

Physics 262: Problem Set #4

These problems are due by the end of the day on Friday, Jan. 30 in the graders' box.

NOTE: For each problem, your solution should begin with a brief statement of the problem, i.e. a description of the setup, including a list of the inputs and the goal.

1. BTM 8.2.1, 8.2.2 and 8.2.3 p. 213-4.
2. Morin 8.55 (Block and cylinder) p. 344
3. Morin 8.70 (Not hitting the pole) p. 347
4. Morin 7.12 (Falling in to the sun) p. 298
5. Morin 7.13 (Intersecting orbits) p. 299
6. Practice in dimensional analysis. Consider a satellite of mass m in a circular orbit of radius r about the earth. Noting that the input parameters are m , r and the constant GM , for each of the following quantities, use dimensional analysis to find the dependence on the radius r of the orbit. That is, for each quantity find the powers α , β and γ so that $r^\alpha m^\beta (GM)^\gamma$ has the appropriate units, and report your result for α in particular.
 - (a) period
 - (b) kinetic energy
 - (c) angular momentum
 - (d) speed
7. Morin 7.20 (Ellipse axes) p. 300
8. Halley's comet is in an elliptical orbit about the sun with $\epsilon = .967$ and a period $T = 76$ years.
 - (a) What is its distance from the sun at perihelion (closest approach) and at aphelion (the maximum distance).
 - (b) What is the speed of the comet at perihelion?
9. (a) A satellite of mass m is in circular orbit about a planet of mass M at radius r_0 . Find the total mechanical energy E_0 .

- (b) Now suppose the thin atmosphere of the planet causes the satellite experiences a weak drag force f (assumed to be constant). At any instant the orbit is approximately circular, but the radius will gradually decrease as the satellite slowly spirals in. If the current radius is r after one revolution the new radius is $r + \Delta r$. Find Δr .
- (c) Find the approximate change in kinetic energy per revolution, ΔK . (Note: K increases!)
10. (BONUS) A space vehicle is in circular orbit about the earth. The mass of the vehicle is $m = 3000\text{kg}$ and the radius is $2R$ where R is the radius of the earth. it is desired to transfer the vehicle to a circular orbit of radius $4R$.
- (a) What is the minimum energy expenditure required?
- (b) Suppose this maneuver is accomplished by using “Hohmann transfer” orbit, i.e. a brief rocket burn (in the tangential direction) increases v_θ enough to change the orbit from circular to an ellipse with perigee $2R$ and apogee $4R$. Then just when it reaches apogee, a second tangential burn changes the orbit to the desired circle. What are the changes in v_θ required in the two brief burns?