4 – Circular Motion and Gravitation

Gravitation – Applications

- For objects near the Earth's surface,
  - m_1 becomes m_E
  - m_2 becomes m
  - r is the distance to the center of earth r_E
    - $r_E = 6.38 \times 10^6 m$
- Fg is the weight of the object so
  - $F_g = mg = G\frac{mm_E}{r_E^2}$ therefore
  - $g = G\frac{m_E}{r_E^2}$

Gravitation - Applications

- Until G was measured m_E was unknown.
- r_E had been known since ancient times but not always believed.

Artificial Satellites

- What gets an artificial satellite up in orbit?
- What keeps it there?
- For approximately circular orbits
  - $\sum F_R = m\frac{v^2}{r} = G\frac{mm_E}{r^2}$
- where m is the mass of the satellite and r is the distance from the center of the earth

Artificial Satellites

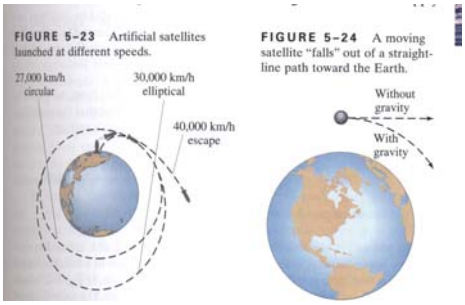

FIGURE 5–23 Artificial satellites launched at different speeds.

FIGURE 5–24 A moving satellite "falls" out of a straight-line path toward the Earth.

Weightlessness

- When the elevator is at REST, the scale shows the force exerted on it by the bag which is equal and opposite to the force exerted by the scale on the bag.
- W=mg
- Under what other conditions would weight equal mg in the elevator?

Weightlessness

- Now the elevator is accelerating upward.
- ΣF =ma
- W-mg = ma
- W = mg + ma
- Choosing up as positive
  - If a is up then w is greater than mg
  - If a is down then w smaller than mg
- This is called **apparent weight**
- W=(3/2)mg

Weightlessness

- Now the elevator cable snaps and the elevator plummets down in free fall.
  - Real elevators have brakes which prevent this.
- a = -g
- w = mg + m(-g) = 0
- apparent weightlessness
- Satellites are in free fall.
- They fall toward the earth.
- Real weightlessness occurs between worlds.