THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA
CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

035

ENGINEERING SCIENCE
(For Both School and Private Candidates)

Time: 3 Hours **Friday, 08th November 2019 a.m.**

Instructions

1. This paper consists of sections A, B and C with a total of **fourteen (14)** questions.
2. Answer **all** questions in sections A and B and **three (3)** questions from section C.
3. Calculators, cellular phones and any unauthorized materials are **not** allowed in the examination room.
4. Write your **Examination Number** on every page of your answer booklet(s).
5. Where necessary, use acceleration due to gravity 'g' = 10 m/s^2.

SECTION A (10 Marks)

Answer **all** questions in this section.

1. For each of the items (i) – (x), choose the correct answer from among the given alternatives and write its letter besides the item number in the answer booklet provided.

(i) You are asked to ring the bell shown in Figure 1, which of the following motion will pertain your action?

A The bell will move upwards from its equilibrium or rest position.
B The bell will move downwards from its equilibrium or rest position.
C The bell will move forward to equilibrium or rest position.
D The bell will move to and fro from equilibrium or rest position.
E The bell will move upwards and then maintain this motion horizontally.

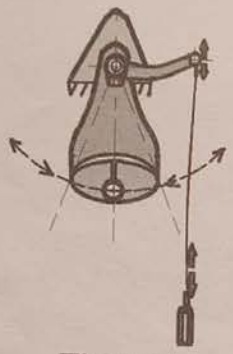

Figure 1

(ii) What is the relationship between friction force and normal reaction force?

A Friction force is direct proportional to normal reaction force.
B Friction force is inversely proportional to normal reaction force.
C Friction force is equivalent to normal reaction force.
D Friction force and normal reaction force are equal.
E Friction force is greater than normal reaction force.

(iii) What are the four characteristics a metal material depends on for it to break?

1 Magnitude of the force applied
2 Direction of the force applied
3 Cross-sectional area of the material
4 Nature of the material
5 Temperature of the material

A 1, 2, 3 and 5.
B 1, 2, 4 and 5.
C 2, 3, 4 and 5.
D 1, 3, 4 and 5.
E 1, 2, 3 and 4.

(iv) What is the refractive index of the glass, if the light has a velocity of 3×10^8 m/s in air and 1.97×10^8 m/s in a certain glass?

A 1.360 B 2.417 C 1.333
D 1.522 E 1.001

(v) Figure 2 shows an observation of the movement of a particle which moves in a form of wave. If the particle takes one second to move from original point 'P' to point 'Q', what is the frequency of this wave?

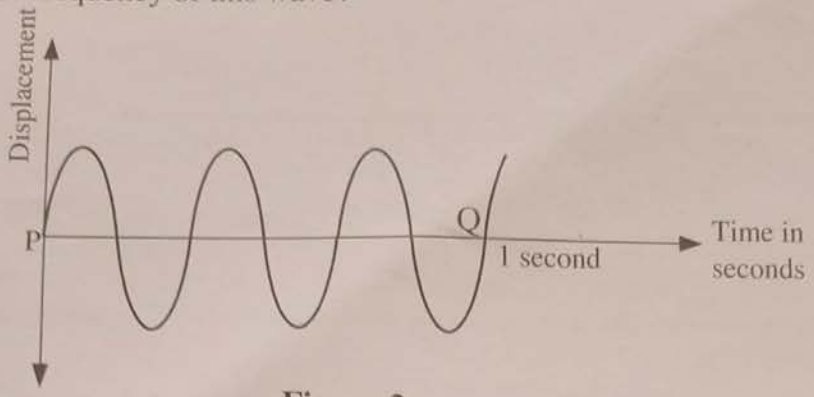

Figure 2

A 2.5 Hz B 3 Hz C 3.5 Hz D 1.5 Hz E 2 Hz

(vi) Why is it possible for cooking, heating and lighting to operate with different electrical power consumption while they get power from the same source?

A Because of the capacitors involved.
B Because of the inductors included.
C Because of the resistors employed.
D Because of the conductors being installed.
E Because of the insulators being used.

(vii) What is the reading of the vernier caliper in the Figure 3?

