**Chapter 9 Summary of terms**

**The Universal Law of Gravity**

* Everything pulls on everything else in a beautifully simple way that involves mass and distance
* According to Newton:
  + Every body attracts every other body with a force that for any two bodies
    - is directly proportional to the product of their masses, m1 and m2
    - and inversely proportional to the square of the distance, d, which is the distance between the centers of the two masses
    - F ~ ( mass1 x mass2) **/** (distance x distance)
    - F~ (m1 x m2) **/** (d x d)
    - The greater the masses m1 and m2, greater the force of attraction between them
    - The greater the distance of separation, d, the weaker the force of attraction

**Check Point page 152**

2. According to the equation for gravitational force, what happens to the force between the two bodies,

* if mass of one of the bodies is doubled?
* if both masses are doubled?

3. Gravitational force acts on all bodies in proportion to their masses. Why then, doesn’t a heavy body fall faster than a light body?

**Exercises page 168**

5. Is the force of gravity stronger on a crumbled paper than on an identical piece of paper that has not been crumbled? Defend your answer

13. Larry weighs 300 N at the surface of Earth. What is the weight of Earth in the gravitational field of Larry?

17. An astronaut lands on a planet that has the same mass as Earth but twice the diameter. How does the astronaut’s weight differ from that on Earth?

19. If Earth somehow expanded to a larger radius, with no change in mass, how would your weight be affected? How would it be affected if Earth instead shrunk? (Let the equation for gravitational force guide your thinking)

**The Universal Gravitational Constant, G**

F = (G x m1 x m2) **/** (d x d)

* Where, G = 6.67 x 10 -11 N. m2**/** kg 2

* G is a very small number
* Therefore, gravity is a very weak force

**Check Point page 155**

1. By how much does the gravitational force between two objects decrease when the distance between their centers is doubled? Tripled? Increased tenfold
2. Consider an apple at the top of the tree that is pulled by Earth’s gravity with a force of 1 N. If a tree were twice as tall, would the force of gravity be ¼ as strong? Defend your answer

**Weight and weightlessness**

* The force of gravity, like any force can produce acceleration
* Objects under the influence of gravity accelerate toward each other
* Because we are almost always in contact with Earth,
* we think of gravity as something that presses us against the Earth
* rather than as something that accelerates us
* the pressing against Earth is the sensation we interpret as weight
* Stand on a bathroom scale (B.S) that is supported on a stationary floor
* The gravitational force between you and Earth pulls you against the supporting floor and the B.S
* According to NTL, at the same time, the floor and the B.S push upward on you
* Located in between you and the supporting floor are springs inside the B.S
* Compression of springs is read as your weight
* If you repeat this weighing procedure in a moving elevator
  + Your weight reading would vary
  + Not during steady motion
  + But during accelerated motion
* If the elevator accelerates upward
  + The B.S and the floor push harder against your feet
  + The scale shows an increase in your weight
* If the elevator accelerates downward,
  + The supporting force of the floor is less
  + You sense a decrease in your weight
* If the elevator is in free fall
  + - The reading on the weighing scale would be zero
    - You would be weightless
    - There is still a gravitational force acting on you, causing your downward acceleration
    - But gravity is not felt as weight because there is no support force
    - Astronauts in orbit are without a support force
      * They are in sustained state of weightlessness
      * Due to the absence of a support force
      * Not the absence of gravity
      * When they are in orbit, they are in a state of free fall

**Exercises page 169**

23. Why does a person in free fall experience weightlessness?

25. Is gravitational force acting on a person who falls of a cliff?

27. What two forces act on you while you are in a moving elevator? When are these forces of equal magnitude and when are they not?

29. Why does a bungee jumper feel weightless during the jump?

31. Your friend says that the primary reason astronauts in orbit feel weightless is that they are beyond the main pull of Earth’s gravity. Why do you agree or disagree?