Paper 1 (Theory)
April, 2026
2 hours

NTARE SCHOOL

END TERM ONE ASSESSMENT 2026

Uganda Advanced Certificate of Education

S5 PHYSICS

Paper 1 (Theory)

2 hours

INSTRUCTIONS TO CANDIDATES

This paper consists of **four** *assessment items.*
Respond to any **three** *items in all.*

Item 1: MECHANICS

A physics laboratory technician was confused about how to differentiate between derived and fundamental quantities. She could not figure out examples of these quantities as well.

One day, a University student on industrial training pursuing a course in civil engineering visited her in the laboratory in an attempt to

- find a formula relating the centripetal force, F, acting on a body of mass, m, moving in a circular path of radius, r at speed, V.
- determine the value of x in the formula $\frac{V}{t} = \frac{\pi P r^x}{8 \eta l}$

where V represents volume of water flowing inside a pipe of length, l and radius, r in time, t, P is the pressure difference across the ends of the pipe. This would help the student in designing these pipes.

However, the laboratory technician could not be of help in both cases. The student intends to design a pipe of length 12 m that allows flow of water through it at a rate of 125 m^3s^{-1} when the pressure difference across its ends is 170 Nm^{-2} but is not certain of the diameter of the pipe which can work.

You have been approached by the laboratory technician and the student on industrial training for help.

Hint:

- *Dimensions of* $\eta = ML^{-1}T^{-1}$
- *Coefficient of viscosity,* η of water $= 1.1 \times 10^{-3}Nsm^{-2}$

Task

As a learner with knowledge about physical quantities and dimensional analysis,

(a) Assist the laboratory technician to

(i) differentiate between the two physical quantities, giving two examples of each quantity.

(ii) generate the required formula for F (take $k = 1$).

(iii) determine the centripetal force, F on a body of mass 50 g moving at a speed of 108 kmh^{-1} in a circle of radius 0.4 m.

(iv) state one limitation in assessing the validity of the formula for F.

(b) Assist the student to;

(i) determine the value of x,

(ii) calculate the appropriate diameter of pipe that suits his target,

(iii) differentiate between scalar and vector quantities citing two examples in each case.

Item 2: HEAT

A food processing plant uses a large oil bath for frying products. The oil must be maintained at a precise temperature of exactly 180.0°C for quality control. If the temperature deviates by more than 2.0°C above or below this value, the entire batch must be discarded.

The plant's physicist has a platinum resistance thermometer and a constant volume gas thermometer. Both thermometers have been calibrated only at the ice point (0°C) and steam point (100°C).

The physicist knows the following:

- The platinum resistance thermometer has a resistance of $5.42\,\Omega$ at the triple point of water.
- The platinum resistance thermometer shows a resistance of $R_0 = 2.00\,\Omega$ at the ice point and $R_{100} = 2.48\,\Omega$ at the steam point.
- The constant volume gas thermometer records a pressure of $P_{tr} = 4.2 \times 10^4\,\text{Pa}$ at the triple point of water.

During a critical production run, the platinum resistance thermometer gives a resistance reading of $R_\theta = 2.60\,\Omega$. At the same time, the constant volume gas thermometer records a pressure of $P_T = 4.8 \times 10^4\,\text{Pa}$ at the oil bath.

The resistance of a platinum resistance thermometer varies with Celsius temperature θ (as measured by a gas thermometer) according to the equation

$$R_\theta = 50 + 0.17\theta + 3 \times 10^{-4}\theta^2$$

The physicist is confused because the two thermometers give slightly different temperature readings for the same oil bath. He must decide whether to discard the batch or allow production to continue.

Task

As a learner of Physics,

(a) define the triple point of water and explain why it is a more reliable fixed point than the ice point or steam point for calibrating thermometers like the constant volume thermometer.

(b) explain why the platinum resistance thermometer and constant volume gas thermometer give slightly different temperature readings for the same oil bath, even though both were calibrated at the ice and steam points.

(c) calculate the Kelvin temperature of the oil bath. Show your working.

(d) calculate the Celsius temperature θ of the oil bath as measured by the platinum resistance thermometer.

(e) compare the two temperatures you calculated in (b) and (c) with the required oil bath temperature of 180.0°C.

(f) Determine whether the actual oil bath temperature is within the acceptable range.

(g) advise the physicist whether to discard the batch or continue production, giving a reason for your answer.

(h) with the aid of a labeled diagram, describe how the constant volume gas thermometer was used to measure the oil bath temperature.

(i) calculate the temperature on the platinum resistance thermometer scale that corresponds to 60.0° C on the gas thermometer scale.

Item 3: LIGHT

In the morning lesson, the physics teacher introduced a new topic called light in which she said that light has properties like rectilinear propagation and reflection. Among other things to look at are laws of reflection and categorizing: stars, buildings, planets, lighted bulb, moon, glow worms, under luminous and non-luminous sources of light.

Ithiel is a learner in the class who was called upon to discuss these concepts. She stood up to tell the teacher that she knows nothing about the concept of light.

Besides Ithiel, is a plane mirror through which she realizes that her image is clearly seen but cannot see it clearly through the painted wall. One student says that it is because of the relation between glancing angle and the angle of deviation of the reflected ray of light but another said it is not.

Task

As a learner of physics doing light, help Ithiel and the rest of the class to:

(a) define the terms; light and reflection of light.

(b) categorize the different sources of light under luminous and non-luminous.

(c) state the laws of reflection of light.

(d) understand the meaning of rectilinear propagation of light through scientific investigation.

(e) know why she can see her image clearly through a plane mirror but not clearly through a painted wall.

(f) establish the relation between the glancing angle and angle of deviation of the reflected ray of light.

(g) name an instrument that can be used to see a distant star on earth and describe how it works.

Item 4: ELECTROSTATICS

A student was playing with a plastic ruler during a break. He rubbed the ruler vigorously against his hair for about 30 seconds. When he brought the ruler close to some tiny pieces of paper lying on a desk, the pieces of paper jumped and stuck to the ruler.

Excited by this, the student then rubbed a set of metallic keys against his head in the same way. However, when he brought the keys close to the same pieces of paper, nothing happened. The paper did not move at all.

The student was confused. "Both objects were rubbed the same way. Why did the ruler attract paper, but the keys did nothing?"

Task

Using your knowledge of electrostatics

(a) explain to the student what happened inside the ruler when it was rubbed against hair.

(b) why was the ruler able to attract small pieces of paper even though the paper was not charged?

(c) explain why the metallic keys had no effect on the pieces of paper after being rubbed in the same way.

(d) describe a simple scientific investigation that the student could carry out to find out whether the ruler becomes positively or negatively charged after rubbing it in hair. Include materials, steps, and what results to expect.

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