Announcements

1. Remember -- Tuesday, Sept. 30th, 9:30 AM – First exam (covering Chapters 1-8 of HRW)

   Bring:

   a) 1 equation sheet
   b) Calculator
   c) Pencil
   d) Clear head

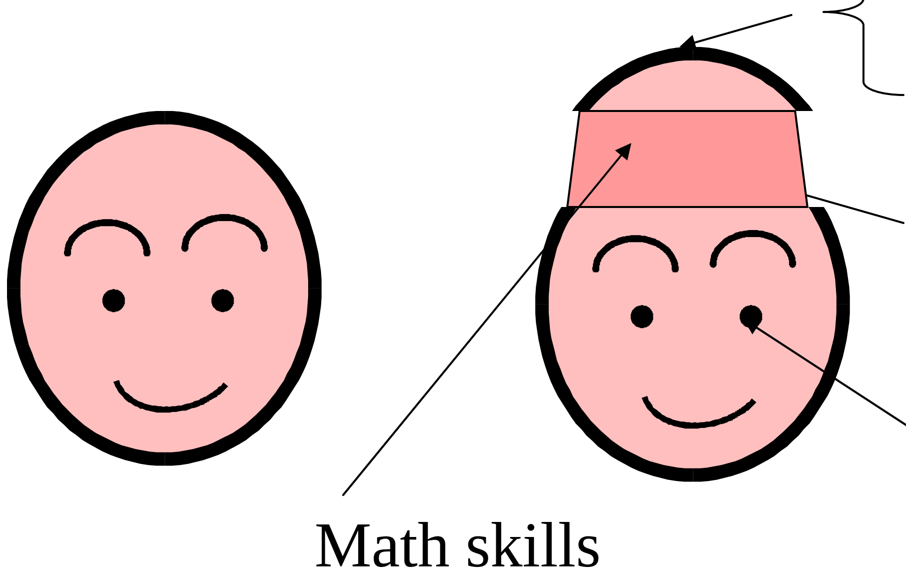
   Note: If you have kept up with your HW, you may drop your lowest exam grade

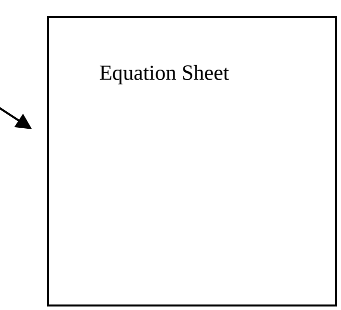
1. Today --Thursday, Sept. 25th, 4 PM – Physics Colloquium by Professor Steven Vogel, James B. Duke Professor of Biology at Duke U. – will discuss the physics of muscles

2. Today's lecture – review Chapters 1-8 problem solving techniques

$$\mathbf{v} = \frac{d\mathbf{r}}{dt} \quad \mathbf{a} = \frac{d\mathbf{v}}{dt}$$

$$\mathbf{F} = m\,\mathbf{a} \qquad W_{i \to f} = \int_i^f \mathbf{F} \cdot d\mathbf{r}$$





Advice:

1. Keep basic concepts and equations at the top of your head.
2. Practice problem solving and math skills
3. Develop an equation sheet that you can consult.

Fundamental concepts and definitions:

$$\mathbf{r}(t) = \int_0^t dt'\,\mathbf{v}(t') = \int_0^t dt' \int_0^{t'} dt''\,\mathbf{a}(t'')$$

$$\mathbf{v}(t) = \frac{d\mathbf{r}(t)}{dt} = \int_0^t dt'\,\mathbf{a}(t')$$

$$\mathbf{a} = \frac{d\mathbf{v}}{dt}$$

$$W_{i\to f} = \int_i^f \mathbf{F}\cdot d\mathbf{r}$$

$$W_{i\to f}^{\text{conservative}} = U(\mathbf{r}_i) - U(\mathbf{r}_f) \qquad U(\mathbf{r}) \equiv -\int_{\mathbf{r}_{ref}}^{\mathbf{r}} \mathbf{F}\cdot d\mathbf{r} \qquad \mathbf{F} = -\nabla U(\mathbf{r})$$

