

Physics I

011

22/07/2021 08.30 AM – 11.30 AM



ORDINARY LEVEL NATIONAL EXAMINATIONS, 2020-2021

SUBJECT: PHYSICS I

DURATION: 3 HOURS

INSTRUCTIONS:

- 1) Write your names and index number on the answer booklet as they appear on your registration form, and **DO NOT** write your names and index number on additional answer sheets of paper if provided.
- 2) Do not open this paper until you are told to do so.
- 3) This paper consists of **THREE** sections **A**, **B** and **C**
SECTION A: This section is **compulsory**. **(55 marks)**
SECTION B: Attempt any **three** questions. **(30 marks)**
SECTION C: This section is **compulsory** **(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 from this section.

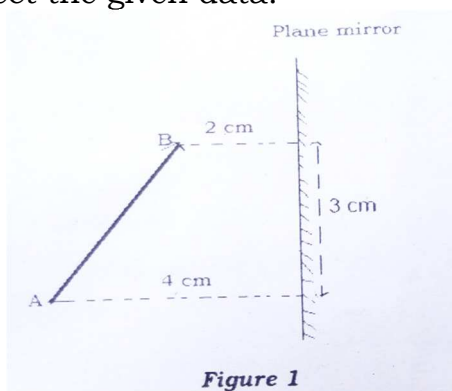
(55 marks)

1. For each statements below, indicate **true** if the statement is correct and **false** if it is wrong.
 - a) The SI Unit of temperature is degree Celsius. **(1 mark)**
 - b) The factors that affect the stability of an object are the size of the base of support, relation of the line of gravity to the base of support and the position of the centre of gravity. **(1 mark)**
 - c) Magnetic force is a contact force. **(1 mark)**
 - d) The gravitational force exerted by Earth (mass: $6 \times 10^{24} \text{ kg}$) on a 1 kg object is equal in magnitude to the gravitational force exerted by 1 kg object on Earth. **(1 mark)**
 - e) The mechanical energy of a freely falling object due to gravity (the only force acting on this object) is conserved. **(1 mark)**

2. Some terms used in environmental physics and related physics concepts are listed below:
Thermoregulation, plant growth, carbon dioxide, global warming, difference in temperature of the object and the environment, greenhouse effect.
Complete each of the blank spaces with appropriate term selected from the given list. Use each term only once and write only the missing term.

- a) One of the factors on which the Newton’s law of cooling depends is **(1 mark)**
- b)is the process that allows your body to maintain its core internal temperature. **(1 mark)**
- c) Environmental factors that affectinclude temperature, water, humidity, light and nutrition. **(1 mark)**
- d) is a gradual increase in overall temperature of the Earth’s atmosphere generally attributed to the **(1 mark)**
caused by increased level of **(1 mark)**

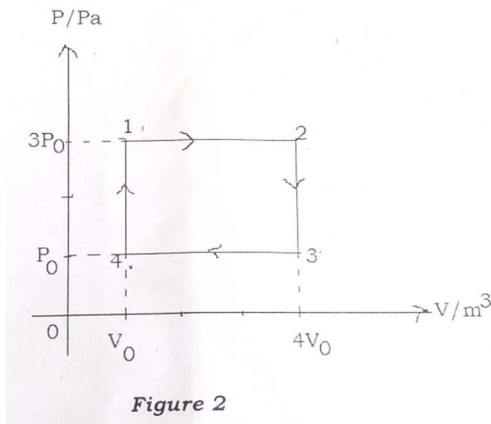
3. a) Copy figure 1 and use ray diagram to determine graphically the image of the object AB formed by a plane mirror. **(2 marks)**
Respect the given data.



