2017 VCE Physics examination report

General comments

Students and teachers should note the following points in relation to the 2017 Physics examination.

- The number of marks allocated to a question should be used as a guide to how comprehensive the answer needs to be.
- Students should use black or blue pen when responding as indicated in the Section B instructions.
- Attempting a question a number of different ways will not be awarded any marks unless all methods are correct. Students are advised to neatly cross out any working that they do not want assessed.
- Students should be encouraged to set out their work clearly so that assessors can follow what they have done. In questions that involve a number of steps, students should annotate the steps of their working.
- In questions that require explanations, students should carefully consider what the question is asking and answer accordingly. Simply copying information from their sheet(s) of notes can result in students including irrelevant, contradictory or incorrect material.
- The use of equations or diagrams in questions that require an explanation is encouraged. It is important that diagrams are sufficiently large and clearly labelled. Graphs and sketches should be drawn with care.
- Students' attention should be drawn to the instructions for Section B, 'In questions where more than one mark is available, appropriate working **must** be shown'. Full marks will not be awarded where only the answer is shown, and some credit can often be given for working even if the final answer is incorrect.
- Students are also reminded of the instruction for Section B, 'If an answer box has a unit printed in it, give your answer in that unit'. Students will not be awarded full marks if they change the unit.
- It is important that students show the numbers substituted into formulas/equations. The formula alone is generally not worth any marks.
- It is expected that formulas be copied accurately from the formula sheet provided with the examination or from the student's sheet(s) of notes.
- Derived formulas from the student's sheet(s) of notes may be used. However, they must be correct and appropriate for the question.
- Students need to be familiar with the operation of the scientific calculator they will use in the examination. Powers of ten calculations often caused problems. Students must ensure that the calculator is in scientific mode and that it does not truncate answers after one or two decimal places.
- Rounding-off calculations should be done only at the end, not progressively after each step.
- Answers should be in decimal form and reflect the correct number of significant figures. Answers should not include surds.
- Students are expected to be able to convert units correctly (for example, centimetres to metres).
- Where values of constants are provided in the stem of the question or on the formula sheet, students are expected to use the number of significant figures given.

- Care needs to be taken when reading the scales on the axes of graphs.
- Arrows representing vector quantities should be drawn so that they originate from the point of application. Where appropriate, the length of the arrows should indicate the relative magnitudes.
- Students should ensure that their answers are realistic. Illogical answers should prompt students to check their working.

Areas requiring improvement included:

- orbital mechanics, particularly the relationship between radius and period
- Einstein's special relativity
- energy and momentum in collisions
- energy relationships in springs
- interference applied to sound
- waves on strings
- the wave predictions of the photoelectric effect
- wave properties of matter particles

Specific 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 – Multiple-choice questions

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

Question	% A	% B	% C	% D	% No Answer	Comments
1	6	12	17	65	0	It is not currently known how to make a magnetic monopole.
2	3	89	3	4	0	$F = qE$ $F = 9.6 \times 10^{-19} \times 10^{4}$ $F = 9.6 \times 10^{-15} N$
3	84	6	8	2	0	$E = \frac{V}{d}$ $1000 = \frac{V}{5 \times 10^{-3}}$ $V = 5.0\,V$
4	1	13	2	84	0	$N_P : N_S = V_P : V_S$ $N_P : N_S = 240 : 12$ $N_P : N_S = 20 : 1$

Question	% A	% B	% C	% D	% No Answer	Comments
5	10	35	51	4	1	$P_{RMS} = V_{RMS}I_{RMS}$ $48 = 12 \times I_{RMS}$ $I_{RMS} = 4.0$ $I_P = I_{RMS} \times \sqrt{2}$ $I_P = 5.7\ A$
6	8	11	21	60	0	$\varepsilon = \frac{\Delta\phi}{\Delta t}$
7	2	1	95	1	0	$F = ma$ $4 = 2a$ $a = 2\ m\ s^{-2}$
8	6	5	87	2	0	$I = Ft$ $I = 4 \times 5$ $I = 20\ N\ s$
9	3	6	87	5	0	$v = u + at$ $v = 0 + 2 \times 10$ $v = 20\ m\ s^{-1}$
10	7	75	8	10	0	Experiments conducted in inertial (non-accelerating) frames will be identical. Experiments conducted in accelerating frames will differ from experiments conducted in inertial frames.
11	18	66	8	7	1	$E = mc^2$ $3.8 \times 10^{26} = m \times (3 \times 10^8)^2$ $m = 4.2 \times 10^9\ kg$
12	3	7	89	2	0	$k = \frac{\Delta F}{\Delta x}$ $k = \frac{400}{1.0}$ $k = 400\ N\ m^{-1}$

