Cardiac Output, Stroke Volume and Heart Rate
• Describe the terms cardiac output, stroke volume and heart rate

• Explain the effects of exercise on cardiac output

• Analyse data to justify the impact of exercise of heart rate, stroke volume and cardiac output
Starter (Pairs)

Find your pulse on your neck or wrist.

Count the beats for 15 seconds, then x 4.
Stand up, do 10 star jumps.
Measure HR again, what has happened? Why?
Heart Rate (HR)

- Heart rate is the number of times you heart beats in a minute (Beats per minute or BPM)
- Your maximum HR is 220 - age
Heart Rate activity

• Using the data you have collected, create a graph to show the changes in your heart rate.

• What do you think you can tell from the graph? Could you link this to gaseous exchange? Vasoconstriction and vasodilation?
Stroke Volume

- The amount of blood pumped out of the left ventricle per heart beat (contraction)
- Measured in millilitres (m/L)

Measure out how much blood you think is pumped out of the heart per beat at rest.

An average adult has a SV of between 60-80 ml

Measure out how much blood you think is pumped out of the heart per beat during exercise.

During exercise an average adult could increase this to 150ml

Measure out how much blood you think is pumped out of the heart per beat for an elite athlete during exercise.

An elite athlete can increase to 200ml
Cardiac Output

- Is the amount of blood that the heart can pump out per minute
- Measured in Litres per minute (L/m)

To work out cardiac output you use the following equation:

Cardiac Output = Heart Rate \times \text{Stroke Volume}
Cardiac Output = Heart Rate x Stroke Volume

So let's say HR is 70 BPM and Stroke Volume is 70 ml.

What will be the cardiac output?
Measure that out as a class.
The tables below show readings from a gymnast during rest and during exercise.

<table>
<thead>
<tr>
<th></th>
<th>Heart rate (bpm)</th>
<th>Stroke volume (ml)</th>
<th>Cardiac output (L/m)</th>
<th>Muscle temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>REST</td>
<td>72</td>
<td>60</td>
<td>4.3 L/m</td>
<td>Normal</td>
</tr>
<tr>
<td>DURING</td>
<td>156</td>
<td>140</td>
<td>21.8L/m</td>
<td>Hot</td>
</tr>
</tbody>
</table>

Describe what the tables tell you? Discuss why these changes have taken place?
Task 1: Define Stroke Volume, Heart Rate and Cardiac Output

Task 2: What is the equation for working out Cardiac Output?

Task 3: What is cardiac output if:

<table>
<thead>
<tr>
<th>Minute</th>
<th>Stroke Volume</th>
<th>Heart Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>70 m/L</td>
<td>70 BPM</td>
</tr>
<tr>
<td>2</td>
<td>75 m/L</td>
<td>85 BPM</td>
</tr>
<tr>
<td>3</td>
<td>83 m/L</td>
<td>92 BPM</td>
</tr>
<tr>
<td>4</td>
<td>85 m/L</td>
<td>105 BPM</td>
</tr>
<tr>
<td>5</td>
<td>92 m/L</td>
<td>110 BPM</td>
</tr>
<tr>
<td>6</td>
<td>101 m/L</td>
<td>120 BPM</td>
</tr>
<tr>
<td>7</td>
<td>105 m/L</td>
<td>120 BPM</td>
</tr>
</tbody>
</table>

Task 4: Can you plot this information on a graph and explain why it is occurring.

APEX: Justify why cardiac output will increase during exercise.

Sentence starters:
Heart rate is...
During exercise cardiac output will increase because...
Anticipatory rise is.....
Select six key terms from the following list:

- Atria
- Ventricles
- Cardiac cycle
- Vasodilation
- Vasoconstriction
- Capillaries
- Vein
- Artery
- Cardiac output
- Stroke Volume

Add each term to your 6 six square grid
1) The number of times your heart beats per minute.

2) Stroke Volume x Heart Rate =

3) The lower chambers of the heart which pump blood out of the heart to the arteries.

4) Increasing the diameter of small arteries to increase blood flow to tissues.

5) The upper chambers of the heart that collect blood from veins.

6) Reducing the diameter of small arteries to reduce blood flow to tissues.

7) Blood vessel carrying blood towards the heart.

8) Blood vessel carrying blood away from the heart.

9) Very thin blood vessels that allow gas exchange to happen.

10) The amount of blood per individual beat