TEST CODE **01238020**

FORM TP 2009104

MAY/JUNE 2009

CARIBBEAN EXAMINATIONS COUNCIL

SECONDARY EDUCATION CERTIFICATE EXAMINATION

PHYSICS

Paper 02 – General Proficiency

$2\frac{1}{2}$ hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of **SIX** questions.
2. Section A consists of **THREE** questions. Candidates must answer **ALL** questions in this section. Answers for this section must be written in this answer booklet.
3. Section B consists of **THREE** questions. Candidates must answer **ALL** questions in this section. Answers for this section must be written in the space provided after EACH question in this answer booklet.
4. All working **MUST** be **CLEARLY** shown.
5. The use of non-programmable calculators is permitted, but candidates should note that the use of an inappropriate number of figures in answers will be penalised.
6. Mathematical tables are provided.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

SECTION A

Answer ALL questions.
You MUST write your answers in the spaces provided in this booklet.

1. In determining the half-life of an alpha-emitting radioactive source, a student recorded the following data in Table 1.

TABLE 1

Time, t/s	Count rate, R/s^{-1}
0	100
50	76
100	62
150	47
200	37
250	29

(a) Plot on page 3, a graph of count rate (R) versus time (t). **(7 marks)**

(b) What is meant by the 'half-life' of a radioactive sample?

_____

_____

(1 mark)

(c) Describe the procedure a student would use to obtain the results in Table 1. State ONE precaution.

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_____

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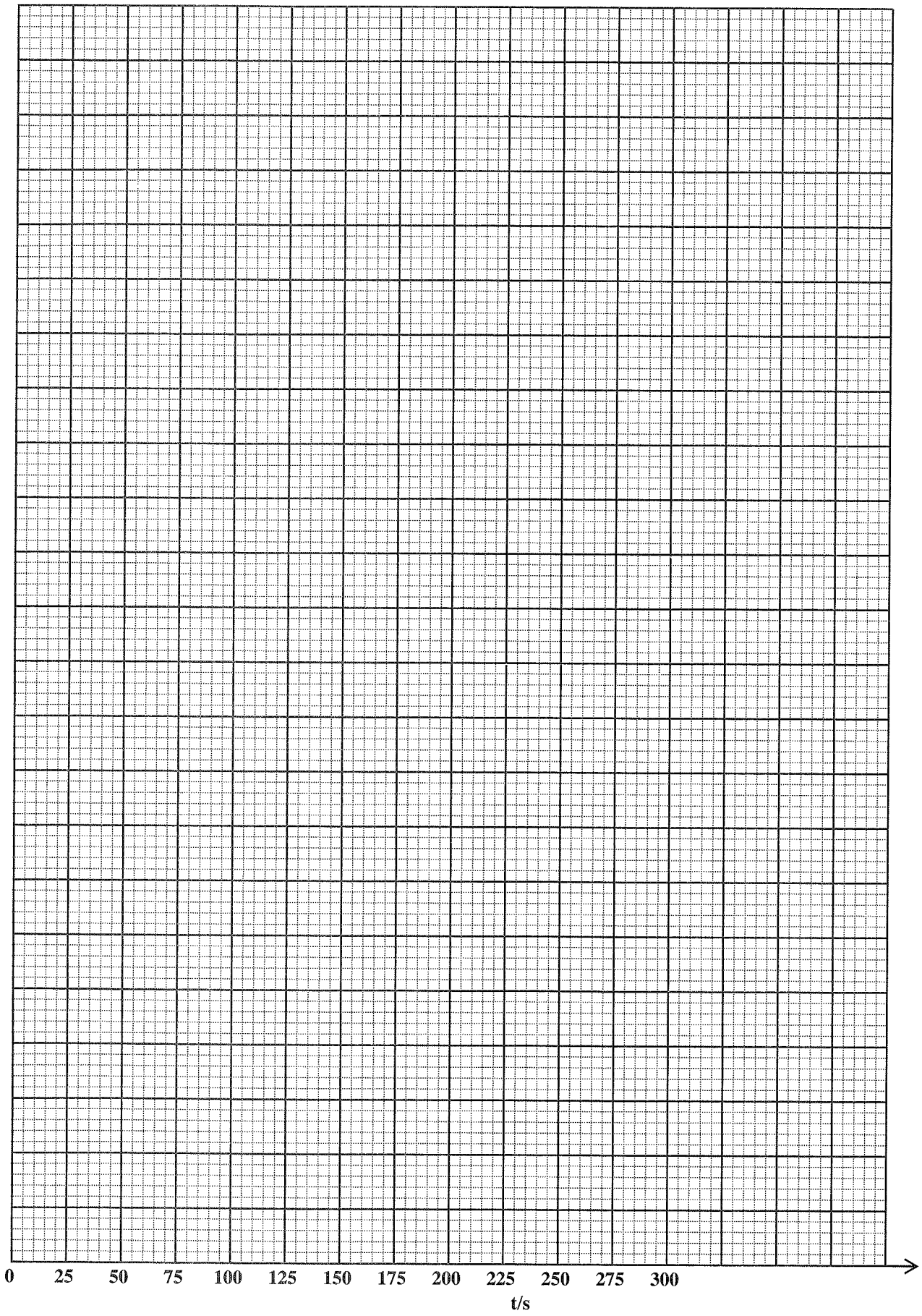
(3 marks)


