TEVETA
Technical Education, Vocational and Entrepreneurship Training Authority

DIPLOMA IN AUTOMOTIVE/HEAVY EQUIPMENT ENGINEERING/AUTOMOTIVE ELECTRICAL AND ELECTRONICS

LEVEL 6 YEAR EXAMINATIONS

FINAL INTEGRATED SUMMATIVE EXAMINATIONS

SITTING: NOVEMBER/DECEMBER 2025

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 (NRC) number on the answer booklet provided. Ensure you append your signature in the space provided on the answer booklet
2. Write the ANSWER SCRIPT SERIAL NUMBER on the examination register and on the entry slip.
3. This paper consists of EIGHT (8) questions.
4. Answer five (5) questions. Question 1 is compulsory and choose any other four (4) questions.
5. Take acceleration due to gravity (g) as 9.81m/s².
6. Scientific calculators are allowed in the examination room. However programmable calculators and cell phones are not allowed in the examination room.

Do not turn this page until you are told to do so

QUESTION 1 - COMPULSORY

(a) Fundamental or base quantities like length, mass, and time are essential building blocks in engineering and technology because they are used to derive other quantities like speed, force and pressure which are crucial for understanding vehicle dynamics and performance.

i. Define term **base quantity**. **[2 Marks]**

ii. Give any **two (2)** examples a Fundamental quantity. **[2 Marks]**

iii. Convert **25 Gm/s** to **km/s** **[3 Marks]**

iv. Check whether $\frac{1}{2}\mathbf{mv^2} = \mathbf{mgh}$ is dimensionally correct **[3 Marks]**

(b) A truck carrying copper start from rest and moved the following successive distances. 125 m to the north, 108 m at 60° south of west, 150 m north of east at 45°, 100 m to the south and finally a displacement D.

i. Use the data given to draw the displacement vectors and components involved respectively. **[4 Marks]**

ii. Given that the resultant of the car is in the x-axis. Find the y-component of vector D. **[3 Marks]**

iii. If the vector A has an x-component which is twice the y-component. The magnitude of vector A is 25m. Calculate the x and y component of vector A. **[3 Marks]**

[TOTAL: 20 Marks]

QUESTION 2

Forces and equilibrium of forces describes the state of a vehicle in automobile when all external forces acting on it are balanced, resulting in neither rotation nor acceleration.

(a) Define the term **rigid body**. **[2 Marks]**

(b) State the **three (3)** specifications or characteristics required to completely define a force. **[3 Marks]**

(c) State the equilibrium law of collinear forces. **[2 Marks]**

(d) The Technologist of weight 600 N holds one end of a rope that passes over a pulley vertically above his head and to the other end of the rope a weight of 534 N is attached.

i. Draw a diagram to illustrate all the forces acting on the system. **[3 Marks]**

ii. Calculate the force with which the man's feet press against the floor. **[4 Marks]**

(e) A 15 m metal bar AB in **Figure Q2 (e)** is able to balance a 15 m truck 20 tonne hauling two loads of 5.5 kN and 10.5kN at distances of 3.0 m and 12.0 m, respectively from **A**. The metal bar is supported at each end in a horizontal position.

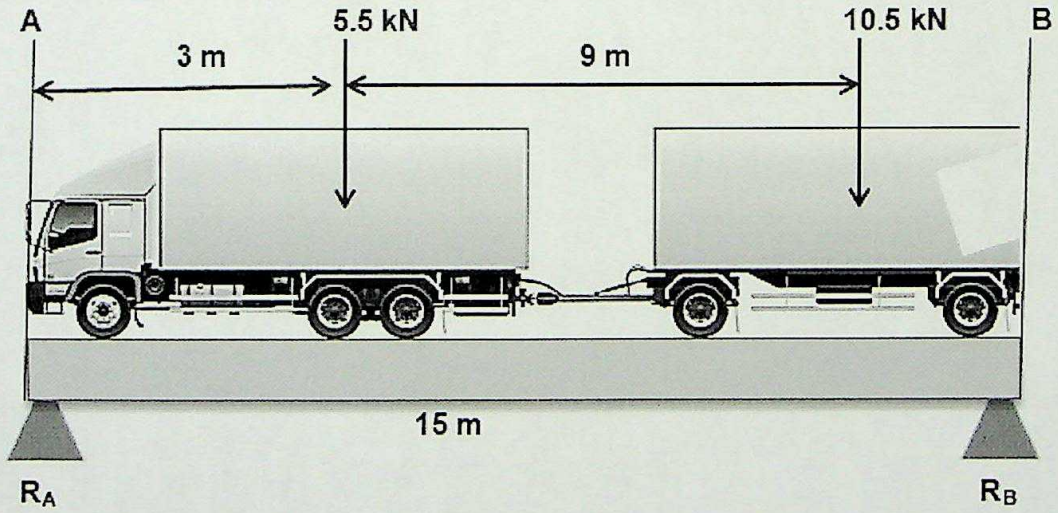


Figure Q2 (e)

Calculate the reactions of the supports when the truck is in equilibrium. Ignore the mass of the truck

i. R_A **[3 marks]**

ii. R_B **[3 Marks]**

[TOTAL: 20 Marks]

QUESTION 3

Work, energy, power and simple machines are fundamental concepts used in engineering and technology for understanding the design of vehicles and modification and transfer of various forces.

