

# 2021 VCE Physical Education external assessment report

## General comments

The 2021 Physical Education examination provided students with the opportunity to display key knowledge and skills through a range of multiple-choice and short-answer questions.

Students with a sound knowledge base were able to link their knowledge to various contexts and situations. Students are reminded about the importance of using correct terminology as this was important in many questions and also assisted students to write concisely. This was particularly applicable in Questions 2a., 3a., 3b. and 8bii.

Students and teachers are also reminded to use [VCAA support documents and material](#) (e.g. the list of VCAA-approved fitness tests, which includes the accepted name for each test). High-intensity interval training (HITT) is another area with support document links that should be reviewed.

The need to understand and respond to command/task words is an important examination skill that should be reviewed. An example was in Question 8biii., where students were required to **justify** their selection of fitness tests.

Students generally were able to complete extended-answer questions, including energy system interplay (Question 7a.). Students who scored highly were able to respond to the specific situation presented (with examples) rather than use a pre-planned answer.

Some students used the terms 'predominant'/'dominant' with regard to energy systems. These terms are not part of the study design and were sometimes used incorrectly. Also, the terms 'aerobic glycolysis' and 'aerobic lipolysis' were used; these terms are not necessary when talking about the aerobic system.

Many students showed a good understanding of biomechanical principles including Newton's laws, conservation of angular momentum and impulse. However, some students should consolidate their understanding with regard to levers (Questions 6a. and 6b.) and stability (Question 3c.) as questions involving these concepts were generally not answered well, particularly in linking the concept of mechanical advantage to range of motion and potential velocity of a third-class lever.

Many students did not show a good understanding of different practice types and distribution. This was shown in Question 4 where many students did not talk about distributed practice correctly.

Students are again advised to undertake many and various practical activities. These provide valuable learning opportunities and contextual learning in many areas that have been covered on examinations.

## Specific information

Note: Student responses reproduced in this report have not been corrected for grammar, spelling or factual information.

This report provides sample answers or an indication of what answers may have included. Unless otherwise stated, these are not intended to be exemplary or complete responses.

The statistics in this report may be subject to rounding resulting in a total more or less than 100 per cent.

## Section A

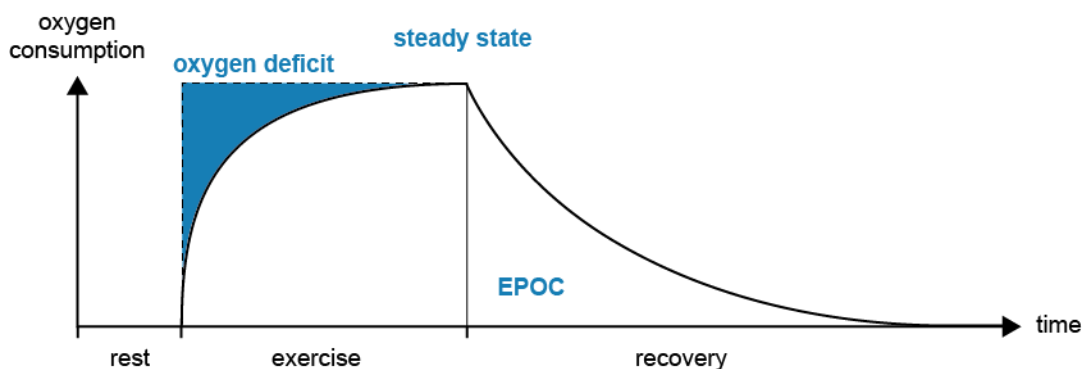
Question	Correct answer	% A	% B	% C	% D	Comments
1	D	13	5	2	79	
2	B	2	66	27	4	
3	C	3	25	70	2	
4	B	10	76	8	6	
5	D	7	5	4	84	
6	B	3	45	41	12	Most students were able to correctly narrow options down to B or C, given these indicated no change to maximum HR. However, B was the correct response given the smaller number had to be Q (in L) and the larger number SV (in ml).
7	C	19	1	77	2	
8	A	54	4	33	9	Given the key term in the question was 'approach to coaching', the only possible responses were A and D (given B and C are skill classifications). Constraints-based approaches (A) seek to develop skills within a game context.
9	A	61	26	12	1	
10	A	67	3	8	22	
11	C	10	8	79	4	
12	D	1	3	3	94	
13	D	6	1	2	92	
14	D	41	1	11	48	Students incorrectly selecting A were able to link high levels of lactate production with the correct system that produces this: anaerobic glycolysis system. However, as the exercise time was approximately 25 minutes, the correct answer was the aerobic system (due to the finite nature of the anaerobic glycolysis system).
15	B	9	78	5	8	

