

1. The tip of the second hand on a certain clock moves along a circular path with a radius of 15.00 cm.
 - a. Use the known period and radius to calculate the speed of the tip in SI units.
 - b. Show that the tip has a centripetal acceleration of roughly 10^{-3} m/s^2 . Express that acceleration in scientific notation. Round off properly, keeping all four significant digits.
 - c. Write the formula with which that acceleration was calculated from the period and path radius.
 - d. Have you simplified that formula and defined each symbol in it? ____ -Have you checked units? ____
 - e. Does 1c agree with 1b? ____ A copy of equaton 1c has been saved in # __ on RS__ .

2. If there were no atmosphere to slow it, we could throw a ball fast enough to put it into an orbit only a few feet above the ground. Its centripetal acceleration would be caused by the force called _____.
 - a. According to # 15 on RS I, the magnitude of its acceleration would be _____
 - b. If the orbit is much higher then its acceleration must be _____ than the one in 2a, as on page 61b.
 - c. Show how the speed required for the low earth orbit in 2a can be calculated from the planet's radius and gravitational field strength. Remember to define your symbols.
 - d. Using scientific notation and SI units, the earth's radius is _____ .
Copy it from a book and give credit to your source. -This radius value has ____ significant digits.
 - e. Use 2a, 2c, and 2d to calculate the speed required for such an orbit around the earth. _____
 - * f. Calculate the period of such a satellite. *Show* how you do it. Remember to round off properly.
 - g. If you did 2e and 2f then you know how to use an orbit radius and gravitational field strength to predict the period of an orbit. Write that formula in its simplest form so that it has no unnecessary exponents or repetition of symbols. See if the units balance. See if it agrees with 2f. $P = \underline{\hspace{2cm}}$

3. When Juan Valdez stands with his burro in the equatorial highlands of Colombia, he is travelling along a circular path because the earth is rotating. In #7 on page 25 we found that his speed is _____ mph.
 - a. His speed is _____ the speed of the satellite in #2. (greater than, less than, equal to)
 - b. Describe the directions of the two forces acting on him and name the object which exerts each one.
 - c. What law relates the total force on such a person to his mass and acceleration? ____ = _____
 - d. Which of the two forces mentioned in 3b must be the stronger one? _____
 - e. Show how his acceleration is calculated from his known period and path radius. (Use 3a on RS VII.)
 - f. The ____ward force mentioned in 3b must be about ____% stronger than the ____ force. * *Explain.*

4. Use the hints and clues below to figure out how strong a simple pendulum's string needs to be:
 - a. Obviously the answer must be expressed in _____. (SI unit)
 - b. Obviously it depends on the _____ of the bob, the _____ of the string, the maximum speed of the swinging motion, and the strength of the local _____al field. (Increasing "g" must ____crease it.
 - c. The _____ conservation principle helps us find the maximum speed of the bob, as on page 63.
 - d. Calculate the maximum tension of a rope with a 100-lb. child swinging on it with a 90° amplitude.

5. A rock thrown diagonally upward lands at its original altitude 2.2 sec. later, 18 m east from the place where it was released. Sketch the its trajectory and the two velocity vs time graphs which describe its motion. Please *show* how answers to the following questions are obtained:
 - a. How long does it take for the rock to reach the highest point in its trajectory?
 - b. Determine the vertical and horizontal components of its initial velocity, and its initial speed.
 - c. Describe the direction of its initial velocity in the manner that you were taught on page 34R.
 - d. Describe the rock's impact velocity and its final displacement in similar fashion.

6. Suppose I gave you the initial values of the rock's horizontal and vertical velocity components instead of the flight time and distance. Show how could you use those clues to figure out:
 - a. -how high the rock would go. b. -how much time it would spend in the air.
 - c. -how far it goes horizontally before returning to its inital altitude.

7. Draw tangent lines at the starting and ending points of the trajectory sketched in #5.
 - a. How must their slopes compare, if air drag can be ignored?
 - b. How does the height of their intersection point compare with the maximum height of the projectile?
 - c. Is that ratio the same for all simple trajectories? ____ *Prove it.* (See 6d on page 72.)

