C A R I B B E A N E X A M I N A T I O N S C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

PHYSICS

UNIT 1 – Paper 02

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions in TWO sections. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. ALL WORKING MUST BE SHOWN in this booklet.
5. You may use a silent, non-programmable calculator to answer questions, but you should note that the use of an inappropriate number of figures in answers will be penalized.
6. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
7. **If you use the extra page(s) you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

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

LIST OF PHYSICAL CONSTANTS

Universal gravitational constant	G	=	6.67×10^{-11} N m^2 kg^{-2}
Acceleration due to gravity	g	=	9.81 m s^{-2}
1 Atmosphere	atm	=	1.00×10^5 N m^{-2}
Boltzmann's constant	k	=	1.38×10^{-23} J K^{-1}
Density of water	ρ_w	=	1.00×10^3 kg m^{-3}
Specific heat capacity of water	C_w	=	4200 J kg^{-1} K^{-1}
Specific latent heat of fusion of ice	L_f	=	3.34×10^5 J kg^{-1}
Specific latent heat of vaporization of water	L_v	=	2.26×10^6 J kg^{-1}
Avogadro's constant	N_A	=	6.02×10^{23} per mole
Molar gas constant	R	=	8.31 J K^{-1} mol^{-1}
Stefan–Boltzmann's constant	σ	=	5.67×10^{-8} W m^{-2} K^{-4}
Speed of light in free space (vacuum)	c	=	3.00×10^8 m s^{-1}
Speed of sound in air	c	=	340 m s^{-1}
Planck's constant	h	=	6.626×10^{-34} J s
Triple point temperature	T_{tr}	=	273.16 K
1 tonne	t	=	1000 kg

SECTION A

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

1. A block of mass 0.50 kg is set to slide down a frictionless inclined plane as shown in Figure 1. The base of the inclined plane is in contact with a vertical wall.

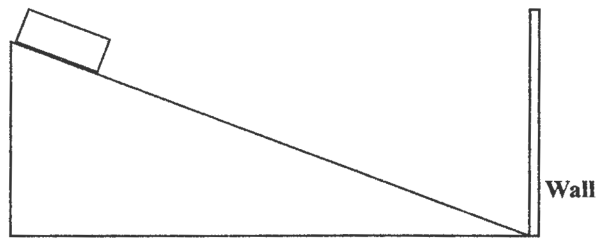

Figure 1. Inclined plane

The block is released from rest from the top of the plane. Its velocity, *v*, at various times, *t*, is recorded in Table 1.

TABLE 1: VELOCITY WITH TIME

Velocity, *v* (m s^{-1})	Time, *t* (*s*)
0.0	0.00
1.3	0.40
2.6	0.80
3.3	1.00
4.0	1.20
–3.1	1.25
–2.7	1.40
–2.0	1.60
–1.3	1.80
0.0	2.20

(a) On the grid provided in Figure 2 **(page 7)**, plot a graph of velocity, *v*, versus time, *t*. **[5 marks]**

