Outcome 2
Use data collected in practical activities to analyse how the major body and energy systems work together to enable movements to occur, and explain the fatigue mechanisms and recovery strategies

Task
Test

Focuses on the acute effects that physical activity has on the cardiovascular, respiratory and muscular systems of the body. The test includes both multiple choice and short answer questions.

This task will be marked out of 60 marks. A second task will be completed for this outcome. It will then be converted to a mark out of 20 which represents one third of the marks allocated for this outcome (60).

Section A: Multiple Choice
Number of questions: 10
Number of marks: 10

Section B: Short Answer
Number of questions: 8
Number of marks: 50

The task has been designed to allow achievement up to and including the highest level in the Performance Descriptors.

You have 60 minutes (5 minutes reading time and 55 minutes writing time) in which to complete this task. This task will be completed under test (closed book) conditions.

Answers to the multiple choice questions should be indicated on the Multiple Choice Answer Sheet and the short answer questions should be completed in the space provided after each question.

Your teacher will advise you of any variation to these conditions.

This task covers a broad range of key knowledge and key skills.
Task

**Part A: Multiple Choice Questions**

Indicate your response on the multiple-choice answer sheet.

**Question 1**
Acute responses to physical activity occur:
A prior to physical activity  
B at the beginning of physical activity  
C half way through physical activity  
D after physical activity is complete.

**Question 2**
At the commencement of physical activity, blood flow is redistributed around the body. Which of the following body parts is blood flow reduced to?
A Heart  
B Muscles  
C Internal organs  
D Skin.

**Question 3**
The component of blood pressure most affected by an increase in physical activity is:
A systolic pressure  
B diastolic pressure  
C cardiac output  
D stroke volume.

**Question 4**
During a 400m race, a runner would experience which of the following?
A A decrease in heart rate.  
B A decrease in intra-muscular fuel stores.  
C A decrease in tidal volume.  
D A decrease in diffusion rates.

**Question 5**
Gas exchange in the muscle occurs at the tissue-capillary interface via diffusion. During physical activity which condition below outlines why diffusion takes place?
A Blood oxygen levels are high and muscle oxygen levels are low.  
B Blood oxygen levels are low and muscle oxygen levels are high.  
C Alveoli oxygen levels are high and blood oxygen levels are low.  
D Alveoli oxygen levels are low and blood oxygen levels are high.

**Question 6**
Tidal volume and respiratory rate are the main components of:
A cardiac output  
B arterio-venous oxygen difference (a-vO₂ diff)  
C vital capacity  
D ventilation.
Task

**Question 7**
The most important factor for increasing cardiac output during exercise is:

A  heart rate  
B  stroke volume  
C  arterio-venous oxygen difference (a-vO₂ diff)  
D  redistribution of blood flow.

**Question 8**
The level of response of acute physiological changes within the body systems when participating in physical activity is dependent on:

A  duration of the activity  
B  type of the activity  
C  intensity of the activity  
D  all of the above.

**Question 9**
Which of the following does not respond linearly to increases in exercise intensity?

A  Cardiac output  
B  Respiratory rate  
C  Oxygen consumption  
D  Muscle fuel stores.

**Question 10**
The muscle fibre type most likely to contribute to increases in body temperature is:

A  slow twitch fibre  
B  fast twitch fibre  
C  oxidative twitch fibre  
D  explosive twitch fibre.

(10 x 1 = 10 marks)
Task

Part B: Short Answer Questions

Question 1

a. Name the three main body systems that respond to meet the physiological changes required to provide energy for physical activity.

i. ________________________________________________________________________

ii. ________________________________________________________________________

iii. ________________________________________________________________________

(3 marks)

Oxygen uptake increases as an acute response to physical activity.

b. Define oxygen uptake.

____________________________________________________________________________

____________________________________________________________________________

(1 mark)

c. Outline the interplay between the body systems identified in part a that allow an increase in oxygen uptake to occur.

____________________________________________________________________________

____________________________________________________________________________

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____________________________________________________________________________

(4 marks)
Question 2
An acute cardiovascular response to exercise is an increase in cardiac output.

a. Explain the term cardiac output.

_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________

(1 mark)

Of the two components that make up cardiac output, one component steadily increases until it reaches a maximum level and plateaus whilst the other continues to increase until maximal exercise levels are reached.

b. Name the component that plateaus.

_____________________________________________________________________________

(1 mark)

c. Explain when this plateau occurs and why.

