higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T500(E)(A5)T

# AUGUST EXAMINATION

# NATIONAL CERTIFICATE

# ENGINEERING SCIENCE N1

(15070391)

**5 August 2016 (X-Paper)**
**9:00–12:00**

**This question paper consists of 10 pages and 1 formula sheet.**

ENGSCN1

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# DEPARTMENT OF HIGHER EDUCATION AND TRAINING
# REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE N1
TIME: 3 HOURS
MARKS: 100

**INSTRUCTIONS AND INFORMATION**

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. You may start with any question but sub-questions must be kept in order and not split or separated.
5. Calculations must contain the following:
   - 5.1 Formula
   - 5.2 Substitution and conversion of values
   - 5.3 Answer
6. Answers to calculations must at all times be given correctly to three decimal numbers and with units.
7. Neat, labelled line sketches must be drawn with the necessary drawing equipment.
8. Use $g = 9{,}8\ m.s^{-1}$.
9. Write neatly and legibly.

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## QUESTION 1

1.1 Define the following:

1.1.1 Weight

1.1.2 Velocity

1.1.3 Displacement

(3 x 1) (3)

1.2 A construction worker pushes a wheelbarrow on a level road in a south-easterly direction. The worker pushes the wheelbarrow for 250 m and takes a rest. He continues for another 150 m and takes a rest, and then continues for another 200 m to his final destination.

Draw a graphic representation of the vectors and determine the resultant displacement vector.

Scale: 100 m = 1 cm (3)

1.3 A ship travels from Cape Town directly east for 400 km then turns north for 350 km to reach Durban.

1.3.1 What is the distance the ship has travelled? (1)

1.3.2 What is the displacement of the ship? (3)

1.4 A rock falls from a cliff and it takes 3,5 seconds to reach the ground.

1.4.1 Use a scale of 2 cm = 1 s and 2 cm = 9,8 m/s to draw a velocity vs time graph representing the movement of the rock.

1.4.2 Determine the height of the cliff.

(2 x 2) (4)
**[14]**

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## QUESTION 2

2.1 Various options are given as possible answers to the following questions. Choose the correct answer and write only the letter (A–D) next to the question number (2.1.1–2.1.6) in the ANSWER BOOK.

2.1.1 A force can be defined as …

A a quantity which possesses size only.
B the mechanical effectiveness of a machine.
C the influences that change in, or tend to change the state of rest or uniform movement in a straight line of an object.
D a quantity which possesses both size and direction.

2.1.2 A vector is …

A the mechanical effectiveness of a machine.
B a quantity which possesses size only.
C the force applied multiplied by the perpendicular distance from the turning point to the line of application.
D a quantity which possesses both size and direction.

2.1.3 A resultant can be defined as …

A that single force that can have the same effect as two or more forces when acting on a body.
B that single force that will balance two or more forces acting on a body.
C the ratio between the displacement of the effort and the displacement of the load.
D the ratio between the load and the effort.

2.1.4 Displacement ratio is …

A that single force that will balance two or more forces acting on a body.
B the ratio between the displacement of the effort and the displacement of the load.
C the mechanical effectiveness of a machine.
D the ratio between the load and the effort.

2.1.5 The moment of a force is …

A a quantity which possesses both size and direction.
B the force applied multiplied by the perpendicular distance from the turning point to the line of application.
C a quantity which possesses only size.
D the mechanical effectiveness of a machine.

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2.1.6 A lifting machine is ...

A that single force that will balance two or more forces acting on a body.
B a device enabling a load larger than the applied effort to be raised.
C an apparatus which is used to measure energy.
D an apparatus which is used to measure temperature.

(6 x 1) (6)

2.2 Determine the resultant of the following two forces acting on a body as shown in FIGURE 1.

Use the parallelogram method.

