

2024 VCE Physical Education external assessment report

General comments

The 2024 VCE Physical Education examination gave students the opportunity to display a wide variety of key knowledge and skills through a series of questions applied to different contexts.

The exam focused on application of information to familiar sports and exercises as well as more novel contexts. Memorised set responses were less successful, and students are encouraged to apply the Study Design knowledge points to a wide range of physical activities, sports and exercises. The exploration of a broad range of contexts through participation and observation can support this diversity of application.

Learning through movement continues to benefit students as those who had completed practicals appeared more likely able to provide suitable exercise examples, such as those required for a warmup (Question 2b.) and plyometrics (Question 2c.). Undertaking a variety of fitness tests helped students understand the concept of specificity when selecting appropriate tests (Question 8c.), identify a process to complete prior to participation (Question 8e.) and recommend protocols to conduct tests (Question 8d.).

The examination included graphs and required data analysis in several questions. Many students included references to the data in the graphs within their responses to support their explanations or discussions, for example in the explanation of the relationship between power output and heart rate (Question 4b.). Students found the graph presented in Question 10 more challenging and are encouraged to gain exposure to many and varied types of data as part of their study and revision program.

Critiquing a training program (Question 5d.) was accessible for many students, with the majority using specific references to data. Students are reminded to be concise in their responses as, at times, in an effort to make many data references, information was included that contradicted an already correct response. Similarly, when a question asks for one answer, for example a stage of a QMA (Question 9c.) or the speed at which LIP occurred (Question 5a.), students are reminded to carefully select their best response.

The use of correct terminology and equations continues to allow students to demonstrate their understanding of the Study Design. Often the use of definitions provided an access point for questions such as fitness components (Question 8a.) and summation of momentum (Question 9a.), as did the equation for cardiac output (Question 6b.).

Question 11 required students to apply a series of concepts to a practical context (integration) and create links between these concepts (interrelationships). While some students wrote separate paragraphs for each concept, more successful responses had strong connections to the context in and through all knowledge points. Successful responses were also well organised and analysed many relationships between the four knowledge points.

To prepare for the examination, students should review the requirements for command words, including critique, evaluate, justify, discuss, outline, explain and describe. It is important for students to understand the methodology required to answer questions containing these terms; for example, when justifying, students need to defend their choice with evidence or reasoning.

Specific information

Note: This report provides sample answers, or an indication of what answers may have been 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 – Multiple-choice

The table below indicates the percentage of students who chose each option. Grey shading indicates the correct answer.

Question	Correct answer	% A	% B	% C	% D	Comments
1	A	92	3	2	2	
2	C	1	6	81	12	
3	A	55	14	24	7	
4	A	79	16	5	0	
5	D	3	8	4	85	
6	D	3	13	12	72	
7	B	8	65	4	23	
8	D	9	3	34	54	
9	D	6	2	5	87	
10	B	16	40	19	26	Muscular power is a combination of force and velocity.
11	A	65	8	15	12	
12	B	20	47	22	11	An effective aerobic training program produces aerobic adaptations to reduce oxygen deficit and therefore decreases reliance on the anaerobic systems at the start of submaximal exercise.
13	A	95	3	1	1	
14	C	1	11	70	18	
15	D	11	30	11	48	Angular momentum is conserved when manipulating a body position during a dive.

Section B

Question 1a.

Marks	0	1	2	Average
%	6	27	68	1.6

The correct answer for squat jumps was 'muscular power'.

The correct answer for abdominal crunches was 'muscular endurance'.

Question 1b.

Marks	0	1	2	Average
%	27	53	20	0.9

Students were required to use the concept of specificity to outline why a 15 m sprint was included in the circuit session for a netball goal keeper.

Responses that scored highly were able explain the concept of specificity and describe an example of how it is important for a netball goal keeper's performance.

The following is a sample response.

The 15 m sprint mimics the movement patterns of a goal keeper when they are sprinting out of the goal circle to intercept the ball.

Question 1c.

Marks	0	1	2	Average
%	29	41	29	1.0

Students were required to list two advantages of undertaking circuit training.