Fundamental “laws”

$$\mathbf{F} = \mathrm{m}\,\mathbf{a}$$

$$\Rightarrow\; W_{i\to f} = \tfrac{1}{2} m v_f^2 - \tfrac{1}{2} m v_i^2$$

$$\tfrac{1}{2} m v_f^2 + U(\mathbf{r}_f) = \tfrac{1}{2} m v_i^2 + U(\mathbf{r}_i) + W_{i\to f}^{\text{nonconservative}}$$

Special cases:

When **F**=(constant), ➔ **a**=(constant)

$\mathbf{v}(t) = \mathbf{v}_i + \mathbf{a}t$; $\mathbf{r}(t) = \mathbf{r}_i + \mathbf{v}_i t + \frac{1}{2} \mathbf{a} t^2$

Special forces:

Gravity near the surface of the earth: $\mathbf{F} = -mg\,\mathbf{j}$

Kinetic friction: $f_k = \mu_k N$ (along surface opposing motion)

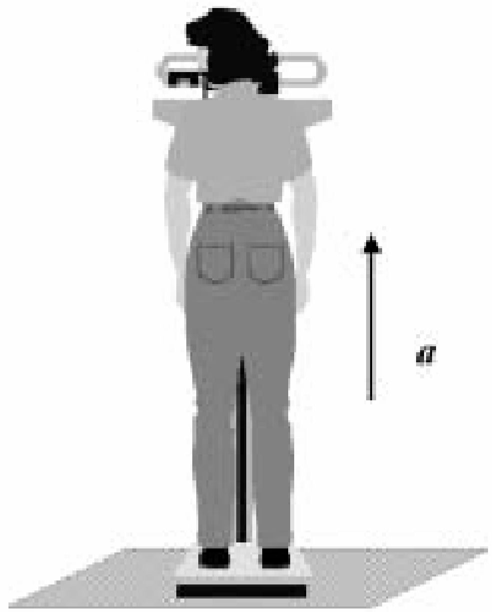
Static friction: $f_s = -F_{applied}$ (for $|f_s| < f_{s,max}$)

