TAKE ANY DOUBT

QUESTION PAPER

&

MEMO

SUBJECT: ENGINEERING SCIENCE

LEVEL: N1

DATE: NOVEMBER 2019

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N1

(15070391)

26 November 2019 (X-Paper)
09:00–12:00

Nonprogramable calculators may be used.

This question paper consists of 10 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. Answers to calculations must be given correctly to THREE decimal places after the comma.

5. ALL calculations must have the following three steps:

   5.1 The formula
   5.2 The replacement of values
   5.3 The answer and correct SI unit

6. Gravitational acceleration (g) should be taken as 9,8 $m.s^{-2}$.

7. Sketches must be neatly done in pencil.

8. Write neatly and legibly.

SECTION A

QUESTION 1

1.1 Choose a description from COLUMN B that matches a term in COLUMN A. Write only the letter (A–G) next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.1.1	Moment of a force	A	force moving through a distance
1.1.2	Energy	B	form of energy
1.1.3	Work	C	the rate at which work is being doing
1.1.4	Heat	D	the turning effect of a force about a point
1.1.5	Heat capacity	E	an indication of the hotness or coldness of a body.
		F	the ability to do work
		G	the amount of heat required to raise the temperature of a substance with 1 °C

(5 × 1) (5)

1.2 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 (1.2.1–1.2.5) in the ANSWER BOOK.

1.2.1 The resistivity of a conductor can be defined as a …

A current in a circuit is directly proportional to the potential difference and inversely proportional to the resistance.
B potential difference between two points of a conductor if 1 J of work is done when a charge of 1 C is displaced between the two points.
C resistance between the opposite sides of a unit cube at a specific temperature.
D quantity of electric charge that passes any point in a circuit in a time of 1 second when a current of 1 A is flowing.

1.2.2 The definition of Joule's law:

A The current in a circuit is directly proportional to the potential difference and inversely proportional to the resistance.
B The heat developed in a circuit is proportional to the resistance, the time and the square of the current.
C It is the resistance between the opposite sides of a unit cube at a specific temperature.
D It is the potential difference between two points of a conductor if 1 J of work is done when a charge of 1 C is displaced between the two points.

1.2.3 The definition of Fleming's right-hand coil rule:

A Fold the fingers of the right-hand around a conductor, the extended thumb in the direction of the conventional current flow. The fingers will show the direction of the magnetic field.
B The heat developed in a circuit is proportional to the resistance, the time and the square of the current.
C Take the coil in the right-hand with the fingers around the coil in the direction of conventional current flow, the extended thumb will show the direction of the north pole of the magnetic field.
D It is the potential difference between two points of a conductor if 1 J of work is done when a charge of 1 C is displaced between the two points.

1.2.4 Which ONE of the following is NOT a factor that will influence the resistance of a conductor?

A The type of conductor
B The current flowing in the conductor
C The length of the conductor
D The temperature of the conductor

1.2.5 Electrical current can be described as the …

A current in a circuit that is directly proportional to the potential difference and inversely proportional to the resistance.
B potential difference between 2 points of a conductor if 1 J of work is done when a charge of 1 C is displaced between 2 points.
C movement of free electrons in a closed circuit.
D quantity of electric charge that passes any point in a circuit in 1 second when a current of 1 A is flowing.

(5 × 1) (5)

1.3 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (1.3.1–1.3.5) in the ANSWER BOOK.

1.3.1 A bimetal strip is an example of the linear expansion of materials.

1.3.2 The law of moments state that a system of forces is in equilibrium when the sum of the clockwise moments is equal to the sum of the anticlockwise moments.

1.3.3 Velocity ratio is the ratio of the distance moved by the effort to the distance moved by the load.

1.3.4 The resultant is the single force that can balance two or more forces.

1.3.5 When three forces acting on a point is in equilibrium, they can be represented in magnitude and direction by the sides of a triangle taken in sequence.

(5 × 1) (5)

1.4 Give ONE word for each of the following descriptions by choosing a word from the list below. Write only the word/term next to the question number (1.4.1–1.4.5 in the ANSWER BOOK.

torque; mass; moment of a force; scalar; velocity; weight; vector; mechanical advantage; speed; displacement ratio

1.4.1 The force of attraction between the earth and a body

1.4.2 The rate of movement in a certain direction

1.4.3 A physical quantity which has only magnitude

1.4.4 The ratio between the load lifted and the effort applied

1.4.5 The tendency of a force to cause or change rotational motion of a body

(5 × 1) (5)

[20]

TOTAL SECTION A: 20

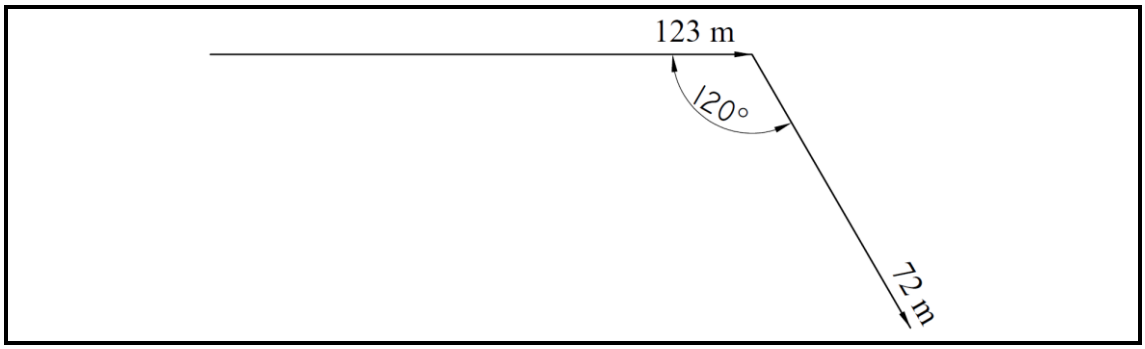
SECTION B

QUESTION 2: DYNAMICS

2.1 A school bus is travelling at a velocity of 45 $m.s^{-1}$ in a northwestern direction. A learner is walking from the back of the bus to the front at a velocity of 3 $m.s^{-1}$ also in a northwestern direction.

