

Unit 9: Gravity

Text:

Chapter 13.

Problems (p. 351-8)

#1: 3, 7, 8, 13, 17, 23, 24

(Universal Gravitation)

#2: 30, 32, 34, 36, 37

(Energy)

#3: 51, 52, 54, 63, 65, 68, 90

*(Orbits)***Vocabulary:**

G, escape speed, tides, Universal Law of Gravitation, black hole, central force

Math:

definitions:

$$F = G \frac{m_1 m_2}{r^2}$$

$$G = 6.67 \times 10^{-11} \text{ Nm}^2 / \text{kg}^2$$

derived formulas:

$$T^2 = \left(\frac{4\pi^2}{GM} \right) R^3$$

$$v_e = \sqrt{\frac{2GM}{r}}$$

$$U = -\frac{Gm_1 m_2}{r}$$

$$E = -\frac{GMm}{2R}$$

skills:

no new math skills needed

Other Information:

$$M_{\text{earth}} = 6 \times 10^{24} \text{ kg}$$

$$R_{\text{earth}} = 6.4 \times 10^6 \text{ m}$$

$$M_{\text{sun}} = 2 \times 10^{30} \text{ kg}$$

$$R_{\text{sun}} = 7 \times 10^8 \text{ m}$$

$$D_{\text{earth-sun}} = 1.5 \times 10^{11} \text{ m}$$

$$M_{\text{moon}} = 7.35 \times 10^{22} \text{ kg}$$

$$R_{\text{moon}} = 1.8 \times 10^6 \text{ m}$$

$$D_{\text{earth-moon}} = 3.8 \times 10^8 \text{ m}$$

Key Objectives:

- derive/prove Kepler's Third Law for the special case of circular orbits.
- derive/prove Kepler's Second Law for any central force
- explain what is meant by the term "escape speed" and be able to derive/use the equation given above.
- do calculations involving Newton's Universal Theory of Gravitation.
- do calculations involving work, kinetic and potential energy using the equations above.
- do calculations involving orbital parameters and energies for orbiting systems.
- in general, be able to use and explain the vocabulary listed above.
- in general, be able to do calculations similar to the worksheet/homework done in class
- be able to derive/explain what happens to the force of gravity as you dig a hole to the center of a planet.
- be able to derive/calculate the time to fall through a hole through the center of the earth.
- be able to explain what you would feel gravitationally if you were inside and outside a hollow sphere.
- explain the source of tides.