2008
Assessment Report

VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

2008 Physics GA 3: Written examination 2

GENERAL COMMENTS

The number of students who sat for the 2008 Physics examination 2 was 6754. The mean score was 64.5% (median 66.67%), which is slightly higher than the means for the past few years. Students presenting for the examination were well prepared. Twenty-five students achieved the maximum score of 90.

It was encouraging to note that some areas of weakness highlighted in previous reports had been addressed. Some areas of concern from this exam included:

- sketching magnetic fields
- unit conversion; for example, nm to m
- calculations involving powers of 10
- the ability to sketch a graph from a provided table of data
- the ability to transform simple equations.

Students and teachers should note the following points in relation to the 2008 examination 2 paper and for future reference.

- Students need to be more careful with their handwriting – if the assessor cannot decipher what is written, no marks can be awarded.
- Written explanations must address the question. Generic answers copied directly from the students' note sheets generally do not adequately cover the specifics of the question.
- In questions that require an explanation, the number of marks generally equates to the number of relevant points that should be made.
- Students should be encouraged to show their working. Some credit can often be given for working even if the final answer is incorrect. Some questions state that working must be shown. In such cases, full marks will not be awarded if only the answer is recorded.
- In explanation-type questions some students wrote everything they could think of related to the topic, instead of answering the question asked. This often resulted in contradictions. When this occurred, full marks could not be awarded.
- Students need to be familiar with the operation of the scientific calculator they will use in the exam.
- Answers should be simplified to decimal form, taking into account significant figures. Answers including surds are not appropriate.

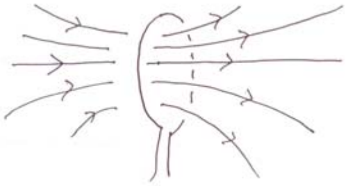
SPECIFIC INFORMATION

Section A – Core

Area of Study 1 – Electric power

Question 1

Marks	0	1	2	Average
%	25	28	46	1.3



Arrows needed to go from left to right and show some divergence. Many students drew small circles around the wire loop. These responses received full marks provided it could be clearly seen which direction the arrows were going.

Question 2

Marks	0	1	2	Average
%	13	0	87	1.8

AB

By applying the 'right hand slap' rule it could be determined that the current flowed in the direction AB.

Question 3

Marks	0	1	2	Average
%	11	14	76	**1.7**

The force on the wire was given by $F = I \times B \times l = 4.0 \times 10^{-3}$.

Students commonly did not convert from centimetre to metre, or converted incorrectly.

Question 4

Marks	0	1	2	3	Average
%	9	12	18	62	**2.4**

The magnetic flux was 8.0×10^{-5} Wb.

Once again students had difficulty with the conversion of centimetre to metre. Some were unable to use their calculators properly, others introduced a factor of two into the equation and others simply did not know the unit for flux.

Question 5

Marks	0	1	2	Average
%	30	0	70	**1.5**

B

With a commutator, the shape of the output voltage would look like graph B.

Question 6

Marks	0	1	2	Average
%	30	0	70	**1.5**

D

The slip rings caused the output to revert to AC so the answer was graph D.

Question 7

Marks	0	1	2	Average
%	32	1	67	**1.4**

The RMS voltage was $\frac{8}{2\sqrt{2}} = 2.8$.

A common error was for students to divide the peak-peak voltage by √2 instead of the peak voltage.

Question 8

Marks	0	1	2	Average
%	50	0	50	**1.1**

C. As the loop entered the field at a constant speed, the flux increased at a constant rate and so a constant voltage was produced. While it moved through the field there was no change in flux and therefore no voltage. As it exited the field the flux decreased at a constant rate and a constant voltage was produced in the opposite direction to the original.

Question 9

Marks	0	1	2	3	Average
%	26	20	10	45	**1.8**

The EMF = $\frac{\Delta(B \times A)}{\Delta t}$ = $\frac{(4.0 \times 10^{-3} \times 0.02 \times 0.02)}{1.0}$ = 1.6×10^{-6} or EMF = Bvl = $4\times10^{-3} \times 0.02 \times 0.02 = 1.6\times10^{-6}$.

