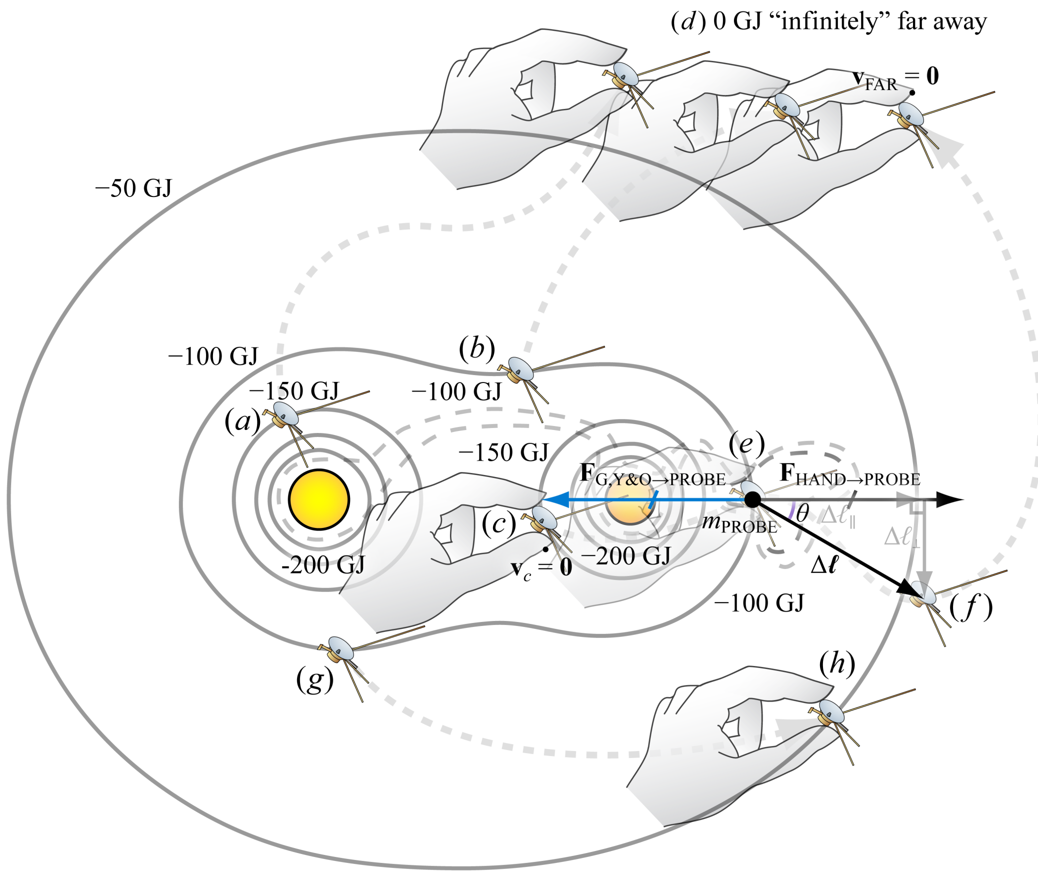
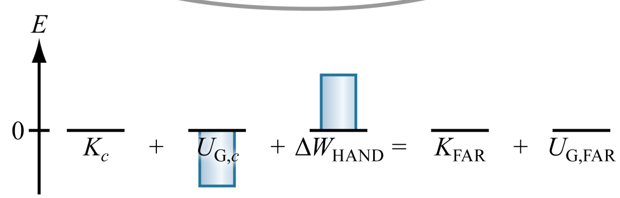
Potential energy landscapes

Use differences in isoline labels to calculate amounts of work needed for transport between positions

$$-\Delta U_{\mathrm{F},1\ldots N} := \Delta W_{\mathrm{F},2\to 1} + \Delta W_{\mathrm{F},1\to 2} + \cdots + \Delta W_{\mathrm{F},N-1\to N}$$





Fix the position of each object except for one and make a map of potential energy as a function of the position of this single moveable object.

isoline – drawing of set of points on a map that share the same value of a variable of interest (e.g. potential energy isoline)

Consider a portion of a path along which the hand applies a force $\vec{\mathbf{F}}_{\mathrm{HAND}}$ that is locally anti/parallel to the displacement and basically balances out the force $\vec{\mathbf{F}}$ associated with the potential energy landscape.

$$|\Delta W_{\mathrm{HAND}}| = |\vec{\mathbf{F}}_{\mathrm{AVG}}||\cos\theta|\Delta\ell$$

$$|\Delta U_{\mathrm{F}}| = |\vec{\mathbf{F}}_{\mathrm{AVG}}|\Delta\ell_{\parallel}$$

$$|\vec{\mathbf{F}}_{\mathrm{AVG}}| = \frac{|\Delta U_{\mathrm{F}}|}{\Delta\ell_{\parallel}}$$

