MACHAKOS UNIVERSITY

University Examinations 2019/2020Academic year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR FIRST SEMESTER EXAMINATION FOR

CERFICATE IN ELECTRICAL ENGINEERING AND ELECTRONICS.

ETC 101: APPLIED SCIENCE I

DATE: 5/12/2019 **TIME: 2.00-4.00 PM**

INSTRUCTION

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks)

Required data and constants:

$_{a}n_{g}$ = 1.572.

Velocity of sound in air 340m/s.

g = 10N/kg, Atmospheric pressure = 103000 pascals.

QUESTION ONE (30 MARKS)

a) i Define a sound wave. What is the SI unit for measuring the frequency of sound waves? (3 marks)

ii List two factors that affect the speed of sound in air (2 marks)

iii Explain how the following properties affect the loudness of sound

I. Amplitude

II. Frequency (2 marks)

iv A disc siren with 100 holes is rotated at a constant speed making 0.3 revolutions per second. If air is blown towards the holes, calculate:

I. The frequency of the sound produced (2 marks)

II. The wavelength of the sound produced (2 marks)

b) i How is radiation different from the other modes of heat transfer? (1 mark)

ii Briefly explain how the following factors affect thermal conductivity of a material:

I. The length of the conductor (1 mark)

II. The cross sectional area of the conductor (2 marks)

iii Draw the cross- section of a basic solar heating panel that uses heat from the sun to warm water which flows through the pipes. (3 marks)

iv Explain the following as regards the solar heater drawn in b(iii) above.

I. Why the pipe is fixed to a dark-coloured collector plate. (1 mark)

II. Why the pipe is coiled several times (1 mark)

III. Why the collector plate is fixed to an insulator (1 mark)

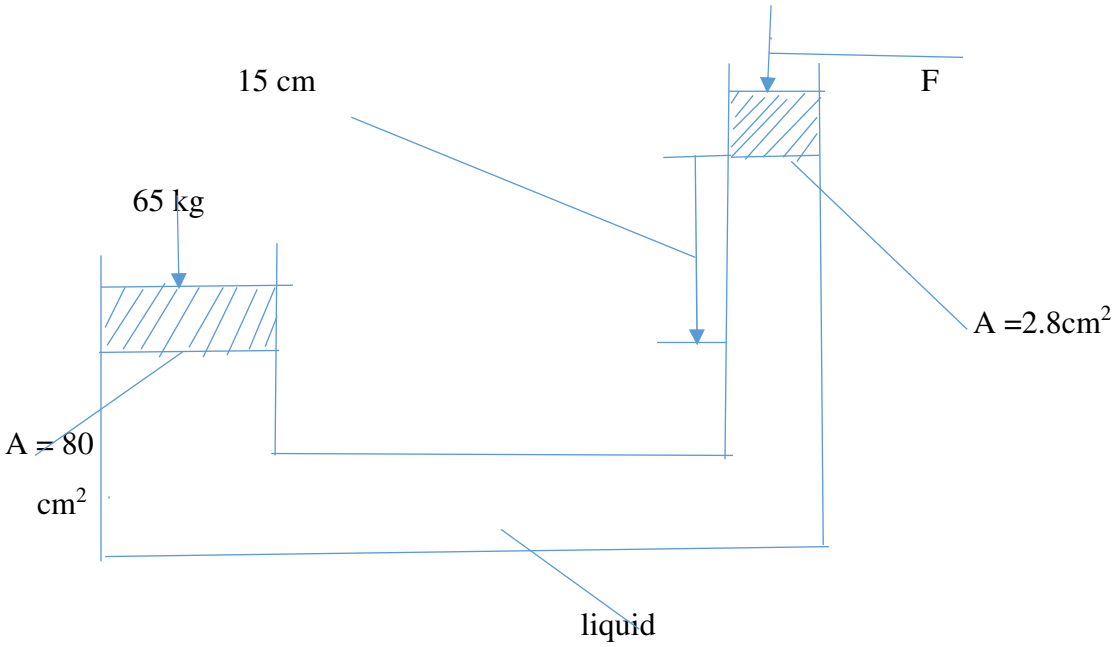
c) i Define the term refraction (1 mark)

ii Draw a diagram to show refraction of a ray of light across glass-air boundaries (1 mark)

iii Calculate the refractive index for light travelling from glass to air (2 marks)

d) i Explain how hydraulic machines work (2 marks)

ii The figure below shows two masses placed on light pistons. The pistons are held Stationary by the liquid whose density is $0.85g/cm^3$.



