06JAN11

- HW ✓ & Q & A
- Warm-up: decay problem
- My Snow Problem (Integration as Accumulation)
- Elastic (spring) Potential Energy
- Work done by a variable force
- Derivation of $\frac{1}{2}mv^2$
- Power
- ~~Intro to Chapter 8 (C of E)~~
- Homework Assignment

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~~[illegible]~~ = 5 m/s at 30° to the horizontal.

4 Figure 7-18*a* shows two horizontal forces that act on a block that is sliding to the right across a frictionless floor. Figure 7-18*b* shows three plots of the block's kinetic energy K versus time t. Which of the plots best corresponds to the following three situations: (a) $F_1 = F_2$, (b) $F_1 > F_2$, (c) $F_1 < F_2$?

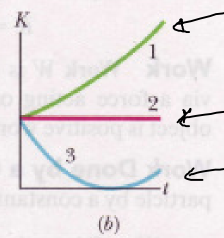
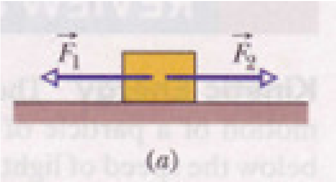


FIG. 7-18 Question 4.

increases

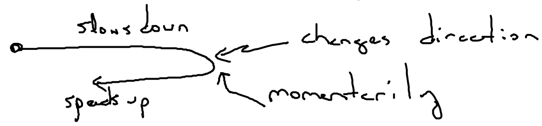
constant

decreases then increases



(a) $F_1 = F_2$, $\Sigma F = 0$ no $\Delta K \Rightarrow$ (2)
slides to right at constant v

(b) initially sliding to right with $F_1 > F_2$



(3)

(c) $F_1 < F_2$ speeds up to the right (1)

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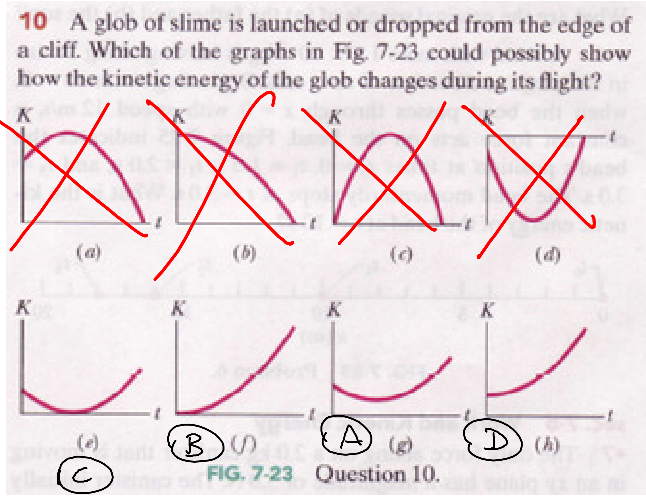
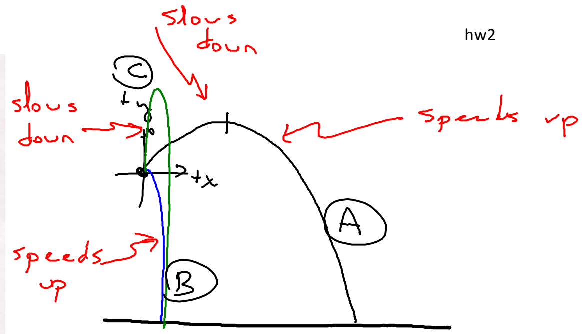
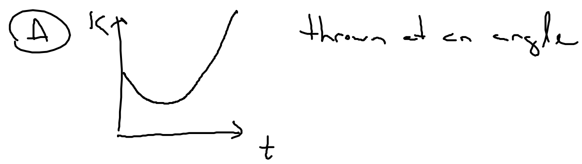
hw2