1. When a car is driven along a circular path on a level surface its centripetal ("lateral") acceleration is caused by a lateral (sideways) friction force exerted on the tires by the pavement. The maximum possible lateral acceleration is typically around 0.75 to 0.8 g. Use that information to predict the minimum possible turning radius for such a car at 56 mph. (The hints below may help.)
 - a. Solve the centripetal acceleration formula (3b on RS VII) for the unknown: $R = \underline{\hspace{2cm}}$
 - b. Before plugging in the given data we must convert to SI. (Otherwise we'll get an result with crazy units.) We found in Ch. II that 56 mph = $\underline{\hspace{2cm}}$ m/sec. (That's on RS II if your ink did not disappear.)
 - c. We discovered in Ch. I that on *this* planet the acceleration caused by gravity (known as "g") is about $\underline{\hspace{2cm}}$, so the given acceleration of 0.75g is equivalent to about $(0.75)(\underline{\hspace{2cm}}) = \underline{\hspace{2cm}}$.
 - d. Show how 1a is used to calculate the turning radius in range form. Remember to round off properly.
2. Exactly how will that minimum turning radius be affected if we double the following quantities?
 - a. the mass of the car: $\underline{\hspace{2cm}}$
 - b. the speed of the car: $\underline{\hspace{2cm}}$
 - c. the gravitational field strength: $\underline{\hspace{2cm}}$
 - d. the friction coefficient: $\underline{\hspace{2cm}}$
3. It's easy to create a general formula for predicting a car's minimum turning radius:
 - a. Newton's second law says we can replace the "a" in the turning radius formula (1a) with $\underline{\hspace{2cm}}$. Remember to simplify the result: $R = \underline{\hspace{2cm}}$
 - b. Using the definition of "friction coefficient" (on RS III) we can replace the "TF" in equation 3a with $\underline{\hspace{2cm}}$. Then $R = \underline{\hspace{2cm}}$. (As usual, the letter μ represents the friction coefficient.)
 - c. Using #8 on RS III, we can replace the "normal force" in that equation with the formula, " $\underline{\hspace{2cm}}$ ".
 - d. After making all of those substitutions and simplifying the result we have a formula for turning radius in terms of driving speed, friction coefficient, and "g": $R = \underline{\hspace{2cm}}$. Does #2 agree with 3d? $\underline{\hspace{2cm}}$
-Do the units balance? $\underline{\hspace{2cm}}$ *If not, please explain why you decided not to correct your mistake.*
 - e. How does the minimum turning radius compare with the minimum stopping distance?
4. A level highway with turns as sharp as the one calculated in #1 would be rather dangerous because the friction coefficient can be reduced drastically by changes in the weather. One way to overcome that problem is to "bank" the turns. That means tilting the road surface so that the downhill direction is toward the center of the circle. The pavement then forms part of a conical surface. The axis of that cone is $\underline{\hspace{2cm}}$ al. (horizontal, vertical, radial, diagonal, centripetal)
 - a. Draw a diagram showing the car on the tilted road surface, as seen from the *front*. Include the axis.
 - b. Draw an arrow on the car to represent the gravitational force acting on it. Draw another arrow on the car to represent the normal force exerted on the car by the "banked" pavement. Label both arrows.
 - c. The plane of the circular path is still $\underline{\hspace{2cm}}$ al, as it was in #1. (horizontal, vertical)
 - d. The direction of the car's acceleration must therefore be $\underline{\hspace{2cm}}$ al.
 - e. That can happen only if the total $\underline{\hspace{2cm}}$ acting on the car is $\underline{\hspace{2cm}}$ al.
 - f. The $\underline{\hspace{2cm}}$ al component of the normal force exerted by the road on the car acts as a centripetal force, so that $\underline{\hspace{2cm}}$ friction is required from the tires. (more, less)
 - g. If the tilt is just right then no friction is needed. (You can then *slide* around the turn on an icy day without going off the road.) Using 4e, draw the vector sum of the two forces acting on the car in that case. Label the angle in that triangle which is equal to the inclination angle, just as we did on p. 36.
 - h. Using #5 on RS VII, express TF in terms of m, v, and R:
 - i. Using 4e and 4g, express TF in terms of mg and the inclination angle:
 - j. The two expressions in 4h and 4i must be equal because they both represent the same TF. Solve that equation for the unknown and use 1a to simplify it. Then plug in the data given in #1 to find out how much we must bank the road to eliminate any need for friction at 56 mph. *Round off properly.*
5. A person in a cylindrical space craft on its way to Jupiter enjoys an artificial gravity of 6.00 N/kg created by spinning the cylinder about its axis. (Some people would say that she is "held against the outer walls by centrifugal force", but we know better.) The ship's radius is 8.00 meters.
 - * a. Use #7 on RS VII to show that the spin rate must be approximately 0.1 rotations per second.
Use the given data to calculate it with three significant digits, and show how you do it.
 - * b. Explain how a person with good legs can determine which way the ship is spinning without any instruments or observations outside. (Clues: What do active people do with their legs? What effects might such activity have on the centripetal force? What does the centripetal force feel like?)
 - * c. Describe a really neat trick that you could do in such a spacecraft but not in a real gravitational field.