

**Physics I**

**011**

**14/11/ 2019**

**8:30 AM – 11:30 AM**



**Rwanda Education Board**

## **ORDINARY LEVEL NATIONAL EXAMINATIONS, 2019**

**SUBJECT: PHYSICS**

**DURATION: 3 HOURS**

### **INSTRUCTIONS :**

- 1) Write your names and index number as they appear on your registration form and **DO NOT** write your names and index number on additional sheets of paper if provided.
- 2) Do not open this question paper until you are told to do so.
- 3) This paper has **THREE** sections: **A** ,**B** and **C**.

**SECTION A** : This section is **compulsory**. **(55 marks)**

**SECTION B** : Attempt any **three** questions. **(30 marks)**

**SECTION C** : Attempt **Only one** question. **(15 marks)**

- 4) Calculators and mathematical instruments may be used.
- 5) Use only a **blue** or **black pen** for writing and a **pencil** for drawing.

## SECTION A: Attempt all questions (55 marks)

- 1) For each of the statements below, indicate **true** if it is correct and **false** if it is wrong:
- a) According to the kinetic theory of matter, when a gas is heated, it cannot expand. (1mark)
  - b) The freezing point of water is equal to the melting point of ice in the same atmospheric conditions. (1mark)
  - c) Temperature and heat have the same units. (1mark)
  - d) Thermal equilibrium means the condition under which two or more substances in physical contact with each other exchange no heat energy and thus they are at the same temperature. (1mark)
- 2) Explain the process of hydrologic cycle (water cycle) (4 marks)
- 3) a) Select a derived physical quantity among the following:  
Time, mass, acceleration and length. (1mark)
- b) A piece of rock with a volume of  $15 \text{ cm}^3$  has a mass of 45 g.
- (i) Express its volume in  $\text{m}^3$  (1mark)
  - (ii) What is its mass in kg ? (1mark)
- 4) A RLC series circuit consists of an inductor, a resistor, a capacitor and an alternating current generator.  
Complete each of the following statements with the correct term from the words bank: increases, decreases or remains constant.  
Write only the answer in your answer booklet without copying the Statement.
- a) If the frequency of alternating current of a generator decreases, the reactance offered by the capacitor to an alternating current ..... (1mark)
  - b) If the frequency of alternating current of a generator decreases, the reactance offered by the inductor to an alternating current ..... (1mark)
  - c) The resistance offered by a resistor to an alternating current .....when the frequency of alternating current of a generator decreases. (1mark)
- 5) a) What will happen to an object at rest if a force is acted upon it? (1mark)
- b) Why do you need to wear a seatbelt in a moving car? (2marks)
- c) Why does the moon orbit around the earth? (1mark)
- 6) a) A positively charged rod is brought close to one end of a neutral metallic plate without touching it.
- (i) What does a neutral metallic plate mean in this context? (1mark)
  - (ii) What type of charge appears on the closest side of the plate? (1mark)

- (iii) Name the method of charging bodies used in this case. **(1mark)**
- b) The electric force between two charged bodies is given by:
- $$F = \frac{1}{4\pi\epsilon} \frac{QQ'}{r^2}$$
- What does **r** mean in this relation? **(1mark)**
- 7) You are provided with three electric components namely:  
one ordinary diode, one resistor, one dry cell and connecting wires.  
Use the symbols of these elements to draw a complete electric circuit  
such that the ordinary diode is forward biased. **(3marks)**
- 8) a) What type of renewable energy comes from tapping heat generated  
inside the Earth? **(1mark)**  
b) Why is the use of renewable energy advantageous to people? **(2marks)**
- 9) Why are convex mirrors used as rear/back view mirrors of vehicles? **(3marks)**
- 10) a) What do you understand by the term 'Pascal's principle'? **(1mark)**  
b) Give any two applications of Pascal's principle in everyday life. **(2marks)**
- 11) The volume of 600 ml of air assumed to be an ideal gas is at 27°C.  
a) Convert 27°C and 67°C into Kelvin. **(2marks)**  
b) What is its volume at 67°C?  
*(Assume that the pressure of the air is kept constant).* **(2marks)**
- 12) A simple machine requires 1000 J of work (work input) to raise a  
load of 500 N through a vertical distance of 1.5 m.  
Find :  
a) the work output (work done by the force of 500 N). **(2marks)**  
b) the efficiency of the machine in %. **(2marks)**
- 13) Suppose a high resistance voltmeter reads 1.5 V when connected across  
a dry cell on open circuit. It reads 1.2 V when the same battery  
is supplying a current of 0.30 A through the circuit when connected  
to a resistor of resistance R .  
Determine :  
a) The electromotive force of the battery. **(2marks)**  
b) Resistance (R). **(3marks)**
- 14) A 1000 kg car starts from rest and accelerates uniformly to a speed  
of 72 km/h during 50 seconds.  
a) Express the car's speed in m/s. **(1mark)**  
b) Show that its acceleration is 0.4 m /s<sup>2</sup>. **(2marks)**  
c) Prove that the linear momentum of the car moving with a speed  
of 72 km/h is 20 000 kgm/s . **(2marks)**

