FORM TP 2021025

TEST CODE 01238020

JANUARY 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 significant 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.**





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## SECTION A

**Answer ALL questions.**

**1.** Figure 1 shows the apparatus which was used by two students to carry out an experiment to determine the focal length, $f$, of a lens by using the object distance, $u$, and the image distance, $v$.

At the end of the experiment the object distance, $u$, and the image distance, $v$, were recorded in Table 1.

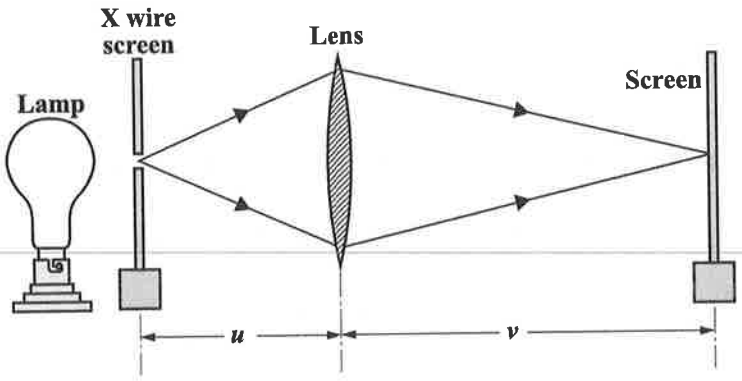


**Figure 1. Experiment to measure the focal length, $f$, of a lens**

**TABLE 1: RESULTS OF THE EXPERIMENT**

| $u$ (cm) | $1/u$ ($cm^{-1}$) × $10^{-2}$ | $v$ (cm) | $1/v$ ($cm^{-1}$) × $10^{-2}$ |
|---|---|---|---|
| 20.0 | | 60.0 | |
| 30.0 | 3.3 | 30.0 | 3.3 |
| 35.0 | | 26.3 | 3.8 |
| 40.0 | 2.5 | 24.0 | 4.2 |
| 45.0 | 2.2 | 22.5 | |
| 55.0 | | 20.6 | 4.9 |

(a) Complete Table 1 by calculating the missing values. **(6 marks)**

(b) On Figure 2 **on page 5** plot a graph of $1/u$ against $1/v$, using 2 cm to represent $1 \times 10^{-2}$ $cm^{-1}$ on each axis. **(7 marks)**

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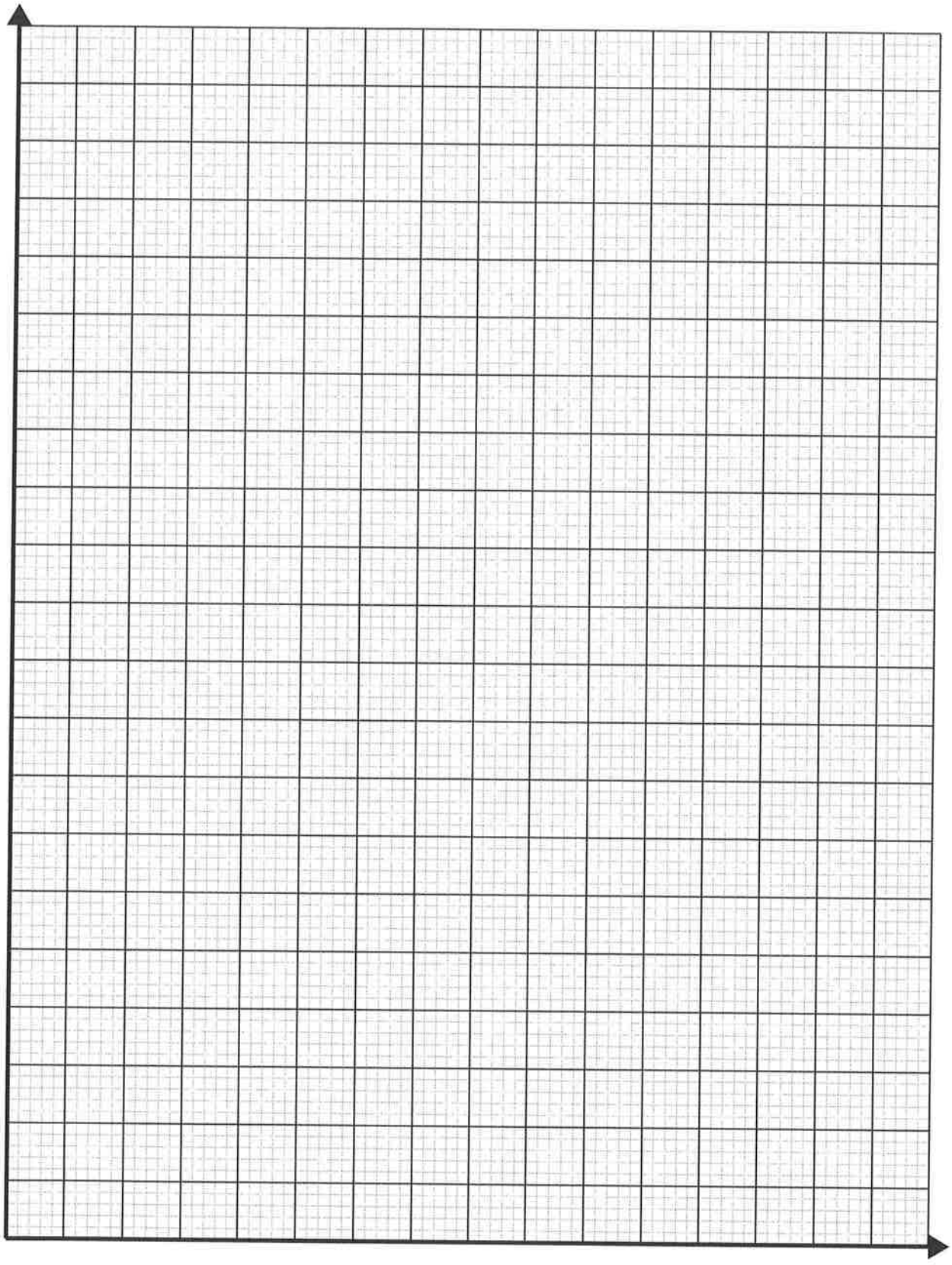