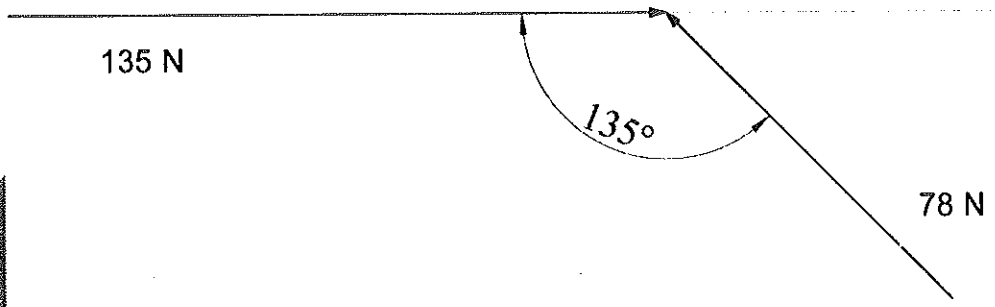


**FIGURE 1** (3)

2.3 A wheel-and-axle lifting machine has a mechanical advantage of 5. The axle has a diameter of 110 mm and the wheel has a diameter of 645 mm.

Calculate the following:

2.3.1 The effort needed to lift a load of 105 kg

2.3.2 The displacement ratio

2.3.3 The efficiency

(3 x 2) (6)

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2.4 Two ropes support a load of 125 N as shown in FIGURE 2 below.

Determine the tensile force in ropes A and B.

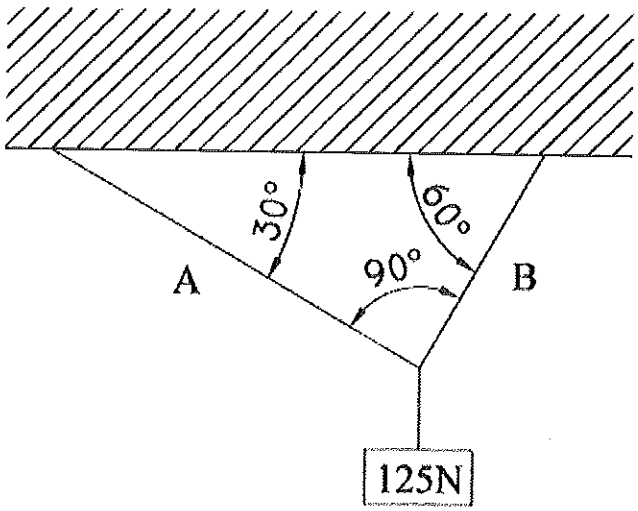


**FIGURE 2**

(3)
**[18]**

**QUESTION 3**

3.1 Choose the correct word(s) from those given in brackets. Write only the word(s) next to the question number (3.1.1–3.1.5) in the ANSWER BOOK.

3.1.1 (Potential energy/Kinetic energy) is the ability of a body to do work due to its position.

3.1.2 (Potential energy/Kinetic energy) is the ability of a body to do work due to its motion.

3.1.3 (Power/Work done) is when a force moves over a distance.

3.1.4 (Power/Work done) is the rate at which energy is used.

3.1.5 (Electrical energy/Chemical energy) is the ability of a body to do work due to a chemical reaction taking place.

(5 x 1) (5)

3.2 The power required to pull a trailer at a constant speed of 75 km/h on a level road is 45 kW.

Determine the following:

3.2.1 The force in the tow bar

3.2.2 The work done in 5 min

(2 x 2) (4)

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3.3 A body with a weight of 250 N is raised 5 m vertically. Select a suitable scale and draw a force/distance graph. (3)
**[12]**

## QUESTION 4

4.1 Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (4.1.1–4.1.5) in the ANSWER BOOK.

