2019 VCE Physics examination report

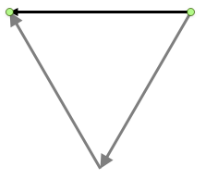
General comments

- Students should be sure to read the question carefully. Many responded with generic answers that did not address the specific aspects of the question.
- Students struggle to convert g to kg, and cm and mm to m. Students are expected to be able to convert between SI units at this level.
- Students are rounding excessively during their working. For example, in Question 5b., $6.37 \times 10^6 + 2.00 \times 10^7$ should not be rounded to 2.6×10^7. Working should maintain as many significant figures and/or decimal places as the data provided in the question stem. Rounding should occur when the final answer is given.
- Students are responding to explanation questions with text copied directly from commercially available reference sheets. These pre-prepared statements cannot adequately respond to the specifics of the questions and students are advised not to waste time copying them onto the paper.
- Students should remember the correct terms are ‘constructive’ and ‘destructive’, in relation to interference. The word ‘deconstructive’ does not have an accepted meaning within the study design.
- Students are finding graphing data difficult and interpreting graphical data even more difficult. Adequate experience in graphing and interpreting data is essential.

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	Comments
1	95	1	1	2	Magnetic forces can be attractive or repulsive, whereas gravitational forces can only be attractive.
2	2	91	4	3	$E = \frac{V}{d}$ $2.0 \times 10^{-4} = \frac{V}{1.0 \times 10^{-2}}$ $V = 2.0 \times 10^{-6}\ V$

Question	% A	% B	% C	% D	Comments
3	60	13	12	14	 The vector sum of the forces results in the net force to the left.
4	10	7	25	58	$g \propto \frac{m}{r^2}$ If m is doubled and r is halved, $g \propto \frac{2}{0.5^2}$ $g = \times 8$
5	8	84	5	3	X: Primary coil. Connected to voltage supply. Y: Secondary coil. Connected to load. Function: Step up. $N_{secondary} > N_{primary}$
6	11	27	57	5	$I_s = \frac{240}{1200}$ $I_s = 0.2\ A_{RMS}$ $I_p = I_s \frac{N_s}{N_p}$ $I_p = 0.2 \times \frac{6000}{1000}$ $I_p = 1.2\ A_{RMS}$
7	6	24	10	60	At 25 revolutions per second the period is doubled and, therefore, the voltage will be halved.
8	63	19	6	12	By Faraday's law, voltage is negative gradient of the flux graph.

Question	% A	% B	% C	% D	Comments
9	9	9	9	73	Medium 1 to Medium 2: towards the normal. Therefore, $n_1 < n_2$. Medium 2 to Medium 3: away from the normal. Therefore, $n_3 < n_2$. $\theta_{r3} > \theta_{i1}$. Therefore, $n_3 < n_1$. Since $n \propto \frac{1}{v}$, $v_3 > v_1 > v_2$
10	8	75	10	7	$n_2 = n_1 sin\theta_{crit}$ $n_2 = 1.75 \times sin62.0$ $n_2 = 1.55$
11	62	5	23	10	Constant speed implies that $F_{thrust} = F_{drag}$.
12	12	20	61	7	The ball is subject only to gravitational force. Therefore, its acceleration is constant.
13	19	5	75	1	$L = \frac{L_0}{\gamma}$ $L_0 = 150 \times 3$ $L_0 = 450\ m$
14	4	7	84	5	$\lambda = \frac{h}{mv}$ $\lambda = \frac{6.63 \times 10^{-34}}{9.1 \times 10^{-31} \times 1.0 \times 10^{7}}$ $\lambda = 7.3 \times 10^{-11}\ m$
15	23	40	25	11	$\lambda \propto \frac{1}{v}$ If v increases, λ decreases. Since the width of the diffraction pattern is proportional to λ, if λ decreases then fringe spacing will decrease.

