TEST CODE **02138010**

FORM TP 2005258

MAY/JUNE 2005

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

PHYSICS

UNIT 01 – Paper 01

1 hour 45 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of **NINE** questions. Candidates must attempt **ALL** questions.
2. Candidates **MUST** write in this answer booklet and all working **MUST** be **CLEARLY** shown.
3. The use of non-programmable calculators is permitted.

1. (a) State Newton's THREE laws of motion.

(i) _____

_____

_____

(ii) _____

_____

_____

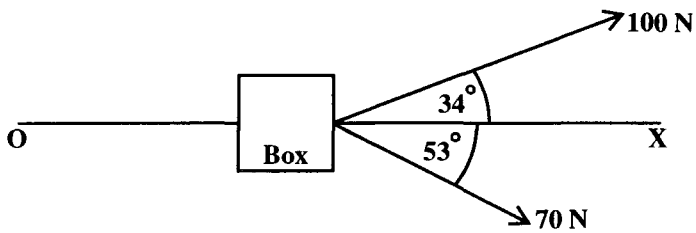
(iii) _____

_____

_____

[3 marks]

(b) The diagram represents a box with a mass of 80 kg being dragged along a rough surface in the direction **OX**.



(i) Find the component of force the 100 N force in the direction **OX**.

_____

[1 mark]

(ii) What is the component of the 70 N force in the direction **OX**?

_____

[1 mark]

(iii) The frictional resistance force to the motion is 30 N. What is the acceleration of the box?

[4 marks]

(iv) Explain why there is no motion along the surface in the direction perpendicular to **OX**.

_____

_____

[1 mark]

Total 10 marks

2. (a) Most countries in the Caribbean have a policy of substituting the use of fossil fuels by the use of alternative or non-traditional sources of energy. In your opinion what are the TWO sources MOST likely to be used in your country? Give ONE reason for EACH of your choices.

_____

_____

_____

_____

_____

_____

[4 marks]

(b) Scientists in the Caribbean estimate that the average family uses unnecessarily up to 20% of the energy it pays for. Briefly describe TWO ways, apart from the obvious switching off of equipment not in use, in which some of the wastage could be avoided.

_____

_____

_____

_____

_____

_____

_____

[2 marks]

(c) In the Caribbean on an average day the solar power received is about 300 W for each square metre of land. An engineer proposes to use photovoltaic cells to supply 25 MW of electricity.

The efficiency of the cells is 15%. What area of land would be required for the proposed 25 MW power station?

[4 marks]

Total 10 marks

3. A ball is projected vertically upwards and reaches a maximum height in a time of 2.0 s before falling back to the point where it was launched.

(a) On the axes in Figure I sketch graphs of displacement, velocity and acceleration against time for this motion, assuming air resistance is negligible.

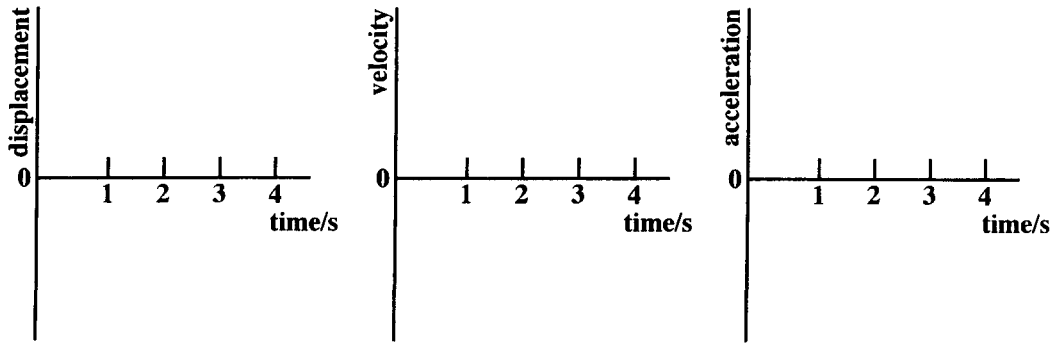


Figure I

[3 marks]

(b) What was the vertical velocity of the ball when it returned to its starting point?

[3 marks]

(c) Find the velocity of the ball after 3 s.