($\vec{\mathbf{F}}$ points "downhill")

Potential energy landscapes

Interpret graphs of potential energy functions

$$-\Delta U_\mathrm{F} := \Delta W_\mathrm{F}$$

For motion constrained to x-axis,

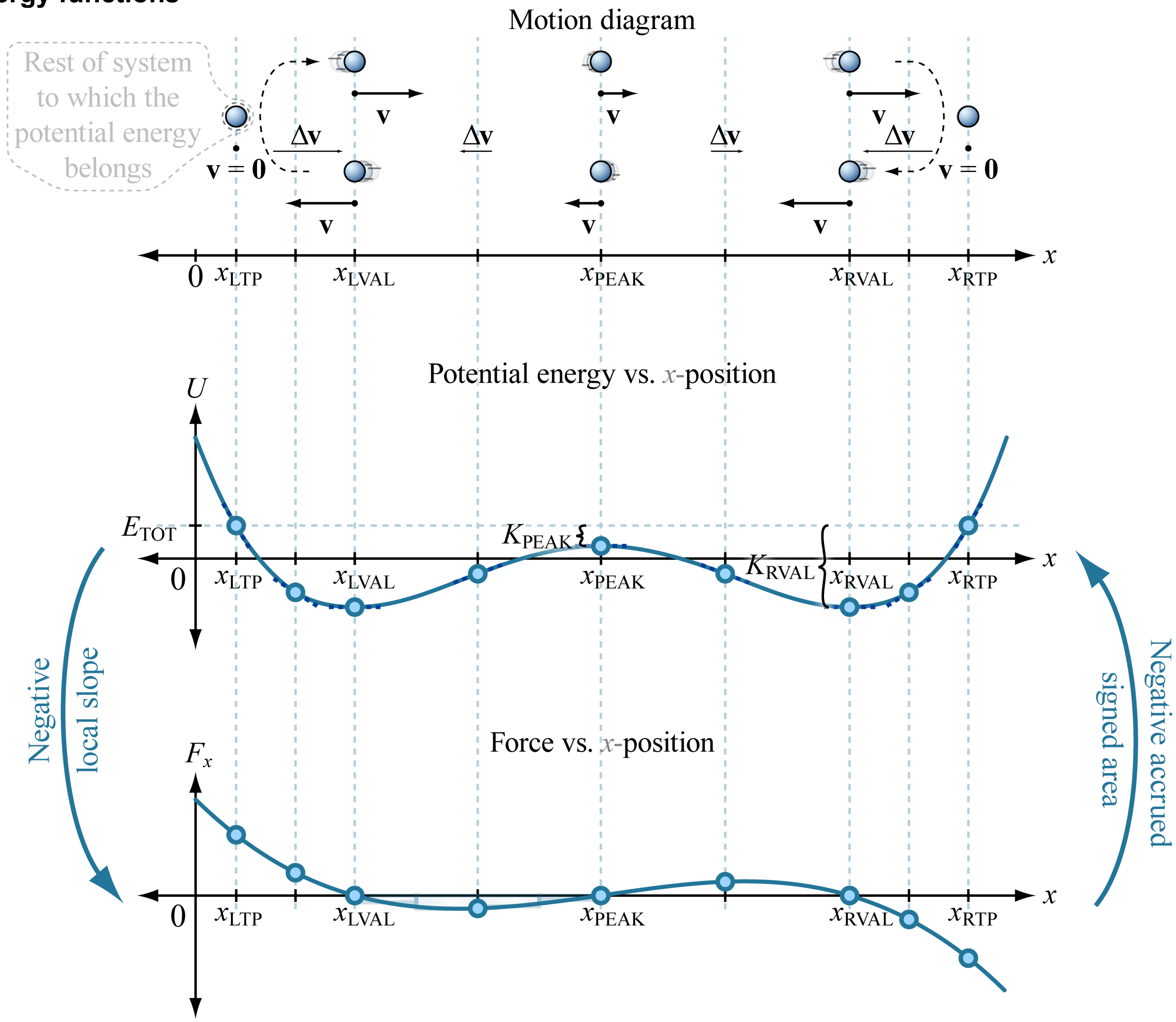
$$\Delta U_\mathrm{F} = -F_{x,\mathrm{AVG}}\,\Delta x$$

$$\Delta U_\mathrm{F} = -\left(\begin{array}{c}\text{Signed area}\\ \text{under graph of}\\ F_x \text{ vs. } x\end{array}\right)$$

The negative of the accrued signed area under the graph of the force function* provides the change in potential energy.

$$F_{x,\mathrm{AVG}} = -\frac{\Delta U_\mathrm{F}}{\Delta x}$$

The negative of the slope of the potential energy function provides the force.



* If force cannot be expressed as a function of position alone, then no associated potential energy function exists.