UNIVERSITY OF MALTA

THE MATRICULATION EXAMINATION
ADVANCED LEVEL

PHYSICS
May 2017

EXAMINERS' REPORT

MATRICULATION AND SECONDARY EDUCATION
CERTIFICATE EXAMINATIONS BOARD

Physics

Advanced Level

May 2017

Part 1: Statistical Information

The distributions of grades awarded in the May 2017 session are given in the table below.

GRADE	A	B	C	D	E	F	abs	TOTAL
NUMBER	21	55	108	90	42	37	20	373
% OF TOTAL	5.6	14.7	29.0	24.1	11.3	9.9	5.4	100

Part 2: Comments regarding candidate's performance

Paper 1

Question 1

In part (a) of question 1, the majority of candidates expressed good understanding of algebraic manipulation of units. However, logical presentation of facts is still lacking. It is still common that mathematical steps contain a mixture of units and symbols for quantities. Generally, this leads to confusion and error. As an example, (C) for Capacitance is mixed up with (C) for Coulombs.
In part (b), candidates had the opportunity to show understanding of forces and force diagrams. To start with, many candidates did not realise that the chest of drawers was moving with constant speed and hence, with no further calculations required, the resultant force acting on the chest is zero Newtons. Very often candidates interchanged the answer for part (i) with that required for part (iii). Furthermore, it was a rare occasion that candidates produced a correct force diagram. The vast majority of candidates did not distinguish between Contact Force and Normal Reaction Force. As a result, the majority of candidates included more than three forces as required.

Question 2

The performance of candidates in this question was generally good. It is evident that most candidates are able to read information from a displacement time graph and calculate the velocity with which the body is travelling. However, a good number of candidates did not sketch the proper velocity-time graph. It is also noted that some candidates, when distinguishing between distance and displacement, did not include whether the quantity in question is a scalar or vector. Furthermore, most of the candidates were not able to keep their explanation general but had to give an example or draw a diagram. Candidates are encouraged to keep their explanation more generic; applicable to many situations.

Question 3

This question was about Work, Energy and Power. Very few candidates managed to define Energy properly. Instead, many candidates recalled the principle of conservation of energy. The vast majority of candidates were able to distinguish between Potential and Kinetic energy but surprisingly, the majority of candidates could not properly explain the terms Potential and Kinetic energy. In part (b), candidates rarely identified how energy is converted while the lift is moving.

Question 4

The majority of candidates managed to recall the definition of a couple. However, the minority did not emphasise on the fact that the lines of action of the forces making up the couple do not coincide. Also, part (b) was attempted by the very few. Most candidates did not attempt this part of the question. On the other hand, part (c) was attempted by the majority of candidates and in most cases, a good answer was generated. Furthermore, the very few included the wrong unit for a correct numerical answer.

Question 5

For part (a) of this question, the absolute majority of candidates noted that during circular motion the particle's direction of motion is continuously changing. However, a high percentage of candidates failed to specify that the particle's velocity, being a vector, is continuously changing. The majority of candidates also attempted part (b). Different methods were observed. However, candidates who opted to apply knowledge on similar triangles failed to prove that the chosen triangles are indeed similar. Also, candidates who used the Sine Rule failed to justify the magnitude of angles used. Furthermore, in part (ciii), a high percentage of candidates failed to show understanding of balance of forces in the vertical plane. It was very common to read that the lift force equals the weight of the plane.

Question 6

A very high percentage of candidates performed well in the numerical part of this question. However, many candidates still cannot recall a proper definition of *Electric Current*. It is also evident that many candidates have a vague idea of the concept of free electrons. It was very common to read that in an electric circuit without a P.D. across its terminals, free electrons are stationary. Furthermore, most candidates do realise that the presence of a source of energy in a circuit transmits energy to the circuit such that free electrons are forced to flow across two points. However, candidates did not always specify that the presence of a P.D. across the terminals of a circuit forces free electrons to flow in a coordinated way through a conductor i.e. free electrons would be forced to drift in one direction.

