2009 Assessment Report

VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

GENERAL COMMENTS

The number of students who sat for the 2009 Physics examination 1 was 6868. With a mean score of 68 per cent, students generally found the paper to be quite accessible. One hundred and seven students achieved the maximum score of 90. The majority of schools continue to choose Detailed Study 2.

Some particular areas of concern in this paper were:

- the number of situations where students incorrectly applied the centripetal force formula mv^2/R
- application of Newton's second law when multiple forces in opposing directions are acting on a mass
- questions on projectile motion. Students are strongly encouraged to treat the horizontal and vertical motions separately and apply constant acceleration formulae. Students who used derived formulae often appeared to be confused
- the motion question involving springs and energy conversions
- simple series and parallel circuits. Many students referred to resistance or voltage running through the circuit
- calculator difficulties. Students must be familiar with the calculator they will use in the examination.

Students should also be aware of the following general information.

- It is expected that formulae are copied correctly from the sheet provided with the examination or from the student's A4 sheet of pre-written notes. If this is not done, zero marks will be awarded to that question.
- Quantities substituted into equations need to be in the correct units.
- Derived formulae from the student's A4 sheet need to be very carefully applied. Relying on these often resulted in students having difficulties.
- Attempting a question in a number of different ways will not be awarded any marks unless all methods are correct. It is expected that students will make clear which working is intended.
- Students need to be careful with their handwriting. If the assessor cannot decipher what is written, no marks can be awarded. Students should avoid using abbreviations which are not commonly known.
- Written explanations must address the question asked. Students who simply copy generic answers from their A4 sheets of pre-written notes will not gain full marks.
- Working which produces unreasonable answers should prompt students to check their work carefully.
- Students should show their working. Credit can be given for working even if the answer is incorrect.
- Students must follow the question's instructions. 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.
- A particular area of concern was the excessive rounding off of working and answers.

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

Question 1

Marks	0	1	2	Average
%	15	3	82	1.7

A simple application of conservation of momentum gave the speed of Ranjiv after landing on the trolley as 2.7 m s^{-1}. A common mistake was to treat the mass after Ranjiv jumped on the trolley as 40 kg or 80 kg instead of the combined value of 120 kg.

Question 2

Marks	0	1	2	3	Average
%	11	13	8	68	2.4

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The interaction was inelastic because the kinetic energy before Ranjiv jumped onto the trolley was 640 J and after was 427 J.

Common errors included determining the momentum before and after instead of the kinetic energy, or failing to square the speed when calculating the kinetic energy.

Question 3

Marks	0	1	2	Average
%	10	3	88	1.8

The motorcyclist was riding in a circle at a constant speed so the net force acting was mv^2/R. This equalled 2560 N.

Question 4

Marks	0	1	2	Average
%	11	0	89	1.8

The net force was represented by an arrow from the motorcycle toward the centre of the circle.

Question 5

Marks	0	1	2	Average
%	41	11	48	1.1

All the elastic potential energy stored in the spring was converted to kinetic energy. $\frac{1}{2} \times m \times v^2 = \frac{1}{2} \times k \times (\Delta x)^2$. So $\frac{1}{2} \times 0.20 \times 25 = \frac{1}{2} \times k \times (0.10)^2$, thus the value of k was 500 N m^{-1}.

Common errors included trying to apply the equation for the force in a spring ($F = -k\,\Delta x$) and the gravitational force ($F = mg$). The value of the compression was often substituted as 10 or 0.01 instead of 0.1.

Question 6

Marks	0	1	2	Average
%	36	4	60	1.3

Students took two different approaches to this question. One approach was to equate the kinetic energy of the block to the work done against friction as it slid across the rough surface, $\frac{1}{2} \times 0.20 \times 5^2 = F \times 2.0$ which gave the friction force as 1.25 N. The other approach was to determine the acceleration of the block using $v^2 = u^2 + 2ax$ which gave a = 6.25 m s^{-2}. Then using Newton's law F = ma = 0.2 x 6.25 = 1.25 N. Both approaches were appropriate.

Question 7

Marks	0	1	2	Average
%	35	2	64	1.3

Since Helen was moving up at a constant speed the net force acting on her was zero. Therefore the normal reaction force (apparent weight) equalled the gravity force = mg = 60 x 10 = 600 N.

Some students did calculations which assumed there was an acceleration. Others derived an apparent weight of zero, seemingly confusing the normal reaction force with the net force. Another incorrect assumption was that there was a net force of mv^2/R.