Determine the value of the force F (3 marks)

QUESTION TWO (20 MARKS)

a) Define pressure and state its SI units (2 marks)

b) In hydraulic press, a force of 200N is applied to a master piston of area $25cm^2$. If the press is designed to produce a force of 500N, determine:

I. The area of the slave piston (2 marks)

II. The radius of the slave piston (2 marks)

c) i Explain how a pressure gauge works. (2 marks)

ii The pressure of a car tyre measured with a pressure gauge is $40N/cm^2$.
What is the total pressure of the tyre in N/m^2? (3 marks)

d) i Define the term atmospheric pressure. (1 mark)

ii A sea diver is 30 m below the surface of sea water. Determine the total pressure on him if the density of the water is 1.03 g/cm^3 (3 marks)

e) i Explain briefly the principle of a simple mercury barometer (3 marks)

ii What test would be made to find out whether such barometer has any gas in the space above the mercury? (2 marks)

QUESTION THREE (20 MARKS)

a) Describe a simple experiment to show that water is a poor conductor of heat. (3 marks)

b) Distinguish between natural and forced convection currents. (2 marks)

c) Explain the following observation:

I. While heating water in a beaker, wire gauze is placed below the beaker. (2 marks)

II. Two thin blankets are warmer than a single thick one (2 marks)

III. The feet feel colder when a person stands on a cemented floor than when on a wooden floor. (2 marks)

d) Describe how a car engine cooling system works (5 marks)

e) Define lagging and give one of its applications (2 marks)

f) Explain the green-house effect and how it affects the earth (2 marks)

QUESTION FOUR (20 MARKS)

a) Differentiate between the following:

I. A ray of light and a beam of light. (2 marks)

II. A convergent beam and divergent beam (2 marks)

b) Draw a ray diagram to show how a pinhole camera forms an image (2 marks)

c) A pinhole camera of length 15 cm forms an image 3cm high of a man standing 9m In front of the camera. What is the height of the man? (2 marks)

d) Define the term refractive index (1 mark)

e) A ray of light passes through air into a certain transparent material. If the angles of incidence and refraction are 60^o and 35^o respectively, calculate the refractive index of the material. (2 marks)

f) The speed of light in medium m_1 is $2.0x10^8$ m/s and its speed in medium m_2 is $1.5x10^8$ m/s. Calculate the refractive index of medium m_2 with respect to medium m_1. (2 marks)

g) The table below shows the results obtained when a pin is placed at the bottom of a tall parallel sided glass jar containing a transparent liquid when viewed normally from the top.

Real depth (cm)	4.0	6.0	8.0	10.2	12.8
Apparent depth (cm)	2.44	3.66	4.88	6.10	7.32

I. Plot a graph of apparent depth against the real depth. (3 marks)

II. Using the graph determine the refractive index of the liquid (1 mark)

h) Define the term critical angle. Derive an expression for the relationship between critical angle and refractive index. (3 marks)

QUESTION FIVE (20 MARKS)

a) In air the the speed of sound is about 330 m/s. State and explain three factors that affect the velocity of sound in air. (3 marks)

b) State two differences between sound and light waves (2 marks)

c) Describe how pulse- echo technique is used to determine the distance of the reflecting Object. State two applications of this technique. (5 marks)

d) A person standing 49.5 m from the foot of a tall cliff claps his hands and hears an echo 0.3 seconds later. Calculate the velocity of sound in air. (3 marks)

e) i What is the relationship connecting the frequency, wavelength and velocity of sound in air? (2 marks)

ii An echo sounder in a ship produces a sound pulse and an echo is received from the sea bed after 0.2 seconds . If the velocity of sound in water is 1400m/s calculate the depth of the sea. (3 marks)

iii If the echo sounder had produced continuous waves of frequency 25 kHz what would be their wavelength in the water? (2 marks)