**Figure 2. Graph of $\frac{1}{u}$ versus $\frac{1}{v}$**

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(c) Use the graph to determine the value of $v$ when $1/u$ is $4.0 \times 10^{-2}\,\text{cm}^{-1}$.

**(2 marks)**

(d) (i) Use the graph to determine the intercepts, $c_1$ and $c_2$, on both axes, and calculate the average value, $c$.

**(4 marks)**

(ii) Use the formula $c = 1/f$ to calculate the focal length, $f$, of the lens.

**(3 marks)**

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(e) Complete the following statement:

The principal focus of a concave lens is defined as the ..... on the principal axis from which rays originally ..... to the principal axis ..... after passing through the lens. **(3 marks)**

**Total 25 marks**

**2.** (a) State the 'principle of moments'.

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**(3 marks)**

(b) State another condition that is necessary for a body to be in equilibrium.

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**(1 mark)**

(c) State the formula for the moment of a force, providing the meaning of each variable and its SI unit.

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**(3 marks)**

(d) Figure 3 shows a girl standing on a uniform plank, AB, of length 3 m and weight 270 N. The plank rests on two scales that are located at P and Q, a distance of 2 m apart. The scales are equidistant from the ends of the plank as shown in Figure 3. The scale at P reads 354 N and the scale at Q reads 417 N.

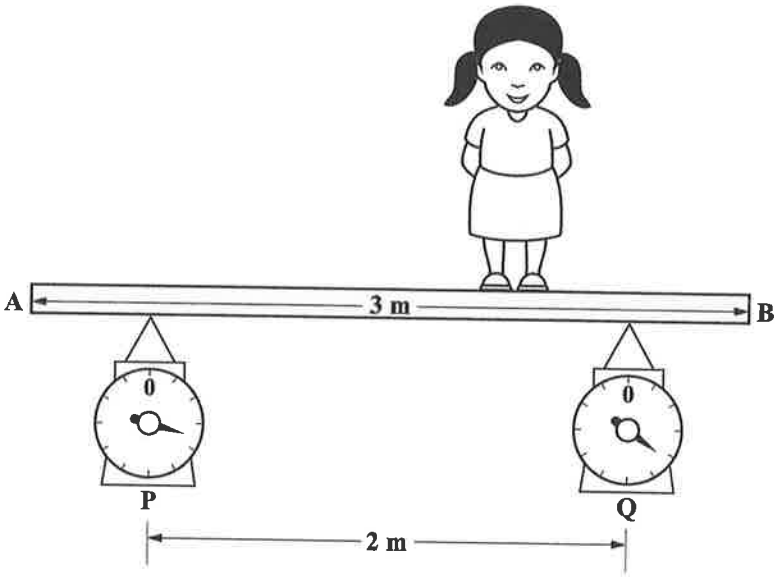


**Figure 3. A girl standing on a uniform plank**

(i) On Figure 3, draw and label ALL the forces that are acting on the plank.

**(2 marks)**

(ii) Calculate the girl's weight.

**(2 marks)**

(e) By taking moments about Q, calculate the girl's distance from the scale at Q.

