THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

FORM TWO NATIONAL ASSESSMENT

035 ENGINEERING SCIENCE

Time: 2:30 Hours **ANSWERS** **Year: 2021**

Instructions

1. This paper consists of Section **A, B** and **C** with a total of **ten (10)** questions
2. Answer **al**l questions.
3. Section **A** and **C** carry **fifteen (15)** marks each and section **B** carries **seventy (70)** marks
4. Cellular phones and unauthorized materials are not allowed in the assessment room
5. Write your **Assessment Number** at the top right-hand corner of every page.

FOR ASSESSOR'S USE ONLY

QUESTION NUMBER	SCORE	ASSESSOR'S INITIALS
1		
2		
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4		
5		
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7		
8		
9		
10		
TOTAL		
CHECKER'S INITIALS		

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SECTION A (15 Marks)

Answer all questions in this section.

1. Choose the correct answer from the given alternatives and write its letter in the box provided.

(i) All measurements in engineering science are related to the fundamental quantities. What are the five fundamental physical quantities in the SI unit system?

A. Mass, Temperature, Light, Time and Length

B. Time, Length, Mass, Temperature, and Luminous Intensity

C. Length, Density, Temperature, Mass and Time

D. Luminous Intensity, Light, Length, Mass and Temperature

The five fundamental SI quantities are Time, Length, Mass, Temperature, and Luminous Intensity.

Answer: B

(ii) An operator man uses a hydraulic press to lift a container. What will be the mechanical advantage, if the hydraulic press is frictionless?

A. Greater than velocity ratio

B. Smaller than velocity ratio

C. Equal to velocity ratio

D. Twice than velocity ratio

For a frictionless hydraulic press, mechanical advantage (MA) equals velocity ratio (VR), as no energy is lost to friction.

Answer: C

(iii) Form Two students were arguing about examples of the effects of force which can be experienced on a body. Which is true concerning the effects of forces experienced on body?

(i) A force reduces the speed of a body in motion

(ii) A force can cause a body to move faster

(iii) Shape can be changed to a new shape by a force

(iv) The direction of a moving body can be changed to other direction by force

(v) Mass of a body is increased by force

(vi) A force can cause damage such as a crack on body

A. (i), (ii), (iii), (iv) and (vi)

B. (i), (ii), (iii), (iv) and (v)

C. (i), (ii), (iii), (v) and (vi)

D. (i), (ii), (iii), (v) and (iv)

Forces can reduce speed, accelerate, change shape, alter direction, and cause damage (i, ii, iii, iv, vi). Mass is not increased by force (v is false).

Answer: A

(iv) An engineer observed that, parts of machine rubbing against each other causes friction that leads to unnecessary heat, noise and wear. How can this problem be minimised?

A. By reducing the speed of the rubbing surface in contact

B. By increasing the areas of the rubbing surface in contact

C. By replacing the parts of rubbing surfaces with parts made of graphite material

D. By lubricating the rubbing surfaces in contact with grease and oil

Lubricating with grease or oil reduces friction by creating a low-friction layer, minimizing heat, noise, and wear.

Answer: D

(v) You are assigned to make a presentation in the class on how to make a sensitive or quick to act thermometer. What features will you consider when manufacturing the thermometer?

A. A large bulb with a wide capillary tube

B. Wide capillary in small bulb

C. Large bulb with a narrow capillary tube

D. Small bulb with a thin glass wall

A sensitive thermometer needs a large bulb (more liquid for expansion) and a narrow capillary tube (small volume amplifies liquid movement).

Answer: C

(vi) An electric bell is placed in a vacuum room and starts ringing when switched on. What will be witnessed by an observer outside the room?

A. The observer will not hear the sound

B. The observer will hear the echo of the sound

C. The observer will hear loud sound

D. The observer will hear some sort of reverberation

Sound requires a medium to travel. In a vacuum, no sound is transmitted, so the observer will not hear the bell.

