Chapter 5, Question 3:
Integral Momentum Equation

Consider a rocket being launched vertically from the surface of the earth. Assuming a control volume (of approximately constant mass) attached to the vehicle, which terms in the integral momentum equation are non-zero?

$$\sum F_y = a_o \int_V \rho dV \quad + \int_V \left[\frac{\partial(\rho u_y)}{\partial t}\right] dV \quad + \quad \int_s u_y(\rho \vec{u}) \cdot \vec{n} ds$$

1) 1st, 3rd and 4th

2) 1st, 2nd and 4th

3) 1st, 2nd, 3rd and 4th

4) I don't know

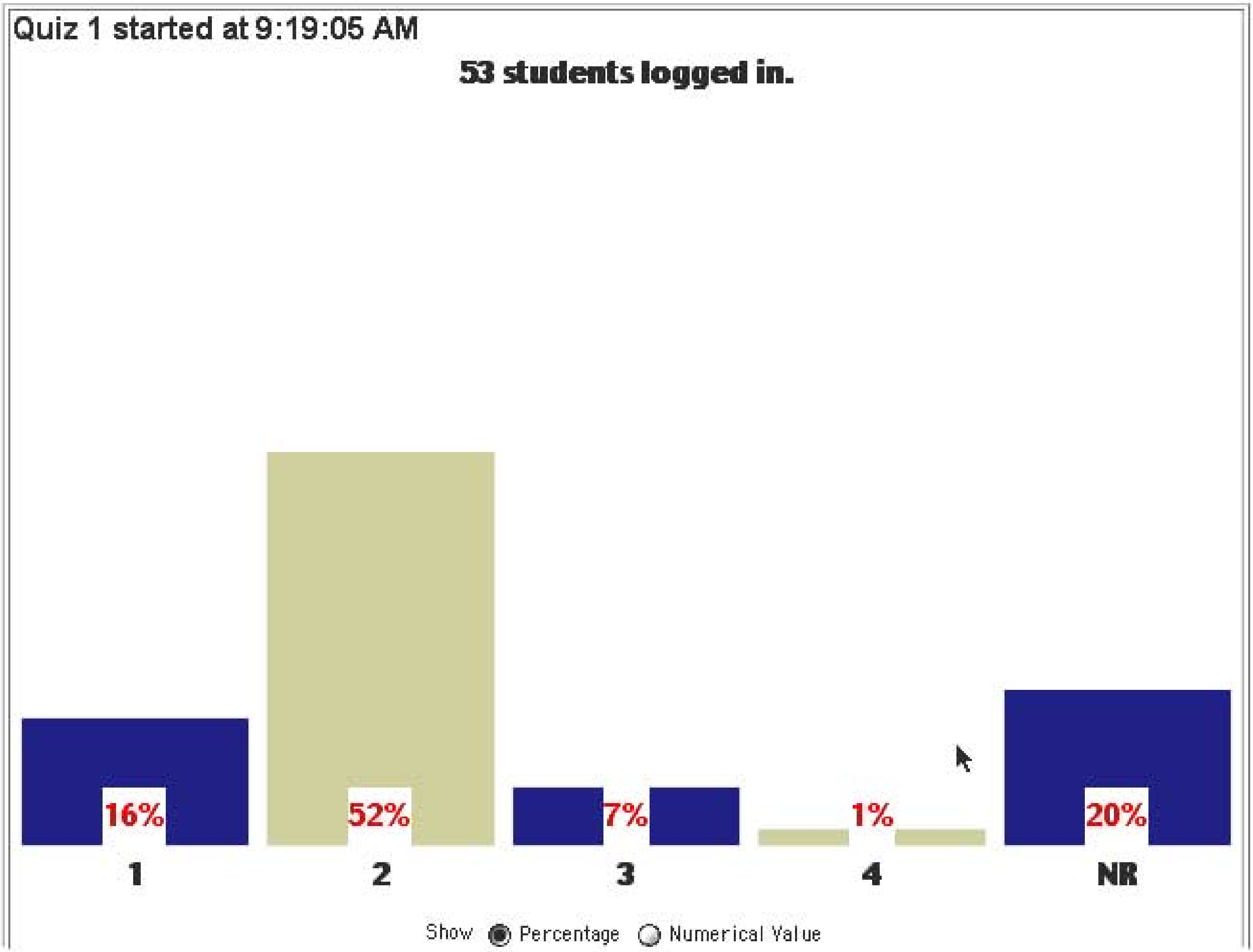
L.O. A&B

Chapter 5, Question 3 Answer:

The correct answer is 2) 1st, 2nd and 4th

First, note why the phrase "of approximately constant mass" appears--this is because the integral form of the momentum equation that we have been using is only valid for a control volume of constant mass. Now consider each of the terms. 1) Are there external forces on the vehicle? Yes--gravity and drag. 2) Is the vehicle (and the control volume that is attached to it) accelerating. Yes--at least we hope so, or launch control has a problem on their hands. Therefore a_o is non-zero. 3) In the reference frame of the vehicle, is there a change in momentum of the mass within the control volume over time or can we assume it is steady? Although there are small changes, it is typical to assume it is steady (so you can quibble about this one--more on this when we get to deriving the rocket equation). So we consider this term to be zero (like the eraser problem). 4) Is there a momentum flux across any of the surfaces of the control volume? Yes. So this term is non-zero.

Class performance (2001):


Quiz 1 started at 9:19:05 AM
53 students logged in.
16%
52%
7%
1%
20%
1
2
3
4
NR
Show Percentage Numerical Value