Acceptable advantages were:

- Many fitness components can be targeted.
- A variety of muscle groups can be trained.
- All energy systems can be trained.
- It can be highly specific to a sport.
- Variety is good for motivation.
- It is easy to run with large groups.

Question 1d.

Marks	0	1	Average
%	60	40	0.4

Students were required to select an exercise from the circuit and apply progression to that exercise.

Some students provided a generic answer such as decrease rest, which didn't apply to one specific exercise. Students are reminded to read the stimulus of each question.

Acceptable responses included:

- add weight to squat jumps/dips/push-ups
- decline crunches
- increase height of jump
- increase distance of repeat sprints.

Question 2a.

Marks	0	1	2	3	4	5	6	Average
%	8	17	25	24	16	8	2	2.6

Students were required to use data and specific references from the stimulus to explain the contribution of the three energy systems in a beach flags competition.

Responses that scored highly were able to:

- reference all energy systems within the context of the beach flags competition
- use specific numbers from the data to support their explanation
- use the key term rate to explain the use of the ATP-CP system for the initial maximal sprints
- describe the role of the aerobic system in restoring CP during rest times
- link the rest times to the energy system contribution for each sprint
- explain why there was an increased contribution of the anaerobic glycolysis system.

Common errors included:

- using the term 'anaerobic systems' rather than each system
- referring to the information without specific data references
- using the terms 'dominant' and 'predominant' incorrectly.

Teachers are reminded that these terms are not contained within the Study Design or Support Materials. They have become increasingly used and have been found to cause confusion for some students in describing the interplay of energy systems. The Frequently Asked Questions document provides alternative terms that should be used when referring to energy system contribution.

The following is a sample response.

The ATP-CP system is the major provider of energy for the initial sprints as they are maximal intensity and short duration (3.6 seconds for the first three races). The ATP-CP has the fastest rate which allows for a rapid resynthesis of ATP. During rest time, the aerobic system restores CP. However, there is insufficient time for all CP to be restored. For example the 53 seconds after the first sprint would not restore all CP as 3 minutes is required for 98% of CP restoration. Therefore, as the sprints progress, there is an increased reliance on the anaerobic glycolysis system (due to CP depletion), which produces energy at a slower rate than the ATP-CP system. This results in slower sprints, such as 3.9 seconds for the 4th race. Between race number 7 and 8 there is significantly more rest time (4.05 seconds) which allows more CP to be restored and therefore available for the next sprint and it is run at the fastest time of 3.5 seconds.

Question 2b.

Marks	0	1	2	3	Average
%	19	29	32	20	1.5

Students were required to provide a suitable example for the three phases of a warmup: general phase, dynamic stretching and sports specific phase.

Responses that scored highly linked the suggested exercises to the movement patterns and muscle groups required in beach flags.

The following is a sample response.

5 min jog on the beach

Dynamic leg swings

Short maximal sprints along the beach

Question 2c.

Marks	0	1	2	Average
%	79	12	9	0.3

Students were required to outline the two stages of muscle contraction (eccentric and concentric) and the characteristics of each stage (rapid/forceful) of a plyometric exercise.

Some responses were able to identify the stages and/or the characteristics of this type of muscle contraction but aligned them incorrectly to the phases of the contraction.

The following is a sample response.

Plyometrics exercises involve a rapid lengthening of the muscle (eccentric contraction) followed by a forceful shortening of the muscle (concentric contraction).

Question 2d.

Marks	0	1	2	Average
%	27	23	50	1.2

Students who demonstrated an understanding of how to perform a plyometric exercise performed well on this question as their description or drawing conveyed their knowledge or practical experience.

Some students chose more general resistance exercises without a clear understanding of the characteristics of plyometric exercises, or prescribed (sets, repetitions, etc.) rather than described and/or drew the exercise.

The following is a sample response.

A clap push up involves the athlete lowering quickly in the down phase then explosively pushing up, launching in the air and clapping while midflight.

Question 2e.

Marks	0	1	Average
%	18	82	0.8

The correct answer was a number within the range 3–10.

Question 2f.

Marks	0	1	Average
%	70	31	0.3

Acceptable answers were:

- 100% maximum effort
- explosive
- 9–10 RPE.

