2007 Assessment Report

VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

GENERAL COMMENTS

The number of students who sat for the 2007 Physics examination 1 was 6544. With a mean score of 55 per cent, students generally found the paper to be challenging, but not as difficult as last year. Four students achieved the maximum score of 90. The majority of schools chose to continue with Detailed Study 2.

Some particular areas of concern in this paper were:

- the questions on universal gravitation. Many students struggled to obtain a ratio, forgot to raise numbers to the required powers (for example, R^3 and T^2), and/or were unable to manipulate large numbers and powers of 10
- handling prefixes; for example, $M = 10^6$
- the questions on projectile motion. Students are strongly encouraged to treat the horizontal and vertical motion separately and apply constant acceleration formulae. Students who used derived formulae (such as range) often appeared to be confused
- the motion question involving springs and energy conversions
- the questions related to the transistor amplifier
- simple series circuits
- the simple mathematics involved in some questions. Students should be advised not to skip steps.

Students should also be aware of the following general information.

- Students should only complete **one** detailed study. A small number of students attempted two or three.
- Students need to be more careful with their handwriting. If the assessor cannot decipher what is written, no marks can be awarded. This applies particularly to multiple-choice questions where one answer is written over another and it is unclear which alternative the student has chosen.
- Written explanations must address the question asked. Students who simply copy generic answers from their note sheets will not gain full marks.
- Students should show their working. Credit can be given for working even if the answer is incorrect.
- Students must follow the instructions given in questions. Some questions specifically require working to be shown; if this is not done, no marks are awarded.
- Care should be taken when reading the scales on axes.
- Multiple-choice questions generally only have one answer. However, if the statement 'one or more answers' appears, there may be one or more answers to the question.

SPECIFIC INFORMATION

For each question, an outline answer (or answers) is provided. In some cases the answer given is not the only answer that could have been awarded marks.

Section A – Core

Area of Study 1 – Motion in one and two dimensions

Questions 1–2

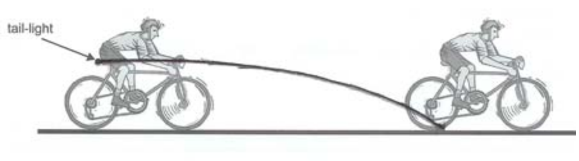
Marks	0	1	2	3	4	Average
%	24	14	17	18	27	**2.1**

Question 1

Applying a constant acceleration equation to the vertical motion gave a height of 1.0 m.

A number of students assumed the initial vertical velocity was 5 m s^{-1}.

Question 2



The tail-light followed a parabolic path from position A, landing below the seat at position B. Some students had the parabola going backwards from position A. It is unclear from what frame of reference they were observing. Others had the light landing about halfway between positions A and B. They missed the essential point that, with the bike moving at a constant speed, the light would land directly under the position from which it fell.

Questions 3–5

Marks	0	1	2	3	4	5	6	7	8	Average
%	8	6	6	8	5	12	10	8	38	**5.6**

Question 3
A simple application of conservation of momentum gave the speed of the 2 kg block as 1 m s^{-1}.

Question 4
The kinetic energy both before and after the interaction was 9 J, so it was an elastic collision.

Students who calculated that the kinetic energy increased should have realised that something was wrong and checked their working.

Question 5
The change in momentum of the 1 kg block was 4 kg m s^{-1}. Then, using Impulse = Change in momentum, the force was 400 N.

The question could also have been done by examining the change in momentum of the 2 kg block. Another alternative was to determine the acceleration and then substitute this into Newton's second law. The most common problem was determining the change in momentum of the block. A few students confused elastic collisions with conservation of momentum.

Questions 6–8

Marks	0	1	2	3	4	5	6	7	Average
%	16	6	11	7	6	17	9	28	**4.2**

Question 6
Since Amelia was falling at a constant speed, the net force acting on her was 0 N.

Question 7
The gravitational force acting was 600 N and the air resistance was 400 N, so the net force was 200 N. Applying Newton's second law then gave an acceleration of 3.3 m s^{-2}.

Question 8
The work done by the air resistance was the area under the graph up to 500 m. This was about 2.5×10^5 J.

The main problem was using W = F × d = 600 × 500, which assumed that the force of the air resistance was constant.

