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

035

ENGINEERING SCIENCE

(For Both School and Private Candidates)

Time: 3 Hours **Monday, 09th November 2015 a.m.**

Instructions

1. This paper consists of sections A, B and C.
2. Answer **all** the questions in sections A and B and **three (3)** questions from section C.
3. Calculators and cellular phones are **not** allowed in the examination room.
4. Write your **Examination Number** on every page of your answer booklet(s).
5. Acceleration due to gravity: $g = 9.81 m/sec^2$.

SECTION A (10 Marks)

Answer **all** questions in this section.

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

(i) Which group is of the basic units?
A Meter, Second and Newton
B Meter, Kilogram and Ampere.
C Meter, second and Joule.
D Ampere, second and Joule.
E Kilogram, Newton and Meter.

(ii) A pair of equal but opposite forces acting at a distance is called
A Coplanar
B Concurrent
C Couple
D Torque
E Weight.

(iii) Which of the following falls under the second class levers?
A Hammer
B Scissors.
C Spade.
D Wheel barrow
E Wheel barrow

(iv) The change of momentum is the same as
A Force
B Reluctance
C Impulse
D Inertia
E Work.

(v) In order for the vehicle to negotiate a corner the following force must be directed to the centre of the turn.
A Centripetal force
B Centrifugal force
C Frictional force
D Rolling force
E Gravitational force.

(vi) The property of the material to suffer penetrations after scratching it is called
A Plasticity
B Ductility
C Formability
D Harden ability
E Tenacity.

(vii) The multiple reflections of sound is known as
A Echo
B Resonance
C Reverberation
D Beat
E Tone.

(viii) Which of the following is a major factor for construction of a step-up transformer?
A The number of turns in primary coil is less than that in secondary coil.
B The number of turns in primary coil is greater than that in secondary coil.
C Size of winding in primary coil is larger than that in secondary coil.
D Size of winding in primary coil is smaller than that in secondary coil.
E Number of twins is the same in primary and secondary coil.

(ix) In light transmission, critical angle occurs when light moves from
A Dense medium to dense medium
B Dense medium to less dense medium
C Less dense medium to dense medium
D Less dense medium to less dense medium
E Dense medium to high dense medium.

(x) Which of the following is true with regard to liquids?
A Viscosity decrease with decrease in temperature.
B Viscosity if constant with increase in temperature.
C Viscosity increase with decrease in temperature
D Viscosity never follow temperature change.
E Viscosity increases at constant temperature.

SECTION B (30 Marks)

Answer **all** questions in this section.

2. Define and state SI unit for:
(a) Current.
(b) Quantity of electricity.

3. A car is travelling at 90km/h and when the brakes are applied it retards uniformly at $2m/s^2$
(a) How long does it take the car to stop?
(b) How far does it travel from the instant the brakes are applied?

4. Both metal Q and P loose the same quantity of heat when their temperatures fall from 60°C to 20°C. Find the mass of Q if the specific heat capacity of Q is twice that of P and the mass of metal P is 400kg.

5. A man holds a 10kg bag at rest at a height of 0.5m from the floor.
(a) How much work does he do?
(b) A man then lifts it straight up to a height of 2m from the floor. How much work does he do then?

6. Find the work done when a torque of 30Nm is applied to tighten a nut by turning it through an angle of 240°.

7. The frequency of a ray of light is 6.0 x 1014Hz and the speed of light in air is 3.0×10^8m/s. The refractive index of the glass is 1.5.
(a) Explain the meaning of the term 'refractive index'.
(b) What is the wavelength of light in air?

8. A torque of 150Nm is applied to a motor shaft at standstill so that it is made to rotate. The speed of the shaft increases from zero to 250rev/min in 15 sec. Find:
(a) The angular velocity of the shaft in rad/sec at the end of the 15sec.

(b) The angular acceleration in rad/sec^2.

9. A tie-bar in a steel structure is of rectangular section 50mm x 30mm. The extension measured in a 250mm length of the tie-bar when applying load to the structure is 0.1mm. Estimate the working stress in the tie-bar, take E as 205KN/mm^2 and the ultimate tensile stress as 460N/mm^2.

