PHYS 124 Section A01
Mid-Term Examination
Autumn 2006

Name :_____**ANSWERS**____

Student ID Number :_____

Instructor : Marc de Montigny
Time : Wednesday, October 25, 2006
9:00 – 9:50 AM

Instructions :

- This booklet contains 9 pages.
- Items allowed : pen or pencil, calculator (programmable or graphic allowed). Personal digital assistants not allowed.
- Please turn off your cell phones.
- This is a closed-book exam. You may use the formula sheet provided in class, subject to your own modifications. Specific rules were described in class. You may lose up to 5 marks (out of 20) if :
  1. full solutions are included,
  2. the formula sheet is not returned with your exam, or if
  3. you have written formulas on both sides.
- The exam is worth 20% of the course's final score. You can obtain a **maximum of 50 marks** out of the possible **62 marks**.
- The exam contains two sections : Multiple-Choice Questions and Problems
  - **7 Multiple-Choice Questions**. Each question is worth 3 marks, for a **total of 21 marks**. No partial marks are allowed. Select the <u>one</u> best answer.
  - **3 Problems**. They are worth a **total of 41 marks**. Partial marks will be given. Show all work clearly and neatly. If you miss a result for a subsequent part of a question, then work algebraically.
- You may use the back of the pages for your own calculations. <u>These will not be marked, unless you specify otherwise.</u>

Multiple-Choice Questions (Total of 21 marks). Circle the one best answer.

MC-1. (3 marks) Which of the following quantities has the dimensions of an acceleration? In these equations, x denotes a distance, t is time, and v is a velocity.

A. xt^2

B. v^2 / x

C. x^2 / t

D. v^2 / t

MC-2. (3 marks) A v-versus-t graph is drawn for a ball moving in one direction. The graph starts at the origin, increases with a positive slope for five seconds, and then levels off to a zero slope for 2 s. We can be sure that

A. the ball decelerates during the first 5 s.

B. the acceleration is constant throughout the complete motion.

C. the velocity is positive for $0 \le t \le 5$ s, and is zero for $5 \le t \le 7$ s.

D. the displacement is zero throughout the complete motion.

E. none of the above is true.

MC-3. (3 marks) An object is thrown into the air (neglect friction). Its speed at the top of its trajectory is half its initial speed. At what angle, relative to horizontal, was this object thrown?

A. 30º

B. 45º

C. 60º

D. 90º

E. None of the above

MC-4. (3 marks) A fireman slides down a pole to the ground floor. During the process, the fireman's speed is increasing. We can assert that

A. the upward force exerted by the pole on the fireman is equal to the fireman's weight.

B. the upward force exerted by the pole on the fireman is greater than the fireman's weight.

C. the upward force exerted by the pole on the fireman is less than the fireman's weight.

D. none of the above is true.

MC-5. (3 marks) A block of mass 10 kg sits at rest on a hill inclined at an angle of 30° above the horizontal. The coefficients of static and kinetic friction are $\mu_s = 0.792$ and $\mu_k = 0.329$, respectively. What is the magnitude of the frictional force acting on the mass?

A. It is equal to 28.0 N.

B. It is equal to 38.8 N.

C. It is equal to 49.1 N.

D. It is equal to 67.3 N.

E. None of the above.

MC-6. (3 marks) Consider a popular ride, as illustrated below. Riders rotate about the striped pole with a certain angular speed. The faster they turn, the farther they get from the pole.

At the instant shown above, the centripetal acceleration is caused by the

A. normal force.
B. friction.
C. horizontal component of the tension in the supporting cable.
D. vertical component of the tension in the supporting cable.
E. gravitational force.

MC-7. (3 marks) A 25-kg block is sliding on a rough, horizontal surface, with an initial velocity 12 m/s. If the kinetic coefficient of friction is $\mu_k = 0.235$, what is the final velocity after the block has traveled a distance of 20 m?

A. 5.10 m/s
B. 7.20 m/s
C. 10.2 m/s
D. 15.4 m/s

[Problems start on next page]

P-2. (13 marks) Newton's Laws of Motion

Masses m_1 = 4.0 kg and m_2 = 9.0 kg are connected by a light string that passes over a frictionless pulley. As shown in the figure below, m_1 is initially held at rest on the floor and m_2 rests on a rough surface, inclined at θ = 40°. The masses are then released from rest, and m_2 slides 1.0 m down along the incline in 4.0 s with a constant acceleration.

