Weightlessness

Read from **Lesson 4** of the **Circular and Satellite Motion** chapter at **The Physics Classroom**:

http://www.physicsclassroom.com/Class/circles/u6l4d.html

MOP Connection: Circular Motion and Gravitation: sublevel 9

1. Analyze the following logical argument. At what step (i through iv) does a logical fallacy occur?

   i. The weight of an object is equal to the force of gravity acting upon that object.
   ii. Orbiting astronauts feel weightless as they orbit the Earth.
   iii. A person who feels weightless is not acted upon by the force of gravity.
   iv. There is no force of gravity acting upon orbiting astronauts.

   Explain your answer.

2. When you stand on a bathroom scale, the scale does **not** measure the force of gravity (i.e., weight) acting upon your mass. What does the scale measure? _____ If a scale does not technically measure your weight, then why is it often used to measure your weight? Express your understanding of forces, Newton's second law of motion, and bathroom scales by discussing these questions.

Otis L. Evaderz is conducting his famous elevator experiments. Otis stands on a bathroom scale and reads the scale while ascending and descending the John Hancock building. Otis weighs 750 N, but notices that the scale readings depend on what the elevator is doing. Use a free-body diagram and Newton's second law of motion to solve the following problems.

3. What is the scale reading when Otis accelerates upwards at +0.50 m/s^2? **PSYW**

4. What is the scale reading when Otis is traveling upward at a constant velocity of at 2 m/s? **PSYW**

5. As Otis approaches the top of the building, the elevator slows down at a rate of 0.50 m/s^2. Be cautious of the sign on acceleration. What does the scale read? **PSYW**

6. Otis stops at the top floor and then accelerates at a rate of -0.50 m/s^2. What does the scale read? **PSYW**

7. As Otis approaches the ground floor, the elevator slows down at a rate of +0.50 m/s^2. Be cautious of the sign on acceleration. What does the scale read? **PSYW**

Otis L. Evaderz desired to conduct the following experiment. Otis wanted the building engineers to allow the elevator to free fall from the top floor for fifty floors. Otis would observe the scale reading. Then the engineers would activate the safety system and slow the elevator down with an acceleration value of +15.0 m/s^2.

8. What would the scale read during the free fall stage of the experiment? **PSYW**

9. What would the scale read during the slowing down stage of the experiment? **PSYW**

10. In questions #3-9, is Otis' weight changing? _____
    Is Otis' sensation of weight changing? _____ Explain why or why not.

11. Earth-orbiting astronauts feel weightless in space because _____. Choose all that apply.
    a. They are in free-fall motion.
    b. There is an absence of contact forces acting upon their bodies.
    c. The weight of objects diminish to close to 0 N at these distances from Earth's center.
    d. There is no gravity in space.
    e. Gravity is the only force acting upon their bodies.
    f. There is no air resistance in space.
    g. They haven't eaten for days.
    h. The rotation rate of the Earth upon its axis is so rapid it gives a sensation of weightlessness.
    i. They are not experiencing any support forces.
    j. Their surroundings are accelerating to the earth at the same rate they are.
    k. The acceleration of gravity (**g**) at these distances is close to 0 m/s/s.

As you sit at rest in your chair, you feel the contact force (F_{norm}) balancing the non-contact force (F_{grav}).

A person in free fall does not experience any contact force and thus feels weightless.