CARIBBEAN EXAMINATIONS COUNCIL

CARIBBEAN SECONDARY EDUCATION CERTIFICATE®
EXAMINATION

24 MAY 2021 (a.m.)

M 2 1 0 1 2 3 8 0 2 0

FILL IN ALL THE INFORMATION REQUESTED CLEARLY IN CAPITAL LETTERS.

TEST CODE | 0 | 1 | 2 | 3 | 8 | 0 | 2 | 0 |

SUBJECT PHYSICS – Paper 02

PROFICIENCY GENERAL

REGISTRATION NUMBER | | | | | | | | | | |

| SCHOOL/CENTRE NUMBER | | | | | |
|---|---|---|---|---|---|
| | | | | | |

| NAME OF SCHOOL/CENTRE |
|---|
| |

| CANDIDATE'S FULL NAME (FIRST, MIDDLE, LAST) |
|---|
| |

DATE OF BIRTH | D | D | M | M | Y | Y | Y | Y |

SIGNATURE _____

0 1 2 3 8 0 2 0 0 1

DO NOT WRITE ON THIS PAGE

FORM TP 2021102

TEST CODE **01238020**

MAY/JUNE 2021

CARIBBEAN EXAMINATIONS COUNCIL

# CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

## PHYSICS

### Paper 02 – General Proficiency

*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. Where appropriate, 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.**





0 1 2 3 8 0 2 0 0 3

## SECTION A

**Answer ALL questions.**

**1.** (a) State Hooke's law.

.....

.....

.....

.....

**(3 marks)**

(b) To determine the spring constant (or stiffness) of a spring, a student placed different masses, *m*, on a hanger that was attached to a spring and recorded the length, *l*, of the spring. Table 1 shows the mass and corresponding values of length.

**TABLE 1: MASS ADDED, *m*, AND CORRESPONDING LENGTH VALUES, *l*, OF A SPRING**

| Mass, *m* (kg) | Force, *F* (N) | Length, *l* (cm) | Extension, *e* (cm) |
|---|---|---|---|
| 0.00 | 0.0 | 70.2 | 0.0 |
| 0.10 | 1.0 | 74.4 | 4.2 |
| 0.20 | | 79.2 | |
| 0.30 | | 83.9 | |
| 0.42 | | 88.2 | 18.0 |
| 0.50 | | 92.7 | |

(i) Complete Table 1 by inserting the missing force and extension values in Columns 2 and 4 respectively. **(4 marks)**

(ii) Using the grid provided in Figure 1 **on page 5**, plot a graph of extension, *e*, versus force, *F*.