4.1.1 The capacity of a body to perform work.

4.1.2 The indication of the degree of hotness or coldness of a body.

4.1.3 The increase in length per unit length per degree of temperature increase.

4.1.4 The quantity of heat needed to increase the temperature of 1 kg of a body by 1 °C.

4.1.5 The quantity of heat needed to increase the temperature of a body by 1 °C.

(5 x 1) (5)

4.2 Explain how a *thermocouple* works. (3)

4.3 Heat can have several effects on a substance.

Name any THREE of these effects and give an example of each. (6 x ½) (3)

4.4 An aluminium block of 12 kg with a specific heat capacity of 908 J/kg °C is heated from 22 °C to 185 °C.

Calculate the heat required to cause the rise in temperature. (2)

4.5 A steel measuring tape is 20 m long at a temperature of 23 °C. The length of the tape changes to 20,036 m when the temperature rises to 48 °C.

Calculate the following:

4.5.1 The change in length in mm

4.5.2 The change in temperature

(2 x 2) (2)

4.6 Draw a neat labelled sketch to describe the working of a bi-metallic strip. (3)
**[18]**

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## QUESTION 5

5.1 Choose a description from COLUMN B that matches a word in COLUMN A. Write only the letter (A–D) next to the question number (5.1.1–5.1.5) in the ANSWER BOOK.

| COLUMN A | | COLUMN B | |
|---|---|---|---|
| 5.1.1 | Matter | A | smallest part of an element |
| 5.1.2 | Atom | B | process where a liquid changes to a gas |
| 5.1.3 | Solidification | C | anything that occupies space and has mass |
| 5.1.4 | Molecule | D | when two or more atoms combine |
| 5.1.5 | Condensation | E | process where a liquid changes to a solid |

(5 x 1) (5)

5.2 Particles in matter move differently in each of the phases of matter.

Describe the movement of particles in the following phases:

5.2.1 Gas

5.2.2 Liquids

5.2.3 Solids

(3 x 1) (3)

5.3 Draw a neat and labelled diagrammatic representation of a simple atom showing the charges of the different particles. (3)

**[11]**

## QUESTION 6

6.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (6.1.1–6.1.5) in the ANSWER BOOK.

6.1.1 An insulator is a substance through which electrical current can flow.

6.1.2 Alternating current changes polarity.

6.1.3 Voltage is the opposition to the flow of current.

6.1.4 Ohm's law states that the current flowing in a circuit is inversely proportional to the voltage and directly proportional to the resistance.

6.1.5 Power is the rate of doing work.

(5 x 1) (5)

6.2 Draw neat SI circuit symbols of the following components:

6.2.1 Galvanometer

6.2.2 Battery

6.2.3 Variable resistor

6.2.4 Open switch

6.2.5 Ammeter

(5 x 1) (5)

6.3 Differentiate between the following types of current. Also give an example of a source of each.

6.3.1 Alternating current

6.3.2 Direct current

(2 x 2) (4)

6.4 A heater element has a resistance of 125 Ω and is connected to a 220 V supply.

Determine the current in the circuit. (2)

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6.5 A kettle which draws 5,25 A is connected to a 220 V supply.

Determine the following:

6.5.1 The power consumption of the kettle

6.5.2 The amount of heat energy generated in 6 minutes

(2 x 2) (4)

6.6 Three resistors with the values 12 Ω, 23 Ω and 33 Ω are connected in series.

Calculate the following:

6.6.1 The total resistance of the three resistors

6.6.2 The current in the circuit if the resistors are connected to a 12 V battery

(2 x 2) (4)

6.7 In your own words, explain what the term *resistivity of a conductor* means. (2)

6.8 Define *Fleming's right-hand rule*. (1)

**[27]**

**TOTAL: 100**

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# ENGINEERING SCIENCE N1

## FORMULA SHEET

Any applicable formula may also be used.