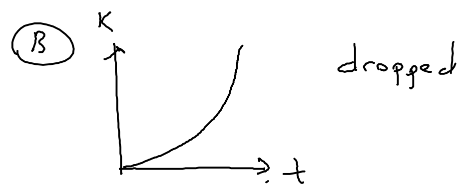


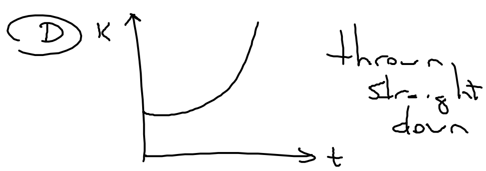
10 A glob of slime is launched or dropped from the edge of a cliff. Which of the graphs in Fig. 7-23 could possibly show how the kinetic energy of the glob changes during its flight?

FIG. 7-23 Question 10.









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••5 A father racing his son has half the kinetic energy of the son, who has half the mass of the father. The father speeds up by 1.0 m/s and then has the same kinetic energy as the son. What are the original speeds of (a) the father and (b) the son?

my calculator was on FLOAT 1

$$\boxed{\begin{aligned} K_f &= \tfrac{1}{2} K_s \\ m_s &= \tfrac{1}{2} m_f \end{aligned}} \Longrightarrow 2K_f = K_s$$

$$K_f = \tfrac{1}{2} m_f v_f^2 \Longrightarrow \underbrace{K_f' = \tfrac{1}{2} m_f v_f'^2 = \tfrac{1}{2} m_f (v_f + 1\,\tfrac{m}{s})^2}$$

$$K_s = \tfrac{1}{2} m_s v_s^2$$

$$K_f' = K_s$$

$$\tfrac{1}{2} m_f (v_f + 1\,\tfrac{m}{s})^2 = 2K_f$$

$$\cancel{\tfrac{1}{2}} \cancel{m_f} (v_f + 1\,\tfrac{m}{s})^2 = 2 \cdot \cancel{\tfrac{1}{2}} \cancel{m_f} v_f^2$$

$$v_f^2 + 2v_f + 1 = 2v_f^2$$

$$x^2 - 2x - 1 = 0 \qquad v_f^2 - 2v_f - 1 = 0$$

$$v_f = 2.4,\ -0.4$$

$$\boxed{v_f = 2.4\,\tfrac{m}{s}}$$

then, $K_f = \tfrac{1}{2} K_s$

$$\tfrac{1}{2} m_f v_f^2 = \tfrac{1}{2}\left(\tfrac{1}{2} m_s v_s^2\right) \Longrightarrow \cancel{\tfrac{1}{2}} \cancel{m_f} v_f^2 = \cancel{\tfrac{1}{2}}\left(\tfrac{1}{2} \cdot \tfrac{1}{2} \cancel{m_f} \cdot v_s^2\right)$$

$$v_f^2 = \tfrac{1}{4} v_s^2$$

$$v_s = \pm\sqrt{4 v_f^2} = \pm 2 v_f$$

$$= 2\,(2.4\,\tfrac{m}{s}) = \boxed{4.8\,\tfrac{m}{s}}$$

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if $v_f = -0.4\,\text{m/s}$

$$v_s = 2(-0.4\,\text{m/s}) = -0.8\,\text{m/s}$$

let's say $m_f = 10\,\text{kg} \Rightarrow m_s = 5\,\text{kg}$

$v_f = 2.4\,\text{m/s}$ & $v_s = 4.8\,\text{m/s}$	$v_f = -0.4\,\text{m/s}$ & $v_s = -0.8\,\text{m/s}$
$K_f = \frac{1}{2}(10\,\text{kg})(2.4\,\text{m/s})^2 = 28.8\,\text{J}$	$K_f = \frac{1}{2}(10\,\text{kg})(-0.4\,\text{m/s})^2 = 0.8\,\text{J}$
$K_s = \frac{1}{2}(5\,\text{kg})(4.8\,\text{m/s})^2 = 57.6\,\text{J}$	$K_s = \frac{1}{2}(5\,\text{kg})(-0.8\,\text{m/s})^2 = 1.6\,\text{J}$
true, $K_f = \frac{1}{2}K_s$	true $K_f = \frac{1}{2}K_s$

either is true!