A common misconception was that the intensity of plyometric exercises could be measured by recording heart rate. Students needed to match the type of exercise with the most appropriate measuring tool. A maximal intensity short duration movement (anaerobic) is unlikely to elicit a maximal heart rate response and so a better tool would be rate of perceived exertion (RPE). A percentage of maximum heart rate will be more suitable for aerobic-based exercise.

Question 3a.

Marks	0	1	Average
%	5	95	1.0

The correct answer was 'cognitive'.

Question 3b.

Marks	0	1	2	Average
%	33	35	32	1.0

Responses that scored highly identified a characteristic of a cognitive learner and then linked that to a requirement for learning (skill acquisition) that included a reference to feedback, practice strategies or approach to coaching.

Acceptable characteristics included:

- makes frequent errors
- unable to detect errors
- unable to correct errors
- quick performance improvements
- movements lack flow/coordination
- unable to use intrinsic feedback
- poor understanding of skill technique.

Acceptable learning requirements included:

- requires augmented feedback from coaches
- requires minimal teaching points
- benefits from demonstrations
- needs to be in a more closed environment
- benefits from blocked practice
- benefits from a direct approach.

Question 3c.

Marks	0	1	2	Average
%	22	36	43	1.2

Students were required to explain how a task constraint in MiniRoos could influence the motor skill development of children in modified soccer.

Responses that scored highly were able to link the constraint to an increase in opportunities to touch the ball and therefore develop motor skills (smaller pitch) or to an ease in performing the skill, therefore providing more motivation as success increases (smaller, lighter ball).

The following is a sample response. .

A smaller pitch means players are closer together which increases their opportunity to touch the ball. More frequent touches on the ball increases participation and likely improves their motor skill development.

Many responses discussed throwing the ball rather than kicking. Students are reminded to read the stimulus and undertake practical activities to comprehend the skills and performance requirements of common sports.

Question 3d.

Marks	0	1	2	3	Average
%	18	27	32	22	1.6

To be awarded full marks, students were expected to recognise the change in practice scheduling was from massed to distributed, which resulted in more frequent participation. They could link more frequent sessions with more frequent opportunities for feedback or skill consolidation, or discuss the impact longer sessions would have had on fatigue, concentration or motivation.

Some responses confused distribution of skill practice with frequency of training and spoke about adaptations, or discussed distribution within a session, rather than scheduling over the week.

The following is a sample response.

The coach changed the practice in week 4-6 from massed practice to distributed practice, which resulted in more improvement. Distributed practice means players were participating more frequently. This led to an increased skill development as players had more frequent opportunity to consolidate their technique.

Question 3e.

Marks	0	1	2	Average
%	28	30	42	1.1

Accepted responses included reference to:

- family
- peers
- gender
- SES
- community (role models)
- cultural norms.

The following are sample responses.

Seeing the success of the Matildas meant young people looked up to them as role models which motivated them to participate in soccer.

The (female) gender of the Matildas team motivated more young children (particularly girls) to participate in soccer as they could see an elite pathway and believed it was possible.

Some responses spoke more generally about an increase in participation without directly referencing a sociocultural factor.

Question 4a.

Marks	0	1	2	3	4	Average
%	35	14	16	18	18	1.7

To be awarded full marks, students were expected to discuss the changes in fuel for an event lasting over four and a half hours and the impact of those changes on performance.

Responses that scored highly discussed the changes in fuel contribution as the cyclist reached the second half of the race (cross-over concept – note, this term was not required to access full marks). Specifically, high-scoring responses referred to the impact of glycogen depletion and the increased reliance on triglyceride as a fuel source on cycling performance and linked the drop in power output or intensity to the slower breakdown of triglycerides.

The following is a sample response.

During the first half of the race, glycogen would be the major fuel to produce energy. But due to the long duration of the race, glycogen stores begin to deplete, meaning the body increasingly turns to triglyceride to provide energy. Due to triglyceride having a greater oxygen cost and therefore taking longer to break down than glycogen, this change in fuel use results in the cyclist slowing down during the second half of the race.

Question 4b.