Graphically determine the resultant velocity of the learner. (2)

2.2 Determine the total displacement of the diagram in FIGURE 1.



(2)

FIGURE 1

2.3 In a velocity experiment of a moving object, the following results were captured:

Displacement (m)	0	3	6	9	12	15
Time (s)	0	1	2	3	4	5

Draw a neat, labelled graph of the movement.

HINT: Use scale 1 s = 2 cm and 3 m = 2 cm. (2)

2.4 The following information was obtained from an experiment of a free-falling object with a mass of 6 kg.

Velocity ($m.s^{-1}$)	0	3	6	9	12
Time (s)	0	1	2	3	4

Draw a neat, labelled graph of the movement.

HINT: Use scale 1s = 2 cm and 3 $m.s^{-1}$ = 2 cm. (2)

2.5 Explain the meaning of the gradient of the graph drawn by you in QUESTION 2.4. (1)

2.6 Convert the following:

2.6.1 A mass of 63 kg to weight

2.6.2 A weight of 255 N to mass

(2 × 1) (2)
[11]

QUESTION 3: STATICS

3.1 The forces shown in FIGURE 2 are working in on an object.

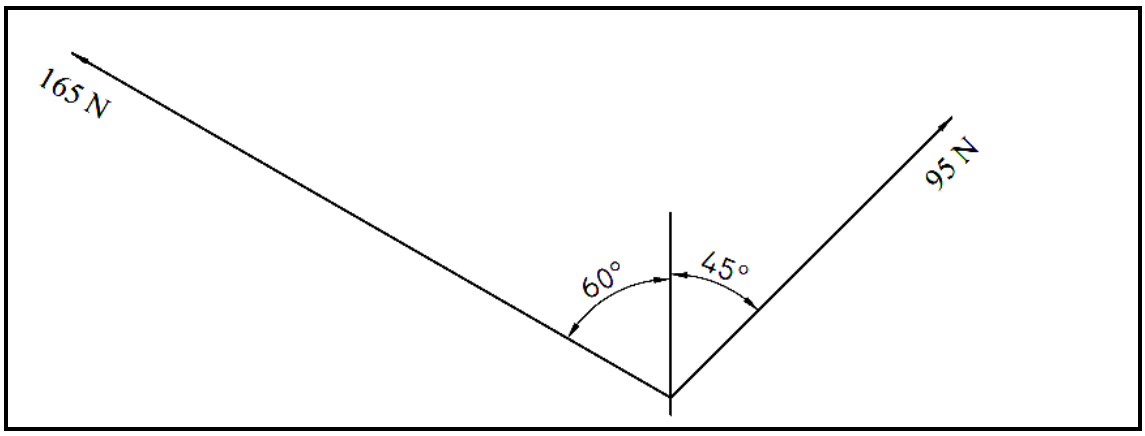


FIGURE 2

By drawing a graph of each of the following, determine:

3.1.1 The resultant force of the two forces (3)

3.1.2 The equilibrant of the two forces (2)

3.2 When three forces are in equilibrium and one or two of them are unknown Bow's notation can be used to determine the unknown force(s).

Determine the unknown force in FIGURE 3 by using Bow's notation.

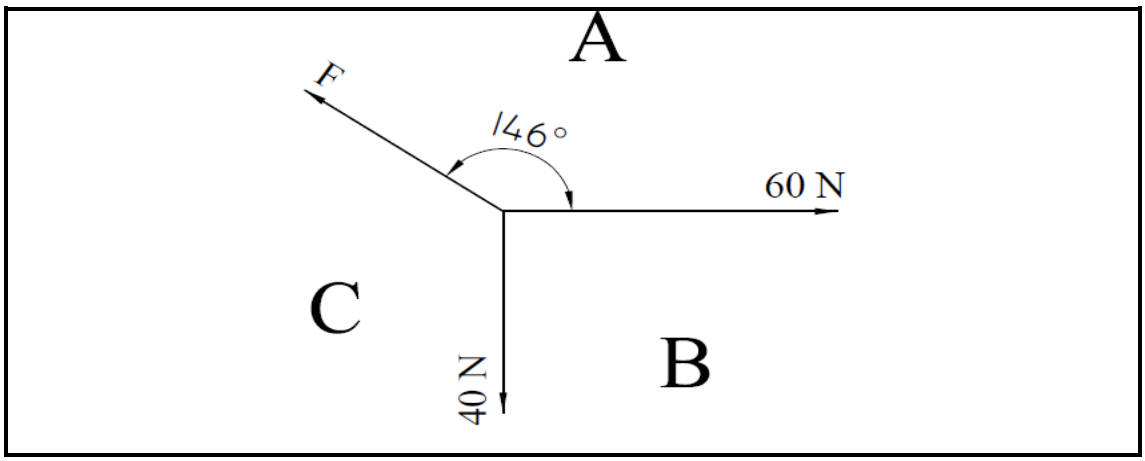


FIGURE 3 (2)

3.3 A single rope pulley system with two pulleys in the upper block and two pulleys in the lower block is used to lift an engine 350 kg. An effort of 1 000 N is needed to lift the engine.

