INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. ALL calculations should consist of at least the following THREE steps:
   (a) The formula used or the manipulation thereof
   (b) The substitution of the given data in formula
   (c) The answer together with the correct SI unit

4. Gravitational acceleration = 9,8 m/s²
   Atmospheric pressure = 101,3 kPa
   Heat value of petrol = 2,5 MJ/kg
   Heat value of coal = 3,0 MJ/kg
   Density of water = 1 000 kg/m³
   Specific heat capacity of water = 4 187 J/kg.°C
   Specific heat capacity of steam = 2 100 J/kg.°C
   Specific heat capacity of steel = 500 J/kg.°C
   Specific heat capacity of copper = 390 J/kg.°C
   Specific heat capacity of aluminium = 900 J/kg.°C
   Linear coefficient of expansion of steel = 0,000 012/°C
   Linear coefficient of expansion of copper = 0,000 017/°C
   Linear coefficient of expansion of aluminium = 0,000 023/°C
   Resistivity of steel at 20°C = 0,000 000 155 Ω.m
   Resistivity of copper at 20°C = 0,000 000 018 Ω.m
   Resistivity of aluminium at 20°C = 0,000 000 028 Ω.m

5. Rule off across the page on completion of EACH question.
6. Drawing instruments must be used for ALL drawings.
7. Marks indicate percentages.
8. Keep subsections of questions TOGETHER.
9. Number the answers correctly according to the numbering system used in this question paper.
10. Write neatly and legibly.
QUESTION 1

1.1 A taxi starts from one stop, accelerates uniformly to a velocity of 16 m/s within 12 seconds, keep this constant velocity for 24 seconds and then decelerates to stop at the next stop within 6 seconds. The TABLE below indicates the velocities of the taxi measured in time intervals.

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>0</th>
<th>6</th>
<th>12</th>
<th>18</th>
<th>24</th>
<th>30</th>
<th>36</th>
<th>42</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velocity (m/s)</td>
<td>0</td>
<td>8</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>0</td>
</tr>
</tbody>
</table>

Draw the velocity/time graph from the values in the table above. (3)

1.2 Calculate the following with the aid of the above graph:

1.2.1 The acceleration of the taxi (2)
1.2.2 The deceleration of the taxi (2)
1.2.3 The total displacement of the taxi between the stops (3)
1.2.4 The average velocity of the taxi during the whole trip (1)[41]

QUESTION 2

2.1 Define the following:

2.1.1 The resultant of a system of forces (1)
2.1.2 The moment of a force (1)

2.2 A horizontal beam, as shown in FIGURE 1 below, rests on two supports, L and R and is loaded as shown.

![FIGURE 1](image-url)
2.2.1 Determine the reactions of both supports by taking moments about each support. (Ignore the self-weight of the beam.)

2.2.2 Check the answers by balancing upward and downward forces.

2.3 The 10 m long beam shown in FIGURE 2 below, is supported at one point only and loaded as shown. Determine the distance X, from the left-end so that the beam is in equilibrium. (Ignore the self-weight of the beam.)

![Diagram of a beam with forces applied at 80 kN and 120 kN at distances]

**FIGURE 2**

**QUESTION 3**

3.1 882 joules of energy is used to lift a 10 kg mass vertically from the ground to a certain height.

Determine the following:

3.1.1 The height to which the mass is lifted

3.1.2 The velocity of the mass just before hitting the ground if it is allowed to free fall from that height

3.2 The momentum of a 20 kg mass is 250 kgm/s.

Determine the following:

3.2.1 The velocity of the mass in m/s

3.2.2 The velocity of the mass in km/h

3.3 A bullet with a mass of 13 g travels at a velocity of 250 m/s.

Calculate the kinetic energy of the bullet.

3.4 Define the law of conservation of energy.
QUESTION 4

4.1 A load with a weight of 2,500 N is lifted through a height of 40 m by means of a cable with a weight of 25 N/m, which is wound onto a drum at the top.

