

Physics I

011

25/07/2024 08:30 AM – 11:30 AM



ORDINARY LEVEL NATIONAL EXAMINATIONS, 2023-2024

SUBJECT: PHYSICS I

DURATION: 3 HOURS

Instructions to candidates:

- 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 answer sheets if provided.
- 2) Do not open this question 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 (55 marks)

- 1) Complete each of the following sentences using appropriate term from the box.
You may use any key word once or not at all.

Magnetized	Magnetic field	Demagnetized	Magnetic pole
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- a) is a region at each end of a magnet where the magnetic field is strongest. **(1 mark)**
- b) Area around a magnet in which it can exert a magnetic force is called..... **(1 mark)**
- c) At around 80°C , a magnet will become permanently if exposed to this temperature for a period. **(1 mark)**
- 2) Identify the answer choice that best completes the statement or answers the question.
- a) The communication channel refers to:
- i) message being transmitted.
 - ii) the physical location where communication takes place.
 - iii) the medium through which the message is transmitted
 - iv) the person initiating the communication. **(1 mark)**
- b) Which of the following cables transmits signals in the form of light?
- i) Co-axial cable
 - ii) Fiber optical cable
 - iii) Wire pair cable
 - iv) Twisted pair cable **(1 mark)**
- c) The following *figure 1* represents an amplifier circuit.

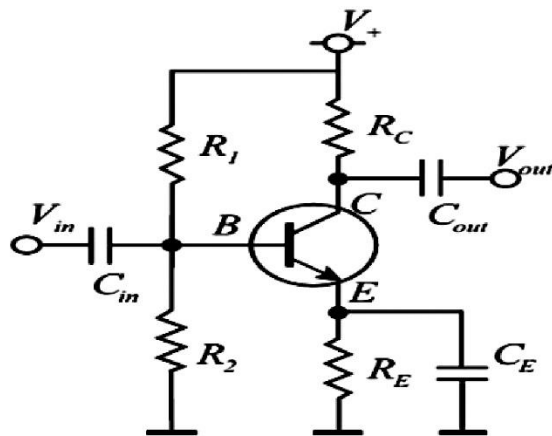


Figure 1

The electronic components shown on the *figure 1* are:

- i) resistor, inductor, transistor ii) resistor, capacitor, ordinary diode
- iii) resistor, capacitor, transistor iv) resistor, transistor, zener diode.

(1 mark)

d) Which of the electronic components below is a semiconductor device?

- i) Connecting wire ii) Inductor iii) Capacitor iv) ordinary diode

(1 mark)

3) Complete the following statements using correct terms from the alternatives.

a) Which of the following is a fixed point around which a lever rotates or pivots?

- i) Effort ii) Load iii) Fulcrum iv) Pulley **(1 mark)**

b) Mechanical advantage of a simple machine is

- i) effort / load ii) load / effort
- iii) load + effort iv) load – effort **(1 mark)**

c) The velocity ratio of a simple machine is the ratio of distance travelled by the to the distance travelled by the in the simple machine.

- i) load; load ii) effort; load iii) load; effort iv) effort ;effort **(1 mark)**

d) All vehicles move with the help of the simple machine called...

- i) wheel and axle ii) inclined plane iii) wedge iv) screw **(1 mark)**

4) State whether each of the following statements is **true** or **false**.

a) The pressure exerted by a static liquid increases linearly with increasing depth. **(1 mark)**

b) Ice floats on water because ice has less density than water. **(1 mark)**

c) A force acting on a larger surface area of an object exerts a larger pressure. **(1 mark)**

d) Relative density of a substance is the ratio of density of water to density of the substance. **(1 mark)**

5) State whether each of the following statements is **true** or **false**.

a) A car parked at the top of a hill possesses potential energy. **(1 mark)**

b) A ball dropped from a height h towards the Earth surface is an example of kinetic energy being converted into potential energy. **(1 mark)**

c) Geothermal energy is heat produced by burning natural gas. **(1 mark)**

6) Select the correct answer among the given alternatives.

- a) The *figure 2* below shows electric field pattern between two-point electric charges.