$f_{s,max} = \mu_s N$

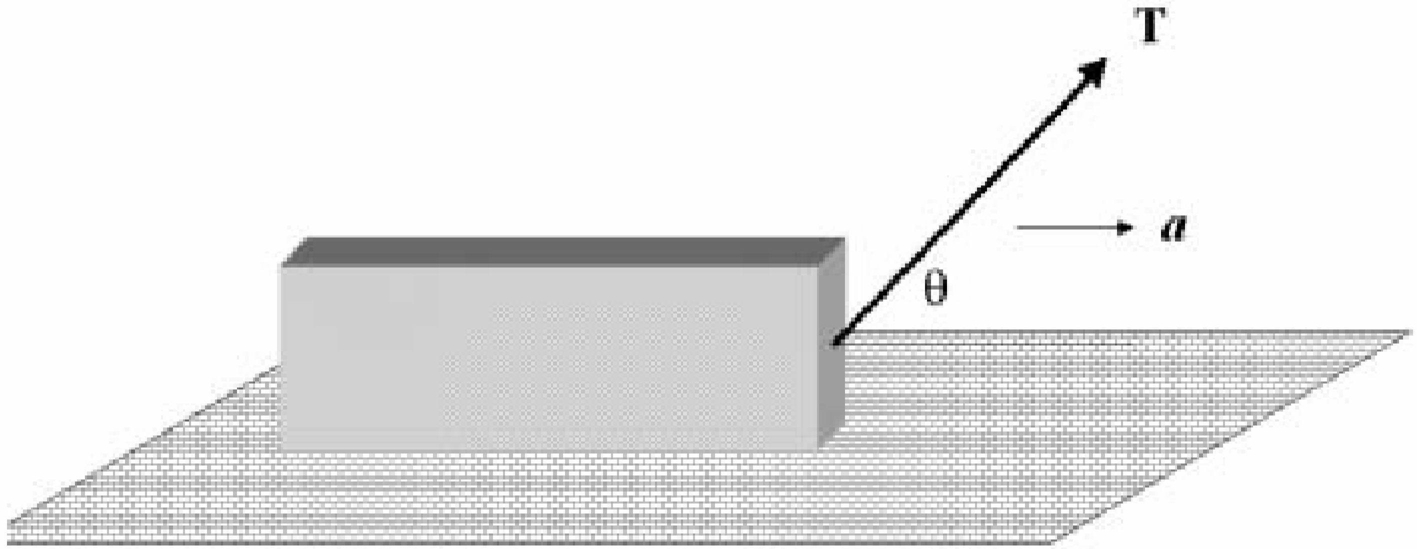
Hooke's law force: $F = -kx$

Problem solving steps

1. Visualize problem – labeling variables
2. Determine which basic physical principle applies
3. Write down the appropriate equations using the variables defined in step 1.
4. Check whether you have the correct amount of information to solve the problem (same number of knowns and unknowns.
5. Solve the equations.
6. Check whether your answer makes sense (units, order of magnitude, etc.).

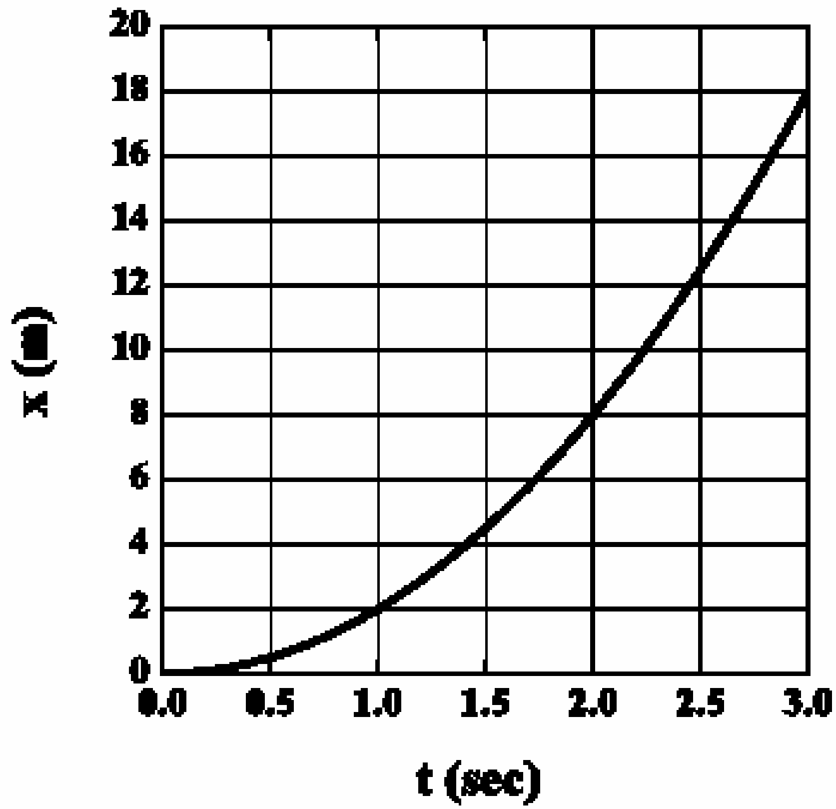


6. Consider the process of measuring weight in an accelerating elevator. Suppose that the elevator is initially rest and the scale (with the person on it) measures 600 N. Now, the elevator accelerates upward at a constant rate of $a = 2.45\ \mathrm{m/s^2}$. What does the scale read now?



7. A heavy box (weight W = 1000 N) is being dragged along the floor with a constant horizontal acceleration $a = 2$ m/s^2 by a rope having a tension **T** at an angle $\theta = 20^o$ measured relative to the horizontal direction. The coefficient of kinetic friction between the box and the floor is $\mu_k = 0.5$. What is the magnitude of the tension **T**?