- b) State any one characteristic of the obtained image. **(1 mark)**

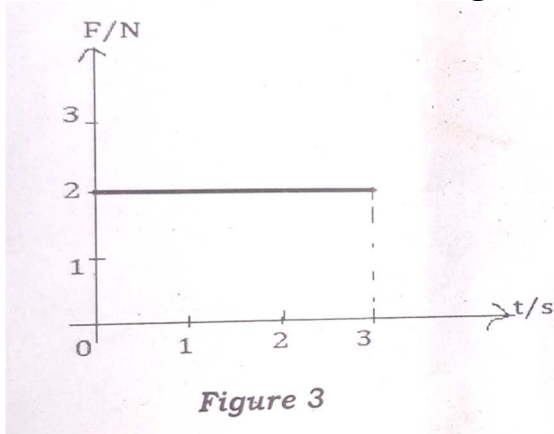
4. a) Do the laws of reflection of light apply to curved mirrors? If yes state them, if no explain why. **(2 marks)**
- b) The magnification m of an image formed by a spherical mirror is 3.
(i) Is the mirror convex or concave? **(1 mark)**
(ii) Is the image smaller or bigger than the object? **(1 mark)**
5. a) What is the SI unit of specific latent heat of fusion? **(1 mark)**
b) Why does a hot object removed from a source of heat cool down? **(1 mark)**
c) The specific heat capacity of water is $4200 \text{ J/kg}^\circ\text{C}$. What do you understand by this statement? **(1 mark)**
6. a) Give any one factor that affects the heating effect/joule effect of an electric current. **(1 mark)**
- b) When a compass is brought near a current carrying conductor, the needle of the compass gets deflected. What type of electric current does this simple experiment demonstrate? **(1 mark)**
- c) Name the effect of electric current different from the two effects mentioned above. **(1 mark)**
7. a) At which stage of the water cycle does the change from liquid water to water vapour occur? **(1 mark)**
b) i) State a process you may use to separate a mixture of sugar and water. **(1 mark)**
ii) What is the method used to separate a mixture of sand and water? **(1 mark)**
8. a) The first law of thermodynamics can be summarized using the expression $\Delta U = W + Q$ where all symbols have the usual meanings. What do the symbols Q and W stand for? **(2 marks)**
- b) What is the change in internal energy for a system that performs a work of 140 KJ on its surroundings and loses 60 KJ of heat? **(1 mark)**
- c) State any one real life application of the principles of thermodynamics. **(1 mark)**

9. Analyze the data from the following P (pressure) – V (volume) diagram (figure 2) and answer the sub questions below:
 When the ideal gas is in state 1, its temperature is T_1 .
 Thermodynamic process is the change in the state of a system that can occur at constant pressure, at constant volume, at constant temperature or without heat added or removed from the system.



- a) Describe the thermodynamic process from state 1 to state 2. **(1 mark)**
- b) Describe the thermodynamic process from state 2 to state 3. **(1 mark)**
- c) What ideal gas law can use to determine the temperature T_2 when the ideal gas goes from state 1 to state 2? **(1 mark)**
10. A piece of rock has a volume of $(30.00 \pm 0.10) \text{ cm}^3$ and a mass of $(60.30 \pm 0.20) \text{ g}$
 Find:
- a) The density of this rock without uncertainty. **(2 marks)**
- b) Its uncertainty. **(1 mark)**
11. a) How does atmospheric pressure vary with altitude? **(1 mark)**
- b) A black copper with a volume of 0.0456 m^3 is submerged in a tank of water. The density of water is $1.0 \times 10^3 \text{ kg/m}^3$ and $g = 9.81 \text{ m/s}^2$.
 What is the upward buoyant force/up thrust force due to water on this block of copper? **(2 marks)**

12. The force shown in the force against time graph (figure 3) acts on a 1.5 kg.



a) From the graph, find the impulse of the force at $t = 3\text{ s}$. **(2 marks)**

b) Use the relationship between impulse and momentum or another method to find the final velocity of the object at $t = 3\text{ s}$ if it was initially at rest. **(1 mark)**

13. A car travelling at an initial speed of 13 m/s accelerates uniformly to a speed of 25 m/s in 5 s.

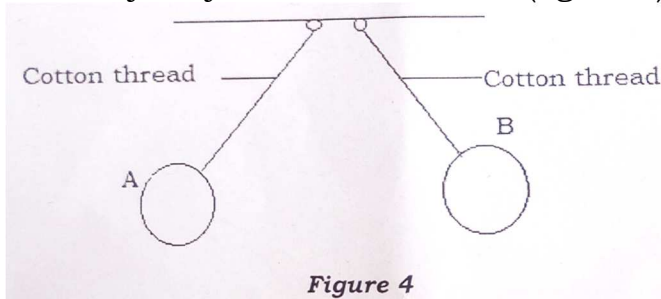
a) Calculate the magnitude of the acceleration of the car during the given interval. **(2 marks)**

b) Find the distance covered by this car in 5 s. **(2 marks)**

14. a) The maximum current in alternating current (AC) circuit is 3 A. What is the root mean square (rms) value of the current in this AC circuit? **(2 marks)**

b) A 400 mH coil of negligible resistance is connected to an AC circuit in which an effective electric current of 6 mA is flowing. Calculate the inductive reactance of the coil if the frequency of the AC is 1000 Hz. **(2 marks)**

15. a) A learner charges two balloons and hangs them side by side and immediately they interact as follows (figure 4).



