1.1 Exercise physiology: responses and recovery

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS cardiac output • stroke volume

Objective

Physiology: responses and recovery. Original classroom practice for IB HL; not an official IB paper.

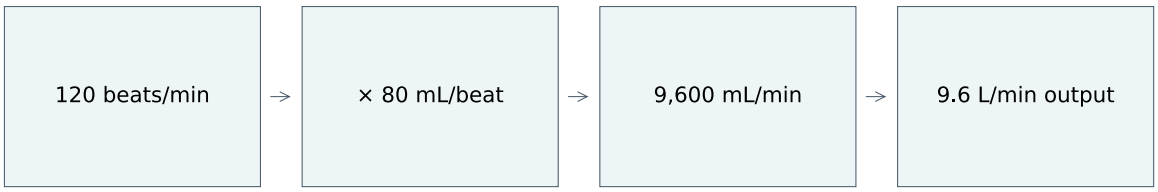
1 Key knowledge and worked examples

■ What would explain this observation?

- Heart rate increases during a short exercise bout, then recovers. This time course connects energy demand, oxygen transport and cardiovascular regulation.

■ Build the model

- **Cardiac output** is heart rate multiplied by **stroke volume** .
- Ventilation supports gas exchange, while blood transport delivers oxygen to working tissues.
- ATP demand changes as muscle activity changes.
- cardiac output: Blood volume pumped per minute.
- stroke volume: Blood volume pumped per beat.



Choose evidence that can test it

- An acute response occurs during or soon after exercise.
- A training adaptation develops over repeated sessions.
- A lower post-exercise heart rate cannot alone establish greater fitness without comparable workload and participant conditions.

In the lab: Use voluntary informed participation, school supervision and an approved low-intensity protocol. Record baseline, a standardized workload and timed recovery measurements. Stop for discomfort and do not use maximal exertion or health diagnosis as a classroom task.

Work from known quantities

- Known: heart rate is 120 beats per minute and stroke volume 80 millilitres per beat.
- Cardiac output = heart rate × stroke volume = 120×80 = 9,600 millilitres per minute = 9.6 litres per minute.

Your turn: Heart rate is 100 beats/min and stroke volume is 70 mL/beat. Find cardiac output in L/min.

Check the conclusion and its limits

- A heart-rate monitor measures one response, not every dimension of performance.
- Hydration, stress, medication and recent activity can confound comparisons.

Not true: A single heart-rate reading proves a person fitness level. One heart-rate reading mixes fitness with hydration, stress, caffeine, posture and recent activity. Fitness judgements need repeated measurements under controlled conditions, and heart rate alone says nothing about strength or skill.

Key:

- Cardiac output is heart rate multiplied by stroke volume.
- An acute response occurs during or soon after exercise.
- Watch for: A heart-rate monitor measures one response, not every dimension of performance.

Write from a cardiac output of 5.4 litres per minute

- Heart rate is 90 beats per minute and stroke volume is 60 millilitres per beat.
- Find the cardiac output. One heart-rate reading does not prove fitness.

2 Practice

2.1 Which distinguishes a training adaptation from an acute response? Choose one answer.

- **A** It develops over repeated training sessions
- **B** It must occur within one heartbeat
- **C** It is unrelated to the body [1]

2.2 Heart rate is 100 beats/min and stroke volume is 70 mL/beat. Find cardiac output in L/min. Show the relation, substitution and units. [2]

2.3 Decide whether this claim is true and justify: One heart-rate reading mixes fitness with hydration, stress, caffeine, posture and recent activity. [2]

2.4 Blood volume pumped per minute: write the technical term. [1]

3 Exam-style questions

3.1 Fictional records have 100 beats/min×70 mL/beat and 140×50. Compare outputs and explain why heart rate alone cannot determine output or fitness. [4]

Solutions

2.1 A An adaptation is a lasting change built over repeated training sessions, such as increased stroke volume. An acute response, like a raised heart rate during one session, appears and fades immediately; the time course is what distinguishes them.

2.2 Output=100 beats/min×70 mL/beat=7,000 mL/min=7 L/min.

2.3 True. True. One heart-rate reading mixes fitness with hydration, stress, caffeine, posture and recent activity. Fitness judgements need repeated measurements under controlled conditions, and heart rate alone says nothing about strength or skill.

2.4 cardiac output. cardiac output means Blood volume pumped per minute.

3.1 Both give 7 L/min. Output is a product; stroke volume matters. These invented arithmetic examples do not diagnose fitness or health.