Marks	0	1	2	3	4	Average
%	30	29	25	14	2	1.3

To be awarded full marks, students needed to use information from the graph to explain the cause and effect relationship between power output and heart rate. This then needed to be linked to the impact on energy system requirements.

Responses that scored highly used data that linked the increase in power output to an increase in heart rate and explained the increase in energy demands (either for aerobic energy or an increased reliance on the anaerobic systems during oxygen deficit) during that time.

The following is a sample response.

As power output increases, heart rate increases. For example, from the 16-19th minute Lucas increases his power output from 300 W to 620 W and his heart rate responds by increasing from 135 bpm to 190 bpm. This indicates he increased his intensity as he makes one of the steep climbs or surges to overtake an opponent. The increase in heart rate supplies the working muscles with more oxygen to help increase the amount of aerobic ATP resynthesized as energy demands rise.

Question 4ci.

Marks	0	1	Average
%	14	86	0.9

The correct response was 'oxygen deficit'.

Question 4cii.

Marks	0	1	2	Average
%	31	36	33	1.0

Students were required to identify two acute responses made by the muscular system to meet the increased power output.

Acceptable responses were:

- increased AVO_2 difference
- increased oxygen extraction
- increased enzyme activity
- increased blood flow to working muscle
- increased temperature
- decreased muscle substrate stores
- increased rate of motor units recruited
- increased number of motor units recruited
- increased lactate production.

Question 5a.

Marks	0	1	Average
%	51	49	0.5

The correct response was 14 km/h.

Question 5b.

Marks	0	1	2	Average
%	51	23	26	0.8

Students were required to use information from the graph to justify why 14km/h was LIP, and in doing so, show their understanding of LIP as a concept.

The following is a sample response.

From speeds 10 km/h to 14 km/h there is a slow increase of blood lactate, however at 15 km/h there is a significant increase from ~4 mmol/L to almost 8 mmol/L suggesting 14 km/h was the final speed when lactate could be removed as fast as it was being produced.

Question 5c.

Marks	0	1	2	3	Average
%	28	37	27	8	1.2

Students were required to use the appropriate fatigue mechanism (accumulation of metabolic by-products) to explain why Mika was unable to complete three minutes at 17 km/h.

Responses that scored highly explained how the accumulation of metabolic by-products impacted on Mika's performance (reduced rate and force of muscle contraction) and ultimately prevented him from completing the final block.

The following is a sample response.

At 17 km/h there was an increase in intensity and the aerobic system could no longer remove by-products as fast as they were being produced. Metabolic by-products (H⁺ ions) accumulated which slowed down muscle contraction and reduced force production. This would result in fatigue, and Mika would be unable to complete the final three-minute block.

Question 5d.

Marks	0	1	2	3	4	Average
%	26	22	19	16	17	1.8

Students were required to critique the effectiveness of a training program to improve LIP.

Responses that scored highly were able to identify a strength of the program, a weakness of the program and make a recommendation to improve the weakness that had been identified. They then used this information to determine that the program was effective or somewhat effective.

The following is a sample response.

This program would be somewhat effective in improving Mika's LIP. A strength of this program is the Fartlek session, which includes periods of work at 85% of max HR. As this is at the top end of the aerobic training zone it will help improve LIP. A weakness of the program is the intensity of the continuous session on Sunday (65% max HR) is below the aerobic training zone. This should be increased to 80% max HR.

A common misconception was that HIIT targets anaerobic capacity and was therefore a weakness of the program. Students and teachers are encouraged to review the VCAA guidelines for HIIT.

Question 6a.

Marks	0	1	Average
%	54	46	0.5

Acceptable standardised tests:

- Cooper 12-minute run test
- 2.4 km run test
- 20 m multi-stage fitness test or 20 m shuttle run test
- Yo-Yo intermittent recovery test
- Harvard step-test
- Rockport 1.6 km walk test.

Note: Students are required to use the correct test names as published in the Support Materials. The use of abbreviated names of the tests (beep test and yoyo test) did not receive marks.

Question 6b.