**(8 marks)**

GO ON TO THE NEXT PAGE

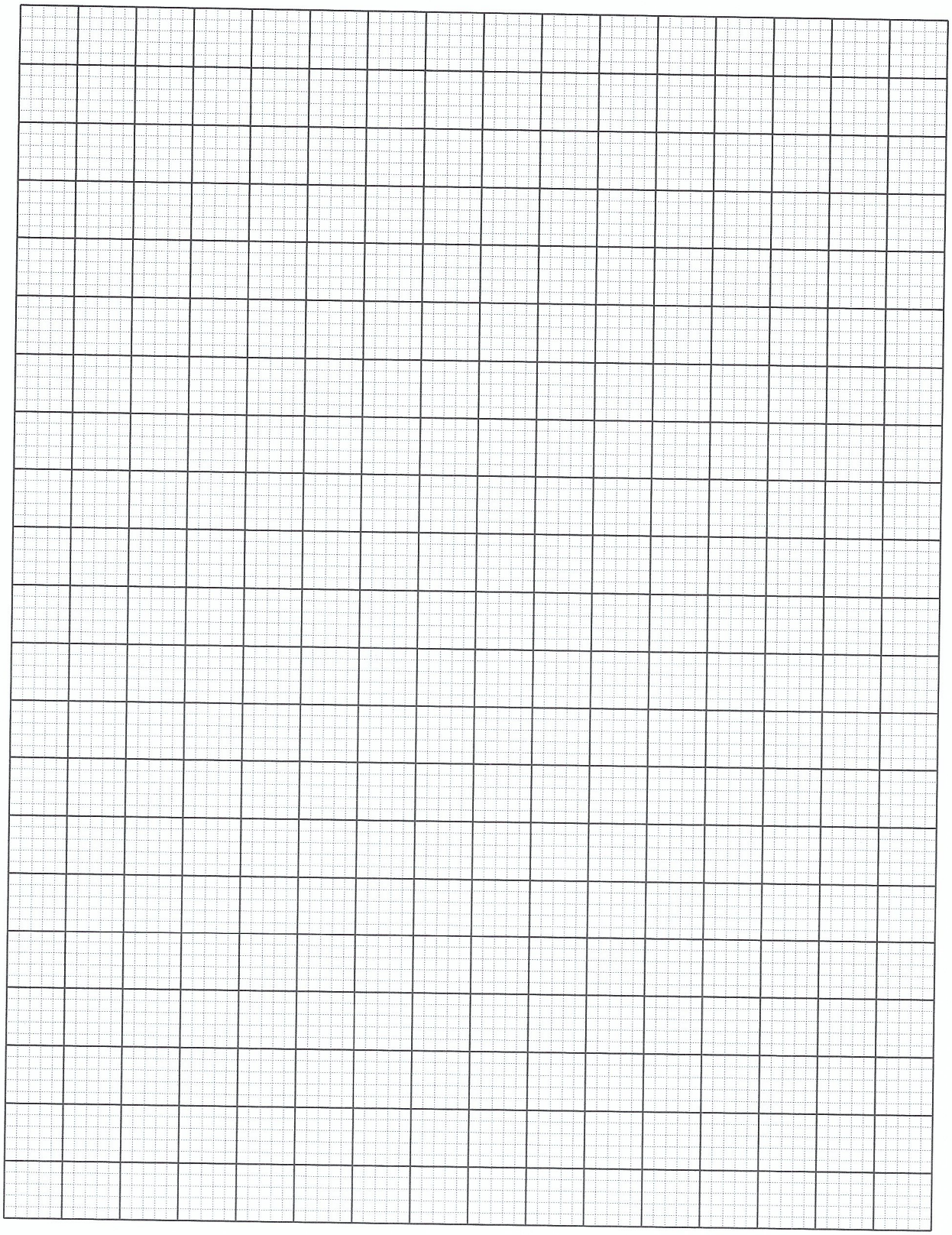

**Figure 1. Graph of extension, *e*, versus force, *F***

(c) Calculate the gradient, $S$, of the graph **on page 5**.

**(4 marks)**

(d) Given the gradient, $S = \frac{1}{k}$, calculate the spring constant, $k$.

**(3 marks)**

(e) Given that $F = ke$, calculate the length, $l$, when a force of 8.0 N is applied. Assume that the spring obeys Hooke's law.

**(3 marks)**

**Total 25 marks**

GO ON TO THE NEXT PAGE

**2.** (a) Define EACH of the following terms:

(i) Moment of a force

.....

.....

.....

.....

**(3 marks)**

(ii) Centre of gravity

.....

.....

.....

.....

**(2 marks)**

(b) State the TWO conditions necessary for a body to be in equilibrium.

.....

.....

.....

.....

**(2 marks)**

(c) Figure 2 shown below is a diagram of a non-uniform wooden plank, *AB*, which is 2.0 m long and weighs 1000 N. The plank is supported from a ceiling by two vertical springs, *P* and *Q*. The plank is attached at a distance of 0.5 m from each end. *C* is the centre of gravity as shown in Figure 2.

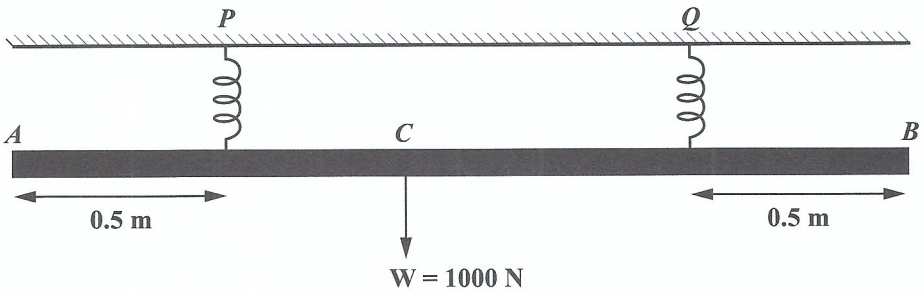


**Figure 2. Diagram of a non-uniform wooden plank supported by two springs, *P* and *Q***

When the plank is horizontal, the tension in Spring P is 600 N.

