L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

INTERMEDIATE MATRICULATION LEVEL
2026 FIRST SESSION

SUBJECT:	**Physics**
DATE:	16th May 2026
TIME:	4:00 p.m. to 7:05 p.m.

A list of useful formula end equations is provided. Take the acceleration due to gravity g=9.81 ms^{-2} unless otherwise stated.

SECTION A

Attempt ALL 8 questions in this section. This section carries 50% of the total marks for this paper.

1. a) Determine if the equation of pressure $Pressure = \frac{Force}{Area}$ is homogeneous by using base units. (2)
   b) Distinguish between the concepts of physically correct and homogenous equations and give **ONE** example of a homogenous equation that is not physically correct. (2)

   (Total: 4 marks)

2. Two bodies, A and B, oscillate with linear simple harmonic motion. The equation defining linear simple harmonic motion is $a = -(constant)\,x$, where a is the acceleration and x is the displacement.
   a) Define simple harmonic motion. (1)
   b) The constant in A is six times larger than the constant in B. Describe the difference in the simple harmonic motion of both bodies. (2)

   (Total: 3 marks)

3. a) Define vector and scalar quantities, giving **ONE** example of each. (2)
   b) An object of mass 7 kg is placed at rest on a horizontal plane which is inclined at an angle of elevation of 20° with the horizontal. Resolve the weight force into two perpendicular components: one along the plane's incline and the other perpendicular to it. (2)

   (Total: 4 marks)

4. a) Define linear momentum. (1)
   b) State Newton's 2nd law in terms of momentum, stating the relevant equation and defining the variables used. (2)

   A tennis ball hits a racket twice, with a change in momentum of 0.3 kgm/s both times. During the first hit, the ball hits the racket on the net, and the contact time is 1.8 s. During the second hit, the ball hits the racket on its hard edge, and the contact time is 0.15 s.

   c) By calculating both forces, determine which strike of the tennis racket experiences the greatest force from the tennis ball. (2)
   d) Discuss how changing the time of impact affects the force of impact. (2)

   (Total: 7 marks)

Please turn the page.

5. An empty container of mass 6 kg is placed on a flat surface at rest. The area of contact with the surface is 400 cm^2.
   a) Define pressure. (1)
   b) Calculate the pressure exerted on the flat surface by the empty container in Nm^{-2}. (2)
   c) Predict the change in pressure exerted on the flat surface, if the container is filled up with water. Explain. (2)

(Total: 5 marks)

6. Consider the following circuit. Bulbs A and B are identical, having a resistance of 10 Ω each. The ammeter is an ideal ammeter, and the battery has no internal resistance.

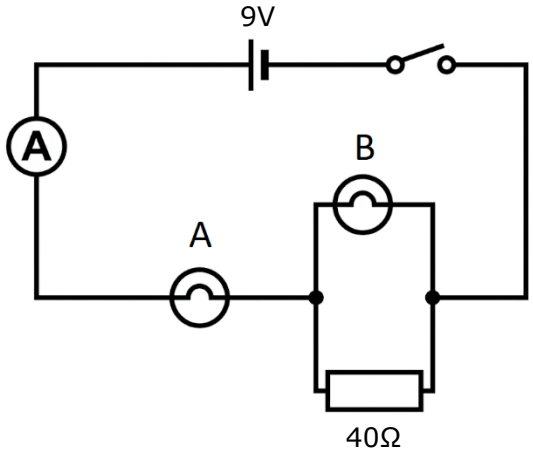

Figure 1

   a) Distinguish between the direction of conventional current and the direction of motion of the charge carriers. (2)
   b) When the switch is closed, both bulbs A and B emit light immediately. Explain how the drift speed arises. (2)
   c) Calculate the current read by the ammeter when the switch is closed. (1)
   d) Calculate the p.d. across bulbs A and B. (2)
   e) Calculate the current flowing through bulb B. (1)
   f) If the ideal ammeter is replaced by a non-ideal ammeter, the value is changed to 0.47 A. Calculate the internal resistance of the non-ideal ammeter. (2)