The most common error made by students was not converting (or incorrectly converting) centimetre to metre. Other students incorrectly worked out the time for the loop to exit the field.

Question 10

Marks	0	1	2	3	4	Average
%	20	32	25	10	13	1.7

As the loop exited the field, the flux into the page decreased. To oppose this change in flux a current was induced from Q to P to provide magnetic flux into the page.

Most students were able to quote Lenz's law but many were unable to apply it to the specific situation. Some quoted Lenz's law as opposing the flux instead of the change in flux. Few referred to the direction of the initial flux or its change and others had the change in flux going to the left or right. Another approach to Lenz's law had an induced electromagnetic force opposing the motion which caused it. Students who employed this approach tried to use the 'right hand slap' rule to deduce the direction of the current, but generally could not successfully do so. It is possible that some students did not read the question carefully and gave the current direction through the external ammeter instead of through the square loop.

Question 11

Marks	0	1	2	3	Average
%	12	3	2	83	2.7

The simplest approach to this problem was $P = V^2/R = 144/3 = 48$.

A significant number of students converted the 12 V_{RMS} to V_{PEAK} before substituting.

Question 12

Marks	0	1	2	3	Average
%	47	20	3	31	1.2

The potential difference across the floodlight was in the same ratio as the resistance = ¾ × 12 = 9. Another approach students could have used involved first obtaining the total resistance = 4.0 Ω then using Ohm's law to calculate the current in the circuit, and finally applying Ohm's law again to obtain the potential difference across the floodlight.

It was apparent that basic circuit theory was poorly understood by students.

Question 13

Marks	0	1	2	3	Average
%	64	5	1	31	1

4.8 A

To determine the current in the circuit students first needed to calculate the total effective resistance. The first stage involved the two light globes in parallel, where the resistance was 1.5 Ω. The resistance of the connecting leads (2 x 0.5) Ω was added to give a total of 2.5 Ω. Then applying Ohm's law gave the current 4.8 A. Evaluating the effective resistance of the circuit was beyond most students.

Question 14

Marks	0	1	2	Average
%	16	2	83	1.7

Using the turns ratio for an ideal transformer, the number of turns on the primary side was 400.

This question was well done.

Question 15

Marks	0	1	2	3	Average
%	21	12	4	63	2.2

Since the transformer was ideal, the power on the primary side was equal to that on the secondary side (40 W). By using P = V x I, 40 = 240 x I_P then I_P = 0.17 A. Some students used a more complicated method where they first calculated the current in the secondary coil and then used the turns ratio of the transformer to determine the current in the primary coil.

Area of Study 2 – Interactions of light and matter

Question 1

Marks	0	1	2	Average
%	51	26	22	0.8

The thermal (random) motion of free (unbound) electrons produces a continuous (broad) spectrum.

Many students referred to the electrons being excited as a description of gaining energy; however, the term was generally linked to the idea of being excited to a higher energy state, which seemed to imply quantized energy states. It was surprising to see that many students referred to the emission of light by electrons in thermal motion as thermionic emission.

Question 2

Marks	0	1	2	Average
%	43	16	41	1.1

The spectrum from a mercury vapour lamp was discrete (quantized), while the spectrum from an incandescent globe was continuous (broad).

Common errors made by students included referring to the mercury lamp as being monochromatic or having a narrow spectrum. Other students gave irrelevant and confused descriptions of coherence.

Question 3

Marks	0	1	2	Average
%	50	2	48	1.1

Since point Z was on the second minimum to the side of the centre, the path difference was 1 ½ λ which was 4.5 cm.

A common difficulty was the correct application of the relationship (n – ½) λ.

Question 4

Marks	0	1	2	Average
%	28	51	20	1

At point Y the path difference was one wavelength, which resulted in constructive interference.

Many students simply referred to the path difference as being an integral number of wavelengths, instead of applying their understanding to the specifics of the question. Others incorrectly referred to the path difference in terms of the distance measured along PQ from point W.