0
25
50
75
100
125
150
175
200
225
250
275
300
t/s

(d) (i) From the graph, make TWO calculations of the half-life of the sample.

(6 marks)

(ii) From your results in (d) (i), calculate the mean (average) half-life.

(2 marks)

(e) Estimate the count rate of the sample after

(i) 425 s

(ii) 4 half-life periods.

(6 marks)

Total 25 marks

2. (a) (i) Give the difference between a 'vector quantity' and a 'scalar quantity'.

_____

_____

(1 mark)

(ii) Complete Table 2 by writing EACH of the physical quantities from the list below in the appropriate column:

Mass, Momentum, Displacement, Heat Capacity, Temperature, Half-Life, Upthrust.

TABLE 2

Vector	Scalar
	Mass

(6 marks)

(b) A taxi reaches a traffic police officer while travelling at 30 m s^{-1} on the highway. The officer immediately signals the taxi which decelerates uniformly and comes to a complete stop in 5 s. (Assume zero reaction time.)

(i) In the space below, draw a velocity-time graph to represent the motion of the taxi from the moment the officer signals, to when the taxi comes to a stop.

(2 marks)

(ii) Determine the distance travelled by the taxi from the time the police signals until the taxi stops.

(3 marks)

(iii) If the speed limit is 80 km h^{-1}, determine whether or not the driver should receive a speeding ticket.

(3 marks)

Total 15 marks

3. (a) When travelling along a hot road on a hot day a traveller may see a distant object with its image directly below it as shown in Figure 1. The image is called a mirage. Three light rays on the diagram are labelled A, B and C.

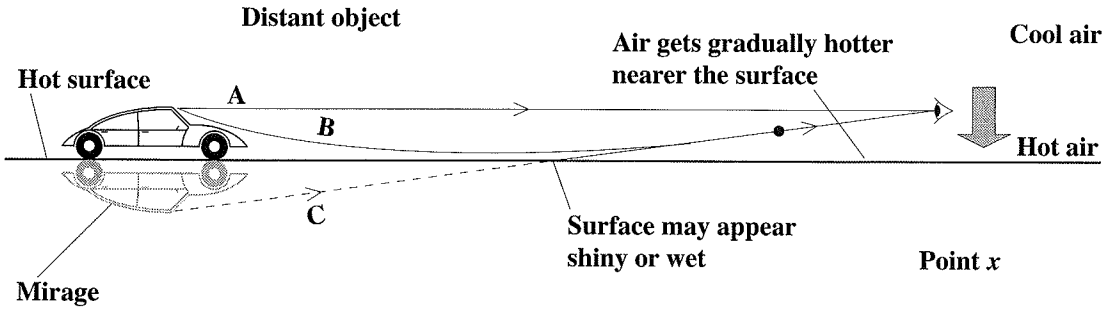


Figure 1

(i) Why does Ray A travel in a straight line from the object to the observer?