Marks	0	1	2	3	4	Average
%	29	26	21	15	9	1.5

To be awarded full marks, students were expected to use stroke volume data from the table, as well as the equation for cardiac output, to explain the impact of having a higher cardiac output on running performance.

Some responses used the cardiac output data as a data reference, which didn't demonstrate an understanding of why elite athletes have a higher cardiac output.

The following is a sample response.

Elite distance runners have a higher cardiac output (Q) than university students due to their increased stroke volume (187 ml/beat compared to 128 ml/beat for university students) as $Q=HR \times SV$. This means elite runners can deliver more oxygenated blood to working muscles, which increases the rate of aerobic ATP production. Therefore, elite runners can run at a faster pace aerobically.

Question 7a.

Marks	0	1	2	Average
%	22	47	31	1.1

Students were required to recommend an appropriate psychological strategy that Kaylee could use to assist her concentration for each day's racing.

Many students correctly identified a psychological strategy but found outlining how the strategy would improve concentration (the ability to maintain attentional focus / eliminate distractions) more challenging. Responses often linked their strategy to arousal regulation rather than concentration.

The following is a sample response.

Kaylee could use controlled breathing and focus on taking slow deep breaths, enabling her to eliminate any external distractions and enhance her concentration.

Question 7b.

Marks	0	1	Average
%	34	66	0.7

The correct answer was 'active recovery'.

Question 7c.

Marks	0	1	2	3	4	Average
%	48	21	19	10	3	1.0

To be awarded full marks, students needed to describe an active recovery and use the physiological benefits of an active recovery to justify why this would be the most suitable.

Responses that scored highly used physiological benefits such as reduced venous pooling or faster removal of metabolic by-products to justify why an active recovery would be the best recovery strategy and linked these benefits to the required outcome, which was to be prepared to swim in the final the following night.

The following is a sample response.

Kaylee would undertake a lower intensity swim following her 200 m backstroke semifinal. This active recovery maintains heart rate and therefore blood flow to the muscles, which results in a faster rate of metabolic by-product removal. This allows Kaylee to return to pre-exercise conditions fastest.

Question 7di.

Marks	0	1	2	Average
%	35	34	31	1.0

Students were required to explain how a specific type of physiological data collected during a training program would inform the monitoring of performance and recovery.

Responses that scored highly explained how the physiological data would be used to identify what the athlete is experiencing and how they might monitor or modify the training program or recovery strategies accordingly.

The following is a sample response.

Kaylee could monitor her muscle soreness after each training session, making sure she allows for more recovery time when needed. This will optimize adaptive responses and reduce the risk of overtraining syndrome.

Question 7dii.

Marks	0	1	2	3	Average
%	58	20	16	7	0.8

Students were required to identify one of the following chronic muscular adaptations and explain how it would assist performance in the 200 m backstroke event:

- increased size/number of mitochondria
- increased myoglobin stores
- increased muscular storage of glycogen/triglycerides
- increased oxidative enzymes
- increased glycolytic enzymes
- increased oxygen extraction ($a\text{-VO}_2$ difference).

The following is a sample response.

Kaylee would experience an increase in stores of oxidative enzymes as a result of training. This means fuel can be broken down more rapidly, which increases the rate of aerobic ATP production. As a result, Kaylee would be able to swim at a faster pace aerobically.

Many responses identified an anaerobic muscular adaptation. While anaerobic adaptations are likely to be beneficial for the 200 m backstroke, the question specifically referred to adaptations from the training program explained in the stimulus of the question, which was aerobic.

Question 8a.

Marks	0	1	Average
%	31	69	0.7

The correct answer is 'the ability to change direction quickly while maintaining balance'.

Question 8b.

Marks	0	1	2	Average
%	62	19	19	0.6

Students were required to identify a factor affecting agility and how this factor can impact on performance in badminton.

Responses that scored highly were able to demonstrate an understanding of a factor affecting agility in the context of a badminton match.

The following is a sample response.

Having a large percentage of fast twitch fibres will increase the athlete's ability to change direction quickly to reach a shuttle on the other side of the court.

Students must use a factor other than one of those used in the definition. Many responses chose speed or balance as a factor, which is embedded within the definition.

