Physics 160, Section 003
In-Term Examination II
Spring, 2006

You may refer to books and notes, but you may not seek assistance in any form from, or offer assistance to, any person other than the instructor. Failure to abide by these instructions subjects you to penalties enumerated in the syllabus.

The test consists of five multiple-choice questions, worth 1 point each, and three problems, each worth a total of 5 points. Total value of the test: 20 points.

1. An object sits on a circular turntable which rotates at constant angular velocity in the clockwise direction, as shown in the figure below.

Which of the following sets of vectors best describes the velocity and acceleration of the object and the net force acting on it?

(A) \[ \vec{F}, \vec{v}, \vec{a} \]
(B) \[ \vec{F}, \vec{v}, \vec{a} = 0 \]
(C) \[ \vec{F}, \vec{v}, \vec{a} \]
(D) \[ \vec{F}, \vec{v}, \vec{a} \]
(E) \[ \vec{F}, \vec{v}, \vec{a} \]

(a) A
(b) B
(c) C
(d) D
(e) E
(f) None of the above.
2. A block slides along a rough surface at constant velocity under the influence of the force $\vec{T}$, as shown below.

Which of the following relationships among the force magnitudes must be true? [Note: The arrows in the diagram indicate the directions, not the magnitudes, of the forces.]

(a) $|\vec{T}| = |\vec{f}|$ and $|\vec{N}| = |\vec{W}|
(b) $|\vec{T}| = |\vec{f}|$ and $|\vec{N}| > |\vec{W}|
(c) $|\vec{T}| > |\vec{f}|$ and $|\vec{N}| < |\vec{W}|
(d) $|\vec{T}| > |\vec{f}|$ and $|\vec{N}| = |\vec{W}|
(e) None of the above.

3. A velocity versus clock reading history is shown below.

Which of the following net force versus clock reading graphs relates best to this history?

(a) A  (b) B  (c) C  (d) D  (e) E  (f) None of the above.

4. Object A has mass number $m_A$ and velocity $\vec{v}_A$. Object B has mass number $m_B = 2m_A$ and velocity $\vec{v}_B = 3\vec{v}_A$. The same constant force $\vec{F}$ is applied to each object until it stops. Object A is brought to rest after time interval $\Delta t$. The time interval required to stop object B is:

(a) $2\Delta t$
(b) $3\Delta t$
(c) $6\Delta t$
(d) $9\Delta t$
(e) $18\Delta t$
(f) None of the above.
5. Object A has mass number \( m_A \) and velocity \( \vec{v}_A \). Object B has mass number \( m_B = 2m_A \) and velocity \( \vec{v}_B = 3\vec{v}_A \). The same constant force \( \vec{F} \) is applied to each object until it stops. Object A travels \( \Delta s \) before coming to rest. The displacement of object B before it stops is:

(a) 2\( \Delta s \)  
(b) 3\( \Delta s \)  
(c) 6\( \Delta s \)  
(d) 9\( \Delta s \)  
(e) 18\( \Delta s \)  
(f) None of the above.

6. Two spherical planets, 1 and 2, with mass numbers \( m_1 \) and \( m_2 \) and radii \( r_1 \) and \( r_2 \), respectively, are in circular orbit around a star with mass number \( M_s \). The radii of the orbits are \(| \vec{\rho}_1 | \) and \(| \vec{\rho}_2 | \), respectively, where \(| \vec{\rho}_2 | = 2 | \vec{\rho}_1 | \), and \( M_s \gg m_1, M_s \gg m_2, m_2 = 2m_1, \) and \( r_2 = 2r_1 \).

(a) How does the magnitude of the gravitational force exerted by the star on planet 1 compare to the magnitude of the gravitational force exerted by the star on planet 2? Make a quantitative comparison.

(b) How does the magnitude of the gravitational force exerted on planet 1 by planet 2 compare to the magnitude of the gravitational force exerted on planet 2 by planet 1? Make a quantitative comparison.

(c) How does the acceleration due to gravity on the surface of planet 1 compare to the acceleration due to gravity on the surface of planet 2? Make a quantitative comparison.

(d) How does the magnitude of the instantaneous translational (or, equivalently, tangential or linear) velocity of planet 1 compare to the magnitude of the instantaneous translational velocity of planet 2? Make a quantitative comparison.

(e) How does the length of a “year” (the period) of planet 1 compare to the length of a “year” of planet 2? Make a quantitative comparison.
7. A car, traveling initially at velocity $\vec{v}_i$, brakes suddenly and skids to a stop after a distance $\Delta s$.

(a) What force was responsible for stopping the car?
(b) What was the magnitude of the acceleration during the skidding, assuming it was constant?
(c) If the car had been going half as fast, everything else being the same, how far would the car have skidded?
(d) In terms of the information given (and any other standard quantities), what was the $\mu_k$ of the tire-road interface under these conditions?
(e) On a rainy day, would $\mu_k$ be bigger, smaller, or the same?

8. A frictionless cart with mass number $m$ moves in the positive direction on a track with velocity of magnitude $|\vec{v}|$. At the end of the track, it collides with a spring and rebounds with a velocity of the same magnitude.

(a) In terms of the information given, what is the cart’s momentum change $\Delta \vec{p}$ as a result of the collision?
(b) In terms of the information given, what is the impulse $\vec{I}$ exerted by the spring on the cart?
(c) In terms of the information given, what is the cart’s kinetic energy change $\Delta K$ as a result of the collision?
(d) In terms of the information given, what was the work $W$ done by the spring on the cart?
(e) Describe in words the sequence of energy changes that takes place in the cart-spring system between initial contact of the cart with the spring and the final separation from contact.