University Physics I

Homework Set 6

1. As of 2018, the fastest car in the world is the Hennessey Venom F5, which can reach a top speed of 301 *mph*. If the weight of the car is 3000 *lbs*:
   a. What is its weight in Newtons?
   b. What is its mass in kilograms?

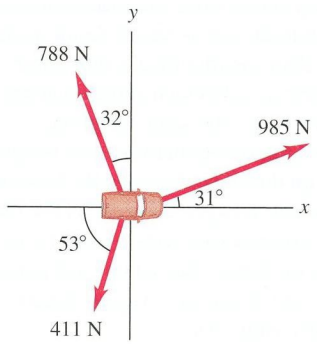
2. What would be the weight of the Hennessey Venom F5 in Newtons on Jupiter, where the free-fall acceleration is 25.9 m/s^2?

3. A 3.00 *kg* object undergoes an acceleration given by $\vec{\boldsymbol{a}} = 2.00\,\hat{\boldsymbol{x}} + 5.00\,\hat{\boldsymbol{y}}$ (m/s^2). Find
   a. The resultant force acting on the object.
   b. The magnitude of the resultant force.

4. The distinction between *mass* and *weight* was discovered after Jean Richer transported pendulum clocks from Paris, France, to Cayenne, French Guiana, in 1671. He found that the clocks systematically ran slower in Cayenne than in Paris. If a 90 *kg* person made the same trip, how much weight would they lose in traveling from Paris ($g = 9.8095\ m/s^2$) to Cayenne ($g = 9.7808\ m/s^2$)?

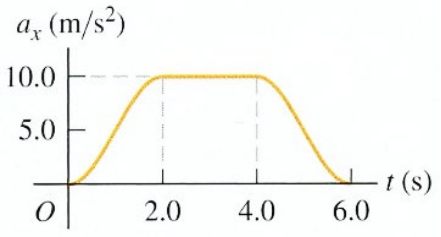
5. A 423.5 N force accelerates a go-cart and its driver from 10.4 *m/s* to 17.9 *m/s* in 5.00 *s*. What is the mass of the go-cart plus driver?

6. To extricate an SUV stuck in the mud, workmen use three horizontal ropes, producing the force vectors shown in the figure at right.
   a. Find the F_x and F_y components of each force.
   b. Find the net force on the SUV in component form.
   c. Find the magnitude and direction of the net force.

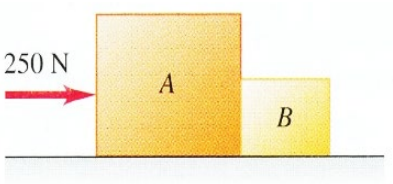


7. World-class sprinters can accelerate out of the starting blocks with an acceleration that is nearly horizontal and has a magnitude of 15 m/s^2.
   a. How much horizontal force must a 55 *kg* sprinter exert on the starting blocks to produce this acceleration?
   b. Which body exerts the force that propels the sprinter: the blocks or the sprinter? Explain.

8. ** A 4.50 *kg* experimental cart undergoes an acceleration in a straight line (the *x*-axis). The graph at right shows this acceleration as a function of time.
   a. Find the maximum net force on this cart.
   b. When does the maximum net force occur?
   c. When is the net force on the cart constant?
   d. When is the net force equal to zero?



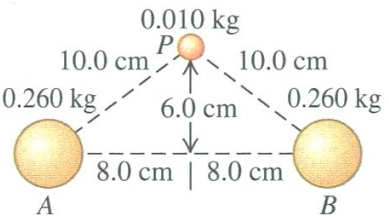
9. Boxes A and B are in contact on a horizontal, frictionless surface as shown in the figure at right. Box A has mass 20.0 *kg* and box B has mass 5.0 *kg*. A horizontal force of 250 N is exerted on box A. What is the magnitude of the force that box A exerts on box B?



10. What is the magnitude of free-fall acceleration (g) of a ball of mass m due to the Earth's gravity at a distance of $2r_e$, where r_e is the radius of the Earth (6370 *km*)? Ignore the rotation of the Earth.

11. A 200 *kg* object and a 500 *kg* object are separated by 4.00 *m*.
    a. Find the net gravitational force exerted by these objects on a 50.0 *kg* object placed midway between them.
    b. At what position between the two masses can the 50.0 *kg* object be placed so as to experience a net force of zero?

12. Two uniform spheres, each of mass 0.260 *kg*, are fixed at points A and B as shown in the figure at right. Find the magnitude and direction of the initial acceleration of a uniform sphere with mass 0.010 *kg* if released from rest at point P and acted on only by forces of gravitational attraction of the spheres A and B.



13. Some of the deepest mines in the world are in South Africa and are roughly 3.5 *km* deep. Consider the Earth to be a uniform sphere of radius 6370 *km*:
    a. How deep (*in km*) would a mine shaft have to be for the gravitational acceleration at the bottom to be reduced by ½ that at the surface? (Assume $\rho_E = 5.5 \times 10^3\ kg/m^3$)

    HINT: Use the density expression $\rho = M/V$ to determine mass as a function of r [M(r)].

    b. What is the value of g at the bottom of the 3.5 *km* shaft?

14. A couple of astronauts agree to rendezvous in space after hours. Their plan is to let gravity bring them together. One of the has a mass of 65 *kg* and the other a mass of 72 *kg* and they start 20 *m* apart. Assuming their acceleration is constant during the motion, how many days would it take for them to meet up?

    NOTE: In truth, as their distances decreased, the force of gravitational attraction between them would increase, making their accelerations increase also. Thus, it would really take less time than you calculate to meet up.