L-Università ta' Malta

MATSEC
Examinations Board

Examiners' Report
AM Physics

First Session 2025

TABLE OF CONTENTS

A. STATISTICAL INFORMATION

The total number of candidates who registered to sit for Physics was 369. Table 1 shows the distribution of grades for the First 2025 session examination.

GRADE	A	B	C	D	E	F	ABS	TOTAL
NUMBER	23	49	76	64	48	74	35	369
% OF TOTAL	6.2	13.3	20.6	17.3	13.0	20.1	9.5	100

Table 1: Distribution of grades for AM Physics 2025, First Session

B. COMMENTS

Paper I – Section A

Question 1

a. Most responses indicate good understanding of the units of the quantities asked. Common mistakes included forgetting to square the units for velocity and forgetting to include all the quantities in the equation. Some responses confused the variable *m* for mass with the unit *m* for meters.

b. i. Responses indicate that many candidates did not understand the problem/scenario or did not conclude that the resultant force required should be pointing East.

ii. A few responses assumed Pythagoras' theorem holds, despite their diagram not implying that the triangle is necessarily right-angled. Some candidates included the downward force *mg* as a velocity component.

Question 2

Overall, responses indicate a lack of understanding between parallel and series within the context of mass-spring systems.

a. Commonly, candidates either omitted the statement including the proportionality limit or used the elastic limit instead of the proportionality limit.
b. A significant number of responses confused the definitions of parallel and series, often adopting the definitions in the context of electricity. In some cases, candidates were calculated individual extensions for the separate springs, rather than considering the entire system.
c. Most candidates worked out this part correctly.
d. Mixed performance in this part question. A good number of candidates provided the correct reasoning. However, a significant number did not associate it with the correct parallel or series setup.

Question 3

a. Most candidates stated Kirchhoff's laws correctly. A few candidates did not include the conservation laws, or the incorrect conservation law was associated with the Kirchhoff law.
b. Mixed performance in this part question. Mistakes in substitution and the subject of the formula were noted. A few candidates did not obtain the correct set of equations. Marks were deducted

if the negative sign was not explained. A few candidates obtained a zero current for one of the components due to the incorrect application of Kirchhoff's laws.

Question 4

a. While most candidates were on the right track, there seemed to be confusion between the two terms, with candidates not stating clearly the differences.
b. Most candidates started their derivation using $V = I(R+r)$, but they did not clarify why the 10 Ω resistance is added at a later point.
c. Not all candidates used the graph to determine the gradient and the *y*-intercept values. Some responses did not identify the gradient as the reciprocal of the EMF value. Some candidates opted to use simultaneous equations to solve for *r* and emf. While the method is correct, there were several mathematical mistakes which resulted in incorrect values.

Question 5

a. A few candidates only compared the alpha particle to Helium but did not include the number of protons and neutrons the particle is composed of.
b. A significant number of candidates used the equation of force between two charged particles instead of an energy equation. A few candidates did not multiply the electron charge value by the number of electrons present in the alpha particle and the carbon atom. A common mistake was an incorrect conversion from MeV to J.
c. Many candidates did not use the correct relationship between the radius and the atomic number, often missing the fact that the relationship can be obtained through the spherical volume equation.
d. Many candidates did not distinguish between positive and negative beta decay. Additionally, the half-life equation was used instead of a nuclear equation. Marks were lost for omitting the neutrino in the equation.
e. Some candidates used the method that requires finding the value of λ. While the method was correct, candidates often made mistakes in unit conversion. A significant number of candidates used simple proportion rather than noting that the value changes exponentially. A common mistake was the use of the value 5730 instead of 5370.

Question 6

a. Mixed performance in part (a). A significant number of candidates did not equate centripetal force to gravitational force. A few candidates confused angular frequency with orbital period.
b. i. Marks were lost for not concluding that the banking provides centripetal force.
   ii. Many candidates did not obtain the correct relationship for the vertical and horizontal components. Additionally, a significant number of candidates assumed the answer of 45 degrees when working out the component.

