TEVETA

Technical Education Vocational and Entrepreneurship Training Authority

# LEVEL 5 CERTIFICATE IN AUTOMOTIVE/HEAVY EQUIPMENT/AUTOMOTIVE ELECTRICAL & ELECTRONICS ENGINEERING

## LEVEL 5 YEAR I EXAMINATIONS

## FINAL INTEGRATED SUMMATIVE EXAMINATIONS

## SITTING: APRIL/MAY 2026

## SUBJECT: ENGINEERING SCIENCE

**TIME: THREE (3) HOURS** **TOTAL MARKS: 100**

**PASS MARK: 50**

**INSTRUCTIONS TO CANDIDATE**

1. Write your examination number and National Registration Card Number on the answer booklet provided. Ensure to append your signature in the space provided on the answer booklet.
2. Write your answer **SCRIPT SERIAL NUMBER** on the examination register and on the entry slip.
3. There are **Eight (8) questions in this paper.**
4. Attempt five (5) questions. **Question One (1) is compulsory** and attempt any other four (4) questions.
5. All questions carry equal marks.
6. Cell phones and programmable calculators are NOT allowed in the examination room.

**DO NOT TURN THIS PAPER UNTIL YOU ARE TOLD TO DO SO.**

**QUESTION 1 - COMPULSORY**

Measurement in automobile technology encompasses various physical quantities that are very relevant in the professional engineering field.

(a) Define the term physical quantity. **[2 Marks]**

(b) State any **four** (4) importance of measurements in engineering. **[4 Marks]**

(c) Write down the standard units (SI) and dimensional units for the quantities below:

i. Pressure. **[2 Marks]**

ii. Specific enthalpy. **[2 Marks]**

(d) The **Figure Q1 (d)** below shows part of the vehicle tire with specifications carefully designed by the manufacturer.




**Figure Q1 (d)**

The tyre is meant to fit on a 16-inch diameter wheel. Compute the area of the tyre in $cm^2$. **[5 Marks]**

(e) Using dimensional analysis show the homogeneity of this equation:

$$p = \frac{mg}{A}$$

Where $P$ = Pressure

$m$ = mass

$g$ = acceleration due to gravity

$A$ = area **[5 Marks]**

**[TOTAL: 20 Marks]**

**QUESTION 2**

(a) In the quest to untie a lug nut from a stationed vehicle with a tire puncture, an automotive technologist rotates the screwdriver around the bolt making it to move by ½ revolutions in 0.2 s before he accidentally drop the screwdriver to the ground with an initial velocity of 4 m/s.

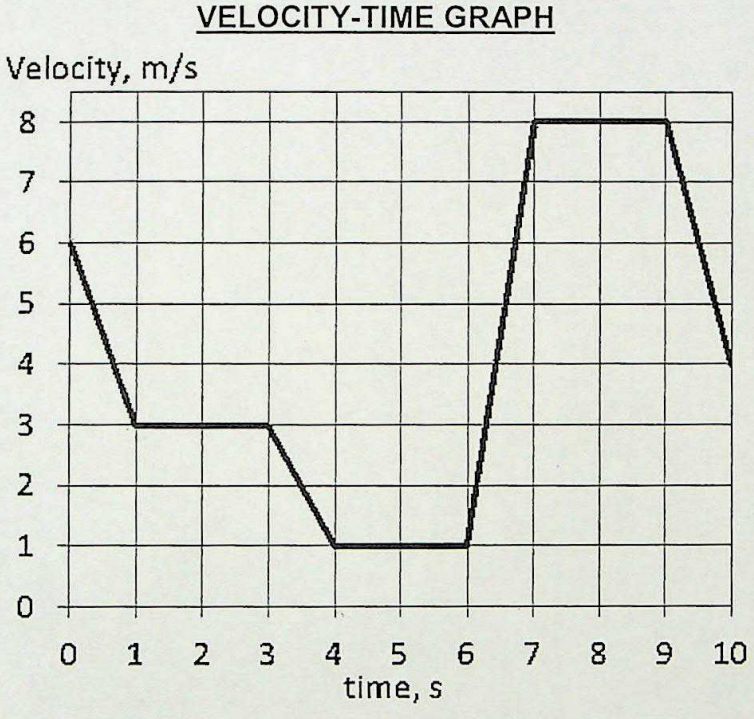
Calculate the:

i. Angular acceleration achieved while trying to untie the screw. **[3 Marks]**

ii. Time taken for the screwdriver to hit the ground. **[3 Marks]**

iii. Height from where the screwdriver was dropped. **[3 Marks]**

(b) A 13-ton truck is moving according to the following velocity-time **Graph Q2 (a)** along a graded road.




