1904/103
PHYSICS TECHNIQUES I
June/July 2018
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

# CRAFT CERTIFICATE IN SCIENCE LABORATORY TECHNOLOGY

## MODULE I

PHYSICS TECHNIQUES I

**3 hours**

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**INSTRUCTIONS TO CANDIDATES**

*You should have the following for this examination:*
*Answer booklet;*
*Scientific calculator (battery operated).*
*This paper consists of **TWO** sections; **A** and **B**.*
*Answer **ALL** the questions in section **A** and any **TWO** questions from section **B** in the answer booklet provided.*
*Each question in section **A** carries **4** marks, while each question in section **B** carries **20** marks.*
*Maximum marks for each part of a question are indicated.*
***Candidates should answer the questions in English.***

**This paper consists of 5 printed pages.**

**Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.**

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**Turn over**

## SECTION A (60 marks)

*Answer **ALL** the questions in this section.*

1. Derive the SI units for:

   (a) acceleration; (2 marks)

   (b) density. (2 marks)

2. A cord of negligible mass which supports a maximum force of 80 N, is used to accelerate a 5.0 kg bucket of water from rest to a vertical distance of 15 m. Determine the minimum time required. (4 marks)

3. (a) State Newton's laws of motion. (3 marks)

   (b) State the principle of conservation of momentum. (1 mark)

4. Determine the minimum diameter of a circular steel wire 2.00 m long which stretches by a maximum of 0.25 cm when a force of 400 N is applied to the end of the wire. (Young Modulus for steel = $1.2 \times 10^{11}$ $Nm^{-2}$). (4 marks)

5. (a) State laws of reflection. (2 marks)

   (b) A speck of dirt is embedded 3.50 cm below the surface of a sheet of ice ($n = 1.309$). Determine its apparent depth when viewed at normal incidence. (2 marks)

6. (a) Define relative density. (1 mark)

   (b) Calculate the mass and weight of the air at 20° C in a living room with a $4.5\ m \times 6.0\ m$ floor and a ceiling 3.0 m high. (density of air = $1.2\ kg\ m^{-3}$). (3 marks)

7. An open storage tank contains water to a depth of 15.0 m. Determine the:

   (a) gauge pressure; (2 marks)

   (b) absolute pressures at the bottom of the tank (atmospheric pressure = $1.01 \times 10^5$ $Nm^{-2}$). (2 marks)

8. A 3000 kg car is slowed down uniformly from 20 m/s to 5.0 m/s in 4.0 seconds. Determine:

   (a) average force acting on the car during that time; (2 marks)

   (b) the distance travelled by the car during the time. (2 marks)

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9. The rotor on a helicopter turns at an angular speed of $3.20 \times 10^2$ revolutions per minute.

(a) Express this angular speed in radians per second. (2 marks)

(b) If the rotor has a radius of 2.00 m, determine the arc length traced in $3.00 \times 10^2$ seconds. (2 marks)

10. A hydraulic lift has input and output pistons with diameters 8.0 cm and 36.0 cm respectively. If a force of 825 N is exerted at the input piston, determine the weight that can be lifted by the output piston. (4 marks)

11. The weight of a metal bracket is measured to be 0.001 N in air and 0.092 N when immersed in water. Determine its density. (4 marks)

12. (a) State Boyle's law of gases. (1 mark)

(b) A tyre contains air at a gauge pressure of $5.0 \times 10^4$ pascals at a temperature of $30.0^{\circ}C$. After nightfall, the temperature drops to $-10.0^{\circ}C$. Determine the new gauge pressure in the tyre. (3 marks)

13. (a) Define specific heat capacity. (1 mark)

(b) A 255 g block of copper at 85° C is immersed in 155 grams of water in a cup at 25° C. Determine the equilibrium temperature, assuming the system is isolated and the heat capacity of the cup can be neglected.
(Specific heat capacity of copper = $400\ J\,kg^{-1}K^{-1}$). (3 marks)

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14. Give any **four** factors that influence the rate of heat flow through a conductor. (4 marks)

15. An object 2 cm high is placed at 15 cm in front of a converging lens of focal length 30 cm. Calculate:

(a) position of image; (2 marks)

(b) size of image. (2 marks)

## SECTION B (40 marks)

*Answer any **TWO** questions from this section.*

16. (a) Determine the energy transferred in 1.00 hour:

(i) By conduction through a concrete wall 2.0 m high, 3.65 long and 0.20 m thick. If one side of the wall is held at 20° C and the other side is at 5° C. (Coefficient of conductivity $= 0.2\ Wm^{-1}K^{-1}$). (2 marks)

(ii) Compare the energy transferred when thickness of wall is doubled. (3 marks)

(b) A rifle of mass 3.00 kg recoils on firing a bullet of mass 5.00 g horizontally with a velocity of 300 m/s. Determine:

(i) recoil velocity of rifle; (4 marks)

(ii) final momentum of bullet and rifle; (3 marks)

(iii) final kinetic energy of bullet and rifle. (3 marks)

(c) (i) State the pressure law of gases. (1 mark)

(ii) Sketch a graph that verifies Charles' law of gases. (4 marks)

17. (a) Determine the amount of energy required to change a 40 g ice cube from ice at $-10°C$ to steam at 110° C. (12 marks)

Specific heat capacity of ice $= 2100\ Jkg^{-1}K^{-1}$.
Specific heat capacity of water $= 4200\ Jkg^{-1}K^{-1}$.
Latent heat of fusion $= 3.36 \times 10^5\ Jkg^{-1}$.
Latent heat of vaporization $= 2.26 \times 10^6\ Jkg^{-1}$.
Specific heat capacity of steam $= 2080\ Jkg^{-1}K^{-1}$).

(b) An object 3 cm high is located at 20 cm and 50 cm in front of a converging lens of focal length 25 cm. Determine:

(i) position of image at both locations; (4 marks)

(ii) magnification at both positions; (2 marks)

(iii) compare the nature of image on both positions. (2 marks)

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18. (a) A 20.0 kg solid gold statue is raised from sea bottom. Determine the tension in the hoisting cable (assumed massless) when the statue is at rest and completely:

(i) under water; (6 marks)

(ii) out of the water; (2 marks)
(density of gold = $1.93 \times 10^3$ kgm$^{-3}$).

(b) A wheel has a radius of 4.0 m. Determine how far a point on the circumference travels if the wheel is rotated through angles.

(i) 30°; (2 marks)

(ii) 30 radians; (1 mark)

(iii) 30 revolutions. (2 marks)

(c) A car moving with a velocity of 36 km h$^{-1}$ accelerates uniformly at 1 ms$^{-2}$ until it reaches a velocity of 54 km h$^{-1}$. Calculate:

(i) time taken; (3 marks)

(ii) distance travelled during the acceleration; (2 marks)

(iii) velocity reached 100 m from the place where the acceleration began. (2 marks)

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19. (a) A one metre uniform rule has supports at point A (10 cm mark) and point B at 100 cm mark. A weight of 20 N is hanged at 30 cm mark and 50 N at 85 cm mark. If the metre rule weighs 2 N. Determine the forces at the supports A and B. (10 marks)

(b) Differentiate the **three** states of matter. (6 marks)

(c) There is global emphasis for countries to adopt solar energy as compared to fossil fuel to drive industrialization. State the advantages of solar energy in this respect. (4 marks)

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