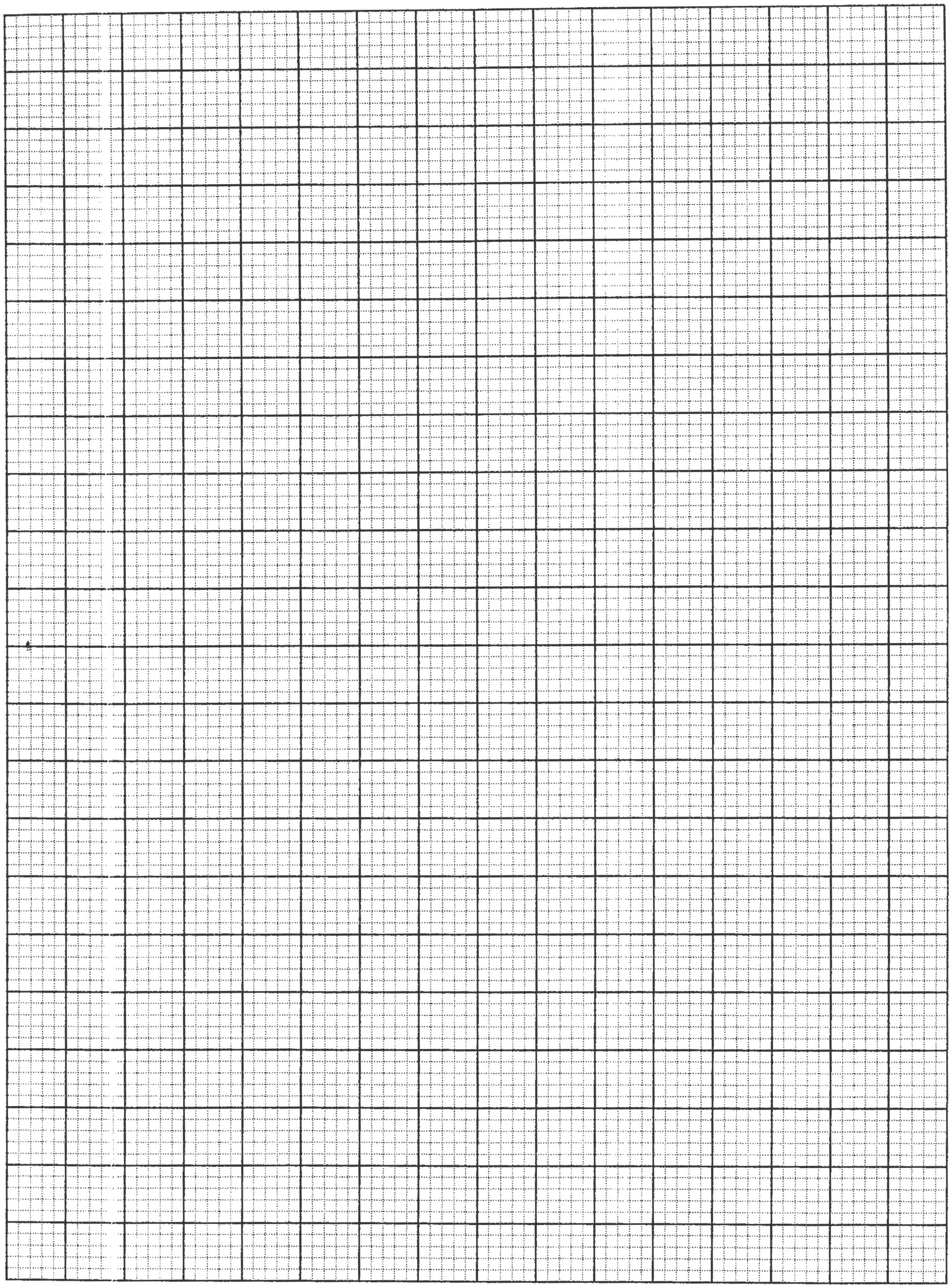

Figure 2. Velocity, *v*, versus time, *t*

(b) Based on the graph, describe qualitatively, the motion of the block.

....

....

....

....

....

....

[3 marks]

(c) From the graph, determine the

(i) acceleration of the block when sliding down the plane

[2 marks]

(ii) length of the incline.

[3 marks]

(d) Comment on the values of the velocity immediately before and after the collision. Give a reason for your answer.

....

....

[2 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

2. (a) Three pieces of apparatus are shown in Figure 3.

