Physics 235, Midterm Exam # 3

December 4, 2018: 8.00 am - 9.30 am

Do not turn the pages of the exam until you are instructed to do so.

Exam rules: You may use *only* a writing instrument while taking this test. You may *not* consult any calculators, computers, books, nor each other.

Problems 1 and 2 must be answered in exam booklet 1. Problems 3 and 4 must be answered in exam booklet 2. The answers need to be well motivated and expressed in terms of the variables used in the problem. You will receive partial credit where appropriate, but only when we can read your solution. Answers that are not motivated will not receive any credit, even if correct.

At the end of the exam, you need to hand in your exam, the blue exam booklets, and the equation sheet. All items must be clearly labeled with your name, your student ID number, and the day/time of your recitation. **If any of these items are missing, we will not grade your exam, and you will receive a score of 0 points.**

You are required to complete the following *Honor Pledge for Exams*. Copy and sign the pledge before starting your exam.

"I affirm that I will not give or receive any unauthorized help on this exam, and that all work will be my own."

____

____

____

Name: ____

Signature: ____


Good Luck !

PROBLEM 1 (25 POINTS) **ANSWER IN BOOK 1**

Consider a projectile, launched vertically upward to a height h above the Earth's surface at a Southern latitude λ.

a. Define the rotating coordinate system (x, y, z) in which you will view the motion of this projectile.

b. Determine the acceleration of the projectile as function of time. Specify the components of the acceleration along the three coordinate axes of your rotating coordinate system; make sure to include the sign of the acceleration to fully specify the direction of the acceleration.

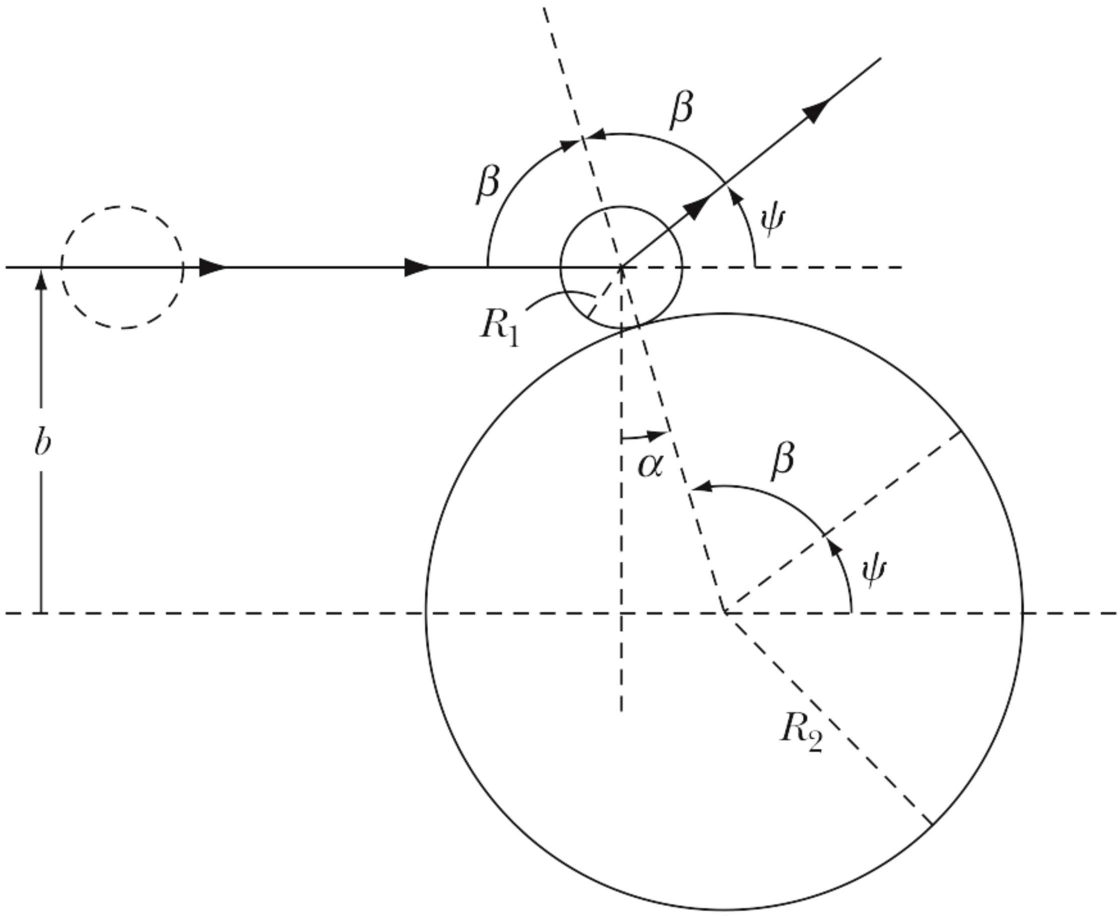
c. How far from its launch position does the projectile hit the ground? Specify the magnitude of the displacement and the direction (N, NE, E, SE, S, SW, W or NW)?