Question	% A	% B	% C	% D	Comments
16	3	16	5	77	The PE effect demonstrates that $E_{photon} \propto f$. Increasing the intensity will produce more photons but will not affect their energy.
17	8	8	10	74	Laser light is coherent and incandescent light is incoherent.
18	83	9	6	2	The students determine the length of the pendulum. Therefore, length is the independent variable. The students measure the period of the pendulum. Therefore, time is the dependent variable. The mass and amplitude remain constant throughout the investigation. Therefore, these are both controlled variables.
19	4	3	85	8	This reduces the uncertainty in the measurement of the dependent variable.
20	4	36	49	11	The kinetic energy is used to deform the car's structure.

Section B

Question 1a.

Marks	0	1	Average
%	56	44	0.5

Students were required to state that the charge is negative and to identify some process for finding this. A reference to a right-hand rule or similar was sufficient.

There was no common error. A number of students referenced a right-hand rule but reported the charge as positive.

Question 1b.

Marks	0	1	2	Average
%	57	33	10	0.6

The force applied to the particle would always be at right angles to the direction of motion and the force would be constant in magnitude. Both these conditions are required to explain the circular motion identified in the question stem.

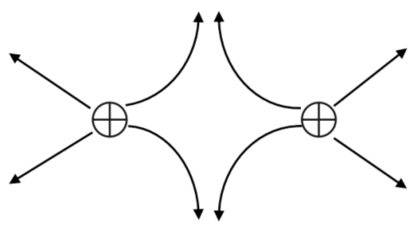
While most students were able to identify that the force was at right angles to the direction of motion, many did not identify that it had to be constant for circular motion to result.

Many students stated that because the velocity was perpendicular to the field the path would be circular.

Question 2

Marks	0	1	2	Average
%	8	23	69	**1.6**

Students were required to draw a diagram as shown below. The diagram had to show the direction of the field lines using arrows and the shape of the field between the two charges to receive full marks.



The most common reason for full marks not being awarded was careless drawing resulting in touching and/or crossing field lines. Students are reminded that when drawing any field, the field lines must not touch or cross.

Question 3a.

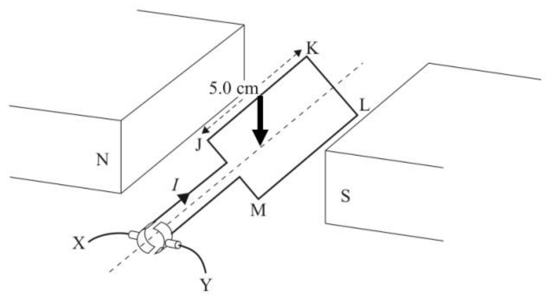
Marks	0	1	Average
%	22	78	**0.8**

Students were required to identify X as the positive terminal.

Question 3b.

Marks	0	1	Average
%	45	55	**0.6**

Students were required to draw a downwards-pointing arrow as shown below.



Question 3c.

Marks	0	1	2	Average
%	19	22	59	**1.4**

The purpose of the commutator is to reverse the direction of current every half turn to keep the motor rotating.

Some students stated that the current is reversed every half turn but could not continue with a clear reason. Students who did not refer to the current reversal every half turn generally responded in a way that indicated they did not understand the question.

Question 3d.

Marks	0	1	2	Average
%	16	2	82	**1.7**

$F = nBIl$

$F = 100 \times 0.45 \times 6.0 \times 0.05$

$F = 13.5\ N$

The most common errors were to omit the 100 turns, fail to convert 5.0 cm into metres, or both.

Question 4a.

Marks	0	1	Average
%	16	84	**0.9**

Students were required to state that the value at Y is 9.8 N kg^{-1}.

Question 4b.

Marks	0	1	2	Average
%	82	5	14	**0.3**

Students were required to indicate that the vector sum of the gravitational fields caused by all the mass of Earth is zero. Students could do this by indicating that at the centre of Earth there are equal masses in all directions, or that the gravitational attraction from one direction is balanced by an equal attraction from the opposite direction.

There were two common errors worthy of note. The first was to attempt to apply $F = \frac{GM}{r^2}$ and state that as r approaches zero, F approaches zero. Students did not seem to realise that as r approaches zero F approaches infinity. The second was to represent the net gravitational field as a circle with radial arrows drawn to the centre and the statement that they all cancel out. This suggested that students either felt gravity was a repulsive force that pushes towards the centre of Earth or that it is not the mass of Earth in it but rather some object or region at the very core that is the source of the gravitational field.