3.3.1 Draw a neat, labelled sketch of the pulley system. (2)

3.3.2 Calculate the mechanical advantage of the pulley system. (1)

3.3.3 Determine the velocity ratio of the pulley system. (1)

[11]

QUESTION 4: ENERGY WORK AND POWER

4.1 Formulate the law of conservation of energy. (2)

4.2 An electric motor is marked 3 kW.

Determine the work done by the motor in 1,5 minutes. (2)

4.3 A bus has a driving force of 2 800 N at 50 km/h. The bus travels from the bus depot to bus stop 1 which is 800 m away and then to bus stop 2 which is 400 m away without stopping.

4.3.1 Draw a force/distance graph and show the positions of the bus stops on the graph.

HINT: Use scale 1 cm = 300 N and 1 cm = 100 m (3)

4.3.2 Calculate the total work done. (1)

4.3.3 Calculate the power of the bus engine (1)

4.4 Explain the transformation of energy of an electrical car from standing still to moving forward. (1)

[10]

QUESTION 5: HEAT

5.1 Describe what is meant by the temperature of a body. (1)

5.2 Name ONE advantage and ONE disadvantage of alcohol thermometers. (2)

5.3 Give THREE physical changes that can be easily seen if heat energy is added to a metal. (3)

5.4 Name TWO uses of a thermocouple in the industry. (2)

5.5 Use water as an example and explain the transfer of heat in the different phases. (3)

5.6 3 905 kg of cooling water flows through a condenser per minute. The difference in temperature between the inlet and outlet water is 75°C. Assume the specific heat capacity of water is 4,2 kJ/°C.

Calculate the energy absorbed by the water in MJ/min. (2)

5.7 A beam of a crane has a length of 47 m at 25°C. When its temperature drops to -11°C during winter, it is found that the length of the beam is only 46,975 m.

Calculate the changes in the beam regarding the following:

5.7.1 Length in mm

5.7.2 Temperature

(2 × 1) (2)
[15]

QUESTION 6: PARTICLE STRUCTURE OF MATTER

6.1 In the three different phases of matter, their particles have different characteristics.

By using the attractive forces between particles, describe what will happen in the three different phases of matter. (3)

6.2 Describe the motion of the particles in the three phases of matter. (3)

6.3 What effect will heat have on the movement of particles in the three different phases of matter? (3)

6.4 What is the difference between the charges of the nucleus and the electron of an atom? (2)

6.5 Define *matter*. (1)
[12]

QUESTION 7: ELECTRICITY

7.1 When electrons move in a specific direction, what is taking place? (1)

7.2 Define an *insulator.* (1)

7.3 Make a sketch of a close circuit that contains a cell, resistor and a galvanometer. (2)

7.4 There are different sources of electricity.

What type of current will be obtained from a battery? (1)

7.5 Three resistors of 3 Ω, 4 Ω and 5 Ω are connected in series with a battery of 12 V.

Calculate the following:

7.5.1 Total resistance

7.5.2 Total current flow

7.5.3 Total power of the circuit

7.5.4 Voltage drop across the 5 Ω resistor

7.5.5 The heat energy developed in the 4 Ω resistor for 2 min

(5 × 2) (10)

7.6 Name the factors which influence the heat effect of an electric current. (2)

7.7 Describe the influence of a change in temperature on the resistance of metal for example copper and silver. (2)

7.8 Make a neat, labelled sketch of a relay switch. (2)

[21]

TOTAL SECTION B: 80
GRAND TOTAL: 100

(15070391)

ENGINEERING SCIENCE N1

FORMULA SHEET

Any applicable formula may also 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

ENGINEERING SCIENCE N1

20 NOVEMBER 2019

This marking guideline consists of 11 pages.

✓ = 1 mark
☑ = ½ mark

SECTION A

QUESTION 1

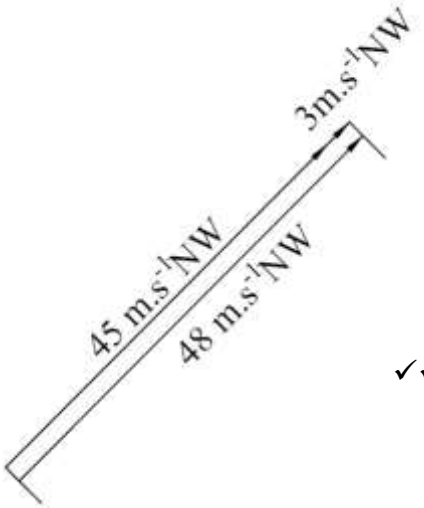
1.1	1.1.1	D		
	1.1.2	F		
	1.1.3	A		
	1.1.4	B		
	1.1.5	G		
			(5 × 1)	(5)
1.2	1.2.1	C		
	1.2.2	B		
	1.2.3	C		
	1.2.4	B		
	1.2.5	C		
			(5 × 1)	(5)
1.3	1.3.1	True		
	1.3.2	True		
	1.3.3	True		
	1.3.4	False		
	1.3.5	True		
			(5 × 1)	(5)
1.4	1.4.1	Weight		
	1.4.2	Speed		
	1.4.3	Scalar		
	1.4.4	Mechanical advantage		
	1.4.5	Torque		
			(5 × 1)	(5)
				[20]