[2 marks]

(d) In practice air resistance may have a significant effect on the ball's motion. Describe how the acceleration of the ball would change during the motion if air resistance is taken into account.

_____

_____

_____

_____

[2 marks]

Total 10 marks

4. A student is provided with TWO identical springs which obey Hooke's Law, $F = kx$. (F is the force extending the spring, x is the extension caused and k is a constant.)

(a) The student hangs a mass of 0.40 kg on one of the springs and it extends by 12.5 cm.

(i) Find the value of the force constant k of this spring.

[1 mark]

(ii) The student then pulls down the mass and makes it oscillate. What will be its period?

[3 marks]

(b) The student then repeats the procedure, first using the TWO springs side by side (in parallel) and then with the TWO springs in series as shown in Figure II.

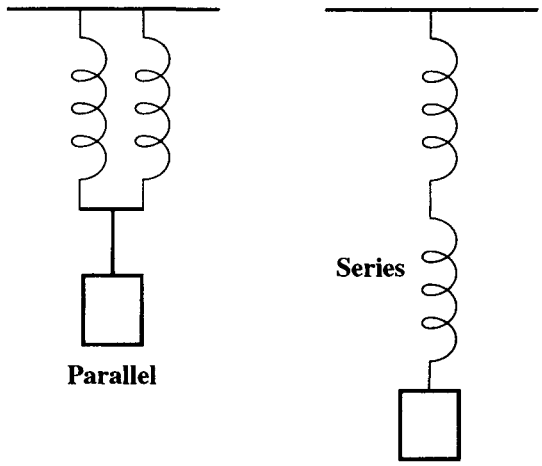


Figure II

Complete the Table 1 below to show the values you would expect her to obtain for the extension (x), period (T) and force constant (k) for the TWO systems. Show any necessary working in the space below the table.

Table 1

	x/cm	k/N m^{-1}	T/S
Parallel			
Series			

[6 marks]

Total 10 marks

5. The diagram in Figure III represents the passage of light through a semi-circular perspex block.

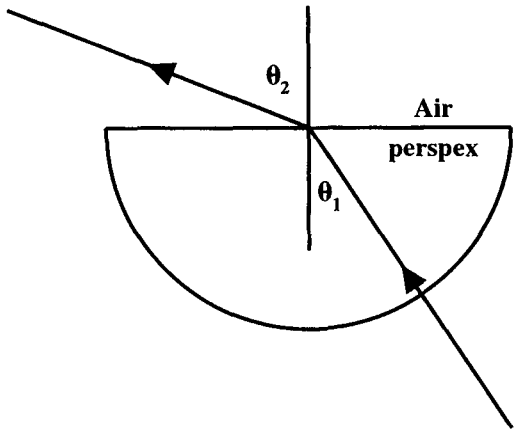


Figure III

(a) (i) Explain why the light is NOT deviated as it passes through the circular surface.

_____

_____

_____

_____

[1 mark]

(ii) With reference to the angles marked on the diagram explain what is meant by the term **'critical angle'**.

