Question 1

Assumption: v is a speed, and will not have a negative sign attached to it, no matter which direction it is going.

(a):

$$m\frac{dv}{dt} = -mg + c_1 v$$

Could only represent a situation where the ball moves down. The drag force described by c_1 is positive and thus must point in the upward direction. If v moved up, it would be accelerating v and thus v can only be moving down in this case.

(b):

$$m\frac{dv}{dt} = -mg - c_1 v$$

Represents a situation where the ball moves up. If the ball moves down, the force would accelerate v and thus v can only be moving up in this case.

(c):

$$m\frac{dv}{dt} = -mg + c_2 v^2$$

This case cannot be represented by the ball moving up or down. Since v is squared, no matter if the v is positive or negative, the overall effect would be an acceleration of v.

(d):

$$m\frac{dv}{dt} = -mg - c_2 v^2$$

This case represents a ball that can be moving either way. Again since vi is squared, the direction doesn't change teh equation, and since c_2 is negative, the ball will always experience a negative drag force.

Question 2

Question 3

$$\left|\frac{c_2 v^2}{c_1 v}\right| = \frac{0.22v\,|v|\,D^2}{(1.55 * 10^{-4})vD} = (1.4 * 10^3)\,|v|\,D$$

(a): I will assume that the quadratic term dominates over the linear term when the ratio is 100 or higher. Solving for v:

$$100 = (1.4 * 10^3)\,|v|\,D$$

$$|v| = \frac{100}{(1.4 * 10^3)D} \approx 7.14\frac{m}{s}$$

Speeds below 7.14 $\frac{m}{s}$ will be dominated by the linear drag and speeds above will be dominated by the quadratic drag.
(b): The velocity of the ball

$$m\frac{dv}{dt} = -mg + c_1 vD + c_2 v^2 D^2$$