Neglect air resistance and consider only small vertical heights h. The rotational velocity of the Earth around its axis is ω.

Your answers must be well motivated and expressed in terms of the variables provided.

PROBLEM 2 (25 POINTS) **ANSWER IN BOOK 1**

Consider a particle of radius R_1 moving toward the right with a velocity v and scattering from a dust particle of radius R_2, initially at rest. The angles used to describe the scattering process are shown in the Figure below. Consider both particles to be hard spheres.



a. Particles with impact parameter b will scatter at an angle ψ. What is the impact parameter b for a given scattering angle ψ?

b. What is the range of impact parameters db that scatter into angular range $d\psi$?

c. What is the differential scattering cross section $\sigma(\psi)$?

d. Integrate the differential scattering cross section over all possible scattering angles to find the total cross section.

Your answers must be well motivated and expressed in terms of the variables provided.

PROBLEM 3 (25 POINTS) **ANSWER IN BOOK 2**

A communication satellite is in a circular orbit of radius R around the earth. Its velocity is v. Its engine accidentally fires, giving the satellite an outward radial velocity v in addition to its original orbital velocity.

a. Calculate the ratio of the new angular momentum to the original angular momentum of the satellite.

b. Calculate the ratio of the new energy and the original energy of the satellite.

c. Describe the subsequent motion of the satellite.

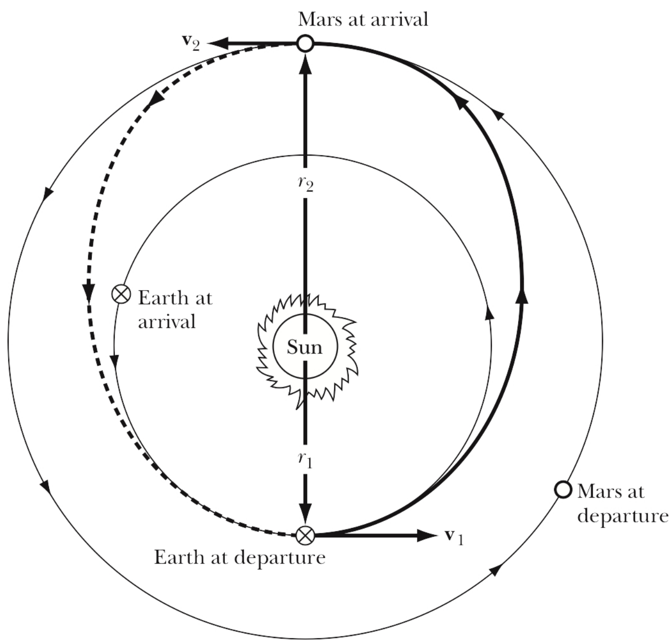
d. Make a sketch of the kinetic energy $T(r)$, the potential energy $U(r)$, and total energy $E(r)$ after the engine fires, as function of r.

Note: for a circular orbit, $T = - U/2$.