Question	% A	% B	% C	% D	% No Answer	Comments
13	7	58	12	23	1	$E = \frac{1}{2}mv^2$ $E = 0.5 \times 400 \times 0.5^2$ $E = 50\ \mathrm{J}$
14	1	1	27	71	0	Diffraction occurs where $\frac{\lambda}{w} \approx 1$
15	86	5	2	7	0	
16	5	66	14	15	0	$\Delta p_x \Delta x = \frac{h}{4\pi}$ Since Δx is being reduced, Δp_x is increasing, leading to increased uncertainty in direction.
17	12	12	17	59	0	This is an example of using deBroglie wavelength to explain quantised energy levels in atoms.
18	59	12	18	10	0	Accuracy is defined as the difference between the mean and the actual value. Precision is defined as the range between measurements.
19	90	6	3	2	0	
20	63	12	14	11	0	

Section B

Question 1

Marks	0	1	Average
%	37	63	**0.7**

Students were required to draw a single, horizontal arrow pointing to the left through the point X. The most common error was to state that there was no field at point X.

Question 2a.

Marks	0	1	2	Average
%	13	6	81	**1.7**

$$F = \frac{kq_1q_2}{r^2}$$

$$F = \frac{9.0 \times 10^9 \times (1.6 \times 10^{-19})^2}{(53 \times 10^{-12})^2}$$

$$F = 8.2 \times 10^{-8} N$$

The requirement to show all working was stated in the instructions for Section B and in the stem of the question. Students who did not show the first two lines of the above solution as their working were not awarded full marks.

The most common error was to fail to square the radius.

Question 2b.

Marks	0	1	2	3	Average
%	41	2	5	51	**1.7**

$$F = \frac{mv^2}{r}$$

$$8.2 \times 10^{-8} = \frac{9.1 \times 10^{-31} \times v^2}{53 \times 10^{-12}}$$

$$v = 2.2 \times 10^{6} \text{ m s}^{-1}$$

The most common error was to attempt to use $F = Bqv$ as a starting point, with no subsequent progress. There was also a range of attempts using either energy or kinematics.

Question 3a.

Marks	0	1	2	3	Average
%	14	13	25	48	**2.1**

$$I = \frac{V}{R} = \frac{9}{6} = 1.5\ A$$

$$F = nBIl$$

$$F = 10 \times 0.50 \times 1.5 \times 0.12$$

$$F = 0.90 \text{ N}$$

Direction: down

The most common errors were omitting the 10 loops, failing to convert 12 cm to 0.12 m or stating the wrong direction.

Students are encouraged to read the question closely to ensure they identify all the relevant data. Students are also expected to be able to convert from centimetres to metres.

Question 3b.

Marks	0	1	2	Average
%	18	14	69	**1.5**

The force is 0 N.

Students were required to identify that the current inside KL runs parallel to the magnetic field or magnetic flux. A number of students stated that the reason was because the current was not perpendicular to the magnetic field. Students should be aware that the current does not have to be perpendicular for a force to exist, and that any angle between the current and the field greater than zero degrees will result in a force on the wire. Students are reminded to think carefully about their wording.

Question 4a.

Marks	0	1	2	3	Average
%	10	7	22	61	**2.4**

$$g = \frac{GM}{r^2}$$

$$g = \frac{6.67 \times 10^{-11} \times 1.3 \times 10^{22}}{(1.2 \times 10^6)^2}$$

$$g = 0.60 \text{ N kg}^{-1} \text{ or m s}^{-2}$$

The most common errors were to use the incorrect mass for the planet or to provide the incorrect unit.