TOTAL SECTION A: 20

SECTION B

QUESTION 2: DYNAMICS

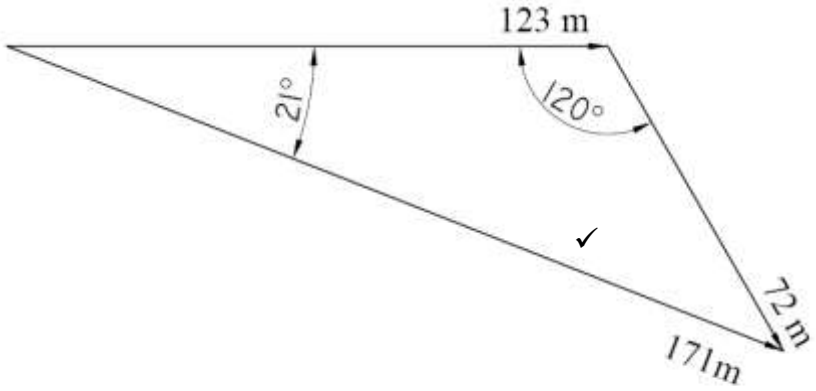
2.1



✓✓

(2)

2.2

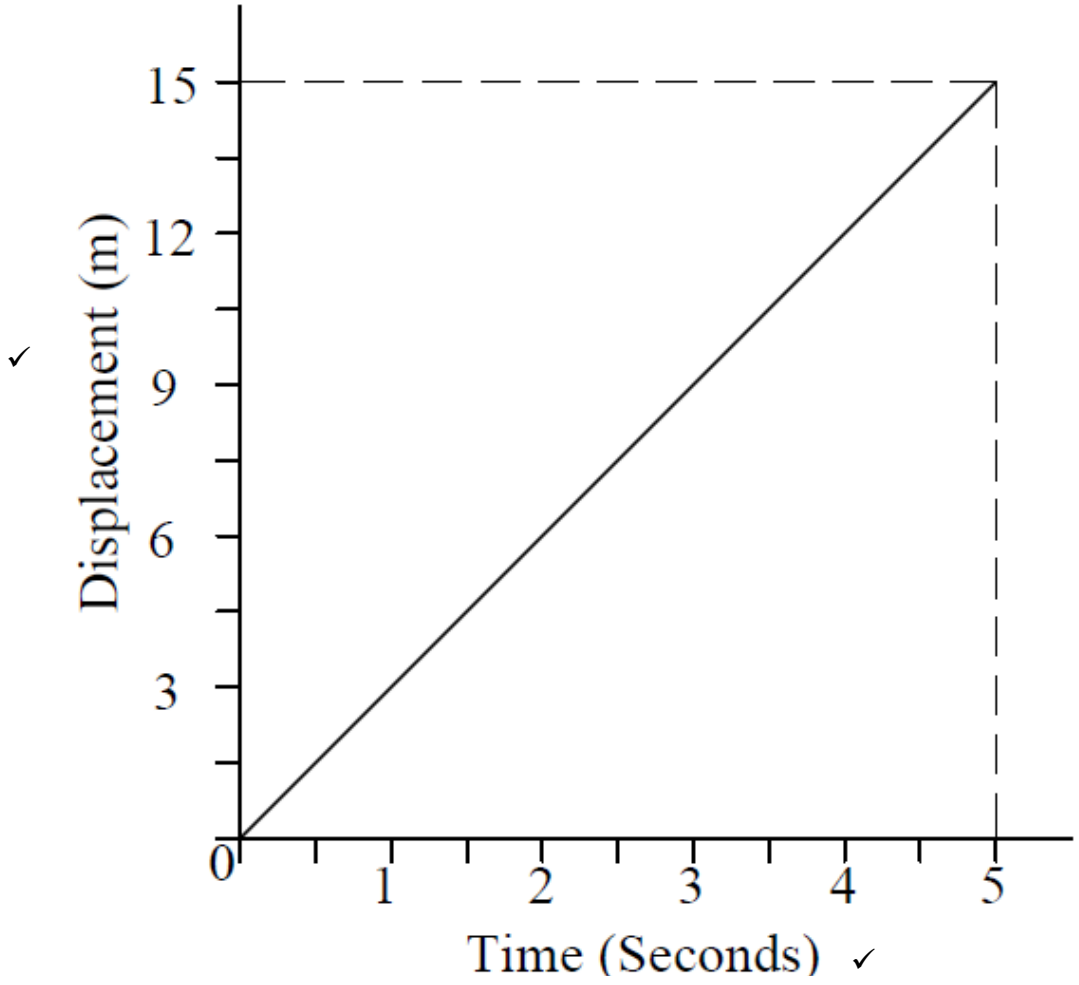


✓

Total displacement = 171 m, E21°S✓

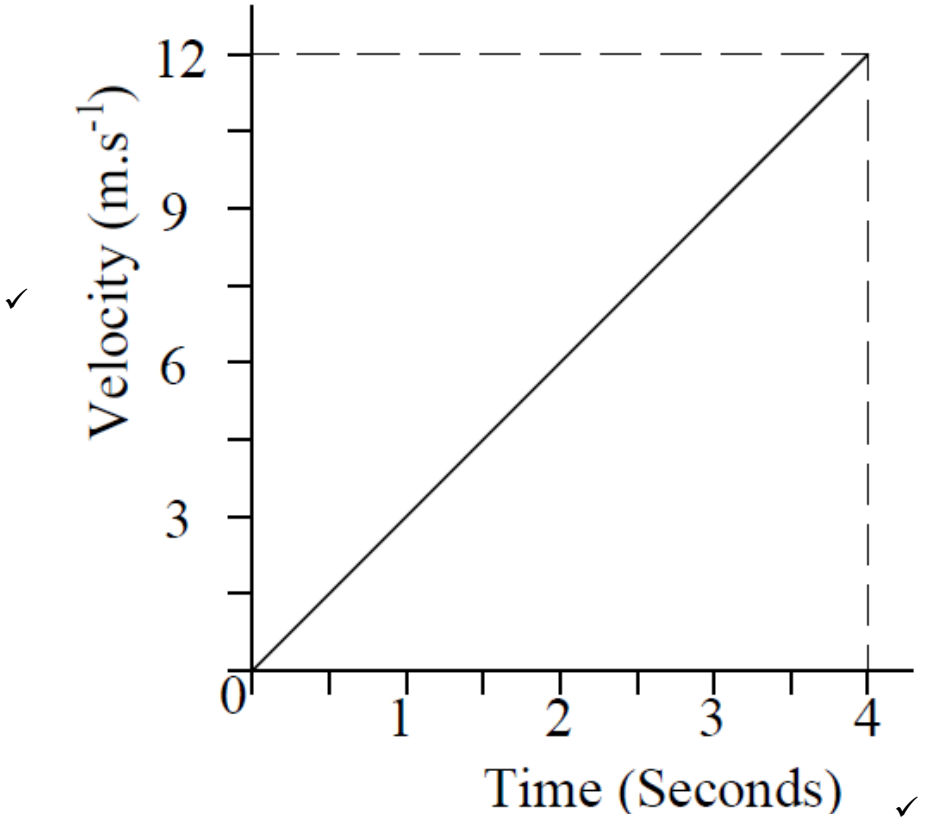
(2)

2.3


15
12
9
6
3
0
Displacement (m)
1
2
3
4
5
Time (Seconds)

✓ ✓ (2)

2.4


12
9
6
3
0
Velocity (m.s-1)
1
2
3
4
Time (Seconds)

