

071605T4AMEM

**AGRICULTURAL MACHINERY & EQUIPMENT MECHATRONICS TECHNICIAN
LEVEL 5**

ENG/OS/AME/CC/3/5/A

APPLY ENGINEERING SCIENCE PRINCIPLES

July /August 2024



**TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION COUNCIL
(TVET CDACC)**

WRITTEN ASSESSMENT

TIME: 3 HOURS

INSTRUCTIONS TO CANDIDATE

1. This paper consists of two sections; **A** and **B**
2. Answer **ALL** the questions as guided in each section
3. Marks for each question are as indicated in the brackets
4. You are provided with a separate answer booklet to answer the questions
5. Do not write in this question paper

This paper consists of FOUR (4) printed pages

**Candidates should check the question paper to ascertain that all pages are printed as indicated
and that no questions are missing**

SECTION A: (40 Marks)

Answer ALL questions in this section

1. A force exerted on a body can cause a change in either the shape or the motion of the body. State **three** main types of mechanical forces that can act on a body. (3 marks)
2. An object is in equilibrium when the forces acting on the object are such that there is no tendency for the object to move. State the **three** groups of equilibrium of an object (3 marks)
3. List **four** methods used to determine the resultant of two coplanar forces acting at a point. (4 marks)
4. State the;
 i. Principles of moments
 ii. Moments of a couple (4 marks)
5. Frictional force is known to cause tear and wear, state **three** instances where frictional force is advantageous. (3 marks)
6. Velocity is defined as the change of displacement per unit time. Differentiate between linear velocity and angular velocity. (2 marks)
7. State the law of machine and outline its importance. (2 marks)
8. The following are some terms related to performance of a machine. Define each one of them.
 a) Input of Machine
 b) Output of Machine
 c) Mechanical Advantage (3 marks)
9. Calculate the work done when a force of 60N pushes an object a distance of 400m in the same direction as force. (3 marks)
10. Differentiate between heat and temperature. (2 marks)
11. Convection is the transfer of heat energy through a substance by the actual movement of the substance itself. Outline **three** practical applications of convection. (3 marks)
12. A fluid is either a liquid or a gas and there are **four** basic factors governing the pressure within fluids. State the factors. (4 marks)
13. Boyle's law is one the gas laws showing the relation between volume and pressure at constant temperature. State the law and derive the formula. (3 marks)

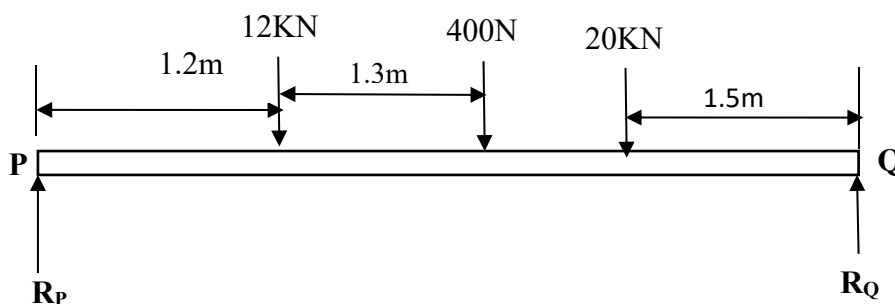
SECTION B: (40 Marks)*Answer ANY THREE questions from this section*

14.

- a) A tank contains water to a depth of 600 mm. Taking the density of water as 1000 kg/m^3 and the gravitational acceleration as 9.8 m/s^2 , calculate the water pressure
- At a depth of 350 mm, (4 marks)
 - At the base of the tank. (4 marks)
- b) A body weighs 2.760 N in air and 1.925 N when completely immersed in water of density 1000 kg/m^3 . Taking the gravitational acceleration as 9.81 m/s^2 , calculate
- The volume of the body, (5 marks)
 - The relative density of the body. (3 marks)
- c) The material of a brake is being tested and it is found that the dynamic coefficient of friction between the material and speed is 0.91. Calculate the normal force when the frictional force is 0.728 kN (4 marks)

15.

- a) State **three** laws of friction (3 marks)
- b) State Newton's second law of motion (1 marks)
- c) A beam P Q is 5.0 m long and is supported at its ends in a horizontal position as shown in the figure below. Its mass is equivalent to a force of 400 N acting at its centre as shown. Point loads of 12 kN and 20 kN act on the beam in the positions shown. When the beam is in equilibrium, determine



- The reactions of the supports, R_P and R_Q , (6 marks)
 - The position to which the 12 kN load must be moved for the force on the supports to be equal (6 marks)
- d) Highlight **two** advantages and two disadvantages of frictional forces. (4 marks)

16. Forces of 5.0 N at 25° and 8.0 N at 112° act at a point. By resolving these forces into horizontal and vertical components, determine their resultant force. (20 marks)

17.

- a) A circular hole of diameter 50 mm is to be punched out of a 2 mm thick metal plate. The shear stress needed to cause fracture is 500 MPa.
Determine
- i. The minimum force to be applied to the punch, (7 marks)
 - ii. The compressive stress in the punch at this value (6 marks)
- b) A sample of carbon dioxide in a pump has a volume of 21.5 mL, and it is at 50.0 °C. When the amount of gas and pressure remain constant, find the new volume of carbon dioxide in the pump if the temperature is increased to 75.0 °C. (3 marks)
- c) Highlight four ideal gas properties and characteristics. (4 marks)

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