Wednesday, January 05, 2011
4:05 PM

Lets say $K_s = 20J \Longrightarrow K_f = 10J$

$$\underbrace{m_s = 5kg}$$ $\qquad m_f = 10kg$

$20J = \frac{1}{2}(5kg)v_s^2 \qquad 10J = \frac{1}{2}(10kg)v_f^2$

$v_s = 2.8\,m/s \qquad v_f = 1.4\,m/s$

this method won't work because adding $1\,m/s$ to v_f does not produce

$$K_f' = K_s$$

$$K_f' = \frac{1}{2}(10kg)(1.4\,m/s + 1\,m/s)^2 = 28.8J \neq 20J = K_s$$

•9 A 3.0 kg body is at rest on a frictionless horizontal air track when a constant horizontal force $\vec{F}$ acting in the positive direction of an x axis along the track is applied to the body. A stroboscopic graph of the position of the body as it slides to the right is shown in Fig. 7-26. The force $\vec{F}$ is applied to the body at $t = 0$, and the graph records the position of the body at 0.50 s intervals. How much work is done on the body by the applied force $\vec{F}$ between $t = 0$ and $t = 2.0$ s?

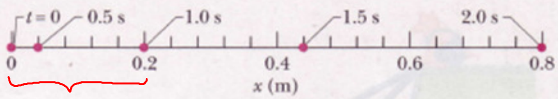

FIG. 7-26 Problem 9.

$a = ?$

$\Delta t = 1s$

$x = 0.2m$

$v_0 = 0$

$$x = \cancel{v_0 t}^{\,0} + \tfrac{1}{2} a t^2$$

$$a = \frac{2x}{t^2} = \frac{2(0.2m)}{(1s)^2} = 0.4 \, m/s^2$$

$v = ?$ $\quad a = \dfrac{v - \cancel{v_0}^{\,0}}{t} \Rightarrow v = at$

$= (0.4 \, m/s^2)(2s)$

$v = 0.8 \, m/s$

$$W = \Delta K = K_f - \cancel{K_i}^{\,0} = \tfrac{1}{2} m v^2 = \tfrac{1}{2}(3kg)(0.8 \, m/s)^2 = \boxed{0.96 \, J}$$

or

$$W = F_x d_x = m a_x d_x = (3kg)(0.4 \, m/s^2)(0.8m) = \boxed{0.96 \, J}$$

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••11 A luge and its rider, with a total mass of 85 kg, emerge from a downhill track onto a horizontal straight track with an initial speed of 37 m/s. If a force slows them to a stop at a constant rate of 2.0 m/s², (a) what magnitude F is required for the force, (b) what distance d do they travel while slowing, and (c) what work W is done on them by the force? What are (d) F, (e) d, and (f) W if they, instead, slow at 4.0 m/s²?

$m = 85\,kg$

$v_0 = 37\,m/s$

$v = 0$

$a = -2\,m/s^2$

(a) $F = ma = (85\,kg)(-2\,m/s^2)$

$\|F\| = \boxed{170\,N}$

(b) $x = \dfrac{\cancel{v^2}^{\,0} - v_0^2}{2a} = \dfrac{-(37\,m/s)^2}{2(-2\,m/s^2)} = 342.25\,m$

thus, distance is $\boxed{342.25\,m}$

(c) $W = \vec{F} \cdot \vec{d} = (-170\,N)(342.25\,m)$

$= \boxed{-58{,}182.5\,J}$

if $a = -4\,m/s$

(d) $\|\vec{F}\| = 340\,N$

(e) $x = 171.125\,m$

(f) $W = 58182.5\,J$

* by doubling a, we double F but half x ∴ same result

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••21 In Fig. 7-32, a constant force $\vec{F}_a$ of magnitude 82.0 N is applied to a 3.00 kg shoe box at angle $\phi = 53.0°$, causing the box to move up a frictionless ramp at constant speed. How much work is done on the box by $\vec{F}_a$ when the box has moved through vertical distance $h = 0.150$ m?