## Section B

### Question 1a.

Mark	0	1	2	3	Average
%	15	22	28	36	1.8

Oxygen consumption during and after exercise

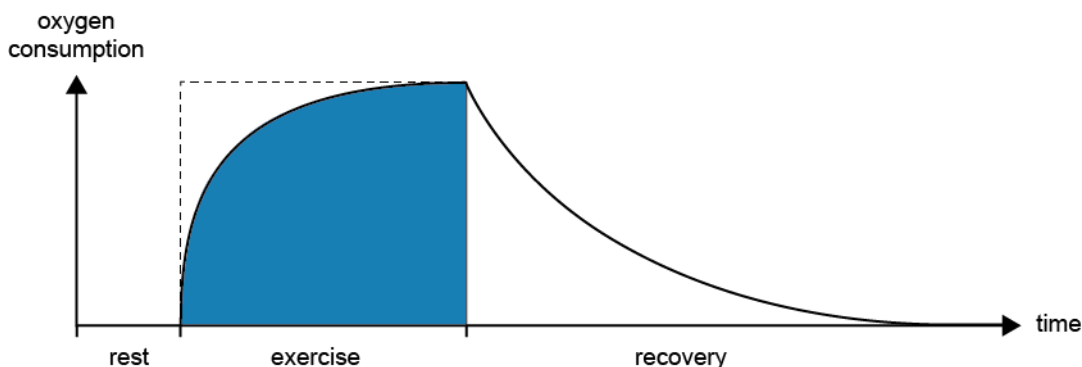


The period of oxygen deficit and excess post-exercise oxygen consumption (EPOC) were to be clearly identified inside the correct area. Steady state was required to be identified at the top of the graph. Responses outside these areas were not accepted.

### Question 1b.

Mark	0	1	Average
%	74	26	0.3

Oxygen consumption during and after exercise



The entire area of exercise was required to be shaded to reflect the production of aerobic energy.

## Question 1c.

Mark	0	1	Average
%	58	42	0.4

Acceptable responses included:

- maintaining heart rate assists with more oxygen to be distributed to assist with the removal of metabolic by-products
- maintaining heart rate assists the body to return to pre-exercise body temperature faster
- maintaining heart rate allows restoration of oxygen to myoglobin
- maintaining heart rate creates a venous pump to increase venous return

Students were required to explain their answer in a brief sentence to satisfy the **outline** command of the question.

## Question 1d.

Mark	0	1	2	3	Average
%	3	11	35	51	2.3

Correct responses were:

- oxygen consumption – increase
- oxygen demand – increase
- oxygen deficit – decrease

Students were only required to provide the option of ‘increase’ and ‘decrease’ as indicated in the question. Further explanation was unnecessary.

## Question 2a.

Mark	0	1	Average
%	54	46	0.5

The correct response was detraining.

## Question 2bi.

Mark	0	1	Average
%	40	60	0.6

Acceptable responses included (one of):

- decreased stroke volume
- increased resting and submaximal heart rate
- increased systolic blood pressure
- decreased haemoglobin or red blood cell content
- decreased cardiac output at maximal intensity
- decreased total blood volume
- decreased blood flow (redirection) to working muscles
- decreased volume of left ventricle.