Question 7

a. i. Most candidates correctly identified the relationship between friction and rolling without slipping.
   ii. Only a small number of candidates performed adequately.
   iii. Common mistakes included the incorrect conservation of energy equation, incorrect moment of inertia expression, and incorrect algebraic arrangement of the equations.

b. A significant number of marks were lost for incorrect angular quantity units. Responses indicate a lack of knowledge surrounding these quantities.

Question 8

a. Most candidates performed well.
b. Most candidates performed well.
c. Most responses did not point out $W_f > W_g$, that the speed is constant / zero acceleration, or that otherwise there would be a change in kinetic energy. Most explanations did not include key physical details.
d. The performance was insufficient.
e. A significant number of responses did not provide the correct description/equation for efficiency. Additionally, responses indicate misunderstanding of which results contribute to the useful work output and which values correspond to the total work input.

Paper I – Section B

Question 9

a. i. Marks were lost for not labelling the diagram well, not including the vernier scale and not including a reference wire. Candidates who used a pulley system either included a metre ruler to measure small extensions or did not specify that the pulley is frictionless, thus making it a non-ideal system to measure the extension of the wires. A few candidates described the system using a spring rather than a wire.
   ii. Candidates provided a clear description of the experiment. Often, candidates did not include the step to measure the diameter of the wire. Most of the marks were lost for not specifying the instruments used to carry out the measurements.

b. Most candidates did not know the difference between proportionality and the elastic limit.
c. Candidates lost marks for reading points from the graph which were either beyond the linear part of the plot or picked points that were difficult to read, resulting in an incorrect value.
d. Most responses included poor definition of ultimate tensile strength. It should be noted that throughout question 9, candidates often confused the terms force, stress and strain.
e. The general performance was inadequate.
f. Most candidates obtained the correct value. Marks were lost for using the gravitational acceleration value instead of a=25 ms^{-2}.

g. Most candidates carried out the correct working. Follow-through marks were given to the candidates who listed the incorrect material in part (e).

Question 10

a. Most candidates provided the correct definition for the temperature coefficient.
b. i. Most candidates provided the correct diagram. Most of the marks were lost due to the lack of labelling. Setups which included an ammeter and voltmeter instead of an ohmmeter were accepted, provided the placement was correct. Some candidates did not include a heat source or the resistive component under test.
   ii. Most candidates stated the correct procedure to measure the resistance of the component using the setup described in (10bi).
c. The general performance was average.
d. Most diagrams were correct. Some candidates included the fan despite being instructed to exclude it. Only a few candidates lost marks for not including a voltmeter or using the incorrect symbol for thermistor/resistor.
e. Most candidates correctly stated that the thermistor resistance decreases but the attempt to specify why the total resistance also decreases was inadequate.
f. Many candidates included a detailed explanation, including how current and voltage vary with resistance and the implications of the speed of the fan. Full marks were not given if one of these components was not included in the description.
g. Some candidates included a logarithmic plot instead of an exponential plot. Some candidate drew a straight-line plot, suggesting that the thermistor is Ohmic. Only a small number of candidates omitted a plot.
h. Many candidates did not explain their answer, or not enough details were provided.

Question 11

a. Most candidates provided the correct description or included a drawing to show the placement of the components.
b. Candidates who only mentioned that charge carriers were electrons and did not include a full definition of charge carriers were not allocated the mark.
c. Many candidates did not include the correct definition of electric current, oftentimes using the term itself to explain it.
d. Most of the marks were lost for using only one point to determine the gradient of the lines.
e. A small number of candidates did not include any calculations using $V = IR$ to determine the values of current I and match them with the results obtained in (11d). Some candidates did not include the time region in which the result holds.
f. Only a few candidates provided the correct plot. Most candidates plotted sloped lines across each region, indicating that they did not notice that the current is constant over a region.
g. Most candidates provided the correct answer (area under the graph).

