

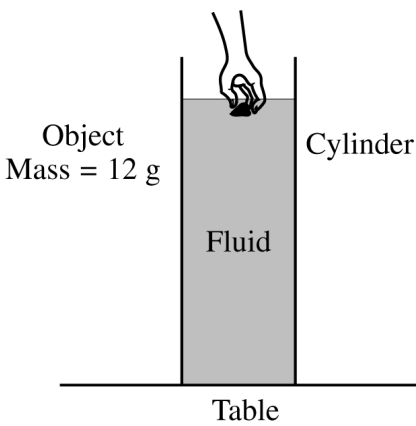
PHYSICS C: MECHANICS

SECTION II

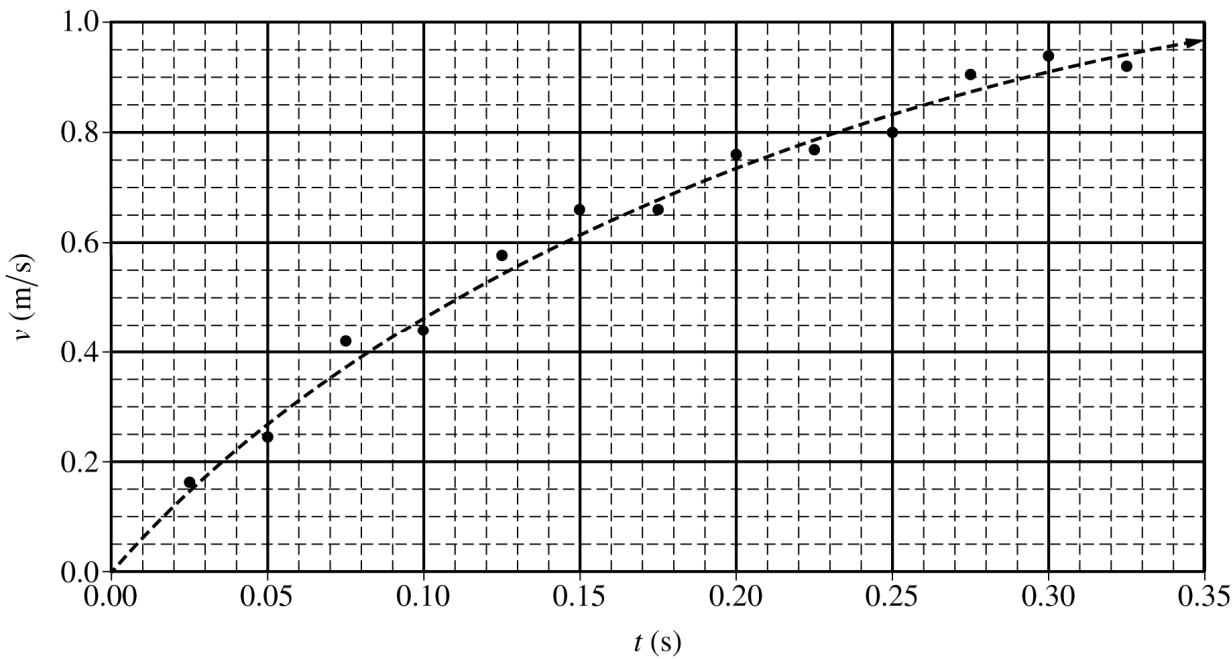
Time—45 minutes

3 Questions

Directions: Answer all three questions. The suggested time is about 15 minutes for answering each of the questions, which are worth 15 points each. The parts within a question may not have equal weight. Show all your work in this booklet in the spaces provided after each part.



1. In an experiment, students used video analysis to track the motion of an object falling vertically through a fluid in a glass cylinder. The object of $m = 12\text{ g}$ is released from rest at the top of the column of fluid, as shown above. The data for the speed v of the falling object as a function of time t are graphed on the grid below. The dashed curve represents the best fit chosen by the students for these data.



- (a)
- Does the speed of the object increase, decrease, or remain the same?
_____ Increase _____ Decrease _____ Remain the same
 - In a brief statement, describe the direction of the object's acceleration and how the magnitude of this acceleration changed as the object fell.
 - Using the graph, calculate an approximate value for the magnitude of the acceleration of the object at $t = 0.20\text{ s}$.

The students use the equation $v = A(1 - e^{-Bt})$ to model the speed of the falling object and find the best fit coefficients to be $A = 1.18\text{ m/s}$ and $B = 5\text{ s}^{-1}$.

- (b) Use the above equation to:
- Derive an expression for the magnitude of the vertical displacement $y(t)$ of the falling object as a function of time t .
 - Derive an expression for the magnitude of the net force $F(t)$ exerted on the object as it falls through the fluid as a function of time t .

The students repeat the experiment with a taller glass cylinder that is filled with the same fluid. The cylinder is tall enough so that the object reaches a constant speed.

- (c)
- Determine the constant speed of the object.
Justify your answer.
 - Determine the force exerted by the fluid on the object at this time.
Justify your answer.