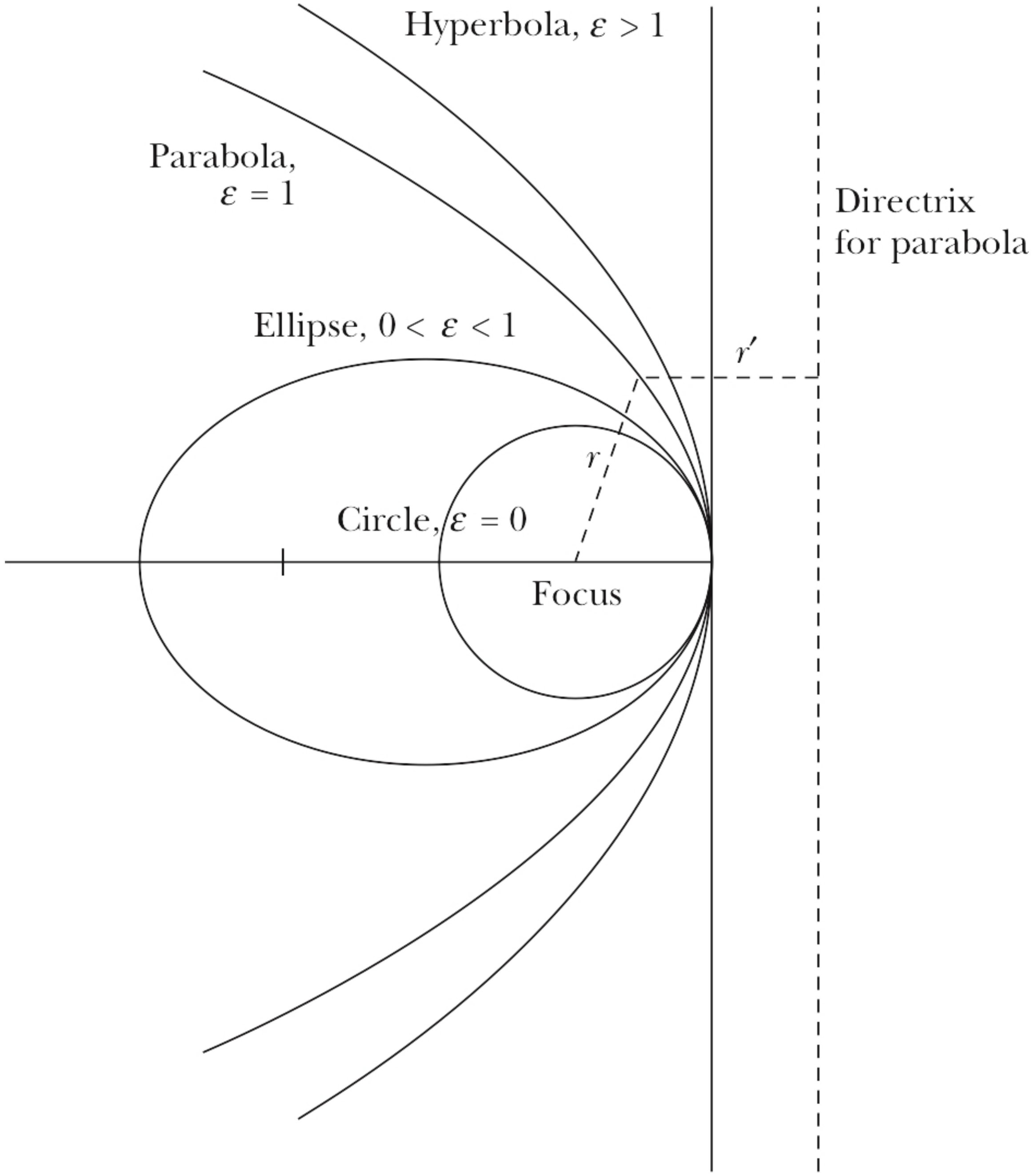
Your answers must be well motivated and expressed in terms of the variables provided.