Question 4c.

Marks	0	1	2	Average
%	74	1	25	**0.5**

The increase in potential energy is represented by the area under the graph multiplied by the mass of the person.

$$E = (0.5 \times 6.37 \times 10^6 \times 9.8) \times 75$$

$$E = 2.3 \times 10^9\ J$$

The most common error was to apply the gravitational potential energy formula, $E_g = mgh$ using a constant $g = 9.8$.

Question 5a.

Marks	0	1	2	Average
%	46	16	38	**0.9**

There is only one force acting on the satellite – gravity – and this force acts towards (the centre of) the Earth.

The most common error was to state that there were forces other than gravity operating, with many students thinking that velocity and momentum were also forces.

Question 5b.

Marks	0	1	2	3	Average
%	21	24	22	33	**1.7**

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

$$T = \sqrt{\frac{4\pi^2(\ 2.00 \times 10^7 + 6.37 \times 10^6)^3}{(6.67.x\ 10^{-11})(5.98\ x\ 10^{24})}}$$

$$T = 4.26 \times 10^4\ s$$

The question also required students to respond to three significant figures. Students and teachers alike should ensure they refer to the VCAA website under advice for teachers. Here they will find an explanation that, for the purposes of VCE Physics, 42 600 has **five** significant figures.

Question 6a.

Marks	0	1	Average
%	17	84	**0.9**

The power drawn was 12 W.

Question 6b.

Marks	0	1	2	3	4	Average
%	29	62	3	1	5	**0.9**

Students could respond through one of the following lines of argument:

a. The power delivered to the lights is less than 12 W.
b. The voltage delivered to the lights is less than 12 V.
c. The current delivered to the lights is less than 1 A.

This then had to be supported by calculations. This required finding the total resistance of the system (which was 12 Ω + 3 Ω = 15 Ω) and the actual current for the system (which was 12 / (12 + 3) = 0.8 A). Students could then support their assertions as follows:

a. $P_{loss} = I^2R = 0.8^2 \times 3 = 1.92\ W$ lost in the lead.
b. $V_{loss} = IR = 0.8 \times 3 = 2.4\ V$ lost over the lead.
c. $I_{required} = 1A. I_{delivered} = 0.8\ A$

The most common errors were either to state the reason and then not follow up with any calculations or calculate a voltage drop across the lead using 3 Ω but 1.0 A rather than 0.8 A.

Question 6c.

Marks	0	1	2	Average
%	77	3	20	**0.45**

Students were required to provide a change using the same equipment. The only valid answer was to move the transformer from the house end of the lead to the light end of the lead so that the current in the lead would be reduced and less power would be lost.

The most common errors involved adding to or changing the equipment, such as adding another transformer or replacing the lead.

Question 7a.

Marks	0	1	Average
%	56	44	**0.5**

The device is an alternator.

The most common error was to identify it as an AC motor.

Question 7bi.

Marks	0	1	Average
%	18	82	**0.8**

The flux through the loop is 0 (zero) Wb.

The most common error was to calculate 0.05 Wb as shown in Question 7d.

Question 7bii.

Marks	0	1	Average
%	33	67	**0.7**

Students were required to state that the plane of the loop is parallel to the magnetic field.

Question 7c.

Marks	0	1	Average
%	15	85	**0.9**

The period of rotation was 0.05 sec.

Question 7d.

Marks	0	1	2	Average
%	18	2	80	**1.6**

$\Phi_{max} = BA$

$\Phi_{max} = 0.40 \times 0.50 \times 0.25$

$\Phi_{max} = 0.05\ Wb$

Most students were able to find the correct answer. Those that did not generally showed no understanding of how to approach the problem.

Question 7e.

Marks	0	1	2	Average
%	47	2	50	1

$$\varepsilon = \frac{\Delta\Phi}{\Delta t}$$

$$\varepsilon = \frac{0.00 - (-0.05)}{0.0125}$$

$$\varepsilon = 4.0V$$

Of those students who did not score full marks, most were able to identify the formula for *emf* but showed no understanding of how to derive the values required for substitution.