Questions 9–10

Marks	0	1	2	3	4	5	6	Average
%	35	9	3	20	16	1	16	**2.5**

Question 9
When the spring is stretched 0.2 m by hanging a mass on the end of it, the force in the spring, '*kx*', must equal the gravitational force on the mass 'mg'. This results in a mass of 0.4 kg.

Many students incorrectly presumed that the change in gravitational potential energy was equal to the energy stored in the spring.

Question 10

Using the formula for the potential energy stored in a spring, $\frac{1}{2}kx^2$, students needed to determine the energy at a stretch of 0.2 m and then at a stretch of 0.3 m and subtract the two answers to give 0.50 Joule.

Some students used the correct formula but substituted 0.1 for the extension. Others used variations of changes in gravitational potential energy which were not related to the question.

Questions 11–12

Marks	0	1	2	3	4	Average
%	47	0	31	0	22	**1.5**

Question 11
The total energy of the system was constant, so the answer was D.

Question 12
Since gravitational attraction is inversely proportional to the square of the radius, the answer was A.

Question 13

Marks	0	1	2	Average
%	58	6	36	**0.8**

Kepler's third law showed that the answer was 574 years.

Other correct approaches involved the centripetal force being provided by the gravitational attraction. Students found this question to be quite difficult.

Questions 14–15

Marks	0	1	2	3	4	5	Average
%	22	4	10	8	6	50	**3.3**

Question 14
The simplest approach was to divide the required horizontal distance of 127 m by the horizontal component of the speed ($40\cos 25^\circ$) to obtain 3.5 s.

The answer could also be found by using the vertical motion. Some students did not use the appropriate components of the velocity, instead using 40 m s^{-1}. Others were confused about which was the vertical component and which was the horizontal.

Question 15
Applying one of the constant acceleration formulae to the vertical motion gave a height of 14.3 m.

The answer here varied depending on the particular approach used and whether the student used 9.8 or 10 for the gravitational field strength. Using derived equations such as range often caused confusion.

Questions 16–17

Marks	0	1	2	3	4	Average
%	23	6	34	21	16	**2.1**

Question 16
The gravitational force always acts down, so the answer was D.

Question 17
A and C

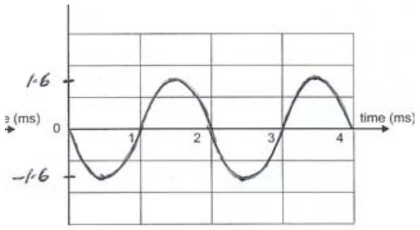
The acceleration (a = 10 m s^{-2}) was the same and, since the height reached was the same, the time of flight must have been the same also. So the answer was A and C. While it was common for students to select C, far fewer realised that A was also correct.

Area of Study 2 – Electronics and photonics

Questions 1–2

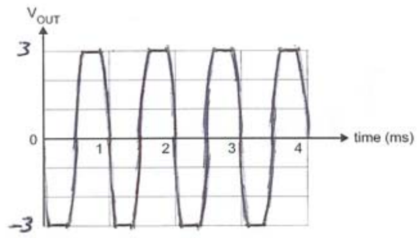
Marks	0	1	2	3	4	Average
%	31	27	20	11	13	**1.5**

Question 1



The signal needed to be inverted with an amplitude of 1.6 V. It also needed to be centred about 0 V and have the same period as the original. Some students had the correct amplitude but centred about 3 V. They had overlooked the effect of the capacitor.

Question 2



The graph shows clipping at the top and bottom at +3 and –3 volts. The graph is also inverted, the period is the same as the input and it is centred about zero.

Questions 3–4

Marks	0	1	2	3	4	5	Average
%	19	13	26	20	15	7	**2.3**

Question 3

Saturation is when the collector current is at maximum, thus the voltage drop across the collector resistor is maximum. So V_{OUT} reaches the minimum possible voltage and cannot go any lower. Therefore V_{OUT} will be clipped at the bottom. The transistor is operating as a closed switch.

Few students were able to provide a clear answer to this question.

Question 4

The best of the available options was B.

Questions 5–7

Marks	0	1	2	3	4	5	6	7	8	Average
%	4	1	12	10	8	19	22	6	17	**5.1**

Question 5
A current of 10 mA means a voltage drop of 1 V across the LED. This leaves 5 volt across the resistor. Using Ohm's law gave a resistance of 500 Ω.

