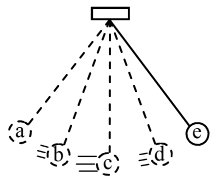
2011-12 PreAP Harmonic Motion 12



1. Consider point e on the pendulum at the left.
   A. Is the velocity at point e +, −, or 0?
   B. Predict if the acceleration at point e is +, −, or 0.
   (*This is a prediction. Don't worry if it is right or wrong.)*

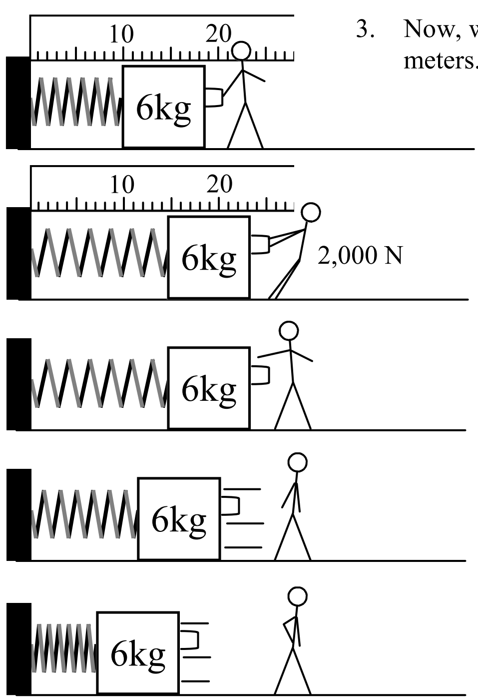
To calculate the average acceleration at point e we need two velocities on either side. Let's say that the velocity at point d is +1 m/s (just for ease) before it gets to point e and is −1 m/s after point e. Let's make the time from d back to d to be 0.5 seconds.

C. * Remembering that $a = \Delta v/t = (v_f - v_i)/t$, calculate the average acceleration at point e.

D. Was your prediction correct?
Often people think that the acceleration is zero at points a and d because the object has a velocity of zero. Remember a projectile thrown into the air. At the very top its velocity is also zero, but it still has gravity pulling down on it. It is still accelerating downward. ***<u>One point cannot define an acceleration</u>****! Also, if v_d = + and v_e = 0, then that is a negative change of velocity and a negative acceleration.*

E. Using the same logic. Is the acceleration at point a +, −, or 0?

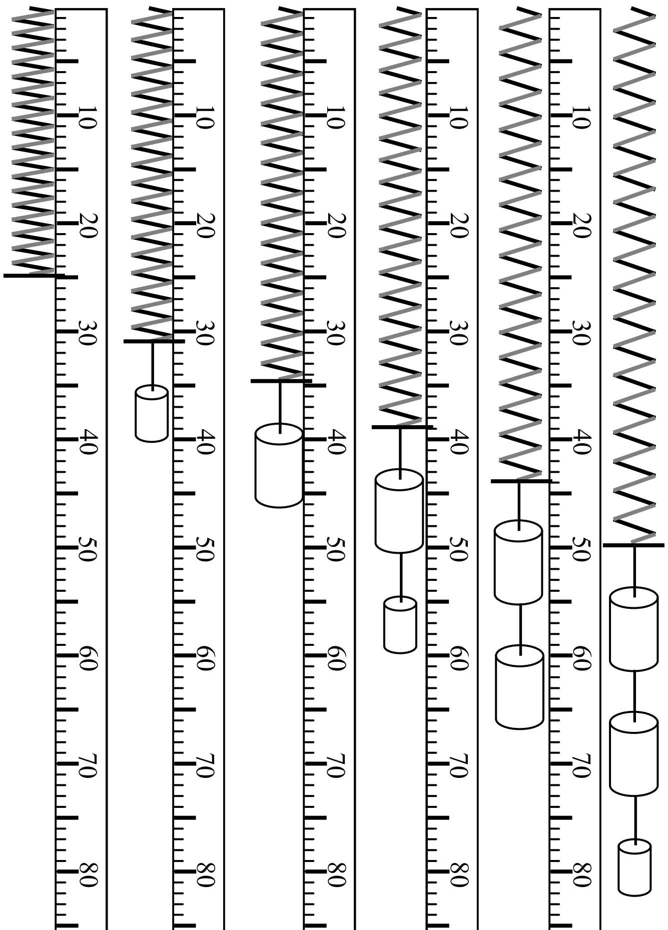
2. What about point c, when the pendulum bob passes its lowest point?
   A. Is the velocity at point c +, −, or 0?
   B. Predict if the acceleration at point c is +, −, or 0.
   C. * Notice that at point b the bob is at the same height as point d. So is V_b <, >, or = to V_d?
   D. Let's again use +1 m/s as v_d (going to the right). Therefore v_b =
   E. * If the time from b to d is 0.75 m/s, calculate the average acceleration at point c.
   F. Was your prediction correct?
   Notice that in this case the acceleration is a minimum (0 m/s^2) when the velocity is a maximum. Strange, huh?



3. Now, what about springs? Imagine a very large mass, spring, and ruler. The ruler measures meters. We will say there is no friction on the mass.
   A. * The spring is relaxed in the first diagram (equilibrium position), so Slim Jim is pulling with how much force?
   B. * Slim Jim then stretches the spring, as shown. Calculate the spring constant.
   C. As Jim stretches the spring does the force of the spring increase, decrease, or stay the same?
   D. So, since F = ma, as he stretches the spring more and more, the acceleration of the mass when released will increase, decrease, or stay the same?

   Slim Jim releases the mass and it vibrates back and forth.
   E. Calculate the period of the spring.
   F. * What is the amplitude of the spring's motion?
   G. Where is the acceleration a maximum (give the position)?
   H. Where is its KE a maximum (give the position)?
   I. Where is the potential energy a minimum?
   J. How far does it move from side to side?
   K. How long does it take to get to the other side?

We are going to rework the spring constant experiment we did last fall. It will be helpful for the test. (Hint. Hint.) The small masses are 100g and the bigger ones are 200g. And, yes, that is still a meter stick.



4. A number masses stretch a spring, as shown. Record all information in the data table at the bottom left.
   - A. The first spring has no mass on it, so this is the natural length of the spring. This is also known as the equilibrium position.
   - B. * Then a 100g mass is placed on the spring and it stretches. After converting to kg, calculate the force pulling down the spring. Use $g = 10$ m/s^2, for simplicity.
   - C. * Write the new position in the table and then measure the distance the spring was stretched from its equilibrium position. This is "x".
   - D. Do the same for all masses and displacements.
   - E. * What are the units for a spring constant?
   - F. * Since slope is always $\Delta y/\Delta x$, which of the spring constant's units must be graphed on the y-axis?
   - G. Graph the given data below, being sure to label axis, including with units. Then calculate the spring constant from you best fit line.

Mass in g	Mass in kg	F in N	x_o in m (natural length)	x' in m (actual position)	x in m (distance stretched)
0	0	0	0.25	0.25	0.00
100	*	*	0.25	*	*
200					

1C) $a = \Delta v/t = (v_f - v_i)/t = (-1-(+1))/0.5 = -2/0.5 = -4$ m/s^2
2B) $v_b = v_d$ (same height) 2E) a = 0, same velocity
3A) 0 N. 3B) k = N/m, so 2,000N/5m = 400 N/m
3F) 5 m 4B) 100g = 0.1 kg Fw = mg, so Fw = 0.1(10) = 1 N
4C) x' = 0.31 m so x = 0.31− 0.25 = 0.06 cm 4E) N/m 4F) pu N on y-axis.