Question 7

Overall, candidates performed moderately well in this question. In general, all parts of this question were attempted. However, a low percentage of candidates could not recall Ohm's law properly while many candidates did not specify the condition for which Ohm's law applies. In part (b) a high percentage of candidates could sketch the required graphs. However, many candidates did not sketch the negative axes for both curves. Furthermore, in many cases, candidates did not emphasise the difference between the way a diode conducts below and beyond the barrier p.d. In part (c), candidates who failed to generate a correct answer mainly failed in either using a wrong formula for conductivity or a wrong formula for the area of a circle.

Question 8

A minority of candidates did not attempt or poorly attempted this question. It is evident that most candidates who attempted this question have sound knowledge of Rutherford's experiment. However, a high percentage of candidates did not distinguish between the frequency of alpha particles involved in the three collision types. Only the minority of candidates specified that most particles penetrate the gold foil without noticeable deviation and that backscattering was rarely observed. On the whole, candidates also have good understanding of the main conclusions about the nature of the atom. Furthermore, in part (c) it was sometimes noticed that candidates could not distinguish between electrostatic potential and potential energy. They used both quantities interchangeably.

Question 9

The candidates who attempted this question were very few in number. Most of the candidates were able to define 'moment of inertia'. However, they found it somewhat difficult to apply the 'Principle of conservation of angular momentum'. Moreover, candidates have shown lack of understanding of the equations of motion as applied to rotational dynamics.

Question 10

Question 10 was not among the most popular. It was attempted by a minority of candidates. Overall, most candidates who attempted this question performed relatively well in part (a). Candidates showed good level of understanding as regards 'Projectile Motion'. The majority of candidates managed to derive the required equations. Candidates showed difficulty in solving problems about projectile motion coupled with the linear motion of the truck. Specifically, a high percentage of candidates

ignored to multiply the time taken to reach maximum height in order to determine the time of flight of the projectile.

Question 11

Rotational dynamics was moderately popular with candidates. However, the performance of the absolute majority of candidates who attempted this question was very low. Many candidates scored low because in many cases, many parts of the question were not even attempted. It is evident that most candidates have a good idea of what the moment of inertia of a rigid body is. However, most candidates lacked the ability to explain in detail why the moment of inertia of a ring is bigger than the moment of inertia of a disc. In part (b) and (c), most candidates scored low as well. Candidates showed lack of ability to apply the correct equations. Further to this, many candidates opted to apply equations for circular motion instead. It is evident that many candidates failed to exhibit good understanding of the difference between linear and angular acceleration.

Question 12

This question was among the most popular with candidates. In their majority, candidates attempted all parts of this question. In part (a), most candidates attempted to translate mathematical formulae into words or perhaps writing down a formula as a definition. For part (b), most candidates are able to identify the differences between the behaviour of copper, rubber and glass. However, many candidates presented a straight line graph for glass ignoring the fact that although brittle, glass exhibits a small degree of plasticity. For the rest of the question, candidates showed good mathematical ability in deriving and solving equations. However, most candidates were not able to answer part (d iv) correctly as they seem to be unaware that the energy stored in a wire per unit volume is related to the stress and strain of the wire.

Question 13

This question was moderately popular with candidates. In particular, most candidates performed very well in part (a). Candidates could easily derive the drift velocity equation. Consequently, candidates found it easy to derive the required result. Also, the majority of candidates attempted part (b) of this question. Here, most candidates have a good idea of the Band Theory of Solids. However, lack of presentation is noticeable. Neatness in sketch drawing and logical presentation of facts are widespread weaknesses. A common inaccuracy in part (c) was noted when candidates were asked to recall Kirchhoff's rules. It was noted that a high percentage of candidates ignored the fact that the loop rule is based on the algebraic sum of the potential changes and not the arithmetic sum. Consequently, most candidates were not successful in generating the correct loop equations. Evidently, this was followed with final wrong answers.

Question 14

This question was moderately popular with candidates. It was attempted in full by most of those who attempted this question. In part (a), most candidates showed ability in choosing the right mathematical equation for the correct solution. However, knowledge about the characteristics of series and parallel circuit configurations is lacking. In part (b i), the absolute majority of candidates opted to define EMF and PD. However, in most cases, candidates did not manage to explain the difference between EMF and PD in full. Some, have a very vague idea while others preferred to use the word 'voltage' in their explanation. In general, candidates showed lack of confidence and ability in dealing with circuit analysis. Moreover, in part (b v), many candidates did not realise that if no current flows through *S*, then resistors *C* and *D* are subject to the same potential difference across terminals.