Question 12

a. Candidates performed well.
b. Candidates performed well.

c. Most candidates drew the correct answer. Marks were lost for including only one electron being shared between each silicon atom.

d. Most candidates only got partial marks for not including that the band gap is large in pure silicon.

e. i. Only a few candidates switched the definitions of p-type and n-type semiconductors.
   ii. Candidates who obtained a correct value in part (12 c) also gave an accurate answer for this question. Marks were lost in cases where candidates gave the incorrect semiconductor type, typically those who defined the semiconductors incorrectly in part (12ei).
   iii. Most candidates did not include an acceptor energy level. In some cases, candidates did not provide a detailed description.
   iv. Marks were lost for not stating that it causes an increase in the production of holes.

Question 13

a. i. Most candidates did not include both kinetic energy and linear momentum. In some cases, candidates stated that mass and velocity were conserved, which was interpreted to mean that the quantities are conserved separately rather than conservation of linear momentum.
   ii. Only a few candidates wrote an equation showing conservation of linear momentum and kinetic energy using different symbols for the two mass and for the different velocities.
   iii. A small number of candidates attempted this part of the question. Common mistakes included the assumption that the particles move off with the same velocity after collision, forgetting to square the velocity in the kinetic energy expression, mistakes in substitution and subject of the formula and incorrectly solving the quadratic equation.

b.
   i. Most marks were lost for not including the following in block A: normal force, tension, and the wrong direction for the friction force.
   ii. Only a few candidates got full marks. Candidates also lost potential follow-through marks for not including expressions and equations showing their working clearly.
   iii. Only a handful of responses were correct. obtained the correct answer.

Question 14

a. i. In the definition of equilibrium, most candidates included that the algebraic sum of forces is zero but did not include torque/moment of forces. Alternative definitions, including both linear and angular acceleration, were accepted. Many candidates gave a description implying that the centre of mass is the actual point where the mass appears, rather than an average position of the mass acting on the entire system.
   ii-vi The performance was very poor.

b. i. Most candidates who attempted this question obtained a correct answer.
   ii. Marks were lost for not including the correct distances in the torque expression. A few candidates attempted to only add up the distances and did not consider the torques.

iii. Most candidates who attempted the question correctly stated that it is a pure clockwise rotation. Only a few candidates obtained the wrong direction or included a translation.

Question 15

a. i. Most candidates obtained the correct answer. A few candidates gave the proton number instead of the number of neutrons.

ii. Candidates did not always give a full description of the atom model, commonly not mentioning the nucleus or the electrons. Only a handful of candidates provided a correct explanation for the atom's instability.

iii. While candidates used the correct equations, many candidates did not find the difference between the two energy levels. A few candidates also did not identify the correct energy levels to use during the calculations.

iv. Only a couple of candidates concluded that there are 6 absorption lines. Most candidates stated there were only 4 absorption lines.

v. While most candidates stated that the highest level is 0 V, not all candidates included a reason why this is considered.

vi. The general performance was inadequate.

b. i. While most candidates listed the correct equations, many candidates did not obtain the relationship between lambda and kinetic energy/velocity. Many candidates also assumed that the velocity is equal to the speed of light, rather than using the kinetic value given in the question.

ii. Most candidates provided a correct setup.

iii. While most candidates obtained the correct conclusion, marks were lost for the reason given.

iv. The general performance was inadequate. Candidates who showed in their calculations that the value is 3 were given full marks, even if they later stated that there are 7 (considering both sides of the diffraction).

Paper II – Section A

Overview

The overall quality of responses was extremely poor, with most candidates scoring either zero or very low marks in most questions. This trend is evident in the consistently low average scores across the paper. A considerable number of candidates submitted booklets that were nearly blank. Diagrams were generally untidy and difficult to interpret, with many poor attempts to use a ruler for basic tasks such as drawing axes for Cartesian plots.

