AP 12: Gravity

Formatting Error … Sorry :)

1. ~~A hypothetical planet has a mass half of that of the earth and a radius of twice that of the earth. On 17.~~
   An object weighs 432 N on the surface of earth. The earth has a radius of r. If the object is raised to a height of 3r **above the surface** of the earth, what is the weight?
   a) 432 N
   b) 48 N
   c) 27 N
   d) 0 N

   $F_G = \frac{GMm}{r^2}$ — 4 x r means $\frac{1}{4^2} = \frac{1}{16}$ the weight!

A hypothetical planet has a mass ½ that of Earth & a r 2x that of Earth….

2. Earth you have a weight of F_w. What would you weigh on the new planet?
   a) F_w
   b) $F_w/2$
   c) $F_w/4$
   d) $F_w/8$

   $F_G = \frac{GMm}{r^2}$ — ½M ⇒ ½ weight; 2 x r ⇒ $\frac{1}{(2)^2} = \frac{1}{4}$ weight — Combined = $\frac{1}{8}$ Weight.

3. A spaceship traveling to the moon. At what point is it beyond the pull of earth's gravity?
   a) When it gets above the earth's atmosphere
   b) When it is half way there
   c) When it is closer to the moon than the earth
   d) Never

   You would need to be infinitely far away to not have gravity.

4. Satellite A has twice the mass of satellite B, and rotates in the same orbit.
   a) The speed of B is twice the speed of A
   b) The speed of B is one-half the speed of A
   c) The speed of B is equal to the speed of A

   $\frac{GMm}{r^2} = \frac{mv^2}{r}$ — Mass doesn't matter!

5. Two objects with masses m_1 and m_2, are originally a distance r apart. The magnitude of the gravitational force between them is F. The masses are changed to $2m_1$ and $2m_2$, and the distance is changed to 4 r. What is the magnitude of the gravitational force.
   a) F/16
   b) F/4
   c) 4F
   d) 16F

   $\frac{G m_1 m_2}{r^2}$ — 2x ⇒ 2x F_G; 2x ⇒ 2x F_G; 4 x r ⇒ $\frac{1}{4^2} = \frac{1}{16} F_G$ — $\frac{4}{16} = \frac{1}{4} F_G$

6. As a rocket moves away from the earth's surface, the rocket's weight
   a) increases
   b) decreases
   c) remains the same
   d) depends on how fast its moving

   Mass stays same but F_G ↓

Questions 7-8 refer to a ball that is tossed straight up from the surface of a small, spherical asteroid with no atmosphere. The ball rises to a height equal to the asteroid's radius and then falls straight down toward the surface of the asteroid.

7. What forces, if any, act on the ball why it is on the way up?
   a) only a decreasing gravitational force that acts downward
   b) only an increasing gravitational force that acts downward
   c) only a constant gravitational force that acts downward
   d) both a constant gravitational force that acts downward and a decreasing force that acts upward
   e) no force acts on the ball

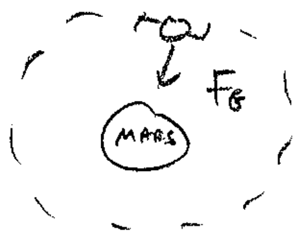
   - Gravity only force
   - Gravity gets weaker as you get further away.

8. The acceleration of the ball at the top of the path is
   a) at its maximum value for the ball's flight
   b) equal to the acceleration at the surface of the asteroid
   c) equal to one half the acceleration at the surface of the asteroid
   d) equal to on-fourth the acceleration at the surface of the asteroid
   e) zero

   $F_G = \frac{GMm}{r^2} = m\text{"}g\text{"}$; $g = \frac{GM}{r^2}$ — 2x ⇒ $\frac{1}{2^2} = \frac{1}{4}\text{"}g\text{"}$

9. A satellite is gong to be put in orbit around Mars to send data for future manned space flights. (10 points)

a. Draw the free body diagram for the satellite in orbit.



b. Derive an equation that shows the speed of a satellite (v_s) as a function of distance the satellite is from the center of mass of the planet (r_{so}) and the mass of the planet (m_p). Your final equation should only contain the variables listed above and fundamental constants.

Circular

$$\Sigma F_c = F_G = \frac{m_s v^2}{r}$$

$$\frac{G M_p m_s}{r^2} = \frac{m_s v^2}{r}$$

$$v = \sqrt{\frac{G M_p}{r}}$$

c. The satellite will be put in an orbit that is 4,600 km above the surface of the planet (r_{mars} = 3,400 km, $m_{mars} = 6.4 * 10^{23}$ kg). What must the speed of the satellite be in order to maintain this orbit?

$$V = \sqrt{\frac{G M_p}{r}}$$

$$V = \sqrt{\frac{(6.67\times10^{-11})(6.4\times10^{23})}{(3,400,000 + 4,600,000)}}$$

r must be in meters!

$$V = 2,309 \text{ m/s}$$