Solutions to Chapter 5 Exercises

2. There are no forces horizontally (neglecting air resistance), so there is no horizontal acceleration, hence the horizontal component of velocity doesn't change. Gravitation acts vertically, which is why the vertical component of velocity changes.

4. The crate will not hit the Camaro, but will crash a distance beyond it determined by the height and speed of the plane.

6. For very slow-moving bullets, the dropping distance is comparable to the horizontal range, and the resulting parabola is easily noticed (the curved path of a bullet tossed sideways by hand, for example). For high speed bullets, the same drop occurs in the same time, but the horizontal distance traveled is so large that the trajectory is "stretched out" and hardly seems to curve at all. But it does curve. All bullets will drop ~ equal distances in equal times, whatever their speed. (It is interesting to note that air resistance plays only a small role, since the air resistance acting downward is practically I the same for a slow-moving or fast-moving bullet.)

8. Both balls have the same range (see Figure 5.9). The ball with the initial angle of 30^o, however, is in the air for a shorter time and hits the ground first.

9. The bullet falls beneath the projected line of the barrel. To compensate for the bullet's fall, the barrel is elevated. How much elevation depends on the velocity and distance to the target. Correspondingly, the gunsight is raised so the line of sight from the gunsight to the end of the barrel extends to the target. If a scope is used, it is tilted downward to accomplish the same line of sight.

14. The moon's tangential velocity is what keeps the moon coasting around the Earth rather than crashing into it. If its tangential velocity were reduced to zero, then it would fall straight into the Earth!

17. Neither the speed of a falling object (without air resistance) nor the speed of a satellite in orbit depends on its mass. In both cases, a greater mass (greater inertia) is balanced by a correspondingly greater gravitational force, so the acceleration remains the same ($a = F/m$, Newton's second law).

19. The moon has no atmosphere (because escape velocity at the moon's surface is less than the speeds of any atmospheric gases). A satellite 5 km above the Earth's surface is still in considerable atmosphere, as well as in range of some mountain peaks. Atmospheric drag is the factor that most determines orbiting altitude.

23. Hawaii is closer to the equator, and therefore has a greater tangential speed about the polar axis. This speed could be added to the launch speed of a satellite and thereby save fuel.

26. In circular orbit there is no component of force along the direction of the satellite's motion so no work is done. In elliptical orbit, there is always a component of force along the direction of the satellite's motion (except at the apogee and perigee) so work is done on the satellite.

32. If a wrench or anything else is "dropped" from an orbiting space vehicle, it has the same tangential speed as the vehicle and remains in orbit. If a wrench is dropped from a high-flying jumbo jet, it too has the tangential speed of the jet. But this speed is insufficient for the wrench to fall around and around the Earth. Instead it soon falls into the Earth.

36. Communication satellites only appear motionless because their orbital period coincides with the daily rotation of the Earth.

39. The satellite experiences the greatest gravitational force at A, where it is closest to the I Earth; and the greatest speed and the greatest velocity at A, and by the same token the greatest momentum and greatest kinetic energy at A, and the greatest gravitational potential energy at the farthest point C. It would have the same total energy (KE + PE) at all parts of its orbit because it's conserved. It would have the greatest acceleration at A, where F/m is greatest.

Solutions to Chapter 5 Problems

1. One second after being thrown, its horizontal component of velocity is 10m/s, and its vertical component is also 9.8m/s. By the Pythagorean theorem,

$$V = \sqrt{(10m/s)^2 + (9.8m/s)^2}$$
$$= 14.0m/s$$

2. (a) From d = 1/2 gt^2, height of plane is 490 m

$$d = \frac{1}{2}gt^2$$
$$= \frac{1}{2}9.8m/s^2(10s)^2$$
$$= 490m$$

(b) In 10 seconds the falling engine travels horizontally 2800 m

$$d = vt$$
$$= 280m/s(10s)$$
$$= 2800m$$

(c) The engine is directly below the airplane. (In a more practical. case, air resistance is overcome for the plane by its engines, but not for the falling engine, so the engine's speed is reduced by air resistance and it covers less than 2800 horizontal meters, landing behind the plane.)

4. The distance wanted is horizontal velocity x time.
First, find the time from the vertical distance the ball falls to the top of the can. The distance is:

1.0 m - 0.2 m = 0.8 m.

The time is found using g = 9.8 m/s^2 and d= (1/2)gt^2.

$$d = \frac{1}{2}gt^2$$
$$0.8m = \frac{1}{2}(9.8m/s^2)t^2$$
$$t = 0.4s$$

Horizontal travel is then calculated using d = vt.

$$d = 4.0m/s^2(0.40s)$$
$$= 1.6m$$

If the height of the can is not subtracted from the 1.0 m vertical distance between floor and tabletop, the calculated d will equal 1.79 m, the can will be too far away, and the ball will miss!)

7. Hang time depends only on the vertical component of initial velocity and the corresponding vertical distance attained.

$$d = \frac{1}{2} g t^2$$

$$1.25m = \frac{1}{2} 9.8m/s^2 (t)^2$$

$$t = 0.51s$$

A vertical 1.25 m drop corresponds to 0.5 s. Double the calculated time (time up and time down) for a hang time of 1s.

For a 6m horizontal just the hang time is the same since horizontal travel is independent of vertical travel.