(i) Explain the cotton threads are not vertical. **(1 mark)**

(ii) What are the possible types of electric charge of the balloon A and B respectively? **(1 mark)**

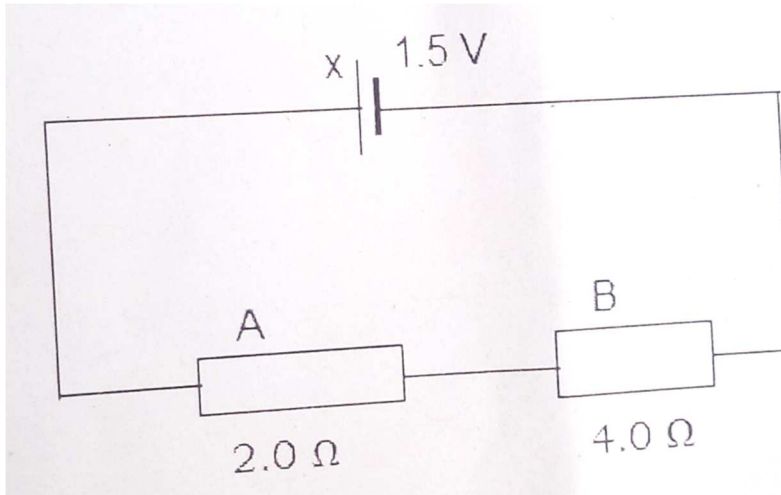
(iii) Suggest a method of charging used by the learner? **(1 mark)**

b) State the equation linking the electric potential V , the electric charge Q of the balloon A and the distance d where V is the electric potential created by Q at a distance d . **(1 mark)**

SECTION B: Attempt only three questions

(30 marks)

16. A cell X of electromotive force (e.m.f) 1.5 V and negligible internal resistance is connected to two resistors A and B as shown in figure 5.



a) Redraw the circuit and put in an ammeter to measure the current through the circuit and the voltmeter to measure the potential difference across the resistor B. **(2 marks)**

b) How are the resistors A and B associated? **(1 mark)**

c) The reading of the voltmeter is 1V (One volt). Find:
(i) The equivalent resistance of the circuit. **(2 marks)**
(ii) The total current in the circuit. **(2 marks)**

d) Find the electrical energy dissipated by the resistor A in 80 s. **(2 marks)**

e) The resistors A and B are wires of the same material. Why do the resistors have different resistance values? **(1 mark)**

17. The diagram below drawn not to scale (figure 6), shows an object 1 cm tall placed at 3 cm away from a concave lens (diverging lens) of focal length 6 cm.

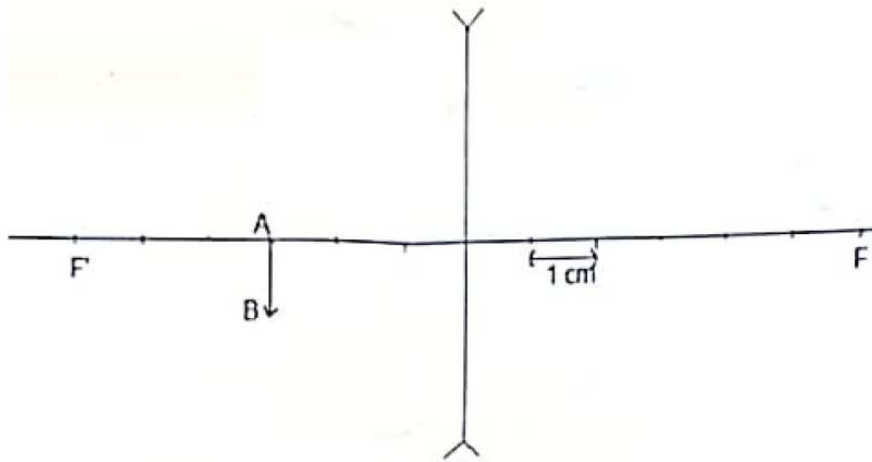


Figure 6

- a) Copy the diagram to scale and draw a ray diagram to illustrate the image formation of the object. **(3 marks)**
- b) Sign convention states that the focal length of a concave lens is negative. Use calculations and sign convention to determine the:
- Image position **(2 marks)**
 - Size of the image. **(2 marks)**
- c) (i) From the graph, determine any two properties of the image formed by this concave lens. **(2 marks)**
- (ii) Name any one use of concave lens in everyday life. **(1 mark)**
18. All living things need energy. You learned that energy is one of the requirements for life. However, it is not only living things that need energy to move and carry out various processes.

