Candidates will require drawing instruments.

This question paper consists of 8 pages, 1 diagram sheet and a 1-page formula sheet.
Answer ALL the questions.

INSTRUCTIONS AND INFORMATION

1. Questions may be answered in any order.
2. Keep subsections of questions together.
3. Rule off across the page on completion of each question.
4. ALL sketches should be drawn using suitable drawing instruments.
5. Sketches should be neat and in proportion.
6. ALL calculations should consist of at least the following THREE steps:
   6.1 The correct, appropriate formula or manipulation thereof
   6.2 Correct substitution of values
   6.3 The answer with the correct SI unit
7. NOTE: \( g = 9.8 \, \text{m/s}^2 \)
   \( 1 \, \text{m/s} = 3.6 \, \text{km/h} \)
QUESTION 1: DYNAMICS

1.1 Choose the description from COLUMN B which best matches the term in COLUMN A. Write only the letter (A - H) next to the question number (1.1.1 - 1.1.8).

<table>
<thead>
<tr>
<th>COLUMN A</th>
<th>COLUMN B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scalar</td>
<td>A actual route that an object has followed</td>
</tr>
<tr>
<td>Vector</td>
<td>B the length of the straight line between two points</td>
</tr>
<tr>
<td>Distance</td>
<td>C measurement that has both magnitude and direction</td>
</tr>
<tr>
<td>Displacement</td>
<td>D indication of the attraction force between a body and the earth</td>
</tr>
<tr>
<td>Speed</td>
<td>E the amount of matter in a body</td>
</tr>
<tr>
<td>Velocity</td>
<td>F a quantity which has only magnitude</td>
</tr>
<tr>
<td>Mass</td>
<td>G displacement per time unit</td>
</tr>
<tr>
<td>Weight</td>
<td>H distance moved in a unit of time</td>
</tr>
</tbody>
</table>

1.2 An off-road racing car drives 11 km south from the starting point A to the first control point B, then 15 km north-east to control point C, then 14 km north to control point D and then 18 km west to the finishing line E.

Calculate the following:

1.2.1 The total distance the racing car has travelled

1.2.2 The displacement of the racing car with the aid of vector adding. HINT: Use scale 1 km = 5 mm

1.2.3 The average speed of the racing car in km/h if the route is finished in 50 min

1.3 The movement of a motorcycle is shown in the graph (FIGURE 1 on the DIAGRAM SHEET).

1.3.1 What happens in the first two seconds (between A and B)?

1.3.2 What happens between the second and the tenth second (between B and C)?

1.3.3 Calculate the distance the motorcycle has travelled between the second and tenth second (between B and C).

PTO
1.4  An arrow travels at a constant velocity and takes 2 seconds to hit a target 50 m away.

1.4.1  Draw a displacement/time graph of the movement.
HINT: 1 second = 40 mm and 10 m = 10 mm

1.4.2  Calculate the velocity of the arrow.

QUESTION 2: STATICS

2.1  Choose the correct answer and write only the letter (a - d) next to the question number in the answer book.

2.1.1  The equilibrant of two or more forces can be defined as follows:

(a) A single force that has the same effect as two or more forces
(b) A force which will balance or neutralise the effect of two or more forces
(c) That effect which changes or tends to change the state of rest or motion of a body
(d) A quantity which has magnitude and direction

2.1.2  A lifting machine is an apparatus:

(a) Which lifts a large load by applying a much smaller force than the load
(b) With which you measure temperature
(c) That single force which has the same effect as the combined effect of two or more forces
(d) The smallest part into which matter can be broken down without losing its unique characteristics

2.1.3  The law of moments is as follows:

(a) The ability of a body to work by means of its motion
(b) The rate at which an object undergoes a certain displacement
(c) Energy cannot be created or destroyed, but can only be changed from one form to another
(d) If a system of forces acts on a body and the body is in equilibrium, the anti-clockwise moments about the turning point are equal to the clockwise moments
2.1.4 Mechanical advantage can be described as...

(a) the ratio in a lifting machine between the distance that the effort moves and the distance that the load moves.
(b) that effect which tends to change the state of rest or motion in a straight line of a body.
(c) the ratio in a lifting machine between the load and the effort.
(d) the ratio between energy delivered by a machine and the energy supplied to the machine. (½)

2.2 Determine, with the aid of a parallelogram of forces, the magnitude and the direction of the resultants of the two forces shown in FIGURE 2 (DIAGRAM SHEET). Use drawing equipment and use scale 10 mm = 5 N for the solution. (4)

2.3 Define the moment of a force. (1)

2.4 Calculate the magnitude of a force that is applied to a spanner with an effective length of 0.4 m to exert a torque of 10 N.m. (2)

2.5 A wheel and axle lifting machine has diameters of 700 mm and 350 mm respectively. When a body with a weight of 1 000 N is lifted it has a mechanical advantage of 4.