Note: As of 2025, 'gender' will **no longer** be accepted as a factor impacting on fitness components. The acceptable term linked to the difference in hormones and other physiological characteristics that impact on fitness components is 'sex'.

Question 8c.

Marks	0	1	2	3	4	Average
%	5	10	30	39	16	2.5

To be awarded full marks, students were expected to identify that the Semo Agility Test was the most suitable test. They needed to use data from the badminton match to justify their selection and explain why the Illinois Agility Test was less suitable.

Many responses used data successfully and displayed a strong understanding of the concept of specificity and the need to replicate movement patterns in test selection.

Some responses demonstrated a lack of understanding or recognition that the command term 'justify' means that a comparison to the other variable identified in the stimulus needs to be made and they must defend their choice with evidence or reasoning.

The following is a sample response.

The Semo Agility Test involves side stepping, running backwards and forwards. This test best replicates the movement patterns of badminton as shown by the frequency of movement, 30 sideways, 26 forwards and 12 backwards movements, making it more specific than the Illinois Agility Test, which is limited to just running forwards.

Question 8d.

Marks	0	1	2	Average
%	59	18	23	0.7

Students were required to outline two ways to increase reliability of the Semo Agility Test.

Acceptable responses included:

- the weather conditions are controlled or run indoors
- same time of the day
- same warm-up exercises
- same nutritional status
- same floor surface
- same clothing /footwear worn
- standardised measurements are used for ease of replication.

Some responses confused reliability with accuracy and outlined ways to decrease error rather than increase reliability.

Question 8e.

Marks	0	1	2	Average
%	30	20	50	1.2

Students were required to identify and explain one process used prior to administering a fitness test.

Some responses identified both processes but didn't describe either.

Acceptable processes were:

- health screen (PAR-Q)
- informed consent.

The following is a sample response.

Athletes should complete a PAR-Q to ensure there are no risk factors and the athlete is physically capable of participating in the test.

Question 9a.

Marks	0	1	2	3	Average
%	17	40	35	8	1.4

Students were required to describe a similarity and a difference between an able-bodied athlete and a wheelchair athlete's free throw using the concept of projectile motion and specifically referring to angle and height of release.

Responses that scored highly understood that both athletes would need a high angle of release, but that the wheelchair athlete would need an even greater angle of release as their height of release was lower.

Some responses used speed of release as a difference which, while impacting on projectile motion, was not listed as one of the projectile factors in the question.

The following is a sample response.

Both Athlete A and B have a height of release lower than their landing height, which means they both need a high angle of release. However, as Athlete B has a lower height of release than Athlete A, they will require an even high angle of release to project the ball upwards and into the ring.

Question 9b.

Marks	0	1	2	3	Average
%	25	36	29	10	1.3

Students were required to use their understanding of summation of momentum to explain how sitting in a wheelchair will impact two factors that contribute to summation of momentum.

Responses that scored highly clearly demonstrated an understanding of summation of momentum within the response and explained the impact of sitting down on factors such as time to produce force, recruiting larger muscles before smaller muscles or using as many muscles as possible.

The following is a sample response.

Summation of momentum refers to the correct sequencing and timing of body segments to produce force. Sitting in a wheelchair will impact the athlete's ability to produce this force as they are unable to use as many body parts as possible. Additionally, this seated position impacts their capacity to use their larger body parts first decreasing their capacity to summate momentum.

Question 9c.

Marks	0	1	2	3	Average
%	25	18	33	23	1.6

Students were required to identify that error correction is the final step of a qualitative movement analysis and explain how a coach would use this to improve Athlete A's free throw technique.

Responses that scored highly identified error correction as the final step and explained that the coach would give feedback to the athlete and then devise practice strategies to improve the technique.

Some responses gave more than one step as an answer, such as evaluation and error correction. Students are reminded that when one answer is required, giving two options will not receive full marks.

The following is a sample response.

The final stage of a QMA is error correction. Here, the coach would give Athlete A feedback on the criteria that needs improving from the evaluation and have them undertake skill and drill practice to correct any errors identified.

Question 10a.