(Total: 10 marks)

7. A light ray strikes a boundary between air and polystyrene at an angle of 50.0 ° with the normal. The refracted ray is transmitted into polystyrene and makes an angle of 31.0 ° with the normal.
   a) Distinguish between reflection and refraction of light. (2)
   b) Air is a transparent medium. Define the terms transparent and opaque. (2)
   c) Calculate the angle of deviation. (1)
   d) Determine the speed of light in polystyrene. (2)

(Total: 7 marks)

8. Consider the following diagram. OA, OB and OC are three current carrying conductors, lying in a magnetic field of flux density 0.22 T of lengths 0.15 m, 0.25 m and 0.29 m respectively. The current in all three conductors is 3 A.

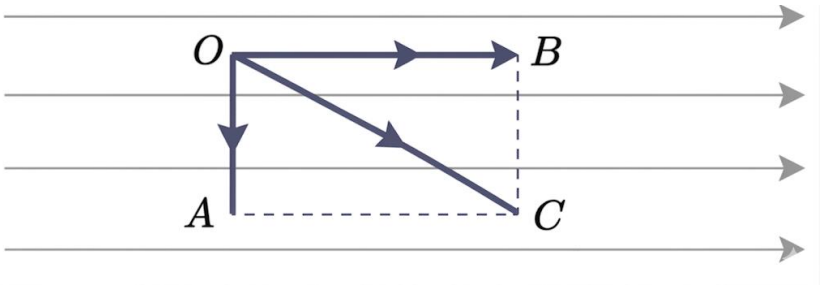

Figure 2

a) Define tesla. (1)

b) Calculate the size and direction of the magnetic force acting on:

i. OA; (2)

ii. OB; (1)

iii. OC. (2)

c) Derive the equation $F = Bqv \sin\theta$ where *F* is the force acting on a single charge, *B* is the magnetic flux density, *q* is the electric charge, *v* is the speed of the charge, and θ is the angle between the vector and the field. (2)

d) Calculate the force on an electron moving with a velocity of $1.2 \times 10^5\ \mathrm{m\,s^{-1}}$ at right angles to a uniform magnetic field of flux density 20 mT. (Charge of an electron is 1.6×10^{-19} C). (2)

(Total: 10 marks)

Please turn the page.

SECTION B

This question carries 14% of the total mark of this paper and must be attempted.

9. A student was using the following setup (Figure 3) to investigate how the extension of two different springs of different stiffness constant, S_1 and S_2, changes when different loads were applied. The original length of both springs is 10 cm.

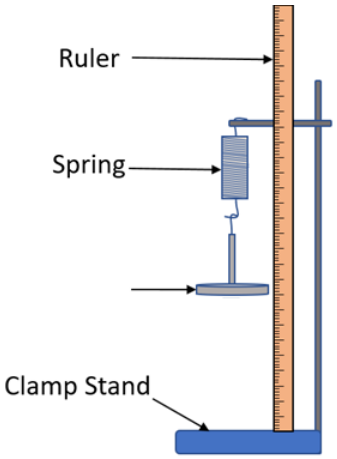

Figure 3

Adapted from www.keystagewiki.com

Load (g)	Force (N)	Total length S_1 (cm)	Extension S_1 (cm)	Total length S_2 (cm)	Extension S_2 (cm)
0	0	0.0	0.0	0.0	0.0
100	1	11.5	1.5	10.7	0.7
200	2	12.9		11.3	
300	3	14.4		12.0	
400	4	16.0		12.8	
500	5	17.4		13.5	

Table 1

a) Define stiffness constant. (1)

b) Copy and complete the empty cells in Table 1. (2)

c) Plot a graph of Force (N) on the y-axis against Extension S_1 (cm) on the x-axis. Label the graph "Spring S_1". (4)

d) On the same axes, plot the Force-Extension graph for spring S_2. Label the graph "Spring S_2". (2)

e) Using the graph/s:

i. Determine which spring is the stiffest. Explain. (2)

ii. Calculate the work done in stretching spring S_2. (3)

(Total: 14 marks)

SECTION C

Answer any TWO questions from this section. Each question carries 18 marks. This section carries 36% of the total mark for this paper.

