TAKE ANY DOUBT

QUESTION PAPER

&

MEMO

SUBJECT: ENGINEERING SCIENCE

LEVEL: N1

DATE: NOVEMBER 2016

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T500**(E)**(N24)T
NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N1

(15070391)

24 November 2016 (X-Paper)
09:00–12:00

This question paper consists of 11 pages and 1 formula sheet.

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. Calculations must contain the following:
   - Formula
   - Replacement/substitution of values in SI units
   - Answer
5. Answers to calculations must at all times be given to three decimal numbers.
6. Neat, labelled line sketches must be made with the necessary drawing equipment.
7. Use g = 9,8 $m.s^{-1}$
8. Write neatly and legibly.

QUESTION 1

1.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 A scalar is a quantity that has only a magnitude.

1.1.2 The unit for mass is Newton.

1.1.3 Speed is the relationship between displacement and time.

1.1.4 Time is a vector.

1.1.5 The unit for acceleration is $m.s^{-2}$

(5 × 1) (5)

1.2 A ship travels at a velocity of 42 m/s in a northwesterly direction. A man on the ship is walking at a velocity of 3,2 m/s from the back of the ship to the front of the ship.

What is the man's resultant velocity in magnitude and direction? (2)

1.3 A body is released from a height 198,45 m above the ground and it takes 4,5 s to reach the ground.

1.3.1 Plot a velocity/time graph for the falling body.

Use a scale of: 2 cm = 1 s and 1 cm = 20 m (3)

1.3.2 Calculate the slope of the graph. (1)

1.3.3 What does the slope of the graph represent? (1)

1.4 A person walks 2 km at 6 km/h, runs 2 km at 16 km/h and rides bicycle for 1 km at 32 km/h.

What is the person's average speed over the 5 km? (2)

[14]

QUESTION 2

2.1 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (2.1.1–2.1.5) in the ANSWER BOOK.

2.1.1 Force can be defined as ...

A the device that will enable a large load to be lifted by a small effort.
B the ratio of the load opposed to the effort.
C that influence which, when applied to a body, will change or tend to change the state of rest or uniform motion.
D the ratio of the distance moved by the effort opposed to the distance moved by the load.

2.1.2 Resultant can be defined as ...

A that influence which, when applied to a body, will change or tend to change the state of rest or uniform motion.
B the ratio of the load opposed to the effort.
C that single force that will bring a system of forces in balance.
D that single force that can replace a system of forces and still have the same effect on a body.

2.1.3 Mechanical advantage can be defined as ...

A the ratio of the load opposed to the effort.
B the device that will enable a large load to be lifted by a small force.
C the ratio of the distance moved by the effort opposed to the distance moved by the load.
D that single force that can replace a system of forces and still have the same effect on a body.

2.1.4 Velocity ratio can be defined as ...

A that single force that will bring a system of forces in balance.
B the ratio of the load opposed to the effort.
C the device that will enable a large load to be lifted by a small force.
D the ratio of the distance moved by the effort opposed to the distance moved by the load.

2.1.5 The moment of a force can be defined as ...

A that single force that can replace a system of forces and still have the same effect on a body.
B that single force that will bring a system of forces in balance.
C the turning effect of a force about a point.
D that influence which, when applied to a body, will change or tend to change the state of rest or uniform motion.

(5 × 1) (5)

2.2 A body is in equilibrium when three forces are working in on it. In FIGURE 1 below two forces, A and B, are shown. A third force, F, is NOT shown in FIGURE 1 below.