1. $v = \frac{s}{t}$
2. $F = m.g$
3. $DR = \frac{E_{dist.}}{L_{dist.}}$ $VV = \frac{M_{afst.}}{L_{afst.}}$
4. $MA = \frac{L}{E}$ $HV = \frac{L}{M}$
5. $VR = \frac{D}{d}$ $SV = \frac{D}{d}$
6. $MOMENT = F.s$
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. $\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} \ldots$

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# MARKING GUIDELINE

## NATIONAL CERTIFICATE

## AUGUST EXAMINATION

## ENGINEERING SCIENCE N1

## 5 AUGUST 2016

**This marking guideline consists of 10 pages.**

**This question paper must be marked out of 98.**

**NOTE:**

1. Do not allocate marks for QUESTION 2.3.3 (2 marks)
2. The total (100) to be reduced by 2 marks to 98 for all candidates
3. Mark all candidates out of a total of 98 marks
4. Convert the mark achieved out of 98 per candidate to a percentage
5. Record the percentage achieved on the mark sheet

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## NOTE TO MARKERS

✓= 1 mark.
ã = ½ mark.

Calculations:
- 1 mark for replacement of values.
- 1 mark for answer and unit.
- **Do not penalise the student for missing units.**

## QUESTION 1

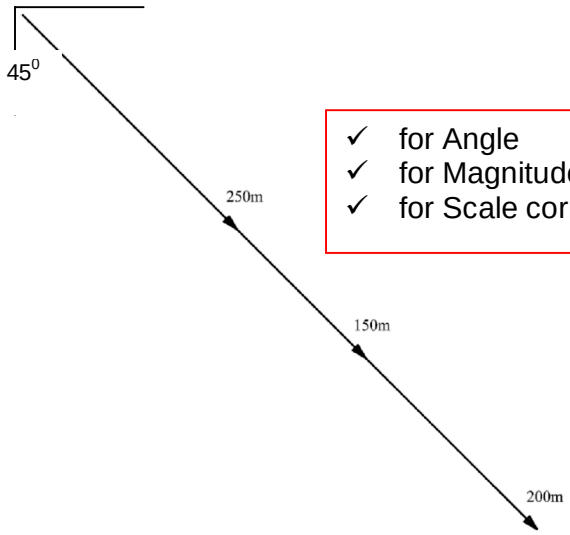
1.1 1.1.1 **Weight is the force with which the earth attracts an object.** ✓

1.1.2 Velocity is the rate of displacement a body undergoes.✓

1.1.3 ✓ Displacement is the straight line path a body moves between two points **or The shortest distance between the start and end of a journey.** (3)

(3 x 1)

1.2




✓ for Angle
✓ for Magnitude
✓ for Scale correctness

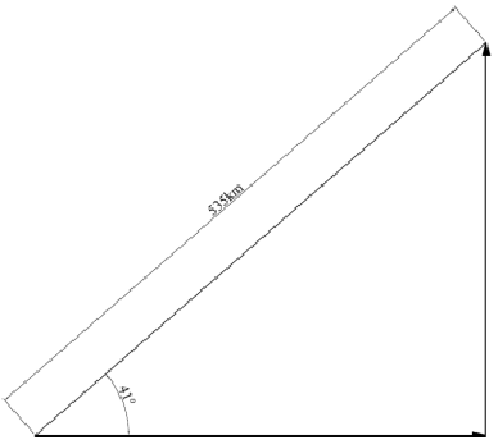
$R = 250 + 150 + 200$

$R = 600\ m\ _\ South - East$ (3)

1.3 1.3.1 $R = 400 + 350$ ✓

$R = 750\ m$ (1)