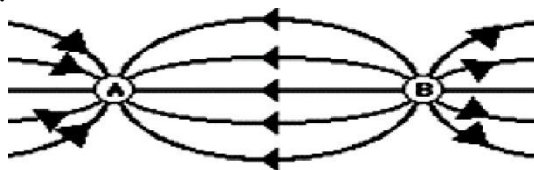


Figure 2

Which row indicates the nature of the electric charges **A** and **B**?

	A	B
i)	Positive	Positive
ii)	Positive	Negative
iii)	Negative	Negative
iv)	Negative	Positive

(1 mark)

- b) The amount of force exerted on a unit positive charge in an electric field is known as

- i) electric potential
iii) electric field intensity

- ii) electric flux
iv) electric current

(1 mark)

- c) What is the magnitude of electric potential V at a distance d away from an electric charge Q ?

i) $\frac{Q}{4\pi\epsilon_0 d}$

ii) $9 \times 10^6 \times \frac{Q}{d}$

iii) $9 \times 10^9 \times \frac{Q}{d^2}$

iv) $6.67 \times 10^{-11} \times \frac{Q}{d}$

(1 mark)

- d) Which of the following is an application of Electrostatics?

- i) Electric motor
iii) paint spraying

- ii) Electric generator
iv) Electromagnet

(1 mark)

7) Match the following physical quantities with their respective dimensional formula.

Physical quantities	Dimensional formula
a) Speed	i) $[ML^2T^{-2}]$
b) Density	ii) $[LT^{-1}]$
c)Acceleration	iii) $[ML^{-3}]$
d) Energy	iv) $[LT^{-2}]$

(4 marks)

8) a) Differentiate between a renewable and a non-renewable energy sources.

(2 marks)

b) Give any one example of the type of energy source below.

i)renewable energy source.

(1 mark)

ii)non-renewable energy source.

(1 mark)

9) You are given four statements:

A) A cheetah is running at 90 km/h east

B) A dog is walking at 5 km/h

C) At t=1 s, a runner is moving at 4 m/s west

D) At t= 5 s, a football is moving at 20 m/s

a) Which of the above statements is an example of instantaneous velocity?

(1 mark)

b) Justify your answer.

(2 marks)

- 10) The following diagram (figure 3) represents electricity generation, transmission and distribution.

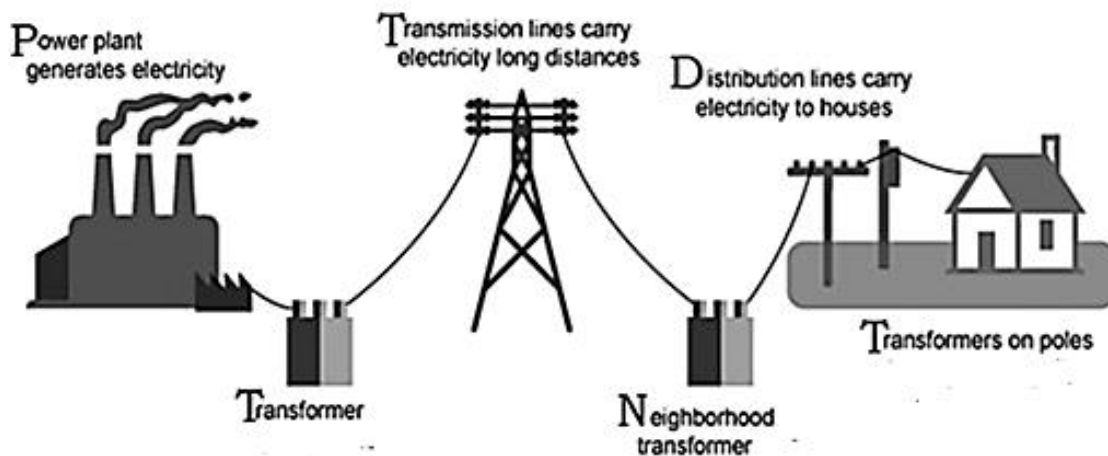


Figure 3

- Why is the efficiency of a real transformer less than 100%? **(1 mark)**
- Explain why the very thicker electric wires are preferable to be used for long electric transmission than thin ones. **(1 mark)**
- Identify the type of transformers on the pole shown above based on voltage level.

