071906T4AEN
AGRICULTURAL ENGINEERING LEVEL 6
ENG/OS/AGR/CC/03/6/A
APPLY PRINCIPLES OF MECHANICAL SCIENCE
July/August 2024

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

WRITTEN ASSESSMENT

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 FIVE (5) 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. Define the following terms: (3 Marks)

   (a) Pressure;

   (b) Force;

   (c) Energy.

2. State the following laws. (2 Marks)

   a) Charles law;

   b) Newton first law of motion.

3. A wagon of mass 10 t is moving at a speed of 6 m/s and collides with another wagon of mass 15t, which is stationary. After impact, the wagons are coupled together. Determine the common velocity of the wagons after impact. (5 Marks)

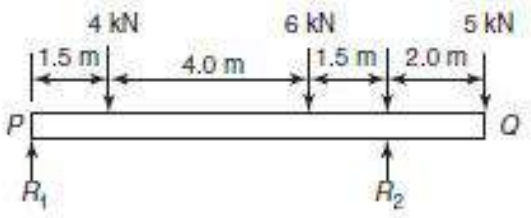
4. The diameter of a ram and plunger of a hydraulic press are 200mm and 30mm respectively. Find the weight lifted by the hydraulic press when the force applied at the plunger is 400N. (5 Marks)

5. State **four** factors that govern pressure in liquids (4 Marks)

   a) State the Archimedes' principle. (1 Mark)

   b) An object weighs 1.04N in air, 0.64N when fully immersed in water and 0.72N when fully immersed in a liquid. If the density of water is 1000 kg m^{-3}, calculate the density of the liquid. (5 Marks)

6. The figure below shows a simply supported beam. Neglecting the mass of the beam, determine the reactions of the supports when the beam is in equilibrium. (5 Marks)



7. Highlight **three** disadvantages of frictional forces. (3 Marks)

8. At the instant of striking, a hammer of mass 30 kg has a velocity of 15 m/s. Determine the kinetic energy in the hammer. (4Marks)

9. A gas occupies a volume of 4000 litres temperature of 37°C and normal atmosphere pressure. Determine the new volume of the gas if it is heated at constant pressure to a temperature of 67°C (normal atmosphere pressure ($P = 1.01 \times 10^5$pa) (3 Marks)

SECTION B (60 Marks)

*Answer Any **THREE** questions in this section*

10.

a) Outline **three** differences between scaar and vector quantities (6 Marks)

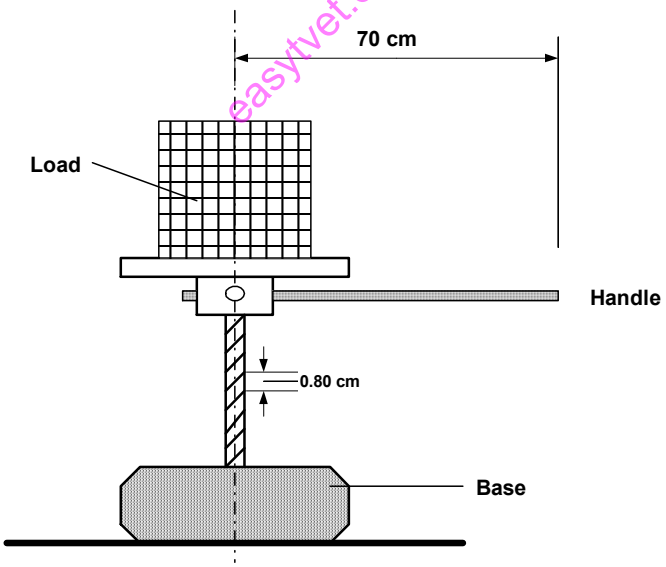
b) Explain **two** states of equilibrium. (4 Marks)

c) Use the parallelogram of forces methods to find the magnitude and direction of the resultant of forces of 300N acting at an angle of 135^{o} and a force of 400 N acting at an angle of -120^{o}.Use scale of 1cm: 40N (10 Marks)

11.

a) Highlight **four** simple machine used to make work easier (4 Marks)

b) The figure below shows a cross-section of a handle of a screw jack 70 cm long. The pitch of the screw is 0.8 cm.