_____

_____

_____

(1 mark)

(ii) What is the name given to the bending of Ray B as it approaches the hot surface?

_____

(1 mark)

(iii) With reference to the normal, the temperature and the density of the air, explain the direction of the bending of Ray B at Point *x*.

_____

_____

_____

_____

(2 marks)

(iv) The mirage is a virtual image. With reference to Rays B and C, explain how the mirage is formed and why it is described as a virtual image.

_____

_____

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(2 marks)

(b) Ultrasounds may be used in determining the growth of a baby in its mother's womb. Sound pulses are directed towards the baby's skull and reflected pulses (echoes) from the front and back of the baby's skull are detected and displayed on an oscilliscope screen, as shown in Figure 2.

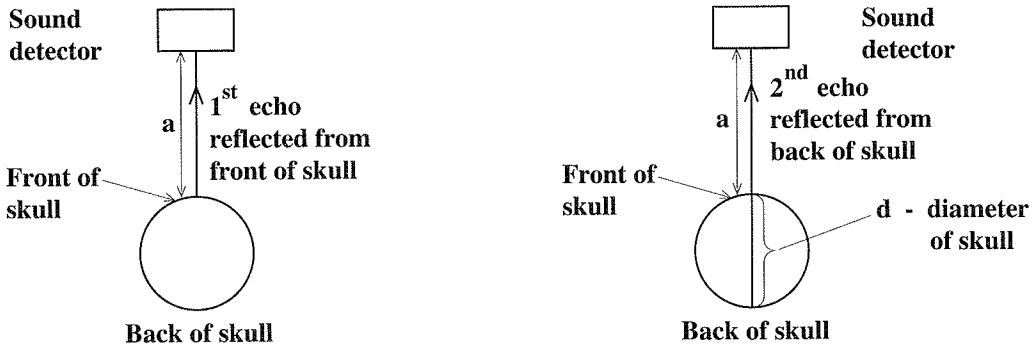

Figure 2

(i) In terms of the distances a and d, write an expression for

a) the distance travelled by the sound pulse after reflection from the front of the skull to the sound detector

_____

(1 mark)

b) the distance travelled by the sound pulse after reflection from the back of the skull to the sound detector.

_____

(1 mark)

(ii) The oscilliscope screen shows that the time between the first and the second echo is 0.11 ms. The speed of the sound pulses is 1200 m s^{-1}.

Determine

a) the difference in distance travelled between the first and the second echo

(2 marks)

b) the diameter, d, of the baby's skull.

(1 mark)

(c) Figure 3 shows how a human eye focuses to see an object O. C represents the optical centre of the lens in the eye.

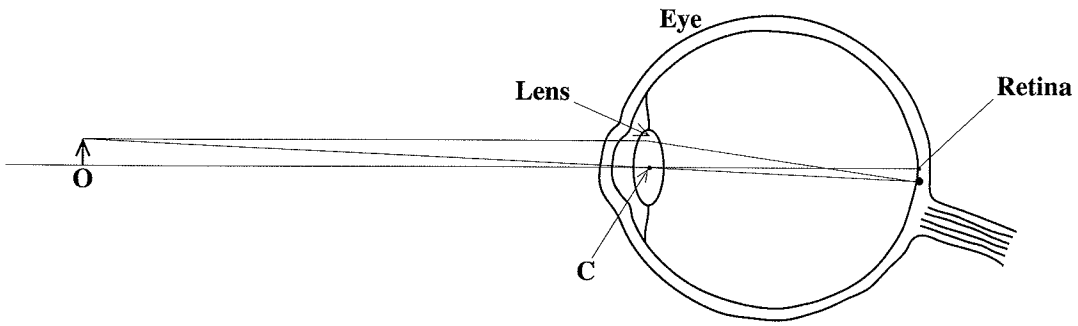

Figure 3

(i) The object O is 100 m from the centre of the eye lens and the magnification of the eye lens is 0.005.

