

071606T4ABT

AUTOBODY TECHNOLOGY LEVEL 6

ENG/OS/ABT/CC/02/6/A

Apply Engineering Mechanics Principles

July/August 2024



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

WRITTEN ASSESSMENT

TIME: 3 HOURS

INSTRUCTIONS TO THE CANDIDATE

1. *This paper consists of **TWO** sections: **A** and **B**.*
2. *Attempt **ALL** the questions in Section **A** and any **THREE** questions from Section **B**.*
3. *Marks for each question are as indicated.*
4. *You are provided with a separate answer booklet.*
5. *Do not write on the question paper.*

This paper consists of FIVE printed pages.

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

Turn over

SECTION A: (40 MARKS)

Attempt ALL the questions in this section.

1. Define the term force and state its SI. (2 Marks)
2. Physical quantities are classified as scalar or vector to describe different aspects of an object. Distinguish between scalar and vector quantities giving an example for each. (3 Marks)
3. The parallelogram law is one of the principles that can be used to determine the resultant of vectors acting simultaneously on an object. State the parallelogram law of forces. (3 Marks)
4. Define the term resultant force. (1 Mark)
5. Equilibrium refers to a state of balance in a system where there is no change or tendency to change in the behavior of the system. Give two conditions of equilibrium of bodies. (2 Marks)
6. State the principle of moment. (2 Marks)
7. Physical properties describe the characteristics of material that can be observed or measured without changing the chemical composition of the material. Define the following physical properties. (3 Marks)
 - a. Density
 - b. Opacity
 - c. Specific heat capacity
8. Methods that are used to inspect and evaluate materials, structures or components without causing damage to them are called nondestructive tests. List FOUR nondestructive tests done on metals. (4 Marks)
9. A rectangular block of plastic material 470 mm long by 22 mm wide by 280 mm high, as shown in **FIGURE 1** below, has its lower face glued to a bench. A force of 200 N is applied to the upper face and in line with it. The upper face moves 15 mm relative to the lower face. Determine the shear stress and the shear strain in the upper face, assuming that the deformation is uniform. (4 Marks)

**FIGURE 1**

10. State THREE laws of dry friction. (3 Marks)
11. A load of mass 240 kg rests on a plane which is inclined at 18° to the horizontal. A force of 2000 N acting parallel to the plane pulls the load up the plane at uniform speed. Determine the coefficient of friction between the load and the surface. (6 Marks)
12. Motion is governed by Newton's laws of motion. State the THREE Newton's laws of motion. (3 Marks)
13. The effort required to raise a load using a simple machine, for various values of load is as shown below.

Load F_l (N)	2050	4120	7410	8240	10300
Effort F_e (N)	252	340	465	505	580

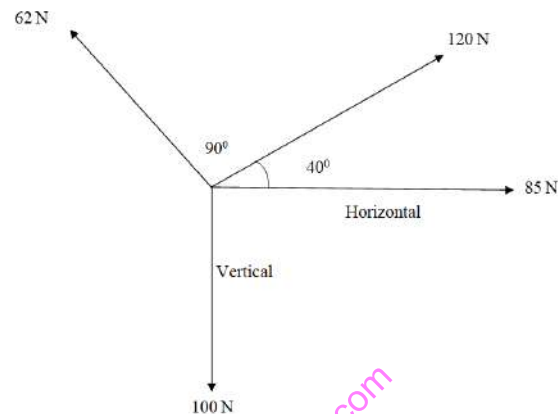
If the velocity ratio of the machine is 30, determine the law of the machine.

(4 Marks)

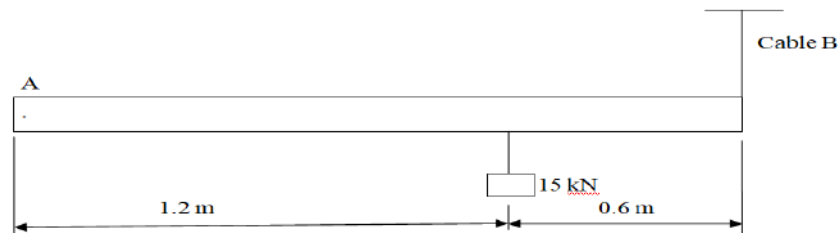
SECTION B: (60 MARKS)*Attempt any THREE questions in this section.*

14.

- a) Four coplanar forces are acting at a pin of a mechanism as shown in **FIGURE 2** below. Using resolution of forces method, determine the magnitude of the resultant force and its inclination to the horizontal axis. (14 Marks)

**FIGURE 2**

- b) **FIGURE 3** below shows a rigid straight bar hinged at A and maintained in horizontal position by cable B. The bar carries a load of 15 kN as shown. Determine the tension in cable B and reaction at the hinge. (6 Marks)

**FIGURE 3**

15.

- a) During wheel balancing, a wheel starts from rest and accelerates uniformly for 10 seconds. It then maintains the uniform angular velocity for the following one minute before retarding to rest in the last 5 seconds. If the wheel makes 1000 revolutions during the period
- Sketch the angular velocity/time graph. (3Marks)
 - From the graph find:
 - The angular velocity (3Marks)

- b) angular acceleration (1Mark)
- c) the angular retardation (1Mark)
- d) The number of wheel revolutions made during the first 50 seconds. (2Marks)

b) A body of mass 150 kg rest on a flat horizontal table. The coefficient of friction between the body and the table is 0.45. Determine the magnitude of the force which is required to pull the body at a uniform speed for the following cases.

- i. When the force is horizontally applied. (5 Marks)
- ii. When the force is inclined at 18° to the table. (5 Marks)

16.

- a) Define the following terms as used in engineering science. (2 Marks)
 - i. Stress
 - ii. Strain
- b) With the aid of a stress – strain curve, explain the behavior of mild steel subjected to tensile test until destruction. (18 Marks)

17.

- a) A uniform disc of diameter 300 mm and mass 5 kg is mounted on one end of an arm of length 600 mm. The other end of the arm is free to rotate in a universal bearing. If the disc rotates about the arm with a speed of 300r.p.m clockwise, looking from the front, determine the speed with which it presses about the vertical axis. (6 Marks)
- b) A man uses an inclined plane to lift a mass of 50 kg through a vertical height of 4.0 m. The inclined plane makes an angle of 30° with the horizontal. If the efficiency of the inclined plane is 72%, calculate the following:
 - i. The effort needed to move the load up the inclined plane at a constant velocity. (7 Marks)
 - ii. The work done against friction in raising the load through the height of 4m. (7 Marks)