Section 1 (answers may vary)

1. What is peak bone mass and why is there a push to optimize it in the early years of life?

Peak bone mass is the greatest amount of bone mass a person obtains during their life at any particular site. There is a push to optimize peak bone mass during earlier years because that is when our bones are growing the most. Peak bone mass starts to decline around the age of 25. If we can maximize peak bone mass earlier in life then osteoporosis is less likely to occur. Our bones will naturally deteriorate but increasing peak bone mass early in life helps to maximize bone strength later in life. Bone also adapts better to weight-bearing exercises in the earlier years of life than later years of life which helps to increase peak bone mass. Bone mass increases earlier in life due to hormone changes during adolescence. Oestrogens and other endocrine hormones peak during this time which correlates with increased bone mass.

2. Why can greater bone growth be obtained by subjects who have no previous history of weight-bearing exercise compared to those who do?

Bone growth from weight bearing exercise comes as a result of different and unusual loads being applied to bone. If an individual has become accustomed to weight bearing exercise, their bones aren’t going to continue to grow from that exercise. Those who haven’t participated in weight bearing exercise previously will experience bone growth, because that activity is applying a different and unusual load to the bones.

Section 2

1. As part of a training regimen, an athlete runs with a parachute. The parachute has an area of 4 meters squared and a coefficient of drag equal to 0.8. The density of air is 1.00 kg/m^3 and the athlete runs at 7 m/s. What will be the work done by the athlete after running 50 meters?

Use the equation, \( F_{\text{drag}} = \frac{1}{2} C_D \rho A v^2 \) and plug the known values in.
\[
F_{\text{drag}} = \frac{1}{2} (0.8)(1.00 \text{ kg/m}^3)(4 \text{ m}^2)(7 \text{ m/s})^2, \text{ so } F_{\text{drag}} = 78.4 \text{ kgm/s}
\]
Next, we know that force * displacement equals work, so \( U = Fd = (78.4 \text{ kgm/s})(50 \text{ m}) \)
\[
U = 3920 \text{ kgm}^2/\text{s} (=\text{Nm}=\text{J}), \text{ so } U= 3920 \text{ J}
\]

2. How much more work will the athlete do if he increases his velocity to 8.5 m/s? Again, use the equation \( F_{\text{drag}} = \frac{1}{2} C_D \rho A v^2 \) just changing the relative velocity.

\[
F_{\text{drag}} = \frac{1}{2} (0.8)(1.00 \text{ kg/m}^3)(4 \text{ m}^2)(8.5 \text{ m/s})^2 \text{ So, } F_{\text{drag}} = 115.6 \text{ kgm/s}
\]
Using the same equation for work \( U = Fd = (115.6 \text{ kgm/s})(50 \text{ m}) \)
\[
U = 5780 \text{ kgm}^2/\text{s} (=\text{Nm}=\text{J}) \text{ so } U= 5780 \text{ J}
\]
Finally, subtract 5780 J from 3920 J. \( 5780 - 3920 = 1860 \text{ J} \)
3. A rower pulls his oar through the water at a velocity of 0.9 m/s, relative to the water. The density of water is 1000 kg/m^3 and the paddle has an area of 0.13 meters squared with a coefficient of drag equal to 1.4. The paddle is located at the end of an oar, 2.2 meters from a pivot point on the edge of the boat. Assuming that the drag force is always perpendicular to the oar, what is the torque of the drag force on the oar?

Use the equation, \( F_{\text{drag}} = \frac{1}{2} C_D \rho A v^2 \), plus an additional equation, \( T = F \times r \).

For the first equation, \( F_{\text{drag}} = 0.5(1.4)(1000)(0.13)(0.9)^2 = 73.71 \text{ N} \)

Use this value and the distance from the pivot point on the edge of the boat to find torque.

\( T = 73.71 \times 2.2, \quad T = 162.162 \text{ Nm} \)

4. A 80 kg skydiver opens up his parachute and begins a gentle descent to the ground. The coefficient of drag acting on the parachute is 1.5 and the area of the parachute is 30 square meters. The density of air is 1 kg/m^3. What is the terminal velocity that the skydiver will reach in his parachute?

Using the equation for terminal velocity, \( v = \sqrt{-\frac{2mg \sin(\theta)}{C_D \rho A}} \)

We have, \( v = \sqrt{-\frac{2(80)(-9.8) \sin(90)}{1.5 \times 1 \times 30}} \)

\( v = 5.90 \text{ m/s} \)