1.3.2




Variance on magnitude ± 5
Variance on angle ± 4ę

Resultant = 535 km, East 41° North✓
✓✓

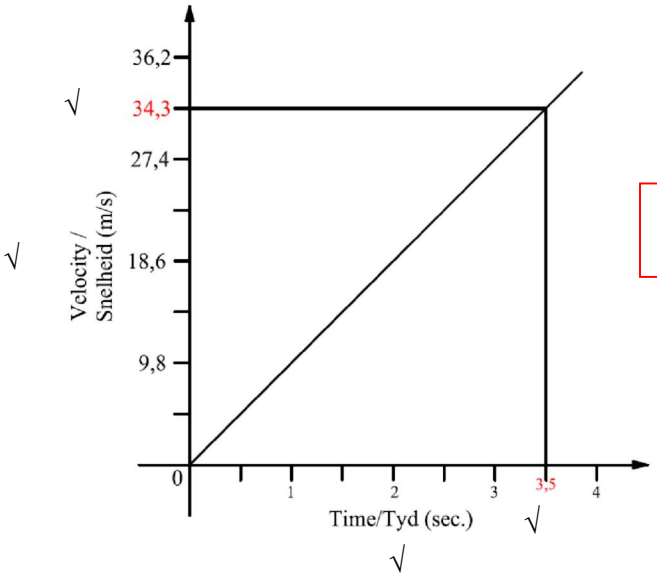
One or the other method

$R = \sqrt{400^2 + 350^2} = 531{,}507 \text{ m}$ ✓✓

$Direction = \theta = \tan^{-1}\frac{350}{400} = East\ 41^{\circ}\ North$ ✓

(3)

1.4 1.4.1




√ √ √ √

No marks for slope,
½ mark for 34.3 & 3.5

(2)

1.4.2 $s = h$

$s = \frac{1}{2}v.t$

$s = \frac{1}{2} \times 34{,}3 \times 3{,}5$ ✓

$s = 60{,}02$ m" ✓

**S = ut + ½ gt²**
**= 0 + ½ + 9.8 x 3.5²**
**= 60.025m**

(2)

**[14]**

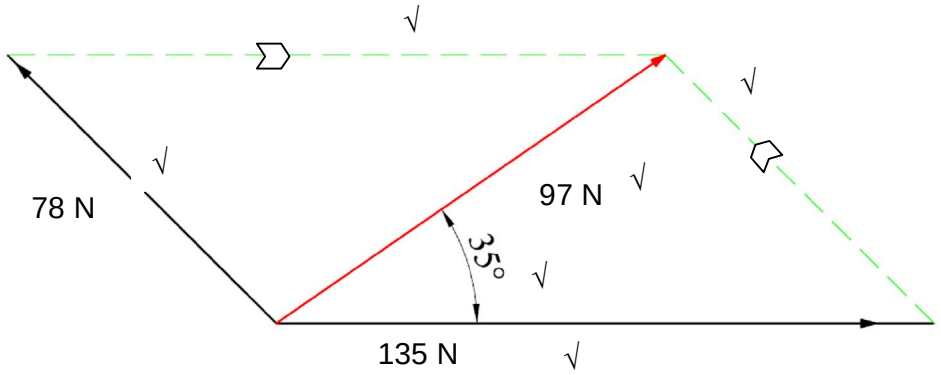
## QUESTION 2

2.1

| | | |
|---|---|---|
| 2.1.1 | C **& D** | ✓ |
| 2.1.2 | D **& C** | ✓ |
| 2.1.3 | A | ✓ |
| 2.1.4 | B | ✓ |
| 2.1.5 | B **& A** | ✓ |
| 2.1.6 | B | ✓ |

(6 x 1) (6)

2.2




Resultant = 97 N, East 35° North

(3)

2.3 2.3.1

$$MA = \frac{L}{E}$$

$$E = \frac{L}{MA}$$

$$E = \frac{105 \times 9,8}{5} \quad ✓$$

$$E = 205,8\ N \quad ✓$$

2.3.2

$$VR = \frac{D}{d}$$

$$VR = \frac{645}{110} \quad ✓$$

$$VR = 5,864 \quad ✓$$

2.3.3

$$\eta = \frac{MA}{VR} \times 100\%$$

$$\eta = \frac{5}{5,864} \times 100$$

$$\eta = 85,266\%$$

**2.3.3 - This is not in the N1 syllabus. (2 MARKS)**

(2 x 2) (4)

2.4 Consider both A and B.

| | A | B | 125 N |
|---|---|---|---|
| x | -A cos 30° = -0,866 A | B Cos 60° = 0,5 B | 0 |
| Y | A sin 30° = 0,5 A | B sin 60° = 0,866 B | -125 |