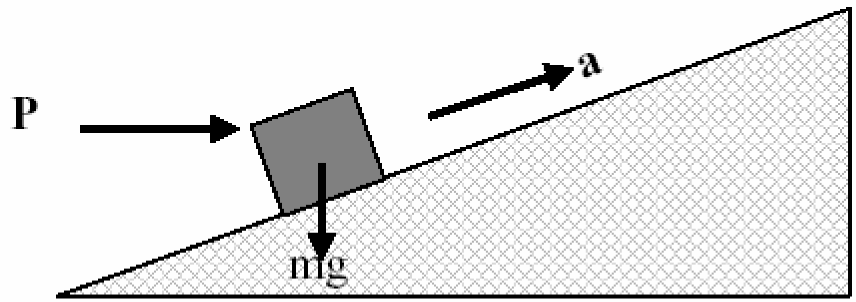
8. In the problem above, assume that the box starts at rest. What is its kinetic energy after it has moved a horizontal distance of 0.4 m?



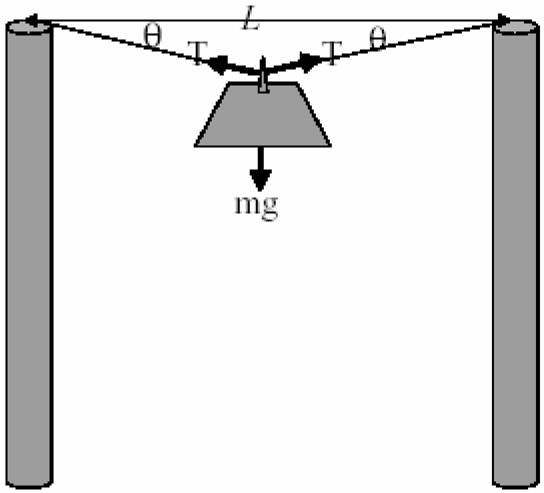
1. Consider the diagram shown above which shows the one-dimensional displacement versus time of a particle. What is

   (a) the *average* velocity $< v >_{avg}$ between the times of $t = 0$ and $t = 3$ s?

   (b) the *instanteous* velocity $v(t)$ at $t = 1$ s?



5. Suppose you are pushing with a horizontal force **P** a box of weight $mg = 300$ N up an incline at a constant acceleration of $a = 0.2$ m/s^2. Assume that the coefficient of kinetic friction between the box and the surface of incline is $\mu_k = 0.2$ and that the angle of the incline is $\theta = 10^o$. What is the magnitude of **P**?



6. A strong rope of length $L = 12$ m is stretched between two poles as shown in the figure. An object of weight $mg = 600$ N is suspended from the center of the rope which now is displaced from the horizontal by an angle of $\theta = 4^o$. What is the magnitude of the tension T in the rope?

RW6 8.P.004. [53202] In Fig. 8-26, a frictionless roller coaster of mass m = 567 kg tops the first hill with speed v_0 = 6.9 m/s.

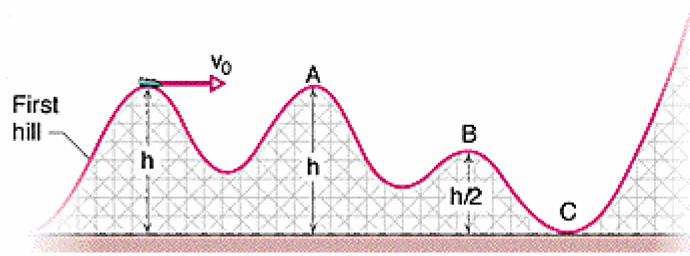


Figure 8-26

Assume that the first hill is h = 37 m tall.

(a) How much work does its weight do on it from that point to point A?

[0.0625] ______ J

(b) How much work does its weight do on it from that point to point B?

[0.0625] ______ J

(c) How much work does its weight do on it from that point to point C?

[0.0625] ______ J

The gravitational potential energy of the coaster-Earth system is taken to be zero at point C.

(d) What is its value when the coaster is at point B?

[0.0625] ______ J

(e) What is its value when the coaster is at point A?