✓ ✓ (2)

2.5 The gradient represents the acceleration of the falling rock. (1)

2.6 2.6.1

$$w = m.g$$
$$w = 63 \times 9{,}8$$
$$\underline{\underline{w = 617{,}4N}} \checkmark$$

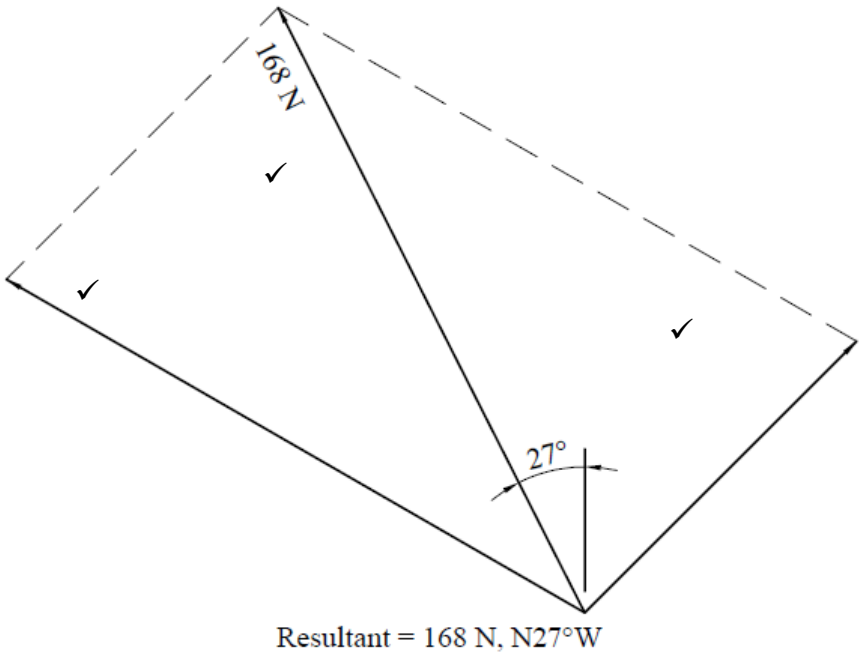
2.6.2

$$w = m.g$$
$$m = \frac{w}{g}$$
$$m = \frac{255}{9{,}8}$$
$$\underline{\underline{m = 26{,}02\ kg}} \checkmark$$

(2 × 1) (2)
[11]