$\sum x = 0$

$-0{,}866\ A + 0{,}5\ B = 0$

$B = 1{,}732\ A$

$\sum y = 0$

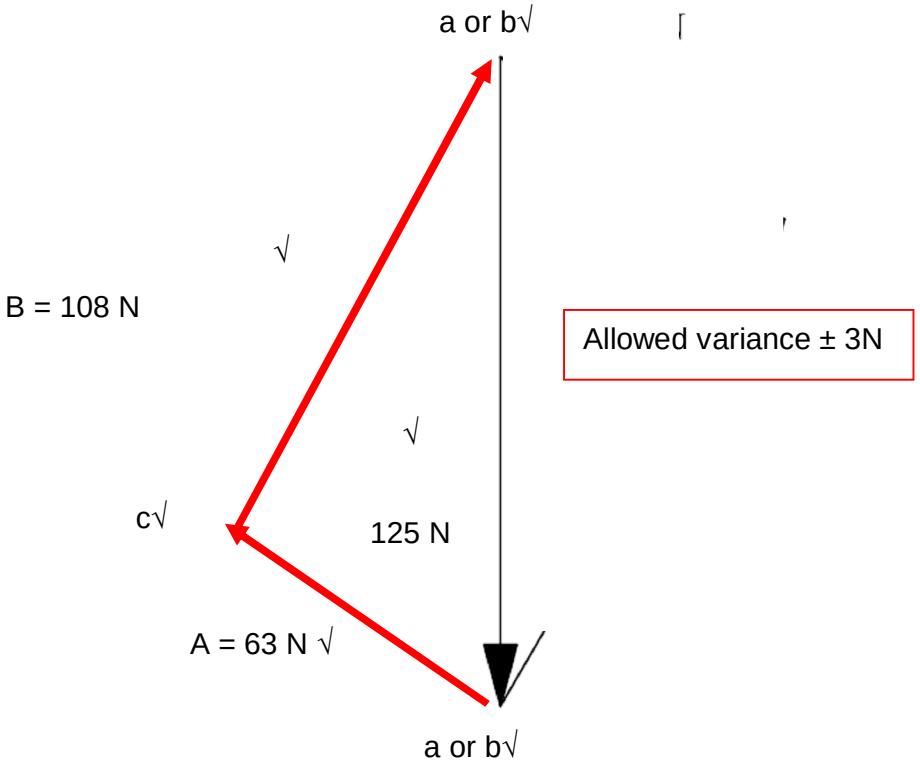
0,5 A + 0,866 B = 125 2

1 in 2

0,5 A + 0,866 x 1,732 A = 125
A = 62,5 N

Therefore B = 1,732 x 62,5 = 108,25 N

OR




(3)
**[16]**

## QUESTION 3

3.1 3.1.1 Potential energy
3.1.2 Kinetic energy
3.1.3 Work done
3.1.4 Power
3.1.5 Chemical energy

(5 x 1) (5)