PROBLEM 4 (25 POINTS) **ANSWER IN BOOK 2**

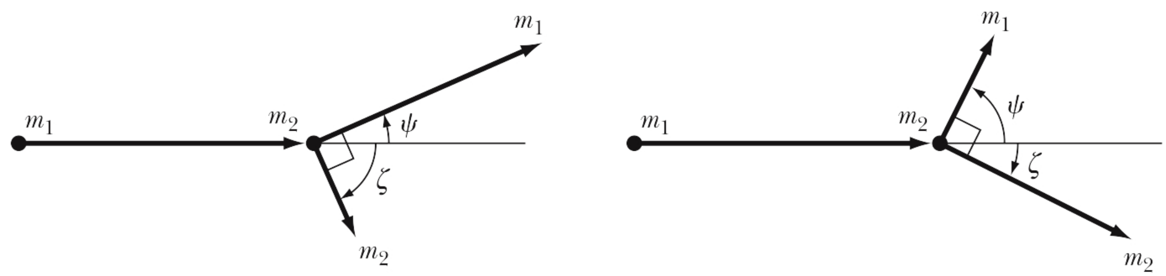
a. Consider the Hofman transfer to travel to Mars. What quantity is minimized if we use this method to travel Mars?



b. Which of the following four orbits corresponds to a system for which the total energy $E = 0$?

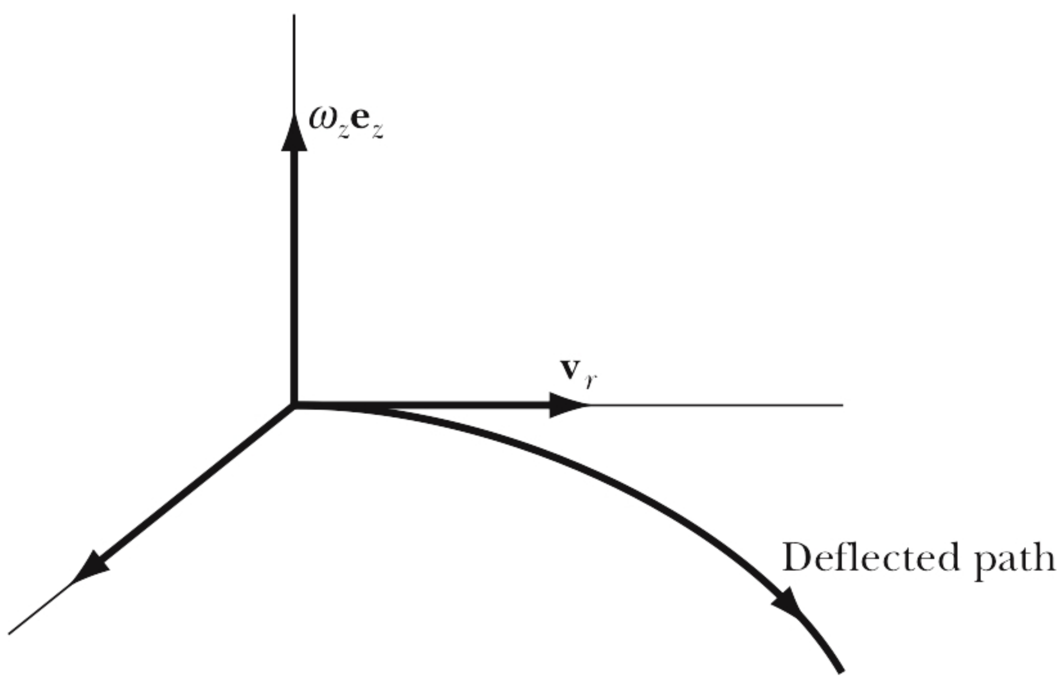


c. Consider the elastic scattering of two particles with mass m_1 and m_2. Mass m_2 is initially at rest in the laboratory system. It is observed that after the collision, the two masses travel at right angles with respect to each other. Two possibilities are shown in the Figure below.



Based on the information provided, what can you say about the two masses?

d. Consider the motion of a particle projected in a horizontal plane. We see that the particle is deflected toward the right of the particle's motion, as shown in the Figure below.



Are we on the Southern or on the Northern hemisphere when we make this observation.

e. What is correct in this image? What is not correct in this image?