Question 1

a. Most candidates correctly defined either 'gravitational potential' or 'gravitational potential energy,' but only a few managed to define both terms and correctly distinguish between them.

b. Responses indicate that many candidates were aware that they had to work out the difference between the potential at Earth's surface and that at low Earth orbit. However, most candidates did not work it out correctly due to using the inadequate formula PE = mgh.

c. i. Most candidates correctly defined the escape velocity.
   ii. Most candidates identified the use of the kinetic energy as part of the solution, but they did not equate it correctly to the corresponding change in PE.
   iii. Most candidates who answered part (cii) correctly managed to answer this one as well. There were other candidates who simply knew the escape velocity by heart, without using the previously obtained formula or showing any working.

Question 2

a. i. Around half the candidates identified the latent heat of fusion correctly
   ii. A considerable number of candidates stated the zeroth law of thermodynamics correctly.
   iii. Most candidates managed to answer part of the question correctly. However, only a few candidates managed to identify all heat exchange processes and correctly equate them in accordance with the conservation of energy.

b. i. Most candidates answered this part correctly.
   ii. Most candidates identified the fact that as one variable increases, the other increases as well. However, most of them either did not mention the keyword 'linear' or did not identify the linear nature of the relationship.

Question 3

a. Most candidates depicted the shape of the magnetic field correctly, but only a few captured both the shape and direction of the field correctly. Even fewer candidates correctly identified the opposite relationship between magnetic and geographic poles.

b. i. Most candidates did not answer this question correctly. A considerable number of errors were made in the use of sine and cosine with respect to the angle that they were using.
   ii. Most candidates correctly identified that flux linkage would increase, but only a few identified the change in the angle of the field to be the main contributor.
   iii. Most candidates did not answer this question correctly.

Question 4

a. Only a few candidates explained self-induction correctly, with most of them only explaining induction in general. Most candidates correctly identified the relevant conservation law.

b. i. Most candidates answered this part correctly.
   ii. Most candidates identified the correct formula to be used from the booklet, but they did not substitute the correct values for voltage and current.
   iii. A considerable number of candidates answered this question correctly.
   iv. Only a few candidates identified the correct role of the inductor at this stage.

Question 5

a. A considerable number of candidates showed awareness of the peak and root mean square current but did not implement the working correctly.

b. i. A considerable number of candidates correctly identified the process as rectification. Fewer candidates identified the diode as the semiconductor component. Even fewer candidates provided an explanation of how rectification is achieved.
   ii. Although most candidates identified the use of a combination of diodes, only a select few managed to get the orientation of the diodes correct such that full-wave rectification is achieved.
   iii. Most candidates showed basic knowledge of the role of the capacitor in smoothing the signal, but only a few candidates provided an adequate explanation.

Question 6

a. Most candidates answered this question correctly.

b. Most candidates answered this question correctly.

c. Most candidates identified that reflection would take place due to the angle exceeding the critical angle. However, only a few candidates identified the second condition for internal reflection to take place. A considerable number of candidates identified that the angle of incidence is larger than the critical angle but then proceeded to say that therefore total internal reflection will not take place.

d. Only a few candidates answered this question correctly.

e. i. Around half the candidates correctly identified dispersion.
   ii. Most candidates identified red's longer wavelength, but only a few explained the impact on light's velocity (slowed down less).

Question 7

a. i. Most candidates correctly identified the straight-line relationship, but fewer candidates identified the gradient.
   ii. A considerable number of candidates answered this question correctly.

b. i. Around half of the candidates answered this question correctly.
   ii. Most candidates did not manage to answer this question. They showed poor understanding of the Doppler shift formula.

Question 8

a. Most candidates answered this question correctly.

b. i. Most candidates answered this question correctly.
   ii. Most candidates answered this question correctly.
   iii. Most responses showed poor understanding of the impact of a circular slit.

c. i. Most candidates identified the correct formula to use, but a considerable number confused d and D, and the attempt to identify the number of separations as 4 was poor.
   ii. Most candidates did not answer correctly.
   iii. The general performance was inadequate.

