

Directions: No books or notes may be used during this exam. Important formulas are provided for you. Graphing calculators and palmtop or laptop computers are not allowed. Write everything on the exam booklet provided. Always include **three** significant digits in your numerical answers.

$$\text{If } ax^2 + bx + c = 0, \text{ then } x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \sin \theta = \frac{\text{opp}}{\text{hyp}} \quad \cos \theta = \frac{\text{adj}}{\text{hyp}} \quad \tan \theta = \frac{\text{opp}}{\text{adj}}$$

$$\bar{v}_{AVE} = \frac{\Delta \bar{x}}{\Delta t} \quad \bar{a}_{AVE} = \frac{\Delta \bar{v}}{\Delta t} \quad \bar{v} = \frac{d\bar{x}}{dt} \quad \bar{a} = \frac{d\bar{v}}{dt}$$

$$\bar{x} = \bar{x}_o + \bar{v}_o t + \frac{1}{2} \bar{a} t^2 \quad \bar{v} = \bar{v}_o + \bar{a} t \quad v^2 = v_o^2 \pm 2a\Delta x \quad \bar{v}_{AVE} = \frac{\bar{v} + \bar{v}_o}{2}$$

$$\Sigma \vec{F} = 0 \quad \Sigma \vec{F} = m\bar{a} \quad \vec{F}_g = m\vec{g} \quad (g = 9.80 \text{ m/sec}^2)$$

$$v = \frac{2\pi R}{T}$$

$$a_c = \frac{v^2}{R}$$

$$F_{fk} = \mu_k F_N$$

$$F_{fs} \leq \mu_s F_N$$

$$F_g = \frac{Gm_1 m_2}{R^2} \quad (G = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2)$$

$$\frac{T^2}{R^3} = \text{constant}$$

$$K = \frac{1}{2} m v^2$$

$$W(\text{total}) = \Delta K$$

$$W = F\Delta R \cos \theta = (F_x \Delta x) + (F_y \Delta y) + (F_z \Delta z)$$

$$W = \int F dR \cos \theta = \int F_x dx + \int F_y dy + \int F_z dz$$

Question 1: WRITE THE FORM DESIGNATOR FOR THIS EXAM (A) IN THE ANSWER BOX FOR QUESTION #1 ON THE FIRST PAGE OF THE EXAM BOOKLET.

Questions 2-6 (5 points each) Multiple Choice. You will be graded on your answer only. It is *not* necessary to show your work for these problems. Put the answer for each question in the proper numbered box on the second page of your test booklet.

2. When an object moves with uniform circular motion, which of the following quantities is *not* constant?

- (A) the circle's radius (B) the object's period (C) the object's velocity (D) the object's speed
(E) None of the above. They're all constant.

3. An object is initially moving at 7.00 m/s on a flat, horizontal surface. The coefficient of kinetic friction between the object and the surface is 0.500. How far does the object move before coming to rest? (A) 0.500 m (B) 1.00 m (C) 2.50 m (D) 3.50 m (E) 5.00 m (F) 24.5 m (G) 49.0 m.

4. How long does it take the moon to go around the earth once? Assume uniform circular motion. The mass of the earth is 5.98×10^{24} kg and the distance from the center of the earth to the center of the moon is 3.84×10^8 m. (A) 1.00 days (B) 14.5 days (C) 27.4 days (D) 29.0 days (E) 30.5 days.

5. Which non-zero force never does any work on a moving object? (A) gravity (B) kinetic friction (C) tension (D) normal (E) applied (F) external.

6. The magnitude of a variable force as a function of horizontal position is $F(x) = \sin x$, where x is measured in meters and F is measured in newtons. The direction of the force is to the left. How much work does the force do when the object moves from $x = 0$ to $x = \pi$ m? (A) -2.00 J (B) -1.00 J (C) 0 J (D) 1.00 J (E) 2.00 J.

TURN THE PAGE OVER

Solve the following three problems on the front of the next three pages of your exam booklet. Show your solutions in a well-organized fashion. Partial credit will be given for proper translations and for identification of the relevant equations. **For full credit, you MUST begin with formulas from the first page of this exam and show which equations you will be using in symbolic form before doing any algebra or putting in any numbers. No credit is given for an answer without showing HOW you got the answer.** Work each problem on a separate page, **in numerical order**. WRITE THE PROBLEM NUMBER AT THE TOP OF EACH PAGE ON YOUR EXAM BOOKLET.

7. (25 pts.) Frictionless Inclined Plane

An object of mass m moves up and to the right on a frictionless inclined plane. The angle between the plane and the horizon is α . There are three constant forces acting on the object: gravity, normal and applied. The applied force is directly to the right. (Its vertical component is zero.) Determine the simplest expressions for the work done by each force and the total (or net) work when the object moves a distance d along the plane.

8. (25 pts.) Stable Orbit

A communication satellite used primarily for cell phone traffic moves with uniform circular motion around the earth in a stable orbit at 7.50 km/s. How far (in meters) is the satellite above the earth's surface? The mass of the earth is 5.98×10^{24} kg and its radius is 6.28×10^6 m.

9. (25 pts.) Fun with Friction

A flatbed truck accelerates non-uniformly to the right on a flat, level horizontal road. The magnitude of the truck's acceleration as a function of time is $a(t) = 5t + 1$, where a is in m/sec^2 , $t \geq 0$ and t is in seconds. Resting on the bed of the truck, which is also flat and level, is a crate. The coefficient of static friction between the crate and the bed of the truck is 0.400 and the coefficient of kinetic friction between the crate and the bed of the truck is 0.300. Assume that the crate remains on the truck's bed at all times. Determine the magnitude of the crate's acceleration as a function of time for $t \geq 0$. (Hint: The answer is a piecewise function.)

WHEN YOU TURN IN YOUR EXAM, SHOW YOUR I.D. CARD AND SIGN THE CLASS LIST.