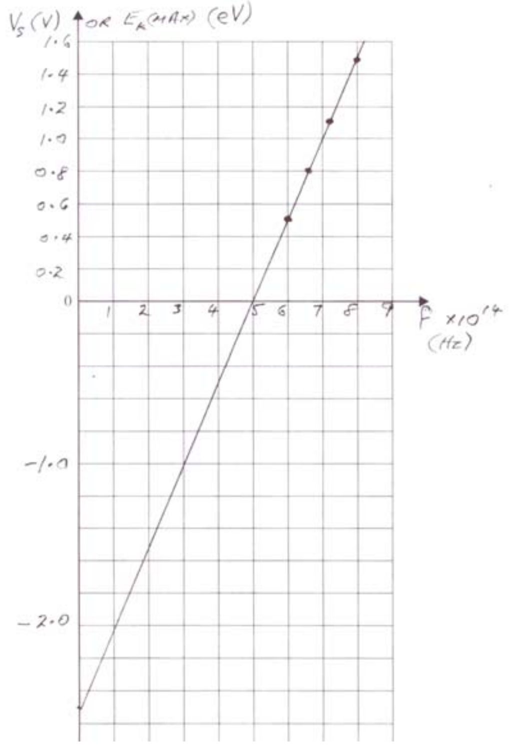
Question 5

Marks	0	1	2	Average
%	40	2	59	1.3

By decreasing the separation of the slits, the pattern would spread out, thus increasing the distance between the maxima and minima points along PQ.

Question 6

Marks	0	1	2	3	Average
%	20	17	27	36	**1.9**



This question required students to draw a graph from supplied data. The graph should have been very familiar from their study of the photoelectric effect.

Common mistakes made by students included failing to label the axes with the physical quantity and unit, not clearly identifying the plotted points and poor selection of scales on axes. Many students did not recognise which were the dependent and independent variables and had the axes interchanged from the normal convention. Students who did not commence the frequency axis at zero or had a break in the scale of the frequency axis had problems determining the work function from the vertical intercept. It was surprising how many students managed to draw four different lines that were sometimes parallel or crisscrossing.

Question 7

Marks	0	1	2	3	Average
%	36	17	19	28	**1.5**

The range of values accepted was $4.3\text{x}10^{-15}$ → $5.7\text{x}10^{-15}$ with a unit of eV s. It was also acceptable to give the answer as $6.9\text{x}10^{-34}$ → $9.1\text{x}10^{-34}$ J s.

Students were able to determine Planck's constant either from the gradient of the graph or by substitution into the equation $E_K = hf - W$. Taking the value of $4.1 \text{ x } 10^{-15}$ from the data sheet was not awarded any marks.

Question 8

Marks	0	1	2	Average
%	56	2	42	**0.9**

The work function was most easily determined from the intercept on the axis with E_K(max) or stopping voltage. The range of values accepted was 2.2 → 2.6. Another valid method was to multiply Planck's constant from Question 7 by the threshold frequency which could be read from the graph.

Students who had not correctly graphed the data in Question 6 struggled with this question. Students are reminded that when the question specifically states the unit in which the answer is to be given, alternatives are not acceptable.

Question 9

Marks	0	1	2	Average
%	21	29	50	**1.4**

The de Broglie wavelength was given by $\lambda = h / m v = 6.63 \times 10^{-34} / (9.1 \times 10^{-31}) \times (2.0 \times 10^{7}) = 3.6 \times 10^{-11}$ m = 0.036 nm.

The question specifically instructed students to give their answer in nanometres and full marks were not awarded if this was not done. Common mistakes included using the wrong version of Planck's constant, substituting $3.0\text{x}10^{8}$ for the speed of the electron or being unable to convert metres to nanometres.

Question 10

Marks	0	1	2	Average
%	33	16	51	**1.3**

Using $E = h c / \lambda = (4.14 \times 10\text{-}15) \times (3 \times 108)/(410 \times 10\text{-}9) = 3.0$ eV. The equivalent method of using $v = f \lambda$ to calculate the frequency and then substituting this into $E = h f$ was commonly used.