10. In a Fun Fair, coloured balls are shot vertically upwards. Each ball is observed falling freely until it reaches terminal velocity before it hits the ground.
    a) State what is meant by terminal velocity. (1)
    b) Describe an experiment to measure the acceleration of free fall. Your answer should include:
        i. a labelled diagram of the setup used; (2)
        ii. an outline of the procedure followed; (2)
        iii. **ONE** precaution that should be taken; (1)
        iv. the readings that should be taken and how the acceleration of free fall can be determined from a graph. (3)
    c) The coloured balls were being shot with a speed of 18.7 ms^{-1}. Calculate the time it takes for one ball to reach the highest point before it starts falling back down. (3)
    d) Draw a velocity-time graph to represent the motion of a coloured ball from the moment it reached the highest point up to before it hits the ground. (2)

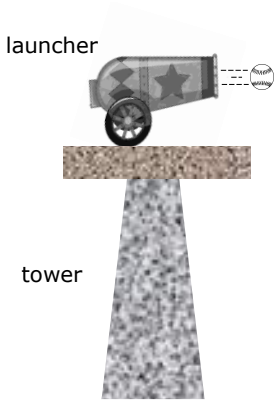

Figure 4

In another part of the Fun Fair, a number of soft balls were being launched at different times for young children to catch. The launcher was hidden on the top part of a tower, 3.2 m high, as shown in Figure 4. Soft balls were being launched horizontally with a speed of 6.4 m s^{-1}.

e) Calculate the horizontal distance, away from the tower, travelled by the soft ball before it hits the ground. (4)

(Total: 18 marks)

11. A technician in a science laboratory wanted to confirm whether a simple liquid-in-glass thermometer measures temperature accurately. This thermometer has a particular thermometric property to be able to measure temperature.

    a) Define thermometric property. (2)
    b) State **TWO** other examples of thermometric properties that can be used to measure temperature. (2)

    To calibrate the thermometer, the technician places it in two temperature fixed points - melting ice and boiling water.

    c) Explain what is meant by a temperature fixed point. (1)
    d) The technician found that when the thermometer was placed in melting ice, the length of the liquid column in the thermometer was 2.2 cm, and when placed in boiling water, the length was 23.4 cm. Calculate the actual temperature of a solution when the liquid column in the thermometer has a length of 9.7 cm. (3)
    e) Using thermometers with different thermometric properties may lead to obtaining different temperatures. Explain. (1)

Question continues on the next page.

The thermometer was used to determine the specific latent heat of vaporisation of a liquid.

f) Define specific latent heat of vaporisation. (2)
g) Outline the procedure which should be followed in an experiment to determine the specific latent heat of vaporisation of a liquid. (3)
h) Explain how the procedure outlined in part (g) should take into account conservation of energy. (2)
i) An unknown amount of water was boiled in a kettle. If 4.48 MJ of energy were used and the specific latent heat of vaporisation of water is 2.25×10^6 J/kg, calculate the mass of water which was converted into steam. (2)

(Total: 18 marks)

12. Touchscreens are now widely used in many modern devices. Their operation relies on the fact that when a finger approaches or touches the screen (Figure 5), it causes a change in capacitance at that specific location. The touchscreen controller identifies where the change has occurred, and registers this as a touch input.