Question 8

Marks	0	1	2	3	Average
%	53	4	1	43	1.4

Helen was travelling up but slowing. By applying Newton's second law and taking down as the positive direction, mg – N = ma. Therefore 600 – N = 60 x 2, which led to a normal reaction (apparent weight) of 480 N.

The main errors students made involved mixing up positive and negative signs for the forces acting. Some students were confused about actual forces and the net force, while others introduced a net force of mv^2/R.

Question 9

Marks	0	1	2	3	4	Average
%	25	12	14	24	26	2.2

Apparent weight is the normal reaction force. Helen was in free fall, accelerating at the value of the gravitational field, so the normal force was zero. Since there was a gravitational field, there was still a weight force acting on Helen. It was common for students to incorrectly state that the normal force equalled the gravitational force, thereby cancelling each other out and creating a feeling of weightlessness. Others referred to Helen reaching terminal velocity and equated this to apparent weightlessness. Another common approach was to explain apparent weightlessness in terms of an astronaut in orbit in a spaceship; however this did not relate to the question.

Question 10

Marks	0	1	2	3	4	Average
%	15	8	2	1	73	3.1

The vertical component of the initial velocity was 60 sin30 = 30 m s^{-1}. By applying the constant acceleration formula $v^2 = u^2 + 2ax$, $0 = 30^2 – 2 \times 10 \times x$, the vertical height achieved was 45 m. Other methods involved first determining the time taken to reach the maximum height. Some students attempted to use a derived formula from their A4 sheet of pre-written notes but this was generally unsuccessful.

Question 11

Marks	0	1	2	3	Average
%	38	11	9	42	1.6

There were a number of legitimate approaches to this question. The most straightforward approach was to use $x = ut + ½ at^2$ for the whole path. Thus $x = 30 \times 9 – ½ \times 10 \times 9^2 = -135$ m, so the height was 135 m. Some students got 135 m but then decided to add or subtract 45 m (the answer to Question 10) from it. Many students did not understand the vector nature of the constant acceleration equations. Most attempted to divide the path into sections, but generally mixed up the times, the signs or the initial velocity.

Question 12

Marks	0	1	2	3	Average
%	33	2	3	62	2

At the minimum speed the wheels of the trolley would be on the verge of losing contact with the rails. Therefore the normal reaction force would be zero. The only force acting on the trolley would be the gravitational force, which would provide the force needed to keep the trolley moving in a circle. So $mg = mv^2/R$, $600 \times 10 = 600 \times v^2/7$. This resulted in a minimum speed of 8.4 m s^{-1}. Again some students attempted to apply their own derived formulae from their A4 sheet of pre-written notes, which was often incorrect. Others assumed that the kinetic energy of the trolley at the top equalled its gravitational potential energy above the bottom of the track.

Question 13

Marks	0	1	2	Average
%	44	29	26	0.8

Students were required to draw **and** label arrow(s) to represent any force(s) acting on the satellite orbiting the Earth. The required answer was one arrow from the satellite and pointing towards the Earth, with a label *weight* or *gravitational force* or *mg* or F_g. It was not acceptable to label it F_{net} or centripetal force or g. Many students incorrectly included an arrow tangential to the path. Others had two arrows pointing towards the Earth. A small number of students did not attempt this question.

Question 14

Marks	0	1	2	3	Average
%	22	15	11	51	1.9

For the orbiting satellite $4\pi^2 Rm/T^2 = GMm/R^2$, therefore $T = \sqrt{4 \pi^2 R^3 / G M}$
$= \sqrt{4\pi^2(1.33 \times 10^7)^3/(6.67\times10^{-11})(5.98\times10^{24})} = 1.53 \times 10^4$ s.

Some students had trouble with derived formulae from their A4 sheets of pre-written notes. Other errors included substituting the mass of the satellite instead of the Earth’s mass, adding the Earth’s radius to that of the orbital radius or simple calculator errors. Students who obtained unreasonable answers such as 10^{14} seconds should have realised they needed to check their work.

Area of Study 2 – Electronics and photonics

Question 1

Marks	0	1	2	Average
%	13	4	83	1.7

The potential difference was 4.3 V. This was found either by using Ohm's law to determine the current, then again to get the potential difference, or by using the voltage divider relationship.

Question 2

Marks	0	1	2	3	Average
%	23	6	2	69	2.2

There were a number of ways to approach this question. The simplest approach was to apply the formula $P = V^2/R$. To determine the potential difference the answer to Question 1 was subtracted from the EMF of the battery to give 5.7 V, so the power was $P = 5.7^2/40 = 0.82$ W. Some students used a correct power formula with incorrect values. For example, using 4.3 V instead of 5.7 V or 30 Ω instead of 40 Ω.