Some students used the wrong Planck's constant and a considerable number were unable to correctly read the scale when determining the wavelength. Other mistakes included not converting the wavelength into metres before substituting into the formula or not realising that nm represents 10^{-9} rather than 10^{-6} or 10^{-12}.

Question 11

Marks	0	1	2	Average
%	29	8	63	**1.4**

Students were required to draw an arrow from $n = 4$ to $n = 2$.

This question was quite well done. The most common incorrect response was to draw the arrow going up instead of down.

Question 12

Marks	0	1	2	Average
%	52	12	37	**0.9**

The shortest wavelength corresponds to the highest energy so the required transition was from $n = 4$ to $n = 1$ or 12.8 eV. By transposing $E = h c / \lambda$ to give $\lambda = h c / E = (4.14 \times 10^{-15}) \times (3 \times 108) / 12.8 = 9.7 \times 10^{-8} = 97$ nm.

It was common for students to have the transition energy as 0.7 eV, perhaps thinking that the smallest wavelength corresponded to the smallest energy. Other common mistakes were using the wrong Planck's constant or incorrectly converting metres to nanometres. Some students assumed the mass of a photon was $9.1\text{x}10^{-31}$ and used equations which apply to matter.

Section B – Detailed studies

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

Detailed Study 1 – Synchrotron and its applications

Question	% A	% B	% C	% D	Comments
1	11	76	8	5	
2	3	6	88	3	
3	82	8	4	5	
4	2	2	93	3	
5	43	36	11	9	Option B was a general statement about scattering and did not address the term ‘diffuse’.
6	8	7	80	5	
7	69	19	6	6	
8	4	10	8	77	
9	7	8	76	9	
10	12	50	16	22	The first peak occurred at 9.60. This gave a spacing between the layers of 0.345 nm. The second peak at 20.20 corresponds to a spacing of 0.333 nm therefore diffraction is occurring from a different plane. Option D simply restated the information in the question and did not really involve an application of Bragg’s law as the question required.
11	18	56	9	17	The electrons were approaching the speed of light, therefore increasing the energy only produced a small increase in speed.
12	2	27	60	11	
13	12	56	19	12	The intense beam of X-rays from a synchrotron produces a clear image. Electrons are not used in Bragg diffraction, X-rays do not circulate in the storage ring and nor are they diverted.

Detailed Study 2 – Photonics

Question	% A	% B	% C	% D	Comments
1	5	19	5	71	
2	4	72	21	3	
3	3	7	80	9	
4	4	15	67	13	
5	6	10	81	3	
6	9	79	6	6	
7	20	60	8	12	
8	23	26	42	8	The total attenuation at 1300 nm was about 5 mW/km. A power reduction from 50 mW to 20 mW was a loss of 30 mW. At 5 mW/km this will allow a maximum length of fibre of 6 km. The most common errors resulted from students only taking into account one of the attenuating factors.
9	10	9	71	10	
10	58	14	21	8	Rayleigh scattering, modal dispersion and absorption would be unaffected by changing the light sources.
11	10	7	43	39	1 000 fibres would provide a clear image, 10 000 000 fibres would be too bulky.
12	8	9	76	7	
13	71	10	11	7	

Detailed Study 3 – Sound

Question	% A	% B	% C	% D	Comments
1	2	87	4	7	
2	7	76	15	2	
3	4	91	2	2	
4	2	4	89	4	
5	11	73	6	9	
6	3	82	15	1	
7	10	15	68	6	
8	5	4	89	2	
9	7	31	58	4	
10	9	9	65	17	
11	66	11	13	10	
12	12	61	18	9	
13	6	8	46	40	Without sound-absorption devices on the walls, sound could reach members of the audience directly from the speakers and also by reflection from the walls. The sound would interfere and cause distortion. Note that different frequencies will not reflect differently from the walls.