**(4 marks)**

**Total 15 marks**

**3.** (a) (i) Define the term 'pressure'.

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**(2 marks)**

(ii) State the SI unit of pressure pascal (Pa), in terms of its base units.

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**(1 mark)**

(b) (i) Describe, with the aid of a diagram, how the pressure in a liquid varies with the depth of the liquid.

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**(3 marks)**

(ii) State the equation for the pressure difference ($\Delta P$) between two points in a liquid, which are a vertical distance, h, apart.

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**(1 mark)**

(c) Figure 4 shows a U-tube containing two immiscible liquids, X and Y.

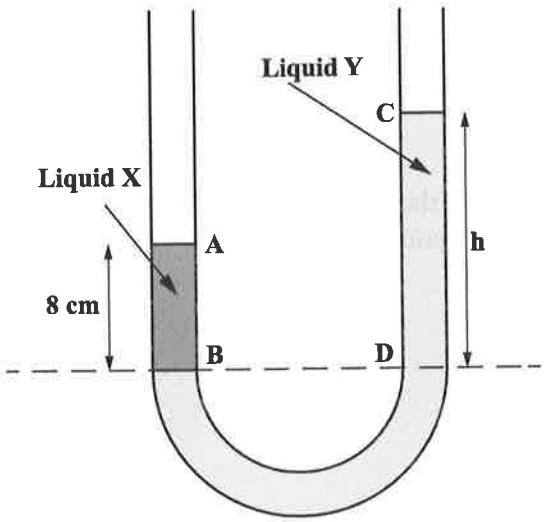


**Figure 4. U-tube of immiscible liquids**

(i) If the density of Liquid X is 1350 kg $m^{-3}$, calculate the pressure (in Pa), due to the liquid column AB, which is 8 cm long.

**(3 marks)**

GO ON TO THE NEXT PAGE

(ii) Hence, use your answer to (c) (i) to calculate the height, h, of the liquid column CD, given that the density of liquid Y is 900 kg $m^{-3}$. **(State any equations used and fully explain the reasoning in obtaining your answer to (c) (ii).)**
**[Use g = 10 $ms^{-2}$]**

**(5 marks)**

**Total 15 marks**

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## SECTION B

**Answer ALL questions.**

**4.** (a) A young student has just entered secondary school. He was accustomed to having his home-cooked meal warmed up at lunch time in the microwave oven at his primary school. He misses this and suggests to his parents that they buy him a vacuum flask similar to the one shown in Figure 5.

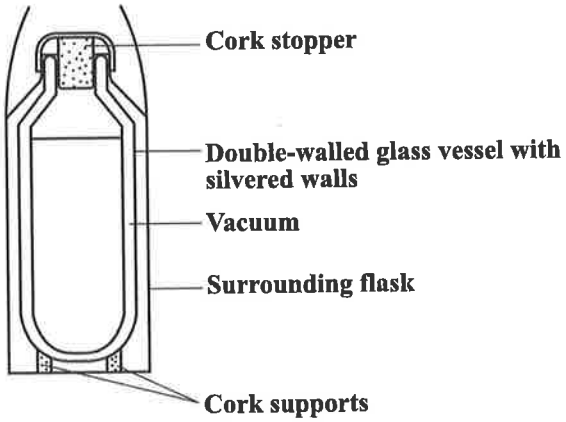


**Figure 5. A vacuum flask**

Using the information in Figure 5, explain in terms of the principles of thermal energy transfer how EACH of the following sections of the vacuum flask helps to keep the home-cooked meal warm.

(i) The cork stopper

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(ii) The vacuum

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(iii) The double-walled glass vessel with silvered walls

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**(6 marks)**

(b) In an experiment to determine the specific latent heat of fusion of ice, shown in Figure 6, the following results were obtained.

The initial mass of the water is 120 g. The initial temperature of the water is 35 °C and the initial temperature of the ice is 0 °C.

The final mass of the water is 140 g and the final temperature of the water plus the melted ice is 18 °C.

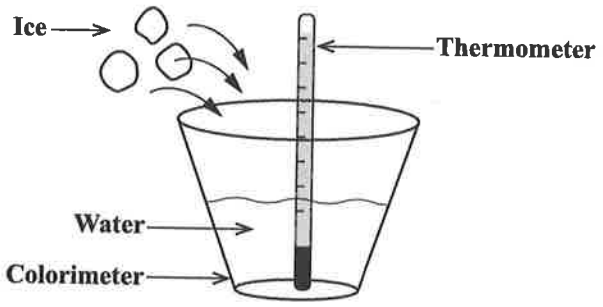


**Figure 6. Experiment to determine the specific latent heat of fusion of ice**

Assume the container has negligible heat capacity and that there is no net heat transfer with the surroundings during the experiment.

(i) Determine the mass of the melted ice.

