Midterm Exam 03 (2018 Fall)

PHYS 203A-002: College Physics

Date: 2018 Nov 13

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(Name)   (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat numbers divisible by 3.

2. Total time = 75 minutes.

3. There are 8 questions in this exam.

4. Equation sheet is provided separately.

5. To be considered for partial credit you need to show your work in detail and organize it clearly.

6. A simple calculator (with trigonometric functions) is allowed.

7. Use of mobile phones is strictly prohibited. It should stay out of reach during the exam.

1. (**10 points.**) It takes $125\,\mathrm{kJ}$ of work to accelerate a car from $20.0\,\mathrm{m/s}$ to $30.0\,\mathrm{m/s}$. What is the car's mass?

2. (**10 points.**) Consider a mass of 25 kg being pulled by a force $F_{\text{pull}} = 80.0\,\text{N}$, exerted horizontally, such that the mass moves on a horizontal frictionless surface.

(a) Identify all the forces acting on the mass.

(b) Calculate the work done by the normal force while the mass has moved a horizontal distance $d = 10.0\,\text{m}$ starting from rest.

(c) Calculate the work done by the gravitational force while the mass has moved a horizontal distance $d = 10.0\,\text{m}$ starting from rest.

(d) Calculate the work done by F_{pull} while the mass has moved a horizontal distance $d = 10.0\,\text{m}$ starting from rest.

(e) Determine the change in kinetic energy of the mass while the mass has moved a horizontal distance $d = 10.0\,\text{m}$ starting from rest.

3. (**10 points.**) A slingshot fires a pebble from the top of a building at a speed of $10.0\,\text{m/s}$ at an arbitrary angle with respect to the horizontal. The building is $30.0\,\text{m}$ tall above ground. Ignore air resistance.

   (a) Identify all the forces acting on the pebble while it is in the air before hitting the ground.

   (b) Determine the speed with which the pebble strikes the ground.

4. (**10 points.**) A person of mass $90.0\,\text{kg}$ standing on a frictionless surface shoots an arrow of mass $20.0\,\text{g}$ horizontally. If the arrow is shot at $60.0\,\text{m/s}$, determine the recoil speed of the person.

5. (**10 points.**) A basketball moving with $5.0\,\text{m/s}$ has a elastic head-on collision with a tennis ball moving with $5.0\,\text{m/s}$ in the opposite direction to that of the basketball. The basketball is ten times heavier than the tennis ball. Determine the velocity of the basketball and the tennis ball after the collision.

6. (**10 points.**) John's mass is $80.0\,\text{kg}$, and Barbara's is $60.0\,\text{kg}$. John is standing on the x axis at $x_J = +10.00\,\text{m}$, while Barbara is standing on the x axis at $x_B = +2.00\,\text{m}$. They switch positions. How far and in which direction does their center of mass move as a result of the switch?

7. (**10 points.**) A motorcycle accelerates uniformly from rest and reaches a linear speed of 24.0 m/s in a time of 8.00 s. The radius of each tire is 0.300 m. What is the magnitude of the angular acceleration of each tire?

8. (**10 points.**) The center of mass of a person may be determined by an arrangement shown in Figure 1 below. A light (massless) plank rests on two scales separated by a distance equal to the height $h = 1.80\,\text{m}$ of the person. The scales that measure the normal forces read $N_1 = F_{g1} = 550.0\,\text{N}$ and $N_2 = F_{g2} = 330.0\,\text{N}$. Determine the distance of the girl's center of mass from her feet.
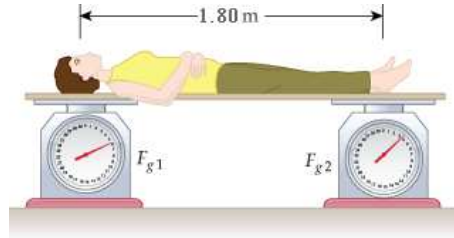

Figure 1: Center of mass.