## Question 2bii.

Mark	0	1	2	Average
%	48	31	21	0.7

Students who scored highly were able to explain how the change they listed affected cycling performance, specifically the reduction in aerobic energy production.

The following are possible responses:

- decreased stroke volume – having less blood being pumped per beat will reduce the oxygen delivery to working muscles reducing aerobic energy production at the same intensity
- increased resting and submaximal heart rate
- increased systolic blood pressure
- decreased haemoglobin or red blood cell content
- decreased cardiac output at maximal intensity
- decreased total blood volume
- decreased blood flow (redirection) to working muscles

Many students made general statements about performance being reduced without making a link back to potential reduction in aerobic energy production.

## Question 2c.

Mark	0	1	2	3	4	5	Average
%	11	17	20	22	20	11	2.6

Acceptable answers are shown in table below.

Frequency	Intensity	Work period	Recovery period	Repetitions
3 × week	Maximal effort High intensity 80–90% VO <sub>2</sub> max. 90% HR max. 100% peak power output	30 seconds to four minutes	60 seconds to four minutes	4–12

Students could use ranges as shown above for intensity, work period, rest period and repetitions. For frequency, only three per week was accepted. These were outlined in examples given in the VCAA support material HIIT supplement (2018–2021).

Apart from making selections based on the above table, students were also required to make realistic and logical links, particularly with intensity and work period. Examples of this would include (but were not limited to):

- a selection of maximal intensity work would be matched with a work period of 30 seconds
- a selection of a four-minute work period would be matched to an intensity of 80–90% VO<sub>2</sub> max.

The following is a sample response.

Frequency	Intensity	Work period	Recovery period	Repetitions
3 × week	90% HR max	One minute	Two minutes	Eight

### Question 3a.

Mark	0	1	Average
%	23	77	0.8

The correct response was muscular strength.

The response of 'strength' was not accepted as it is a general term and does not name a fitness component. Students are required to use correct terminology.

### Question 3b.

Mark	0	1	2	3	4	Average
%	34	13	28	6	19	1.6

Students who scored highly were able to identify and explain the processes of informed consent and pre-exercise screening (e.g. PAR-Q test) and use correct terminology.

Some students explained that they should undertake an activity analysis. This response was not accepted as this process should come before fitness tests and fitness components have been identified. Some students also used incorrect terminology when explaining health screening and informed consent.

The following is a possible response.

*New clients should complete a PAR-Q or health screening to understand their readiness to participate and whether his program is suitable for them (i.e. any risk factors).*

*They should also have informed consent explained so they are aware of the test procedure and risks associated with the test and with an allowance to withdraw at any time. Confidentiality of test results would also be explained.*

### Question 3c.

Mark	0	1	2	3	Average
%	29	44	20	6	1.0

Students who scored highly were able to clearly describe how the player adjusted his line of gravity within his base of support to prepare for a collision from the front. Many students correctly identified the widening of their base of support but did not clearly describe the movement of the line of gravity to the front of their base of support to give them more stability as the contact moves them backward.

Some students referred to the centre of gravity, which was not a requirement of the question.

The following is a possible response.

The player would increase their base of support, for example, by widening their stance or spreading their feet. They would move their line of gravity to the front end of their base of support in relation to the oncoming

force. This would allow more room for the line of gravity to remain within the base of support when contact is made from the front so as to improve stability.

## Question 4

Mark	0	1	2	3	4	5	6	7	8	Average
%	15	11	14	15	14	12	9	6	3	3.4

Students who scored highly were able to link the principle of Newton's third law and conservation of angular momentum to the example of the diver. They were also able to explain how the combination of practice strategies in one session were used and why they would benefit the performer.

Many students showed a very good understanding of both biomechanical principles and were able to explain this well in how they would assist the diver. Many students could not demonstrate a complete understanding of practice strategies, particularly how distributed practice could be applied within a practice session. Some students also confused blocked practice with massed practice.