Given that the efficiency is 65%, calculate:

i The velocity ratio of the system; (3 Marks)

ii The mechanical advantage of the screw jack (3 Marks)

(d) The effort required to raise a load using a simple machine, for various values of load is as shown: (10 Marks)

load (Fl)	2050	4120	7410	8240	10300
Effort (Fe)	252	340	465	505	580

If the movement ratio for the machine is 30,

i Draw a graph of Effort force (Y-axis) Vs Load force (X-axis) using the data given above;

ii Using the graph in (i) above, deduce the law of the machine;

iii Calculate the limiting force ratio and the limiting efficiency of the machine.

12.

a) Fill gaps in the table below. (4 Marks)

No	**Initial form of energy**	**Final form of energy**	**Transducer**
i.	Mechanical Energy		Generator
ii.		Electrical Energy	Microphone
iii.	Electrical Energy		Bulb
iv.	Mechanical Energy	Heat Energy	

b) A lorry having a mass of 1.5 tonnes is travelling along a level road at 72 km/h. When the brakes are applied, the speed decreases to 18 km/h. Determine how much the kinetic energy of the lorry is reduced. (6 Marks)

c) The coefficient of friction of brakes pad and a steel disc is 0.82. determine the normal force between the pad and the disc if the frictional force required is 1025N. (4Marks)

d) A planing machine has a cutting stroke of 2 m and the stroke takes 4 seconds. If the constant resistance to the cutting tool is 900 N,

Calculate for each cutting stroke:

(i) the power consumed at the tool point; (3 Marks)

(ii) The power input to the system if the efficiency of the system is 75%. (3 Marks)

13.

a) Differentiate between "sensible heat" and "latent heat of vaporization" (2 Marks)

b) Determine the amount of heat energy needed to change 400g of ice, initially at $-20℃$, into steam at $120℃$. Assume the following: latent heat of fusion of ice $= 335kj/kg$, latent heat of vaporization of water $= 2260kj/kg$, specific heat capacity of ice $= 2.14kj/kg\,℃$, specific heat capacity of water $= 4.2\ kj/kg\,℃$ and specific heat capacity of steam $= 2.01\ kj/kg\,℃$. (12 Marks)

(12 Marks)

Calculate the following:

(i) Heat energy needed to change the temperature of ice from −20 °C to 0°C ;

(ii) Latent heat needed to change ice at 0 °C into water at 0 °C;

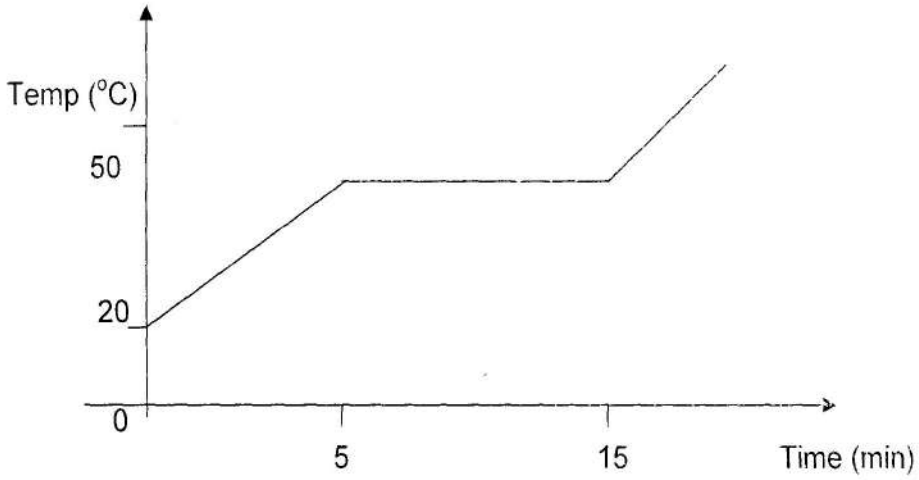
(iii) Heat energy needed to change the temperature;

(iv) Latent heat needed to change water at 100 °C into steam at 100 °C ;

(v) Heat energy needed to change steam at 100 °C into steam at 120 °C .

(vi) Total heat energy needed.

c) A heater rated 1 .25 kW is used to heat 3 kg of a substance which is initially in solid state.



Use the information in the graph to find:

i. Specific heat capacity of the substance in solid form; (2 Marks)

ii. Latent heat of fusion of the substance; (2 Marks)

iii. Time taken for the temperature to reach 90°C, assuming specific heat capacity does not change. (2 Marks)

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