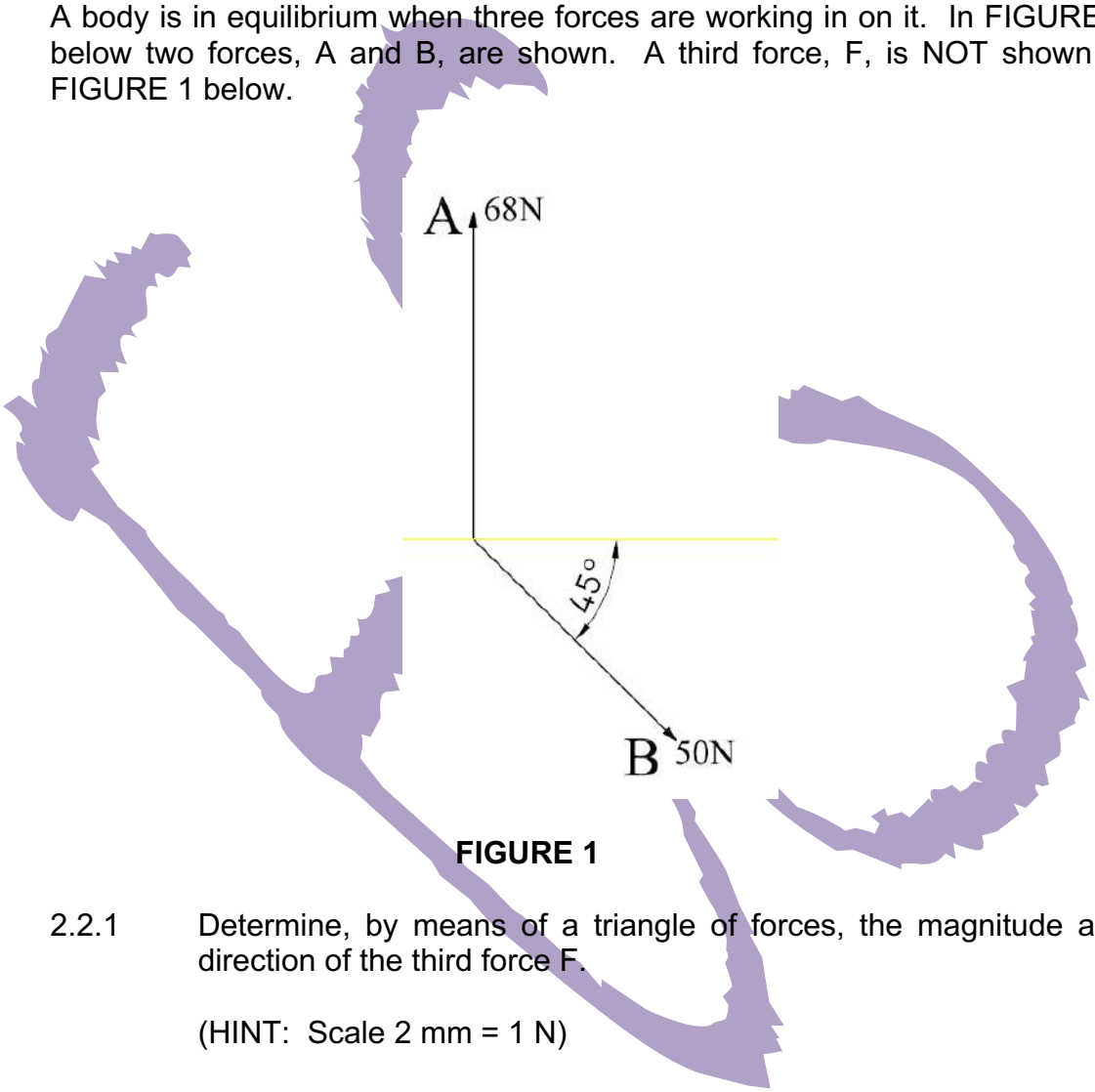


FIGURE 1

2.2.1 Determine, by means of a triangle of forces, the magnitude and direction of the third force F.

(HINT: Scale 2 mm = 1 N) (3)

2.2.2 What is this force F called? (1)

2.3 A lever was used to raise a load of 320 kg. The effort applied was 500 N and it moved through a distance of 1,12 m. The distance the load travelled was 521 mm.

Calculate the following:

2.3.1 The mechanical advantage

2.3.2 The velocity ratio

(2 × 1) (2)

2.4 Make a neat, labelled sketch of a wheel and axle lifting machine with a wheel diameter of 700 mm and an axle diameter of 250 mm. (3)

2.5 Determine the value of the unknown length (L) in the simple lever in FIGURE 2 below.

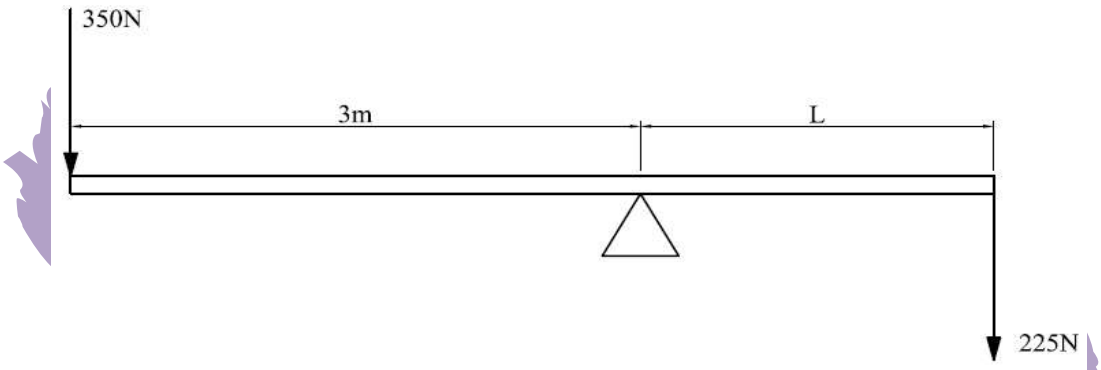


FIGURE 2 (2)