Use step down transformers or step up transformers to answer this question.

(1 mark)

- Why is electricity very important at home? **(1 mark)**

- 11) The brick shown in the diagram (figure 4) is being pushed by a force $\vec{F}$ on an unsmooth and horizontal table.

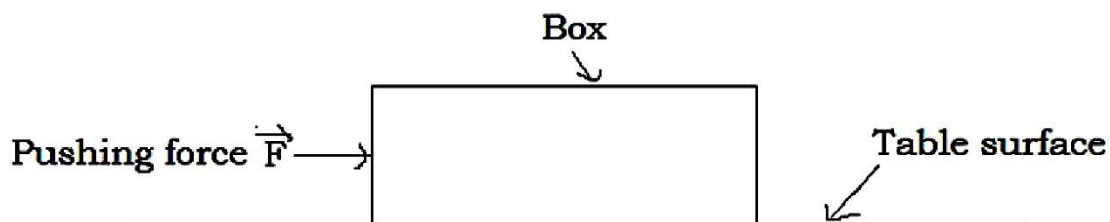


Figure 4

- The pushing force does not make the brick move.
Explain why.
 - the brick does not move rightwards. **(1 mark)**
 - the weight of the brick does not make it move downwards. **(1 mark)**

- b) A different pushing force $\vec{F}'$ does make the brick slide across the table from rest. The graph below (*figure 5*) shows the variation of the resultant force $\vec{F}_r$ acting on the brick with time t .

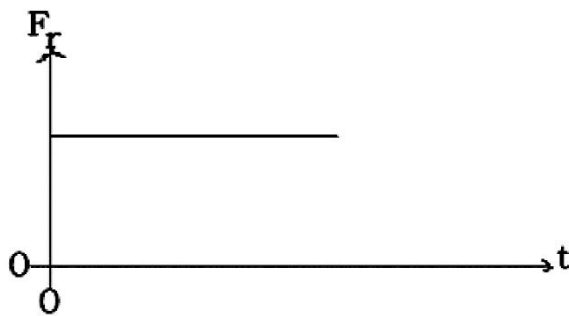


Figure 5

- i) Does the linear momentum P of the brick increase or decrease with time or remain constant? **(1 mark)**
- ii) Write down one thing that the sliding brick will do to the unsmooth and horizontal surface of the table. **(1 mark)**

- 12) A vehicle having rectilinear motion is moving with a velocity of 10 m/s and accelerates uniformly to 15 m/s over a distance of 125 m.

a) What is its acceleration?

- i) 1 m/s² ii) 1.5 m/s² iii) 0.5 m/s² iv) 0.04 m/s² **(2 marks)**

b) What will be the time taken to cover this distance?

- i) 5 s ii) 15 s iii) 20 s iv) 10 s **(2 marks)**

- 13) When electric current of 4 A passes through a certain resistor for 10 min, 2.88 x 10⁴ J of heat are produced. 1 kWh is energy consumed by a device of power 1 kW in 1 hour.

a) Convert electric energy $E = 2.88 \times 10^4$ J to kWh. **(1 mark)**

b) Calculate the voltage across the resistor. **(2 marks)**

- 14) Figure 6 shows an alternating current (AC) circuit comprising a pure capacitor and AC generator connected in series.



Figure 6

$$v = V_m \cos 2\pi f t$$

If the frequency f of electromotive force of AC generator is increased, what will be the effect on:

a) impedance of electric circuit? Justify your answer. **(2 marks)**

b) rms electric current flowing through this electric circuit?
Justify your answer. **(2 marks)**

- 15) What would happen to Earth without the hydrosphere?

Limit your answer to 10 lines maximum. **(3 marks)**

Section B: Attempt any three questions (30 marks)

- 16) When light passes through a lens, it is refracted at both faces of the lens.

a) Copy the diagram (figure 7) into your answer booklet and complete the path of the light ray through the section of the lens. Include the normal line at both faces.

