higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T560(E)(N19)T

NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N2

(15070402)

19 November 2014 (Y-Paper)
13:00–16:00

This question paper consists of 8 pages and 1 formula sheet.

ENGINEERING

Copyright reserved

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE N2
TIME: 3 HOURS
MARKS: 100

ENGINEERING

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. ALL the 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 the formula
   (c) The answer together with the correct SI unit
5. The following values MUST be used in this question paper, whenever applicable:

Gravitational acceleration	= 9,8 m/s²
Atmospheric pressure	= 101,3 kPa
Heat value of petrol	= 25 MJ/kg
Heat value of coal	= 30 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	= 0,000 023/°C
Linear coefficient of expansion of aluminium	= 0,000 017/°C
Resistivity of steel at 20 °C	= 0,000 000 155 Ωm
Resistivity of copper at 20 °C	= 0,000 000 018 Ωm
Resistivity of aluminium at 20 °C	= 0,000 000 028 Ωm

6. Rule off after each question.
7. Drawing instruments MUST be used for all the drawings.
8. Subsections of questions must be kept together.
9. Write neatly and legibly.

Copyright reserved

QUESTION 1: DYNAMICS

1.1 Define the following terms:

1.1.1 Velocity (1)
1.1.2 Distance (1)

1.2 A car maintains the following velocities measured in time intervals as indicated in the table below:

Time (s)	0	10	20	30	40	50	60
Velocity (m/s)	10	20	30	30	30	30	0

1.2.1 Draw a velocity/time graph. (2)

1.2.2 What does the gradient of a velocity/time graph represent? (1)

1.2.3 From the graph in QUESTION 1.2.1, calculate the following:

(a) The acceleration during the first 20 seconds (2)
(b) The displacement during the first 20 seconds (3)
(c) How long did it take for the deceleration (2)
[12]

QUESTION 2: STATICS

2.1 A horizontal beam as shown in FIGURE 1 rests on two supports L and R.

2.1.1 Determine the reactions of both supports by taking moments about each support. (Ignore the weight of the beam.) (6)

2.1.2 Check the answer by balancing upward and downward forces. (1)

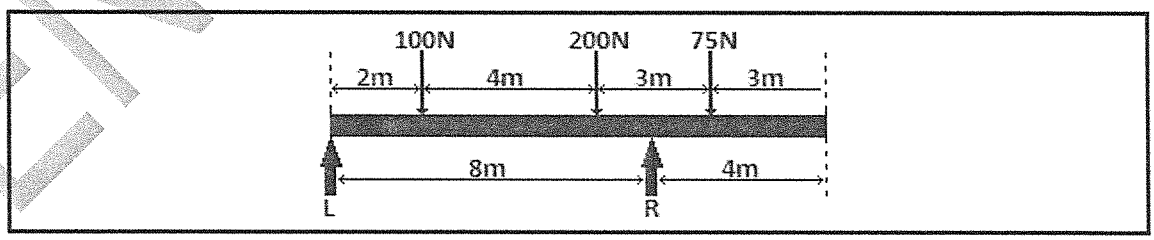


FIGURE 1

2.2 Give ONE example where you will find a couple in practice in engineering. (1)

2.3 The vertical component of a force that is acting at an angle of 60° to the horizontal is 200 N.

Calculate the magnitude of the 60^0 force. (2)