(i) Calculate the tension in Spring *Q*. **Show ALL working.**

**(2 marks)**

GO ON TO THE NEXT PAGE

(ii) By taking moments about $A$, determine the horizontal distance from $P$ to $C$.

**(5 marks)**

(iii) State why the centre of gravity is located closer to the point $P$ than the point $Q$.

.....

.....

**(1 mark)**

**Total 15 marks**

**3.** (a) Waves can be described as transverse or longitudinal.

(i) Explain what is meant by a 'transverse wave'.

.....

.....

.....

.....

**(3 marks)**

(ii) Give ONE example of a 'transverse wave'.

.....

.....

**(1 mark)**

(b) (i) Define the term 'ultrasound'.

.....

.....

.....

.....

**(2 marks)**

(ii) State ONE example of the application of ultrasound.

.....

.....

**(1 mark)**

(c) Figure 3 shows the path of a light ray from air through a cube of ice, along with two rays showing partial reflection.

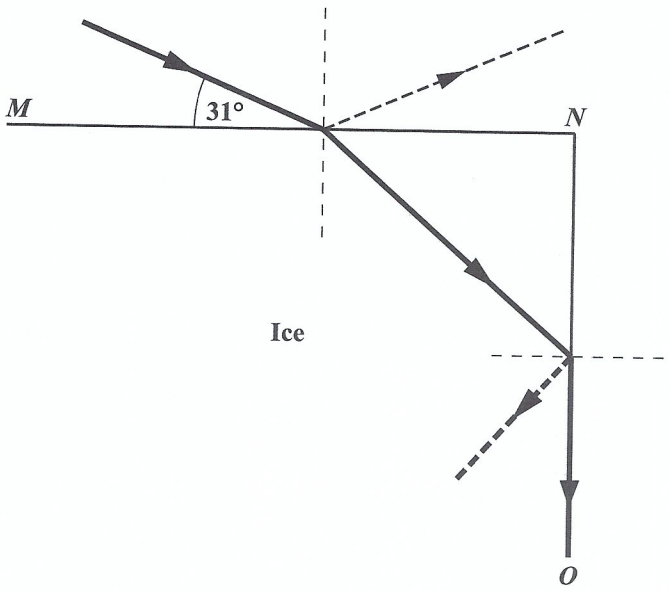


**Figure 3. Light ray passing through a cube of ice**

Determine

(i) the angle of incidence on the face *MN*

**(2 marks)**

(ii) the angle of reflection on the face *MN*

**(1 mark)**

(iii) the angle of refraction at the face *MN*, given that the refractive index of ice is 1.31.

**(4 marks)**

(d) On the diagram in Figure 3 **on page 11**, label the critical angle, $\theta_c$, for ice. **(1 mark)**

**Total 15 marks**

## SECTION B

**Answer ALL questions.**

**4.** (a) (i) On Figure 4 below, sketch the graph of pressure versus temperature (in degrees Celsius) for an ideal gas.

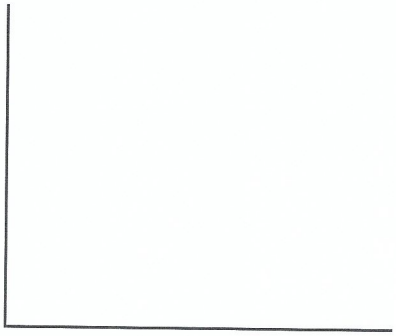

**Figure 4. Pressure versus temperature**

**(2 marks)**

(ii) Explain how the graph could be used to derive the Kelvin scale.

.....

.....

.....

.....

**(2 marks)**

(iii) Using $T$ to represent the Kelvin temperature and $\theta$ to represent the Celsius temperature, state the mathematical relationship between the Kelvin and Celsius temperature scales.

.....

.....