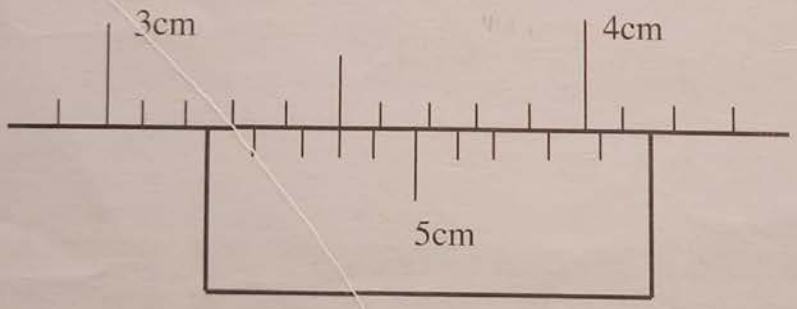

Figure 3

A 3.54cm B 3.53cm C 3.55cm D 3.25cm E 3.45cm

(viii) When a man pushes a wheel barrow and causes it to move away, what factors determine the work done?

A Distance and energy B Velocity and acceleration C Force and energy
D Force and distance E Force and acceleration

(ix) One of the important applications of the expansion of solids is bimetallic strip. Which one of the following is the areas in which the bimetallic is used?

A Motor, generator and transformer.
B Electric cooker, heater and oven.
C Thermostat, thermometer and electric iron.
D Alternator, dynamo and rectifier.
E Thermometer, heater and electric heater.

(x) Derived physical quantities are obtained by dividing or multiplying two or more fundamental physical quantities. Identify one of the derived physical quantity.

A Mass B Weight C Time
D Temperature E Length

SECTION B (45 Marks)

Answer **all** questions in this section.

2. Two boys are standing 10 m apart South to North and one has to kick the ball to another boy. If the boy at North kicked the ball to the boy in South at an angle of 45^{o} to horizontal, estimate the maximum height the ball will attain.

3. (a) Briefly explain how the strength of the magnetic field inside a solenoid can be made stronger.

(b) Why electrical cables are left loosen during installation of power transmission? Briefly explain.

4. What will be the magnitude of the resultant force if the following pulling forces act on a body? The forces are: 8 N due North, 10 N due West, 6 N 60^{o} South of West, 5N 45^{o} South of East and 3 N 30^{o} East of North. Use analytical method.

5. (a) Suppose you have been assigned to measure the following quantities:
(i) Density or relative density of liquid such as milk.
(ii) Atmospheric pressure.
(iii) Gases such as the pressure of steam in a boiler.
(iv) A pressure of a gas supply.
Identify the instrument that you would use in each case.

(b) Identify the principles that would be applied in the construction of a car hydraulic brake.

6. Two cars A and B situated 60 km apart all at rest started moving at the same time along a straight line in the same direction with uniform accelerations of 5 m/s^2 and 3 m/s^2 respectively. If car B was ahead of car A, how long in minutes will car A overtake car B?

7. An object of 10 cm high is placed at 30 cm away from a concave mirror. A 2 cm high image is formed on the same side as the object. Determine:
(a) the image distance from the mirror.
(b) the value of focal length.

8. Figure 4 shows a uniform wooden lath AB, weighing 1 N rests on two sharp-edged supports C and D. Calculate the reactions at the supports R_1 and R_2.

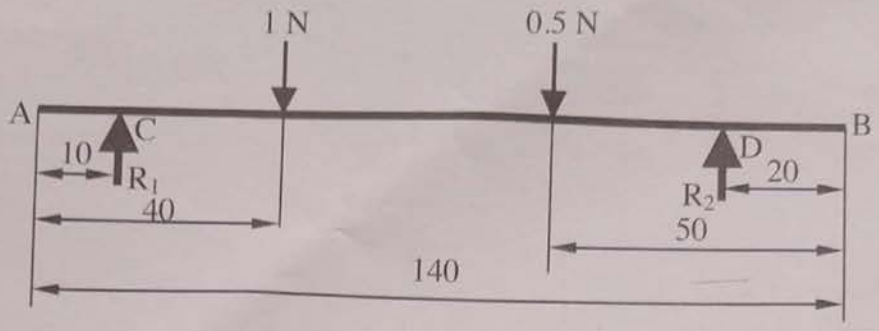

Figure 4

9. A car moving with a velocity of 10 m/s accelerates uniformly for 0.5 km until its velocity is 18 m/s. If the rolling diameter of the wheels is 600 mm, determine the wheels angular acceleration.