- 15) A charge  $Q=1 \times 10^{-11}$  C acts as a positive point charge to create an electric field at a distance of 0.05 m away.
- Draw the electric field line created by  $Q$  at a distance of 0.05 m away. **(1mark)**
  - Determine the electric field strength created by  $Q$  at a distance of 0.05 m. (Coulomb's law constant  $k=9 \times 10^9 \text{ Nm}^2/\text{C}^2$ ) **(2marks)**

### SECTION B: Attempt any three questions (30 marks)

- 16) The diagram below (figure 1) shows an object 2 cm tall placed at 6 cm away from a convex lens (converging lens) of focal length 3 cm.

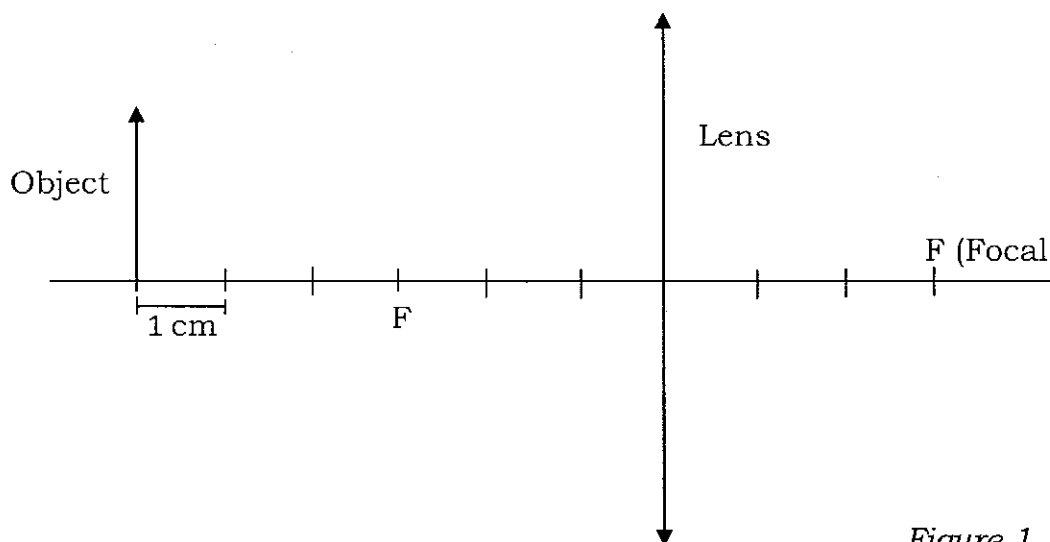


Figure 1

- Copy the diagram and draw a ray diagram to scale (use the graph paper provided at the end of your answer booklet) to illustrate the image of the object. **(3marks)**
  - From the graph (don't use calculations), determine the:
    - Image position. **(1mark)**
    - Size of the image. **(1mark)**
    - Properties of the image obtained. **(3 marks)**
  - Give names of two optical instruments that use convex lenses. **(2marks)**
- 17) In addition to your knowledge and skills, use the concept of state of equilibrium in relation to the position of centre of gravity to answer the following sub questions:
- Explain the following types of static equilibrium:
    - Neutral equilibrium. **(1mark)**
    - Stable equilibrium. **(1mark)**
    - Unstable equilibrium. **(1mark)**

- b) The diagram below (figure 2) shows three solid blocks (made of the same wood) A, B and C with their cross sectional areas resting on a horizontal table.