3.2 3.2.1

$$P = F.v$$

$$F = \frac{P}{v}$$

$$F = \frac{45\,000}{20.833} \quad ✓$$

$$F = 2160.035\ N \quad ✓$$

3.2.2

$$P = \frac{W}{t}$$

$$W = P.t$$

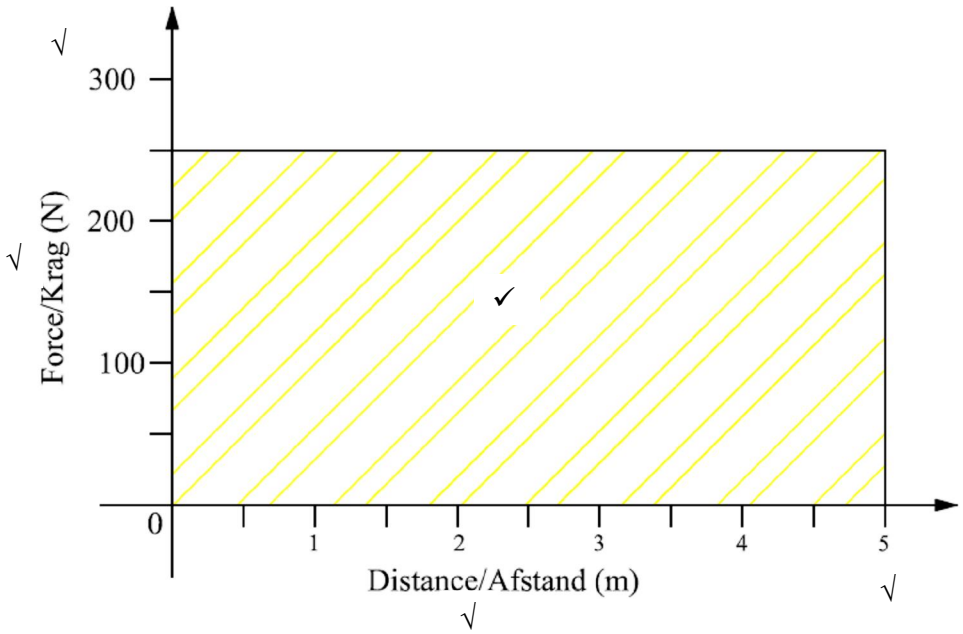
$$W = 45\,000 \times (5 \times 60) \quad ✓$$

$$W = 13\,500\,000\ J$$

$$W = 13{,}5\ MJ \quad ✓$$

(2 x 2) (4)

3.3




(3)
**[12]**

## QUESTION 4

4.1
4.1.1 Energy
4.1.2 Temperature
4.1.3 (Coefficient of) **linear expansion**
4.1.4 Specific heat capacity
4.1.5 Heat capacity

(5 x 1) (5)

4.2
- A thermocouple consists of two conductors of different metals.
- One end joined ï the other end connected to galvanometer.
- As soon as the joined end is heated up ï electric current will flow.
- Galvanometer will read the current flow.

**Also accept drawing.**

(Any 3 x 1) (3)

4.3
- Change of temperature√ ï heating up of metals.√
- Colour change√ ï heating up metals to different temperatures.√
- Change of state√ ï ice + heat = water + heat = gas.√
- Change of composition ï sand and limestone heated = glass.
- Change of resistance ï conductor + heat = higher resistance.
- Generation of an electric current ï thermocouple.
- Change in dimensions ï length of a rod changing when heated.
- Change in shape.

**And any suitable correct answer.**

(Any 6 x ½) (3)

4.4
$$Q = m.c.\Delta\theta$$
$$Q = 12 \times 908 \times (185 - 22) \checkmark\checkmark$$
$$Q = 1776048\ J$$
$$Q = 1{,}776\ MJ$$

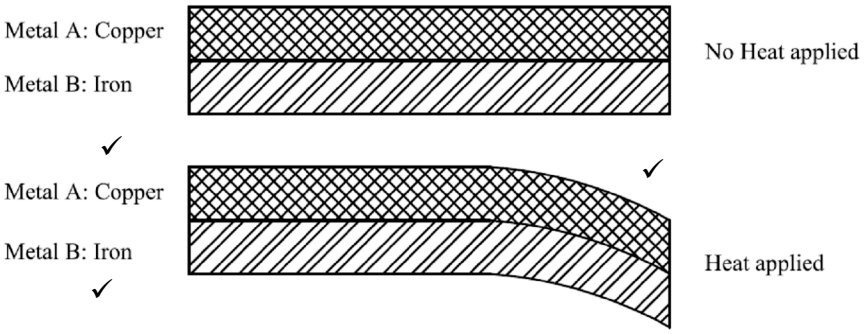
(2)

4.5 4.5.1
$$\Delta l = l_O - l_f$$
$$\Delta l = 20{,}036 - 20 \checkmark$$
$$\Delta l = 0{,}036\ m$$
$$\Delta l = 36\ mm$$