Answer: A

(vii) Form two student was assigned to measure the potential difference between the points and an electric current in a circuit. Which measuring instruments should the student have before carrying out the measurements?

A. A wattmeter and an Ammeter

B. A voltmeter and Wattmeter

C. Voltammeter and an Ammeter

D. A voltmeter and an Ammeter

Potential difference is measured with a voltmeter, and current with an ammeter.

Answer: D

(viii) Kazimoto who is a Form Two student was pushing his books cabinet to its position after finishing the cleanliness of his room. During this activity his friends Maganga, Gwalu, and Hogoma, who were watching him made a comment:

(i) Maganga said: Good Kazimoto, you are so powerful as you have managed to use your energy with respect to time and power with energy to store the cabinet to its position

(ii) Gwalu commented to Maganga: Power and energy are two different things, energy is the Power per time taken and power is the ability to do work

(iii) Hogoma responded to Gwalu: Power is the rate of doing work and energy is the ability to do work

(iv) Kazimoto commented as well that, energy is the capacity to perform work while power is the energy consumed per time taken

From their arguments, who was right?

A. Kazimoto and Gwalu

B. Kazimoto and Hogoma

C. Gwalu and Hogoma

D. Maganga and Kazimoto

Energy is the capacity to do work, and power is the rate of doing work (energy per time). Hogoma (iii) and Kazimoto (iv) are correct.

Answer: B

(ix) One student was assigned by a teacher to write a formula for calculating resultant force (R) formed by two forces, pulling a heavy concrete slab along a horizontal surface by means of two ropes where the ropes made an angle of 90° between them. If the forces in the ropes were F_1 and F_2 respectively which is the correct formula?

A. $R = \sqrt{(F_1^2 + F_2^2)}$

B. $R = \sqrt{(F_1^2 - F_2^2)}$

C. $R = \sqrt{(F_1 + F_2)}$

D. $R = \sqrt{(F_1 - F_2)}$

For two forces at 90°, resultant force $R = \sqrt{(F_1^2 + F_2^2)}$ (vector addition).

Answer: A

(x) Engineering Science teacher presented the diagram shown in Figure 1 on the blackboard and asked the students to give the name of the product of the parameters 'F' and 'a' what will be the student answer to the teacher?

A. Work done

B. Torque

C. Moment

D. Impulse

Without Figure 1, assume F is force and a is distance (lever arm). Product F × a is torque (or moment, used interchangeably).

Answer: B

2. Match the linear motion actions in List A with the corresponding parameters in List B by writing the letter of the correct answer in the table provided.

List A

(i) Is a decreasing velocity with time

(ii) It is a distance in a specific direction

(iii) Is a path of an object from one point to another

(iv) Is a rate of change of displacement

(v) Is a rate of change of velocity

List B

A. Acceleration

B. Change in velocity

C. Displacement

D. Distance

E. Gravitational acceleration

F. Retardation

G. Speed

H. Velocity

(i) Decreasing velocity → F (Retardation)

(ii) Distance in a direction → C (Displacement)

(iii) Path of object → D (Distance)

(iv) Rate of change of displacement → H (Velocity)

(v) Rate of change of velocity → A (Acceleration)

SECTION B (70 Marks)

Answer all questions from this section.

3. Given the data in the table below:

Test	Distance in meters	Time taken in seconds
1	30	10
2	42	12

(a) Calculate the initial velocity and uniform acceleration.

Using $s = ut + \frac{1}{2}at^2$:

Test 1: $30 = u \times 10 + \frac{1}{2}a \times 10^2 \rightarrow 30 = 10u + 50a$ (1)

Test 2: $42 = u \times 12 + \frac{1}{2}a \times 12^2 \rightarrow 42 = 12u + 72a$ (2)

Solve: Multiply (1) by 12, (2) by 10:

$360 = 120u + 600a$ (3)

$420 = 120u + 720a$ (4)

Subtract (3) from (4): $60 = 120a \rightarrow a = 0.5\ m/s^2$

Substitute a into (1): $30 = 10u + 50 \times 0.5 \rightarrow 30 = 10u + 25 \rightarrow u = 0.5\ m/s$

Answer: Initial velocity = 0.5 m/s; Acceleration = $0.5\ m/s^2$

(b) Determine the final velocity at each round of a test. The recorded data provided were as shown.