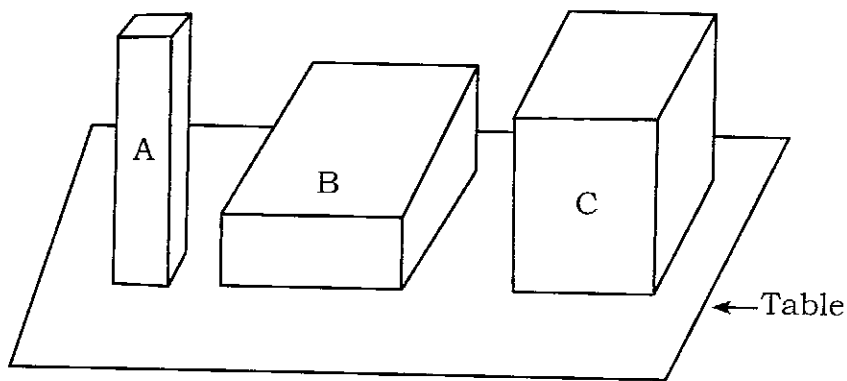
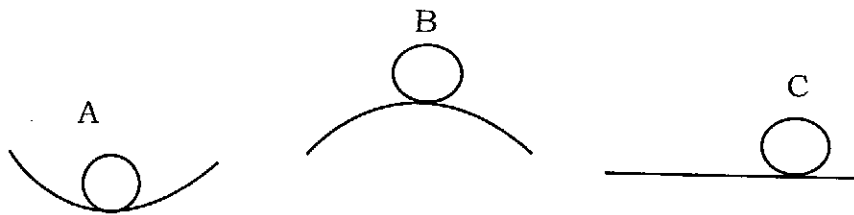


Figure 2

List the blocks in order from the least stable to the most stable and justify your answer.

**(4marks)**

- c) Observe the following diagrams (figure 3) and specify the type of equilibrium for each spherical object (ball) A, B and C.



**(3marks)**

Figure 3

18) a) How can you tell that an object submerged into water will sink or float on water? **(3marks)**

b) A student uses the following apparatus (figure 4) to demonstrate pressure difference in water. The apparatus is hollow and has three short tubes at different depths. The student completely fills the apparatus with water. Water comes out through all the three side tubes.

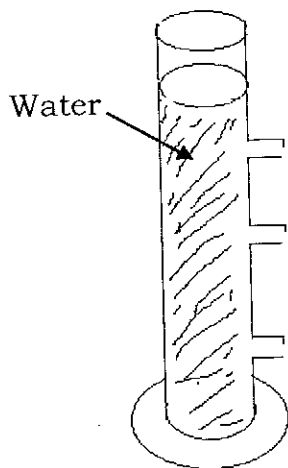


Figure 4

(i) Copy the diagram and draw the path followed by the water you would expect to see from each side tube. **(3 marks)**

(ii) Describe the pattern of the paths of water from the side tubes shown in your diagram. **(2marks)**

c) Why does an object feel a buoyant force when it is submerged in a liquid? **(2marks)**

19) a) Differentiate between heat capacity and specific heat capacity of a substance. **(3marks)**

b) Describe how the following modes of heat transfer take place. **(1mark)**

(i) Conduction of heat. **(1mark)**

(ii) Convection of heat. **(1mark)**

(iii) Radiation of heat. **(1mark)**

- c) The vacuum flask shown (figure 5) has five labelled features, each one designed to reduce heat transfer.

