8.77 Convert the final speed of the car from \( \text{km/h} \) to \( \text{m/s} \).

\[
v = 150 \text{ km/h} = (150 \text{ km/h}) \left( \frac{10^3 \text{ m}}{\text{km}} \right) \left( \frac{h}{3600 \text{ s}} \right) = 41.7 \text{ m/s}.
\]

According to the CWE theorem, the work done by the total force is equal to the change in the kinetic energy of the car, so

\[
W_{\text{total}} = \Delta K E = \frac{mv_f^2}{2} - \frac{mv_i^2}{2} = \frac{(1.00 \times 10^3 \text{ kg})[(41.7 \text{ m/s})^2 - (0 \text{ m/s})^2]}{2} = 8.69 \times 10^5 \text{ J}.
\]

The average power of the total force is

\[
P_{\text{ave}} = \frac{W_{\text{total}}}{\Delta t} = \frac{8.69 \times 10^5 \text{ J}}{8.00 \text{ s}} = 1.09 \times 10^5 \text{ W} = 109 \text{ kW}.
\]

8.78 Choose a coordinate system with \( \hat{i} \) pointing in the direction the spring is stretched, and with origin at the equilibrium position of the mass. So at any time, \( x(t) \) is the position of the mass from its equilibrium position.

a) The position of the oscillator at any instant is \( x(t) = A \cos(\omega t + \phi) \). When \( t = 0 \text{ s} \), the position is \( x = A \), so when \( t = 0 \text{ s} \),

\[
A = A \cos \phi \implies \cos \phi = 1 \implies \phi = 0 \text{ rad}.
\]

Hence

\[
x(t) = A \cos(\omega t).
\]

b) The velocity component is

\[
v_x(t) = \frac{dx(t)}{dt} = -A \omega \sin(\omega t).
\]

c) When \( t = 0 \text{ s} \), the velocity \( \vec{v} = 0 \text{ m/s} \), so at this time the instantaneous power of the force is

\[
P = \vec{F} \cdot \vec{v} = \vec{F} \cdot (0 \text{ m/s}) = 0 \text{ W}.
\]

d) At the position \( x = 0 \text{ m} \), the force \( \vec{F} = 0 \text{ N} \), so at this time the instantaneous power of the force is

\[
P = \vec{F} \cdot \vec{v} = (0 \text{ N}) \cdot \vec{v} = 0 \text{ W}.
\]

e) The instantaneous power of the force is

\[
P = \vec{F} \cdot \vec{v} = [-kx(t)\hat{i} \cdot \vec{v}(t)] = [-kA \cos(\omega t)]\hat{i} \cdot [-A \omega \sin(\omega t)]\hat{i} = k\omega A^2 \cos(\omega t) \sin(\omega t) = \frac{k\omega A^2}{2} \sin(2\omega t).
\]

f) The power is a maximum for the first time when the argument of the sine function is \( \frac{\pi}{2} \) rad. That is, when

\[
2\omega t = \frac{\pi}{2} \implies t = \frac{\pi}{4\omega}.
\]

Since \( \omega = 2\pi \nu \), and the period \( T = \frac{1}{\nu} \), then

\[
t = \frac{1}{8\nu} = \frac{T}{8}.
\]

g) During one complete oscillation, the mass returns to its original position. The force on the oscillator is conservative, so the total work done by this force is zero over any closed path, in particular the path traversed during any period \( T \). Hence, the average power of the total force over a whole period is 0 W.