Question 3

Marks	0	1	2	3	Average
%	14	6	3	77	2.4

The first step in answering this question was to determine the effective resistance of the parallel components, $1/R = 1/40 + 1/20 \Rightarrow R = 13.33$ Ω. After adding 30 Ω to get the total resistance of 43.33 Ω, Ohm's law was used to get the current of 0.23 A. Some students tried to do all of the calculations in one step. The first step caused arithmetic problems for some students.

Question 4

Marks	0	1	2	3	Average
%	46	13	1	41	1.4

From the graph the potential difference across each diode was 3 V, so the total voltage drop across each of the parallel branches was 9 V. Therefore, the potential difference across R_2 was 3 V. By applying Ohm's law the current through R_2 was 0.05 A.

Many students still appear to be confused about voltage drop in series and parallel circuits. It was common to see $I = 12/60$ where students assumed the EMF of the battery was totally across R_2. Other students were confused about how the potential differences across the parallel components should be combined. It was common for them to be added like resistances.

Question 5

Marks	0	1	2	Average
%	4	40	56	1.5

Diodes 4, 5 and 6 were all in forward bias and will all be ON. Diode 2 was in reverse bias so it will not allow current through it, and therefore no current would pass through diodes 1 or 3 either. So 1, 2 and 3 will all be OFF.

While students generally knew that LEDs 4 to 6 would be ON, many were unsure of what would happen with the first three LEDs.

Question 6

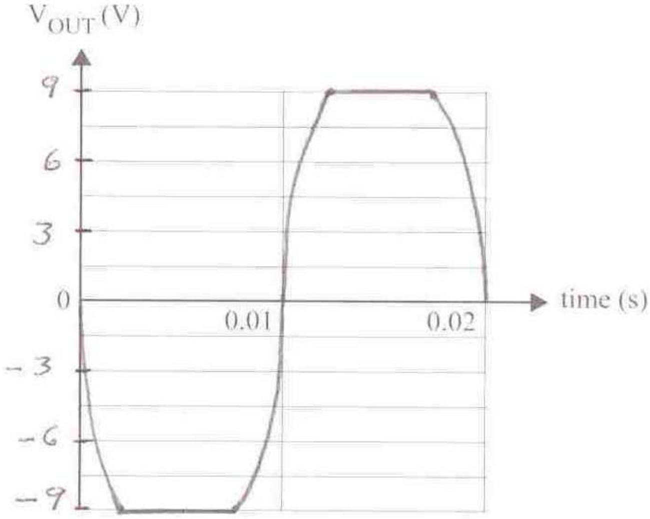
Marks	0	1	2	Average
%	14	19	68	1.6

The voltage gain was the magnitude of the gradient of the linear section of the graph, which was 300.

Students should note that gain does not have a unit. Some students missed the millivolt unit on the horizontal axis, while others had arithmetic difficulties evaluating the gradient.

Question 7

Marks	0	1	2	3	Average
%	8	12	16	65	2.4



The required graph was inverted and clipped at ±9 V.

Question 8

Marks	0	1	2	Average
%	42	18	40	1

The microphone signal was B, the carrier wave was A, the modulated signal was C and the final signal fed to the speaker was B.

This question was a little different to previous questions on modulation and this may have caused difficulties for some students. A common error was to confuse the carrier wave (high frequency) with the signal wave.

Question 9

Marks	0	1	Average
%	6	94	1

Reading from the graph, when the temperature was 5°C the resistance was 5000 Ω.

Question 10

Marks	0	1	2	3	Average
%	23	14	3	59	2

From the graph the resistance of the thermistor was 500 Ω. By substituting this into the voltage divider formula, the variable resistor needed to be set at 1000 Ω.

Instead of using the voltage divider formula, some students simply doubled the resistance of the thermistor because the variable resistor had to have twice the potential difference across it compared with the thermistor. It was surprising how many students misread the graph for the resistance of the thermistor. Another common error for some students was placing the correct resistor values (500 Ω or R) into the voltage divider equation. Other students had a derived formula from the voltage divider equation, however they were generally unable to apply it correctly.

Question 11

Marks	0	1	2	3	Average
%	21	22	13	44	1.8

At lower temperatures, $R_{THERMISTOR}$ will increase. The variable resistor still requires a potential difference of 8 V to operate the switch, so the ratio between the resistances must be maintained. Therefore the variable resistor must be increased.