$v = u + at$

Test 1: $v = 0.5 + 0.5 \times 10 = 5.5\ m/s$

Test 2: $v = 0.5 + 0.5 \times 12 = 6.5\ m/s$

Answer: Test 1: 5.5 m/s; Test 2: 6.5 m/s

4. (a) Draw a Leclanché cell diagram showing the structure of the cell, and name its four main components.

Description: A container with a zinc rod (negative) and carbon rod (positive) in ammonium chloride paste, surrounded by manganese dioxide depolarizer.

Components: Zinc (anode), Carbon rod (cathode), Ammonium chloride (electrolyte), Manganese dioxide (depolarizer).

(b) (i) Briefly explain the effect of the formation of a layer of hydrogen on the positive terminal.

Hydrogen gas forms on the carbon rod, insulating it, reducing current flow, and causing polarization, which lowers cell efficiency.

Answer: Hydrogen insulates carbon rod, reducing current and efficiency.

(ii) How can the formation of a layer of hydrogen on the positive terminal in (b)(i) prevented.

Use manganese dioxide as a depolarizer to oxidize hydrogen, preventing buildup.

Answer: Manganese dioxide oxidizes hydrogen.

(c) Give one advantage and one disadvantage of using the cell.

Advantage: Simple, inexpensive design.

Disadvantage: Low power output, unsuitable for heavy loads.

Answer: Advantage: Inexpensive. Disadvantage: Low power output.

5. (a) A Form Two teacher wrote the following statement on the blackboard "friction force is directly proportional to the normal reaction between two surfaces in contact with relative motion." Derive a mathematical equation represented by this statement.

Frictional force $F_f \propto$ Normal force N

$F_f = \mu N$, where μ is the coefficient of friction.

Answer: $F_f = \mu N$

(b) Using the formula obtained in (a), find the coefficient of friction where a block of 2 kg is pulled on a rough horizontal surface with a force of 15 N.

Assume constant velocity (F_f = applied force = 15 N).

Normal force $N = mg = 2 \times 9.81 = 19.62$ N

$\mu = F_f / N = 15 / 19.62 \approx 0.764$

Answer: Coefficient of friction ≈ 0.764

6. In an experiment of expansion of metals, student heated a steel ball to a temperature of 50°C to give a diameter of 50.25 mm. The ball was then placed over a hole of diameter 50 mm. Estimate the temperature of the ball as to drop it through the hole. (Consider $\alpha = 0.000012$ /°C).

To drop through, diameter must be ≤ 50 mm.

$\Delta D = 50.25 - 50 = 0.25$ mm

$\Delta D = D_0 \times \alpha \times \Delta T$

$0.25 = 50 \times 0.000012 \times \Delta T$

$\Delta T = 0.25 / (50 \times 0.000012) = 416.67$°C

Initial T = 50°C, so final T = 50 - 416.67 ≈ -366.67°C (cooling required, unrealistic; assume cooling to 0°C or error in problem).

7. Suppose you are given a 100 g of lead shots, measuring cylinder partly full of water to a reading of 80 ml. When lead shots placed into it, the reading rose to 88.8 ml. Estimate the density and relative density of the lead shots.

Volume = 88.8 - 80 = 8.8 ml = 8.8 cm^3

Density = Mass / Volume = 100 g / 8.8 cm^3 ≈ 11.364 g/cm^3

Relative density = Density / Density of water = 11.364 / 1 = 11.364

Answer: Density ≈ 11.364 g/cm^3; Relative density ≈ 11.364

8. (a) In an engineering science laboratory teacher received the following equipment: Wheelbarrow, Scissors, Spade, Nut Cracker, Tong, and Fishing rod. Arrange these equipments according to their classes of lever.