The following is a sample response.

*Blocked practice is suitable given the dive is performed in a closed environment with no variability in the performance conditions, allowing the same skill to be performed repeatedly. Given the performer is a child, distributed practice within a session allows for regular breaks given the shorter attention span of a child and allows for rest breaks and regular feedback to be provided.*

*Newton's third law describes action and reaction forces, so that for every action, there is an equal and opposite reaction.*

*In diving, the diver exerts a force against the diving board and experiences an equal and opposite reactive force that moves them in the opposite direction, propelling them into the air.*

*In performing a dive, the angular momentum (moment of inertia x angular velocity) produced at take-off is conserved throughout the air until contact with the water.*

*When in the tuck position, the diver rotates faster (higher angular velocity) than in the layout position, as the moment of inertia is lower as the body mass is located closer to the axis of rotation (the angular momentum remains constant). To slow the rotation for entry to the water (lower angular velocity) the diver extends the arms and legs to increase the moment of inertia (body mass moved away from the axis of rotation).*

## Question 5a.

Mark	0	1	Average
%	30	70	0.7

The correct response was aerobic system. This was the only answer accepted.

Some students incorrectly stated aerobic glycolysis system. As this term refers to the use of glycogen/glucose only by the aerobic system, this is incorrect.

## Question 5b.

Mark	0	1	2	3	4	Average
%	26	14	24	15	20	1.9

Students who scored highly were able to discuss the changes in fuel use from the 25%  $\text{VO}_2$  max. to the 85%  $\text{VO}_2$  max. and were able to show an understanding of the rate of energy production of different fuels.

Some students wrote about the interplay of energy systems, which was not required in this question.

The following is a possible response.

*At an intensity of 25%  $\text{VO}_2$  max., the demand for energy is low and the rate of energy required to be produced is also low. Therefore, fat (FFA and triglycerides) can be relied on heavily to meet energy demands (as seen with 85% use in the graph). Whereas, when intensity increases to 85%  $\text{VO}_2$  max. an increased rate of energy production is required. Therefore, the proportion of muscle glycogen and glucose used increases (75%+), as this fuel produces energy at a faster rate than fat.*

## Question 6ai.

Mark	0	1	Average
%	23	77	0.8

The correct response was third-class lever.

## Question 6aii.

Mark	0	1	2	3	Average
%	42	21	19	18	1.1

Students who scored highly were able to explain that a third-class lever has a mechanical advantage of less than one. Students could have referred to this as mechanical disadvantage, but this was not necessary. As a result of a greater range of motion at the end of the lever there is potential for a greater velocity that can be imparted onto the ball. Some students were able to identify the mechanical advantage but were not able to explain how this impact affects velocity. Many students were not able to clearly communicate their understanding of the concept of mechanical advantage.

The following is a possible response.

The lacrosse stick increases the length of the resistance arm reducing the mechanical advantage to less than one. This favours speed as it has a greater range of motion at the end of the stick. The lever therefore has potential for greater velocity that can be imparted onto the ball.

## Question 6b.

Mark	0	1	2	3	4	Average
%	20	23	21	23	13	1.9

Students who scored highly were able to describe how the principle of impulse can be used to help prevent the ball from bouncing out of the lacrosse net. Many students were able to correctly identify the formula for impulse and were able to explain that distributing the force over a longer time would assist the player.



Students are reminded that, in this situation, impulse remains the same, regardless of the technique used and it is the time that force is applied that is manipulated.

The following is a possible response.

Impulse = force x time. By 'giving with the ball' the lacrosse player changes the momentum of the ball over a greater period of time and dilutes the impact force, helping prevent the ball from bouncing out of the net.