_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________

(2 marks)
Question 3
Laura is a 30 year old female who enjoys exercise and has recently participated in a variety of fun runs. She has competed in 5km and 10km events and is about to participate in her first half marathon (21km approximately).

a. Outline three immediate changes that will occur within her respiratory system in response to this type of activity and explain how these responses contribute to her exercise performance.

<table>
<thead>
<tr>
<th>Acute respiratory response</th>
<th>Contribution to exercise performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td></td>
</tr>
<tr>
<td>ii.</td>
<td></td>
</tr>
<tr>
<td>iii.</td>
<td></td>
</tr>
</tbody>
</table>

(6 marks)

Another acute response to participating in a half marathon that Laura would experience is a change in her arterio-venous oxygen difference (a-vO₂ diff).

b. Explain the term arterio-venous oxygen difference (a-vO₂ diff).

_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________

(2 marks)
c. Indicate the nature of the change that will occur to the arterio-venous oxygen difference during physical activity and explain why this change occurs.

_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________

(3 marks)

Question 4
Australian hurdler Sally Pearson won gold in the 100m hurdles at the 2012 London Olympics. In winning her gold medal she also broke the Olympic record for this event with a time of 12.35 seconds.

a. Outline four acute responses of the muscular system that would have occurred during this race.

i. _______________________________________________________________________

ii. _______________________________________________________________________

iii. _______________________________________________________________________

iv. _______________________________________________________________________

(4 marks)

b. Choose one of these responses and explain in detail how it would have assisted Sally to win gold.

_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________

(2 marks)
In the London Games of 2012, Tiki Gelana of Ethiopia also won a gold medal but in her case it was in the women’s marathon. She also broke the Olympic record for this event with a time of 2 hours, 23 minutes and 7 seconds.

c. Describe the difference in energy substrate levels between Sally Pearson and Tiki Gelana at the end of their respective events.

_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________
(4 marks)

Question 5
An 18 year old VCE student participated in the Multi Stage Fitness Test (Beep test) as part of a fitness testing battery. This test is incremental in nature, measuring aerobic capacity and predicting VO$_2$ Max.

During the test the student wore a heart rate monitor and recorded his heart rate at one minute intervals until exhaustion as well as during recovery.

<table>
<thead>
<tr>
<th>Heart Rate (beats per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest</td>
</tr>
<tr>
<td>RHR</td>
</tr>
<tr>
<td>54</td>
</tr>
</tbody>
</table>

a. Explain the relationship between heart rate and exercise intensity. Justify with collected data.

_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________

(2 marks)
Task

b. Explain why this relationship exists.
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
(2 marks)

c. Heart rate can rise above resting levels just before the start of physical activity. What is this response commonly called?
_____________________________________________________________________________
(1 mark)

d. With reference to the heart rate data in the table above, does the student reach their maximum heart rate during this test? Explain.
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
(2 marks)

Question 6
Blood lactate levels are often measured during exercise performance testing, especially of elite athletes.

Explain the likely difference between blood lactate that would be expected during sub-maximal and maximal intensity exercise.
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
(4 marks)
Question 7
The following table shows data collected from two Australian Rules Football players. One individual is a local club level player whilst the other is an elite (AFL) player.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Heart Rate (bpm)</th>
<th>Stroke Volume (mL/beat)</th>
<th>Oxygen Uptake (L/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Rest</td>
<td>65</td>
<td>70</td>
<td>0.35</td>
</tr>
<tr>
<td>A Maximal</td>
<td>190</td>
<td>120</td>
<td>4.0</td>
</tr>
<tr>
<td>B Rest</td>
<td>50</td>
<td>80</td>
<td>0.4</td>
</tr>
<tr>
<td>B Maximal</td>
<td>180</td>
<td>170</td>
<td>5.0</td>
</tr>
</tbody>
</table>

a. Which subject is the elite player? Tick the correct box.
   Subject A ☐
   Subject B ☐

   (1 mark)

b. With reference to the data above, justify your response to part a.

   (2 marks)

c. Calculate the cardiac output of Subject A during maximal exercise.

   (1 mark)

Question 8
During physical activity blood volumes decrease.

a. Which component of blood decreases?

   (1 mark)
b. The size of the decrease in blood volumes can vary. Identify a reason why this may occur.

