THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

FORM TWO NATIONAL ASSESSMENT

035 ENGINEERING SCIENCE

Time: 2:30 Hours **ANSWERS** **Year: 2023**

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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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) An electrician wanted to minimize diameter of a wire to an accuracy of 0.01 cm. Which measuring instrument should be used?

A. Micrometer screw gauge

B. Vernier caliper

C. Tape measure

D. Engineers caliper

A micrometer screw gauge provides high precision (0.01 mm or 0.001 cm accuracy), suitable for measuring wire diameter accurately.

Answer: A

(ii) How can you minimize the friction that leads to unnecessary heat, noise, and wear?

A. By reducing the speed of rubbing surface in contact

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

C. By lubricating the rubbing surface in contact with grease and oil

D. By replacing the rubbing surfaces parts with parts of graphite materials

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

Answer: C

(iii) A form two teacher demonstrated practically the upthrust acting on a body and the weight of a liquid it displaces. Which law was demonstrated by the teacher?

A. The law of buoyancy

B. The law of floatation

C. The law of sinking

D. The law of submerged

The demonstration of upthrust equaling the weight of displaced liquid refers to Archimedes' principle, also known as the law of buoyancy.

Answer: A

(iv) Magesa released an apple of a mass m(kg) to fall freely from a height of h(m). What will be the velocity of an apple just before hitting the ground?

A. mgh

B. 2mg/h

C. 2gh

D. √(mg/h)

Using conservation of energy: Potential energy mgh = Kinetic energy ½mv²

$v^2 = 2gh$

$v = \sqrt{(2gh)}$

Since √(2gh) is equivalent to √(2) × √(gh), and no option matches exactly, the closest is 2gh (assuming a typo in options or units).

Answer: C

(v) A motor vehicle mechanic set a small trolley in motion on a horizontal surface by a force (F) Newtons. He pulled it by means of a rope inclined at 30° to the horizontal. How would you represent the horizontal force due to force F?

A. F × Cos 30° N

B. F × Sin 30° N

C. F × Cos 60° N

D. F × Sin 60° N

The horizontal component of force F at 30° to the horizontal is F × Cos 30°.

Answer: A

(vi) Form two students visited a school workshop to learn torque of forces. One of them was assigned to untighten a wheel nut. The student failed to untighten a nut until the teacher gave him a circular pipe. What was the circular pipe for?

A. To increase force

B. To reduce the torque

C. To reduce force

D. To increase the torque

The circular pipe extends the length of the spanner, increasing the moment arm, thus increasing the torque (Torque = Force × Distance).

Answer: D

(vii) In a racing car competition, a speedometer of one racing car reads the following values of velocity „v“ in time „t“ as indicated in the table below:

t(s)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
v(m/s)	0	12	26	36	48	60	60	60	60	60	50	40	30	20	10	0

Suggest the velocity-time graph for the motion of the car.

Text Description: The graph has time (s) on the x-axis and velocity (m/s) on the y-axis. It rises linearly from (0,0) to (10,60), remains constant at 60 m/s from t=10 to t=18, then decreases linearly from (18,60) to (30,0).

Answer: Velocity-time graph: Linear rise to (10,60), constant at 60 m/s to (18,60), linear fall to (30,0).

(viii) A person left his car on a full sunlight in a parking lot and went shopping. He came back and found out that the pressure of air inside a car tire is increased. What caused a change of the tyre pressure?

A. Size of air molecules

B. Number of air molecules

C. Speed of air molecules

D. Mass of air molecules

Increased temperature from sunlight increases the speed of air molecules, raising the pressure inside the tire (per the ideal gas law, PV = nRT).

Answer: C

(ix) A man uses a hydraulic press to lift a container. If the hydraulic press is frictionless, what will be the mechanical advantage of the press?

A. Greater than velocity ratio

B. Equal to velocity ratio

C. Smaller than 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: B

(x) A student was studying the properties of image formed in a pinhole camera. When he places a candle several centimeters from the hole of the camera, a very small image was produced on the screen of the camera. Suggest the adjustment that can be made on the camera or box to produce a magnified image on the screen.

A. To move the candle away from the pin hole

B. To move the box away from the candle

C. To move the box closer to the handle

D. To move the hole larger than the pin hole

To magnify the image in a pinhole camera, increase the distance between the pinhole and the screen by moving the box (screen) away from the candle.

Answer: B

2. Match the electrical parameters in List A with their corresponding components in List B by writing the letter correct response beside the number in the table provided.

List A

(i) It allows electric current to pass through human body and metals.

(ii) It prevents serious electrical shocks.

(iii) It prevents the quantity of electricity.

(iv) It is a potential difference between two points.

(v) It prevents overloading of electric circuit.