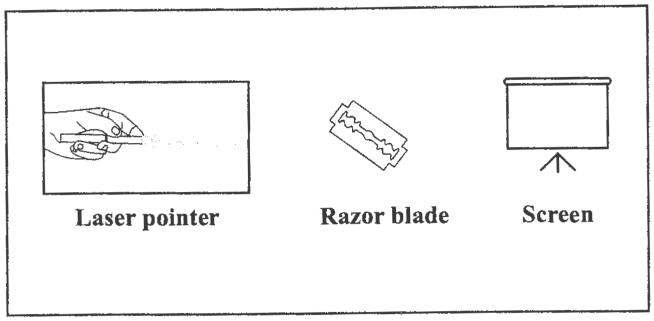

Figure 3. Pieces of apparatus

With the aid of a labelled diagram, describe how the pieces of apparatus shown in Figure 3 can be used to disprove the theory of the particulate nature of light.

....

....

....

....

....

....

....

....

....

[6 marks]

GO ON TO THE NEXT PAGE

(b) With the aid of an appropriate diagram, show that for Young's double slit experiment, $y = \lambda D/a$, where λ is the wavelength of the source, a is the slit separation, D is the distance between the slits and the screen, and y is the separation between the central bright fringe and the first order fringe.

[4 marks]

GO ON TO THE NEXT PAGE

(c) In Young's double slit experiment, the slit spacing was 0.56 mm and the distance across the four-fringe spacing was 3.6 mm when the screen was at a distance of 0.8 m from the slits.

(i) Calculate the wavelength of the monochromatic light used in this experiment.

[3 marks]

(ii) On a suitable sketch, indicate the intensity variation of the fringes from the central maximum to the fourth bright fringe.

[2 marks]

Total 15 marks

3. (a) Write an equation to represent the first law of thermodynamics. State the meaning of EACH symbol used.

....

....

....

....

[2 marks]

(b) Table 2 shows the variation of pressure, P, and volume, V, for a fixed mass of an ideal gas as it expands in a cylinder. The temperature of the gas is fixed at 300 K.

TABLE 2: VARIATION OF PRESSURE AND VOLUME

Pressure, P ($\times 10^5$ Pa)	**Volume, V (m^3)**
4.00	0.001
2.00	0.002
1.35	0.003
1.00	0.004
0.80	0.005
0.70	0.006

(i) On the grid provided in Figure 4 **(page 13)**, plot a graph of pressure, P, against volume, V. **[4 marks]**

(ii) Use the graph, to determine the work done by the gas during expansion.

[3 marks]

