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 **Year: 2020**

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. Section A carries **ten (10)** marks and sections B and C carry **forty five (45)** marks each.
4. Calculators, cellular phones and any unauthorised materials are **not** allowed in the examination room.
5. Write your **Examination Number** on every page of your answer booklet(s).
6. Where necessary, use acceleration due to gravity 'g' = 10 m/s^2.

SECTION A (10 Marks)

Answer **all** questions in this section.

1. From 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) Which electrical component is represented by a symbol shown in Figure 1?

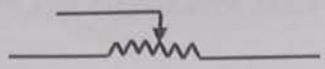

Figure 1

A A capacitor B A rheostat C An inductor
D A transformer E A fixed resistor

(ii) The depth of a sea can be easily estimated by applying the concept of
A resonance. B reverberation. C audibility range.
D ultrasonic waves. E echo.

(iii) Which one is the correct combination of the factors affecting the amount of heat energy required to cause raise in temperature of a given material?
A Mass, temperature change and the nature of material
B Mass, volume and temperature change
C Mass, density and nature of the material
D Volume, density and nature of the material
E Temperature, volume and density of the material

(iv) Which list represents examples of the third class levers?
A Scissors, spade and wheelbarrow
B Wire cutter, bottle opener and wheelbarrow
C Wheelbarrow, bottle opener and paper cutter
D Spade, tweezers and broom
E Broom, tweezers and wire cutter

(v) What happens when parallel light rays enter concave mirror?
A The mirror converges rays to principal focus which is virtual.
B The mirror converges rays to principal focus which is real.
C The mirror converges rays to radius of curvature which is virtual.
D The mirror converges rays to radius of curvature which is real.
E The mirror converges rays to principal axis which is real.

(vi) What does the 'tensile force' do on engineering material?
A It creates pressure on the material.
B It causes decrease in diameter of the material.
C It produces an increase in length of the material.
D It produces decrease in length of the material.
E It enlarges the diameter of the material.

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(vii) If a bucket is filled with water, the pressure at the bottom of a bucket will depend on
1 a density of water.
2 a bottom area.
3 a viscosity of water.
4 a depth of water.

A 1 and 3 B 2 and 4 C 2 and 3
D 3 and 4 E 1 and 4

(viii) What will happen when the circuit is switched on and the three identical bulbs P, Q and R are connected to a battery as shown in Figure 2?

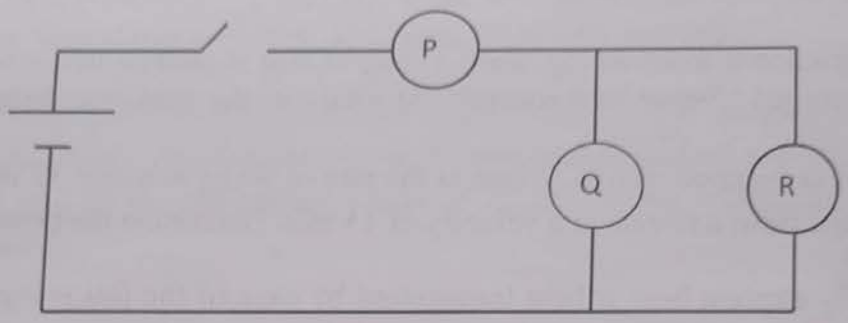

Figure 2

A Q and R will be brighter than P. B Q and R will not shine at all.
C All the bulbs will be equally bright. D P and Q will be brighter than R.
E Q and R will be dimmer than P.

(ix) What does a body of mass 'm' kilograms which is at a height of 'h' metres above the earth surface possesses?

A Magnetic energy B Gravitational energy C Thermal energy
D Potential energy E Kinetic energy

(x) Which of the following instruments would be preferred if an auto-mechanic is required to measure a diameter of a wire to the nearest 0.001 cm?

A Vernier caliper B Micrometer screw gauge C Screw gauge
D Vernier gauge E Micrometer linear gauge

SECTION B (45 Marks)

Answer **all** questions in this section.

2. (a) Why a ship made of iron floats in sea water while the iron nail sinks? Give two reasons.

(b) Why building designers made the wall of a dam much thicker at the bottom than at the top? Briefly explain.

3. A belt passing round a pulley of a grinding machine has a linear velocity of 44 m/s and the pulley has a radius of 200 mm. If there is no slippage of the belt on the wheel, how many revolutions per second are made by the pulley?