Question 7f.

Marks	0	1	2	Average
%	18	12	70	1.5

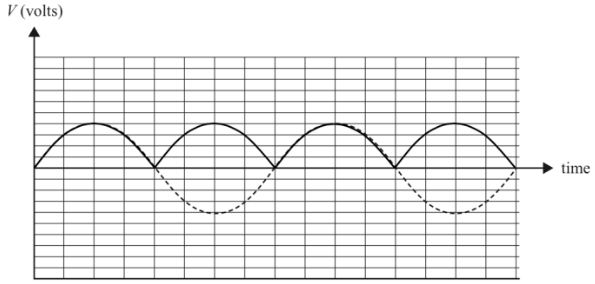
Students were required to specify two of the following:

- increase the rate of rotation of the loop
- increase the number of loops
- increase the strength of the magnetic field
- increase the area of the loop

Question 7g.

Marks	0	1	Average
%	23	77	0.8

Students were required to draw a full wave rectified waveform as shown below.



Question 8a.

Marks	0	1	2	3	Average
%	32	4	19	46	**1.8**

The problem required a conservation of energy approach. As an example:

$$mgh_A = mgh_B + \frac{1}{2}mv^2$$

$$0.25 \times 9.8 \times h_A = 0.25 \times 9.8 \times 0.4 + 0.5 \times 0.25 \times 3^2$$

$$2.45h_A = 0.98 + 1.125$$

$$h_A = \frac{2.105}{2.45}$$

$$h_A = 8.6\,m$$

The most common error was to fail to understand how to apply conservation of energy.

Question 8b.

Marks	0	1	2	3	Average
%	41	10	2	48	**1.6**

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

$$N = \frac{0.25 \times 3^2}{0.2} - 0.25 \times 9.8$$

$$N = 11.25 - 2.45$$

$$N = 8.8\,N$$

The most common error was to fail to understand the relationship between the centripetal force, the weight force and the normal reaction force.

Question 8c.

Marks	0	1	2	3	Average
%	59	20	16	6	**0.7**

Students were required to state that the centripetal force required for circular motion exceeds the weight force of the car. This requires that a normal reaction force, which acts downwards, be added to enable the car to travel around the track at 3.0 m s^{-1}.

Some students chose to approach this problem by calculating the minimum speed at which the car could travel around the loop, which was 1.4 m s^{-1}. They then went on to explain how the stated speed was greater than this value, which meant that a normal reaction force would be present.

The most common error was to indicate that the centripetal force exceeded the weight force but not explain where the required extra force would come from.

Question 9

Marks	0	1	2	3	Average
%	19	31	4	46	**1.8**

The appropriate approach is to apply conservation of momentum.

$$mv_{1i} + 4mv_{2i} = mv_{1f} + mv_{2f}$$

$$m \times v_{1i} + 0 = 4.0 \times 10^6 \times 4m - 6.0 \times 10^6 \times m$$

$$m \times v_{1i} + 0 = 16.0 \times 10^6 \times m - 6.0 \times 10^6 \times m$$

$$m \times v_{1i} + 0 = 10.0 \times 10^6 \times m$$

$$v_{1i} = 1.0 \times 10^7\ m\,s^{-1}$$

The most common error was to forget to subtract the momentum of the proton after the collision due to the vector nature of its momentum.

Question 10a.

Marks	0	1	2	Average
%	22	4	75	**1.5**

To show the time to the highest point students were required to demonstrate a proof such as:

$$v_{vert} = 25\sin(39) = 15.7$$

$$t = \frac{v_{vert}}{a} = \frac{15.7}{9.8}$$

$$t = 1.60\ sec$$

Question 10b.

Marks	0	1	2	Average
%	35	6	59	**1.3**

Given that the students were given the time to the top of flight as 1.60 sec, they should have doubled this to give a total time of flight of 3.20 sec. The horizontal range can then be found using:

$$x = v_{horiz} \times t$$

$$x = 25\cos(39) \times 3.2$$

$$x = 62\ m$$

The most common errors were to use 1.60 sec as the time of flight or to fail to correctly find the horizontal component of the velocity.