ENGINEERING

2.4 Determine graphically the magnitude and direction of the resultant of the system of forces as shown in FIGURE 2.

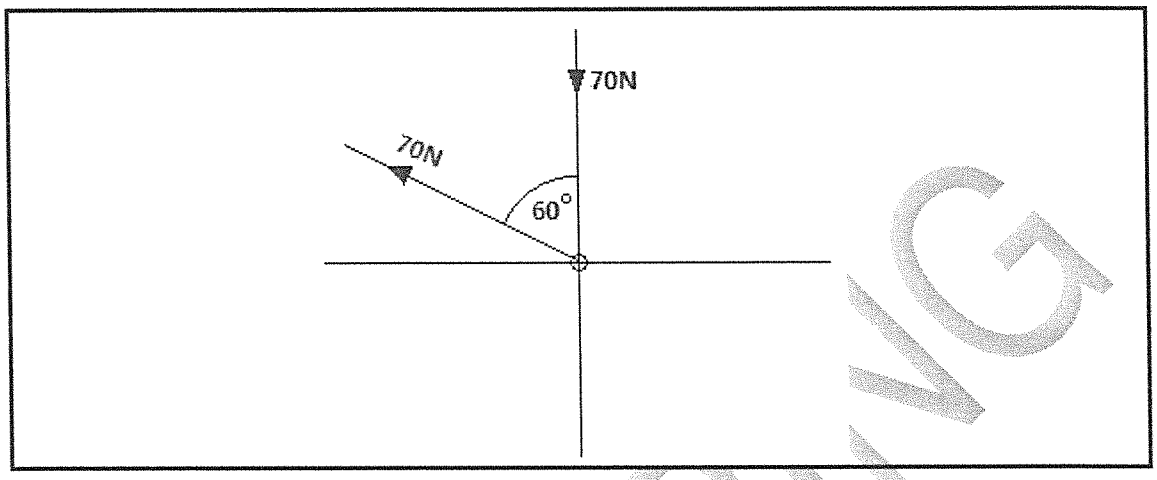


FIGURE 2

(4)
[14]

OUESTION 3: ENERGY AND MOMENTUM

3.1 Define *potential energy*. (2)

3.2 A stone with a mass of 4 kg is dropped down a mine shaft, 400 m deep.

Calculate the following:

3.2.1 The potential energy of the stone before it is dropped down the mine shaft with reference to the bottom of the shaft (2)

3.2.2 The velocity with which the stone will hit the ground at the bottom of the mine shaft (2)

3.2.3 The time it will take the stone to reach the bottom of the mine shaft (2)

3.3 Define *momentum of a body*. (2)

3.4 Calculate the momentum of a 2 500 kg truck travelling at a velocity of 40 m/s. (2)
[12]

ENGINEERING

QUESTION 4: WORK DONE (POWER AND EFFICIENCY)

4.1 Define the term *power.* (2)

4.2 FIGURE 3 below shows a graph of a uniformly varying load against distance, obtained when a platform is lifted by a 100 m long cable which is wound onto a drum at the top. The force axis represents the force in the cable where it touches the drum and the distance axis represents the length of cable already wound onto the drum.

Calculate the following by making use of FIGURE 3:

4.2.1 The weight of the cable per metre length (1)

4.2.2 The work done in winding the total length of the cable onto the drum with the cage fixed to the lower end onto the drum (2)