**(1 mark)**

(ii) Calculate the heat lost by the water.

**(3 marks)**

(iii) Write an expression for the TOTAL heat gained by the ice in melting and the melted ice in warming to 18 °C.

**(2 marks)**

(iv) Hence calculate the specific latent heat of fusion of ice.

[Specific heat capacity of water = 4.2 J $g^{-1}$ $K^{-1}$]

**(3 marks)**

**Total 15 marks**

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**5.** (a) Draw the electric fields for EACH of the following arrangements.

(i)

**(2 marks)**

(ii)

**(2 marks)**

(iii)

**(2 marks)**

(b) If the number of electrons transferred from a charged rod to earth through a wire is $4 \times 10^8$ and the total charge transferred is 0.64 C, calculate

(i) the magnitude of the charge on one electron

**(3 marks)**

(ii) the current that flows through the wire if it takes 0.40 s for all the electrons to flow to earth.

**(3 marks)**

(iii) State the direction in which the charges will flow, if the rod is positively charged.

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**(1 mark)**

(c) Explain how the static 'build up' of charges on a vehicle could be hazardous.

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**(2 marks)**

**Total 15 marks**

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**6.** (a) Figure 7 shows the experimental arrangement of the apparatus used to carry out the Rutherford's alpha (α) particle scattering experiment to identify the structure of the atom.

A beam (collimated beam) of alpha particles from a radioactive source was fired at a thin piece of gold foil and the angle of deviation of the alpha particles observed.

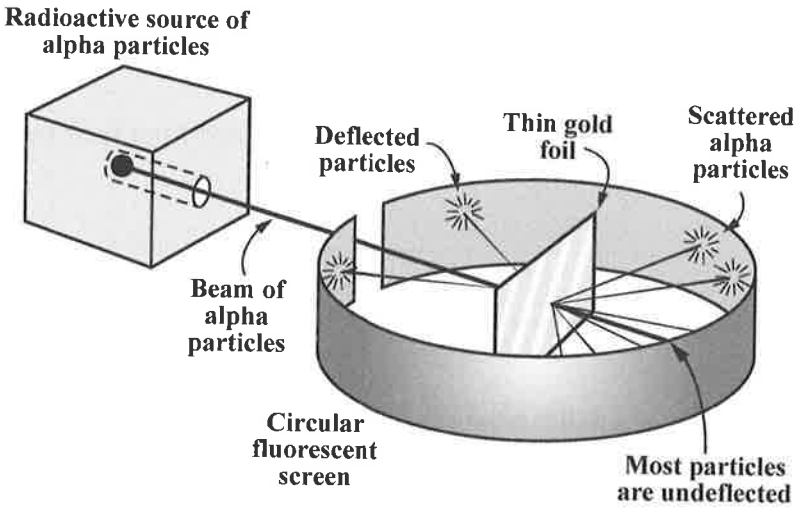


**Figure 7. Rutherford's alpha particle scattering experiment**

(i) Write the names of the two scientists who assisted Rutherford in performing this experiment.

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**(2 marks)**

(ii) Explain why the experiment was carried out in an evacuated chamber.

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**(2 marks)**

(b) State the conclusions that were deduced from EACH of the following observations made from the alpha particle scattering experiment.

(i) Most of the alpha particles passed through the gold foil undeviated.

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**(1 mark)**

(ii) A few alpha particles were deflected from their path but continued through the gold foil.

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**(1 mark)**

(iii) A smaller number of alpha particles rebounded.

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**(1 mark)**

(c) Describe the Rutherford model of the atom, based on the conclusions of the experiment stated in (b).

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**(2 marks)**

(d) Energy is produced within stars by the process of fusion where alpha particles help convert beryllium into carbon, according to the equation below.

$$^{4}_{2}He + ^{9}_{4}Be \rightarrow ^{1}_{0}n + ^{12}_{6}C$$

(i) In the equation above, which symbol is used to represent the alpha particle?

.....

.....

**(1 mark)**

(ii) The following table shows the mass of each nuclei in the process above.

| | |
|---|---|
| $^{4}He_{2}$ | 4.00260 u |
| $^{9}Be_{4}$ | 9.01212 u |
| $^{1}n_{0}$ | 1.00867 u |
| $^{12}C_{6}$ | 12.0000 u |

Calculate the loss in mass, $\Delta m$, in kg, due to the reaction.

**[1u = 1.66 × $10^{-27}$ kg]**

**(2 marks)**

(iii) Calculate the energy equivalence of the mass in (d) (ii).

**[$c = 3.00 \times 10^8$ $ms^{-1}$]**

**(3 marks)**

**Total 15 marks**

**END OF TEST**

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

## EXTRA SPACE

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## 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: _____