AP Physics C
Simple Forces

Name _____

1. A pitcher throws a 0.2 kg baseball at an initial velocity of v_o=25 m/s. The catcher's mitt recoils a distance of 8 cm before the ball comes to rest. What was the average force applied by the catcher's glove to the baseball?

F_{avg} = 780 N

2. A 20 kg box is sitting on a table.
   a. What is the normal force acting on the box?

N = 196 N

   b. A 10 kg box is placed on top of the 20 kg box. What is the normal force exerted by the table on the 20 kg box? What about the normal force on the 10 kg box?

N = 98 N

3. A 2100 kg elevator is supported by a cab le that cannot withstand more than 22,000 N before breaking. What is the maximum acceleration that can be given to the elevator?

a_{max} = 0.68 m/s^2

4. A gun fires a .06 kg bullet from rest with a constant force of 243 N. What is the acceleration of the bullet, and what is the length of the barrel? The bullet reaches a speed of 100 m/s at the muzzle.

a_{max} = 4050 m/s^2

L = 1.2 m

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5. A student of mass m=40 kg stands on a platform scale in an elevator in a tall building. The positive direction for all vector quantities is upward.

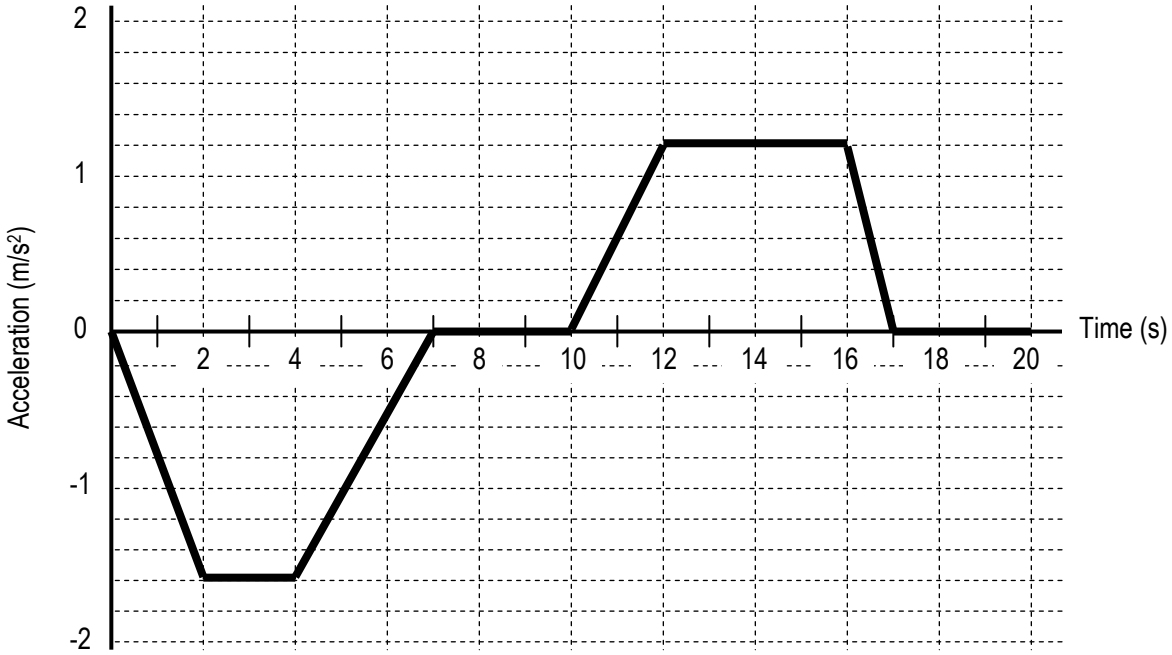
(a) Draw a free-body diagram showing and labeling all the forces acting on the student, who is represented by the dot below.

●

(b) Derive an expression for the reading on the scale in terms of the acceleration *a* of the elevator, the mass *m* of the student, and fundamental constants.

SR = m(a + g)

A student is provided with the following graph showing the acceleration *a* of the elevator as a function of time *t*.



(c) During what time interval(s) is the force exerted by the platform scale on the student a maximum value?

(d) Calculate the magnitude of that maximum force for a 45 kg student.

(e) During what time interval(s) is the speed of the elevator constant?

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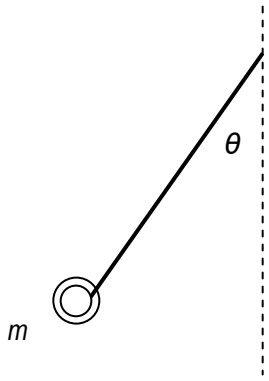
6. An airplane accelerates uniformly from rest. A physicist passenger holds up a thin string of negligible mass to which she has tied her ring, which has a mass *m*. She notices that as the plane accelerates down the runway, the string makes an angle θ with the vertical.

(a) On the picture below, draw a free-body diagram of the ring, showing and labeling all the forces present.



The plane reaches a takeoff speed of 65 m/s after accelerating for a total of 30 s.

(b) Determine the minimum length of the runway needed.

L = 975 m

(c) Determine the angle θ that the string makes with the vertical during the acceleration of the plane before it leaves the ground.

$\theta = 12.5^\circ$