10. A balloon's fabric weighs 10N and it has a gas capacity of 3m^3. The gas in the balloon has a density of 0.1kg/m^3. If the density of air is 1.3kg/m^3, calculate the resultant force on the balloon when it is floating in air.

11. An electric train starts from rest on a level track and reaches a speed of 75km/h in 45seconds. The train has a mass of 250tonne and the total opposing force amount to 70N/tone. Calculate the average acceleration.

SECTION C (60 Marks)

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

12. (a) State Fleming's Right Hand Rule and Fleming's Left Hand Rule. **(03 marks)**

(b) A coil of 2000 turns gives rise to a magnetic flux of 4mwb when carrying a current of 5A. Estimate the average e m f that will be induced in the coil if a current of 5A is reversed in direction in one-tenth of a second. **(04 marks)**

(c) (i) Differentiate Ammeter from voltmeter.
(ii) A circuit consists of a wire in series with a parallel arrangement of 6Ω and 3Ω and a p d of 12v are connected to the whole circuit. Estimate the current in each of the three wires and the p d across each. **(13 marks)**

13. (a) Distinguish between hardness and brittleness of materials. **(03 marks)**

(b) A steel brake rod is 1.2m long and is subjected to a maximum load of 4.5 KN. If the extension of the rod is not to exceed 0.384 mm; determine a suitable diameter for the rod. Take young's modulus of elasticity as 200 x 10^{3}N/mm^2. **(06 marks)**

(c) The following results were obtained during a tensile test to destruction on a specimen of low carbon steel of diameter 11.28 mm and a gauge length of 50mm. Load at yield point 26KN, maximum load on specimen 47.5KN, final length at point of fracture is 67mm and the diameter of specimen at fracture is 8.2mm. From these results determine:
(i) Yield stress
(ii) Tensile strength
(iii) Percentage elongation
(iv) Percentage reduction in area. **(11 marks)**

14. (a) A uniform lever 150cm long is pivoted at its mid-point. A 50g mass is suspended from the left-hand end and an 80g mass from the right-hand end. A string is tied 50cm to the right of

the fulcrum passes upwards over a pulley so that a string is at 30° to the lever. With the aid of labeled sketch, evaluate the mass that must be suspended from the string for the lever to balance. **(14 marks)**

(b) A block and tackle system of 5 pulleys is used to raise a load of 500N steadily through a height of 20m. The work done against friction is 2000J. Evaluate the value of:
(i) Work done by the effort.
(ii) Efficiency of the system.
(iii) The effort applied. **(6 marks)**

15. (a) A long tube open at both ends is immersed in water with one end just projecting from the water. A small loudspeaker producing a note of frequency 425Hz is held above the mouth of the tube. If the tube and speaker are gradually raised, find the length of the air column in the tube when resonance first occurs, and in the second resonance. Ignore any end correction. (Take velocity of sound in air = 340m/sec). **(11.5 marks)**

(b) The shortest length of the air column in a resonance tube (one end closed), which resonate at a note of frequency 500Hz is found to be 160mm.
(i) Calculate the wavelength of the sound in air.
(ii) What is the velocity of wave in the air column?
(iii) What is the shortest length of column air which resonates in similar conditions to a note of frequency 800Hz. **(08.5 marks)**

16. (a) Differentiate between a ray and a beam of light. **(03 marks)**

(b) A pin-hole camera 200mm long produces an image of 2mm diameter of the sun. If the sun's distance from the earth is about 1.5×10^8km, estimate;
(i) The sun's diameter.
(ii) The diameter of the disc which will just 'cover' the sun's disc when held 1meter from the eye. **(08.5 marks)**

(c) State two conditions for total internal reflection of light to occur. **(03 marks)**

(d) A mirage is often seen by a motorist as a pool of water on the road some distance ahead.
(i) Draw a sketch diagram to show the formation of a mirage.
(ii) Give an explanation of formation in (d) (i) above. **(05.5 marks)**