**Graph Q2 (a)**

Calculate the:

i. Acceleration between 3 m/s and 1 m/s. **[3 Marks]**

ii. Total length of the journey. **[5 Marks]**

iii. Kinetic friction force if the coefficient of kinetic friction between the tires of the truck and the graded road is 0.4. **[3 Marks]**

**[TOTAL: 20 Marks]**

**QUESTION 3**

Properties of materials used in making vehicles influence the forces that affect the position of vehicles whether stationary or in motion.

(a) State **two (2)** forces that act on a vehicle. **[2 Marks]**

(b) List **any two (2) chemical** materials used in motor vehicle. **[2 Marks]**

(c) State the law of elasticity. **[2 Marks]**

(d) A 30 mm in diameter steel wire with an initial length of 85 cm is subjected to a load of 35 kN. If the wire is increased in length by 0.04 mm and UTS = 98 x $10^6$ Pa. Calculate the:

i. Tensile stress. **[4 Marks]**

ii. Longitudinal strain. **[3 Marks]**

iii. Young's modulus. **[3 Marks]**

iv. Factor of safety **[3 Marks]**

**[TOTAL: 20 Marks]**

**QUESTION 4**

In motor vehicle industry the concept of forces such friction, tension torque and moment of forces influences vehicle efficiency and performance.

(a) Define the term friction torque. **[2 Marks]**

(b) Distinguish between torque and moment of a force. **[4 Marks]**

(c) An engine block of mass 15 kg is being held up on a 20 kg beam as shown in the **Figure Q4 (c)** below. The net torque about the pin point is = 0. Calculate the tension **T** created. **[10 Marks]**

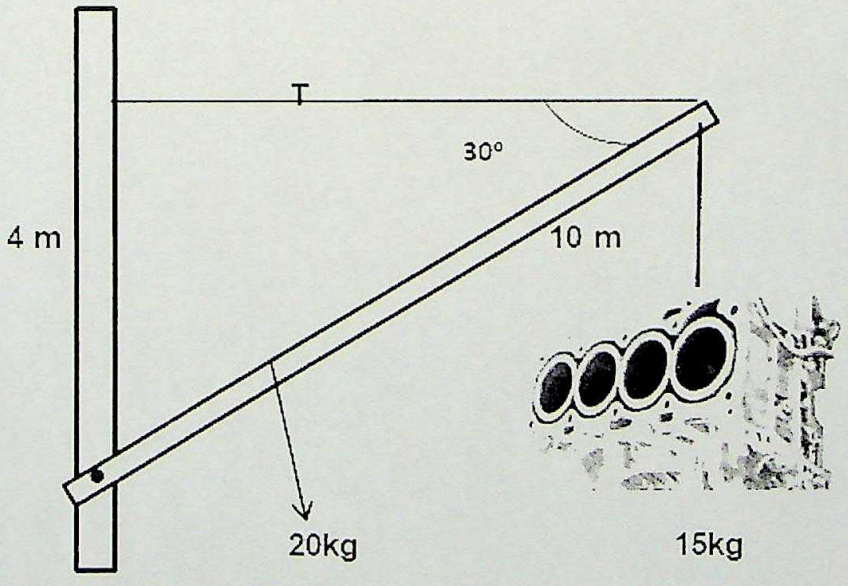



**Figure Q4 (c)**

(d) If the engine block in **Figure Q4 (c)** reaches the ground in spinning motion covering a diameter of 45 cm and the coefficient of friction between the surface of the ground and engine is 0.8. Compute the **net torque** causing this rotation. **[4 Marks]**

**[TOTAL: 20 Marks]**



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## QUESTION 5

(a) Define the term moment of inertia. **[2 Marks]**

(b) State Newton's third law of motion. **[2 Marks]**

(c) An enclosed mass of fuel is contained in a square container. Four particles each of mass **m** move in the four corners of the container and keep themselves at the edges **a**. Show that the moment of inertia of the system about a line perpendicular to the plane of the square and passing through the centre of the square is $2ma^2$. **[4 Marks]**

