7-1 force vectors (a) are conservative. vectors (b) are not conservative because the vector field on the right side of the square is stronger (larger in magnitude) than the ones on the left side. The work by going around in a square closed path would not be zero

7-2 The work-energy theorem $\Delta K = W_{net}$ (Eq 6.14 on p. 94) is, yes, based on N's second law, but the conservation of energy is valid only for the case of conservative forces. The existence of conservative forces is not based on any of N's three laws. Once the internal energy (like heat) of a system is included, then again the conservation (extended) law becomes again valid.

7-3 We cannot define a pot'l energy associated with friction, because the friction force is non-conservative (the energy lost to friction will not be returned to the system when you backtrack) See problem 7-11

7-4 Kinetic energy (being the square of a velocity x mass) cannot be negative. But both PE and Total Energy can (yes) be negative.

7-10 at points B and D, where the slope of the curve U vs x is largest, is the magnitude of the force largest.

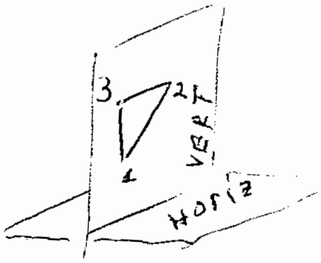
7-11 :


Force of friction $= mg\mu$, opposite to the direction of motion

path a) work $= -2L * mg\mu$

" b) " $= -\sqrt{L^2+L^2} * mg\mu$ } not equal.

7-12

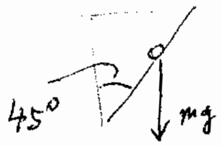



Triangle lies in vertical plane.

path a) : $1 \to 3 + 3 \to 2$

work $= -mg \cdot L + 0$

path b)




$mg\cos\theta =$ component of weight along the diagonal

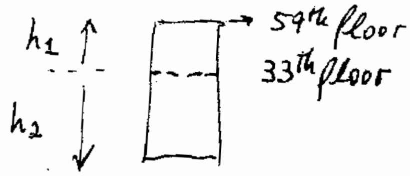
$= -mg\cos(45)$

work = length * component of force

$= \sqrt{2L^2} \times mg\underbrace{\cos(45^\circ)}_{\frac{1}{\sqrt{2}}} = -L \cdot mg$

same as a)

7-13 : Example 7.1 ③




$h_1 = (59-33) \times 3.5\ m = 91\ m$

$h_2 = 33 \times 3.5 \qquad = 115.5\ m$

relative to 33th floor $(U=0)$, $U_{59} = h_1 \cdot \overbrace{m \cdot g}^{539\ kgm} = 91 \times 55 \times 9.8 = 49 \times 10^3$ J

$U_{\cancel{ground}\,0} = -h_2 mg = -115.5 \times 539 = -62.2 \times 10^3$ J

$U_{33} = 0$

relative to the ground floor:

$U'_{33} = h_2 \times mg = +62.2 \times 10^3$ J

$U'_{59} = (h_1 + h_2) \times mg = 206.5 \times 539 = 11{,}130$ J

$U'_0 = 0$

These potential energies $U_{33} - U'_{33}$, $U_{59} - U'_{59}$, $U_0 - U'_0$
all differ by the same constant $-62.2 \times 10^3$ J

7-14 : PE of hiker $m = 70$ kg

a) atop Mt Washington $1900\,m \times 70\,kg \times 9.8\ m/s^2 = 1.30 \times 10^6$ J

b) In death valley $(-86\ m) \times 70\,kg \times 9.8\ m/s^2 = -5.90 \times 10^4$ J

7.27 : $F = -\frac{dU}{dx}$

a) $F = -3/1.5 = -2$ N

b) $F = 0$

c) $F = -(-1-3)/(3-2.5) = 4/0.5 = 8$ N

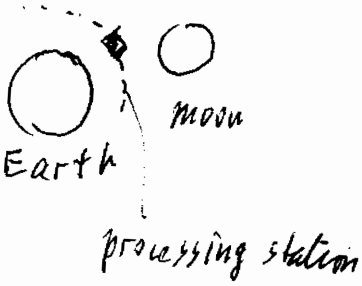
d) $F = -(-2-(-1))\,(4-3) = +1$ N

e) $F = -(2-(-2))/(5-4) = -4$ N

f) $F = 0$

Bonus 7-68 Ore mined on moon






to escape moon: speed 2.4 km/s

$\frac{1}{2} m v^2 = \frac{1}{2} k x^2$

$m$: 1000 kg ore

$v$: escape velocity

$k$: spring constant

$x$ = compression = 15 m

$$\frac{1}{2} \times 10^3 \text{kg} \times \left(2.4 \times 10^3 \text{m/s}\right)^2 = \frac{1}{2} k \times (15 \text{m})^2$$

$$k = \frac{10^3 \times (2.4 \times 10^3)^2}{(15)^2} = 10^3 \times 25.6 \times 10^3 = 25.6 \times 10^6 \text{ N/m}$$

absurdly large