[0.0625] ______ J

(f) If mass m were doubled, would the change in the gravitational potential energy of the system between points A and B increase, decrease, or remain same?

- ○ decrease
- ○ remain same
- ○ increase [0.0625]

4. HRW6 8.P.026. [53215] Tarzan, who weighs 653 N, swings from a cliff at the end of a convenient vine that is 24 m long (Fig. 8-44). From the top of the cliff to the bottom of the swing, he descends by 3.2 m. The vine will break if the force on it exceeds 950 N.

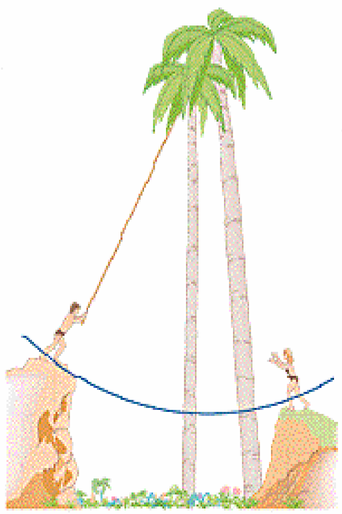


Figure 8-44

(a) Does the vine break?

- yes
- no [0.0625]

(b) What is the greatest force on the vine during the swing?

[0.0625] ______ N

At what angle does it break?

- 17°
- 10°
- The question is irrelevant since the vine does not break.
- None of these answers is correct.
- 28° [0.0625]

5. HRW6 8.P.036. [245811] A conservative force $F(x)$ acts on a 3.0 kg particle that moves along the x axis. The potential energy $U(x)$ associated with $F(x)$ is graphed in Fig. 8-43. When the particle is at x = 3.0 m, its velocity is -1.0 m/s. The "kinks" in the graph occur at (1, -2.8), (4, -17.2), and (8.5, -17.2); and the endpoint is at (15, -2).

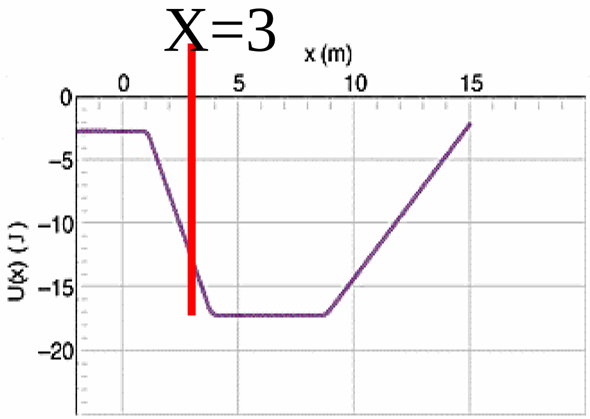


Figure 8-43

(a) What are the magnitude and direction of $F(x)$ at this position?

Magnitude

[0.0625] ______ N

Direction

- positive x
- negative x [0.0625]

(b) Between what limits of x does the particle move?

[0.0625] ______ m (lower limit)

[0.0625] ______ m (upper limit)

(c) What is its speed at x = 7.0 m?

[0.0625] ______ m/s

5. HRW6 7.P.026. [53190] The only force acting on a 2.3 kg body as it moves along the x axis varies as shown in Fig. 7-33. The velocity of the body at $x = 0$ is 4.0 m/s.

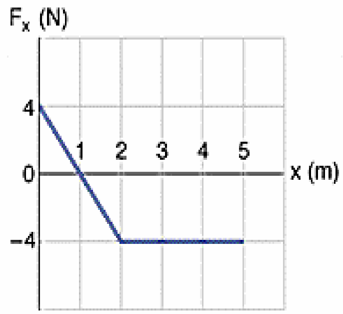


Figure 7-33

(a) What is the kinetic energy of the body at $x = 3.0$ m?

[0.1052632] ______ J

(b) At what value of x will the body have a kinetic energy of 8.0 J?

[0.1052632] ______ m

(c) What is the maximum kinetic energy attained by the body between $x = 0$ and $x = 5.0$ m?

[0.1052632] ______ J