79. Although we do not show graphs here, we do jot down down an idea for each part.

(a) Find the center of mass of a rod in which the density is not uniform. If the rod extends along the $x$ axis from the origin to $x = 5$ m, then with mass-per-unit-length (as a function of $x$) equal to $e^{-x}$ in SI units, use Eq. 9-9 to find $x_{\text{com}}$. *A sketch of the solution is*

$$x_{\text{com}} = \frac{1}{M}\int_0^5 xe^{-x}dx \approx 37 \text{ m}$$

where $M$ was figured from $\int_0^5 e^{-x}dx \approx 1$ kg.

(b) A firecracker is dropped from a height of 20 m. Halfway down it explodes into two identical pieces. As a result of the explosion, one of the pieces is (momentarily) at rest. What is the speed of the other piece immediately after the explosion? *A sketch of the solution is*

$$v_{\text{firecrack}} = \sqrt{2g(10\,\text{m})} = 14 \text{ m/s}$$

and we use momentum conservation:

$$mv_{\text{firecrack}} = \frac{m}{2}v_{\text{piece}} \implies v_{\text{piece}} = 28 \text{ m/s} .$$

(c) An 80 kg person is climbing a ladder at a steady rate of 25 cm/s. If we assume his total power output $P$ is three times his rate of gaining gravitational potential energy, then compute $P$. *The solution is*

$$P = 3\frac{\Delta U}{\Delta t} = 3\frac{mg\Delta y}{\Delta t} \approx 590 \text{ J}$$

where $\Delta t = 1$ s and $\Delta y = 0.25$ m.

(d) Unlike the ideal physics of point particles moving through a vacuum, a runner cannot continue at a constant velocity effortlessly. If a runner's total power output is 650 W while running at 5.8 m/s, then what is the force retarding him (which includes several friction-related effects)? *The solution is*

$$P = Fv = \implies F = \frac{P}{v} \approx 110 \text{ N} .$$