Question 15

This question was not very popular with candidates. However, most candidates who attempted this question showed good understanding of the photoelectric effect. In their majority, they could state and explain the main conclusions drawn from the photoelectric effect. On the other hand, very few candidates could explain the terms involved in Einstein's photoelectric equation. Instead, most candidates stated the meaning of each letter used. Also, the majority of candidates did not properly explain why both metals produce photoelectrons when exposed to UV radiation in part (ci). Moreover, candidates performed fairly well in using Einstein's photoelectric equation as required in part (d).

Paper 2

Question 1

In part (a) of this question, the majority of the candidates incorrectly provided a straight line graph of temperature against time while only few of them referred to the tangent at room temperature to measure the rate of increase in temperature in part (b). Few candidates provided correct answers for parts (c) and (d). Candidates correctly explained that 'the water should be stirred prior to each temperature reading'.

Question 2

The majority of the candidates performed well in this question. In particular, they used correct formulae to calculate the heat transfer to the gas and its specific heat capacity at constant volume. Few candidates provided correct explanations for part (b).

Question 3

The majority of the candidates had an average performance in this question. They showed knowledge on the rate of heat flow through the bar with and without lagging and provided correct graphs. However in part (e), few candidates were able to use the given equation to explain the shape of the graph for an unlagged bar.

Question 4

The majority of the candidates had an average performance in this question. They provided correct observations from Hubble's diagram but few of them were able to obtain an approximate value for Hubble's constant. Most candidates were unable to identify the main source of uncertainty and explain how the graph shows the uncertainty. Correct estimations of the age of the universe were provided by the majority of the candidates. However few of them succeeded in estimating the distance between two particles in deep space which move a distance of 1 m in one year.

Question 5

The candidates had a below average performance in this question. They lacked solid knowledge on the effects of alternating currents in circuits containing coils. Only few candidates made reference to rate of change of flux linkage, back emf and eddy currents to explain the observations required in parts (a), (b) and (c).

Question 6

Question 6 is associated with the lowest average score from all questions in section A. The absolute majority of the candidates showed poor understanding of this area of study. A small group of the candidates did not even attempt it while those who did scored very low. They found difficulties in explaining the direction of travel of the accelerated particles and in deriving simple relationships for the length of tube A and the final KE of an electron after having travelled through n gaps.

Question 7

The majority of the candidates had an average performance in this question. Candidates successfully calculated the magnetic flux density in part (a) but surprisingly few of them provided a clear diagram of the magnetic flux pattern between the two current carrying conductors. Few candidates managed to derive the provided equation of the force per unit length acting on each conductor in part (b) of the question.

Question 8

The majority of candidates had a below average performance in this question. They found difficulties using the correct formula for refractive indexes with respect to the different media travelled by the ray of light. Few candidates were able to provide an explanation why a pulse of ordinary light does not retain its shape as it travels along an optical fibre.

Question 9

This question was attempted by 64% of the candidates. They had an average performance. Candidates were able to derive the equation for work done on the gas for a small decrease in volume

(part a) but lacked knowledge on the properties of a reversible change (part b). The majority of the candidates provided correct calculations to determine temperatures required in part (c i) and the network done during th cycle (part c ii). Candidates found it difficult to derive the simple equation for the molar heat capacity at constant pressure in part (c iii) and were unable to determine the heat transfer during the provided processes. The majority of the candidates were knowledgeble to calculate the efficiency of the cycle.

Question 10

This question was attempted by 37% of the candidates. The majority of them provided correct answers to all questions in part (a) and lacked knowledge to provide correct answers to parts (b) and (c). For example a number of candidates failed to write down a relationship between the charge supplied and the voltmeter reading and to provide an explanation why the capacitor should have a small capacitance (part b iii). Surprsingly a considerable number of candidates were unable to calculate the time constant in part (c i) while few candidates used the correct formula to determine the time for the voltmeter to fall by 10% in both cases presented in parts (c ii) and (c iii).