Question 11

Marks	0	1	2	3	Average
%	27	35	29	9	**1.2**

Students can find a statement of Einstein's postulates in the study design: 'The speed of light has a constant value for all observers regardless of their motion or the motion of the source.'

To explain how this differs from the concept of light in classical physics, students were required to explain that if there was relative motion between the source and observer then the measurement of the speed of light would vary. Specifically, if the source and the observer were approaching each other the speed of light would appear faster than 3×10^8 m s^{-1} and if the source and observer were retreating from each other the speed of light would appear slower than 3×10^8 m s^{-1}.

While most students were able to state the second postulate many were unable to adequately explain the classical predictions. Many students simply stated that the speed of light would not be constant, which failed to provide enough detail.

Question 12

Marks	0	1	2	3	Average
%	38	14	7	41	**1.5**

$$T = 0.120 \times 4$$

$$T = 0.480\ sec$$

$$f = \frac{1}{T} = \frac{1}{0.480}$$

$$f = 2.08\ Hz$$

$$v = f\lambda$$

$$v = 2.08 \times 1.40$$

$$v = 2.92\ m\ s^{-1}$$

The most common error was to incorrectly calculate the frequency.

There were a number of students who demonstrated a different solution:

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

$$v = \frac{1.40 \div 4}{0.120}$$

$$v = 2.92\ m\ s^{-1}$$

This was also accepted.

Question 13a.

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

$v = f\lambda$

$\lambda = \frac{40}{7.5}$

$\lambda = 5.3\ m$

Question 13b.

Marks	0	1	2	Average
%	41	42	17	**0.8**

No, a standing wave will not form.

Students were required to state that the string length is not a multiple of $\lambda/2$.

Many students simply stated the string length is not a multiple of the wavelength rather than half the wavelength.

Some students chose an alternative proof and stated that since $\lambda = \frac{2L}{n}$, if solving for n did not yield an integer then a standing wave could not form. This was also accepted.

Question 14a.

Marks	0	1	2	Average
%	57	17	26	**0.7**

The path difference is $0.806 - 0.723 = 0.083\ m$. This is also 3λ.

Therefore, $\lambda = \frac{0.083}{3} = 2.77 \times 10^{-2} m$.

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

$f = \frac{3 \times 10^{8}}{2.77 \times 10^{-2}}$

$f = 1.08 \times 10^{10}\ Hz$

The most common error was to fail to convert cm to m. Students must ensure they are working in the correct units.

Question 14b.

Marks	0	1	2	Average
%	34	49	17	**0.7**

The signal strength between P_0 and P_1 is a minimum because the path difference is $\lambda/2$. This results in destructive interference.

The most common error was to provide a generic explanation for destructive interference and state the $\left(n-\frac{1}{2}\right)\lambda$ formula. This did not address the question, which was specifically about the node between P_0 and P_1. Students are advised against copying responses from their A3 reference sheet, as these responses will not be awarded marks if they do not address the question.

Question 14c.

Marks	0	1	2	Average
%	35	24	41	**1**

Light is a transverse wave. Polarised light is such that its plane of oscillation is in one direction only. While students were not required to include a diagram, many did, which aided their explanation. Students are encouraged to use diagrams wherever they find them useful.

A number of students attempted to describe how polarisation affected either the electric field and/or the magnetic field of the light. It should be noted that the study design states that polarisation need only be understood in relation to a transverse wave model. Students and teachers should be careful not to overly complicate concepts to the point where understanding is compromised.

Question 15a.

Marks	0	1	2	3	Average
%	21	24	28	27	**1.6**

The effect being observed is dispersion. The refractive index of the glass is different for different wavelengths, so different wavelengths refract at different angles. This is why the different colours exit the prism at different angles.

Many students referred to diffraction, which is not occurring here.

Question 15b.

Marks	0	1	Average
%	32	68	**0.7**

The colour at point X would be red. The colour at point Y would be blue/violet.

Question 16ai.

Marks	0	1	2	Average
%	25	37	38	1.1

$$h = \frac{rise}{run}$$

$$h = \frac{2.0}{3.8 \times 10^{14}}$$

$$h = 5.3 \times 10^{-15}\ eV\ s$$

Some allowance was made for students' reading of the graph.