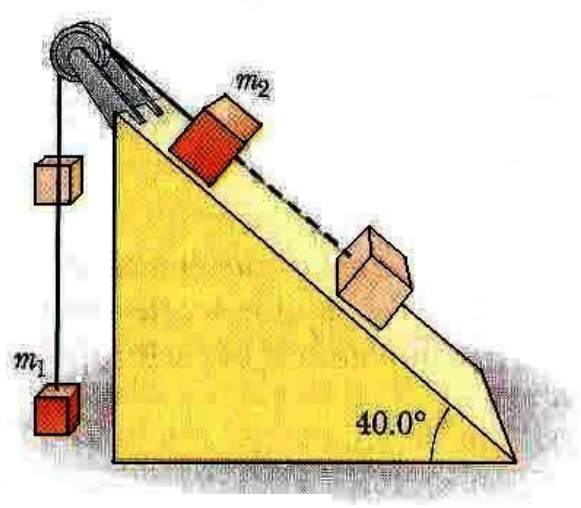
A. Draw the free-body diagram for each mass, as m_2 is sliding down. **(2 marks)**

B. For each mass, choose a coordinate system and write out Newton's Second Law of motion for the forces acting on m_1 and m_2. **(4 marks)**

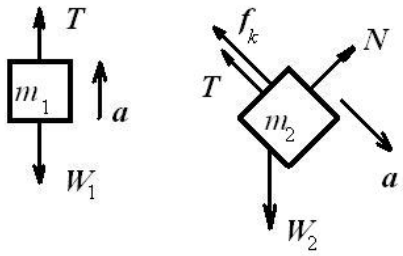
C. Determine the acceleration of each mass. **(2 marks)**

D. Determine the tension in the string. **(2 marks)**

E. Find the coefficient of kinetic friction between m_2 and the incline. **(3 marks)**



A.



B. m_1 : $\sum F = T - m_1 g = m_1 a$ (vertical direction)

m_2 : $\sum F_x = m_2 g \sin\theta - f_k - T = m_2 a$ (x parallel to incline, downward)

m_2 : $\sum F_y = N - m_2 g \cos\theta = 0$ (y perpendicular to incline, upward)

C. apply to m_2: $x - x_0 = v_{0x} t + \frac{1}{2} a t^2$ so that $a = \frac{2(x - x_0)}{t^2} = 0.125$ m/s^2.

D. $T = m_1(a + g) = 39.7$ N.

E. $m_2 g \sin\theta - T - m_2 a = f_k = \mu_k m_2 g \cos\theta$, $\mu_k = \frac{m_2(g \sin\theta - a) - T}{m_2 g \cos\theta} = 0.235.$

P-3. (12 marks) Conservation of Energy

Starting from rest, a 42.0-kg seal slides down a rough ramp into an amusement park pool, as shown below. The top of the ramp is h = 1.75 m higher than the surface of the water, and the ramp is inclined at an angle θ = 35.0º above the horizontal. After sliding down, the seal reaches the water with a speed of 4.40 m/s. Between the top of the ramp and the contact with water :

A. what is the change of the seal's kinetic energy? **(2 marks)**

B. what is the change of the seal's potential energy? **(2 marks)**

C. Is the frictional force static or kinetic? **(1 mark)**

D. Use the principle of conservation of mechanical energy to find the work W_{NC} done by the frictional force. **(2 marks)**

E. What is the magnitude of the normal force acting on the seal? **(2 marks)**

F. Find the coefficient of friction (state whether it is static or kinetic) between the seal and the ramp. **(3 marks)**

A. $\Delta K = \frac{1}{2} m\left(v_f{}^2 - v_i{}^2\right) = 407$ J.

B. $\Delta U = -mgh = -721$ J.

C. Kinetic.

D. $W_{NC} = \Delta K + \Delta U = -314$ J.

E. $N = mg\cos\theta = 338$ N.

F. $W_{NC} = -\mu_k Nd = -\mu_k N\left(\frac{h}{\sin\theta}\right)$, so that $\mu_k = -\frac{W_{NC}\sin\theta}{Nh} = 0.305$