(1 mark)
Multiple Choice Answer Sheet

Student Name: ________________________________

Instructions:
Attempt all questions. Each question is worth 1 mark. Marks will not be deducted for incorrect answers. Indicate your answers by shading the appropriate box on the Multiple Choice Answer Sheet.

Q1  A  B  C  D
Q2  A  B  C  D
Q3  A  B  C  D
Q4  A  B  C  D
Q5  A  B  C  D
Q6  A  B  C  D
Q7  A  B  C  D
Q8  A  B  C  D
Q9  A  B  C  D
Q10 A  B  C  D
Key knowledge and key skills
The following key knowledge is the focus of this task:
• the mechanisms responsible for the acute responses to exercise in the cardiovascular, respiratory and muscular systems.

The following key skills are the focus of this task:
• participate in physical activities to collect and analyse data relating to the range of acute effects that physical activity has on the cardiovascular, respiratory and muscular systems of the body.


Highest performance descriptor
The following table indicates the relationship between the highest level of the Performance Descriptor and the questions in this QAT.

<table>
<thead>
<tr>
<th>Aspect of Highest Performance Descriptor</th>
<th>Question/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thorough and insightful understanding of the mechanisms responsible for acute effects of the cardiovascular, respiratory and muscular systems of the body.</td>
<td>Across all questions</td>
</tr>
</tbody>
</table>


Note: This is one of two tasks for this outcome.

Assessment Planning
Teachers will need to decide the placement of this task in relation to the other (compulsory) task- the Practical Laboratory Report for this outcome.
Part A: Multiple Choice Questions

Multiple Choice Answer Sheet

Q1  A  B  C  D
Q2  A  B  C  D
Q3  A  B  C  D
Q4  A  B  C  D
Q5  A  B  C  D
Q6  A  B  C  D
Q7  A  B  C  D
Q8  A  B  C  D
Q9  A  B  C  D
Q10 A  B  C  D
Part B: Short Answer Questions

Below are suggested responses. Teachers should consider the merits of alternative responses.

Question 1
a. Three marks available here – one mark for each body system correctly identified as follows:
   i  Cardiovascular system
   ii  Respiratory system
   iii  Muscular system
b. One mark available here as follows:
   Oxygen uptake refers to the total amount of oxygen taken in, transported to and used by the body to provide energy for muscular contraction.
c. Four marks available here as follows:
   As physical activity begins the working muscles require more oxygen to produce energy (1 mark). The cardiovascular system and respiratory system work together to deliver more oxygen to the working muscles via increases in heart rate, stroke volume, cardiac output, arterio-venous difference (a-vO2, diff), respiratory rate, tidal volume and ventilation to deliver more oxygen (2 marks), whilst the muscles themselves work to utilise the additional oxygen made available (1 mark).

Question 2
a. One marks available here as follows:
   Cardiac output refers to the amount of blood ejected from the left ventricle of the heart per minute.
b. One mark available here as follows:
   Stroke volume
c. Two marks available here as follows:
   Stroke volume plateaus during submaximal activity at approximately 40-60% of maximal exercise capacity (1 mark). Stroke volume plateaus at this exercise intensity because there is insufficient time for further filling of the ventricle as a result of simultaneous increases in heart rate (1 mark).

Question 3
a. Six marks available here - one mark for identification of an appropriate acute response and one mark for the explanation of how this response contributes to increased exercise performance. Any of the following responses could be provided:
   • Increased ventilation – more oxygen taken in per minute means that more oxygen is available to be transported to the working muscles resulting in an improvement in aerobic performance.
   • Increased tidal volume – more oxygen taken in with each breath which contributes to an increase in ventilation meaning that more oxygen is available to be transported to the working muscles resulting in an improvement in aerobic performance.
   • Increased respiratory rate – more breaths per minute which contributes to an increase in ventilation meaning that more oxygen is available to be transported to the working muscles resulting in an improvement in aerobic performance.
   • Increased diffusion – more oxygen diffuses across the alveolar-capillary membrane meaning that more oxygen is available to be transported to the working muscles resulting in an improvement in aerobic performance.
   • Increased oxygen uptake – more total oxygen is taken in, transported to and utilised by the working muscles meaning an improvement in aerobic performance.
b. Two marks available here as follows:
   The arterio-venous oxygen difference (a-vO$_2$ diff) represents the difference in the concentration of oxygen in the arterial blood and the concentration of oxygen in the venous blood (1 mark). It reflects the amount of oxygen used or extracted by the muscles (1 mark).

c. Three marks available here as follows:
   The arterio-venous oxygen difference (a-vO$_2$ diff) will increase during exercise (1 mark) as working muscles extract more oxygen from blood into the muscle to produce aerobic energy during exercise – up to 75% more than at rest (2 marks).