Determine the distance of the retina from the centre of the eye lens.

(3 marks)

(ii) Write a formula for calculating the magnification of the eye lens using the object height and the image height

_____

_____

(1 mark)

Total 15 marks

GO ON TO THE NEXT PAGE

SECTION B

Answer ALL questions.

You MUST write your answers in the space provided after each question.

4. (a) (i) State the law of the conservation of energy.

(ii) What is the difference between 'potential energy' and 'kinetic energy'?

(iii) Does the fact that heat is lost when work is done against friction violate the law of conservation of energy? Justify your answer.

(6 marks)

(b) The three-week-long cycling race, the Tour de France, is said to be one of the most gruelling sporting events in the world.

(i) If a cyclist of mass 70 kg uses a bicycle of mass 7 kg, how much work must the cyclist do against gravity in order to ascend to 2100 m from sea level (0 m)?

(ii) One particular descent goes from 2100 m to 1600 m. Assuming the work done against friction is 90% of the potential energy change of the cyclist and the cycle, what INCREASE in speed in km/h can a rider attain by the end of the descent?

(iii) What is the average rate of energy conversion of the cyclist and cycle if the descent in part (ii) takes 1 minute at constant speed?

(Acceleration due to gravity, g = 10 m s^{-2}) **(9 marks)**

Total 15 marks

Write the answer to Question 4 here.

5. Magnets are characterized by magnetic field lines.

(a) Sketch the magnetic field associated with (i) a single bar magnet and (ii) between two strong bar magnets with their north poles facing, and in line with, each other. **(4 marks)**

(b) An emergency flashlight is an essential item during hurricanes and blackouts. One model has a crank handle connected to an alternating current generator, rechargeable batteries and light emitting diodes (LEDs) as shown in Figure 4. When the handle is turned, a permanent magnet also turns in the presence of a stationary coil. This produces a current which charges the batteries.

Figure 4

(i) How is the electromotive force (e.m.f.) generated in the stationary coil?

(ii) What ADDITIONAL component is needed to be able to charge the batteries?

(iii) At a reasonable cranking rate, the unit generates 6.2 V. Calculate the current in the circuit if the resistance is 310 Ω.

(5 marks)

(c) A similar device includes a transformer so that an MP3 player can also be charged. The primary coil has 300 turns.

(i) How many turns are needed in the secondary winding if the voltage is stepped up from 6.2 V to 15.5 V?

(ii) Given that the current in the primary winding is 10 mA, what power is transmitted to the secondary windings if the transformer is 77% efficient?

(6 marks)

Total 15 marks

Write the answer to Question 5 here.

6. (a) You are given a container of negligible heat capacity and a thermometer.

Describe how the specific latent heat of fusion of ice can be determined using the method of mixtures. **(6 marks)**

(b) A physics student was provided with 25 g of ice to convert to steam. How much heat is needed to change this 25 g of ice at 0° C to steam at 100° C? **(9 marks)**

(Specific heat capacity of ice = 2×10^3 $Jkg^{-1}K^{-1}$)
(Specific heat capacity of water = 4.2×10^3 $Jkg^{-1}K^{-1}$)
(Specific latent heat of vaporisation of water = 2.3×10^6 Jkg^{-1})
(Specific latent heat of fusion of ice = 3.4×10^5 Jkg^{-1})

Total 15 marks

Write the answer to Question 6 here.

END OF TEST