List B

A. An electric lamp

B. Conductors

C. Coulomb

D. Earth rod

E. Electric current

F. Fuse

G. Resistance

(i) Allows current through body/metals → B (Conductors)

(ii) Prevents serious electrical shocks → D (Earth rod)

(iii) Prevents the quantity of electricity → C (Coulomb, assuming typo for "represents")

(iv) Potential difference between points → E (Electric current, assuming typo for voltage)

(v) Prevents overloading of circuit → F (Fuse)

SECTION B (70 Marks)

Answer all questions from this section.

3. A uniform beam 4 m long, is simply supported at two points A and B. Points A is 0.5 m from left-hand end and point B is 1.5 m from the right-hand end. The beam carries load of 600 N at the left end, 800 N at its centre, and 400 N at the right end. Determine the magnitude of the support reactions at A and B.

Take moments about A (clockwise positive):

Distance: Left end (0 m), A (0.5 m), centre (2 m), B (2.5 m), right end (4 m).

$\Sigma M_A = 0$:

$-600 \times 0.5 + 800 \times 1.5 - 400 \times 3.5 + R_B \times 2 = 0$

$-300 + 1200 - 1400 + 2R_B = 0$

$-500 + 2R_B = 0$

$R_B = 250$ N

$\Sigma F_y = 0$:

$R_A + R_B - 600 - 800 - 400 = 0$

$R_A + 250 - 1800 = 0$

$R_A = 1550$ N

Answer: $R_A = 1550$ N; $R_B = 250$ N

4. In a sugar industry the copper tubes of the boiler are 4.2 m long at a temperature of 20°C. Determine the length of the tube when:

(a) Surrounded only by feed water at 10°C.

Linear expansion: $\Delta L = L_o \times \alpha \times \Delta T$

$L_o = 4.2$ m, $\alpha = 17 \times 10^{-6}$ K^{-1}, $\Delta T = 10 - 20 = -10$°C

$\Delta L = 4.2 \times 17 \times 10^{-6} \times (-10) = -0.000714$ m

$L = L_o + \Delta L = 4.2 - 0.000714 = 4.199286$ m

Answer: Length = 4.199286 m

(b) The boiler is operating and the mean temperature of the tubes rises to 320°C.

$\Delta T = 320 - 20 = 300$°C

$\Delta L = 4.2 \times 17 \times 10^{-6} \times 300 = 0.02142$ m

$L = 4.2 + 0.02142 = 4.22142$ m

Answer: Length = 4.22142 m

5. Study carefully the Figure given and answer the questions that follow:

(a) When switch „S“ is closed, will the current flowing through A_1 be less or greater than the current flowing through A_2?

Assume A_1 measures total current, A_2 measures current through one branch (e.g., R_2). In parallel, total current (A_1) is greater than branch current (A_2).

Answer: Current through A_1 is greater than A_2.

(b) When the switch „S“ is opened, why is the current flowing through A_2 smaller than when the switch is closed?

When S is open, the circuit may revert to series or disconnect R_2, reducing current through A_2 due to increased resistance or no flow.

Answer: Open switch increases resistance or stops flow, reducing A_2 current.

(c) Why when the switch „S“ is open, the current flowing through ammeter A_1 and A_2 is the same?

If S is open and the circuit is series, A_1 and A_2 measure the same current as they are in the same path.

Answer: In series (S open), A_1 and A_2 measure the same current.

(d) Calculate the equivalent resistance between point X and Y when S is closed.

For $R_1 = 10\ \Omega$, $R_2 = 15\ \Omega$ in parallel:

$1/R\_eq = 1/R_1 + 1/R_2 = 1/10 + 1/15 = 0.1 + 0.0667 = 0.1667\ \Omega^{-1}$

$R\_eq = 1/0.1667 \approx 6\ \Omega$

Answer: Equivalent resistance = 6 Ω

6. (a) Why is recommended to use a spanner of longer stem to loosen a nut on a bolt?

A longer stem increases the moment arm, increasing torque (Torque = Force × Distance), making it easier to loosen the nut.

Answer: Longer stem increases torque, easing nut loosening.

(b) The lifting gear on a vehicle body is situated 3 m from the pivot. If the body contains two loads of 15 kN and 7.5 kN whose centres of gravity are 0.8 m and 2 m required from the gear to raise the body.

Assuming a lever system, take moments about the pivot:

Loads at 0.8 m and 2 m from gear, gear 3 m from pivot.

Distances from pivot: 15 kN at 3 - 0.8 = 2.2 m, 7.5 kN at 3 - 2 = 1 m.

Moment due to loads: 15 × 2.2 + 7.5 × 1 = 33 + 7.5 = 40.5 kNm.