### Question 6c.

Mark	0	1	2	3	4	Average
%	43	15	10	13	19	1.5

Students who scored highly were able to describe how the four stages of a qualitative analysis could be applied by the coach to improve the player's technique. It is likely these students performed a qualitative analysis in a practical environment at school. Many students gave a general description of a coach helping the player practise without demonstrating an understanding of the stages involved in an analysis.

The following is a possible response.

*Michelle's coach would need to prepare to undertake the analysis by ensuring she has established when she will collect footage of her technique / what criteria she will use in analysing her technique or setting up the camera to record the skill execution. She will then collect the footage (**observation**), make a digital recording / record success / make notes that she directly observes.*

*The coach would now watch the footage and evaluate the technique, using the criteria, noting areas of strength and improvement. Finally, her coach would work with Michelle during the **error correction** phase to provide feedback and strategies/drills to improve her technique.*

### Question 6d.

Marks	0	1	Average
%	22	78	0.8

Acceptable responses included any of:

- prepares the body physiologically/psychologically for exercise
- increases the body's physiological responses (e.g. heart rate)
- increases muscle temperature
- reduces risk of injury
- increases blood flow to working muscles.

### Question 6e.

Marks	0	1	2	3	4	Average
%	10	24	30	25	10	2.0

Students who scored highly were able to critique the warm-up by giving a strength, weakness and suggestion for improvement as well as stating that the warm-up as shown would be ineffective or partly effective.

Strengths of the warm-up shown could be that it has the correct components in the correct order and contains dynamic stretching. Weaknesses of the warm-up could include that walking would not be an

effective intensity, three reps of dynamic stretching is too low or that the sports-specific component lacks variety or intensity.

The following is a possible response.

*The warm-up listed is ineffective for a lacrosse player preparing for a match. Although the three parts of the warm-up are shown in the correct order the walking for two minutes would not be a high enough intensity or duration to increase blood flow and warm the muscles in the cardio component. This could be replaced with jogging for five minutes, which would be a better preparation for the player.*

## Question 7a.

Mark	0	1	2	3	4	5	6	Average
%	6	9	20	27	23	12	3	3.0

Students who scored highly were able to explain the energy system interplay during a squash game with specific examples from the data shown. The question was well answered with students clearly understanding and describing interplay. It was important to show understanding of each of the three systems and how they work together during a match.

Some students incorrectly used the words 'predominant' and 'dominant' in their answers. These terms are not mentioned in the study design nor the support material. Students are encouraged to use terms such as increased/decreased contribution in conjunction with data, to describe the contribution of each energy system in each example.

The following is a possible response.

*While all three energy systems contribute to ATP resynthesis throughout the match, the aerobic system will contribute the most due to the duration of 45 minutes. The ATP-CP system will provide energy for high-intensity sprints, lunges and smash shots as this system provides energy at the fastest rate. The seven-second break between points allows for some CP restoration via the aerobic system so that for 20% of points lasting less than six seconds the ATP-CP system may have a great contribution. However, in the 60% of points between six and 30 seconds, Michael will have CP depletion and will increase reliance on the anaerobic glycolysis system to allow for repeated/sustained high-intensity rallies. As the match continues and for the 18.9% of rallies lasting longer than 30 seconds, the aerobic system will increase its contribution.*

## Question 7b.

Mark	0	1	Average
%	31	69	0.7

As the percentage of time spent above 90%  $\text{VO}_2$  max. increases, blood lactate concentration increases.

## Question 7c.

Mark	0	1	2	3	Average
%	51	25	18	6	0.8

Students who scored highly were able to refer to the fitness component of anaerobic capacity and refer to the graph. They showed an understanding of how increased use of the anaerobic systems would lead to

greater blood lactate concentration. Some students gave a general description of the graph or referred to lactate inflection point (LIP), which was not correct in this context.

The following is a possible response.