Question 4b.

Marks	0	1	2	3	Average
%	33	34	3	30	**1.3**

$$T = \sqrt{\frac{4\pi^2 r^3}{GM}}$$

$$T = \sqrt{\frac{4\pi^2 \times (1.8 \times 10^7)^3}{6.67 \times 10^{-11} \times 1.30 \times 10^{22}}}$$

$$T = 5.2 \times 10^5 \text{ s}$$

A number of students struggled to start and were unable to state any valid mathematical relationship that would yield the period. A number of students who were able to state a correct formula substituted the mass of Charon rather than the mass of Pluto.

Question 4c.

Marks	0	1	2	3	Average
%	51	12	14	23	**1.1**

Students were required to identify that:

- Melissa is correct (and Rick and Nam are incorrect)
- the orbital characteristics (particularly velocity) of a satellite are independent of the mass of the satellite.

They were also required to provide some mathematical argument to support their assertion such as indicating the lack of a satellite mass in the formula $v = \sqrt{GM/r}$. Students were not required to perform any calculations.

Students found this question difficult. Many students suggested that all three students were correct to some extent. Marks cannot be awarded where it is unclear whether the student has recognised an incorrect argument.

Some students who were able to identify Melissa's opinion as the only correct one still had difficulty identifying why she was correct.

The current study design places much emphasis on scientific literacy and students are encouraged to practise responding to these types of questions.

Question 5a.

Marks	0	1	2	3	Average
%	20	7	5	67	**2.2**

$\phi = BA$

$B = \frac{0.2}{0.12}$

$B = 1.7\ T \text{ or } Wb\ \text{m}^{-2}$

The most common error was to include n = 10 in the formula. Students are reminded that the number of loops does not affect the flux calculation.

Question 5b.

Marks	0	1	2	3	Average
%	27	27	2	43	**1.6**

$\varepsilon = n\frac{\Delta\phi}{\Delta t}$

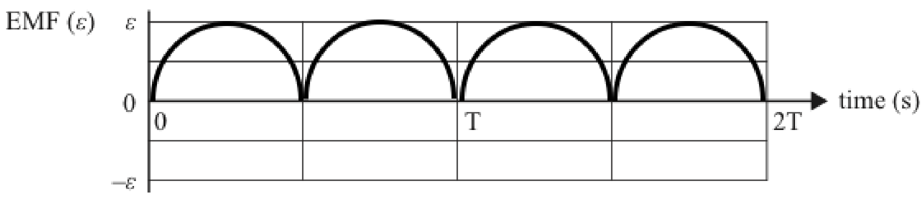
$\varepsilon = 10\ \times \frac{0.20}{0.063}$

$\varepsilon = 32\ \text{V}$

The most common error was to use an incorrect time.

Question 5c.

Marks	0	1	2	Average
%	31	4	65	**1.4**



The inverted form of this waveform was also acceptable.

The most common error was to draw a biased sine wave.

Question 6a.

Marks	0	1	2	Average
%	21	8	70	**1.5**

$P_{loss} = I^2 R$

$P_{loss} = 200^2 \times 3$

$P_{loss} = 1.2 \times 10^5\ W$

$P_{loss} = 120\ \text{kW}$

The most common error was incorrectly converting to kW.

Question 6b.

Marks	0	1	2	Average
%	50	5	45	**1**

$I \times 2\ (to\ 400A)$

$P_{loss} = I^2 R$

$P_{loss} = 400^2 \times 3$

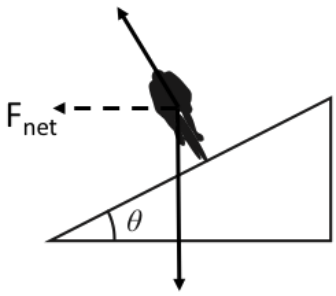
$P_{loss} = 4.8 \times 10^5\ W$

$\Longrightarrow$ Factor of 4

Many students were unable to find the new current. A number of students who found the new current reported the power loss ($4.8 \times 10^5 W$) rather than the factor-of-four increase.