GO ON TO THE NEXT PAGE

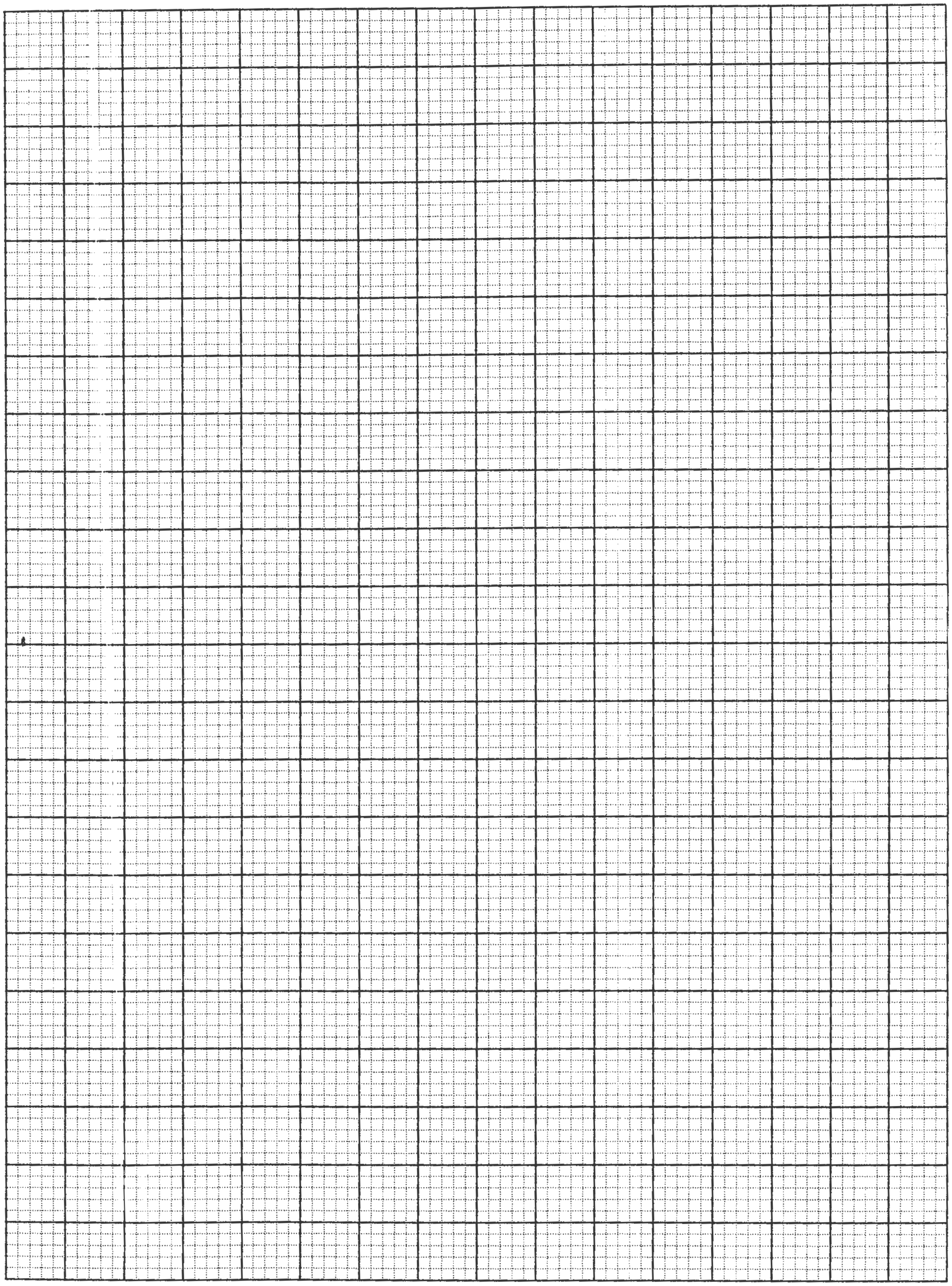

Figure 4. Pressure, *P*, versus volume, *V*

(iii) Use the ideal gas equation to determine the number of moles of gas present.

[2 marks]

(iv) Comment on the change in the internal energy of the gas.

....

....

....

....

[2 marks]

(v) Determine the quantity of heat that is absorbed by the gas during expansion.

[2 marks]

Total 15 marks

SECTION B

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

4. (a) (i) State the SI base unit of volume.

....

....

[1 mark]

(ii) The volume, V, of liquid that flows through a pipe in time, t, is given by the equation

$$\frac{V}{t} = \frac{\pi P r^4}{8Cl},$$

where P is the pressure difference between the ends of the pipe of radius r and length l. The constant, C, depends on the frictional effects of the liquid.

Determine the base unit of C.

[3 marks]

(b) (i) Define the term 'work', stating an appropriate unit for its measurement.

....

....

....

....

[2 marks]

(ii) A car which has a total mass of 840 kg is travelling along a road that has a uniform downhill gradient as shown in Figure 5. The angle of the road with respect to the horizontal is 7°.

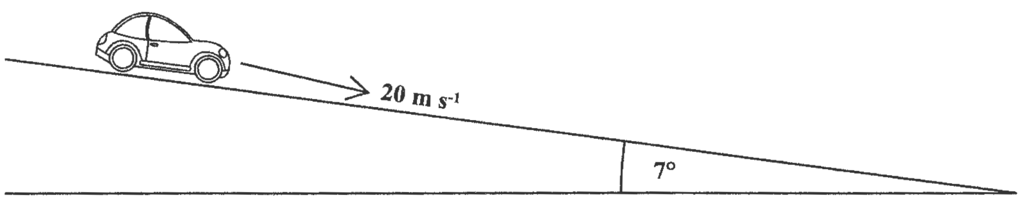

Figure 5. Travel path of car

Calculate the component of the weight of the car down the slope.

