$\boxed{10.1}$



$F_1 = 89.0\,N$
$x_1 = 0.0191\,m$

Since $F = kx \longrightarrow k = F/x$

$$\therefore\ k = F_1/x_1 = \frac{89.0\,N}{0.0191\,m} = 4659.7\ N/m.$$

Now that the spring constant is known, we can again use $F = kx$ (Hooke's law) to determine $F_2$ when $x_2 = 0.0508\,m$:

$$F_2 = kx_2 = (4659.7\ N/m)(0.0508\,m) = 236.7\ N.$$

Rounded to three significant figures,

$$F_2 = \boxed{237\ N}$$

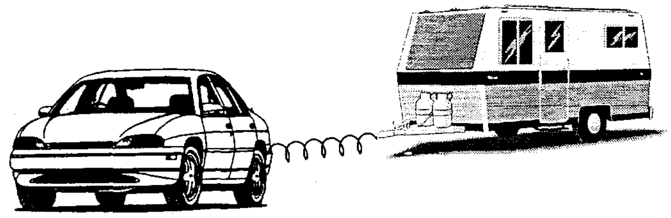
$\boxed{10.2}$

Hooke's law states for a spring, $F = kx$.

Since the bow string behaves as a spring with $k = 480\ N/m$, when a force $F = 240\ N$ is applied

$$x = \frac{F}{k} = \frac{240\ N}{480\ N/m} = \boxed{0.50\ m}$$

10.5



In order to cause the 92 kg trailer to accelerate $0.30\ \mathrm{m/s^2}$, the spring exerts a force given by

$$F = ma = (92\ \mathrm{kg})(0.30\ \mathrm{m/s^2}) = 27.6\ \mathrm{N}$$

According to Hooke's law, the force exerted by a spring is related to the displacement by

$$F = -kx$$

Since $k = 2300\ \mathrm{N/m}$,

$$x = \frac{-F}{k} = \frac{-27.6\ \mathrm{N}}{2300\ \mathrm{N/m}} = \boxed{-0.012\ \mathrm{m}}$$

The negative sign reflects that the force is in a direction opposite the displacement. So, if the car attempts to accelerate the trailer to the left, the spring is displaced (stretched) to the right by 0.012 m.

$\boxed{10.15}$

If we assume that the atoms vibrate with simple harmonic motion, then speed and acceleration are given by

$$v = -\omega A \sin(\omega t) \quad \#1 \qquad \text{and} \qquad a = -\omega^2 A \cos(\omega t) \quad \#2$$

Because sine and cosine functions have values that range from $-1$ to $+1$, we see from eq #1 that speed is maximum when $\sin(\omega t) = -1$, and that acceleration in eq #2 is maximum when $\cos(\omega t) = -1$. Thus,

$$v_{max} = \omega A \quad \#3 \qquad \text{and} \qquad a_{max} = \omega^2 A \quad \#4$$

Since $A = 1.1 \times 10^{-11}\,m$

and $\omega = 2\pi f = 2\pi(2.0 \times 10^{12}\,\text{cycle}/s) = 4\pi \times 10^{12}\,\text{rad}/s$

$$v_{max} = (4\pi \times 10^{12}\,\text{rad}/s)(1.1 \times 10^{-11}\,m) = 138.23\,m/s$$

$$a_{max} = (4\pi \times 10^{12}\,\text{rad}/s)^2(1.1 \times 10^{-11}\,m) = 1.7371 \times 10^{15}\,m/s^2$$

Rounded to two significant figures,

$$v_{max} = \boxed{140\,m/s.} \qquad \text{and} \qquad a_{max} = \boxed{1.7 \times 10^{15}\,m/s^2}$$

$\boxed{10.24}$

$x = 0.470\,m$
$k = 425\ N/m.$

a. $P.E._{elastic} = \frac{1}{2} k x^2 = \frac{1}{2}(425\ N/m)(0.470\,m)^2 = 46.94125\ J$

Rounded to three significant figures, $P.E_{elastic} = \boxed{46.9\ J}$

b. If all of this potential energy is used to propel a 0.0300 kgm arrow (that is, if this potential energy becomes the kinetic energy of the arrow), then

$$P.E._{elastic} = K.E._{arrow}$$

$$P.E._{elastic} = \frac{1}{2} m v^2 \longrightarrow v = \pm\sqrt{\frac{2\ P.E._{elastic}}{m}}$$

$$\therefore\ v = \pm\sqrt{\frac{2\,(46.9\,J)}{0.0300\ kg}} = \boxed{\pm\ 55.9\ m/s}$$

$\boxed{10.31}$

$m = 1.00 \times 10^{-2}$ kg
$k = 124$ N/m
$v_1 = 8.00$ m/s when $x_1 = 0$ m. (i.e. the spring is "unstrained")

This problem is a study of the energies of simple harmonic motion. We know that kinetic energy is given by

$$K.E. = \tfrac{1}{2} m v^2 \quad \#1.$$

And we know that the potential energy of a spring is given by

$$P.E. = \tfrac{1}{2} k x^2 \quad \#2.$$

So by conservation of energy $K.E._1 + P.E._1 = K.E_2 + P.E._2$ or

$$\tfrac{1}{2} m v_1^2 + \tfrac{1}{2} k x_1^2 = \tfrac{1}{2} m v_2^2 + \tfrac{1}{2} k x_2^2 \quad \#3.$$

