2008 Physics GA 1: Written examination 1

GENERAL COMMENTS

The number of students who sat for the 2008 Physics examination 1 was 6846. With a mean score of 64 per cent, students generally found the paper to be quite accessible. Twelve students achieved the maximum score of 90. The majority of schools (71 per cent) chose to continue with Detailed Study 2, while approximately 15 per cent studied each of Detailed Studies 1 and 3.

Some general areas of concern in this paper were:

- the simple mathematics required by some questions. Students should be advised not to skip steps. Also, students often 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
- reading the scales on axes
- calculator difficulties. Students need to be thoroughly familiar with their scientific calculators
- responses that were difficult (or impossible) to follow. Students should be encouraged to devote some time to planning their answer and then reading over it once complete.

Students should also be aware of the following general information.

- It is necessary to indicate on the multiple-choice answer sheet which detailed study has been completed.
- 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 asked. Students who simply copy generic answers from their note sheets will not gain full marks.
- Some questions state that working must be shown. In such cases, full marks will not be awarded if only the answer is recorded.

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
%	40	23	37	**1.0**

The net force on the ship was 7×10^4 N. By applying Newton's second law, the acceleration of the ship was 0.07 m s^{-2}.

Students who had obtained the correct net force acting on the ship often then used the total mass of the ship and tugboat when calculating the acceleration.

Question 2

Marks	0	1	2	Average
%	44	5	51	**1.2**

As the ship was travelling at a constant speed, the net force was zero and the tension in the tow rope (9.0×10^4) had to equal the resistance force on the ship. From the graph, a resistance force of 9×10^4 equated to a speed of 4 m s^{-1}.

Some students failed to realise that the force in the diagram and resistance force in the graph referred only to the ship and not to the tugboat.

Question 3

Marks	0	1	2	Average
%	21	4	76	**1.6**

The tension in the string provided the force needed to keep the car moving in a circle, $m\frac{v^2}{R} = 6.0$ N.

Some students used $v = 2\pi \frac{R}{T}$ and calculated T, thinking it represented tension instead of period. Others made a similar mistake using $\frac{v^2}{R} = \frac{4\pi^2 R}{T^2}$.

Question 4

Marks	0	1	2	Average
%	36	0	64	**1.3**

To maintain constant circular motion the resultant force must be in the direction P.

Students who selected direction O may have thought it had something to do with a gravitational force.

Question 5

Marks	0	1	2	Average
%	21	13	66	**1.5**

By calculating the vertical component of the initial velocity and then substituting it into the constant acceleration formula $v^2 = u^2 + 2ax$, the maximum height was 16.2 m.

Some students used cosine instead of sine for the component. Others determined the vertical component of the velocity and assumed this was the height reached. Still others tried an energy approach, assuming that the kinetic energy at the start was equal to the potential energy at the maximum height. It was common for students to correctly write the vertical component of velocity as $30\sin 36.9$, but then obtain slightly incorrect values when using their calculator.

Question 6

Marks	0	1	2	Average
%	26	0	74	**1.5**

As air resistance was to be ignored, the only force acting on the ball was gravity. Therefore, the resultant force was in direction R.

A reasonable number of students chose Q, the direction of the velocity.

Question 7

Marks	0	1	2	3	Average
%	35	13	12	40	**1.7**

Analysing the horizontal component of the ball's motion (velocity $30\cos 36.9 = 24$ and distance = 72) showed that the time for the ball to hit the advertising board was three seconds. Then, applying the constant acceleration formula, $x = ut + \frac{1}{2}at^2$, to the vertical motion gave a height of 9 m.

Some students attempted to use a range formula and generally became confused. Others omitted the negative sign when substituting into the constant acceleration equation.

Question 8

Marks	0	1	2	Average
%	19	6	76	**1.7**

Conservation of momentum gave a final speed of 2.0 m s^{-1}.

The most common error in this question occurred when students substituted the wrong mass after the locomotive and trucks joined.

Question 9

Marks	0	1	2	3	Average
%	23	19	11	46	**1.9**

Impulse = change in momentum = $20\times10^3\left(8-2\right) = 1.2\times10^5$ kg m s^{-1}, direction = west

Some students could not determine the change in velocity, but the more common error was not knowing what mass to use.