(d) Suppose a 14-ton truck is parked at 50 m on the 75 m long bridge and the bridge weighs 200 kN/m. Assume the bridge is rigid.

i. Draw a free body diagram to show the forces acting on the bridge. **[3 Marks]**

ii. Calculate the reaction forces at the supports of the bridge at the two ends. **[9 Marks]**

**[TOTAL: 20 Marks]**

## QUESTION 6

(a) State Boyle's law. **[2 Marks]**

(b) Differentiate heat of fusion from heat of vaporization. **[3 Marks]**

(c) Convert 30 °F to K **[3 Marks]**

(d) An insulated copper can of mass 20 g contains 50 g of water at a temperature of 84° C. A block of copper mass 47 g at a temperature of 990 °C is lowered into the copper can containing water. As a result, the contents reach the temperature of 100 °C making some water to turn into steam. Calculate how much thermal energy is transferred from the copper block as it cools to 100 °C. Give your answer to an approximate number. **[6 Marks]**

(e) A calorimeter contains 0.5 kg of water at 20 °C. 100 g of ice at 0 °C is added to the water to melt it. After all the ice melts the temperature goes to 5 °C. Assume no heat loss to the surrounding and the specific heat capacity of water is 4184 J/kg°C. Calculate the specific latent heat of fusion of ice. **[6 Marks]**

**[TOTAL: 20 Marks]**

**QUESTION 7**

(a) State Kirchhoff's laws

i. Current **[2 marks]**

ii. Voltage. **[2 marks]**

(b) Distinguish an electric charge from an electron. **[2 marks]**

(c) The **Figure Q7 (c)** shows an electric circuit with various resistors connected in series and parallel. The voltage source V1 = 20V.

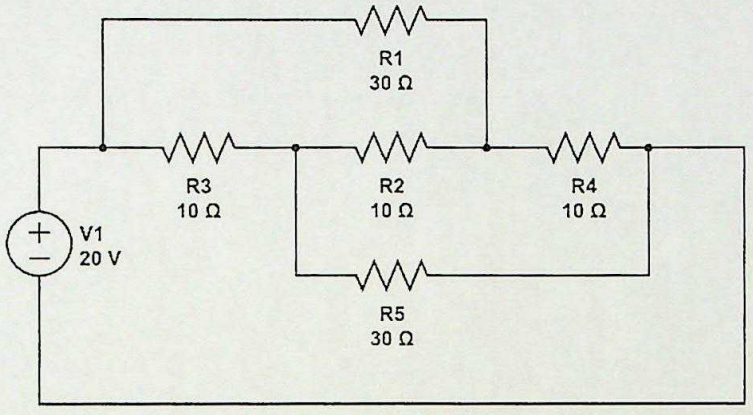



**Figure Q7 (c)**

Calculate the:

i. Equivalent resistor. **[4 Marks]**

ii. Total current flow. **[4 Marks]**

iii. Power dissipated. **[3 Marks]**

(d) A pump allows water to flow through a fire hose with a velocity of 3 m/s and a pressure of $4 \times 10^5$ Pa at the nozzle the pressure decreases to atmospheric pressure $1.01325 \times 10^5$ Pa. Given that there is no change in height, density of water is 1000 kg/m$^3$ and gravity is 9.81 m/s$^2$. Calculate the velocity of the water exiting the nozzle. **[3 Marks]**

**[TOTAL: 20 Marks]**

**QUESTION 8**

In Zambia the transportation of goods by trucks add to traffic problems on our roads.

(a) Arrestor beds are constructed as a safety measure to allow trucks to come to rest when their brakes fail whilst going uphill. Write down **two (2)** design feature of arrestor beds. **[2 Marks]**

(b) A 10-ton truck travels up a straight inclined road of length 23 m at a constant speed of 20 km/h. The total work done by the engine of the truck to get there is $7 \times 10^5$ J. the work done to overcome friction is $8.5 \times 10^4$ J.

Calculate the:

i. Height **h** reached by the truck at the top of the road. **[6 Marks]**

ii. Instantaneous power delivered by the engine of the truck. **[6 Marks]**

iii. Potential energy of the truck. **[3 Marks]**

iv. Kinetic energy when it is ¼ up the road. **[3 Marks]**

**[TOTAL: 20 Marks]**