**Chapter 10 Summary of terms**

**Projectile Motion**

* Without gravity, you could toss a rock at an angle skyward and it would follow a straight-line path.
* Because of gravity, however, the path curves
* A tossed rock that is projected by some means and continues in motion by its own inertia is called a Projectile.

**Horizontal component (H.C.) of velocity for a projectile**

* It is as simple as the horizontal velocity of a bowling ball rolling freely on the lane of a bowling alley.
* If the retarding effect of friction can be ignored, there is no horizontal force on the ball and its velocity is constant
* It rolls of its own inertia and covers equal distances in equal intervals of time

**Vertical component (V.C) of velocity for a projectile**

* The V.C is exactly the same as for an object falling freely straight down.
* The faster the object falls, the greater the distance covered in each successive second.
* Or, if the object is projected upward, the vertical distances of travel decrease with time on the way up

**The curved path of a projectile**

* It is a combination of horizontal and vertical motion
* The H.C of velocity for a projectile is completely independent of the V.C of velocity, when air resistance is small enough to ignore
* The constant H.C of velocity is not affected by the vertical force of gravity
* Each component, H.C and V.C are independent of the other
* The combined effects of H.C and V.C produce the trajectories of projectiles

**Projectiles launched Horizontally**

* The ball’s H.C. of velocity doesn’t change as the falling ball moves forward
* The ball travels the same horizontal distance in equal times
* That is because there is no component of gravitational force acting horizontally
* Gravity acts only downward, so the only acceleration of the ball is downward
* The vertical positions become farther apart with time
* The vertical distances traveled are the same as if the ball were simply dropped
* The curvature of the ball’s path is the combination of constant horizontal motion and accelerated vertical motion

**Parabola**

* The trajectory of a projectile that accelerates only in the vertical direction while moving at a constant horizontal velocity is a parabola
* When air resistance is small enough to neglect, its trajectory is parabolic

**Check Point page 173**

* At the instant a cannon fires a cannonball horizontally over a level range,
* Another cannonball held at the side of the cannon is released and drops to the ground.
* Which ball, the one fired downrange or the one dropped from rest, strikes the ground first?

**Projectiles launched at an angle**

* Stones thrown at an angle upward and downward
* The dashed straight lines show the ideal trajectory if there were no gravity
* The vertical distance beneath the idealized straight line paths is the same for equal times
* This vertical distance is independent of what’s happening horizontally
* Vectors representing both H.C and V.C for a projectile following a parabolic trajectory
	+ H.C everywhere along the trajectory is the same
	+ V.C changes
	+ Actual velocity is represented by the vector that forms the diagonal of the rectangle formed by the vector components
	+ At the top of the trajectory, the V.C is zero
	+ So, the velocity at the zenith is only the H.C of the velocity
	+ Everywhere else along a trajectory, the magnitude of velocity is greater

**Paths of several projectiles**

* + - Neglecting the effects of air drag
		- So trajectories are all parabolas
		- The projectile rises just like it falls, covering the same amount of ground while rising as while falling
		- The projectile will rise to its maximum height in the same time it takes to fall from that height to its initial level
		- The projectile arrives at its initial level with the same speed it had when it was initially projected

**Projectiles having same initial speed but different launching angles**

* + - They reach different altitudes (heights above the ground)
		- They have different horizontal ranges(distances travelled horizontally)
		- Same range is obtained from two different launching angles that add up to 90 degrees
		- But, for the smaller angle, the object remains in the air for a shorter time
		- The greatest range occurs when the launching angle is 45 degrees

**Check Point page 176**

1. A baseball is batted at an angel into the air. Once airborne and neglecting air drag, what is the ball’s acceleration vertically? Horizontally?
2. At what part of its trajectory does the baseball have minimum speed?

**Exercises page 190**

7. Fragments of fireworks beautifully illuminate the night sky. (a) What specific path is ideally traced by each fragment? (b) What paths would the fragments trace in a gravity-free region?

9. At what point in its trajectory does a batted baseball have its minimum speed? If air drag can be neglected, how does this compare with the horizontal component of its velocity at other points?

13. Two golfers each hit a ball at the same speed, but one at 60 degrees with the horizontal and the other at 30 degrees. Which ball goes farther? Which hits the ground first? (Ignore air resistance)

15. A projectile is fired straight upward at 141 m**/**s. How fast is it moving at the instant it reaches the top of its trajectory? Suppose that it were fired upward at 45 degrees instead. Then its horizontal component of velocity is 100 m**/**s. What would be the speed of the projectile at the top of its trajectory?

**Fast Moving Projectiles – Satellites**

* An Earth satellite is simply a projectile that falls around Earth rather than into it
* The speed of the satellite must be great enough to ensure that its falling distance matches Earth’s curvature
* Satellites, such as the space shuttles, are launched to altitudes of 150 km or more, to be above almost all of the atmosphere and to be nearly free from air resistance
* Are the satellites orbiting at high altitudes free from gravity?

NO. The force of gravity on a satellite 200 km above Earth’s surface is nearly as strong as it is at the surface

* Newton:
* Moon was simply a projectile circling Earth under the attraction of gravity
* Moon has a tangential velocity (parallel to Earth’s surface) sufficient to ensure motion around the Earth, rather than into it.
* If there is no resistance to reduce its speed, the moon or any Earth satellite “falls” around and around the Earth

**Check Point page 179**

Is the following explanation valid? Satellites remain in orbit instead of falling to Earth because they are beyond the main pull of Earth’s gravity.

**Circular Satellite Orbits**

* A satellite in circular orbit is always moving in a direction perpendicular to the force of gravity that acts upon it
* The satellite does not move in the direction of the force, which would increase its speed
* Nor does it move in a direction against the force, which would decrease its speed.
* Instead the satellite moves at right angles to the gravitational force that acts upon it
* No change in speed occurs, only a change in direction
* So we see why a satellite in circular orbit sails parallel to the surface of Earth at constant speed - a very special form of free fall
* Period- The time for a complete orbit about Earth
* The higher the orbit of a satellite
* The less its speed,
* Longer its path,
* And the longer its period

**Check Point page 181**

1. True or False: The space shuttle orbits at altitudes in excess of 150 km to be above both gravity and Earth’s atmosphere