**Question 4**

a. Four marks available here – one mark for each muscular system response correctly identified.
   Response must relate to anaerobic energy production. Any of the following are acceptable responses:
   - Increased motor unit and muscle fibre recruitment
   - Increased blood flow to the muscles
   - Increased muscle temperature
   - Increased muscle enzyme activity
   - Increased arterio-venous oxygen difference (a-vO$_2$ diff)

b. Two marks available here for correctly describing/explaining how the response selected would have assisted performance.
   - Increased motor unit and muscle fibre recruitment – more motor units recruited and muscle fibres activated to produce explosive movements assisting in anaerobic performance
   - Increased blood flow to the muscles – redistribution of blood flow from internal organs to working skeletal muscles (80-90%) to address the increase in demand for extra fuels and oxygen to produce energy assisting in anaerobic performance
   - Increased muscle temperature – increased rate of metabolism therefore heat generated as a by-product due to increased production of ATP to meet the high energy demands of the event assisting in anaerobic performance
   - Increased muscle enzyme activity – increased muscle enzyme activity to produce the increased amounts of ATP required by the muscles to meet the high energy demand assisting in anaerobic performance
   - Increased arterio-venous oxygen difference (a-vO$_2$ diff) greater extraction of oxygen from the blood in order to meet the increasing demands of exercise (not fully realised as event finishes before aerobic system becomes predominant however still occurs via energy system interplay)

c. Four marks available here as follows:
   Sally’s event is predominantly anaerobic (1 mark) therefore she would mainly see a decrease in ATP and PC stores (1 mark). Tiki’s event is predominantly aerobic (1 mark) therefore she would see a decrease in ATP and PC stores as well as a greater decrease in glycogen and triglyceride stores (1 mark).

**Question 5**

a. Two marks available here as follows:
   Heart rate increases linearly with increases in exercise intensity (1 mark). At rest heart rate is lowest at 54 bpm, and it increases during exercise up to a highest rate of 202 bpm, before reducing during recovery back towards the resting heart rate value (1 mark).

b. Two marks available here as follows:
   Heart rate increases during physical activity in order to increase oxygen delivery to the working muscles (1 mark) whilst at the same time facilitating the removal of waste products such as carbon dioxide (1 mark).
Solution Pathway

c. One mark available here as follows:
   • Anticipatory response

d. Two marks available here as follows:
   Yes the student does reach their maximum heart rate during this test (1 mark) since maximum heart rate is equal to 220 minus age.
   
   \[ 220 - 18 = 202 \text{ bpm} \] – this value was achieved in 11th minute (1 mark).

Question 6
Four marks available here as follows:
Blood lactate levels will be lower during sub-maximal physical activity as compared to maximal exercise where the level of blood lactate will be higher (1 mark). This is because during sub-maximal activity the athlete is relying primarily on the aerobic system at this intensity. This results in little production of lactate and lactate levels in the blood remain low (1 mark). When exercise intensity increases to maximal levels the athlete is relying on the anaerobic systems (including the anaerobic glycolysis system) and this results in the production of increased amounts of lactate (1 mark). This then enters the blood and blood lactate levels begin to rise as the rate of lactate production begins to exceed the rate at which lactate can be removed from the blood and will begin to accumulate in the body (1 mark).

Question 7
a. One mark available here as follows:
   • Subject B
b. Two marks available here as follows:
   Subject B is the elite player as they have a higher stroke volume at both rest (80 mL/beat) and maximal exercise (170 mL/beat) compared with Subject A (70 mL/beat and 120 mL/beat) (1 mark). Subject B also has a lower heart rate at both rest and maximal exercise compared to Subject A (50 bpm and 180 bpm compared to 65 bpm and 190 bpm) (1 mark).
c. One mark available here as follows:
   \[ Q = \text{HR x SV} \]
   \[ 190 \text{ bpm x 120 mL/min} = 22,800 \text{ mL/min or 22.8 L/min} \] (1 mark).

Question 8
a. One mark available here as follows:
   • blood plasma (1 mark)
b. One mark available here for any one of the following factors:
   • intensity of the physical activity
   • hydration level of individual
   • environmental temperature.