MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF PURE AND APPLIED SCIENCE

DEPARTMENT OF APPLIED SCIENCE

UNIVERSITY ORDINARY EXAMINATION

2017/2018 ACADEMIC YEAR

FIRST YEAR **SECOND** SEMESTER EXAMINATION FOR DEGREE OF BACHELOR OF EDUCATION SCIENCE

APH 104 – WAVES AND OPTICS I

DURATION: 2 HOURS

DATE: 19TH APRIL, 2018

TIME: 9.00 – 11.00 A.M.

Instructions to Candidates:

1. Answer **Question 1** and **Any Other Two** questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A – ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE

a) Define the following terms
   i. Doppler effect
   ii. Refraction of light
   iii. Amptitude of a wave (3 marks)

b) Distinguish between transverse and longitudinal wave (2 marks)

c) State:
   i. Fermat's principle
   ii. Huygen's principle (2 marks)

d) The equation of a transverse travelling wave is $y = 4\ Sin\ 2\pi\ (5\ x\ 20t)$ where x and y are in metres and t in seconds calculate the:
   i. Amplitude (1 mark)
   ii. Wavelength (3 marks)
   iii. Period (2 marks)
   iv. Frequency (2 marks)
   v. Speed of the waves (2 marks)

e) State one consequence of Fermat's Principle (1 mark)

f) Describe Young's double slit experiment (6 marks)

g) Show that the speed of a wave can be expressed as $\mathrm{V} = \frac{\omega}{\mathrm{k}}$ where ω is the angular frequency and k is the wave number (3 marks)

h) By what factor would you have to multiply the tension in a stretched string in order to double the wave speed (3 marks)

SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

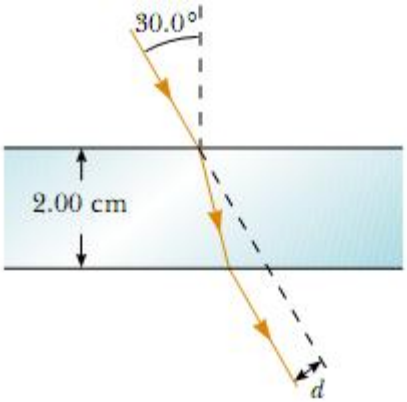
QUESTION TWO

a) Explain one application of total internal reflection (2 marks)

b) State the linear superposition principle (2 marks)

c) Derive the equations for the first three resonant modes/harmonies for:
   i. A closed pipe (6 marks)
   ii. A vibrating string (6 marks)

d) When the light illustrated in the figure below passes through the glass block, it is shifted laterally by the distance d. If n=1.5, what is the value of d? (4 marks)



QUESTION THREE

a) Two sources of sound are emitting waves of wavelengths 5m and 5.5m. If the sound velocity is 340 m/s, what number of beats will be produced (4 marks)

b) A turning fork of frequency 400Hz is moved away from an observer and toward a flat wall with a speed of 2 m/s. What is the apparent frequency

i. Of the unreflected sound waves coming directly to the observer? (4 marks)

ii. Of the sound waves coming to the observer after reflection? (4 marks)

iii. How many beats per second are heard? Assume the speed of sound in air to be 340m/s (2 marks)

c) A tuning fork vibrating at 512Hz falls from rest and accelerates at 9.80 m/s^2. How far below the point of release is the tuning fork when waves of frequency 485Hz reach the release point? Take the speed of sound in air to be 340 m/s. (6 marks)

QUESTION FOUR

a) How do standing waves differ from progressive waves (2 marks)

b) If one end of a heavy rope is attached to one end of a light rope, use mathematical equations to explain how the speed, the frequency and wavelength of a wave change as it travels into the lighter rope from the heavier one? (6 marks)

c) A flat flint glass plate (n=1.66) rests on the bottom of an aquarium tank. The plate is 8.00 cm thick (vertical dimension) and is covered with a layer of water (n=1.33) 12.0 cm deep. Calculate the apparent thickness of the plate as viewed from straight above the water (8 marks)

d) A uniform flexible cable is 20m long and has a mass of 5 kg. It hangs vertically under its own weight and is vibrated from its upper end with a frequency of 7Hz. Find the speed of the transverse wave on the cable at its midpoint (4 marks)