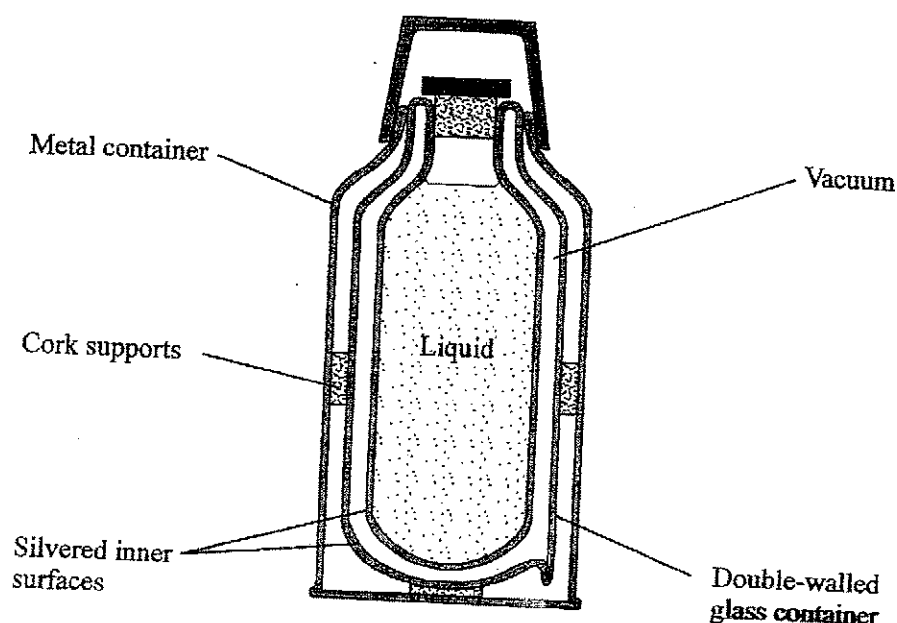


Figure 5

Analyze figure 5 shown above and answer the sub questions below.

- (i) Which labelled feature of the vacuum flask reduces heat transfer by both conduction and convection? **(1mark)**
- (ii) Explain how this feature of the vacuum flask reduces heat transfer by both conduction and convection. **(1mark)**
- (iii) Which labelled feature of the vacuum flask reduces heat transfer by radiation? **(1mark)**
- (iv) Explain how this feature of the vacuum flask reduces heat transfer by radiation. **(1mark)**

- 20) a) A coil of wire is connected to a sensitive galvanometer as shown in the diagram below (figure 6).

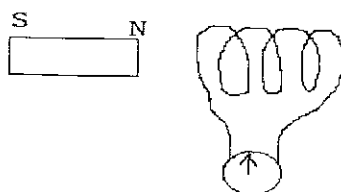


Figure 6

- (i) What is observed on the zero centre of the galvanometer when the bar magnet is stationary in the coil? **(1mark)**

- (ii) What is observed on the centre zero galvanometer when the bar magnet is moved towards the coil? **(1mark)**
- (iii) What is observed on the centre zero galvanometer when the bar magnet is moving away from the coil? **(1mark)**
- (iv) What is the cause of the observed results made when the magnet is moving towards the coil or when it is moving away from the coil? **(1mark)**
- b) Suggest two ways that may be used to increase the induced electromotive force in a coil. **(2marks)**
- c) A transformer is a device based on the principle of electromagnetic induction. **(1mark)**
- (i) Name one electric device that uses a transformer. **(1mark)**
- (ii) The input coil of a transformer has 200 turns of a wire and is connected to a 230 V alternating current supply. What is the voltage across the output coil when it has 600 turns? **(2marks)**
- (iii) What is the benefit of using transformers in the transmission of electrical power? **(1mark)**

### SECTION C: This question is compulsory (15 marks)

- 21) A student carried out an experiment in order to determine the electromotive force,  $E$ , of a dry cell.

The results were as follows:

| Resistance, $R/\Omega$ | Current, $I/A$ | $\frac{1}{\text{current}}, \frac{1}{I}/A^{-1}$ |
|------------------------|----------------|------------------------------------------------|
| 2                      | 0.385          |                                                |
| 4                      | 0.250          |                                                |
| 6                      | 0.200          |                                                |
| 8                      | 0.150          |                                                |
| 10                     | 0.125          |                                                |
| 12                     | 0.100          |                                                |

- a) Copy and complete the table above including only  $R$  and  $\frac{1}{I}$ .

Round off to one decimal place for example 2.1 or 3.0

- b) Plot a graph of  $\frac{1}{I}$  (vertical axis) against  $R$  (on horizontal axis)

and draw the best fit straight line.

- c) Determine the slope  $S$ .

- d) Determine the value of  $E$  given that  $E = \frac{1}{S}$  and

interpret your results.