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: Mission CG9

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 determine the scale reading for each situation.

Situation	Free-Body Diagram	F_{net} (mag. and dir'n)	F_{norm} (N)	Scale Reading (N)
1. Otis accelerates upward at 0.50 m/s/s.				
2. Otis moves upward with a constant speed of 2.0 m/s.				
3. Otis is moving upward and slows down at a rate of 0.50 m/s/s.				
4. Otis accelerates downward at 0.50 m/s/s.				
5. Otis moves downward with a constant speed of 2.0 m/s.				
6. Otis is moving downward and slows down at a rate of 0.50 m/s/s.				
7. The elevator cable snaps and Otis free falls at 9.8 m/s/s.				
8. The safety system slows Otis' falling body down at a rate of 15.0 m/s/s.				

9. For the situations in Questions #1-8, is Otis' weight changing? ___________

Is Otis' sensation of weight changing? ___________ Explain why or why not.

10. 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.

11. Analyze the following 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.

12. 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.