

MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
Department of Physics

Physics 8.01X

Fall Term 2002

## PRACTICE EXAM 1

### Problem 1:

a. A person is initially standing inside a closed box that rests on a scale. The person jumps in the air. While the person is in the air inside the box, does the scale change its reading from when the person is standing on the floor? Assume the scale can adjust instantaneously to any change in applied force. Briefly explain your answer.

b. A hummingbird is also in a closed box that is resting on a scale. The hummingbird is initially resting on the floor. The hummingbird then takes off from the ground and hovers at a fixed height above the floor of the box. Does the scale change its reading from when the hummingbird is resting on the floor? Assume the scale can adjust instantaneously to any change in applied force. Briefly explain your answer.

### Problem 2:

A punt kicked at  $60^\circ$  travels down a field a distance of 60.0 yards. If the football were kicked with the same speed but at an angle of  $45^\circ$ , how far would it go? You may assume that distances down field are measured when the ball returns to the same height it was kicked from. What is the hang time for the punt in both cases?

**Problem 3:**

In experiment FO, the voltage across the capacitor is given by

$$V_{cap}(t) = V_{cell} \left(1 - e^{-\frac{t}{RC}}\right). \quad (1)$$

- a. Briefly explain why the time of charging can be approximated by  $t \sim \frac{RC}{V_{cell}} V_{cap}(t)$  for small values of  $t$  compared to  $RC$ .
- b. Using the values  $V_{cell} = 1.6 \text{ V}$ ,  $R = 20 \text{ M}\Omega$ , and  $C = 10^{-6} \text{ F}$ , how long does it take for the voltage across the capacitor to reach  $V_{cap} = V_{cell}(1 - e^{-0.2})$ ?
- c. The following data were recorded. The LVPS was set at  $6.0 \text{ V}$ . The time constant was measured to be  $RC = 10.9 \text{ s}$ . The distance of fall and the voltage readings across the capacitor were:

Distance of fall (mm)	$V_{cap}$ (mV)
260	126
130	90
65	65

From these data, calculate the value for  $g$ . Briefly explain how you made your calculation.