Some students still had difficulty correctly describing how and/or why one resistor should be altered in response to the changes in another. Some assumed that the resistor must increase and tried, often incorrectly, to reason backwards. Some students omitted steps from their reasoning. Students are reminded that reasoning must be written down to obtain marks.

Section B – Detailed studies

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

Question	% A	% B	% C	% D	Comments
Detailed Study 1 – Einstein's relativity					
1	4	6	88	1	
2	79	7	9	6	
3	4	93	1	1	
4	8	15	68	8	Using the length contraction relationship $L = L_o/\gamma$ where L = 0.6 and L_o = 1, the Lorentz factor can be obtained and from it the speed.
5	5	2	3	91	
6	7	82	9	2	
7	8	17	14	60	Using $E = mc^2$, the total energy was $9x10^{16}$ J, which is approximately 10^{17} J.
8	5	3	7	85	
9	5	5	83	7	
10	12	5	80	2	
11	60	14	14	9	The total energy is composed of the rest energy plus the work done. $E_{Total} = E_K + E_{Rest} = mc^2$, so $E_K = mc^2 – E_{Rest} = m_o\gamma c^2 – m_oc^2 = m_oc^2(\gamma – 1) = 1.9x10^{-10}$ J.
12	4	5	8	82	
13	11	5	78	4	
Detailed Study 2 – Investigating materials and their use in structures					
1	4	8	4	85	
2	9	11	2	79	
3	86	8	1	5	
4	14	7	18	60	Applying the strain relationship $\varepsilon = \Delta L/L$, the change in length was 0.010 m. Since it was under tension the length was increased by 0.010 giving a total length of 10.010 m.
5	11	13	11	65	Young's modulus was the gradient of the straight line section of the graph for hard steel. $E = 400x10^6/2.5x10^{-3} = 1.6x10^{11}$.
6	4	80	7	8	
7	7	71	10	10	
8	3	14	15	67	To determine the torque multiply the force by the distance = (100 x 10) x 1.20 = 1200 N m.
9	71	7	10	11	
10	7	30	18	44	The structure was in equilibrium so the sum of the torques acting was zero. Hence $0.8xT\sin30^0 – 1000x1.20 – 200x0.60 = 0$ and T = 3300 N.
11	7	6	80	6	
12	12	13	60	14	The force exerted by the beam on pillar B is the same as the force exerted by pillar B on the beam. Since the beam was in equilibrium, students needed to take torques about point A to find the force. Bx12 – 6000x9 – 12000x6 = 0. So B = 10 500 N.
13	7	4	87	2	

Question	% A	% B	% C	% D	Comments
Detailed Study 3 – Further electronics					
1	5	2	5	88	
2	50	8	33	9	The amplitude of the voltage was 10.5x√2 = 14.8 and the period was 20 ms.
3	8	68	21	2	The average voltage drop across the resistor was 9 or 10 volts. So the power dissipated was V^2/R = 100/500 = 0.2 W.
4	2	4	72	21	
5	45	34	14	7	The Zener diode would maintain a 6 V output so long as the input to the regulator circuit remained above 6 V. The graph (Figure 3) showed that the potential difference dropped below the required value for a short time in each cycle.
6	5	7	81	7	
7	9	14	67	9	From the graph the time constant was 3 seconds, which equalled the product of the resistance and the capacitance. So the capacitance was 3×10^{-3} F or 3000×10^{-6} F which was 3000 µF.
8	24	8	63	3	The potential difference across the capacitor after 60 s would be 10 V. By applying Ohm's law the current in the circuit would be 10/1000 = 0.01 A or 10 mA.
9	7	64	22	5	Since the time constant was 3 s, the potential difference across the capacitor would have decreased by 63% and therefore be 3.7 V.
10	7	24	65	3	Whatever the polarity of the power supply, the current will always pass from X → Y through the load. Therefore the answer was option C.
11	56	25	8	11	The multimeter would read the RMS value of the voltage drop. This would be 10/√2 = 7 V.
12	6	68	13	13	The EMF of the battery was 10 V. Since the Zener diode was in reverse bias, from the graph the potential difference across it was 6 V and therefore that across R_2 was 4 V.
13	12	24	46	17	By applying Ohm's law the current through R_2 was 4/100 = 40 mA and through R_1 was 6/3000 = 2 mA. Since $I_{R2} = I_{Zener} + I_{R1}$ therefore the current through the Zener diode was 38 mA.