*Anaerobic capacity is the amount of energy that can be produced via the anaerobic energy systems. The greater the percentage of time someone spends above 90%  $VO_2$  max., the greater the reliance on the anaerobic glycolysis system, which will increase lactate production (e.g. 14mmol for 80% of time spent above 90%  $VO_2$  max.).*

## Question 8a.

Mark	0	1	2	3	Average
%	39	5	19	37	1.5

Students were able to use the fitness components of aerobic power, muscular power or anaerobic capacity, with associated data descriptions to access available marks in this question.

The following is a possible response.

Aerobic power is important due to the long duration of the game (2 hours and 5 minutes) as well as the time spent above 70% HR max (60 minutes). This shows the need to produce aerobic energy during the match.

## Question 8bi.

Mark	0	1	Average
%	40	60	0.6

Acceptable responses included (depending on choice of fitness component) the following.

Aerobic power:

- 20 m multi-stage fitness test or 20 m shuttle run test
- Yo-Yo test (or Yo-Yo intermittent recovery test)
- Coopers 12-minute run test
- Harvard step test
- 2.4 km run test
- Rockport 1.6 km walking test

Anaerobic capacity:

- Phosphate recovery test

Muscular power:

- Seated basketball throw (if students used term 'basketball throw', the description/drawing in part bii. needed to indicate the test is conducted in a seated position).
- Standing long jump test
- Vertical jump test
- Margaria Kalamen stair sprint test

These are all VCAA-endorsed fitness field tests for relevant components. Students who scored highly selected a test that they were then able to justify in further parts of the question. Students were required to use correct terminology for naming the tests. For example, 'beep test' was not an acceptable response.

## Question 8bii.

Mark	0	1	2	Average
%	34	22	44	1.1

Students who scored highly were able to correctly describe or draw and describe the fitness test they selected in Question 8bi.

The following are possible responses.

- The Yo-Yo test involves running to a 20 m line and then back before taking a short rest (10 seconds) before repeating the sequence following an ever-decreasing time limit, which is defined by a beep on a soundtrack. The score is the highest level attained while keeping up with the speed given.
- Seated basketball throw (muscular power) involves sitting against a wall and chest passing the ball as far as possible while keeping their back against the wall (i.e. isolating the use of the upper body).
- Phosphate recovery (anaerobic capacity) involves seven-second sprints across a course with 23 seconds recovery after each sprint. The individual attempts to move past as many cones (numbered 1–10) as possible. Their score (decrement) is measured on their ability to maintain performance across all seven sprints.

## Question 8biii.

Mark	0	1	2	3	Average
%	41	26	21	13	1.0

Students who scored highly were able to justify the selection of the test from physiological, psychological and sociocultural perspectives. From the physiological perspective, students were required to justify their selection based on game movements (e.g. Yo-Yo test aligns itself to the stop–start nature of the game involving short sprints followed by small rest periods).

The following is a possible response.

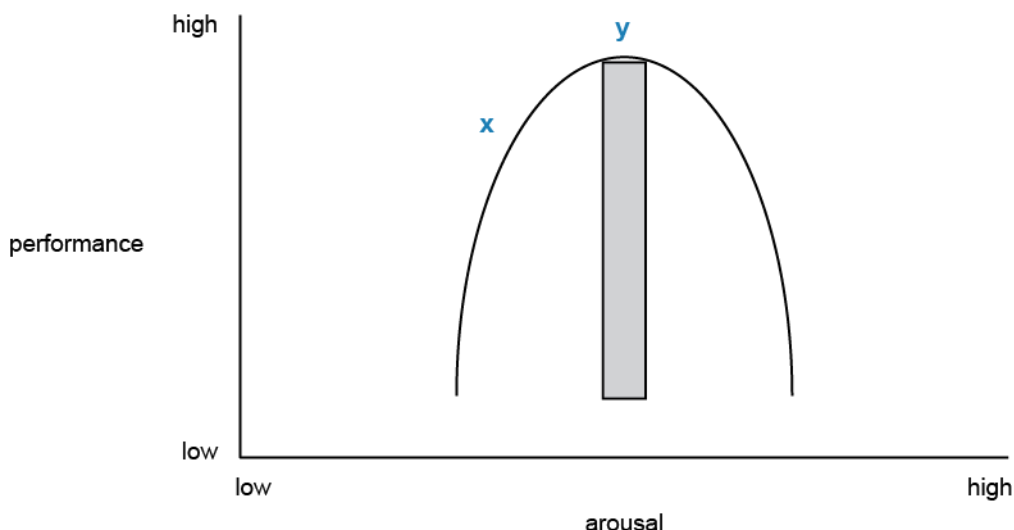
*The Yo-Yo test is a suitable test for Alex because it mimics the physiological movements of tennis (i.e. the periods of work and short rest during the test are specific to the intermittent nature of play and the break between points).*