Many students assumed the voltage drop across the LED would be 1.6 V or 0.7 V.

Question 6
Reversing the LED would result in no current flow, which would mean no voltage drop across the resistor and therefore 6 V across the LED.

Many students realised that there would be zero current, then deduced that there would be zero volts across the LED. There was a disturbing tendency for students to write about voltage 'flowing'.

Question 7
10 lux

This answer could be read from the graph.

Questions 8–9

Marks	0	1	2	3	4	Average
%	17	16	23	17	27	**2.3**

Question 8
Since the critical light intensity is 20 lux, the resistance of the LDR is 1500 Ω. Substituting this into the equation for a voltage divider gives a resistance of 750 Ω.

Some students determined that the LDR had a resistance of 1500 Ω, but could not substitute correctly into the formula. Others seem to have assumed that the light intensity was still 10 lux instead of 20 lux.

Question 9
Decreased

At a brighter light intensity, the resistance of the LDR would be reduced. This would result in V_{OUT} being less than 4 V. To increase it to 4 V, the variable resistor must be decreased. Some students said it had to be decreased but could not explain why.

Questions 10–11

Marks	0	1	2	3	4	Average
%	18	0	42	0	40	**2.5**

Question 10
At X there is light of varying intensity, so the answer was D.

The light intensity cannot go below zero, so B was not an option. Even when there is no signal at W to modulate the output of the laser diode, there is a uniform brightness emitted.

Question 11
The varying brightness incident on the photodiode would cause a voltage like C to be produced.

Section B – Detailed studies

Detailed Study 1 – Einstein's relativity

Question 1

Marks	0	1	2	3	Average
%	21	22	35	22	**1.7**

The correct terms were **Earth**, **interference** and **no**.

A few students omitted this question altogether.

Questions 2–4

Marks	0	1	2	3	4	5	6	7	Average
%	19	4	24	8	17	10	9	8	**3.2**

Question 2

The speed of sound was 290 m s^{-1} (340 – 50). So the time taken was $\frac{3000}{290}$ = 10.3 s.

Many students were unable to determine the speed of sound. The range of values given was quite varied.

Question 3

Since the speed of light is independent, the time was $\frac{90000}{3\times10^8}$ = 0.300 s, which was option B.

Question 4

Substituting 0.1000 c for the speed into the appropriate formula gave the Lorentz factor as 1.005.

Question 5

Marks	0	1	2	Average
%	52	0	48	**1.0**

Bill's spaceship would appear to Ann to be length contracted. She would measure the length to be $\frac{L_0}{\gamma}$. So B was the appropriate option.

Question 6

Marks	0	1	2	3	Average
%	40	17	7	36	**1.5**

Ann is incorrect; length contraction occurs for each observer.

Questions 7–8

Marks	0	1	2	3	4	Average
%	35	0	38	0	27	**1.9**

Question 7

Since the clock in the satellite is moving relative to the ground-based observer, the satellite clock will appear to be running slowly. The correct option was B.

It was common for students to select B and D.

Question 8

The experimenters measure the lifetime to be longer than the proper time. So, to obtain the proper time the experimenters' time must be divided by 16, giving option A.

Questions 9–10

Marks	0	1	2	3	4	5	6	Average
%	42	4	3	14	5	4	28	**2.8**

Question 9

Substituting 16 for γ in the Lorentz formula gave the speed of the pion as 0.998 c. Students had to show their working to obtain marks. Some students struggled with the mathematics involved.

Question 10

Applying Einstein's equation, $E = mc^2$, showed that the mass converted by the sun each second was 4.4×10^9 kg.

Detailed Study 2 – Investigating materials and their use in structures

Questions 1–3

Marks	0	1	2	3	4	5	6	7	8	Average
%	5	8	19	16	7	11	8	10	16	**4.3**

Question 1
The correct answers were **length**, **shear** and **elasticity**.

A few students omitted this question altogether.

Question 2
Taking moments about the place suggested gave the required answer quite simply. Many students complicated it unnecessarily by not following the advice in the question.

Torques continues to be an area of difficulty for students.

Question 3
The correct answer, 2, could be obtained by taking moments about the centre of mass, or by taking the net force to be zero and substituting the answer from Question 2.

Question 4

Marks	0	1	2	Average
%	64	0	36	**0.8**

The steel reinforcing rods need to be placed where the platform is in tension, so the correct choice was option D.

