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071506T4MTP**MECHANICAL TECHNOLOGY LEVEL 6****ENG/OS/ME/CC/03/6****Apply Mechanical Science Principles****July/August 2025**

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**TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION
COUNCIL (TVET CDACC)****WRITTEN ASSESSMENT****Time: 3 HOURS**

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INSTRUCTIONS TO CANDIDATE:

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1. This paper has **TWO** sections: A and B.
2. Attempt **ALL** questions in section A and **ANY THREE (3)** questions in section B.
3. You ~~are~~ **use** a separate answer book.
4. Marks for each question are as indicated.
5. You should have a non-programmable scientific calculator for this examination.
6. Do not write on the question paper.

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This paper consists of FIVE (6) printed pages.

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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)

1. The concept of couple is a fundamental aspect of statics, dynamics, and structural behavior.
 - i. Define the term 'engineering systems'.
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 - ii. State ONE application couple in engineering systems. (2 Marks)
2. Friction is a force resisting the relative motion of materials sliding against each other. Give TWO advantages (2 Marks)
3. Mechanical advantage is used to amplify force making it easier to perform work. Give the formula of determining mechanical advantage. (1 Mark)
4. Parallelogram Law of Forces is used for calculating the resultant of two forces. State this Law (3 Marks)
5. There are several factors affecting pressure in liquids. List FOUR factors that pressure in liquids depends on. (4 Marks)
6. Heat flow is the movement of thermal energy from one place to another due to a temperature difference. Define the following terms as applied in heat flow.
 - i. Heat;
 - ii. Specific heat capacity. (4 Marks)
7. Energy forms in a system can either be kinetic or potential energy.
 - i. Distinguish between kinetic energy and potential energy
 - ii. Give an example in each form of energy. (4 Marks)
8. Gas law is a set of scientific laws that describe the behaviour of gases. State the following gas law:
 - i. Boyle's law;
 - ii. Charles law. (4 Marks)
9. Fortin and aneroid barometers are used in measuring atmospheric pressure. Identify TWO differences between them. (4 Marks)
10. Material properties help us understand how materials behave under different conditions. Define the following as associated with mechanical properties:
 - i. Ductility.
 - ii. Elasticity.
 - iii. Malleability. (3 Marks)

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11. Energy transferred to a body or to a physical system relies on energy conserved. State the law of conservation of energy. (2 Marks)

12. Friction reduction in a mechanical system affects energy efficiency and performance. Identify THREE ways of reducing friction in mechanical system. (3 Marks)

13. Forces can be of different depending on the nature of a mechanical system, Identify FOUR types of forces. (4Marks)

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AM

SECTION B**Attempt any THREE questions from this section**

14.

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- a. A bullet of mass 20 g travelling with a velocity of 16m/s, penetrates a sand bag and is brought to rest in 0.05 seconds. Determine the:

i. Acceleration of the bullet

(3Marks)

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ii.

De

p t h o f p e n e t r a t i o n

(3Marks)

iii. Average retarding force of the sand bag in Newton's

(2 Marks)

b.

400 g of ice at -20°C is required to be changed into $^{\circ}\text{C}$.

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Assuming the following:

- Latent heat of fusion of ice = 335 kJ/kg,
- Latent heat of vaporisation of water = 2260 kJ/kg,
- Specific heat capacity of ice = 2.14 kJ/(kg $^{\circ}\text{C}$),
- Specific heat capacity of water = 4.2 kJ/(kg $^{\circ}\text{C}$)

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Date: 01.08.2025 07:55 AM • Specific heat capacity of steam = 2.01 kJ/(kg $^{\circ}\text{C}$)

Determine;

- Heat energy needed to change the temperature of ice from -20°C to 0°C ,
- Latent heat needed to change ice at 0°C
- Heat energy needed to change the temperature of water from 0°C (i.e., melting point) to 100°C .
- Heat energy needed to change water at 100°C into steam at 100°C ,
- Heat energy needed to change steam at 100°C into $^{\circ}\text{C}$,
- Total heat energy needed,

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(12 Marks)

15.