Make a neat sketch of the force-distance graph from the information given above. The force axis will be vertical while the distance axis will be horizontal. (3)

4.2 Determine the following from the graph sketched in QUESTION 4.1.

4.2.1 The work done in winding up the total length of cable with the load attached. (2)

4.2.2 The power applied when the load is 20 m from the drum and the velocity is 2.5 m/s is (2)

4.3 The engine of a vehicle, travelling at 25 m/s on a level road, delivers 80 kW.

Determine the following:

4.3.1 The total tractive resistance (wind, friction, et cetera.) that the vehicle has to overcome (2)

4.3.2 The work done by the engine in 10 minutes (2)

QUESTION 5

5.1 Name the type of mechanical drive that will be used in the following cases:

5.1.1 Bicycle (1)

5.1.2 Motor vehicle gearbox (1)

5.1.3 Farming implements driven by a tractor where the implement is not close to the tractor (1)
5.2 The compound gear train shown in FIGURE 3 below, consists of four gears. The number of teeth on gear A is 80 teeth, on gear B is 120 teeth and on gear C is 55 teeth. Gear B is running at 120 r/min and gear D is running at 132 r/min.

Determine the following:

5.2.1 The rotational frequency of gear A
5.2.2 The number of teeth on gear D

\[
\begin{align*}
N_a &= ? \\
T_A &= 80 \text{ T}
\end{align*}
\]

\[
\begin{align*}
N_b &= 120 \text{ r/min} \\
T_B &= 120 \text{ T}
\end{align*}
\]

\[
\begin{align*}
N_d &= 122 \text{ r/min} \\
T_D &= ? \text{ T}
\end{align*}
\]

\[
\begin{align*}
T_C &= 55 \text{ T}
\end{align*}
\]

FIGURE 3

5.3 The following data refers to a belt drive.

Effective force in the belt = 950 N
Power transmitted by the belt = 3.25 kW
Diameter of driver pulley = 320 mm

Calculate the following:

5.3.1 The belt speed in m/s
5.3.2 The rotational frequency of the driver pulley in r/s

5.4 A chain block (Weston differential pulley block) has 32 slots in the larger pulley and 30 slots in the smaller pulley. An effort of 200 N is required to lift a mass of 300 kg.

Determine the following:

5.4.1 The mechanical advantage of the chain block
5.4.2 The velocity ratio of the chain block
5.4.3 The efficiency of the chain block

(1) [15]

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QUESTION 6

6.1 A swimming pool has a length of 8 m, breadth of 4 m and depth of 3 m. The pool is filled with fresh water that has a density 1 000 kg/m³.

Determine the following:

6.1.1 The gauge pressure at the bottom of the pool

6.1.2 The total force (force of pressure) exerted on the bottom area of the pool

(2)

(2)

6.2 The following statements are part of the laws of friction. Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only ‘true’ or ‘false’ next to the question number (6.2.1 – 6.2.3) in the ANSWER BOOK.

6.2.1 Friction is dependent on the nature of the surfaces in contact.

6.2.2 Friction is dependent on the area of the surfaces in contact.

6.2.3 Friction is dependent on the speed of sliding between the surfaces in contact.

(1)

(1)

(1)

6.3 A body with a mass of 50 kg is moving down an incline with an angle of 21° to the horizontal. The coefficient of friction between the body and the incline surface is 0.315.

Calculate the following:

6.3.1 The weight component perpendicular to the sliding plane

6.3.2 The weight component parallel to the sliding plane

6.3.3 The frictional force

6.3.4 The external force required to pull the body up the incline plane

(1)

(1)

(2)

(2)

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[13]

QUESTION 7

7.1 Define the coefficient of linear expansion.

(2)

7.2 400 kg of water has to be heated from 15 °C to 90 °C.

Determine the following:

7.2.1 The heat energy required to heat the water

7.2.2 The mass of coal required for the heating if 60% of the heat released by the coal is absorbed by the water

(2)

(2)
7.3 Determine the length of a copper pipe at 75 °C if its length at 10 °C is 6 m. 