*As Alex is a state-level player, the motivation required to complete an exhaustive test such as the Yo-Yo test will not be a concern, compared to an amateur athlete (psychological perspective). Additionally, from a sociocultural perspective, the test is a field test, meaning that it is more accessible in terms of resources (cost) and facilities (compared to a laboratory-based test).*

## Question 8c.

Marks	0	1	2	Average
%	49	26	25	0.8

Relationship between arousal and performance



Many students placed their X and Y points at the very bottom of the curve, which was not accepted. The arousal/performance relationship for an elite athlete would mean small gradients above and below optimal could lead to large differences in performance.

## Question 8d.

Marks	0	1	2	3	Average
%	23	18	35	24	1.6

Students who scored highly were able to name and describe a recognised psychological strategy that may be used to help concentration. Many students did not refer the strategy selected back to how it would assist concentration. The strategy could be used either during a game or between games to assist concentration.

Acceptable strategies include:

- pre-set routines
- meditation
- positive self-talk / cue words
- adequate sleep
- mental imagery
- stress inoculation training.

The following is a possible response.

*By completing set routines (e.g. after each point) the athlete can relax between points and then 'switch on' at a defined point in his routine. This will help him focus on selected cues to maintain concentration.*

*By completing meditation (in practice), the athlete can improve their ability to centre their thoughts on one task and therefore improve their ability to identify cues (such as a serve).*

*Using positive self-talk / cue words (such as 'refocus'), an athlete can identify a loss of concentration and bring their attention back to the correct cues related to a serve.*

## Question 9a.

Mark	0	1	Average
%	32	68	0.7

The correct response was task constraint.

## Question 9b.

Mark	0	1	2	3	4	Average
%	10	7	13	28	43	2.9

Students who scored highly were able to discuss how one modification was able to impact on motor skill development, participation and performance.

The following is a possible response.

*A lighter discus javelin allows a child the ability to throw the discus more easily. This allows the correct technique for a motor skill development in discus to be taught. This may include how to do the footwork and arm swing correctly without having to worry about the weight of the object.*

*If skill development is occurring, this increases the motivation for a child to continue to participate and as a result further increase their performance by being exposed to more coaching and competition.*

## Question 10a.

Mark	0	1	Average
%	38	62	0.6

The correct response was fartlek training.

## Question 10b.

Mark	0	1	2	3	4	5	Average
%	19	18	21	20	16	6	2.1

Students who scored highly were able to evaluate that this program would be effective by referencing examples of specificity (running, intermittent speeds reflecting game play), intensity (70% periods in aerobic training zone, 90% periods at top end of aerobic zone) and duration (20 minutes, effective for improving aerobic power).

Some students referred to the length of the session (20 minutes) as an example of specificity. This response was not accepted given that no game or quarter duration was provided and the specificity needed to be linked to improving aerobic power within an AFLW context.

The following is a possible response.