2.6 The effective force in a belt is 450 N and it runs on a 320 mm pulley.

Calculate the torque applied to the pulley. (2)

[18]

QUESTION 3

3.1 Give ONE word or term for each of the following descriptions by choosing a word/term from the list below. Write only the word or term next to the question number (3.1.1–3.1.5) in the ANSWER BOOK.

potential energy; kinetic energy; heat energy; electric energy; chemical energy; atomic energy

3.1.1 The ability to do work due to its motion.

3.1.2 The ability to do work by means of splitting of atoms.

3.1.3 The ability to do work due to heat.

3.1.4 The ability to do work due to the flow of electricity.

3.1.5 The ability to do work due to its position under the force of gravity.
(5 × 1) (5)

3.2 According to the law of conservation of energy, energy cannot be created or destroyed but can only be transferred from one form to another form of energy.

In the following examples, indicate from what form of energy to what form of energy the transfer took place:

3.2.1 A car battery

3.2.2 A generator
(2 × 1) (2)

3.3 A truck pulls a trailer at a speed of 100 km/h and exerts a force of 920 N on the trailer.

Calculate the following:

3.3.1 The work done in 25 minutes (2)

3.3.2 The power required to pull the trailer (1)

3.4 A rope is used to pull up a load of 500 N upwards through a distance of 20 m.

Draw a neat force/distance graph of this motion.

(HINT: 20 mm = 100 N; 1 cm = 2 m) (2)
[12]

QUESTION 4

4.1 Choose the correct word(s) from those given in brackets. Write only the word(s) next to the question number (4.1.1–4.1.5) in the ANSWER BOOK.

4.1.1 (Heat/Temperature) is an indication of the degree of hotness or coldness of a body.

4.1.2 (Heat capacity/Specific heat capacity) is the amount of heat energy required to raise the temperature of a material with 1 °C.

4.1.3 A (pyrometer/thermometer) can measure temperatures that are below 100 °C only.

4.1.4 (Conduction/Convection) is when heat is propagated in a solid.

4.1.5 Heat propagation by means of radiation can take place in a (vacuum/solid).

(5 × 1) (5)

4.2 Make a neat, labelled sketch of an alcohol thermometer. (3)

4.3 Briefly describe the working of a thermocouple. (2)

4.4 A liquid absorbs 1,5 MJ of heat energy. The specific heat capacity of the liquid is 3,47 kJ/kg °C and it has a mass of 23 kg.

Calculate the final temperature if the initial temperature was 15 °C. (3)

4.5 A round bar, 1,36 m long, is being heated up to be bended and the temperature rises from 20 °C to 350 °C. The length increases to 1,3608 m.

4.5.1 Calculate the difference (change) in temperature.

4.5.2 Calculate the difference (change) in the length of the bar.

(2 × 1) (2)

4.6 A bimetallic strip consists of two different strips of metals, like steel and copper.

Explain what will happen if the bimetallic strip is heated up. (2)

4.7 What type of instrument is used to measure the temperature in a furnace? (1)

[18]

QUESTION 5

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

COLUMN A		COLUMN B	
5.1.1	Particles are very close to each other	A	matter
5.1.2	Consists of two or more atoms combined	B	atom
5.1.3	Anything that occupies space and has a mass	C	solid
5.1.4	An atom that has lost or gained an electron	D	ion
5.1.5	Smallest part of an element	E	molecule

(5 × 1) (5)

5.2 When heat is added or removed, matter changes from one phase to another phase.

5.2.1 What is the process called when a solid changes into a liquid?

5.2.2 What is the process called when a liquid changes into a gas?

(2 × 1) (2)

5.3 In the three different phases of matter, the molecules move at different rates.

Compare the movement of particles in a liquid and in a solid. (2)

5.4 Name the THREE different parts (charges) of an atom and also give the charge of each one. (½ × 6) (3)

[12]

QUESTION 6

6.1 Complete the following sentences by using the word(s) in the list below. Write only the word(s) next to the question number (6.1.1–6.1.5) in the ANSWER BOOK.

voltage; ammeter; resistor; alternating; conductor; direct; current; voltmeter

6.1.1 A ... can let electricity flow easily.

6.1.2 A ... opposes the flow of electricity.

6.1.3 To measure the current in a circuit you need an ...

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

6.1.5 In ... current the polarity changes continuously.

(5 × 1) (5)

6.2 Redraw the following table in the ANSWER BOOK and tabulate the materials in the list below under the headings.

CONDUCTORS	ISOLATORS
6.2.1	6.2.4
6.2.2	6.2.5
6.2.3	6.2.5

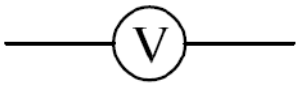
copper; mica; PVC; zinc; rubber; silver

(½ × 6) (3)