Paper II – Section B

Question 9

a. i. Most candidates answered this question correctly.
   ii. Most candidates answered this question correctly.
   iii. Most candidates answered this question correctly, but there was a significant amount that applied the wrong/inconsistent sign convention when adding the heat supplied and work done.

b. i. Most candidates worked out the values for volume and pressure at A and B correctly. However, most candidates did not manage to calculate these quantities for state C, as they struggled with identifying and correctly using the equations governing an adiabatic process.
   ii. Most candidates exhibited limited knowledge of the second law of thermodynamics, and a considerable number did not explain in the context of a heat engine as requested.
   iii. A lot of candidates used the formula for efficiency of a generic heat engine, rather than that for an ideal one.

Question 10

a. Most candidates answered this question correctly.

b. i. Most candidates answered this question correctly.
   ii. Around half of the candidates answered correctly.
   iii. Around half of the candidates answered correctly.

c. Most candidates either left it out or wrote a completely wrong formula. Others have some correct components (mostly the amplitude), but very few use the correct trigonometric function.

d. Most candidates correctly identified the need to subtract the mass of the toddler from the total mass in order find that of the swing. However, a considerable number of candidates did not work out the total mass correctly.

f. Only a few candidates answered correctly. Most of these performed well throughout the paper.

f. Most candidates identified light damping correctly (i), but the majority mixed up or showed similar graphs for heavy and critical damping.

Question 11

a. i. Most candidates answered this question correctly.
   ii. Most candidates exhibited a decent understanding of heat transfer via convection, but only a few managed to mention all the core aspects of the process.
b. i. Most candidates correctly identified the thermal conductivity and cross-sectional area, but a significant amount did not mention the key aspects 'thermal' and 'cross sectional.'
   ii. Most candidates answered this question partially correct, as most responses did not mention that a constant temperature gradient is achieved.
   iii. Most candidates worked out most of this question correctly, but there were a lot of errors in the final answer due to incorrect subtraction of the temperatures at both ends of a rod, such as using (T-400) instead of (400-T).
   iv. Most candidates answered this question partially correct.
   v. Only a few candidates answered this question correctly.

Question 12

a. Most candidates answered this question correctly.
b. Most candidates answered this question partially correctly, as most simply mentioned distance, instead of the square of the distance.
c. i. Most candidates answered this question correctly.
   ii. Most candidates answered this question correctly.
d. i. Most candidates answered this question correctly.
   ii. Most candidates did not answer this question correctly due to a variety of mistakes, ranging from using incorrect formulas or substituting incorrect values.
   iii. Most candidates did not answer this question correctly due to a variety of mistakes, ranging from using incorrect formulas or substituting incorrect values.

Question 13

a. Most candidates managed to get most of the marks, but only a few included every component correctly within the circuit.
b. Most candidates managed to get some marks, but only a few were able to provide a satisfactory level of detail.
c. i. Most candidates answered this question correctly.
   ii. Whilst most candidates identified the exponential behaviour of Voltage, a considerable number of candidates incorrectly plotted the voltage across the capacitor instead, capturing an asymptotic increase of voltage.
   iii. Only a few candidates answered this question correctly.
   iv. Most candidates answered this question correctly.
   d. Most candidates answered this question correctly.

Question 14

a. i. A lot of responses confused a generator with a motor. Almost all responses did not mention the 'Lorentz force' and referred to this phenomenon as 'catapult force'.
   ii. Most candidates answered this question correctly.
   iii. Almost all candidates were unable to answer this question.
   iv. Most candidates were unable to answer this question. Only a select few provided a satisfactory description, whilst most were only able to identify the 'back e.m.f.' without a proper explanation.

b. i. Most candidates answered this question correctly.
   ii. Only a few candidates answered this question entirely correct, as most of them equated the ratio of the number of turns to the efficiency, rather than the ratio of power input to power output.
   iii. Most candidates managed to mention at least one way of increasing the efficiency of a transformer alongside the correct reason.
   iv. Most candidates identified the stepping up of voltage but the attempt to provide an adequate explanation was poor.