*This method is very effective in improving aerobic power. **Specificity** is suitable given the changes in intensity that an AFLW midfielder will need to complete, without coming to complete rest.*

***Intensity** is appropriate – it is largely completed in the aerobic training zone, with the increase to 90% suited to the spikes that will occur when sprinting to the next contest/away from the pack. **Duration** is*

*appropriate, given the 20-minute conditioning phase is suitable for the achievement of aerobic adaptations.*

### Question 10c.

Mark	0	1	Average
%	64	36	0.4

Acceptable responses included (one of):

- increase the time of one of the work periods (i.e. 90 seconds to 95 seconds)
- increase the number of work periods within a time (i.e. increase from four to five reps of 60 seconds)
- complete the course over a hilly terrain instead of on flat course
- decrease the recovery period (i.e. 60 seconds to 55 seconds)
- increase intensity of bursts by maximum of 2% to 92% heart rate monitor (HRM)
- increase total time to 22 minutes
- increase total number of work periods by one

### Question 10d.

Mark	0	1	2	3	4	Average
%	28	18	23	18	13	1.7

Students who scored highly were able to define cardiac output (heart rate  $\times$  stroke volume) as well as identify that cardiac output is increased from rest to maximal intensity. They were also able to explain the parameters involved, specifically that stroke volume will plateau and further increases will be a result of increased heart rate.

The following is a possible response.

- Cardiac output (Q) is the amount of blood pumped out of the heart per minute.
- Any increase in heart rate (HR) or stroke volume (SV) will increase cardiac output (given that  $Q = SV \times HR$ ).
- As an individual moves from rest to exercise all three parameters will increase.
- At sub-maximal intensity stroke volume **plateaus** as the left ventricle has a finite capacity, therefore, any further increase in Q is due to an increase in HR.

This example correctly uses referenced abbreviations.

### Question 10e.

Marks	0	1	2	3	Average
%	22	24	26	27	1.6

Students who scored highly were able to specifically reference the importance of carbohydrates, protein and water in the recovery process. Some students referenced why these would be important during exercise, which was not correct.

The following is a possible response.

- Carbohydrates replenish muscle glycogen levels that were used during exercise.
- Protein promotes muscle growth and repair of tissue damaged during exercise.
- Water replaces lost fluid (blood plasma) during exercise and treats dehydration.

## Question 11a.

Mark	0	1	2	3	4	Average
%	30	31	21	12	6	1.3

Students who scored highly were able to reference (define) lactate inflection point (LIP) and that having a higher LIP would enable the aerobic athlete to maintain a higher intensity without the build-up of fatigue due to accumulation of metabolic by-products. Some students confused lactate tolerance with LIP. Lactate tolerance is not a suitable answer in this context due to the extended time of the event.

The following is a possible response.

*LIP is the final point where lactate production balances with lactate removal. Kipchoge has a higher LIP (more aerobically trained) than the 800m runner. This allows Kipchoge to maintain the 2:50 pace to work aerobically at a higher intensity for a longer time. Whereas the 800m runner needs to exceed LIP and therefore will succumb to fatigue caused by the accumulation of metabolic by products.*

## Question 11bi.

Mark	0	1	Average
%	68	32	0.3

Acceptable responses included:

- increased mitochondrial density/mass
- increased oxidative capacity – increased oxidative enzyme activity

These were the only two acceptable answers leading directly to an increase in LIP.

Some students referred to increased myoglobin or increased arterio-venous oxygen (A-VO<sub>2</sub>) difference. These responses were not accepted as they do not lead directly to an increase in LIP (e.g. increased A-VO<sub>2</sub> difference is a result of the mitochondria or oxidative enzymes using oxygen for adenosine triphosphate (ATP) resynthesis).

## Question 11bii.

Mark	0	1	2	Average
%	80	7	13	0.3

Students who scored highly were able to describe how the adaptation identified in Question 11bi. was able to improve LIP.

The following are possible responses.

*Mitochondria are the sites for aerobic energy production; therefore, a greater density will allow for more oxygen to be utilised in producing ATP aerobically (therefore higher LIP).*

*An increased capacity to oxidise fat and carbohydrate in response to endurance training can allow for ATP to be produced at higher intensities (therefore leading to a higher LIP).*