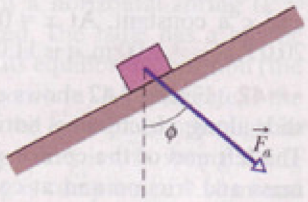

FIG. 7-32 Problem 21.

Since it's moving up the ramp at constant v, $\Delta K = 0$

thus, the work done by $\vec{F}_a$ is equal to the negative work done by the force of gravity $\Longrightarrow W_a = -W_g$

$$W_a = -W_g = --f_g h = +mgh$$

$$= (3\,kg)(9.8\,m/s^2)(0.15\,m)$$

$$= \boxed{4.41\,J}$$

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WARM UP The half-life of Pu-239 is 24,100 years. Suppose that 10 grams of Pu-239 was released in the Chernobyl nuclear accident. How long will it take for the 10 grams to decay to 1 gram?

$$\frac{dN}{dt} = kN \Rightarrow \int \frac{dN}{N} = \int k\,dt$$

$$\ln|N| = kt + C$$

$$\text{Since } N \geq 0 \Rightarrow e^{\ln N} = e^{kt + C}$$

$$N = e^{kt+C}$$

$$N = e^{C} e^{kt}$$

$$N = Ce^{kt}$$

$$@\, t = 0 \Rightarrow N = Ce^{0} \Rightarrow C = N_0$$

$$N = N_0 e^{kt}$$

$$N = 10e^{kt}$$

$$5 = 10e^{k \cdot 24{,}100}$$

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Solve for k: $\ln\frac{1}{2} = \ln e^{24100k}$

