Motion Near the Earth's Surface

1. What would be the force of gravity on a 60.0 kg astronaut if she could stand on the surface of
   (a) Mars (g = 3.72 N/kg)
   (b) Uranus (g = 10.49 N/kg)
   (c) Pluto (g = 0.31 N/kg)

2. A horizontal force is applied to a 2.0 kg block moving on a level table. A force that is one-quarter the force of gravity on the block is required to move it at a constant velocity. Calculate the force necessary to accelerate the moving block from rest to a speed of 3.0 m/s in a time of 4.0 s.

3. A space traveler has landed on the surface of an unknown planet similar to Earth. He drops a small steel ball from the top of his space ship and finds it takes 3.0 s to reach the ground 18 m below. If the force of gravity on the astronaut is 710 N on Earth, how much will it be on the planet?

4. An aerospace scientist has designed a rocket with a mass of 1.0×10^3 kg. He wants it to accelerate straight up with an initial acceleration of 21 m/s^2. What thrust (force) must the rocket engine develop?

5. A rocket of mass 1.0×10^3 kg is being fired to a height of 5.0×10^3 m. The rocket engine shuts off when the rocket reaches a height of 1.0×10^3 m and the rock continues to rise to a height of 5.0×10^3 m.
   (a) Draw a free-body diagram to show the forces acting on the rocket
      (i) while the engine is on
      (ii) after the engine shuts off
   (b) What velocity must the rock have at the 1.0×10^3 m point to enable it to reach a height of 1.0×10^5 m?
   (c) What acceleration did the rocket experience when the engine was
      (i) on?
      (ii) off?
   (d) What force did the engine exert on the rocket?

6. An exceptional vertical jump from rest would raise a person 0.80 m off the ground. To do this, what constant force would a 70.0 kg person have to exert against the ground? Assume that person lowers himself by 0.20 m prior to jumping and remains in a standing position while in the air.

7. A 0.10 g spider is descending on a strand that supports it with a force of 5.6×10^{-4} N. What is the acceleration of the spider? Ignore any air resistance.

8. A 5000 kg helicopter accelerates upwards at 0.50 m/s^2 while lifting a 2000 kg car.
   (a) What is the life force exerted by the air on the rotors?
   (b) What is the tension in the cable that connects the car to the helicopter?

Numerical Answers

1. (a) 223 N
   (b) 629 N
   (c) 18.6 N
2. 6.4 N
3. 290 N
4. 30 800 N
5. (b) 280 m/s
   (c) (i) 39 m/s^2
   (c) (ii) -9.8 m/s^2
   (d) 49 000 N
6. 3430 N
7. -4.2 m/s^2
8 (a) 72 100 N
   (b) 20 600 N