Midterm Exam 03 (2021 Fall)

PHYS 203A-002: College Physics

Date: 2021 Nov 4

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(Name)   (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat numbers divisible by 4.

2. Total time = 75 minutes.

3. There are 9 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. (**5 points.**) A $75\,\mathrm{kg}$ mass is resting on the floor of an elevator that is speeding up at $2.0\,\mathrm{m/s^2}$ while moving upward. Is the work done by the normal force zero in this case? Explain.

2. (**5 points.**) You start from your car in a parking lot, walk to the Neckers building, use the North staircase to reach the classroom in Neckers 440, attend the lecture, use the West staircase to climb down, and return back to the car. What is the total work done by the gravitation force on you during the round trip?

3. (**5 points.**) A ball bounces of the wall. The ball's speed before hitting the wall was 5.0 m/s. It bounces off after collision with the same speed in the opposite direction. Determine the total impulse acting on the ball. The mass of the ball is 50.0 g.

4. (**5 points.**) Distinguish between a perfectly rolling wheel on a highway, a wheel sliding on an icy road, and a wheel slipping on a road covered with snow. In particular, report the relation between linear velocity and angular velocity in these cases.

5. (**10 points.**) A roller coaster of mass $m = 500.0\,\mathrm{kg}$ moves on the curve described in Figure 1. Assume frictionless surface. Given that it is moving with speed $8.0\,\mathrm{m/s}$ at point C and is moving with speed $12\,\mathrm{m/s}$ at point E, determine the work done by the gravitational force on the roller coaster between C and E.
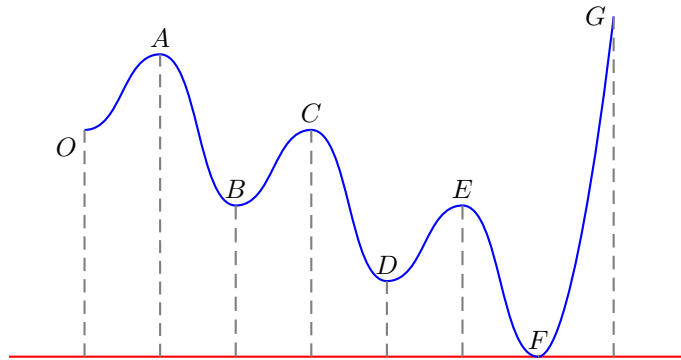

Figure 1: Problem 5

6. (**10 points.**) A shooter of mass $75\,\text{kg}$ shoots a bullet of mass $5.00\,\text{g}$ horizontally while standing on a frictionless surface at rest. If the muzzle velocity of the bullet is $600.0\,\text{m/s}$, what is the recoil speed of the shooter?

7. (**10 points.**) A $25\,\text{kg}$ mass moving with a speed $4.0\,\text{m/s}$ (elastically) collides with a $75\,\text{kg}$ mass initially at rest. Determine the magnitude and direction of the final velocities of the masses after collision.

8. (**10 points.**) Where is the center of mass of Earth-Moon system? Given radius of Earth is 6.4×10^6 m, radius of Moon is 1.7×10^6 m, mass of Earth is 6.0×10^{24} kg, mass of Moon is 7.4×10^{22} kg, and distance between Earth and Moon is 3.84×10^8.

9. (**10 points.**) A motorcycle accelerates uniformly from rest and reaches an angular speed of $75.0 \, \text{rad/s}$ in a time of $8.00 \, \text{s}$. The radius of each tire is $0.300 \, \text{m}$. What is the magnitude of the angular acceleration of each tire?