F=ma Problem Set: Easy

TJPT Officers

December 2015

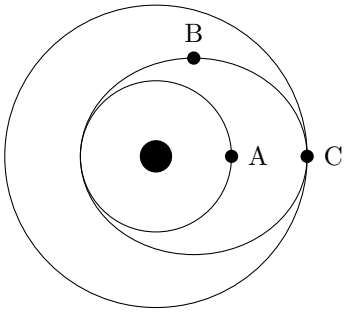
This problem set will be the first part of a series of problem sets that will focus on preparing you for the F=ma exam. This set in particular will be focused on giving problems that would be reminiscent of problems that would appear on the first 15 problems of the F=ma exam. These problems will largely be derived from past F=ma exam problems, but other problems may appear. As usual, do them to the best of your ability and if you can solve all of these problems you are well on your way to qualify for the semifinalist exam! If you have any questions, please email us at **tjhsstphysicsteam@gmail.com**.

1. (F=ma 2012) A cannonball is launched with initial velocity of magnitude v0 over a horizontal surface. At what minimum angle $\theta_{\min}$ above the horizontal should the cannonball be launched so that it rises to a height H which is larger than the horizontal distance R that it will travel when it returns to the ground?

2. (F=ma 2011) A crude approximation is that the Earth travels in a circular orbit about the Sun at constant speed, at a distance of 1.5×10^8 km from the Sun. Which of the following is the closest for the acceleration of the Earth in this orbit?

   (A) exactly $0\,\mathrm{m/s^2}$
   (B) $0.006\,\mathrm{m/s^2}$
   (C) $0.6\,\mathrm{m/s^2}$
   (D) $6\,\mathrm{m/s^2}$
   (E) $10\,\mathrm{m/s^2}$

3. (F=ma 2009 #5) Three equal mass satellites A, B, and C are in coplanar orbits around a planet as shown in the figure. The magnitudes of the angular momenta of the satellites as measured about the planet are L_A, L_B, L_C. Which of the following statements is correct?



   (A) $L_A > L_B > L_C$
   (B) $L_C > L_B > L_A$
   (C) $L_B > L_C > L_A$
   (D) $L_B > L_A > L_C$
   (E) The relationship between the magnitudes is different at various instants in time.

4. (F=ma 2010) A car attempts to accelerate up a hill at an angle θ to the horizontal. The coefficient of static friction between the tires and the hill is $\mu > \tan\theta$. What is the maximum acceleration the car can achieve (in the direction upwards along the hill)? Neglect the rotational inertia of the wheels.

5. (F=ma 2008) A uniform round tabletop of diameter 4.0 m and mass 50.0 kg rests on massless, evenly spaced legs of length 1.0 m and spacing 3.0 m A carpenter sits on the edge of the table. What is the maximum mass of the carpenter such that the table remains upright? Assume that the force exerted by the carpenter on the table is vertical and at the edge of the table.

6. (F=ma 2007) When the speed of a rear-drive car is increasing on a horizontal road, the direction of the frictional force on the tires is

   (A) backward on the front tires and forward on the rear tires.

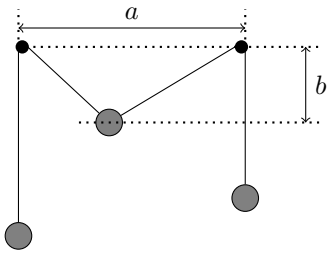
   (B) forward on the front tires and backward on the rear tires.

   (C) forward on all tires.

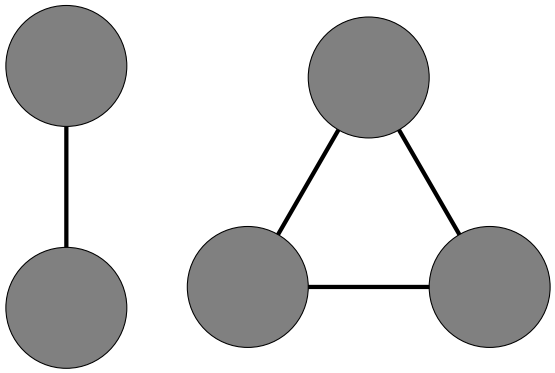
   (D) backward on all tires.

   (E) zero.

7. (F=ma 2010) The three masses shown in the accompanying diagram are equal. The pulleys are small, the string is lightweight, and friction is negligible. Assuming the system is in equilibrium, what is the ratio a/b? The figure is not drawn to scale!



8. You are given a large collection of identical heavy balls and lightweight rods. When two balls are placed at the ends of one rod and interact through their mutual gravitational attraction (as is shown on the left), the compressive force in the rod is F. Next, three balls and three rods are placed at the vertexes and edges of an equilateral triangle (as is shown on the right). What is the compressive force in each rod in the latter case in terms of F?



9. Poiseuille's law determines the flow rate of a liquid F (in m^3/s) in terms of the parameters of a pipe. If P_1 and P_2 are the pressures on either side of the pipe, L is the length, r is the radius, and η is the viscosity (in $\mathrm{kg\,m^{-1}\,s^{-1}}$), the flow rate is given by

$$F = k\frac{(P_1 - P_2)r^\alpha}{\eta L},$$

   where k is a dimensionless constant and α is some integer power. Determine α.