[2 marks]

(c) The driver applies a braking force of 4500 N to stop the car when it is travelling at a speed of 20 m s^{-1}.

(i) Show that the deceleration of the car is 4.2 m s^{-2} with the braking force applied.

[2 marks]

(ii) Calculate the distance the car travels from the time the braking force is applied until the car comes to rest.

[2 marks]

(iii) Calculate the loss of kinetic energy of the car.

[1 mark]

(iv) Determine the work done by the resisting force of 4500 N in bringing the car to rest.

[1 mark]

(v) Explain why the quantities in (c) (iii) and (c) (iv) are NOT equal.

....

....

....

....

[1 mark]

Total 15 marks

5. (a) (i) Distinguish between the terms 'threshold of hearing' and 'threshold of pain' when applied to the intensity of sound.

....

....

....

....

[2 marks]

(ii) What TWO properties of the human ear makes the decibel (dB) scale particularly useful?

....

....

....

....

[2 marks]

(iii) The sound from a vuvuzela (a horn popular at football matches) can be as high as 115 dB. Determine the intensity of such a sound in $W\ m^{-2}$.

(The threshold of hearing, I_0, is $1 \times 10^{-12}\ W\ m^{-2}$.)

[6 marks]

GO ON TO THE NEXT PAGE

(b) Figure 6, **not drawn to scale**, shows a loudspeaker connected to an audio frequency signal generator/amplifier that is set up 3 metres in front of a large flat wall. A small microphone which detects regions of high and low intensity is moved between the speaker and the wall.

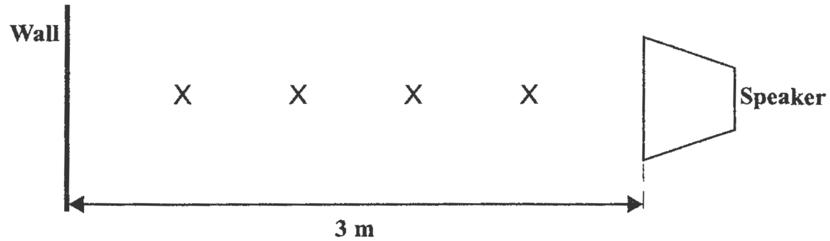

Figure 6. Loudspeaker connected to amplifier

(i) Explain why there are positions between the speaker and the wall where intensity is a minimum, and why these minima do NOT actually have zero intensity.

....

....

....

....

....

....

....

[2 marks]

(ii) The points marked X are points of minima between the wall and the speaker. Determine the frequency setting of the signal generator.

[3 marks]

Total 15 marks

6. (a) Define EACH of the following terms and state their units:

(i) Heat capacity

....

....

....

....

[2 marks]

(ii) Specific heat capacity

....

....

....

....

[2 marks]

(iii) Specific latent heat

....

....

....

....

[2 marks]

(b) In an experiment to measure the specific heat capacity of water, a stream of water flows at a steady rate of 5.0 g s^{-1} over an electrical heater dissipating 140 W. A temperature rise of 5.0 K is observed. A quantity, L, of the heat supplied is lost to the environment. On increasing the rate of flow of water to 10.0 g s^{-1}, the same temperature rise is produced with a dissipation of 250 W. The heat lost to the environment is also L.

(i) Deduce a value for the specific heat capacity of water.

[6 marks]

(ii) Suggest ONE reason why the power, when the rate of flow of water is 10.0 g s^{-1}, is NOT twice that needed when the rate of water is 5.0 g s^{-1}.

....

....

....

....

[1 mark]

(iii) State ONE advantage of using a continuous flow method for measuring the specific heat capacity of water.

....

....

....

....

[1 mark]

(iv) Suggest a type of thermometer that can be used in the experiment in Part (b).

....

....

[1 mark]

Total 15 marks

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.