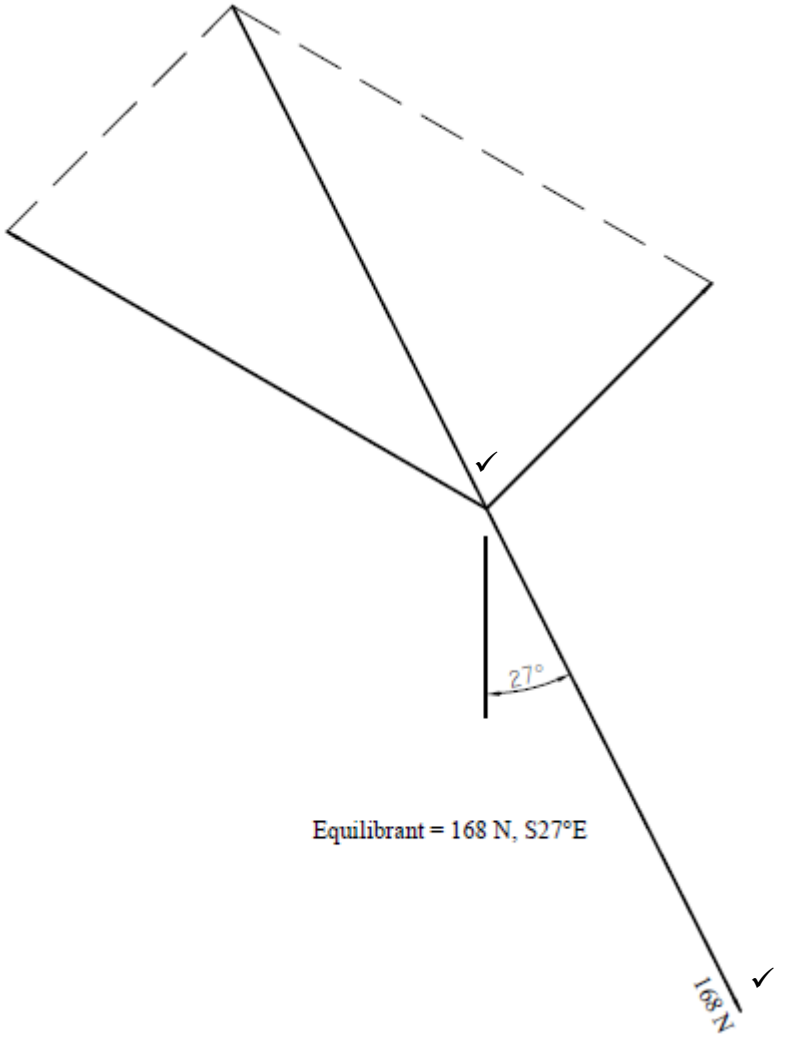
QUESTION 3: STATICS

3.1 3.1.1



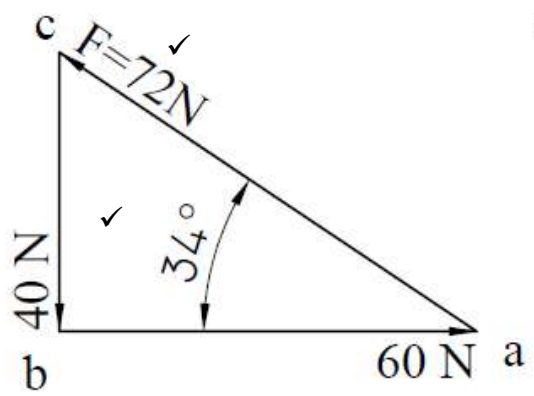
(3)

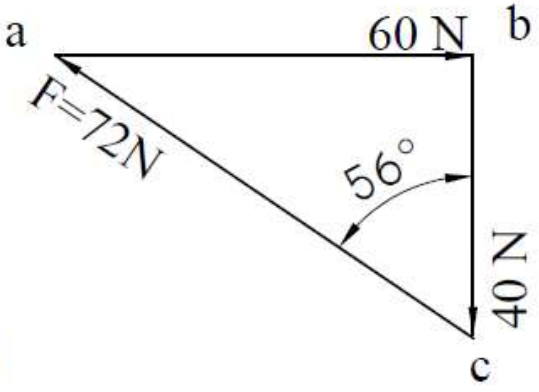
3.1.2


27°
Equilibrant = 168 N, S27°E
168 N

(2)

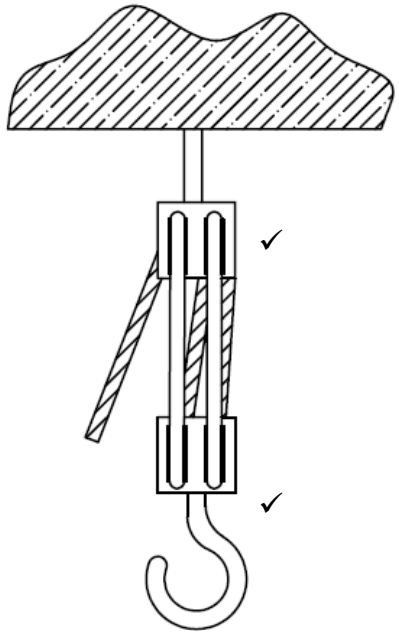
3.2


c
F=72N
40 N
34°
b
60 N
a


a
60 N
b
F=72N
56°
40 N
c

(2)

3.3 3.3.1



(2)

3.3.2 $$MA = \frac{Load}{Effort}$$

$$MA = \frac{350 \times 9{,}8}{1\,000}$$

$$\underline{\underline{MA = 3{,}43}} \checkmark$$

(1)

3.3.3 VR = Ropes supporting pulleys

$\underline{\underline{VR = 4}}\checkmark$

(1)

[11]