Question 7a.

Marks	0	1	2	Average
%	20	24	55	**1.4**



The most common errors were the inclusion of extra forces or drawing F_{net} as down the slope.

Question 7b.

Marks	0	1	2	Average
%	31	2	67	1.4

$\theta = tan^{-1}\left(\frac{v^2}{rg}\right)$

$\theta = tan^{-1}\left(\frac{10^2}{20 \times 9.8}\right)$

$\theta = 27^\circ$

The most common errors were arithmetic.

Question 8a.

Marks	0	1	2	Average
%	33	4	64	1.3

$mg = \frac{mv^2}{r}$

$v = \sqrt{rg}$

$v = \sqrt{6.4 \times 9.8}$

$v = 7.9 \text{ m s}^{-1}$

The most common errors were arithmetic.

Question 8b.

Marks	0	1	2	Average
%	60	5	35	0.8

$\frac{1}{2}mv^2 + mgh = \frac{1}{2}mv^2$

$0.5 \times 4^2 + 9.8 \times 5 = 0.5 \times v^2$

$8 + 49 = 0.5\, v^2$

$v = 10.7 \text{ m s}^{-1}$

The most common error was to ignore the initial kinetic energy and simply convert the gravitational potential energy into kinetic energy.

Question 9a.

Marks	0	1	2	3	Average
%	45	14	1	40	**1.4**

$t = \frac{d}{v}$

$t = \frac{26}{20cos30} = 1.50\ s$

$x = ut + \frac{1}{2}at^2$

$x = (20sin30\ \times\ 1.5) + (0.5\ \times\ -9.8\ \times\ 1.5^2)$

$x = 3.98$

$x = 4.0\ \text{m}$

Students demonstrated a range of inappropriate techniques, suggesting that they did not have a clear strategy for solving these types of projectile problems.

Students should be mindful of how they set out their working so they can clearly demonstrate their understanding of how to solve multi-step problems such as this.

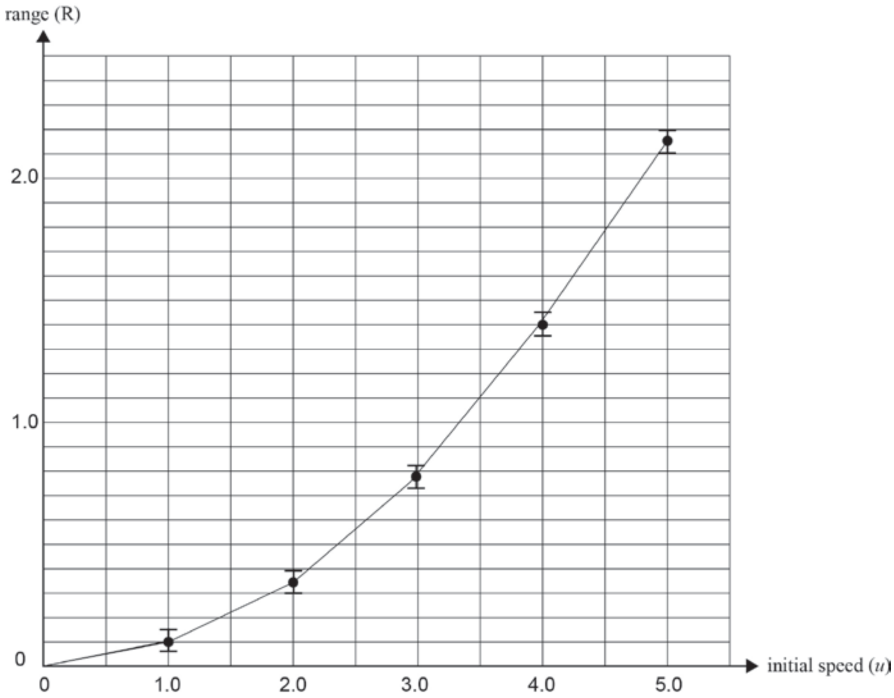
Question 9b.

