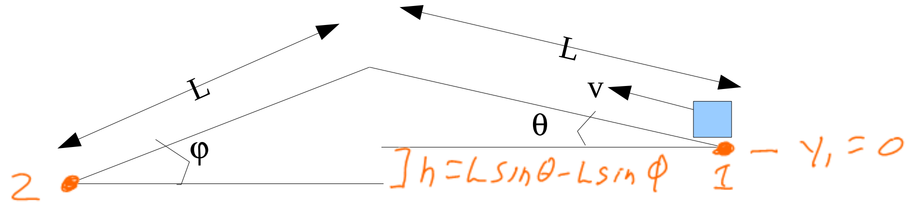
$$V = \sqrt{4.8^2 + 6.1^2} = 7.8 \frac{m}{s}$$

$$\theta = \arctan\left(\frac{6.1}{4.8}\right) = 52^\circ \text{ S of East}$$

or

142° from north

14.(25 pts) A box of mass M at a shipping office initially slides at speed v starting from the bottom and slides up a ramp of length L and angle θ and coefficient of kinetic friction μ_1 before cresting the top and sliding down a ramp of the same length L and coefficient of kinetic friction μ_2 and angle φ. Give an expression for v_f, the final speed of the box at the bottom of the second ramp, in terms of any of the given symbols and possibly g. (Use the methods of this section of the class rather than the methods of chapter 2).



Conserve Energy

$$E_1 = E_2$$

$$K_1 + U_1 + W_o = K_2 + U_2$$

$$\frac{1}{2}mv^2 + mgy_1^{\,0} + F_f \cdot D_1 + F_f D_2 = \frac{1}{2} m v_f^2 + mg y_2$$

$$y_1 = 0 \qquad y_2 = -h = L\sin\phi - L\sin\theta$$

$$\frac{1}{2}mv^2 + -\mu_1 mg\cos\theta L + -\mu_2 mg \cos\phi L = \frac{1}{2} m v_f^2 + mg(L\sin\phi - L\sin\theta)$$

m drops out

$$v_f = \sqrt{v^2 + 2gL(-\mu_1\cos\theta - \mu_2\cos\phi) + 2gL(\sin\phi - \sin\theta)}$$