QUESTION 4: ENERGY WORK AND POWER

4.1 Energy cannot be destroyed or created✓ but can be transformed from one form to another form of energy.✓ (2)

4.2 $$P = \frac{W}{t}$$

$$W = P.t$$

$$W = 3\,000 \times (1{,}5 \times 60) \checkmark$$

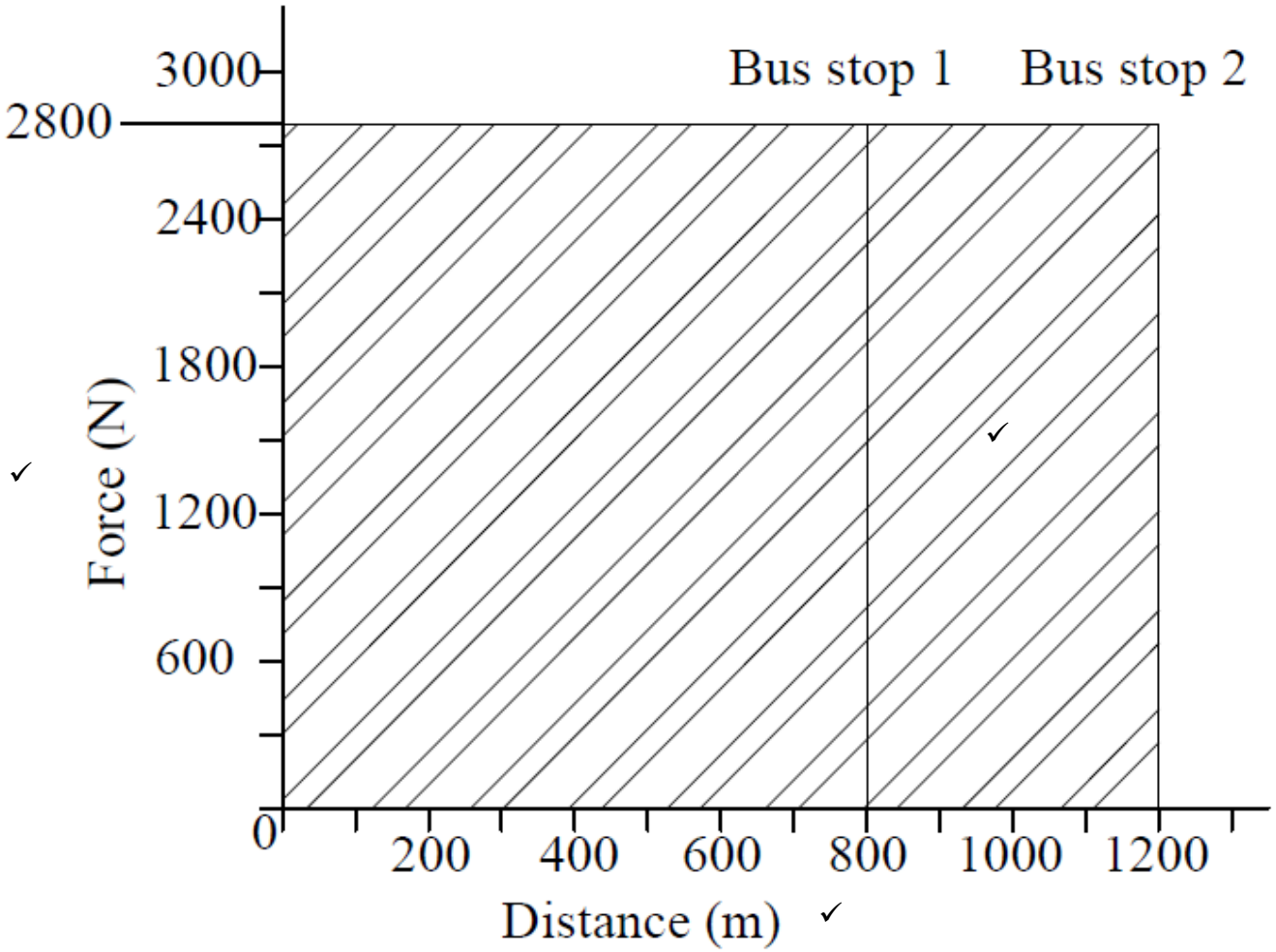
$$\underline{\underline{W = 270\,000J}} \checkmark$$

$$\underline{\underline{W = 270kJ}}$$

(2)

4.3 A bus has a driving force of 2 800 N at 50 km/h. The bus travels from the bus depot to bus stop 1 which is 800 m away, and then to bus stop 2 which is 400 m away, without stopping.

4.3.1



(3)

4.3.2 $W = F.s$

$W = 2\,800 \times 1\,200$

$\underline{\underline{W = 3360000J}}$ ✓

$\underline{\underline{W = 3{,}36\ MJ}}$

(1)

4.3.3 $P = F.v$

$P = 2\,800 \times \frac{50}{3{,}6}$

$\underline{\underline{P = 38888{,}889\,W}}$ ✓

$\underline{\underline{P = 38{,}889\,kW}}$

(1)

4.4 Kinetic energy to potential energy (1)

[10]

QUESTION 5: HEAT

5.1 Temperature is the degree of hotness or coldness of a body. (1)

5.2

ADVANTAGES	DISADVANTAGES
• Very low freezing point	• Meniscus is hollow
• Can be coloured for visibility	• Adhere to the glass
• More accurate	• Respond slowly to temperature changes
• Less expensive	• Cannot measure high temperatures
• Not poisonous	