Marks	0	1	2	3	Average
%	6	17	20	57	**2.3**

Classification	**Variable**
controlled	mass of the ball or angle of launch
dependent	range
independent	launch velocity

Question 9c.

Marks	0	1	2	3	4	5	6	7	8	Average
%	3	1	1	3	6	10	18	14	43	6.5



Common errors included:

- omitting the units on the axes
- incorrect or omitted uncertainty bars
- ruling a straight line through the points.

There were also some students who placed the initial speed on the *y*-axis and the range on the *x*-axis, despite the axes already being labelled. This suggests that students need to spend more time identifying independent and dependent variables.

Question 10

Marks	0	1	2	Average
%	38	9	53	1.2

$$\boldsymbol{L = \frac{L_0}{\gamma}}$$

$$\gamma = \frac{L_0}{L} = \frac{1}{0.333} = 3$$

$$\sqrt{1 - \frac{v^2}{c^2}} = 0.333$$

$$\frac{v^2}{c^2} = 0.888$$

$$v = 0.94c$$

While many students recognised the need to use the length contraction formula, most demonstrated little understanding of how to apply it.

Question 11a.

Marks	0	1	2	Average
%	55	3	42	**0.9**

$t = \frac{d}{v}$

$$t = \frac{9.14 \times 10^{-5}}{0.99875 \times (3 \times 10^{8})}$$

$t = 3.05 \times 10^{-13}$ s

The most common error was to calculate the correct time then apply a time dilation to the result. This suggested that students did not understand how to interpret frames of reference.

Question 11b.

Marks	0	1	2	Average
%	60	2	38	**0.8**

$L = \frac{L_0}{\gamma}$

$$L = \frac{9.14 \times 10^{-5}}{20}$$

$L = 4.6 \times 10^{-6}$ m

The most common error was to correctly identify the form of the equation but then confuse proper length with contracted length, resulting in length dilation rather than contraction. Some students did not recognise that the calculated contracted length was longer than the proper length. This suggested that students had very little understanding of this phenomenon.

Question 11c.

Marks	0	1	2	3	Average
%	54	21	17	8	**0.8**

Students were required to confirm that it was time dilation that was responsible for the scientists' results. Due to the particle's velocity, its half-life as measured in the scientists' frame of reference is increased. Therefore, fewer particles will decay before reaching the detector and more particles will be detected.

It was possible for students to explain the scientists' results by applying length contraction. In that case they needed to identify that due to the particle's velocity the distance to the detector, as measured in the particles' frame of reference, is reduced. Therefore, more particles will be able to reach the detector before they decay and more particles will be detected.

It was clear that the majority of students had no understanding of these phenomena. Many responses simply stated that 'due to time dilation and length contraction the particles last longer and travel a shorter distance'. Many students explained the results by applying both time dilation and length contraction at the same time, which generally resulted in a confused response that indicated the students were not aware of which frame of reference they were referring to.

The question stem clearly stated that the particles being discussed are not muons and the experiment is taking place in a laboratory; however, many responses referred to atmospheric muons reaching the ground.

Question 12

Marks	0	1	2	3	Average
%	23	18	6	54	**1.9**

$m_1 v_i + m_2 v_i = (m_1 + m_2) v_f$

$(4 \times 5) + (2 \times 2) = 6 v_f$

$v_f = 4.0 \text{ m s}^{-1}$

$E_k(initial) = \frac{1}{2} m_1 v_i^2 + \frac{1}{2} m_2 v_i^2$

$E_k(initial) = (0.5 \times 4.0 \times 5^2) + (0.5 \times 2.0 \times 2^2)$

$E_k(initial) = 54 \text{ J}$

$E_k(final) = \frac{1}{2}(m_1 + m_2) v_f^2$

$E_k(final) = 0.5 \times 6.0 \times 4^2$

$E_k(final) = 48 \text{ J}$

Therefore, the collision is inelastic.

The most common error was to calculate the initial kinetic energy of the system but fail to calculate the final velocity, and therefore the final kinetic energy. A number of students interpreted the diagram as stating that the final velocity of the system was zero.

