Exercise Physiology Problem Set #1

Mt Whitney is the highest mountain in the 48 contiguous states. Standing 4,418 **m** (14,494 feet), its east face rises over 10,000' above the nearby Owens Valley of eastern California. The east face is a favorite target of accomplished rock climbers. Typically they leave from a camp at approximately 11,000' (about 3353 m) and climb the vertical wall of fractured granite to the summit. The best climbers using the "easiest" route in good weather conditions and can complete this climb in less than 10 hours. They then return to base camp by a well-worn trail used by many hikers and even pack animals.

Suppose that our climber has a mass of 60 kg. Further, assume that she climbs vertically and that air resistance and friction are negligible.

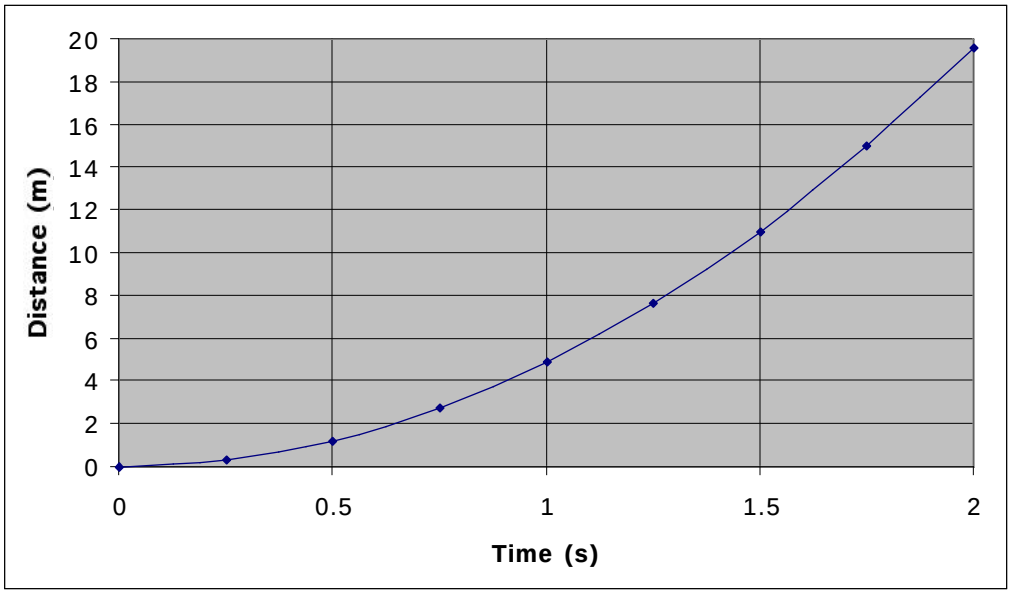
(i) What is the value of the force (in **Newtons**) that she must overcome when climbing?

(ii) How much work does she do (in **Joules and k**J) in climbing the vertical distance from base camp to the summit? If **one kcal = 4.2 kJ**, how much work did she do in Kcal.

(iii) Does she actually do the amount work than you calculated in (b)? Explain.

(iv) Suppose that she completes the climb in 10 hours. Calculate her average power input (using the same assumptions as in (a) and (b)) in **kJ per hou**r. Then calculate the value in **watts**.

There is one mishap in her climb. Late on, she slips and falls for two seconds before being belayed (arrested) by her carefully placed rope. Here is a graph of her fall:



In addition, here is a table of the distances and times in the graph above:.

time (s)	distance (m)
0	0
0.25	0.31
0.5	1.23
0.75	2.76
1	4.90
1.25	7.66
1.5	11.03
1.75	15.01
2	19.60

(e) Calculate her average velocity for each 0.25 of her fall.

(f) Calculate her average acceleration for the 0.5 to 0.75, and the 1.5 to 1.75 s. intervals? Is this what you would have expected? Briefly explain.

(g) When the rope arrests her it stretches approximately 1 m and stops her in 0.25 s. Climbing ropes are supposed to do this. What is the <u>average</u> force she feels (through her seat harness) over the 0.25 s when she stops?

Two additional things to think about that have relevance to topics we will soon cover:

(i) If the rope did not stretch and therefore stopped her instantaneously, would the force she experienced have been greater? Why must climbing ropes be designed to stretch?

(ii) Go back to your answer in question (b). This represents the work or energy change involved in moving her body a certain distance. However, it is not the amount of energy she needed to use to make the climb. That is because she is not 100% efficient in turning the energy she "burns" during the climb into actual movement. Efficiency is defined as:

$$\text{Efficiency}(\%) = \frac{\text{"Useful Work" (WorkOutput)}}{\text{Work needed to accomplish the "Useful Work"}} * 100$$

If our climber is 10% efficient, how many **Kcal** did she use in the climb?