$$\ln\left(\frac{1}{2}\right) = 24{,}100k$$

$$k = -2.876 \times 10^{-5}$$

$$N = 10e^{-2.876 \times 10^{-5} t}$$

$$1 = 10e^{-2.876 \times 10^{-5} t}$$

Section 6.2

$$\ln \frac{1}{10} = \ln e^{-2.876 \times 10^{-5} t}$$

$$\ln\left(\frac{1}{10}\right) = -2.876 \times 10^{-5} t$$

$t = 80{,}062$ yrs

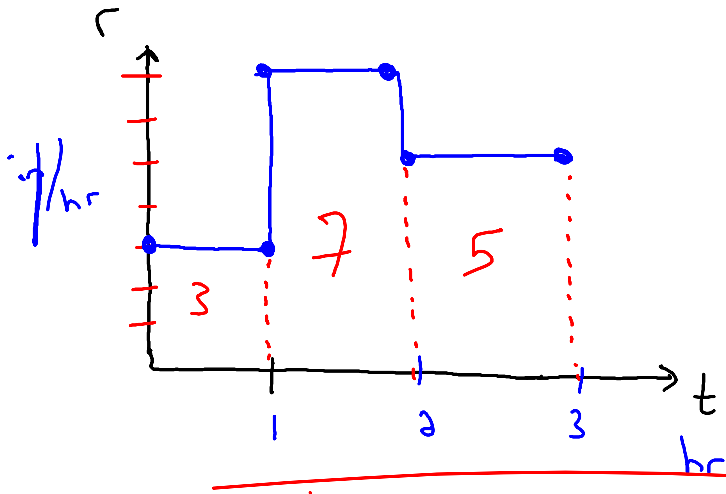
$t = 80{,}058$ yrs

My Snow Problem

Part One

Snow

hr	r
$0 \to 1$	3 in/hr
$1 \to 2$	7 in/hr
$2 \to 3$	5 in/hr



$\boxed{\text{15 in total}}$

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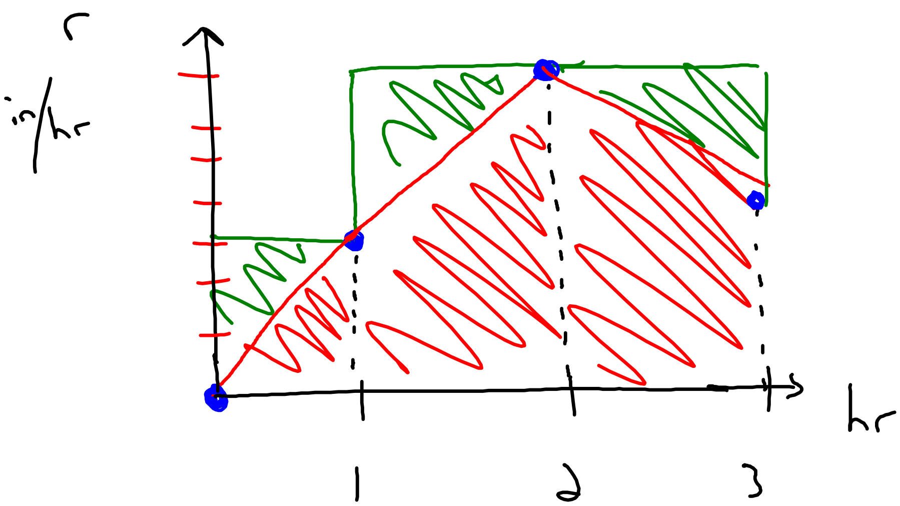
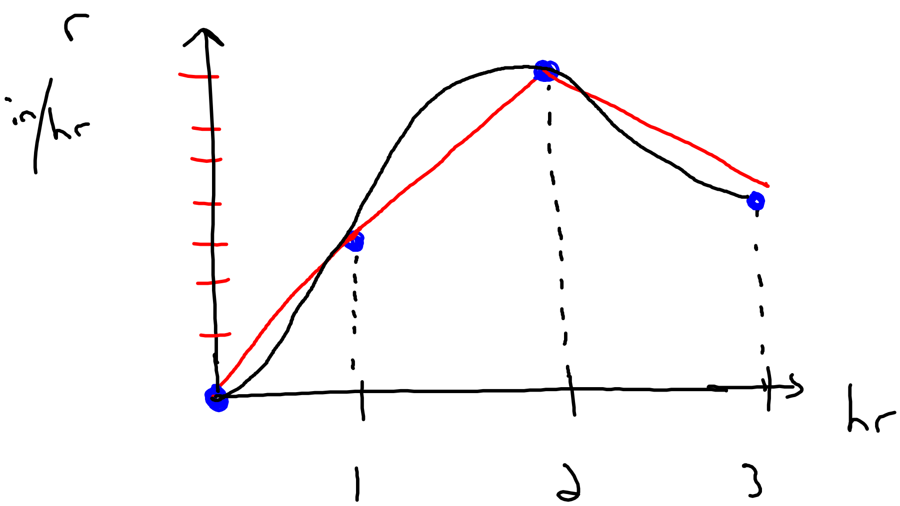
My Snow Problem

Part Two

t	r
0	0
1	3
2	7
3	5





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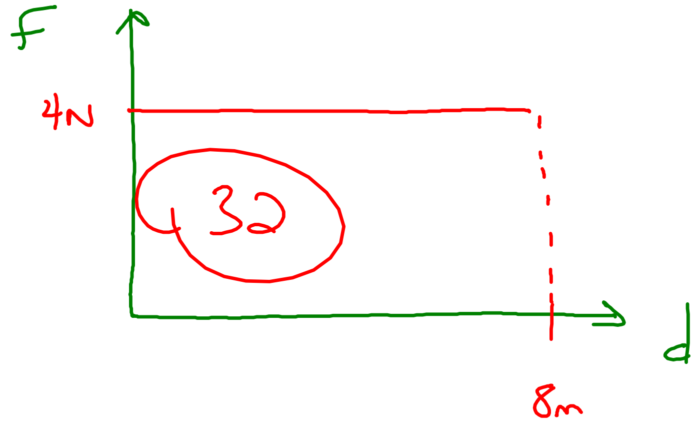
Work done by a variable force