Question 13a.

Marks	0	1	2	3	Average
%	67	2	1	30	**1**

$mgx = \frac{1}{2} k x^2$

$2.0 \times 9.8 \times x = 0.5 \times 20 \times x^2$

$x = 1.96 \text{ m}$

The most common error was to use $mg = kx$.

Question 13b.

Marks	0	1	2	3	4	Average
%	32	11	15	26	16	**1.8**

Students were required to identify the following:

- The gravitational potential energy is maximal at the top and **decreases** as the mass falls.
- The spring potential energy is minimal at the top and **increases** as the mass falls.
- The kinetic energy is zero at the top and **increases** to its maximum in the middle before **decreasing** to zero at the bottom.
- The total energy of the mass (gravitational + kinetic) decreases as the mass falls.

The question stem asked students to explain how the energies varied as the mass falls. Many students failed to do this, instead simply stating where each energy was maximal or minimal but not stating clearly how the energy varied.

The question clearly asked how the total energy of the mass varies (rather than the system), but some students stated that the total energy of the mass remained constant. Students who clearly stated that the total energy of the system remained constant were correct.

A large number of students wrote that 'the energy is all gravitational at the top then it is converted to kinetic in the middle before being converted to spring energy at the bottom'. This overly simplistic representation suggested that students do not have a sufficient understanding of spring systems.

Also of concern was the number of students who suggested that at the midpoint 'most of the energy is kinetic'. This was also incorrect. The kinetic energy component of the total energy never accounts for more than 25 per cent, which contradicts the assertion of 'most' and, in fact, at the midpoint most of the energy (50 per cent) is gravitational potential energy.

Question 14a.

Marks	0	1	Average
%	19	81	**0.8**

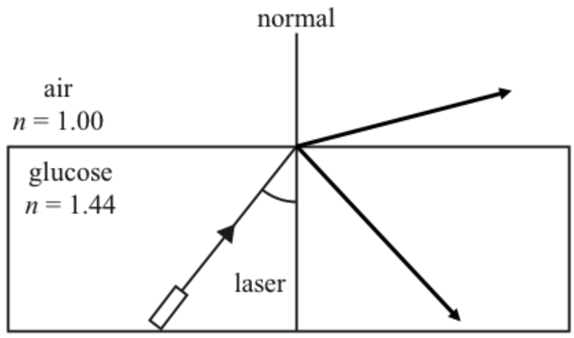
$$sin\theta_c = \frac{n_1}{n_2}$$

$$\theta_c = sin^{-1}\left(\frac{1.00}{1.44}\right)$$

$$\theta_c = 44°$$

Question 14b.

Marks	0	1	2	Average
%	35	56	9	**0.8**



It was not necessary to calculate the angles of the refracted or reflected rays.

While most students drew the refracted ray, very few included the reflected ray. It should be emphasised that the current study design places a great deal of emphasis on the importance of practical work to support learning.

Students should be given every opportunity to experience phenomena such as refraction firsthand so that they can see for themselves how often the representations are simplifications of the real world.

Question 14c.

Marks	0	1	2	Average
%	32	25	43	**1.1**

Students were required to identify the following:

- the phenomenon is total internal reflection
- the light ray is reflected back off the interface and into the glucose solution, which is why the observer cannot see it.

The most common errors were not to name the phenomenon or to refer to it as refraction. This is an important concept and students should be able to name and describe it appropriately.

Question 15a.

Marks	0	1	Average
%	12	88	**0.9**

$v = f\lambda$

$\lambda = \frac{340}{680}$

$\lambda = 0.5 \text{ m}$

Question 15b.

Marks	0	1	2	3	Average
%	29	26	24	22	1.4

Students were required to identify the following:

- Sam is correct (Elli is incorrect).
- The addition of the second speaker will produce an interference pattern.
- The intensity that a student hears will depend on the path difference between the two speakers.

Of biggest concern was the large number of students who clearly did not understand the details of the question. They then said that both Sam and Elli were correct. Students frequently wrote about how the interference pattern was evidence to support Elli's statement, when Elli's statement clearly denied the existence of such a pattern.