Many students were not able to identify the correct unit of Planck's constant.

Question 16aii.

Marks	0	1	Average
%	56	44	0.5

$$f_0 = 3.7 \times 10^{14}$$

$$\lambda = \frac{c}{f} = \frac{3.0 \times 10^{8}}{3.7 \times 10^{14}}$$

$$\lambda = 810\ nm$$

Some allowance was made for students' reading of the graph.

Question 16aiii.

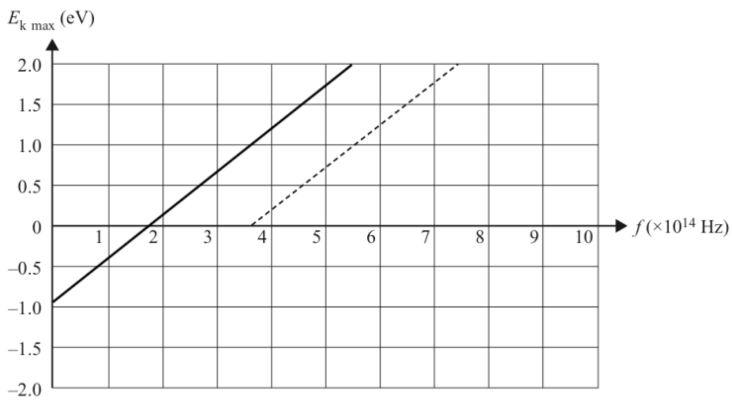
Marks	0	1	Average
%	44	56	0.6

The y-intercept of the graph is ~1.9 eV. Some allowance was made for students' reading of the graph.

Question 16b.

Marks	0	1	2	Average
%	21	9	69	1.5

A solid line parallel to the dashed line as shown below.



Question 17a.

Marks	0	1	2	3	Average
%	28	19	31	22	**1.5**

Moving electrons exhibit a wave property (de Broglie wavelength). As diffraction is dependent on wavelength, if the de Broglie wavelength of the electron is the same as the wavelength of the X-ray then the diffraction patterns will be the same.

Many students indicated that the electron and the X-ray would have the same wavelength and the same momentum but different energies. They then failed to link any of these to the process of diffraction.

Question 17b.

Marks	0	1	2	3	4	Average
%	66	6	3	1	23	**1.1**

Find momentum of the electron:

$$p = \sqrt{(2mE_k)}$$

$$p = \sqrt{(2 \times 9.1 \times 10^{-31} \times 3.0 \times 10^{3} \times 1.6 \times 10^{-19})}$$

$$p = 2.96 \times 10^{-23}\ kg\ m\ s^{-1}$$

The X-ray photon will have the same momentum as the electron.

Find the wavelength of the X-ray from its momentum:

$$\lambda = \frac{h}{p}$$

$$\lambda = \frac{6.63 \times 10^{-34}}{2.96 \times 10^{-23}}$$

$$\lambda = 2.24 \times 10^{-11}\ m$$

Find frequency:

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

$$f = \frac{3.0 \times 10^{8}}{2.24 \times 10^{-11}}$$

$$f = 1.34 \times 10^{19}\ Hz$$

There were other workings that were also accepted.

This process was complex, with many steps to be taken. While marks are awarded for steps throughout the solution they can only be awarded if the assessor can clearly see the correct physics being demonstrated. Very few students were able to set out their work in a way that could easily be followed. Students should observe the solution presented here and note that it has been annotated with short phrases indicating the physics being applied. This annotation makes it easier for the assessor to identify the students' understanding and award marks accordingly.

Question 18a.

Marks	0	1	2	Average
%	30	16	54	**1.3**

The hydrogen atom would need to absorb exactly 12.8 eV of energy from an incident photon or electron.

The most common errors were to refer to emission or to discuss the process of electron shell transition in general.

Question 18b.