6.3 Name the following circuit symbols:

6.3.1 

6.3.2 

6.3.3 

6.3.4 

(½ × 4) (2)

6.4 A geyser draws a current of 15,3 A when connected to a 220 V voltage supply.

Calculate the value of the resistance of the element. (2)

6.5 Give TWO examples of situations where the heating effect of electrical current is a disadvantage. (2)

6.6 Determine the time needed to generate 485 kJ of heat energy when a current of 3,75 A flows through the element of 45 Ω of a heater. (2)

6.7 An electrical grill has a label indicating 1500 W; 220 V.

Calculate the following:

6.7.1 The resistance of the element

6.7.2 The current flowing through the element

(2 × 2) (4)

6.8 Three resistors with values of 23,5 Ω, 63 Ω and 12,4 Ω are connected in series.

Calculate the total resistance of the circuit. (2)

6.9 Name TWO factors that would influence the resistance of a conductor. (2)

6.10 Make a neat, labelled sketch of the magnetic lines around a bar magnet. (2)

[26]

TOTAL: 100

ENGINEERING SCIENCE N1

FORMULA SHEET

Any applicable formula may be used.

1. $v = \frac{s}{t}$
2. $F = m.g$
3. $VV = \frac{M_{afst}}{L_{afst}}$ $DR = \frac{E_{dist}}{L_{dist}}$
4. $HV = \frac{L}{M}$ $MA = \frac{L}{E}$
5. $SV = \frac{D}{d}$ $VR = \frac{D}{d}$
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. $I = \frac{V}{R}$
15. $R_t = R_1 + R_2 + \ldots$
16. $\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$
17. $Heat = I^2.R.t$
18. $P = V.I$
19. $P = \frac{V^2}{R}$
20. $P = I^2.R$

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MARKING GUIDELINE

NATIONAL CERTIFICATE

NOVEMBER EXAMINATION

ENGINEERING SCIENCE N1

24 NOVEMBER 2016

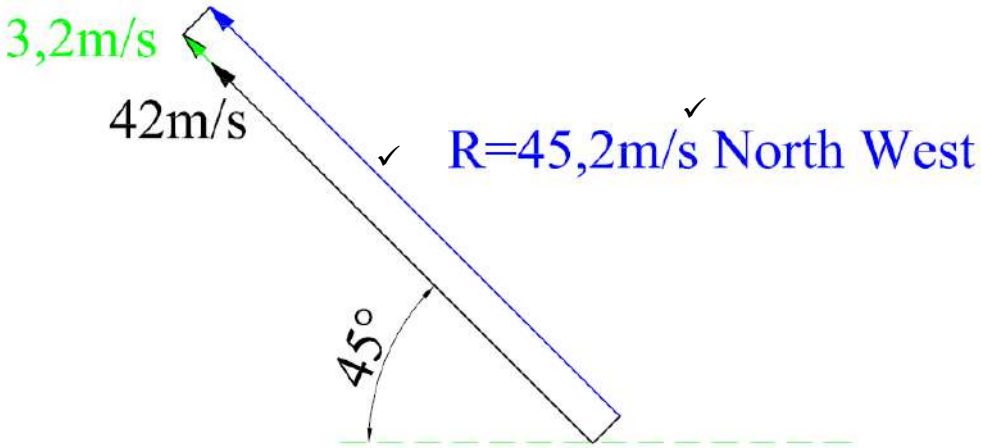
This marking guideline consists of 11 pages.

QUESTION 1

1.1 1.1.1 True
1.1.2 False
1.1.3 False
1.1.4 False
1.1.5 True

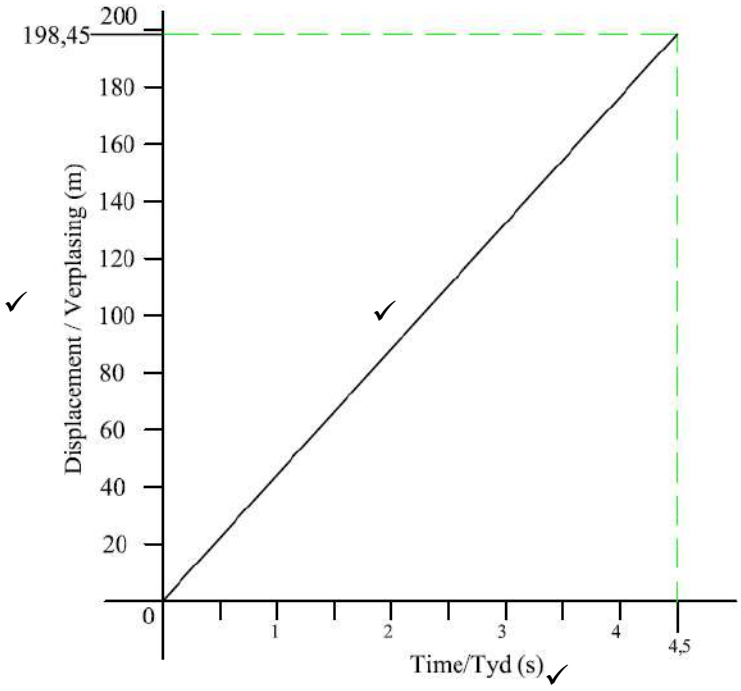
(5 × 1) (5)