2.5.1 Draw this diagram of the lifting machine. (4)
2.5.2 Calculate the displacement ratio. (1)
2.5.3 Calculate the effort required. (2)

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QUESTION 3: ENERGY, WORK AND POWER

3.1 Give an example of each of the following forms of energy:

3.1.1 Kinetic energy (½)
3.1.2 Electrical energy (½)
3.1.3 Chemical energy (½)
3.1.4 Heat energy (½)

3.2 The graph in FIGURE 3 (DIAGRAM SHEET) shows the movement of a lift. Calculate, from the graph, the following:

3.2.1 The mass of the lift (2)
3.2.2 The work done (2)
3.2.3 The power if the movement takes place in 8 seconds (1)

3.3 Define the law of conservation of energy. (1)

3.4 Define potential energy. (1)
3.5 Choose the correct answer and write only the letter (a - d) next to the question number in the answer book.

3.5.1 The unit of power can be derived from ...
(a) force × time.
(b) force × velocity.
(c) work × time.
(d) momentum × time. (½)

3.5.2 When a force acts on a body, work will only be done when ...
(a) the force and the movement are perpendicular to each other.
(b) the force is larger than the weight of the body.
(c) there is no friction or acceleration.
(d) the force undergoes a movement. (½)

QUESTION 4: HEAT

4.1 What is the difference between temperature and heat? (2)

4.2 Compare the advantages of the mercury thermometer with those of an alcohol thermometer. Copy the table below in the answer book and complete it.

<table>
<thead>
<tr>
<th>MERCURY THERMOMETER</th>
<th>ALCOHOL THERMOMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
|                      |                      | (4)

4.3 How is heat propagated in the following phases (processes):

4.3.1 Solids
4.3.2 Liquids
4.3.3 Gases
4.3.4 Vacuum (2)

4.4 Draw a neat, labelled diagram of a pyrometer. (4)

4.5 What effect does the bi-metallic strip represent? (1)

4.6 When 120 kJ of energy is added to 15 kg of brass the temperature rises to 52 °C. If the specific heat capacity of brass is 393 J/kg°C, calculate the initial temperature of the brass. (3)

4.7 A water pipe has a length of 30 m at midday. During the night the length changes to 29,544 m. Calculate the change in length of the pipe. (2)
QUESTION 5: PARTICLE STRUCTURE OF MATTER

5.1 Fill in the missing word(s) in the following sentences. Write only the question number and answer in the answer book.

If matter is in the solid phase the particles move 5.1.1 ... than in the liquid phase.
A molecule can be further divided into smaller parts called 5.1.2 ... .
An electron has a 5.1.3 ... charge.
The nucleus of an atom consists of 5.1.4 ... and 5.1.5 ... .
The nucleus of an atom has a 5.1.6 ... charge.
When an atom loses an electron it forms a 5.1.7 ... ion.
When an atom gains an electron it forms a 5.1.8 ... ion. (4)

5.2 Show in which ONE of the three phases of matter the following substances occur at room temperature:

5.2.1 Lead
5.2.2 Hydrogen
5.2.3 Diesel
5.2.4 Sulphuric acid (2)

5.3 Make a neat, labelled drawing of the structure of an atom. (3)

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QUESTION 6: ELECTRICITY

6.1 Classify the following matter as conductors or insulators:

carbon; paper; plastic; iron; aluminium; bakelite (3)

6.2 Define direct current and alternating current and give an example of a source of each. (3)

6.3 Give Ohm's law in equation form. (1)

6.4 Define potential difference. (1)

6.5 Two resistors with values of 6 ohms and 9 ohms and a variable resistor that is set at 14 ohms are connected in parallel and in turn are connected to two cells in series with values of 1.5 V each. A voltmeter is connected over the cells and an ammeter in series with the cells in the circuit to measure the total current.

6.5.1 Draw this circuit diagram and show ALL the components. (3)

PTO
Calculate the following:

6.5.2 The total resistance
6.5.3 The total current
6.5.4 The voltage over the 9 ohm resistor
6.5.5 The power in the 6 ohm resistor
6.5.6 The heat generated in the 6 ohm resistor if the current flows for 3 seconds

6.6 An electrical kettle is marked 800 W, 220 V.

Calculate the following:

6.6.1 The current flowing through the kettle
6.6.2 The resistance of the element

6.7 State THREE factors that influence the resistance of a conductor.

6.8 What will happen to the resistance of the following substances if the temperature is increased:

6.8.1 Brass
6.8.2 PVC

6.9 Make a neat, labelled sketch that will describe the working of a relay-switch.

TOTAL: 100
ENGINEERING SCIENCE N1

FORMULA SHEET

Any applicable formula may also be used.

1. \( v = \frac{s}{t} \)
2. \( F = m.g \)
3. \( DR = \frac{E_{\text{dist.}}}{L_{\text{dist.}}} \)
4. \( MA = \frac{L}{E} \)
5. \( VR = \frac{D}{d} \)
6. \( \text{MOMENT} = F.s \)
7. \( T = F.R \)
8. \( W = F.S \)
9. \( P = \frac{W}{t} \)
10. \( P = F.v \)
11. \( Q = m.c. \Delta t \)
12. \( L_f = L_o + \Delta L \)
13. \( L_f = L_o - \Delta L \)
14. \( P = V.I \)
15. \( P = i^2.R \)
16. \( P = \frac{V^2}{R} \)
17. \( Q = P.t \)
18. \( I = \frac{V}{R} \)
19. \( R_t = R_1 + R_2 \ldots \)
20. \( \frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} \ldots \)