Questions 5–6

Marks	0	1	2	3	4	Average
%	11	0	46	0	43	**2.7**

Question 5
Since the hammer bounced off without damage, the two objects were behaving elastically and the answer was B.

Question 6
Since the cast iron shattered, it had gone beyond its breaking point. The mild steel was deformed, so it was in the plastic region and had gone beyond the elastic limit. Therefore the answer was C.

Questions 7–8

Marks	0	1	2	3	4	5	6	Average
%	26	12	10	15	12	6	19	**2.8**

Question 7

Substituting into the formula stress = $\frac{\text{force}}{\text{area}}$ gave the force as 1.88×10^4 N.

Some students encountered difficulty when converting MPa to Pa and when determining the cross-sectional area. Some used the diameter instead of the radius, others forgot to square the radius and still others had the wrong formula for area.

Question 8
The strain energy can be obtained by determining the area under the graph (strain energy per cubic metre) and multiplying by the volume. This gave an answer of 3.8 J.

The most common error was neglecting the volume. A few students calculated the strain energy to the point of destruction.

Questions 9–10

Marks	0	1	2	3	4	5	Average
%	12	0	41	7	2	38	**3.1**

Question 9
The correct response was D.

Question 10
The tension in AB was 115 N.

A relatively simple method was to take moments about point C. This worked well if students multiplied the force by the perpendicular distance. However, they often got into trouble attempting to multiply the distance by the perpendicular component of the force. Other methods included using a triangle of forces or resolution of forces. Students often struggled when attempting to use these latter two methods.

Detailed Study 3 – Further electronics

Question 1

Marks	0	1	2	3	Average
%	15	12	30	42	**2.1**

The correct answers were **an oscilloscope**, **an audible hum** or **undervoltage** and **capacitor**.

A few students omitted this question altogether.

Question 2

Marks	0	1	2	Average
%	41	0	59	**1.2**

A turns ratio of $\frac{6}{240}$ was required, so the correct response was C.

Questions 3–4

Marks	0	1	2	3	4	Average
%	15	0	22	0	63	**3.1**

Question 3
C was the correct option.

Question 4
A full-wave rectifier would produce the trace shown in option B.

Question 5

Marks	0	1	2	Average
%	64	13	24	**0.7**

From the graph, a 63 per cent reduction in voltage down to 4.4 V would take about 40 ms. Substituting this into the formula for the time constant gave a value for the capacitor of 4.0×10^{-4} F. This converted to 400 μF.

Some students assumed a 37 per cent reduction in voltage would give the time constant.

Question 6

Marks	0	1	2	Average
%	45	0	55	**1.2**

Since the time constant was 40 ms, the best option was C.

Questions 7–8

Marks	0	1	2	3	4	Average
%	43	1	16	0	40	2.1

Question 7
The output voltage was across the reverse bias Zener diode. The graph of the Zener diode shows that it will provide 6 V when in reverse bias.

Some students read the voltage from the forward bias side of the graph.

Question 8
With an input supply of 9 V, the resistor and diode form a series circuit. Since the diode drops 6 V across it, the voltage measured across the resistor must be 3 V.

Questions 9–11

Marks	0	1	2	3	4	5	6	Average
%	37	15	13	12	13	7	4	2.0

Question 9
With no load, the current in the diode would be the same as that through the resistor. Applying Ohm's law to the resistor gave a current of 30 mA.

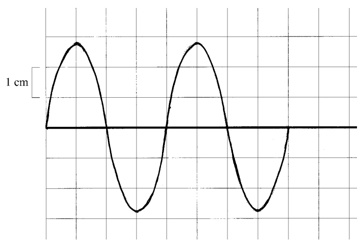
Question 10
- Drawing a greater current would result in more voltage being lost in components, particularly the transformer.
- The effective load resistance would be decreased, thus reducing the time constant, increasing the ripple and thereby reducing the effective voltage.

Students could take either of the above approaches to answer this question.

Question 11
Any two of the following solutions were accepted:
- increase the output of the transformer
- install a voltage regulator
- increase the size of the capacitor.

Question 12

Marks	0	1	2	Average
%	41	20	39	1.1



Students had to show the correct amplitude of about 2.8 grids and a period of 4 grids. The graph could be phase shifted from that shown and only one cycle was necessary.