Physics 5A Final Review Problems

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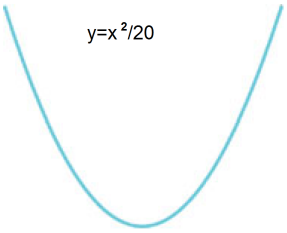
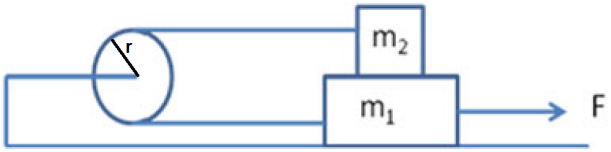
1. A stone is dropped into the water from a tower 44.1m above the ground. Another stone is thrown vertically down 1.0 s after the first one is dropped. Both the stones strike the ground at the same time. What was the initial velocity of the second stone?

2. A uniform chain of length L lies on a table. If the coefficient of friction is μ, what is the maximum length of the part of the chain hanging over the table such that the chain does not slide?

3. A block is placed on a ramp of parabolic shape given by the equation $y = x^2/20$. If $\mu_s = 0.5$, what is the maximum height above the ground at which the block can be placed without slipping? If we suddenly turned off friction how fast would the block be moving at the lowest point of parabola.



4. Two blocks with masses m_1 and m_2 are attached by an unstretchable string around a frictionless pulley of radius r and moment of inertia I . Assume that there is no slipping of the string over the pulley and that the coefficient of kinetic friction between the two blocks and between the lower one and the floor is identical. If a horizontal force F is applied to m_1, calculate the acceleration of m_1

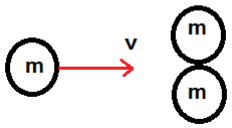


5. The potential energy of an object is given by

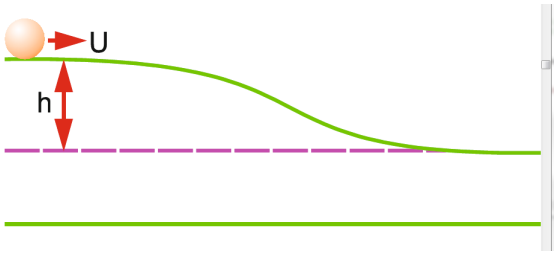
$$U(x) = 5x^2 - 4x^3$$

where U is in joules and x is in meters.
(i) Sketch the potential function and force function.
(ii) What is the force, $F(x)$, acting on the object?
(iii) Determine the positions where the object is in equilibrium and state whether they are stable or unstable.

6. Two billiard balls are resting on a smooth table, and just touching. A third identical ball moving along the table with velocity v perpendicular to their line of centres strikes both balls simultaneously. Find the velocities of the three balls immediately after impact, assuming that the collision is elastic.



7. A disc rolls without slipping along a horizontal surface with velocity u. The disc then encounters a smooth drop of height h, after which it continues to move with velocity v. At all times the disc remains in a vertical plane. Determine the value of v in terms of g, h and u.



8. Consider a point mass m with momentum p rotating at a distance r about an axis. Starting from the definition of the angular momentum $L \equiv r \times p$ of this point mass, show that

$$\frac{dL}{dt} = \tau$$

where τ is the torque.

9. A uniform rod of length l and mass M rests on a frictionless horizontal surface. The rod pivots about a fixed frictionless axis at one end. The rod is initially at rest. A bullet of mass m travelling parallel to the horizontal surface and perpendicular to the rod with speed v strikes the rod at its centre and becomes embedded in it. Using the result of the previous question, show that the angular momentum of the rod after the collision is given by

$$|L| = \frac{l}{2}mv$$

(i) Is $\vec{L} = (l/2)m\vec{v}$ also correct?
(ii) What is the final angular speed of the rod?
(iii) Assuming $M = 5m$, what is the ratio of the kinetic energy of the system after the collision to the kinetic energy of the bullet before the collision?

10. Where is the center of mass of the SunJupiter system? (The mass ratio is $M_S/M_J = 1047$. Through what angle does the Suns position as seen from the Earth oscillate because of the gravitational attraction of Jupiter? The distance from earth to the sun is $1AU = 1.5 \times 10^{11}m$, and the jupiter sun sun distance is $R_{j-s} = 5.2AU$.

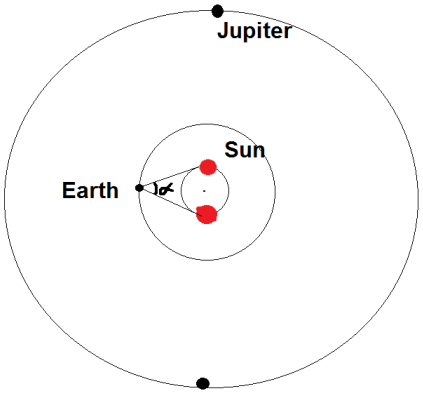


Figure 1: The angle α is what question is asking for. This is oversimplified case of whats actually going on, in real life we would have to use pertubation theory.

11. A rocket of mass 1000Mg (= 1 mega gram=$10^6 kg$) has an upward acceleration equal to 0.5g . How many kilograms of fuel must be ejected per second at a relative speed of $2000\frac{m}{s}$ to produce the desired acceleration?

12. An object A moving with velocity v collides with a stationary object B. After the collision, A is moving with velocity $\frac{1}{2}v$ and B is moving with velocity $\frac{3}{2}v$. (a) Find the ratio of masses. (b) If the masses stuck together what velocity would they have after colliding?

1 Challenge Problem!

13. Three perfectly elastic bodies of masses 5 kg, 1kg, 5kg are arranged in that order on a straight line, and are free to move along it. Initially, the middle one is moving with velocity $27\frac{m}{s}$, and the others are at rest. Find how many collisions take place in the subsequent motion, and verify that the final value of the kinetic energy is equal to the initial value.