Marks	0	1	2	Average
%	90	7	3	0.1

The correct answer is 'high intensity interval training (HIIT)'.

Accepted advantages included:

- increases VO_{2max}
- rapid adaptative response
- motivation can be enhanced due to shorter session time
- specificity in pace/replicating the 1500m event
- increases lactate tolerance.

Most responses were unable to identify that the training method was HIIT. Students were required to use information from the stimulus to determine the appropriate training method. This stated Jessica used active recovery between repetitions, as well as her aim of increasing maximal speed that can be worked at aerobically, which replicated the pace of her event (some of which was above VO_{2max}). The signposting of information regarding the replication of race pace (at and above VO_{2max}) ruled out long interval as the best possible response.

Question 10b.

Marks	0	1	Average
%	52	48	0.5

The correct answer was ' VO_{2max} . is reached'.

Question 10c.

Marks	0	1	Average
%	90	10	0.1

Students were required to use information from the graph to support their response to 10b.

Accepted responses were:

- VO_2 plateaus but intensity increases, indicating VO_{2max} . has been reached
- a VO_2 level of almost 70 mL/min/kg is too high to be a submaximal steady state
- after the plateau, split times decrease but VO_2 remains stable, indicating VO_{2max} has been reached.

Question 10d.

Marks	0	1	2	3	Average
%	68	16	10	6	0.6

To be awarded full marks, students needed to use information from the graph to determine that the split time decreased between 1000 m and 1500 m, demonstrating an increase in intensity. They needed to link this increase in intensity (above VO_{2max} .) with an increased reliance on the anaerobic energy systems.

Many students found analysing data presented in the graph challenging. Many responses incorrectly included that the decrease in split time meant that intensity was decreasing and used that assumption to discuss energy system contribution.

The following is a sample response.

Between 1000m and 1500m VO_2 has remained stable at almost 70 mL/kg/min but the split times decrease from approximately 14.3 sec at 100m to 13.7 sec at 1500m. This indicates that even though VO_{2max} has been reached, intensity has increased. This requires an increase in contribution from the anaerobic glycolysis system to accommodate the rise in energy demands.

Question 11

Mark	0	1	2	3	4	5	6	7	8	Average
%	17	16	19	19	15	8	5	2	0.5	2.6

Students were required to discuss the interrelationship between levers, fitness components, task constraints and Newton's second law of linear motion to explain why pickleball has gained popularity with older Australians.

Responses that scored highly were able to show interrelationships between the four knowledge points in the context of the stimulus. They integrated references to the stimulus throughout their discussion. Students linked knowledge points such as the reduced length of the paddle (task constraint) with the resulting change in mechanical advantage of the third-class lever. High-scoring responses then used the stimulus to demonstrate their understanding of the change in fitness components such as muscular strength of older Australians to explain why the changes increased accessibility and therefore popularity of the sport.

Some responses presented the knowledge points in isolation or focused more on describing the lever system in tennis.

The following is a sample response.

Pickleball has gained popularity with older Australians due to the task constraints that have been implemented. Both tennis and pickleball require the control of a striking implement which acts as a third-class lever. These levers require great force to overcome the resistance due to the mechanical advantage being less than one. However, the paddle for pickleball is shorter than the tennis racquet (41 cm vs. 67 cm) which reduces the resistance arm to make it easier to move due to less force required to overcome the resistance. This suits older Australians since their muscle mass and therefore their capacity to produce peak force (muscular strength) as well as their ability to produce this explosively (muscular power) is reduced due to their age. Moreover, the concept is reinforced by Newton's 2nd law of linear motion in which a force applied to an object will result in an acceleration that is inversely proportional to its mass and directly proportional to the size of the force ($f=ma$). A reduction in the mass of the paddle results in the force required by older Australians to decrease to accelerate the paddle and successfully hit the ball. Another fitness component impacted by the change in muscle size and mass as age increases is speed. A task constraint of reducing the court size to 13.41 m x 6.1 m means that the playing area is smaller and therefore does not require as much speed to cover the court and hit the ball. This allows older Australians more opportunity to execute skills successfully, which enhances the enjoyment of the game and therefore the likelihood of continued participation and motor skill development.