Concordia
UNIVERSITY

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COURSE	NUMBER	SECTION	
PHYSICS	204/1	BA	
EXAMINATION	DATE	TIME	# OF PAGES
FINAL	August 6, 1992	19:00 - 22:00	3

INSTRUCTOR
DR. C.S. KALMAN

MATERIALS ALLOWED: ☐ NO ☐ YES (PLEASE SPECIFY)

CALCULATORS ALLOWED: ☐ NO ☒ YES (non-programmable)

SPECIAL INSTRUCTIONS
An unmarked copy of "Physics" by Serway may be used during the exam. (Highlighting or underlining is permitted.)

1. A body of mass 0.51 kg resting on a rough table ($\mu = 0.4$) is connected by a light string over a smooth pulley to a body of mass 0.42 kg hanging freely. Find the common acceleration of the two bodies and the tension in the string.

2. A tennis ball of mass 0.022 kg is moving at 3.1 m/s at an angle of 222° to the horizontal. It is struck by a tennis racket which exerts a force on it of $73t - 442t^2$ N. for one tenth of a second at an angle of 32° to the horizontal. Find the final velocity of the tennis ball. (Express your answer using $\hat{i}$, $\hat{j}$ unit vectors).

3. To what distance would a 958 kg car have to be raised in order that when released its kinetic energy on reaching the ground is 3.25×10^5 joules.

4. The force of attraction between the positively charged nucleus and the negatively charged electron in the hydrogen atom is given by

$$F = -k\frac{e^2}{x^2},$$

where e is the charge of the electron, k a constant and x is the separation between electron and nucleus. Assume the nucleus is fixed. The electron initially moving in a circle of radius x_1 about the nucleus jumps suddenly into a circular orbit of smaller radius x_2.

a) Using the notion of centripetal force, calculate the change in kinetic energy of the electron.

b) Calculate the change in potential energy of the atom.

c) How much is the change in total mechanical energy of the atom. (The energy is released in the form of radiation.)

5. A pulley of moment of inertia 0.021 kg - m^2 and radius 0.12 m

is acted upon by a force which varies in time as $F = 0.23t + 0.12t^2$ where F is in Newtons and t is in seconds. Suppose that the pulley is initially rotating at 0.18 r/s and the force acts tangentially to the pulley. Find the magnitude of the angular velocity of the pulley two seconds after the force began to act on the pulley.

6. Discuss the action of forces on a projectile using as an example a tennis ball struck by a tennis racket. Be sure to discuss all the forces acting on the ball at the instant it leaves the racket and when the ball is at the highest point in its motion.

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COURSE	NUMBER	SECTION	
PHYSICS	204/1	BA	
EXAMINATION	DATE	TIME	# OF PAGES
FINAL	August 21, 1995	3 hours	3

INSTRUCTOR
Nehad TASHTOUSH

MATERIALS ALLOWED [X] NO [ ] YES (PLEASE SPECIFY)

CALCULATORS ALLOWED [ ] NO [X] YES non-programmable only.

SPECIAL INSTRUCTIONS
Attempt all questions

Problem # (1) *12 marks*

(a) A 40-kg box initially at rest is pushed a distance of 5 m a long a rough, horizontal floor with a constant applied horizontal force of 130 N. If the coefficient of friction between the box and floor is 0.3, find
(1) the work done by the applied force,
(2) the work done by friction,
(3) the change in kinetic enegy of the box, and
(4) the final speed of the box. *(8 marks)*

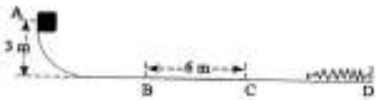

Fig. 1 [Problem (1.b)]

(b) A 10-kg block is released from point A on a track *ABCD* as shown in Fig.1. The track is frictionless except for the portion *BC*, of length 6 m. The block travels down the track and hits a spring of force constant k = 2250 N/m and compresses it a distance of 0.3 m from its equilibrium position before coming to rest momentarily. Determine the coefficient of kinetic friction between the track position *BC* and the block. *(4 marks)*

Problem # (2) *10 marks*

(a) A 1200 kg car is traveling initially with a speed of 25 m/s in an easterly direction crashes into the rear end of a 9000-kg truck moving in the same direction at 20 m/s. The velocity of the car right after the collision is 18 m/s to the east. (Fig.2)

(1) What is the velocity of the truck right after the collision. *(4 marks)*

(2) How much mechanical enegy is lost in the collision, and how do you account for this loss in energy. *(3 marks)*

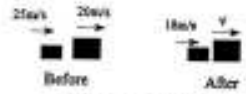

Fig.2 [Problem 2.a]

(b) A 3-kg particle is located on the x axis at x = -5m, and a 4-kg particle is on the x-axis at x = 3 m. Find the center of mass. *(3 marks)*

Problem # (3) *10 marks*

Three particles are connected by rigid rods of nigligible mass lying along the y axis (Fig.3). If the system rotates about the x axis with an angular speed of 2 rad/s, find
(1) the moment of inertia about the x axis *(4 marks)*
(2) the total kinetic energy, and *(3 marks)*
(3) the linear speed of each particle. *(3 marks)*

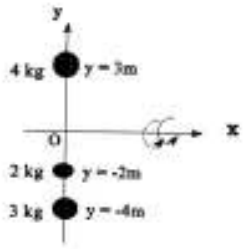

Fig. (3) [Problem # (3)]

Problem # (4) *7 marks*

(a) A 1.5 kg particle moves in the xy plane with velocity $\mathbf{v} = (4.2\hat{i} - 3.6\hat{j})$ m/s. Determine its angular momentum when its position vector is $\mathbf{r} = (1.5\hat{i} + 2.2\hat{j})$ m. *(4 marks)*

(b) What are the necessary conditions for equilibrium of an object? (State them) *(3 marks)*

Problem # (5) *11 marks*

A body oscillates with simple harmonic motion along the x axis. Its displacement varies with time according to the equation

$$x = (4.0\ \text{m})\cos(\pi t + \pi/4)$$

where t is in s, and the angles in the parentheses are in radians.

(1) Determine the amplitude, frequency and the period of the motion. *(3 marks)*
(2) Calculate the velocity and acceleration of the body at any time. *(2 marks)*
(3) Using the results to (b), determine the position, velocity and acceleration of the body at t=1 s.
(4)Determine the maximum speed and maximum acceleration of the body. *(2 marks)*
(5)What is the phase of the motion at t=2 s. *(2 marks)*