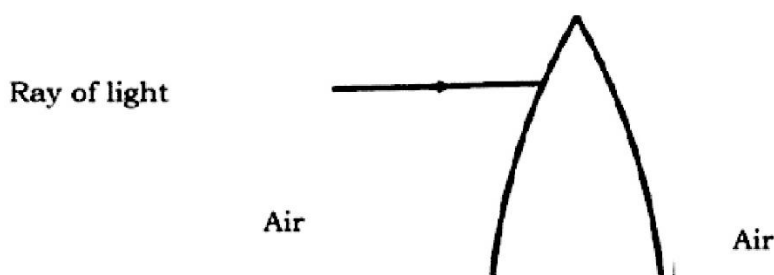


Figure 7

(2 marks)

b) Draw a ray diagram to show the formation of a virtual image in a converging lens. **(2 marks)**

c) A converging lens of focal length 25 cm and a diverging lens of focal length -10 cm are placed in contact.

i) Calculate

- the power of the converging lens. **(2 marks)**
- the power of the diverging lens. **(1 mark)**
- the power of the combination of these lenses. **(1 mark)**

ii) Is the system formed by this combination of lenses converging or diverging? Explain your answer by ignoring the lens thickness. **(2 marks)**

17) You are provided with the following components of electric circuit namely connecting wires, 1 ammeter, 1 voltmeter, 1 resistor, 1 rheostat, 2 dry cells and 1 switch/plug key.

Design a laboratory experiment to verify Ohm's law.

In your design, you should consider the following steps:

- a) Draw an electric circuit diagram showing the arrangement of the given laboratory materials; **(3 marks)**
- b) State the procedures to be followed and the measurements to be taken; **(3 marks)**
- c) Analyse the data collected during measurements; **(2 marks)**
- d) State at least two safety precautions to be taken during the experiment. **(2 marks)**

18) Ideal gas is a hypothetical gas whose molecules occupy negligible space and have no interactions, and which consequently obeys the gas laws exactly.

- a) Draw a graph that illustrates Boyle's law of ideal gas. **(2 marks)**
- b) A balloon has a volume of 2 500.0 ml of helium on a day when the temperature is 30.0 °C.
 - i) Convert 2 500.0 ml to litre(l). **(1 mark)**
 - ii) Convert 30.0 °C to kelvin(K). **(1 mark)**
 - iii) If the temperature at night falls to 283.0 K, what will be the volume of the balloon if the pressure remains constant? **(2 marks)**

c) Pure helium gas is contained in a leak-proof cylinder containing a movable piston. The initial volume, pressure, and temperature of the gas are 15 litres, 2.0 atm, and 310 K, respectively.

If the volume is decreased to 12 litres and the pressure is increased to 3.5 atm, find the final temperature of the gas. **(2 marks)**

d) A sample of gas in a rigid container has a pressure of 1.40 atm. Its temperature is increased to 312.5 K and the pressure is measured to be 2.38 atm. What was the initial temperature before heating? **(2 marks)**

19) Archimedes' Principle states that a body immersed in a fluid experiences an up thrust (buoyant force) and this is fundamental to the equilibrium of a body floating in motionless water.

a) Consider a massless balloon filled with 10^{-3} m^3 (1000 cm^3) of water in a container of water as shown in *figure 8*. The density of water is 1000 kg/m^3 (1 g/cm^3) and acceleration due to gravity $g = 9.81 \text{ m/s}^2$.

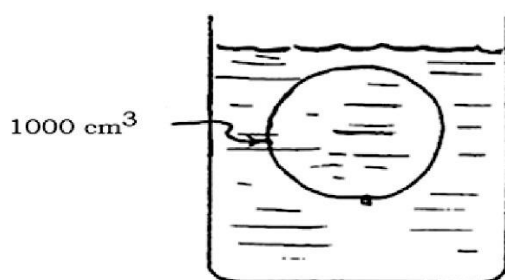


Figure 8

i) What is the volume of water displaced by the balloon? **(1 mark)**

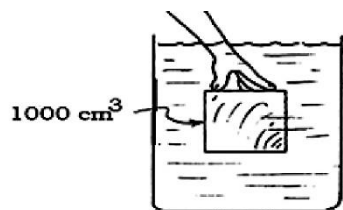
ii) Show that the weight of the water displaced in the container is 9.81 N. **(2 marks)**

iii) What is the buoyant force acting on the balloon?