First-class (fulcrum between effort and load): Scissors, Nut Cracker, Tong.

Second-class (load between fulcrum and effort): Wheelbarrow.

Third-class (effort between fulcrum and load): Spade, Fishing rod.

Answer:

First-class: Scissors, Nut Cracker, Tong

Second-class: Wheelbarrow

Third-class: Spade, Fishing rod

(b) A student used a lever to shift a heavy iron block from one point to another during the cleanliness session in the workshop as shown in the Figure 2. Calculate the mechanical advantages of this lever.

Without Figure 2, assume a first-class lever with effort arm L_e and load arm L_l.

Mechanical advantage (MA) = L_e / L_l.

Assume typical values (e.g., L_e = 1 m, L_l = 0.2 m):

MA = 1 / 0.2 = 5

Answer: MA = 5 (assumed lever arms).

Note: Figure needed for exact MA.

9. (a) A motor vehicle technician was servicing an engine in an automotive garage. He noted that the engine has mass of 150 kg and suspended by a crane with 4 m above the ground. Determine the potential energy due to its position.

PE = mgh = 150 × 9.81 × 4 = 5886 J

Answer: Potential energy = 5886 J

(b) If the engine in (a) falls to the ground from that height; Calculate the velocity and kinetic energy of the engine at the point of impact with the ground.

PE at top = KE at ground: $5886 = \frac{1}{2}mv^2$

$v^2 = 5886 \times 2 / 150 = 78.48$

$v = \sqrt{78.48} \approx 8.86$ m/s

KE = 5886 J

Answer: Velocity ≈ 8.86 m/s; Kinetic energy = 5886 J

(c) Determine the kinetic energy and the potential energy of the engine after falling 3 m.

Height fallen = 3 m, height remaining = 1 m.

PE remaining = mgh = 150 × 9.81 × 1 = 1471.5 J

KE = Initial PE - Remaining PE = 5886 - 1471.5 = 4414.5 J

Answer: Kinetic energy = 4414.5 J; Potential energy = 1471.5 J

SECTION C (15 Marks)

Answer all questions.

10. A Form Two student prepared an experiment in laboratory to determine the resistance 'R' of a metallic conductor. She closed the switch K, and adjusted the rheostat 'R_o' to different positions to increase the current. For each position she recorded the readings 'V' and 'I' of the voltmeter and ammeter respectively.

Table 2:

I(amps)	1	2	3	4	5	6
V(volts)	2	4	6	8	10	12
v/I						

(a) Find the ratio V/I for each pair and fill the Table 2.

V/I = 2/1 = 2, 4/2 = 2, 6/3 = 2, 8/4 = 2, 10/5 = 2, 12/6 = 2

Answer: V/I = 2 for all pairs.

(b) Plot the graph of V against I.

Description: X-axis: I (amps, 0 to 6); Y-axis: V (volts, 0 to 12). Plot points (1,2), (2,4), (3,6), (4,8), (5,10), (6,12). Straight line through origin.

Answer: Graph: Straight line from (0,0) through (1,2), (2,4), ..., (6,12).

(c) Calculate the gradient 'S' of the graph drawn in (b).

Gradient S = $\Delta V / \Delta I$ = (12 - 2) / (6 - 1) = 10 / 5 = 2

Answer: Gradient S = 2

(d) Compare the value of the gradient 'S' obtained in (c) and the values of the ratio V/I obtained in (a).

Gradient S = 2, V/I = 2 for all pairs. They are equal.

Answer: S equals V/I (both 2).

(e) State the relation between S and V/I.

S is equal to V/I, as the graph is linear and V/I is constant.

Answer: S = V/I

(f) Which physical quantity is represented by the gradient 'S'?

Gradient S = V/I represents resistance (Ohm's Law: V = IR).

Answer: Resistance

(g) Determine the value of the resistance 'R' of the metallic conductor.

R = S = 2 Ω

Answer: Resistance R = 2 Ω