1.2 $Velocity = 42 + 3,2$ ✓
$Velocity = 45,2\ m/s; North\ west$ ✓



(Analytical or graphical method can be taken as correct) (2)

1.3 1.3.1



(3)

1.3.2
$$Slope = \frac{Displacement}{Time}$$
$$Slope = \frac{198,45}{4,5}$$
$$\underline{Slope = 44,1m/s} \checkmark$$
(1)

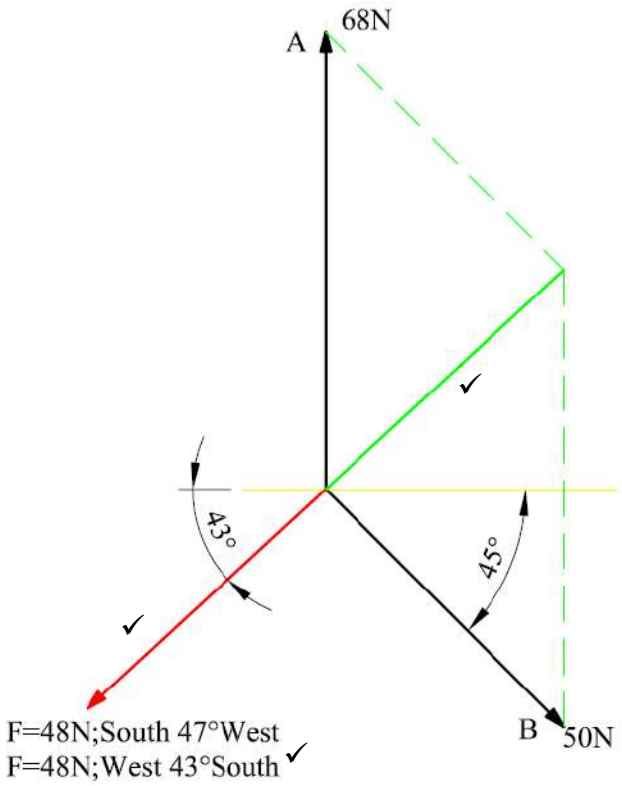
1.3.3 Average velocity (1)

1.4
$$t_1 = \frac{s}{v} = \frac{2}{6} = 0,333h$$
$$t_2 = \frac{s}{v} = \frac{2}{16}0,125h$$
$$t_3 = \frac{s}{v} = \frac{1}{32} = 0,0313h$$
$$t_{ave} = t_1 + t_2 + t_3$$
$$t_{ave} = 0,333 + 0,125 + 0,0313$$
$$\underline{t_{ave} = 0,4893h} \checkmark$$
$$v_{ave} = \frac{s}{t_{ave}}$$
$$v_{ave} = \frac{5}{0,4893}$$
$$\underline{v_{ave} = 10,219m/s} \checkmark$$
(2)
[14]

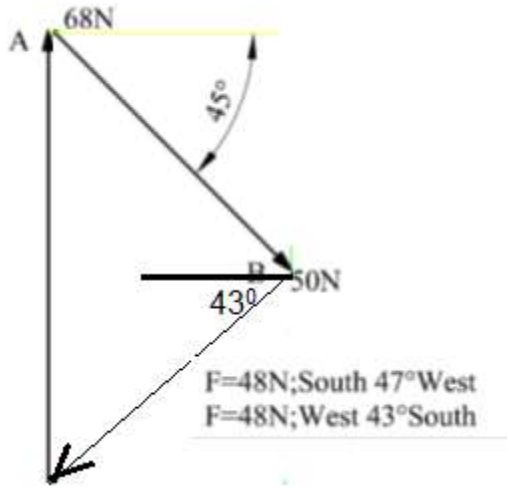
QUESTION 2

2.1
2.1.1 C
2.1.2 D
2.1.3 A
2.1.4 D
2.1.5 C
(5 × 1) (5)

2.2 2.2.1



OR



OR

Plane mirror reflection of this (3)

