Summary notes concerning work and energy:

· Kinetic energy $KE = \frac{1}{2}mv^2$

· Work $d(work) = dl\cdot(\text{force in direction of } d\vec{l}\,)$
$= \text{force}\cdot(dl \text{ in direction of } \vec{F}\,)$
$= \text{force}\cdot dl\cdot\cos(\text{smallest angle between } d\vec{l} \text{ and } \vec{F}\,)$
(here "*d*" means a little bit of")
Work = sum of all d(work)'s

· Work-energy theorem

Net work done by all forces $= \Delta KE$

· Conservative forces are forces that
*** depend on the position of *m* only**
*** do positive work when *m* goes in one direction and negative work when *m* goes in the other direction**
*** do zero net work when *m* goes through a round trip**

Examples of conservative forces: gravity, force exerted by a spring, macroscopic electrical forces
Examples of nonconservative forces: kinetic and static friction, normal forces, tension

· Change in potential energy associated with a conservative force

$$\Delta PE = -\text{work done by the conservative force}$$

Examples of potential energies: gravity—$\Delta PE = mg\Delta y$, spring—$\Delta PE = k\Delta(x^2)/2$

· Another way of writing the work-energy theorem

$$\begin{gathered}\text{Net work done by all forces} \\ = \text{net work done by conservative forces} + \text{net work done by nonconservative forces} \\ = -\Delta PE + \text{net work done by nonconservative forces} \\ = \Delta KE\end{gathered}$$

OR

net work done by nonconservative forces $= \Delta KE + \Delta PE = \Delta(KE + PE)$

· Mechanical energy $ME = KE + PE$
· Conservation of mechanical energy
When nonconservative forces do no work, mechanical energy is conserved:

$$0 = \Delta(KE + PE)$$

Note: On the microscopic level mechanical energy is *always* conserved. Microscopic mechanical energy can be converted into macroscopic mechanical energy—as when you push an

object (potential energy stored in molecules in your cells is transferred to the motion of the object being pushed). Macroscopic mechanical energy can be converted into microscopic mechanical energy—as when kinetic friction causes a moving object to slow down; then the coherent motion of many atoms in the object is converted into incoherent motion of atoms (with a net rise in temperature being the result).