NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Scholarship, 2005

Physics
93103

National Statistics

Assessment Report

Physics, Scholarship, 2005
93103

National Statistics

No. Scholarship Results	Results			
179	**Outstanding**	**Scholarship**	**Scholarship**	
	No. Awards	% of L3 Cohort	No. Awards	% of L3 Cohort
	18	0.3%	161	2.5%

Commentary

Approximately 1100 candidates presented themselves for the Scholarship Physics examination. The performance of most candidates was well below what is expected of a candidate in this type of examination. The top candidates were clearly very well prepared and had an excellent grasp of the physics covered at this level. However the majority of candidates were completely unprepared for this standard or type of examination.

Most candidates had a good conceptual understanding of the following aspects:

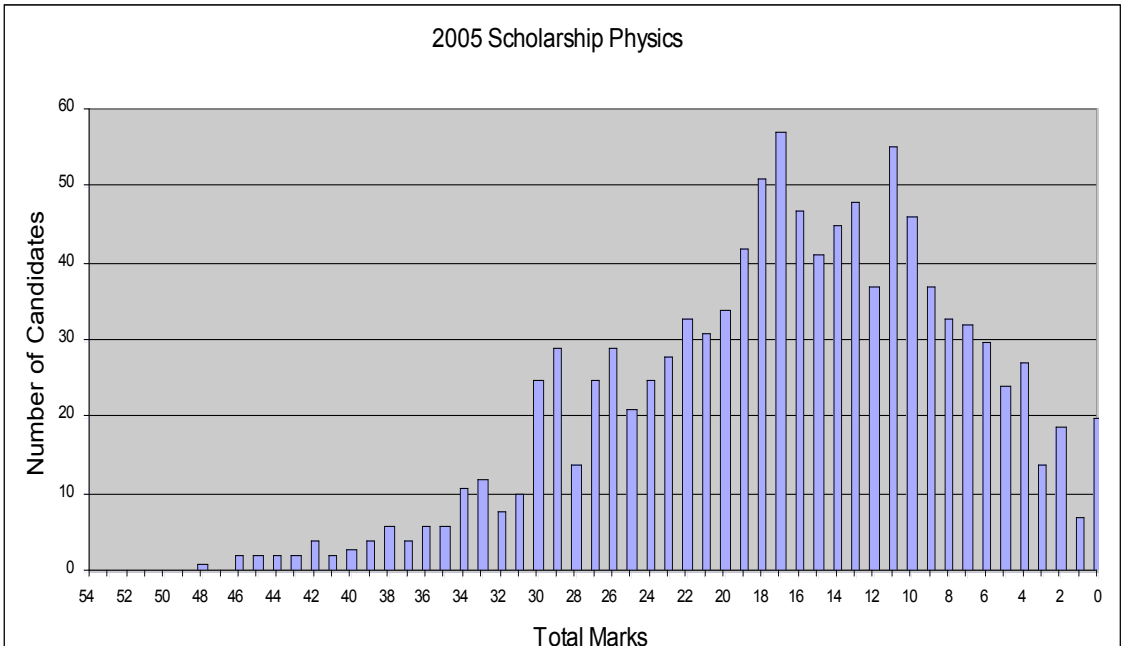
- simple momentum descriptions
- the photoelectric effect
- simple harmonic motion
- the Doppler Effect.

Most candidates had a weak understanding of the following aspects:

- applications of Newton's laws including force vector resolution
- conservation of angular momentum
- simple DC circuit analysis, including capacitors in series.

Candidates' mathematical ability was satisfactory for this level but showed a slight decline on the previous year.

The distribution of marks is shown below.



Points to note from the above graph:

- the average mark was below 17 out of 54
- less than 10 percent gained marks over 30
- only 18 candidates gained more than 40.

The conclusion that can be drawn from this profile is straightforward: Too many candidates were inappropriately prepared for an examination of this standard. A large percentage of the Physics cohort of candidates sat this examination; almost 18 percent. Teachers and schools should spend time with potential candidates to determine whether they have sufficient ability to attempt an examination of this standard. Evidence should be used from past national examination results and the working knowledge of the teacher. Candidates intending to sit the examination need to be encouraged to extend themselves by attempting more challenging problems and spending a lot of time explaining their understanding of physics in a supportive environment. Candidates need to be nurtured and supported with appropriate stimulus material. This process should commence as early as possible in the candidate's physics education, ideally prior to Level 3.

Best-performing candidates most commonly demonstrated the following skills and / or knowledge:

- significant physical insight across a wide variety of situations
- ability to provide clear and concise explanations
- coherent and structured mathematical approaches to calculations
- depth and breadth of conceptual understanding.

Other candidates most commonly demonstrated the following skills and / or knowledge:

- very sound problem-solving skills
- ability to express their understanding and knowledge in writing
- a range of abilities in terms of insight into the essential physics of a situation

- examination specific skills such as:
  - understanding the physical meaning of a calculation
  - control of redundancy and irrelevance in essay writing
  - accurate resolution of vectors into components
  - description of forces involved in a simple physical situation.