10. One boy in the mechanical workshop has to tight a nut of a school lorry. A force of 50 N is to be applied at right angles to the end of a spanner 150mm long. Find the work done by the boy if the spanner is moved through 150°.

SECTION C (45 Marks)

Answer **three (3)** questions from this section.

11. Suppose the equipment made up of 1kg of aluminium, 1.5 kg of copper and 2.5 kg of iron is cooled from 50°C to 20°C at a rate of 1.9 kJ/min. If the relative specific heat capacities are aluminum 0.21, copper 0.09 and iron 0.12.
    (a) Determine the thermal capacity of the equipment. **(11.5 marks)**
    (b) How long would it take to cool down the given range? **(3.5 marks)**

12. (a) A barrel weighing 1000 N is raised from the ground to a platform 1.25 m high by rolling it up on a plank. If the effort is applied in a horizontal direction (assuming that resistance due to friction is negligible), what length of plank is necessary to allow the barrel to be raised by a force of 250 N as shown in Figure 5. **(9 marks)**

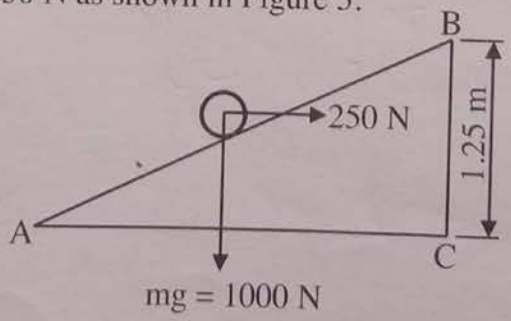

Figure 5

(b) A wooden windlass used by one of artisan miners has a crank of 30 cm long and a barrel of 15 cm diameter (assuming 80% efficiency). What is the effort required to raise a load of 300 N ? **(6 marks)**

13. (a) The weighted rod in Figure 6 floats with 6 cm of its length under water of density 1000 kg/m^3. What length of the rod is under the surface when the rod floats in brine of density 1200 kg/m^3. **(8 marks)**

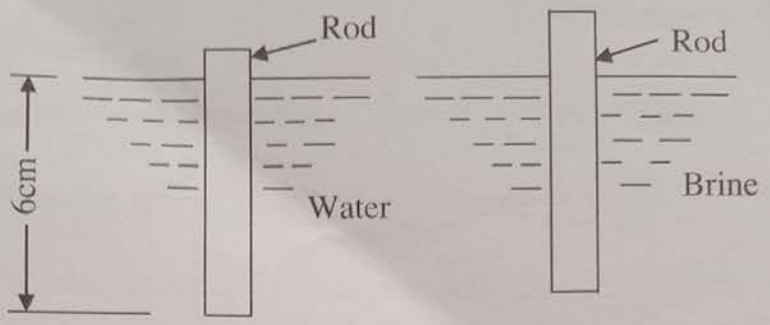

Figure 6

(b) A cube of volume 7.2 m^3 displaces 2000 N of water when floating in a swimming pool. What is the volume of the cube which is above the water surface? **(7 marks)**

14. (a) A new type of light bulb has recently been invented. It produces the same amount of light as an ordinary (old) 1000 W bulb but uses only 25 W of electrical power. It is expected to last for 5000 hours.

(i) How many kilowatt-hours does a 1000 W lamp use in 5000 hours?

(ii) How much will it cost if TANESCO charges 300 Tanzanian shillings for 1 kilowatt-hour? **(3.5 marks)**

(b) A house is on the main supply of 230 volts which supplies voltage to 1.5 kW hot plates, six 60 W lamps and a 100 W refrigerator. The hot plates are on a different fuse line from the lighting circuit which includes the refrigerator. What amount of current flows through the fuses in each line when all appliances are in use? **(5 marks)**

(c) A transformer in the Cement Factory, receives 0.55 A from 240 volts mains, it is used to light 12 volt – 40 watt lamps in parallel, find;

(i) its efficiency.

(ii) the total cost of using it for 10 hours at Tsh 300 per kilowatt – hour. **(6.5 marks)**