Students are again reminded that using answers from their sheet(s) of notes will invariably result in no marks being awarded since the required response must address the specific situation in the question.

Question 15c.

Marks	0	1	2	3	Average
%	68	8	11	14	0.7

$$\Delta x = \frac{\lambda L}{d}$$

$$\Delta x = \frac{0.5 \times 24}{4}$$

$$\Delta x = 3 \text{ m}$$

Since student 2 is 3 m from the centre they will be at an antinode and will hear a (relatively) high intensity. Since student 5 is 1.5 m from the centre they will be at a node and will hear a (relatively) low intensity.

The most common error was to assume that the students were indicators of the positions of the nodes and antinodes of the pattern. A number of students found the path differences using Pythagorean triangles and determined the correct answers in this way.

Question 16a.

Marks	0	1	2	Average
%	37	1	62	1.3

$$\lambda = 2L = 2 \times 4$$

$$\lambda = 8 \text{ m}$$

Question 16b.

Marks	0	1	2	Average
%	41	2	57	**1.2**

The second lowest frequency occurs when $\lambda = 4\ \mathrm{m}$.

$$f = \frac{v}{\lambda}$$

$$f = \frac{240}{4}$$

$$f = 60\ \mathrm{Hz}$$

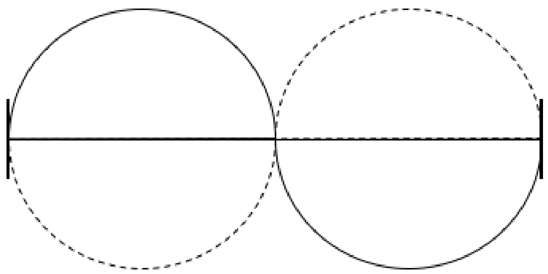
Question 16c.

Marks	0	1	2	3	Average
%	35	21	23	21	**1.3**

Students were required to identify the following:

- Waves, travelling in opposite directions, are reflected at the ends.
- The waves overlap (superposition) to produce an interference pattern.

Students were required to provide a diagram such as the one below.



Many students were able to identify the interference aspect but were unable to link this to travelling waves. There were also a number of students who drew diagrams of pulses travelling on strings, which made it difficult for them to demonstrate the production of the standing wave.

Question 17a.

Marks	0	1	2	Average
%	66	3	31	**0.7**

$$V = h \times \Delta f$$

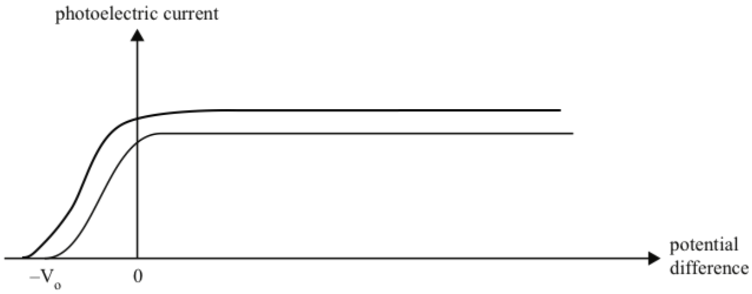
$$V = 4.14 \times 10^{-15} \times (6.25 - 5.50) \times 10^{14}$$

$$V = 0.31V$$

Some students did not understand the need to find the difference between the two energies. Some used the incorrect Planck's constant.

Question 17b.

Marks	0	1	2	Average
%	24	36	40	1.2



The most common error was to increase the photocurrent but keep the same stopping voltage.

Question 17c.