2.2.2 Equilibrant (1)

2.3 2.3.1

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

$$MA = \frac{320 \times 9,8}{500}$$

$$\underline{MA = 6,272} \quad ✓$$

2.3.2

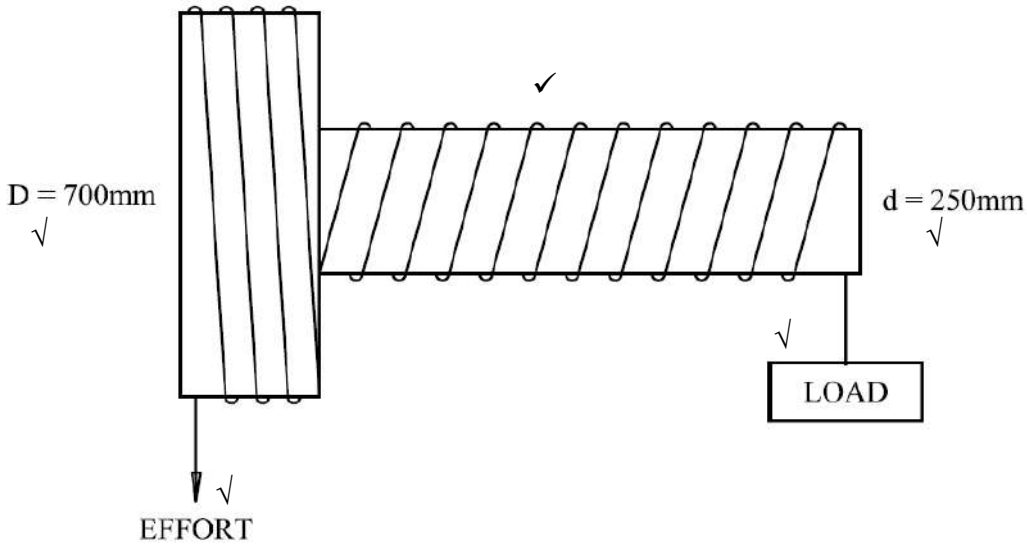
$$VR = \frac{L}{l}$$

$$VR = \frac{1,12}{0,521} \qquad VR = \frac{s_E}{s_L}$$

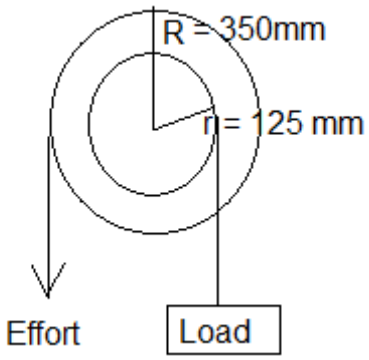
$$\underline{VR = 2,150} \quad ✓$$

(2 × 1) (2)

2.4



OR



(3)

2.5

$$LM = RM$$

$$350 \times 3 = 225 \times L$$

$$L = \frac{350 \times 3}{225} \quad ✓ \qquad \sum ACWM = \sum CWM$$

$$\underline{L = 4,667m} \quad ✓$$

(2)

2.6 $\Gamma(torque) = F.r$

$\Gamma(torque) = 450 \times 0{,}32$ ✓

$\Gamma(torque) = 144 N.m$ ✓ (2)

[18]

QUESTION 3

3.1 3.1.1 Kinetic energy
3.1.2 Atomic/chemical energy
3.1.3 Heat energy
3.1.4 Electric energy
3.1.5 Potential energy

(5 × 1) (5)

3.2 3.2.1 Chemical energy to electrical energy

3.2.2 Kinetic energy to electrical energy

(2 × 1) (2)

3.3 3.3.1 $t = 25\ x\ 60 = 1500\ s$

$v = \frac{100}{3.6} = 27.78\ m/s$

$s = vt$

= 27.78 × 1500

= 41670 m ✓

$W = Fs$

= 920 × 41670

= 38336400 J

= 38.34 × 10^6 J = 38.34 MJ ✓ (2)