first, let's look at the case with constant F



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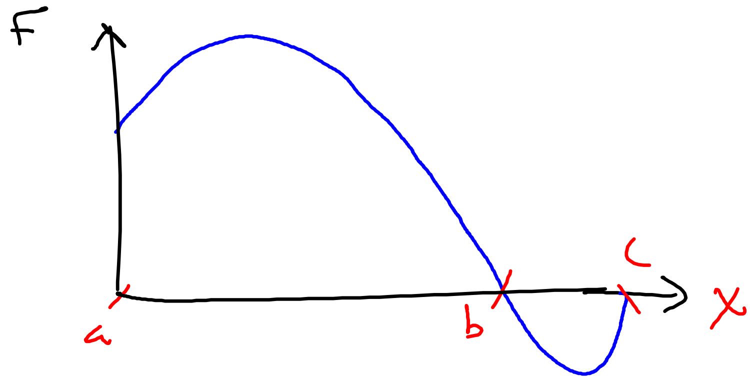
now, let's look at a variable force



Work from a to b $\quad W = \int_a^b F(x)\,dx$

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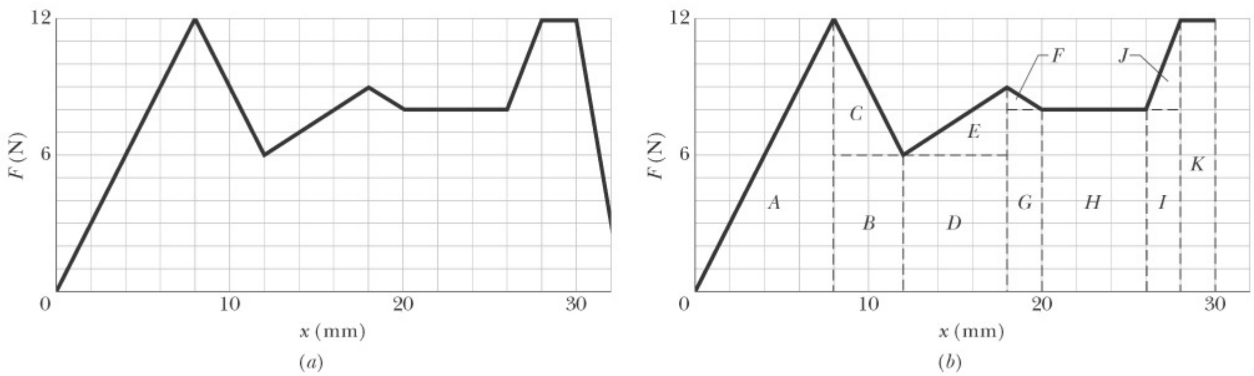

also, given an acceleration graph

ex from an equation

$m = 8\,kg$, from $t = 1s$ to $t = 5s$

$x = 4t^4 - 5t^2 + 6t + 3$

$v = \frac{dx}{dt} = 16t^3 - 10t + 6$

$v(1) = 16 - 10 + 6 = 12\,m/s$ $v(5) = 1956\,m/s$

$K_i = \frac{1}{2}mv_i^2 = 576\,J$

$K_f = \frac{1}{2}mv_f^2 = 15{,}303{,}744\,J$

$W = \Delta K = K_f - K_i = 15{,}303{,}168\,J$

$a = \frac{dv}{dt} = 48t^2 - 10$

$F = ma$ finish tomorrow

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☆ Homework Assignment ☆

- study for tomorrow's quiz
- HRW Chapter 7

  Questions: 7, 8

  Problems: 34, 36, 37, 40, 43, 44

DUE MONDAY

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