Marks	0	1	2	3	4	5	Average
%	36	6	15	12	15	16	2.1

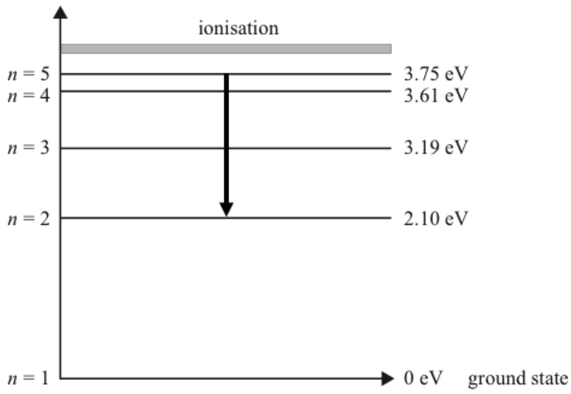
Students were required to identify two of the following:

- Negligible time delay – The wave model predicts that if the intensity of light is low enough then there will be a measurable delay between initiating the illumination of the metal and the observation of a photocurrent. The actual observation is that regardless of the intensity of the illumination, the photocurrent is observed to flow as soon as the metal is illuminated.
- The existence of a threshold frequency – The wave model predicts that all light, regardless of frequency, should produce a photocurrent since the measure of its energy is its amplitude. The actual observation is that frequencies below a certain value (the threshold frequency) will not produce a photocurrent regardless of the intensity (amplitude) of the wave.
- The independence of stopping voltage from intensity – The wave model predicts that increasing the intensity of the light source will increase the amount of energy delivered to the metal per unit of time. This will result in more photoelectrons being released and a greater range of kinetic energies of the photoelectrons as indicated by an increased stopping voltage. The actual observation is that increasing the intensity increases the photocurrent but has no effect on the stopping voltage.

Many students spent a great deal of their response discussing either the results of the photoelectric effect that did not refer to the wave model or discussing the particle explanation for the phenomena described above, rather than the wave predictions. While the first sentence made the general statement that ‘The results of photoelectric effect experiments in general provide strong evidence for the particle-like nature of light.’, the question posed to the students related to the wave model and its failure to explain certain phenomena. References to the particle model were off-topic and were not awarded marks.

Question 18a.

Marks	0	1	Average
%	27	73	**0.8**



Question 18b.

Marks	0	1	2	Average
%	47	11	43	**1**

$E = 3.75\ eV$

$$E = \frac{hc}{\lambda}$$

$$\lambda = \frac{4.14 \times 10^{-15} \times 3 \times 10^{8}}{3.75}$$

$\lambda = 331\ \text{nm}$

The most common errors were to use either 1.65 eV as the photon energy or to use 3.75 – 3.61 = 0.41 as the photon energy. The transition, and thus the energy, was clearly stated in the question stem. Students are reminded to read the question carefully before answering.

Question 18c.

Marks	0	1	2	Average
%	68	17	15	**0.5**

Students were required to identify:

- There is no transition with an energy difference of 2.5 eV.
- Therefore, no such emission is possible and no photon of this energy can be observed.

The most common error was to state that there is no energy level at 2.5 eV.

Question 19

Marks	0	1	2	3	4	Average
%	33	18	21	18	10	**1.6**

Students were required to identify the following:

- Mary is correct and Roger is incorrect.
- Electrons do possess wave properties and their wavelength is known as their deBroglie wavelength.

Students were then required to refer to two of the following:

- If electrons are passed through a crystal they will produce a diffraction pattern, just as if X-rays were passed through the crystal.
- If electrons are passed through a single slit they will also produce a diffraction pattern.
- If electrons are passed through two closely spaced slits they will produce an interference pattern.

Most students were unable to demonstrate any understanding of the question or the subject of electron diffraction.

The most common error was the assertion that ‘Mary is correct for electrons and Roger is correct for light’. Any suggestion that both were correct was seen as a contradiction, which meant that full marks could not be awarded. The question did not relate to whether light diffracts or not and most students were unable to understand that Roger’s assertion that only light diffracts is incorrect.

Also of concern was the reference to Young’s double-slit experiment with electrons. Young did not perform his experiment with electrons, and students who asserted that Young observed electron interference were incorrect.

Once again there seemed to be a reliance on prepared responses copied from the student’s sheet of notes. Responses such as this did not receive any marks as they did not refer to the question. Students are reminded that copying responses from their sheet(s) of notes will not result in marks being awarded as prepared responses will not satisfactorily address the question.