3.3.2 $P = \frac{W}{t}$

$= \frac{38336400}{1560}$ ✓

= 25557,6 W = 25,56 KW

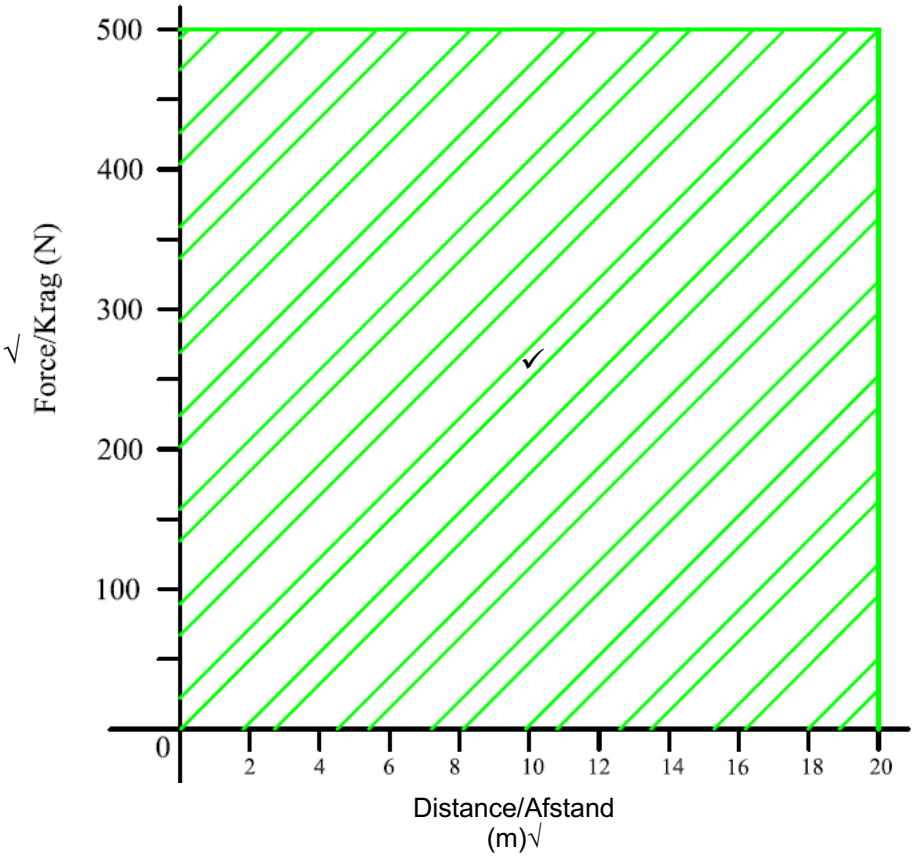
OR

$P = Fv$

= 920 * 27,78

=25557,6 W = 25,56 KW (1)

3.4



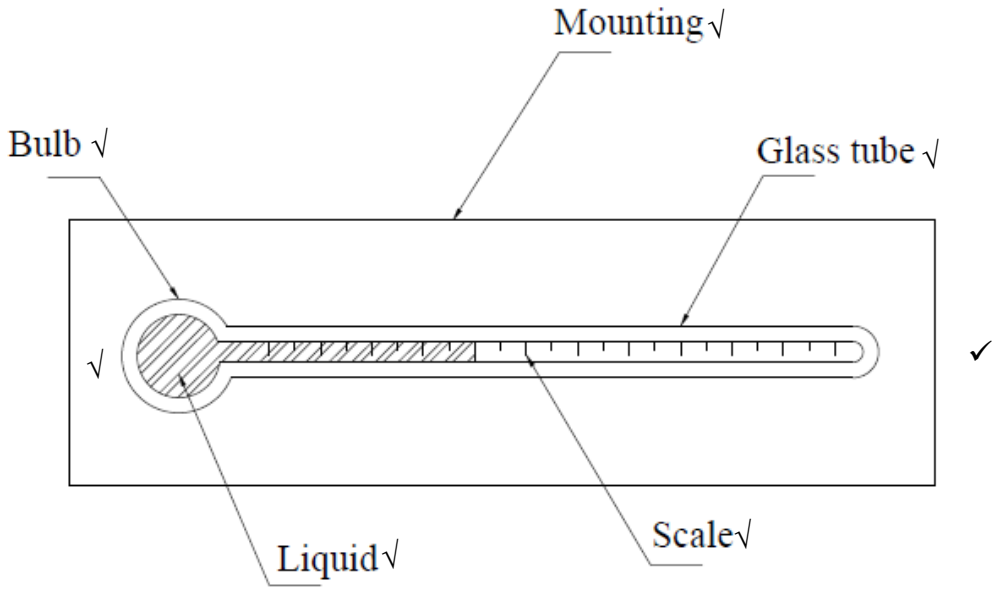
(2)
[12]

QUESTION 4

4.1
4.1.1 Temperature
4.1.2 Heat capacity
4.1.3 Thermometer
4.1.4 Conduction
4.1.5 Vacuum

(5 × 1) (5)

4.2



(3)

4.3 A thermocouple consists of two different types of metals joined at one end and the other end joined electrically (galvanometer).✓ When the joined end is heated a voltage drop is created between the open ends and can be measured with a galvanometer.✓ (2)

4.4 $Q = m.c.(t_f - t_o)$

$t_f = \frac{Q}{m.c} + t_o$ ✓

$t_f = \frac{1,5 \times 10^6}{(23 \times 3470)} + 15$ ✓

$\underline{t_f = 33,795\ °C}$✓

(3)

