

Name: **Answers**

Cardiac Adaptations to Exercise

Overview

Over the course of a six month training program an endurance athlete had three cardiac measurements (heart rate, stroke volume and cardiac output) taken periodically to determine the effect training has on the heart. Complete the following activity to determine the effect training has on the heart and how maths is used by exercise physiologists to track the progress of an athlete.

Definitions

- Complete the following table to define the cardiac measurements that were taken during the training program (you may use the internet to help you).

Cardiac value	Definition	Measurement unit
Heart rate	Amount of times the heart beats per minute	beats per minute
Stroke volume	Volume of blood that leave the left side of the heart per beat	ml per beat
Cardiac output	Volume of blood that leaves the left side of the heart per minute	L per minute

Calculations

The following equation is used to calculate cardiac output:

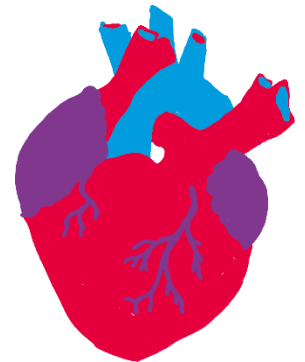
$$\text{Cardiac output} = \text{Heart rate} \times \text{stroke Volume}$$

- Rearrange the equation to make:
 - heart rate** the subject of the equation:

$$\text{Heart rate} = \text{cardiac output}/\text{stroke volume}$$

- stroke volume** the subject of the equation:

$$\text{Stroke volume} = \text{cardiac output}/\text{heart rate}$$



Resting values



The table below displays how training effects the cardiac values at rest.

3. Use the cardiac equations above to complete the values in the table below:

Month of training	Heart rate	Stroke volume	Cardiac output	Cardiac output
0	80 bpm	60 ml	4.800 ml/min	4.800 L/min
2	61 bpm	85 ml	5185 ml/min	5.185 L/min
4	55 bpm	103 ml	5665 ml/min	5.665 L/min
6	51 bpm	110 ml	5610 ml/min	5.610 L/min

4. Use excel to create 3 line graphs to display how training effects your heart function at rest.
- Graph One – Heart Rate (X axis – month of training, Y axis – heart rate)
 - Graph Two – Stroke Volume (X axis – month of training, Y axis – stroke volume)
 - Graph Three – Cardiac Output (X axis – month of training, Y axis – cardiac output)
5. Describe the trend of the graph for each of the cardiac values.

Graph	Trend
Heart rate	Resting heart rate decreased over the training period
Stroke volume	Resting stroke volume increased over the training period
Cardiac output	Resting cardiac output increased over the training period

6. Explain why you think training has this effect on an athlete's resting heart rate.

Training increased the stroke volume of the heart. As the stroke volume increases then the heart does not need to beat as often to maintain the same cardiac output. Therefore training will result in a decrease in the resting heart rate of an athlete.



Maximum effort values

The table below displays how training effects the cardiac values at maximum effort (exercising as hard as you can for 45 seconds).

7. Use the cardiac equations above to complete the values in the table below:

Month	Heart rate	Stroke volume	Cardiac output	Cardiac output
0	195 bpm	120 ml	23400 ml/min	23.400 L/min
2	196 bpm	166 ml	22736 ml/min	22.736 L/min
4	194 bpm	203 ml	39382 ml/min	39.382 L/min
6	195 bpm	220 ml	42900 ml/min	42.900 L/min

8. Use excel to create 3 line graphs to display how training effects your heart function at maximum effort.

- Graph One – Heart Rate (X axis – month of training, Y axis – heart rate)
- Graph Two – Stroke Volume (X axis – month of training, Y axis – stroke volume)
- Graph Three – Cardiac Output (X axis – month of training, Y axis – cardiac output)

9. Describe the trend of the graph for each of the cardiac values.

Graph	Trend
Heart rate	Maximum heart rate stayed the same over the training program
Stroke volume	Maximum stroke volume increased over the training program
Cardiac output	Maximum cardiac output increased over the training program

10. Explain why you think that training has this effect on an athlete's stroke volume.

As the heart is a muscle, when you complete training the left side adapts by getting bigger and stronger. The increase strength and size of the left ventricle allows it to move more blood each beat.

11. If we were to measure the athlete's oxygen consumption per minute at maximum effort would the value be greatest at zero or six months? Explain how you were able to come to this conclusion.

The oxygen consumption would be greatest after 6 months of training. I made this conclusion as the cardiac output increased, this means that more blood is flowing through the body. As

the blood carries oxygen, the increase in blood moving would mean more oxygen is being transported and used by the body.