_____

_____

_____

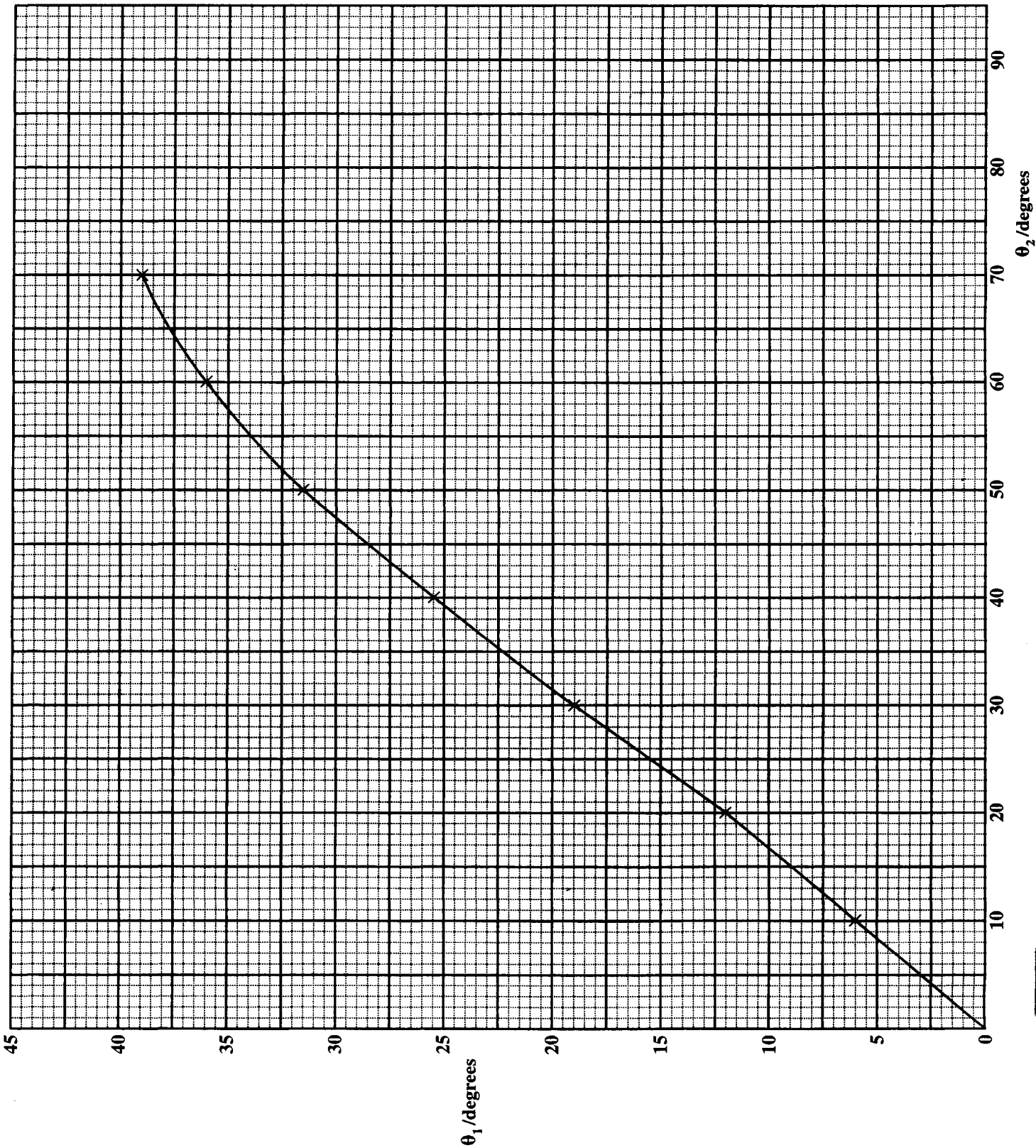
_____

_____

_____

[2 marks]

The following graph refers to question 5 (b)



(b) The graph on page 10 shows how the angle θ_2 varies with the angle of incidence θ_1.

(i) By extrapolating the graph, find the (approximate) value of the critical angle.

_____

[1 mark]

(ii) Use the value found in (b) (i) to find the refractive index of the perspex.

_____

_____

_____

[2 marks]

(c) Read off the value of the angle of refraction when the angle of incidence is 45° and use this to find the value for the refractive index of the perspex. **[3 marks]**

(d) Draw rays on Figure III to show what happens when the angle θ_1 equals 60°.

[1 mark]

Total 10 marks

6. A middle-aged man has an eye defect. He cannot focus clearly on objects less than 80 cm from his eyes.

(a) What is the name of this eye defect?

_____

[1 mark]

(b) Add a suitable lens to Figure IV and draw rays to show how the defect may be over-come.

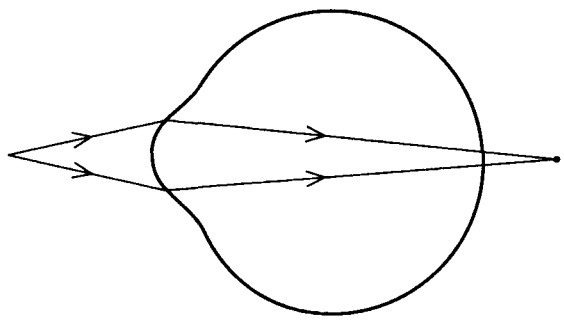


Figure IV

[2 marks]

(c) What would be the focal length and power (in diopters) of the lenses needed if the man is enabled to read comfortably a book held 25 cm from his eyes?