- a. Heat is a form of energy and is measured in Joules. Explain the following terms as applied to heat.

i. Latent heat of fusion

(2 Marks)

ii. f vaporization

(2 Marks)

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- b. Define the following terms as used in mechanical science

i. Density, ρ

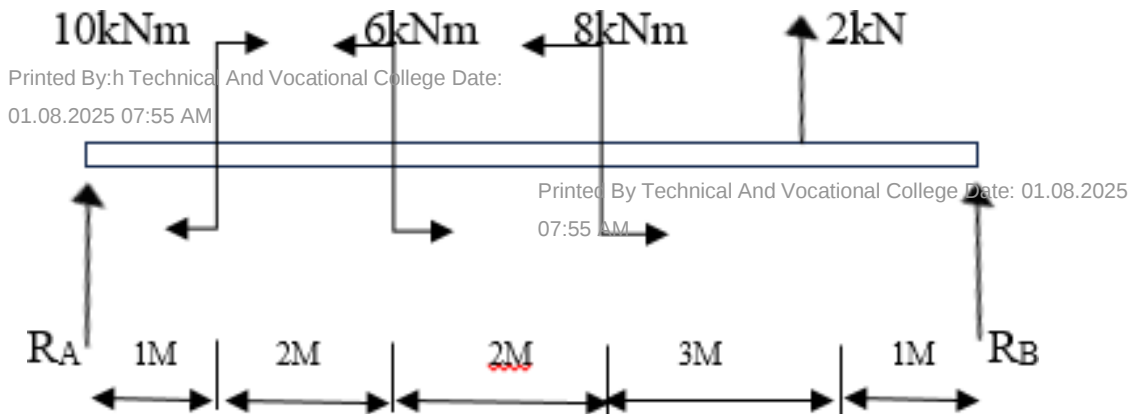
Printed By: Relative density (2 Marks)

- c. A simply supported beam is used to support loads during an assembly line production.

Determine the beam as shown in the figure below.

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(4Marks)



- d. A shaft with its rotating parts has a moment of inertia of 20 kg m^2 . It is accelerated from rest by an accelerating torque of 45 N m .

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Date: 01.08.2025 07:55 AM Determine the speed of the shaft in rev/min;

- After 15 seconds, (5 Marks)
- After the first 5 revolutions. (5 Marks)

16.

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- a. A canister containing a meteorology balloon of mass 4 kg is fired vertically upwards from a gun with an initial velocity of 400 m/s . Neglecting the air resistance, calculate;

1. kinetic energy (2 Marks)

ii. Its velocity at a height of 1 km

Printed By: Technical And Vocational College (5 Marks)

iii. Maximum height reached

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(3 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 . Calculate;

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i. The volume of the body,

(4Marks)

ii. The density of the body

(3 Marks)

iii. Density of the body.

(3Marks)

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17.

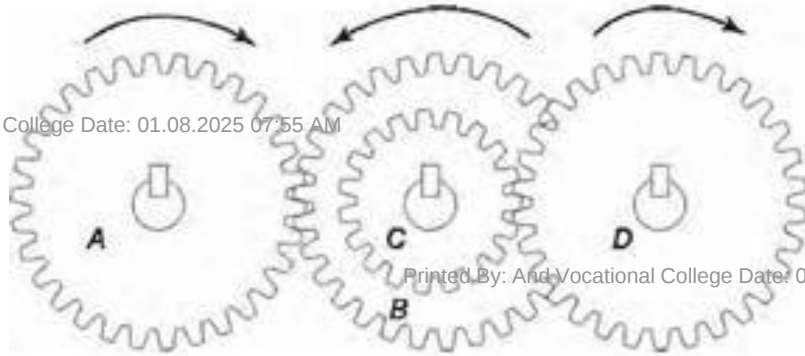
- a. A vessel X contains gas at a pressure of 750 kPa at a temperature of 27°C. It is connected via a valve to vessel Y with a similar gas at a pressure of 1.2 MPa and a temperature of 27°C. The volume of vessel X is 2.0 m³ and that of vessel Y is 3.0 m³.

Determine;

- the mass gas in vessel X (2marks)
- the mass gas in vessel Y (2marks)
- The final pressure at 27°C when the valve is opened and the gases are allowed to mix.

Assume R for the gas to be 300 J/(kg K). (3 Marks)

- b. Four compound gear train shown in the figure below, consists of a driver gear A, having 40 teeth, engaging with gear B, having 160 teeth. Attached to the same shaft as B, gear C has 48 teeth and meshes with gear D on the output shaft, having 96 teeth.



Determine;

- the ratio of this gear system (2 Marks)
 - the efficiency when the force ratio is 6 (2 Marks)
- c. With the aid of diagrams describe THREE orders of levers. (9 Marks)