(a) State **two (2)** applications of simple machines in automobile. **[4 Marks]**

(b) A wheel and axle with an efficiency of 84 % lifts 35 kg mass to a height of 0.5 m in 2 minutes. The radius of the wheel and axle is in the ratio 5:1 respectively.

Calculate:

i. The effort required to lift the mass of 35 kg. **[6 Marks]**

ii. Useful power produced in lifting the mass. **[4 Marks]**

iii. Potential energy at 0.5 m. **[3 Marks]**

iv. Initial velocity as the mass is lifted. **[3 Marks]**

[TOTAL: 20 Marks]

QUESTION 4

In automotive industry work and friction play vital opposition roles. Work is what allows the vehicle to move forward, accelerate and maintain speed while friction on the other hand is a force that opposes motion of vehicles and it is vital for traction, braking and vehicle stability.

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

(b) List any **two (2)** factors that affect friction. **[4 Marks]**

(c) Mention **two (2)** importance of lubrication in vehicles. **[2 Marks]**

(d) A box of mechanical tools of mass 25kg is being pushed by two different forces as shown in **Figure Q4 (c).**

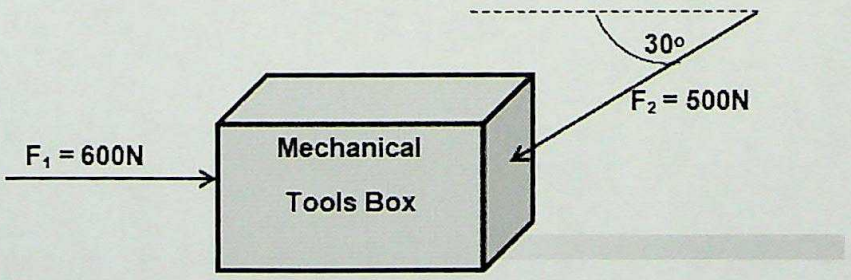


Figure Q4 (c)

Calculate the:

i. Acceleration of the tools box if the floor is frictionless. **[5 Marks]**

ii. Normal force acting on the vehicle. **[4 Marks]**

iii. Work done when it is pushed 5 m. **[3 Marks]**

[TOTAL: 20 Marks]

QUESTION 5

To understand the motion of various objects such as automobile moving elements, engineers should put Newton's laws of motion into consideration.

(a) State Newton's 2nd law of motion with regard to forces. **[2 Marks]**

(b) Distinguish translational from angular motion **[4 Marks]**

(c) **Figure Q5 (c)** shows two cars **A** and **B** which are 200m apart. Car **A** is moving with 4m/s towards car **B** while car **B** is traveling at 3m/s towards car **A**. Calculate the time it takes the cars to meet and where will they meet. **[5 Marks]**

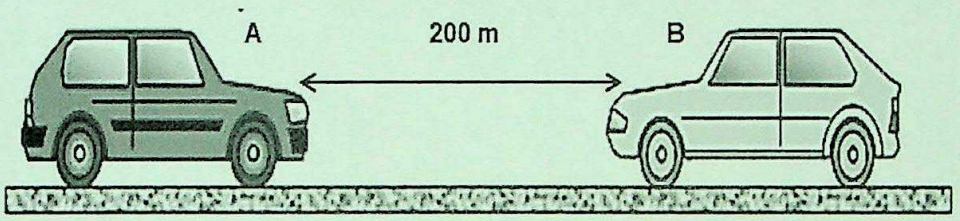


Figure Q5 (c)

(d) A tyre of an automobile spins with a constant velocity of 15 rad/s. The radius of the tire is 65 cm.

Calculate:

ii. The number of revolutions it will make in 7 minutes **[4 Marks]**

iii. How fast it will be turning in m/s **[3 Marks]**

(e) Two objects with mass 10 kg and 5 kg are held 5 m vertically from the horizontal ground. If the two objects are released to fall freely to the ground which object will hit the ground first and why? **[2 Marks]**

[TOTAL: 20 Marks]

QUESTION 6

Heat and temperature play critical roles hence it is crucial for engineers and technologists to understand heat.

(a) Define the term latent heat. **[2 Marks]**

(b) Differentiate heat capacity from specific heat capacity **[4 Marks]**

(c) With one example of its application, State **Charles' law** **[3 Marks]**

(d) Convert 36 ^{o}C to ^{o}F **[3 Marks]**

(e) The rear window of a vehicle is 6 m x 3 m and 1.8 cm thick. If the outside temperature is 295K and the inside temperature is 298K. Calculate the rate of heat through the glass window given thermal conductivity (**k** = 0.84 W/ m^{o}C). **[4 Marks]**

(f) A pump allows water to flow through the radiator with a velocity of 5 m/s and a pressure of 6 x 10^5 Pa at the nozzle the pressure decreases to atmospheric pressure 1.013 x 10^5 Pa. Calculate the velocity after a decrease in pressure. **[4 Marks]**

[TOTAL: 20 Marks]

QUESTION 7

To understand the behaviour of various materials under different conditions used in designing reliable and efficient machinery, Engineers and Technologists should have wider knowledge of the properties of materials.