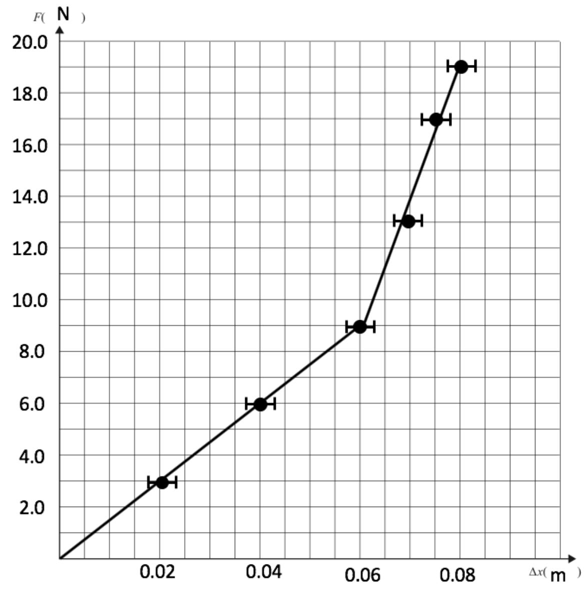
Marks	0	1	2	3	Average
%	21	9	9	61	**2.1**

2.6 eV, 1.9 eV, 0.7 eV.

The most common error was to list all the possible energies emitted when returning to the ground state. Other errors were arithmetic.

Question 19a.

Marks	0	1	2	3	4	5	6	Average
%	11	9	11	15	16	20	17	**3.5**



There were a range of errors:

a. incorrect conversion of mm to m and g to N, which is an expected skill at this level

b. incorrect orientation of the uncertainty bars

c. the drawing of a continuous curve through the data points

It was clear that visualising data and interpreting data are skills that a great many students do not have. Teachers are recommended to provide students with multiple, repeated opportunities to generate data, graph it and draw detailed and complex conclusions. This question made it apparent that many students did not understand how this data referred to a spring system and how knowledge of springs would help to interpret this data.

Question 19bi.

Marks	0	1	2	Average
%	60	5	35	**0.8**

$$k_A = \frac{rise}{run}$$

$$k_A = \frac{9.0}{0.60}$$

$$k_A = 150\ N\ m^{-1}$$

The most common errors were to not convert the mass to Newtons or the displacement to metres.

Question 19bii.

Marks	0	1	2	Average
%	80	6	14	**0.4**

$k_B = \frac{rise}{run}$

$k_B = \frac{7.0}{0.20}$

$k_B = 350\ N\ m^{-1}$

Or

$k_{A+B} = \frac{rise}{run}$

$k_{A+B} = \frac{10.0}{0.20}$

$k_{A+B} = 500\ N\ m^{-1}$

$k_B = k_{A+B} - k_A$

$k_B = 500 - 150$

$k_B = 350\ N\ m^{-1}$

Most students either made no attempt, or demonstrated that they did not know how tackle this problem.

Question 19ci.

Marks	0	1	2	Average
%	55	4	41	**0.9**

The question stem stated that the required method was to use the area under the graph to calculate the energy.

$E = \frac{1}{2}bh$

$E = 0.5 \times 0.080 \times 12$

$E = 0.48\ J$

Over half the students made either no attempt or were unable to demonstrate how to find the area. A number of students attempted to use $E = \frac{1}{2}kx^2$ but were unable to apply this in any meaningful way.

Question 19cii.

Marks	0	1	2	Average
%	84	2	15	**0.3**

The total area under the graph to 80 mm is given by the area of the triangle plus the area of the trapezium.

$$E = \frac{1}{2}bh + \frac{1}{2}(a+b)h$$

$$E = (0.5 \times 0.060 \times 9) + (0.5 \times (9 + 19) \times 0.02)$$

$$E = 0.55\,J$$

Again, over 80 per cent of students were unable to demonstrate any meaningful understanding.

Question 19ciii.

Marks	0	1	2	Average
%	79	0	21	**0.4**

To find the work done compressing spring B alone, subtract the spring A energy from the total energy.

$$PE_B = PE_{A+B} - PE_A$$

$$PE_B = 0.55 - 0.48$$

$$PE_B = 0.07\,J$$

Again, most students were not able to demonstrate an understanding of how to solve this problem.

Question 19d.

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

The single spring (A) could provide suspension for small bumps while the combined spring system (A+B) could provide suspension for more severe bumps.