P510/1

PHYSICS

Paper 1 (Theory)

14th July 2026.

1½ Hours.

GANGU SECONDARY SCHOOL

UGANDA ADVANCED CERTIFICATE OF EDUCATION

S.5 MID TERM TWO ASSESSMENT 2026

PHYSICS.

PAPER 1 (THEORY).

Time: 1 ½ hours.

INSTRUCTIONS TO CANDIDATES:

This paper consists of three items.

Attempt ALL.

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ITEM 1

An internet service provider technician in Kampala is deploying fiber optic cables on the exterior wall of a commercial building. The technician uses a uniform aluminum ladder of length **5.0 m** and mass **20 kg.**

The technician places the upper end of the ladder against a smooth glass section of the vertical wall (where friction is negligible) and the lower end on a rough concrete pavement. For optimal reach, the base of the ladder is positioned exactly **3.0 m** away from the base of the vertical wall. Before climbing up with heavy tools, the safety assessment to determine if the pavement provides enough grip to prevent the ladder from dangerously slipping outward is required.

Tasks:

a) Analyze the physical system by drawing a clearly labelled free-body diagram showing all the forces acting on the ladder in this position.
b) Determine the magnitude of:
    i. The normal reaction force from the wall.
    ii. The frictional force acting between the base of the ladder and the concrete pavement.
c) If the maximum limiting friction coefficient (**μ**) between the rubber shoes of the ladder and this specific concrete is known to be 0.35, evaluate whether the ladder is safe in its current position or if it is on the verge of slipping. What technical advice would you give the technician regarding the placement distance from the wall to improve safety?

ITEM 2

National water and sewerage corporation (NWSC) is designing a new water distribution network to supply a growing residential area in Mukono. To prevent low water pressure at household taps, engineers use a mathematical model to estimate the volume flow rate of water $\left(\frac{v}{t}\right)$ through the main supply lines:

$$\left(\frac{v}{t}\right) = \frac{\pi r^4 p}{8\eta l}$$

Before procurement orders are placed for kilometers of high-density polyethylene (**HDPE**) pipes, the design validation board must verify that the engineering software's governing formula is physically sound. A newly hired intern claims that the estimation of flow capacity. You are tasked with resolving this dispute by conducting a dimensional analysis check.

Support material:

- t = Time taken for the flow.
- v = Volume of the liquid.
- r = Internal radius of the pipe.
- p = Pressure difference between the two ends of the pipe.
- l = Length of the pipe segment.
- η = Coefficient of viscosity of the liquid (Given dimensions: $[\boldsymbol{ML^{-1}T^{-1}}]$).

Constants $\boldsymbol{\pi}$ and **8** are dimensionless. ($[\mathbf{M^0L^0T^0}]$).

As the lead hydraulic engineer, draft a Design Verification Note:

a) State the baseline dimensions for the volume flow rate $\left(\frac{v}{t}\right)$ on the left-hand side.
b) Deduce and list the individual base dimensions for the radius (**r**), pipe length (***l***), and pressure difference (***p***).
c) Process the entire right-hand side to mathematically see whether the flow equation is dimensionally consistent

ITEM 3

During a structural analysis of a support frame, six coplanar concurrent forces act outwards from a central anchoring node. The directions and magnitudes of these force vectors are recorded as follows:

i. A force of **40 kN** acting in the direction **N 30° E**
ii. A force of **60 kN** acting in the direction **N 45° E**
iii. A force of **20 kN** acting in the direction **N 60° W**
iv. A force of **30 kN** acting in the direction **N 60° W**
v. A force of **50 kN** acting directly **Due South**
vi. A force of **15 kN** acting directly **Due East**

Tasks:

a) Draw a clearly labeled vector free-body diagram showing the true line of action for all six forces meeting at the central anchoring node.
b) Resolve all forces acting on the node into their respective horizontal (East-West) and vertical (North-South) components.
c) Calculate the total magnitude of the resultant force vector acting on the anchor.
d) Determine the exact direction (quadrant bearing) of this resultant vector.
e) State the magnitude and direction of a single additional balancing force required to bring the node into a state of complete static equilibrium.