Since $x_2$ equals the amplitude $A$ when $v_2 = 0$, eq#3 becomes

$$\tfrac{1}{2} m v_1^2 = \tfrac{1}{2} k A^2 \quad \#4$$

Solving for $A$ in eq#4,

$$A = v_1 \sqrt{m/k} = 8.00 \text{ m/s} \sqrt{\frac{1.00 \times 10^{-2} \text{ kg}}{124 \text{ N/m}}} = 0.071842 \text{ m}$$

Rounded to three significant figures,

$$A = \boxed{0.0718 \text{ m}}$$

$\boxed{10.39}$

$T = 2.0\,s$
$L = ?$

$\omega = \sqrt{g/L}$ and $\omega = 2\pi f = \frac{2\pi}{T}$

$\therefore \quad \frac{2\pi}{T} = \sqrt{g/L} \longrightarrow L = g\left(\frac{T}{2\pi}\right)^2$

$L = 9.80\,m/sec^2 \left(\frac{2.0\,s\ /\cancel{cycle}}{2\pi\ rad/\cancel{cycle}}\right)^2 = \boxed{0.99\ m}$

$\boxed{10.48}$

The response materials display to forces that either compress or stretch them is reflected by Young's modulus, Y, where

$$Y = \frac{F/A}{\Delta L/L_0} = \frac{\text{stress}}{\text{strain}} \quad \#1$$

From table 10.1, the Young's modulus for bone under compression is

$$Y = 9.4 \times 10^9 \ N/m^2 \quad \#2$$

a. Since the stress = $F/A$, the maximum stress equals the greatest force $F = 6.8 \times 10^4 \ N$ divided by the smallest area $A = 4.0 \times 10^{-4} \ m^2$

$$\therefore \text{ max. stress} = \frac{6.8 \times 10^4 \ N}{4.0 \times 10^{-4} \ m^2} = \boxed{1.7 \times 10^8 \ N/m^2} \quad \#3$$

b. we can rearrange eq 1 to determine the strain.

$$\text{strain} = \frac{\text{stress}}{Y} = \frac{1.7 \times 10^8 \ N/m^2}{9.4 \times 10^9 \ N/m^2} = \boxed{0.018}$$

$\boxed{10.49}$

$\Delta P = P_2 - P_1 = 0 - 1.01 \times 10^5\,Pa = -1.01 \times 10^5\,Pa$

$B_{Al} = 7.1 \times 10^{10}\,N/m^2$

$\Delta V/V_0 = ?$

Since $B \equiv \dfrac{-\Delta P}{\Delta V/V_0} \longrightarrow \dfrac{\Delta V}{V_0} = \dfrac{-\Delta P}{B}$

$$\therefore \quad \frac{\Delta V}{V_0} = \frac{-(-1.01 \times 10^5\,N/m^2)}{7.1 \times 10^{10}\,N/m^2} = \boxed{1.4 \times 10^{-6}}$$

$\boxed{10.69}$

The period of a simple pendulum is given by

$$T = 2\pi\sqrt{\ell/g}$$

$$\therefore\ g = \frac{4\pi^2 \ell}{T^2}$$

We are given $\ell = 1.2\,m$. Since 100 cycles are completed in 280 s, the time required to complete one cycle (the period) is

$$T = \frac{280\,s}{100\text{ cycles}} = 2.80\ s/\text{cycle}$$

$$\therefore\ g = \frac{4\pi^2(1.2\,m)}{(2.80\ s/\text{cycle})^2} = 6.0426\ m/s^2\ *$$

Rounded to two significant figures, $g = \boxed{6.0\ m/s^2}$

* In case you are wondering, cycles (like radians) can be ignored.

$\boxed{10.71}$

The statue applies a force $F = mg = (3500\,kg)(9.80\,m/s^2)$ or

$F = 34{,}300\ N.$

$A = 7.3 \times 10^{-2}\,m^2$

$Y = 2.3 \times 10^{10}\ N/m^2$

$L_o = 1.8\,m$

$\Delta L = ?$

Since $Y = \dfrac{F/A}{\Delta L / L_o} \longrightarrow \Delta L = \dfrac{F L_o}{Y A} = \dfrac{(34{,}300\,N)(1.8\,m)}{(2.3 \times 10^{10}\,N/m^2)(7.3 \times 10^{-2}\,m^2)} = \boxed{3.7 \times 10^{-5}\,m}$

$\boxed{10.75}$

$x_1 = 0.018\,m$
$m_1 = 2.8\,kg$
$m_2 = ?$ for $f_2 = 3.0\,Hz$.

Since $F_1 = kx_1 \longrightarrow k = \frac{F_1}{x_1} = \frac{m_1 g}{x_1} = \frac{(2.8\,kg)(9.80\,m/s^2)}{0.018\,m.} = 1,524.44\cdots\,N/m$

Now that we know $k$ for the spring we can use

$$\omega = \sqrt{k/m} \quad \#1$$

to determine $m$.

From eq #1 and with $\omega = 2\pi f$ we write

$$2\pi f = \sqrt{k/m} \longrightarrow (2\pi f)^2 = \frac{k}{m}$$

$$\therefore\; m_2 = \frac{k}{(2\pi f_2)^2} = \frac{1,524.44\cdots\,N/m}{[2\pi\,(3.0\,cycles/s)]^2} = \boxed{4.3\,kg}$$