Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 3rd Exam April 9, 2004

Name (print, last first): _____ Signature: _____

On my honor, I have neither given nor received unauthorized aid on this examination.

YOUR TEST NUMBER IS THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE.

(1) **Code your test number on your answer sheet (use 76–80 for the 5-digit number)**. Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. Code your UFID number on your answer sheet.
(2) Print your name on this sheet and sign it also.
(3) Do all scratch work anywhere on this exam that you like. **Circle your answers on the test form.** At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout with scratch work most questions demand.
(4) **Blacken the circle of your intended answer completely, using a #2 pencil or blue or black ink**. Do not make any stray marks or some answers may be counted as incorrect.
(5) The answers are rounded off. Choose the closest to exact. There is no penalty for guessing.
(6) **Hand in the answer sheet separately.**

$$g = 9.80 \text{ m/s}^2$$

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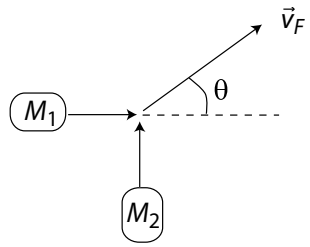
1. An auto of mass $M_1 = 10^3$kg is initially moving along the x axis with speed 30 m/s, and a pickup truck of mass $M_2 = 2 \times 10^3$kg is initially moving in the perpendicular direction along the y axis with speed 40 m/s. The vehicles collide and undergo a sticking collision. What is the angle θ between the x axis (initial direction of M_1) and the final common velocity vector $\vec{v}_F$?



(1) 69° (2) 10° (3) 21° (4) 35° (5) 42°

2. In the previous problem, what is the value of E_F/E_I, where E_F is the total kinetic energy (sum of kinetic energies) of the two vehicles after the collision, and E_I is the total kinetic energy of the two vehicles before the collision?

(1) 0.59 (2) 0.14 (3) 0.29 (4) 0.79 (5) 1.69

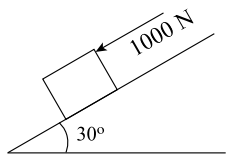
3. An auto of mass M_1 and truck of mass $M_2 = 3M_1$ undergo an elastic collision. The truck is initially at rest and the auto's initial velocity is in the positive x direction. After the collision the auto is moving the negative x direction with speed 20 m/s. What is the auto's initial speed, in m/s, before the collision?

(1) 40 (2) 30 (3) 50 (4) 60 (5) 70

4. Two balls of masses M_1 and M_2 are heading directly at each other, each with speed 20 m/s. They undergo a head-on collision, and each rebounds in the backwards direction with speed 10 m/s. What is the value of the ratio M_1/M_2?

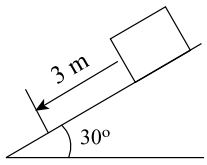
(1) 1 (2) 0.5 (3) 0.33 (4) 2 (5) 3

5. A 25 kg block is pushed down an incline by a force $F = 1000$N that is parallel to the incline. The incline is frictionless and makes an angle of 30° with respect to the horizontal. If the block starts with speed 3 m/s down the incline, what is its speed, in m/s, after it has moved 2 m down along the incline?



(1) 13.7 (2) 11.1 (3) 9.2 (4) 7.6 (5) 3.2

6. A 10 kg block is moving down an incline with initial speed 4 m/s. The incline makes an angle of 30° with respect to the horizontal. The block moves 3 m down along the incline before friction brings it to rest. How much work is done by friction in bringing the block to rest?



(1) -227 J (2) $+321$ J (3) $+5$ J (4) -632 J (5) -54 J

7. A pendulum ball of mass $M_1 = 10$kg hanging in equilibrium is struck by a horizontally-moving ball with the same mass $M_2 = M_1 = 10$kg. The mass M_2 is brought to rest by the collision (its speed immediately after the collision is zero). After the collision, M_1 rises through a height of 2 m before turning around. What is the speed of M_2, in m/s, before the collision?

(1) 6.3 (2) 2.1 (3) 4.2 (4) 8.4 (5) 10.6

8. An elevator motor lowers a 10^3kg elevator at constant speed while the elevator drops from the 4th floor to the 2nd, a distance of 40 m. How much work is done by the motor and its cable during this process?

(1) -4×10^5J (2) $+4 \times 10^5$J (3) $+8 \times 10^5$J (4) $+6 \times 10^4$J (5) -8×10^5J

9. A 10^3kg auto skids 20 m along a horizontal surface before friction brings it to rest. The coefficient of kinetic friction is 0.7. What is the auto's initial speed in m/s?

(1) 16.6 (2) 12.1 (3) 19.8 (4) 25.6 (5) 38.9

10. A baseball bat hits a stationary rock and exerts a force of 1000 N on it for 0.1 s. The kinetic energy of the rock is 1000 J after the hit. What is the rock's mass?

(1) 5 kg (2) 4 kg (3) 3 kg (4) 2 kg (5) 1 kg

11. An auto is observed to travel around a circular track without skidding. The radius of the track is 100 m and the auto makes one revolution in 20 s. What is the minimum value of the static coefficient of friction of the road?

(1) 1 (2) 0.4 (3) 0.6 (4) 0.2 (5) 1.2

12. An automobile decelerates uniformly to rest from 30 m/s in 4 s. The radius of the tires is $\frac{1}{3}$m. What is the magnitude of the angular acceleration of the wheels during the process?

(1) 22.5 s^{-2} (2) 28.6 s^{-2} (3) 18.3 s^{-2} (4) 13.25 s^{-2} (5) 2.6 s^{-2}

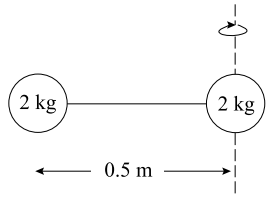
13. A wheel of radius $\frac{1}{3}$m spins up uniformly from rest. After 6 s it has an angular velocity of 9 rad/s. What is the magnitude of the total acceleration, in m/s, of a point on the rim of the wheel at that moment?

(1) 27 (2) 22 (3) 18 (4) 14 (5) 7

14. Satellites A and B are in circular orbits around Earth. The radii R_A and R_B of the satellite orbits satisfy $R_B/R_A = 3$. Satellite A makes one orbit in 3 hours. How much time in hours is required for satellite B to make one orbit?

(1) 15.6 (2) 12.1 (3) 20.7 (4) 26.9 (5) 33.3

15. A dumbbell consists of 2 masses, each of 2 kg, separated by 0.5 m. The dumbbell rotates about an axis through one of the masses as shown. The dumbbell is spun up from rest by application of a torque $T = 10\text{Nm}$ to the other mass. What is the angular velocity of rotation of the dumbbell after 10 s?



(1) 200 s^{-1} (2) 400 s^{-1} (3) 500 s^{-1} (4) 300 s^{-1} (5) 100 s^{-1}

16. A thin bicycle tire of radius $\frac{1}{3}$ m and mass 2 kg is spun up from rest with a constant angular acceleration of 0.5 rad/s^2. What is the wheel's kinetic energy after 5 s?

(1) 0.7 J (2) 0.9 J (3) 0.5 J (4) 0.3 J (5) 0.1 J

THE FOLLOWING QUESTIONS, NUMBERED IN THE ORDER OF THEIR APPEARANCE ON THE ABOVE LIST, HAVE BEEN FLAGGED AS CONTINUATION QUESTIONS: 2