4.5 4.5.1 $\Delta t = t_f - t_o$

$\Delta t = 350 - 20$

$\underline{\Delta t = 330\ °C}$ ✓

4.5.2 $\Delta l = l_f - l_o$

$\Delta l = 1,3608 - 1,36$

$\underline{\Delta l = 0,0008\ m}$ ✓

(2 × 1) (2)

4.6 Because the linear expansion✓ of copper is faster than that of steel, the bi-metallic strip will bend in the direction of the steel.✓ (2)

4.7 Pyrometer (1)

[18]

QUESTION 5

5.1 5.1.1 C
5.1.2 E
5.1.3 A
5.1.4 D
5.1.5 B

(5 × 1) (5)

5.2 5.2.1 Melting/liquidation

5.2.2 Evaporation/vaporisation

(2 × 1) (2)

5.3
- Liquid: Movement of molecules is fast.
- Solid: Movement of molecules is slow. (2)

5.4
- Electron√ – Negative√
- Proton√ – Positive√
- Neutron√ – Neutral√ (½ × 6) (3)

[12]

QUESTION 6

6.1 6.1.1 Conductor
6.1.2 Resistor
6.1.3 Ammeter
6.1.4 Voltage
6.1.5 Alternating

(5 × 1) (5)

6.2

CONDUCTORS	ISOLATORS
6.2.1 Copper√	6.2.4 Mica√
6.2.2 Zinc√	6.2.5 PVC√
6.2.3 Silver√	6.2.6 Rubber√

(6 × ½) (3)

6.3 6.3.1 Ammeter√
6.3.2 Battery√
6.3.3 Voltmeter√
6.3.4 Open Switch√

(4 × ½) (2)

6.4
$$R = \frac{V}{I}$$
$$R = \frac{220}{15,3} \checkmark$$
$$\underline{R = 14,379\Omega} \checkmark$$
(2)

6.5 Heating up of motors,✓ generators✓ and transformers. (Any 2 × 1) (2)

6.6
$$Q = I^2.R.t$$
$$t = \frac{Q}{I^2.R}$$
$$t = \frac{485000}{3,75^2.45} \checkmark$$
$$\underline{t = 766,419s} \checkmark$$
$$\underline{t = 12\min 46,419s}$$
(2)

6.7 6.7.1
$$P = \frac{V^2}{R}$$
$$R = \frac{V^2}{P}$$
$$R = \frac{220^2}{1500} \checkmark$$
$$\underline{R = 32,267\ \Omega} \checkmark$$

6.7.2
$$P = VI$$
$$I = \frac{P}{V}$$
$$I = \frac{1500}{220} \quad \checkmark$$
$$I = 6,818A \quad \checkmark$$

OR

$$I = \frac{V}{R}$$
$$= \frac{220}{32.267}$$
A = 6,818

(2 × 2) (4)

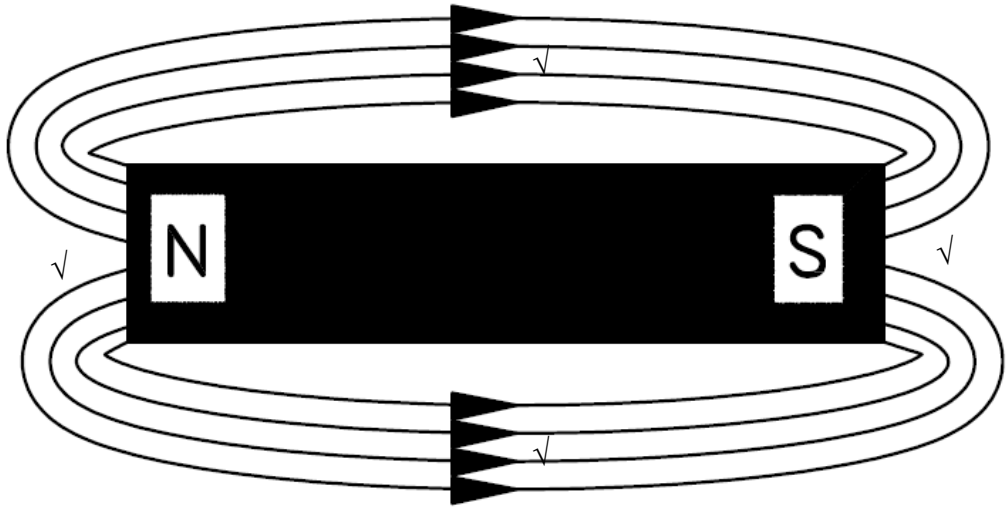
6.8 $R = R_1 + R_2 + R_3$

$R = 23{,}5 + 63 + 12{,}4$ ✓

$\underline{R = 98{,}9\Omega}$ ✓ (2)

6.9
- Temperature
- Length
- Diameter
- Type (resistivity) (Any 2 × 1) (2)

6.10



(2)
[26]

TOTAL: 100