Question 11

This question was attempted by 77% of the candidates. This was the most popular question. They had an average performance in this question. The majority of them provided the correct definition of SHM and few of them failed to explain how the graph shows a body performing SHM. Correct calculations for parts (a ii) and a(iii) were provided while candidates found difficulty in calculating the KE at the given value of x in part (a iv). Few candidates succeded to provide correct sketches required in part (b) mainly due to difficulties in establishing the gradient of the graphs.

Question 12

This question was attempted by 44% of the candidates. They had a below average performance in this question. The majority of the candidates were able to define electric field strength in part (a). In part (b), they were also able to determine the direction of the free electrons and to provide the forces acting on an electron in the conductor while moving. The majority of the candidates were able to derive an equation for *E* in part (b iii). In part (c ii), a number of candidates provided the wrong direction of the magnetic field while in part (c iii) they were able to derive an equation for the work done. Candidates showed lack of knowledge in answering the rest of the questions.

Question 13

This question was attempted by 68% of the candidates. In part (a), it was evident that many candidates mentioned monochromatic waves as one condition for interference but failed to refer to coherence as the second condition. No particular difficulties were evident in parts (b) and (c). However, many candidates failed to provide a complete list of required measurements and instruments used to obtain a value for the wavelength of red light in part (d). The majority of the candidates correctly answered part (e) but provided partially correct answers to part (f) when providing estimates for the distance between slits. The candidates showed lack of knowledge on the effects on the number of fringes if the laser was to be replaced by a filament lamp and a red light filter.

Question 14

Only 12% of the candidates attempted this question. Those who attempted this question lacked solid knowledge on all concepts examined in this question. In particular candidates found difficulties on the use of the oscilloscope to determine frequencies. Few candidates made an attempt to answer questions from part (d) onwards.

Question 15

About 64% of all candidates attempted this question with their majority attempting the question in full. Surprisingly, this question carries an average score which is unusual since candidates usually have a good performance on this topic. On the whole, candidates found no difficulty to define the terms required in (a). However, it is important to note that a mathematical formula is usually not sufficient as an explanation. In part (b), candidates did not perform particularly well by using the wrong formulae. Many still confuse the equation to be used to calculate the free-fall acceleration. A lot of candidates used the correct jargon for the explanation in part (c i) while some of them failed to calculate the difference in g. Few candidates had a successful attempt to part (d) of the question.

Paper 3

In the first part of the practical paper, the candidates were asked to investigate diffraction of monochromatic light from a laser diode by a compact disc (CD) and determine the spacing between the tracks on the CD. In the second part of the experiment, the laser diode was used to determine the focal length of a convex lens. In the first part, a laser diode was positioned upright underneath a CD held horizontally between clamps mounted on a stand. The reflected light from the CD produced dark and bright fringes and measurements of the distance between the CD and screen as well as the separation between the bright fringes led the candidates to determine the separation between the 'slits' or tracks on the CD, through graph plotting and data analysis. In the second part of the experiment, the laser diode was positioned horizontally and pointed towards a convex lens. Candidates were asked to move the lens in a perpendicular direction to that of the laser beam, keeping a constant separation between lens and laser diode. The distance moved by the lens and the distance moved by the resulting bright spot on a screen positioned perpendicular to the direction of the laser beam were measured. The focal length of the lens could then be determined through a number of calculations and data analysis. In general, candidates did very well in the practical session, with the average mark being slightly higher than 90%. The number of candidates that obtained 90% or higher is about 73%. The marker noted the following difficulties that were encountered by candidates in this exam:

In part A:

- only a few number of candidates did not convert values read in centimeters into meters;
- a small number of candidates incorrectly worked out some of the calculations in the table;
- candidates correctly sketched and plotted well sized graphs. Only very few candidates forgot to write down the axis titles and the graph title;
- a number of candidates were unable to rearrange the expression given in the form $y = mx + c$ and hence determine correctly the 'slit' separation;
- the value of the gradient was given without its unit;
- a number of candidates were unable to convert the separation of the slits into nanometers.

In part B:

- a number of candidates were unable to express the given equation in the form $y = mx + c$ and hence were unable to determine the focal length of the convex lens;
- a very small number of candidates were unable to find two sources of error and their corresponding precautions;

In general, candidates did well in the practical session thus illustrating significant attention to detail.

Chairperson

2017 Examination Panel