[4 marks]

(d) Draw a ray diagram (not to scale) to show where the image in one of the correcting lenses would be formed for an object 80 cm away. Hence explain why the gentleman takes off his glasses when NOT reading.

[3 marks]

Total 10 marks

7. (a) The graph in Figure V shows the extension caused by different loads hung from a uniform wire 2.0 m long and 0.43 mm in diameter.

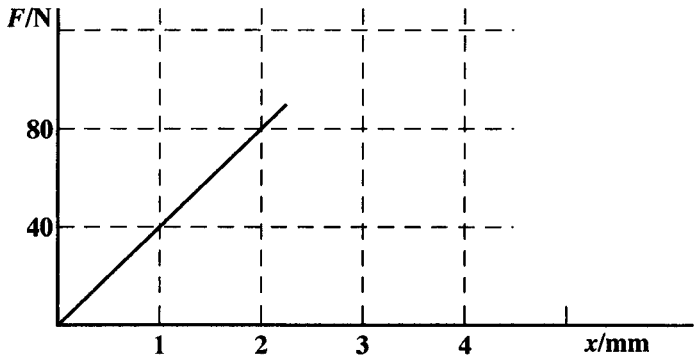


Figure V

(i) Extend the graph to show the effect of loading the wire beyond its elastic limit. **[1 mark]**

(ii) Show on the graph how the work done in stretching it 1.5 mm can be represented. **[1 mark]**

(iii) Calculate the work done in stretching the wire 1.5 mm

[2 marks]

(iv) Find the Young Modulus of the wire under test.

[4 marks]

GO ON TO THE NEXT PAGE

(b) On the axes shown in Figure VI sketch the graphs you would expect to obtain when stretching a strip of rubber or stretching a glass fibre up to their breaking point.

Rubber **Glass**

Figure VI

[2 marks]

Total 10 marks

8. (a) In what form is the energy transmitted when heat is transferred by radiation and how does the receiving object get hot?

_____

_____

_____

_____

_____

[2 marks]

(b) Write an equation for Stefan's law of blackbody radiation and explain CAREFULLY the meaning of EACH term.

_____

_____

_____

_____

[3 marks]

(c) A blackened sphere of radius 15 cm and initially at 30°C is suspended inside an oven which is held at a constant temperature of 120°C.

(i) What is the rate of energy absorption by the sphere from the oven?

_____

_____

_____

[2 marks]

(ii) What, initially, is the **net** rate of energy absorption of the sphere?

_____

_____

_____

_____

[2 marks]

(iii) What is the condition for the sphere's temperature to stop rising and remain constant at 120°C?

_____

_____

(Surface area of a sphere = $4\pi r^2$)

[1 mark]

Total 10 marks

9. (a) An ideal gas initially with a volume of 2.0 m^3 at a pressure of 1.0 x 10^5 Pa is taken through a cycle as described by the graph in Figure VII.

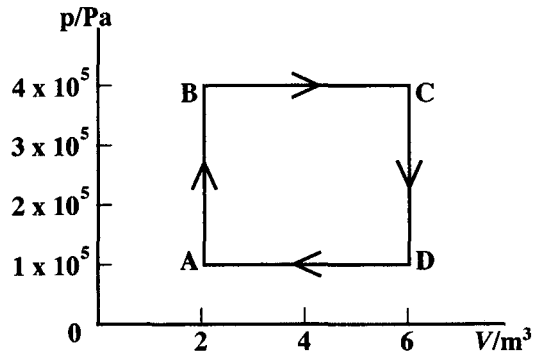


Figure VII

(i) Complete the second column of Table 2 with a brief description of the process occurring in the four parts of the cycle. **[4 marks]**

(ii) In the third column of Table 2 insert the amount of work done ON the gas in EACH stage. **[3 marks]**

Table 2

Section	Description	Work done/J
AB		
BC		
CD		
DE		

(iii) By means of shading show on Figure VII the net work done per cycle for this process. **[1 mark]**

(iv) The 1st law of thermodynamics can be written in the form: $\Delta U = Q + W$
What are the values of ΔU and Q for a whole cycle in Figure VII, starting from A and ending at A.

_____

_____

_____

[2 marks]

Total 10 marks

END OF TEST