Question 10

Marks	0	1	2	3	Average
%	17	18	10	55	**2.2**

Inelastic

The kinetic energy before was 6.4×10^5 J, and after was 1.6×10^5 J. Since there was a loss of kinetic energy, the collision was inelastic.

Some students did not calculate the kinetic energies as required. A number of other students calculated the momentum before and after the collision, thinking this determined whether it was an elastic collision.

Question 11

Marks	0	1	2	Average
%	47	7	47	**1.1**

The two forces were equal as required by Newton's third law of motion – action and reaction.

It was also acceptable for students to explain it in terms of conservation of momentum requiring equal and opposite impulses. Many students assumed that because the masses were different the forces would also have to be different.

Question 12

Marks	0	1	2	Average
%	41	19	40	**1.1**

The energy stored in the spring was given by the formula $\frac{1}{2}kx^2 = \frac{1}{2}10 \times 0.20^2 = 0.20$ J.

The main error was substituting the total length of the spring for *x* instead of just the extension. Other common errors included not converting distances to metres, equating the difference in gravitational potential energy to the spring potential energy and forgetting to square the extension.

Question 13

Marks	0	1	2	Average
%	62	0	38	**0.8**

The mass will have zero speed at the extremities and maximum speed in the middle region, so the answer was D.

Question 14

Marks	0	1	2	Average
%	50	0	50	**1.0**

Gravitational potential energy increases linearly with height, commencing with zero at the bottom of its motion, so the answer was A.

Question 15

Marks	0	1	2	Average
%	32	40	28	**1.0**

The speed decreased from X to Y and the total energy remained constant.

Some students said that the speed changed, but did not say where it was greater. Others suggested that the potential energy increased and the kinetic energy decreased but did not relate this to the total energy.

Question 16

Marks	0	1	2	Average
%	25	16	58	**1.4**

Applying the formula $F = GM\dfrac{m}{R^2}$ showed that the gravitational force was 2.7×10^3 N.

Students often wrote the formula correctly but then neglected to square the radius. A significant minority calculated the value of *g* instead of *F*.

Question 17

Marks	0	1	2	3	Average
%	33	12	11	45	**1.8**

By equating the gravitational force to that needed to maintain circular motion, students obtained the formula $T = \sqrt{\dfrac{4\pi^2 R^3}{GM}}$, which gave a period of 7.2×10^3 s.

Problems included substituting the wrong mass, forgetting to cube the radius and general problems with calculators.

Area of Study 2 – Electronics and photonics

Question 1

Marks	0	1	2	Average
%	43	4	53	**1.2**

The current through the LED was the same as that through the 300 Ω resistor, which could be evaluated using Ohm's law. Since the voltage drop across the LED was 2.5 V (from the graph), the voltage drop across the resistor was 5.5 V (8 – 2.5). Then, use of Ohm's law gave a current of 18.3 mA.

The main error was dividing the total voltage (8.0 V) by the resistance of 300 Ω.

Question 2

Marks	0	1	2	Average
%	42	3	56	**1.2**

R_1 and R_2 can be treated as a simple voltage divider. The voltage drop across R_2 was 2 V.

This question could also be answered by applying Ohm's law twice. Some students determined the voltage across R_1 instead.

Question 3

Marks	0	1	2	Average
%	31	5	64	**1.4**

The voltage across the collector resistor was $3 \times 10^{-3} \times 1000 = 3$ V. Therefore, the voltage between Q and earth was $6 - 3 = 3$ V.

Common incorrect answers were 6 V or 0 V. It is difficult to know where these came from.

Question 4

Marks	0	1	2	Average
%	36	3	61	**1.4**

The power dissipated was 9×10^{-3} W.

Question 5

Marks	0	1	2	Average
%	25	15	60	**1.4**

The amplification was 50. This was determined from the gradient of the linear section of the graph. A negative sign was not required.

The most common error involved not reading the scale on the horizontal axis correctly. It was also surprising how many students attempted to calculate the gradient by $\frac{\text{run}}{\text{rise}}$.