Less able candidates who did not achieve Scholarship most commonly demonstrated:

- poorly developed knowledge
- poorly developed mathematical skills
- poorly developed writing skills
- poor physical insight
- lack of critical thinking
- lack of examination specific skills such as:
  - inability to understand the physical meaning of a calculation
  - introduction of irrelevant and erroneous material during essay writing
  - inability to describe forces and torques existing in a simple physical situation
  - inability to analyse simple DC circuits
- reliance on the formulae sheet as the basis of their answers to all types of questions. Scholarship Physics does not rely on appropriate formulae selection. At this level more advanced problem-solving strategies are required
- inability to make physical sense of their calculations.

Comments on specific questions:

Section A

Question 1:
A: Reasonably well done. Most candidates gained marks in this part of the question but many used inefficient algebraic methods. Candidates need to clearly set out a proof of this nature.
B: Poorly done. Many candidates believe the Earth to be in the process of disintegration! Candidates who simply responded "no" gained zero marks.
C: Very poorly done. A significant proportion of candidates gained one mark for identifying the equatorial bulge but very few candidates could adequately explain the reduction in the normal force. It is clear that many candidates are no longer taught free body force diagrams. Candidates at scholarship level are required to be able to use these diagrams in their explanations or problem solutions. Many candidates stated that magnetic effects accounted for the weight difference.

Question 2:
Reasonably well done by most candidates. Candidates who chose (B) (the photoelectric effect) generally out-performed those who chose (A) ($E=\Delta mc^2$). Candidates were generally able to present the major underlying physical principles. It was pleasing to see that candidates were able to answer the question in the space provided and generally did not resort to vague statements to simply 'pad-out' their essays.
Candidates who chose Essay (A) were often unable to relate Einstein's equation to the concept of binding energy. The general concept of binding energy was poorly understood by virtually all candidates. Despite the encouragement to draw a graph very few candidates provided the obvious binding energy per nucleon graph. Many candidates stated that fusion was an energy-absorbing process whereas fission was an

energy-releasing process. Many candidates believe that Einstein's work was experimental in nature and that his motivation was to produce nuclear power. Both these beliefs are incorrect.
Specific comments relating to Essay (B): Generally candidates were able to state the major underlying physical principles. The most common error, which was not penalised, was to state that Einstein actually did the experimental work related to the photoelectric effect.

Question 3:
A: Poorly done. Candidates could not see that angular momentum was conserved due to a radial force acting. Many stated that centripetal force was conserved.
B: Poorly done. Most candidates who attempted part (a) were able to gain partial credit for this part, but very few noticed that the tension tended towards infinity at small radius.
C: Poorly done. It appears that almost no candidate knew that ΔE_K=work done. The derivation is trivial once that relationship is used. Some more mathematically able candidates managed to derive the relationship using integral calculus. The use of calculus is not required for Scholarship Physics, however candidates were not penalised for using it.

Section B

Question 1:
A: Well done by most candidates.
B: Generally well done. A surprising number of candidates believed that the wagon would accelerate as it lost superphosphate.
C: Generally well done. The most common mistake was to not allow for the reduction in speed after filling the wagon.
D: Poorly done. Candidates who were able to draw a correct free body force diagram were generally able to solve this problem. Most candidates were unable to correctly resolve force vectors.

Question 2:
A: Generally well done.
B: Well done by the more able candidates. A typical error was to ignore the second altitude.
C: Generally well done. Most candidates were able to successfully calculate the speed but were unable to state a valid assumption.
D: Poorly done. Only the most able candidates realised that the microphone needed to be directly below the plane in order to detect phugoid oscillations. A significant number of candidates believed that the Doppler effect depended on distance. This appears to stem from confusion between frequency and amplitude.

Question 3:
A: Poorly done. A large number of candidates attempted to explain part of this phenomenon using centrifugal forces. Teaching programmes at this level should not include any discussion of centrifugal forces. Very few candidates could explain why the normal force was only on the two outside wheels.
B: Poorly done. Despite the instruction to take moments about the centre of gravity very few candidates even attempted this part of the question.

C: Reasonably well done. A significant proportion of candidates believed that increased stability would be gained by stacking the passengers and equipment as high as possible.
D: Well done by most candidates who attempted this part.

Question 4:
A: Reasonably well done by most candidates. A significant number of candidates showed a lack of appropriate working.
B: Poorly done. Very few candidates realised that the resistances of the bulbs could not be assumed to be constant. A number of candidates gained partial marks for correctly predicting the changes in intensity but virtually no one was able to explain why.
C: Poorly done. Only a very small group of candidates realised that the bulbs' resistance characteristics were required.

Question 5:
A: Poorly done. A significant number of candidates managed to gain partial marks for correctly calculating the current. Very few candidates knew that series capacitors have the same charge on them.
B: Poorly done. A number of candidates realised that the current would be unchanged but very few were able to correctly calculate the charge on each of the capacitors.
C: Poorly done. A very small number of candidates identified the symmetry involved in this circuit.