4. A gun is aimed horizontally at a target 60 m away. The bullet hits a target 0.08 m below the aiming point: Find the time of flight of the bullet and its speed as it emerges from the gun. Take $g = 10\ m/s^2$.

5. A stone is allowed to fall freely from the top of a tower 60 m high at exactly the same moment a second stone is thrown vertically upwards from the ground at a speed of 20 m/s. Calculate the required distance in meters above the ground at which the stones will pass each other.

6. (a) The frictional force acting when a bag of rice is pushed in a wheel barrow is 50 N. The load moved 25 m in 20.4 seconds. At what rate the work was done?

   (b) Water is pumped from a stream at the rate of 90 kg in every 30 seconds and sprayed on an orchard from a nozzle at a velocity of 15 m/s. Determine the power of the pump.

7. (a) Briefly explain how is heat transmitted by each of the following principal method of heat transmission.
   (i) Conduction (ii) Convection (iii) Radiation

   (b) A glass breaks when cold water in it is suddenly replaced by hot water. Briefly explain by giving three reasons.

8. (a) Why strings of different thickness are used on a stringed instrument such as violin or guitar?
   (b) Why the lowest pitch note played on drum is lower than that played on a guitar?

9. Figure 3 shows two co-planar forces 30 N and 50 N act at a point O. By using analytical method, calculate the value of the resultant force.

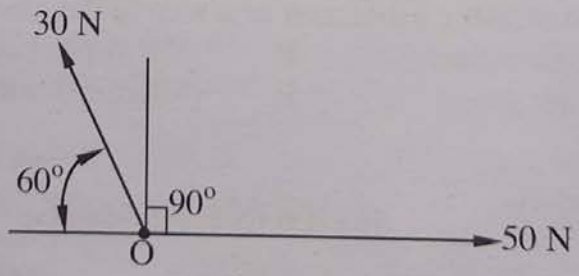

Figure 3

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10. The following instrument are found in Engineering science laboratory. Identify which class of lever does each belong to?
    (a) A bottle opener (b) A see – saw (c) A fishing rod
    (d) A fire tong (e) A claw hammer

SECTION C (45 Marks)

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

11. (a) A helical spring shortens by 25 mm when a compressive load of 150 N is applied. Calculate the total shortening if an additional 90 N were applied. **(7.5 marks)**

    (b) A tie bar having a 25 mm square section is 2 m long. When carrying a load of 33 kN its extension is 0.5 mm. Another tie bar of 20 mm square section and of the same material has a length of 1.25 m, and carries a load of 25 kN. What will be the extension of this second tie bar? **(7.5 marks)**

12. (a) A 4 kg block extends a spring by 16.0 cm from its upstretched position. Then a block is removed and a 2.5 kg body is hung from the same spring. If the spring is then stretched and released, what is the time period of oscillation? **(5 marks)**

    (b) A particle of mass 0.1 kg is suspended by a spring of force constant of 10 N. If the particle is displaced along the direction of the length of the spring, find its frequency of vibration. **(2.5 marks)**

    (c) A simple pendulum is formed by a bob of mass 2 kg at the end of a cord 600 mm long. Calculate;
        (i) an equivalent angular speed
        (ii) the period of oscillation and
        (iii) number of complete oscillations it will make per second. **(7.5 marks)**

13. (a) What is the coefficient of friction? **(1.0 marks)**
    (b) A machine of mass 300 kg rests on a plane inclined at 15^{o} to the horizontal. If the coefficient of friction between the machine and the plane is 0.3, by means of calculation determine;
        (i) the minimum force parallel to the plane, required to move the machine up the plane at constant speed.
        (ii) the minimum force parallel to the plane, required to pull the machine down the plane at constant speed.
        (iii) the minimum horizontal force necessary to move the machine up the plane. **(14 marks)**

14. (a) Sketch the diagram of a plane mirror and label the incident and the reflected rays of light. **(02 marks)**

(b) (i) Calculate the critical angle for a water – air surface, taking refractive index of water as $\frac{4}{3}$.

(ii) The critical angle of ice was found to be 51°. Calculate its refractive index. **(04 marks)**

(c) By using a simple well labelled diagram, explain how mirage occurs. **(06 marks)**

(d) If the speed of light in glass is 1.97×10^{8} and its refractive index is 1.52, calculate the speed of light in air. **(03 marks)**