EXAM-2

PHYS 201 (Spring 2008), 03/24/08

Name: Solution Key

Lab-Sect. no.:

Signature:

Duration: 50 minutes
Show all your work for full/partial credit!
Include the correct units in your final answers for full credit!
Unless otherwise stated, quote your results in SI units!

students : 46+1+1

S17	S18	S19
17	12	18

✓

1.) *Multiple Choice* *(25 pts.)*

For each statement below, circle the correct answer (TRUE or FALSE, no reasoning required).

(a) If a car takes a turn on a road without sliding, the static friction force between tires and road acts as a centripetal force.
TRUE FALSE

(b) Since work depends on force and displacement, it is a vector quantity.
TRUE FALSE

(c) The normal force is a nonconservative force.
TRUE FALSE

(d) The acceleration of an object in simple harmonic motion is largest when the object's speed is zero.
TRUE FALSE

(e) When a tennis ball is thrown at a wall and bounces back with the same speed, the impulse on that ball by the wall is zero.
TRUE FALSE

No.	Points
1	SD
2	SD
3	KD
4	HQ
5	RR
Sum	

2.) *Circular Motion* *(15 pts.)*

Assume the Moon (mass M_M=7.35·$10^{22}kg$) to be in a circular orbit around Earth (mass M_E=6·$10^{24}kg$) at a distance of 384000km. Calculate the period of the Moon's revolution around Earth (in days).

3

$$F_G = F_c$$

3

$$G \frac{M_E M_M}{r^2} = \frac{M_M v^2}{r} \quad 3 \qquad v = \frac{2\pi r}{T}$$

3 3

$$G \frac{M_E}{r} = \frac{4\pi^2 r^2}{T^2} \Rightarrow T = \sqrt{\frac{4\pi^2 r^3}{G M_E}} = 27 \text{ days}$$

$$\frac{T^2}{r^3} = \frac{4\pi^2}{G \cdot M_E}$$

3.) *Mechanical Energy and Nonconservative Work* (*20 pts.*)

A skier (mass $80kg$) starts from the top of a $8\ m$ high hill. With an initial speed of $1.5m/s$ he glides down the frictionless slope to the bottom.

(a) What is the skier's speed at the bottom?

(b) At the bottom, he encounters a rough horizontal ice patch of length 12m. The friction coefficient between the rough ice and the skies is 0.25. What is the speed of the skier after passing the ice patch?

(a) $E_i = E_f$

$$\frac{1}{2}mv_i^2 + mgh = \frac{1}{2}mv_f^2$$

$$\Rightarrow \boxed{v_f = \sqrt{v_i^2 + 2gh}} = \boxed{12.6\ \frac{m}{s}}$$

(b) $W_{nc} = \Delta E = \Delta K = K_f - K_i = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$$W_{nc} = -f_k s = -\mu_k F_N s = -\mu_k mgs$$

$$-\mu_k mgs = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$\Rightarrow \boxed{v_f = \sqrt{v_i^2 - 2\mu_k gs}} = \boxed{10.0 m/s}$$

4.) *Gravitation and Simple Harmonic Motion* (*20 pts.*)
Consider a simple pendulum on the Moon's surface. The Moon's radius and mass are R_M=1740km M_M=7.35·10^{22}kg.

(a) Using Newton's Law of gravitation, calculate the acceleration due to gravity on the Moon's surface, g_M.

(b) What should be the length of a simple pendulum which has a period of 1s on the Moon's surface?

(8) (2)

(a) $g_M = G \frac{M_M}{r_M^2} = 1.62 \frac{m}{s^2}$

(b) $T = 2\pi \sqrt{\frac{L}{g}}$

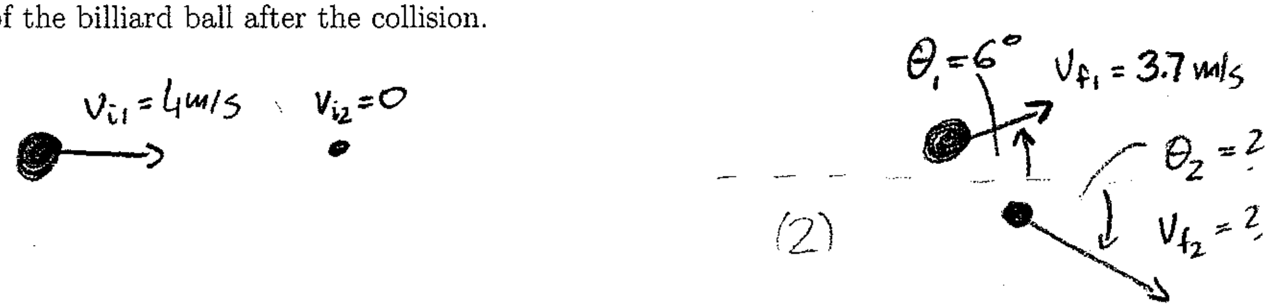
(2)

$\Rightarrow L = \frac{T^2}{4\pi^2} g_M = 0.041\,m = 4.1\,cm$

(8)

5.) *2-D Inelastic Collision* (*20 pts.*)

An incoming bowling ball (m_1=5kg, v_{i1}=4m/s due East) collides with a billiard ball (m_2=0.8kg) initially at rest. After the collision, the bowling ball is deflected by 6 *degrees* North of East, with a final speed of 3.7 m/s. Calculate the speed and direction of motion (the angle South of East) of the billiard ball after the collision.



(2)

momentum conservation:

$$\vec{P}_i = \vec{P}_f$$

(2)

x-comp. $m_1 v_{i1x} = m_1 v_{f1x} + m_2 v_{f2x}$ (5)

$$\Rightarrow v_{f2x} = \frac{m_1}{m_2}\left(v_{i1x} - v_{f1x}\right) = 6.25\left(4 - 3.7\cos(6)\right) = 2.00 \frac{m}{s}$$

y-comp. $0 = m_1 v_{f1y} + m_2 v_{f2y}$

$$\Rightarrow v_{f2y} = -\frac{m_1}{m_2} v_{f1y} = -6.25 \times 3.7 \times \sin(6°) = -2.42 \frac{m}{s}$$ (5)

$$\boxed{v_{f2} = \sqrt{v_{f2x}^2 + v_{f2y}^2} = 3.14 \ m/s}$$ (3)

$$\tan\theta_2 = \frac{v_{f2y}}{v_{f2x}} \Rightarrow \boxed{\theta_2 = \tan^{-1}\left(\frac{v_{f2y}}{v_{f2x}}\right) = 50.4°}$$ (3)