Force F at gear (3 m): 40.5 = F × 3

F = 40.5 / 3 = 13.5 kN

Answer: Force required = 13.5 kN

7. A simple machine raises a load of 120 kg through a distance of 1.2 m. The effort applied in the machine is 150 N and it moves through a distance of 12 m. Determine:

(a) The mechanical advantage.

Load = 120 kg × 9.81 m/s² = 1177.2 N

Mechanical advantage (MA) = Load / Effort = 1177.2 / 150 ≈ 7.85

Answer: Mechanical advantage ≈ 7.85

(b) Velocity ratio.

Velocity ratio (VR) = Distance moved by effort / Distance moved by load = 12 m / 1.2 m = 10

Answer: Velocity ratio = 10

(c) The efficiency of the machine.

Efficiency = (MA / VR) × 100 = (7.85 / 10) × 100 = 78.5%

Answer: Efficiency = 78.5%

8. A student performed an experiment to measure the density of a solid with an irregular shape by means of measuring cylinder and recorded the results as follows:

Mass of an irregular solid, m = 178 g.

Initial volume of water in the measuring cylinder, $V_1 = 80\ cm^3$.

Final volume of water in the measuring cylinder, $V_2 = 80\ cm^3$.

(a) Draw a neat sketch diagram to show the levels of water in the measuring cylinder:

(i) Before the solid is immersed.

(ii) After the solid is immersed.

Text Description:

(i) Cylinder with water level at 80 cm^3 mark.

(ii) Cylinder with water level at 80 cm^3 (noted as likely erroneous, expecting rise).

Answer:

(i) Water at 80 cm^3.

(ii) Water at 80 cm^3 (likely error, should rise).

(b) Formulate an equation to find the difference in volume V_3 in terms of V_1 and V_2.

$V_3 = V_2 - V_1$

Answer: $V_3 = V_2 - V_1$

(c) Use the equation you have formed in (b) to find the volume of the irregular solid.

$V_3 = 80\ cm^3 - 80\ cm^3 = 0\ cm^3$

Note: This suggests an error in V_2 (should be higher). Assuming a typical value, e.g., $V_2 = 100\ cm^3$:

$V_3 = 100 - 80 = 20\ cm^3$

Answer: Volume = 20 cm^3 (assuming $V_2 = 100\ cm^3$).

(d) Determine the density of the irregular solid.

Density = Mass / Volume = 178 g / 20 cm^3 = 8.9 g/cm^3

Answer: Density = 8.9 g/cm^3

Note: Assumed V_2 correction; please confirm V_2 value.

9. Two poles were used to support one point of the tent. The forces of the two poles with their angle of inclination to the point of action are 5 N at 25° and 8 N at 112° respectively. Determine the resultant force by resolving these forces into horizontal and vertical components.

Horizontal components:

$F_1\_x = 5 \times \text{Cos } 25° \approx 5 \times 0.9063 = 4.5315$ N

$F_2\_x = 8 \times \text{Cos } 112° = 8 \times (-0.3746) \approx -2.9968$ N

Total X = 4.5315 - 2.9968 = 1.5347 N

Vertical components:

$F_1\_y = 5 \times \text{Sin } 25° \approx 5 \times 0.4226 = 2.113$ N

$F_2\_y = 8 \times \text{Sin } 112° \approx 8 \times 0.9272 = 7.4176$ N

Total Y = 2.113 + 7.4176 = 9.5306 N

Resultant force: $R = \sqrt{(X^2 + Y^2)} = \sqrt{(1.5347^2 + 9.5306^2)} \approx \sqrt{(2.3553 + 90.8323)} \approx \sqrt{93.1876} \approx 9.653$ N

Answer: Resultant force ≈ 9.653 N

SECTION C (15 Marks)

Answer all questions from this section.

10. The bus started from rest and in 30 seconds reached a speed of 20 m/s. The speed remained steady for 15 seconds and decreased steadily until the bus stopped in 5 seconds later.

(a) Draw a velocity-time graph.

Text Description:

X-axis: Time (s); Y-axis: Velocity (m/s).

Line from (0,0) to (30,20) (acceleration).

Horizontal line from (30,20) to (45,20) (constant speed).

Line from (45,20) to (50,0) (deceleration).

(b) Use the diagram in (a) to calculate:

(i) The distance covered from start to end of the journey.

Distance = Area under velocity-time graph:

Acceleration (0-30 s): Area of triangle = ½ × 30 × 20 = 300 m

Constant speed (30-45 s): Area of rectangle = 15 × 20 = 300 m

Deceleration (45-50 s): Area of triangle = ½ × 5 × 20 = 50 m

Total distance = 300 + 300 + 50 = 650 m

Answer: Distance = 650 m

(ii) The acceleration during the motion.

Acceleration (0-30 s) = $\Delta v / \Delta t = (20 - 0) / 30 = 0.6667$ m/s²

Answer: Acceleration = 0.6667 m/s²