Question 15

a. i. Most candidates answered this question correctly.
   ii. Most candidates correctly plotted a straight horizontal line, but the attempt to identify the y-intercept as R was inadequate.
   iii. Most candidates answered this question correctly.
   iv. Most candidates answered this question partially correctly, but there were a lot of mistakes in the conversion and correct usage of units.

b. i. Most candidates answered this question correctly.
   ii. Most candidates provided nonsensical steps when trying to derive the correct formula because they were provided with the final answer. Only a few were able to derive it correctly.
   iii. A considerable number of responses were incorrect.
   iv. A considerable number of candidates tried to find the velocity of one molecule instead of one mole by using the Boltzmann's constant instead of the ideal gas constant.

c. i. Most candidates answered this question correctly.
   ii. Most candidates answered this question correctly.

Paper III

In the first part of the practical paper, candidates investigated the properties of a convex lens using an optical bench setup consisting of a light source, mesh object, convex lens, concave lens, screen, and measuring rulers. Candidates were first required to set up the system and form a real, sharp image of the mesh on the screen using only the convex lens, then to describe the qualitative properties of the resulting image. They then examined the two distinct lens positions that produce a sharp image for a fixed object–screen distance, applying the thin lens formula to explain why these positions exist.

Next, candidates devised and carried out an experiment to determine the minimum object–screen distance below which no sharp image can form. This distance was then used to obtain a first approximation of the focal length of the convex lens.

Candidates then measured the width of ten grid squares on the object and, for six object distances between 21 cm and 31 cm, measured the corresponding image widths on the screen. They calculated the magnification for each setting and plotted a graph of 1/m against object distance. By linearising the lens equation, they determined the focal length of the convex lens from the graph. Candidates who followed the procedure carefully and plotted their graphs accurately generally performed very well on this part of the experiment.

In the second part of the practical, candidates investigated the effective focal length of a convex–concave lens combination and used this to determine the focal length of a concave lens.

The convex lens was fixed at a set distance from the object, and the screen position was adjusted to form a sharp image. The concave lens was then introduced between the convex lens and the screen, and the distance between the lenses was varied systematically. For each lens separation, candidates measured the new object–screen distance to determine the effective focal length of the lens pair.

Using the relationship between the inverse of the effective focal length and the separation between the lenses, candidates plotted a straight-line graph, from which they determined the focal length of the concave lens. This section tested candidates' ability to perform careful measurements, organise data clearly in tables, apply the correct formulae, and interpret graphical results accurately.

The mean total mark obtained was approximately 54 marks out of 80, with the middle 50% of candidates scoring between 49 and 58 marks. A substantial proportion of candidates achieved marks above 58, while only a small number scored below 32, indicating that the majority demonstrated a satisfactory to good level of competence across both parts of the practical examination.

Part A

A small number of candidates struggled to state the thin-lens equation correctly and to explain how it leads to two distinct lens positions.

Surprisingly, many candidates were unable to describe a straightforward investigation clearly and in a logical, step-by-step manner, despite knowing what was required.

A few candidates incorrectly wrote the relationship between magnification, object distance, and focal length in linear form.

Part B

A small number of candidates did not follow the correct experimental procedure.

Despite this being clearly stated in the paper, some candidates produced a graph with a negative gradient.

Some candidates were unable to determine the focal length of the concave lens because they could not rearrange the expression for the effective focal length of the two-lens system into a linear form or did not recognize how to do so.

Many candidates were unable to identify a valid source of error and propose an appropriate precaution.

The data suggests that most candidates were well prepared for lens experiments, which rely on systematic measurement, graphical analysis, and correct use of formulae.

Chairperson
Examination Panel 2025