(Any ONE correct answer of each) (2 × 1) (2)

5.3
- Colour
- Temperature
- Length (3)

5.4 Measuring of temperature in stoves,✓ ovens,✓ etc.
(Any TWO correct answers) (2 × 1) (2)

5.5
- Solid – conduction
- Liquid – convection
- Gas – convection (3)

5.6
$$E = m.c.\Delta t$$
$$E = 3\,905 \times 4\,200 \times 75 \checkmark$$
$$E = 1230075000 J/\min$$
$$\underline{\underline{E = 1230{,}075\ MJ/\min}} \checkmark$$
(2)

5.7 5.7.1
$$\Delta L = L_f - L_o$$
$$\Delta L = 47 - 16{,}975$$
$$\Delta L = 0{,}025\ m$$
$$\underline{\underline{\Delta L = 25\ mm}} \checkmark$$

5.7.2
$$\Delta t = t_f - t_o$$
$$\Delta t = 25 - (-11)$$
$$\underline{\underline{\Delta t = 36°C}} \checkmark$$

(2 × 1) (2)
[15]

QUESTION 6: PARTICLE STRUCTURE OF MATTER

6.1
- Solid – Attractive forces between the particles are very strong.
- Liquid – Attractive forces not as strong as in a solid.
- Gas – Attractive forces are weak. (3)

6.2
- Solid – Motion of particles are very slow.
- Liquid – Motion of particles are fast.
- Gas – Motion of particles are very fast. (3)

6.3 When heat is added to a solid the particles will start moving faster✓ until it changes phase to a liquid.✓ If more heat is added the particles will move faster until the liquid changes phase to a gas.✓ (3)

6.4
- Nucleus – positive
- Electron – negative (2)

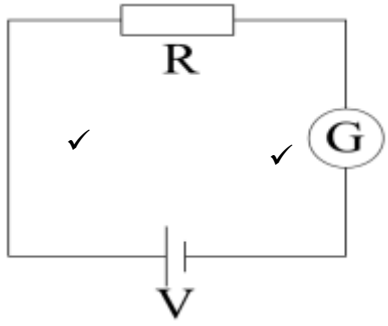
6.5 Matter is anything that has mass and volume. (1)
[12]

QUESTION 7: ELECTRICITY

7.1 Electrical current starts to flow. (1)

7.2 Material that does not allow current to flow. (1)

7.3



(2)

7.4 Direct current (1)

7.5 7.5.1

$$R_t = R_1 + R_2 + R_3$$
$$R_t = 3 + 4 + 5 \checkmark$$
$$\underline{\underline{R_t = 12\ \Omega \checkmark}}$$

7.5.2

$$I = \frac{V}{R}$$
$$I = \frac{12}{12} \checkmark$$
$$\underline{\underline{I = 1\ A}} \checkmark$$

7.5.3 $P = \frac{V^2}{R}$

$P = \frac{12^2}{12}$ ✓

$\underline{\underline{P = 12\,W}}$ ✓

7.5.4 $V = I.R$

$V = 1 \times 5$ ✓

$\underline{\underline{V = 5\,V}}$ ✓

7.5.5 $E = I^2 R.t$

$E = 1^2 \times 4 \times (2 \times 60)$ ✓

$\underline{\underline{E = 480J}}$ ✓

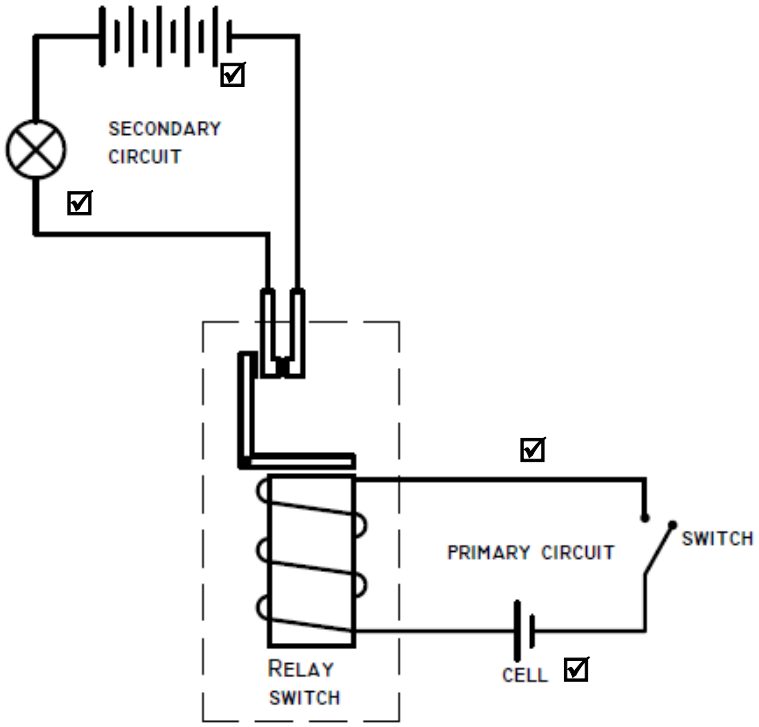
(5 × 2) (10)

7.6
- Current
- Resistance
- Time

(Any 2 × 1) (2)

7.7 Temperature increases – resistance increases (2)

7.8



(2)
[21]

TOTAL SECTION B: 80
GRAND TOTAL: 100