7.4 Explain what is meant by the term specific enthalpy of evaporation, also known as specific latent heat of evaporation. 

QUESTION 8 

8.1 Name the sub-atomic particles in the nucleus of an atom and give the electrical charge of each. 

8.2 What is meant by the expression element? 

8.3 State THREE uses of electrolysis. 

8.4 Name TWO methods for the prevention of corrosion. 

QUESTION 9 

9.1 Two resistors are to be connected for maximum current flow. State which connection is to be used, series or parallel connection. 

9.2 A 3 Ω resistor and an unknown resistor are to be connected in parallel. The resultant resistance is to be 2 Ω. Determine the resistance of the unknown resistance. 

9.3 Determine the resistance between A and B in FIGURE 4 as shown below. 

\[ \begin{align*} &A \quad 4 \Omega \quad 5 \Omega \quad B \\ &\quad \downarrow 12 \Omega \end{align*} \] 

FIGURE 4 

9.4 Make a neat, labelled sketch of an apparatus that may be used to demonstrate self-induction. 

9.5 Calculate the resistance of a copper conductor that has a length of 42 km and a cross-sectional area of 0,000 314 16 m². 

TOTAL: 100
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FORMULA SHEET

All the formulae needed are not necessarily included. Any applicable formula may also be used.

\[ w = m \cdot g \]
\[ W = F \cdot s \]
\[ P = \frac{W}{t} \]
\[ \eta = \frac{Output}{Input} \cdot 100\% \]
\[ \eta = \frac{Uitset}{Inset} \cdot 100\% \]
\[ \mu = \frac{F_{\mu}}{N_R} \]
\[ \mu = \tan \Phi \]
\[ F_T = F_{\mu} \quad \text{horizontal} \quad a = 0 \]
\[ F_S = w \sin \theta \]
\[ F_C = w \cos \theta \]
\[ F_T = F_{\mu} \pm F_S \quad \text{...} \quad a = 0 \]
\[ F_e = T_1 - T_2 \]
\[ \frac{T_1}{T_2} = \text{tension ratio} \quad \text{spanningsverhouding} \]
\[ P = F_e \cdot v \]
\[ v = \pi \cdot d \cdot n \]
\[ n = \frac{N}{60} \]
\[ N_A \cdot T_A = N_B \cdot T_B \]
\[ SV = \frac{N_A}{N_2} = VR \]
\[ E_P = m \cdot g \cdot h \]
\[ E_K = \frac{1}{2} m \cdot v^2 \]
\[ E_T = E_P + E_K \]
\[ HV = \frac{L}{E} = MA \]
\[ VV = \frac{S_E}{S_L} = DR \]
\[ \frac{HV}{VV} \cdot 100\% = \eta = \frac{MA}{DR} \cdot 100\% \]
\[ VV = \frac{2D}{(d_1 - d_2)} = DR \]
\[ VV = \frac{2D}{(D - d)} = DR \]
\[ Q = m \cdot c \cdot \Delta t \]
\[ m \cdot w_w = Q = m \cdot h \nu \]
\[ p = \frac{Q}{t} \]
\[ \Delta l = l_o \cdot \alpha \cdot \Delta t \]
\[ l_f = l_o \pm \Delta l \]
\[ 1 \text{ m/s} = 3.6 \text{ km/h} \]
\[ s = u \cdot t + \frac{1}{2} \cdot a \cdot t^2 \]
\[ v = u + a \cdot t \]
\[ v^2 = u^2 + 2a \cdot s \]
\[ \Sigma \uparrow F = \Sigma \downarrow F \]
\[ \Sigma M = \Sigma 4 M \]
\[ P_{ABS} = P_{ATM} + P_{MET} \]
\[ p = \Delta g \cdot h \]
\[ \frac{1}{R_{PAR}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n} \]
\[ R_{SER} = R_1 + R_2 + \ldots + R_n \]
\[ R = \frac{\rho \cdot l}{a} \]