The machines and appliances in our world around us also need energy to do work. Energy sources can be classified into two categories: renewable energy sources and non-renewable energy sources namely fossil fuel and nuclear energy sources for power production.

Where does energy come from?

In order to answer this interrogation, answer the sub-questions below:

- a) (i) Identify one example of fossil fuel. **(1 mark)**
- (ii) Where do fossil fuels come from? **(1 mark)**
- b) (i) State any five renewable energy sources. **(5 marks)**
- (ii) Assess all renewable energy sources and write down any one renewable energy that is solar energy in origin. **(1 mark)**
- c) Formulate any two reasons why the government of Rwanda is encouraging people to use renewable energy sources by financing

biogas projects and thus makes investment subsidy for any digester meeting the requirements. **(2 marks)**

19. a) Enumerate any four types of simple machine. **(4 marks)**

b) What type of simple machine is each of the following tools?

(i) Stairs **(1 mark)**

(ii) A shovel/spade **(1 mark)**

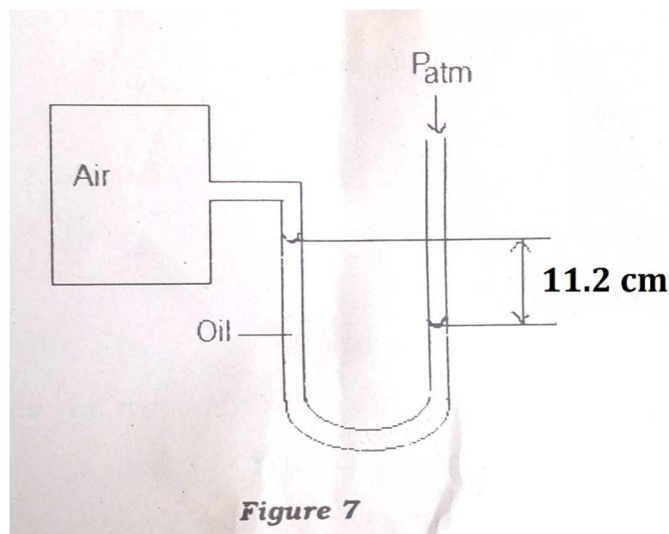
c) A pulley system has a velocity ratio of 4 and an efficiency of 80%.

(i) Determine the value of mechanical advantage of this pulley system. **(2 marks)**

(ii) Calculate the value of the effort required to raise the load of 480 N. **(2 marks)**

20. Figure 7 shows, not to scale, a sealed container filled with air and attached to manometer. The liquid in the manometer is an oil of density 860 kg/m^3 . The atmospheric pressure (P_{atm}) is 101.2 kPa and the acceleration due to gravity is $g = 9.81 \text{ d/s}^2$.

The vertical distance between the two oil surfaces is 11.2 cm.



a) What are the two real-life applications of manometer? **(2 marks)**

b) Express (i) the given atmospheric pressure (P_{atm}) in N/m^2 . **(1 mark)**

(ii) The distance between two oil surfaces in m. **(1 mark)**

c) Observe carefully the above manometer and answer the following sub-questions.

(i) Does air in the sealed container have more pressure than the atmospheric pressure? Justify your answer. **(2 marks)**

(ii) Calculate the pressure, P_{oil} , due to oil only. **(1 mark)**

- (iii) A learner says that the formula to be used to calculate the pressure of air, P_{air} , in the sealed container is $P_{\text{atm}} - P_{\text{air}} = P_{\text{oil}}$
 A learner B propose another formula $P_{\text{atm}} + P_{\text{air}} = P_{\text{oil}}$
 Who is right? **(1 mark)**
- (iv) Apply the correct expression to calculate the pressure of air (P_{air}) in the sealed container. **(2 marks)**

SECTION C: This question is compulsory.

(15 marks)

21. Engineers at a car company conducted various tests on a car moving on a special road. During one of the tests they measured the change in position during given time interval. They recorded the results in the table below:

Time t/s	Position X/m
0.0	0.0
1.0	5.0
2.1	10.0
3.0	15.0
3.9	20.0
5.0	25.0

- a) Suggest the purpose of this test. In other words, formulate the reason why they carried out such tests. **(1 mark)**
- b) For this test, write down:
 (i) Independent variable **(1 mark)**
 (ii) Dependent variable **(1 mark)**
- c) Use the information in the table above and draw a position –time graph. Put the position X along y-axis and the time t along x-axis. **(8 marks)**
- d) (i) Find the slope S of the graph. **(2 marks)**
 (ii) Interpret your result. **(1 mark)**
- e) Prove that the readings were subjected to a random error. **(1 mark)**