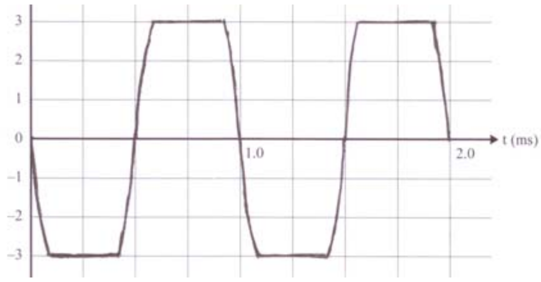
Question 6

Marks	0	1	2	3	Average
%	24	24	44	8	**1.5**

The gradient of the graph was negative because the transistor amplifier inverted the signal. The horizontal sections were related to clipping and the limit on the range of the output voltage was related to the 6 V supply.

Question 7

Marks	0	1	2	3	Average
%	11	10	27	52	**2.3**



Neglecting the clipping at ±3 V was the most common error.

Question 8

Marks	0	1	2	3	Average
%	29	12	32	27	**1.7**

The capacitor was required to maintain the correct bias conditions established for the second transistor by R_1 and R_2. It did this by preventing any DC from the first stage of the amplifier passing through to the second stage. Only the AC signal was allowed to pass through.

Some students had difficulty showing that they understood what was meant by correct biasing.

Question 9

Marks	0	1	Average
%	3	97	**1.0**

At a temperature of 20°C the resistance of the thermistor was 1000 Ω.

Question 10

Marks	0	1	2	3	Average
%	30	14	4	52	**1.9**

At 5°C the resistance of the thermistor was 4000 Ω. By using the relationship for a voltage divider, the variable resistor should be set at 2000 Ω.

Students commonly mixed up R_1 and R_2 in the voltage divider formula.

Question 11

Marks	0	1	2	3	Average
%	36	32	14	19	**1.2**

If the temperature in the coolroom was lower the resistance of the thermistor would increase (this could be seen from the graph). Since the variable resistor still requires 4 V to control the relay, its resistance must be increased to maintain the same resistance ratio with the thermistor.

Many students were unable to provide a carefully reasoned argument, as was required by this question.

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	% No Answer	Comments
Detailed Study 1 – Einstein's relativity						
1	4	81	12	2	0	
2	19	10	59	11	1	
3	45	10	10	33	1	
4	21	12	62	4	1	
5	10	13	69	7	1	
6	3	86	4	6	1	
7	4	72	21	2	1	
8	4	83	10	2	1	
9	1	6	89	2	1	
10	9	71	11	7	1	
11	10	13	67	7	2	
12	25	7	7	60	2	
13	14	60	12	12	3	
Detailed Study 2 – Investigating materials and their use in structures						
1	7	2	7	83	0	
2	7	89	2	2	0	
3	60	17	15	7	1	
4	67	14	13	6	1	
5	16	21	56	5	1	Total strain energy = strain energy per cubic metre × volume. The volume was 1.5 × 20 = 30 (option C).
6	2	11	74	12	1	
7	11	8	71	8	1	
8	53	37	4	6	0	The total weight of the structure can be considered to act at the centre of mass, which would be directly above Y. A load of 14000 N acting down through Y would result in XY being in tension (option A).
9	50	24	12	12	1	At Z there is a support force up. This implies that XZ is in compression, exerting a force down and to the left on Z. Therefore, YZ must exert a force to the right on Z to maintain equilibrium, so YZ is in tension (option A).
10	87	6	4	3	1	
11	7	11	59	22	2	
12	14	47	27	9	2	At maximum load there will be zero force applied at X. Evaluating torques about point Y gives $2\times 40000 = 4\times m\times 10$. So m = 2000 kg (option B).
13	10	12	10	67	1	
Detailed Study 3 – Further electronics						
1	1	7	89	3	0	
2	22	5	71	2	0	
3	8	9	4	78	0	
4	15	11	70	3	0	
5	3	85	3	9	0	
6	3	6	12	79	0	
7	82	11	5	2	0	
8	9	18	5	67	0	
9	2	2	5	91	0	
10	3	5	90	2	0	

Question	% A	% B	% C	% D	% No Answer	Comments
11	58	16	17	8	1	If the input to the voltage regulator remained above the required value, then the output would be as shown in option A. However, if the ripple input dropped below the critical value, the output would be more like that shown in option B. Hence, both answers were accepted.
12	4	9	82	3	1	
13	4	7	76	11	1	