**(2 marks)**

(b) A container stores 5.0 $m^3$ of gas at a pressure of 13 atmospheres and a temperature of –23 °C. Calculate the volume that the same gas would occupy at a temperature of 27 °C and atmospheric pressure of 1 atmosphere.

**(5 marks)**

(c) Blocks X and Y in Figure 5 are identical except for their temperatures.

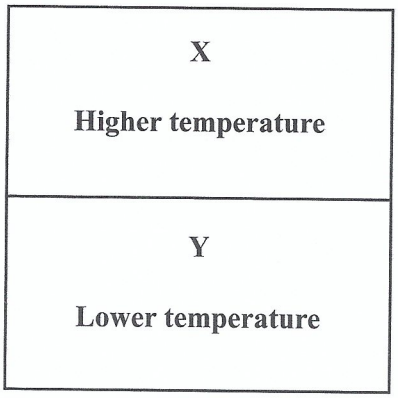


**Figure 5. Diagram of two identical blocks with different temperatures**

(i) Explain the difference in the motion of the particles in Block X compared with the motion of the particles in Block Y.

.....

.....

.....

**(2 marks)**

(ii) In which direction would thermal energy be transferred?

.....

.....

**(1 mark)**

(iii) State the condition under which the transfer of thermal energy would cease.

.....

.....

**(1 mark)**

**Total 15 marks**

**5.** Figure 6 shows a simple d.c. motor which consists of a coil of wire, *ABCD*, between the poles of a magnet. The dotted line represents an axle about which the coil can turn. A current flows through the coil in the direction shown by the arrows.

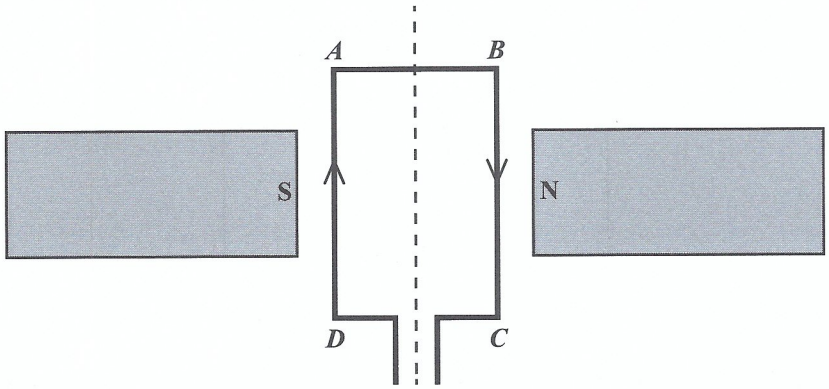


**Figure 6. Simple d.c. motor**

(a) (i) Draw the magnetic field between the poles of the magnet on Figure 6.

**(2 marks)**

(ii) State the direction in which side *DA* of the coil will move as the current starts flowing through the circuit.

.....

.....

**(1 mark)**

(iii) Name the rule used to determine the direction in which side *DA* of the coil moves.

.....

.....

**(1 mark)**

(iv) Explain why a split-ring (commutator) is used in a d.c. motor.

.....

.....

.....

.....

**(2 marks)**

GO ON TO THE NEXT PAGE

(b) Figure 7 shows a graph of the variation of voltage with time across the output terminals of an a.c. generator.