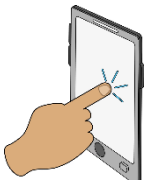

Figure 5

a) Define capacitance of a capacitor. (1)
b) Sketch a labelled diagram of the basic structure of a parallel plate capacitor. (2)
c) A parallel-plate capacitor has square plates of side 12 cm, separated by 4.0 mm. The space between the plates is completely filled with a dielectric of relative permittivity $\varepsilon_r = 5.0$. Calculate the capacitance of the capacitor. ($\varepsilon_0 = 8.85 \times 10^{-12}$ F/m). (3)
d) The capacitor is connected to a 9.0 V supply. Calculate the charge stored on the capacitor. (2)
e) The dielectric is removed while the capacitor remains connected to the supply. Determine the value of the charge which is now stored in the capacitor. (2)
f) Explain why the charge changes when the dielectric is removed. (2)

A capacitor C, of capacitance 220 μF, is connected in series with a 47 kΩ resistor and a DC supply. The capacitor is initially uncharged.

g) Calculate the time constant of the circuit. (2)
h) Figure 6 shows the graph obtained when capacitor C was charged. State the voltage across the capacitor after one time constant. (1)

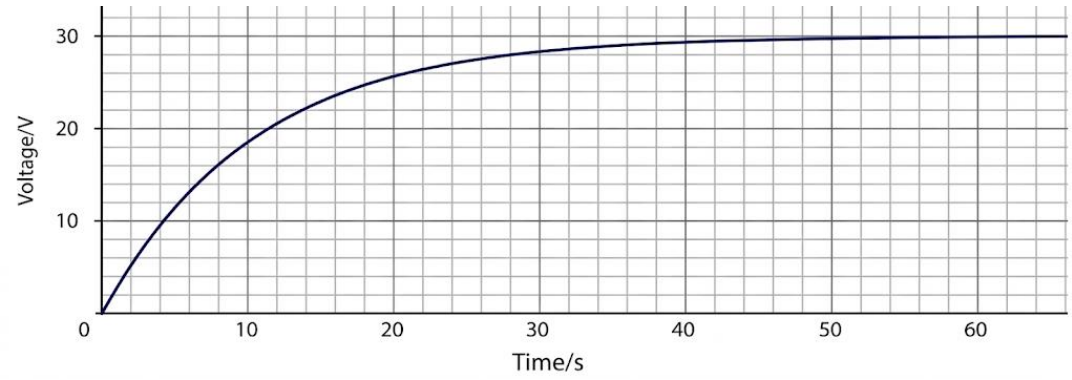

Figure 6

i) Sketch and label the corresponding graph of charge in capacitor C against time while it was being charged. Include the maximum value of charge in the sketch. (3)

(Total: 18 marks)

13. Radioactive elements are elements whose nuclei are unstable, and their radioactive decay process involves spontaneous emission of radiation such as alpha, beta, or gamma rays as they decay into more stable nuclei.

    a) State the law of radioactive decay. (2)
    b) Describe the alpha, beta and gamma decay processes. (3)

    Strontium ($^{90}_{38}\mathrm{Sr}$) and radium ($^{226}_{88}\mathrm{Ra}$) are two important radioactive. Strontium is valuable in medical imaging, while radium played a historic role in early cancer treatment.

    c) Write down nuclear equations to represent the following decay processes of strontium and radium.
        i. Strontium-90 emits a beta particle and becomes yttrium (Y). (1)
        ii. Radium-226 emits an alpha particle and becomes radon (Rn). (1)
    d) Another useful radioactive element is carbon-14 which is used in radioactive dating. The half-life of carbon-14 is 5700 years.
        i. A wooden tool was discovered while excavating an archaeological site. When tested only 12.5% of the original carbon was found. How old is the tool? (2)
        ii. Calculate the number of radioactive nuclei present in the excavated wooden tool if the activity of the carbon-14 is 0.55 Bq. (3)
        iii. The calculated number of radioactive nuclei present in a sample may be inaccurate when compared to the actual number. Explain. (2)
    e) Uranium, which is another radioactive element, is widely used in generating electrical energy using nuclear fission of uranium in nuclear power stations.
        i. Describe the fission of uranium. (2)
        ii. The process mentioned above produces carbon-free electrical energy which has various positive implications. However, there are also negative implications. Give **TWO** disadvantages of using uranium to generate electrical energy. (2)

(Total: 18 marks)