(a) Define the term **factor of safety** **[2 Marks]**

(b) State any **four (4)** mechanical properties of materials. **[4 Marks]**

(c) State Poisson's ratio. **[2 Marks]**

(d) Consider the **Figure Q7 (d)** where a cable 12 m long with diameter 0.35 mm is stretched by a 12 kg load creating a temporal elongation of 0.02 mm at A. and later breaks.

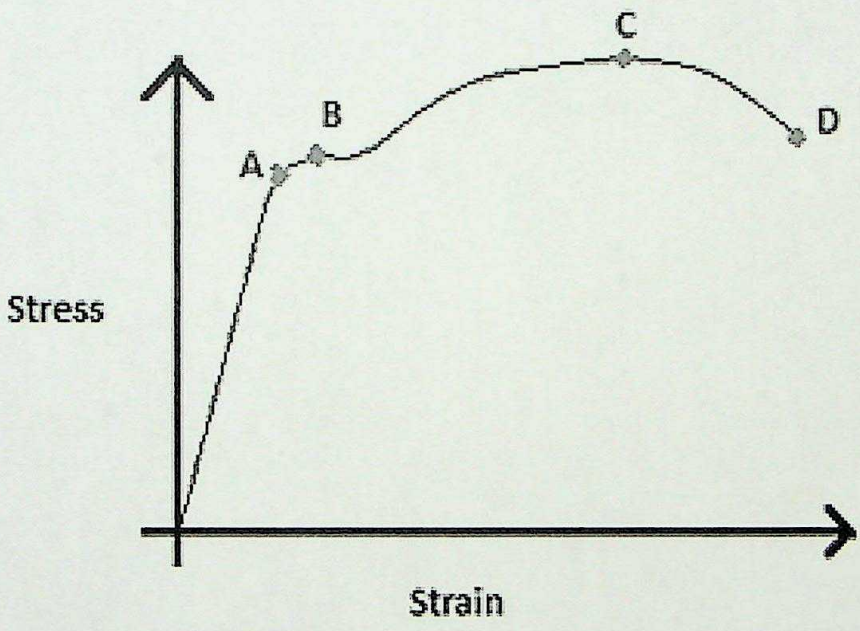


Figure Q7 (d)

i. Identify the labelled parts. **[4 Marks]**

ii. Draw the **Figure Q7 (d)** graph in your answer booklet and indicate the elastic stage, plastic stage, units for stress and strain **[4 Marks]**

iii. Calculate the young's modulus of the material. **[4 Marks]**

[TOTAL: 20 Marks]

QUESTION 8

All aspects of a vehicle from starting the engine, lighting, and gauges are powered by electricity.

(a) Define the term power in electrical terms. **[2 Marks]**

(b) Distinguish a cell from a battery. **[4 Marks]**

(c) Three light globes are connected as shown in **Figure Q8 (d)**. A total current of 6.0 A flows as shown. Under these conditions the light bulbs have resistances of $R_1 = 4.0\ \Omega$, $R_2 = 5.0\ \Omega$ and $R_3 = 20\ \Omega$ respectively

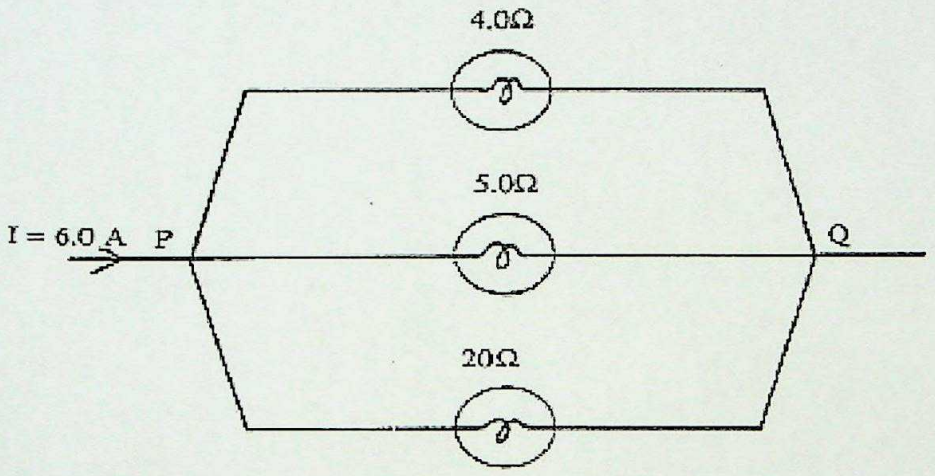


Figure Q8 (d)

Calculate the:

i. Electric potential between points P and Q **[5 Marks]**

ii. Current flowing through each bulb **[6 Marks]**

iii. Power dissipated by all the bulbs **[3 Marks]**

[TOTAL: 20 Marks]