QP1

You board a stationary elevator on the ground floor. A uniform vertical gravitational field $g = -9.8m/s^2$ is present. Before the elevator starts moving, you drop a "super" ball from a height of 2 m above the floor. The "super" ball bounces perfectly elastically from the floor (meaning that the velocity changes direction in a negligible amount of time, without changing its magnitude).

a) (1 point) How long does it take for the ball to reach the floor of the elevator?

b) (2 points) How long does it take for the ball to travel from the floor to its maximum height above the floor (at which point you catch it again)?

Now the elevator starts to accelerate until it reaches a velocity of $v_0 = 0.5m/s$ just before it reaches the second floor. At this point the velocity remains constant at 0.5 m/s. As it passes the second floor you again drop the ball from a height of 2 m above the floor.

c) (3 points) How long does it take the ball to hit the floor of the elevator? Hint: you might want to express the height of the elevator floor and the ball, with respect to the second floor, as a function of time.

After you've caught the ball, and just as the elevator passes the fourth floor, it starts to accelerate again, with an acceleration give by $a = +kt^2$ with $k = 4m/s^4$. At this point you again drop the ball from a height of 2 m above the floor.

d) (2 points) How long does it take the ball to hit the floor of the elevator?

e) (2 points) After you get off the elevator you decide to throw the ball straight up in the air. This is real air with air friction (note that air friction introduces an additional acceleration that is proportional to the velocity by opposite in direction). Does it take longer for the ball to go up or come down, or are they equal? Explain your reasoning. Hint: you might want to consider the total acceleration on the ball.