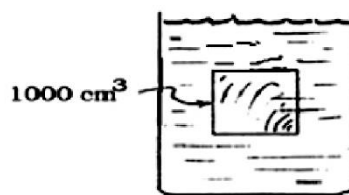
The figure shows that the body floats completely submerged just below the surface of the liquid without rising or sinking.

Explain your answer. **(2 marks)**

- b) Assume the balloon is replaced by a 0.5 kg piece of wood that has exactly the same volume (1000 cm^3 or 10^{-3} m^3), as shown in *figure 9* (1 and 2).



1) Piece of wood when it was submerged in water



2) Piece of wood just when it was released

Figure 9

- i) What is the buoyant force acting on the piece of wood just after it was released? **(1 mark)**
- ii) What is the weight of the piece of wood in air? **(2 marks)**
- iii) Just after releasing the piece of wood, will the piece of wood float partially immersed in the water, float completely submerged just below the surface of water or sink? Explain your answer. **(2 marks)**

20) Thermal expansion is the tendency of matter to change in shape, volume, and area in response to a change in temperature. The rise in temperature of a substance depends on the amount of heat transferred to it, its nature and its mass.

- a) i) Identify the general mode of heat transfer in Solids. **(1 mark)**
- ii) Identify the general mode of heat transfer in liquids. **(1 mark)**
- b) Differentiate between heat and temperature. **(2 marks)**
- c) The temperature of an iron block 20 cm long, 10 cm wide and 5 cm high is raised from 10°C to 40°C . The coefficient of linear expansion $\alpha = 1.2 \times 10^{-5}/^\circ\text{C}$. Find the physical quantities below:
 - i) initial volume of the iron block. **(2 marks)**
 - ii) coefficient of volume expansion of iron block. **(1 mark)**
 - iii) change in volume of this iron block. **(2 marks)**
 - iv) final volume of the mentioned iron block. **(1 mark)**

Section C: Compulsory question (15 marks)

21) In an experiment to investigate the relationship between the force on an object and the acceleration it experiences, a learner used the following experimental set up shown in *figure 10*.

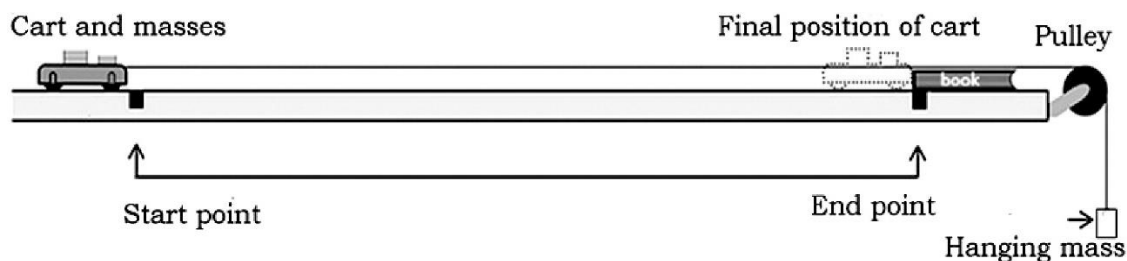


Figure 10

He/she recorded the readings in the table below

Force/N	a/ms ⁻²
0.20	0.40
0.25	0.52
0.30	0.60
0.35	0.68
0.40	0.80
0.50	1.00

Questions

- a) Identify a measuring instrument to measure the following physical quantities
- i) Mass. **(1 mark)**
 - ii) Distance. **(1 mark)**
- b) Provide a formula used to determine the acceleration of the cart. Justify your answer. **(2 marks)**
- c) Plot a graph of the force F applied to the body(y-axis) against its acceleration a (x-axis). You can draw the best fit line on a graph paper. **(6 marks)**
- d) i) What does your graph tell you about the relationship between the acceleration of the body and the force applied to it? Support your answer. **(2 marks)**
- ii) Determine the slope of your graph. Interpret your result. **(2 marks)**
- e) On a trial run of this experiment, a learner found that the graph did not go through all plotted points. Suggest any one reason for this. **(1 mark)**

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