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Variational Mechanics in One and Two Dimensions¹

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We develop heuristic derivations of two alternative principles of least action to be introduced early in the undergraduate physics curriculum. A particle moving in one dimension can reverse direction at will if energy conservation is the only criterion. Such arbitrary changes in direction of motion are eliminated by demanding that *abbreviated action*, the area under the momentum *vs.* position curve in the phase diagram, have the smallest possible value consistent with conservation of energy. Minimizing abbreviated action predicts particle trajectories in two (and three) dimensions and leads to the more powerful principle of least action of Hamilton, which not only generates conservation of energy but also predicts motion even when potential energy changes with time.

¹Jozef Hanc, Slavomir Tuleja