4.5.2
$$\Delta t = t_O - t_f$$
$$\Delta t = 48 - 23 \checkmark$$
$$\Delta t = 25\ ^\circ C$$

(2 x 1) (2)

4.6




(3)
**[18]**

**QUESTION 5**

5.1

| | | | |
|---|---|---|---|
| 5.1.1 | C | ✓ |
| 5.1.2 | A | ✓ |
| 5.1.3 | E | ✓ |
| 5.1.4 | D | ✓ |
| 5.1.5 | B | ✓ |

(5 x 1) (5)

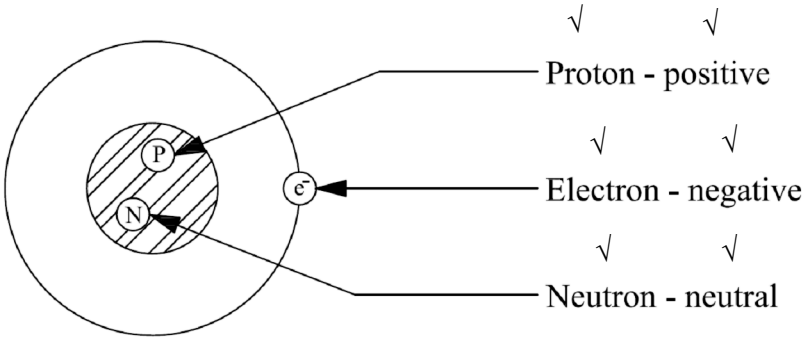
5.2

| | |
|---|---|
| 5.2.1 | Particles move very fast. |
| 5.2.2 | Particles move fast. |
| 5.2.3 | Particles move slowly. |

Use comparative escalation. ie. Fast, slow, very slow.

(3 x 1) (3)

5.3

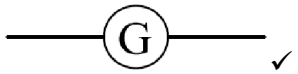



(3)
**[11]**

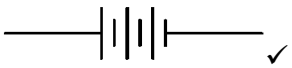
## QUESTION 6

6.1
6.1.1 False ✓
6.1.2 True ✓
6.1.3 False ✓
6.1.4 False ✓
6.1.5 True ✓

(5 x 1) (5)

6.2
6.2.1 

✓

6.2.2  ✓

6.2.3 ✓

6.2.4 ✓

6.2.5

✓

Or any other correct drawing.

(5 x 1) (5)

6.3
6.3.1 Current changes direction constantly✓ ï Generator.✓
6.3.2 Current flows in one direction✓ ï Battery.✓

(2 x 2) (4)

6.4
$$I = \frac{V}{R}$$
$$I = \frac{220}{125}$$ ✓✓
$$I = 1,76 \text{ A}$$

(2)

6.5 6.5.1
$$P = V.I$$
$$P = 220 \times 5,25$$ ✓✓
$$P = 1155 \text{ W}$$
$$P = 1,155 \text{ kW}$$

6.5.2
$$E = P.t$$
$$E = 1155 \times 6 \times 60$$ ✓✓
$$E = 415800 \text{ J}$$
$$E = 415,8 \text{ kJ}$$

(2 x 2) (4)

6.6.1 $R_t = R_2 + R_2 + R_3$

$R_t = 12 + 23 + 33$ ✓✓

$R_t = 68\ \Omega$

6.6.2 $I = \frac{V}{R}$

$I = \frac{12}{68}$ ✓✓

$I = 0{,}176$ A

$I = 176$ mA

(2 x 2) (4)

6.7 Resistivity is the resisting power of a specific material.

OR

Or any other suitable explanation

✓✓ Resistivity of a conductor is the resistance measured between the opposite faces of a unit cube of that material at a certain temperature. (2)

6.8 Fleming's right-hand rule: When the thumb of the right hand points in the direction of the electric current, then the four fingers show the direction of the magnetic field.✓ (1)

**[27]**

**TOTAL: 98**

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