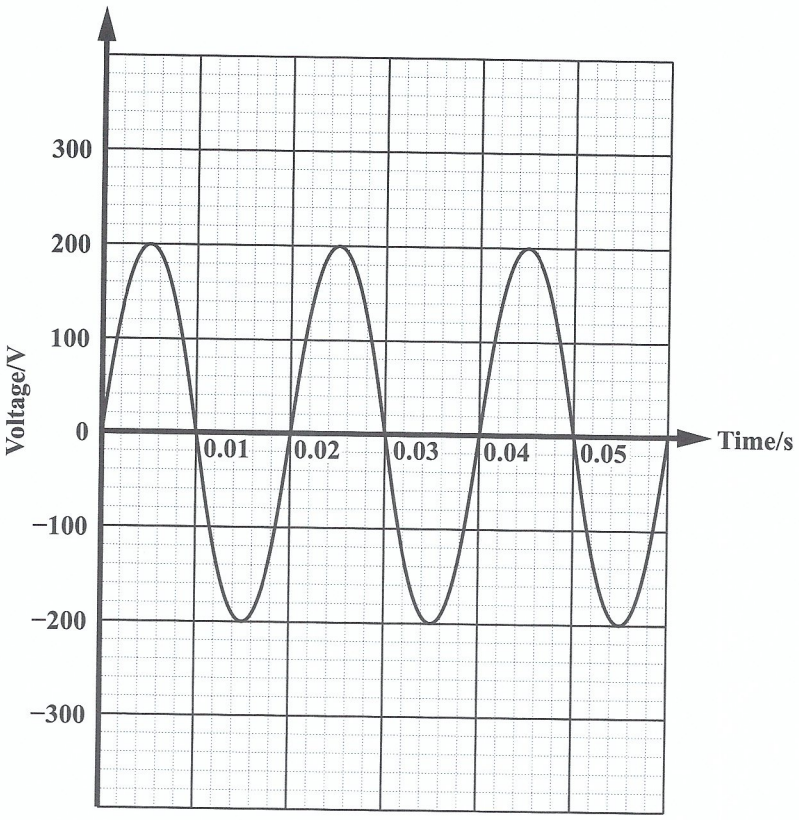


**Figure 7. Graph of voltage against time**

(i) Calculate the value of the frequency for the generator.

**(3 marks)**

(ii) The peak voltage is applied by the generator across a 100.0 Ω resistor. Calculate the peak value of the current in the resistor.

**(3 marks)**

(c) The generator is subsequently rotated at twice the frequency in (b) (i). State the effect this will have on

(i) the period of the output

.....

.....

**(2 marks)**

(ii) the value of the output voltage.

.....

.....

**(1 mark)**

**Total 15 marks**

**6.** Radium-226 is radioactive and is represented by the nuclide $^{226}_{88}Ra$.

(a) For a neutral atom of Radium-226, state

(i) the number of protons

.....

**(1 mark)**

(ii) the number of neutrons

.....

**(1 mark)**

(iii) the number of electrons.

.....

**(1 mark)**

(b) A Radium-226 nucleus decays by α–particle emission to Radon (Rn) nucleus.

(i) Explain what is meant by the term 'radioactivity'.

.....

.....

.....

.....

**(3 marks)**

(ii) Complete the equation for the decay of Radium-226.

$$^{226}_{88}Ra \longrightarrow$$

**(2 marks)**

(c) Radium-226 has a half-life of 1600 years.

(i) Define the term 'half-life'.

.....

.....

.....

.....

**(2 marks)**

(ii) At a certain time, a sample contains $8.0 \times 10^8$ Radium nuclei. Calculate the number of α–particles emitted by the Radium nuclei in the next 4800 years.

**(4 marks)**

(iii) How much more time will elapse before the number of Radium nuclei remaining falls to $0.5 \times 10^8$?

**(1 mark)**

**Total 15 marks**

**END OF TEST**

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

## EXTRA SPACE

**If you use this extra page, you MUST write the question number clearly in the box provided.**

**Question No.** ☐

## EXTRA SPACE

**If you use this extra page, you MUST write the question number clearly in the box provided.**

**Question No.** ☐

DO NOT WRITE ON THIS PAGE

## CANDIDATE'S RECEIPT

### INSTRUCTIONS TO CANDIDATE:

1. **Fill in all the information requested clearly in capital letters.**

TEST CODE: | 0 | 1 | 2 | 3 | 8 | 0 | 2 | 0 |

SUBJECT: PHYSICS – Paper 02

PROFICIENCY: GENERAL

REGISTRATION NUMBER: | | | | | | | | | | |

FULL NAME: _____
**(BLOCK LETTERS)**

Signature: _____

Date: _____

2. **Ensure that this slip is detached by the Supervisor or Invigilator and given to you when you hand in this booklet.**

3. **Keep it in a safe place until you have received your results.**

### INSTRUCTION TO SUPERVISOR/INVIGILATOR:

Sign the declaration below, detach this slip and hand it to the candidate as his/her receipt for this booklet collected by you.

I hereby acknowledge receipt of the candidate's booklet for the examination stated above.

Signature: _____
Supervisor/Invigilator

Date: _____