4.2.3 The power applied when the end of the cable is 50 m from the drum and the velocity is 12 m/s (2)

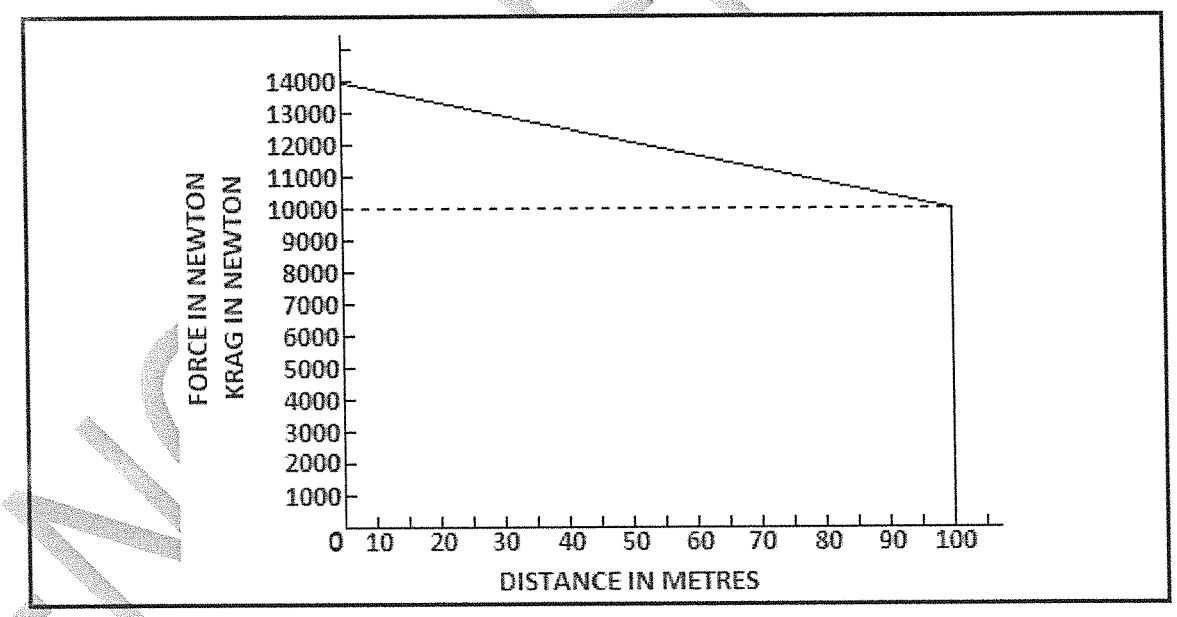


FIGURE 3

4.3 The tangential force applied to a flywheel is 500 N. The diameter of the flywheel is 800 mm.

Calculate the following:

4.3.1 The torque delivered by the flywheel (2)

4.3.2 The work done by the flywheel in 200 revolutions (2)
[11]

ENGINEERING

QUESTION 5: MECHANICAL DRIVES AND LIFTING MACHINES

5.1 Name THREE methods of transmitting power with reference to mechanical drives. (3)

5.2 State TWO advantages of chain drives as compared to belt drives. (2)

5.3 Refer to FIGURE 4 below.

Calculate the following:

5.3.1 Mechanical advantage (2)

5.3.2 Velocity ratio (3)

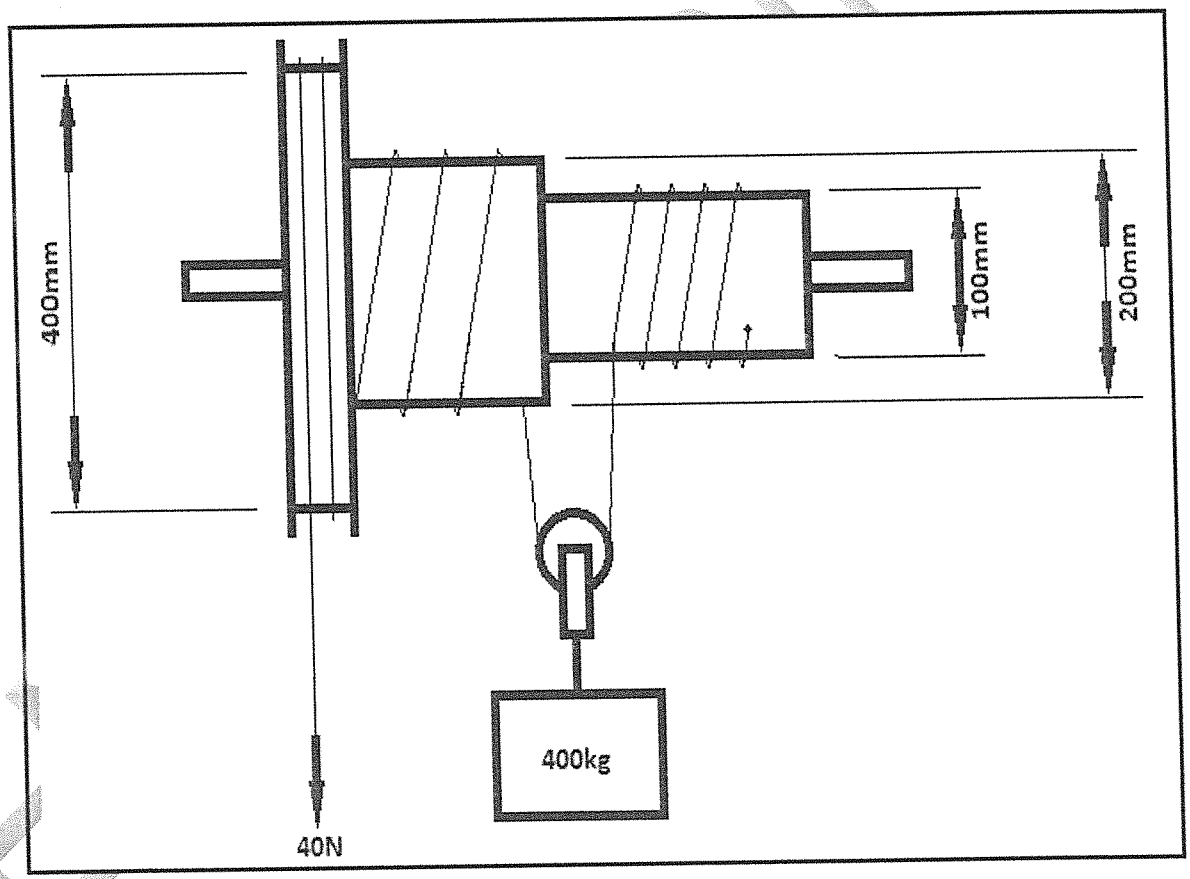


FIGURE 4

5.4 The gauge pressure on a diver's body in seawater is 900 kPa. The density of seawater is 1 030 kg/m^3.

Calculate the following:

5.4.1 The depth of the diver in the seawater (2)

5.4.2 The absolute pressure on the diver's body (1)
[13]

Copyright reserved

QUESTION 6: FRICTION

6.1 Name TWO factors that influence *friction*. (2)

6.2 A body with a mass of 40 kg is at the point of sliding down an incline plane of 20°.

Calculate the following:

6.2.1 The coefficient of static friction (1)

6.2.2 The weight component perpendicular to the sliding plane (2)

6.2.3 The weight component parallel to the sliding plane (2)

6.2.4 The external force required to pull the body up the incline plane (3)
[10]

QUESTION 7: HEAT

7.1 Define the term *heat value* of a combustible. (2)

7.2 Six litres of water at a freezing point of 0 °C is heated to 80 °C.

Calculate the heat required for this temperature rise in kJ.

Mass of 1 ℓ of water = 1 kg. (3)

7.3 A 6 kg steel part at 90 °C is immersed in water with a temperature of 15°C.

Calculate the mass of water required if the final temperature of the mixture is 35 °C. (3)

7.4 Define *coefficient of linear expansion* of a material. (2)

7.5 A steel pipe is 450 m long at 22 °C. Steam at a temperature of 500 °C is allowed to flow through the steel pipe.

Calculate the change in length, in mm, of the steel pipe. (2)
[12]

ENGINEERING

Copyright reserved

QUESTION 8: PARTICLE STRUCTURE OF MATTER

8.1 State the charge on the following atomic particles:

8.1.1 The nucleus (1)

8.1.2 An electron (1)

8.1.3 A neutron (1)

8.2 What is an *electrolyte*? (1)

8.3 State TWO uses of electrolysis. (2)
[6]

QUESTION 9: ELECTRICITY

9.1 Define Coulomb's law. (2)

9.2 Illustrate mutual induction with the aid of a neat, labelled sketch. Your sketch should include the following: batteries, switch, coil and galvanometer. (3)

9.3 Name TWO of the four factors on which a conductor's resistance depends. (2)

9.4 A circuit consists of two parallel resistors of 3 ohms each which in turn are connected in series with a resistor of 4 ohms.

Calculate the total resistance of the circuit. (3)
[10]

TOTAL: 100

ENGINEERING

Copyright reserved

FORMULA SHEET

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

$$w = m \,.\, g$$

$$W = F \,.\, s$$

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

$$\eta = \frac{Output}{Input} \,.\, 100\%$$

$$\eta = \frac{Uitset}{Inset} \,.\, 100\%$$

$$\mu = \frac{F_\mu}{N_R}$$

$$\mu = \tan\Phi$$

$$F_T = F_\mu \ldots \begin{matrix} horizontal \\ horisontaal \end{matrix} \ldots a = 0$$

$$F_S = w\sin\theta$$

$$F_C = w\cos\theta$$

$$F_T = F_\mu \pm F_S \ldots a = 0$$

$$F_e = T_1 - T_2$$

$$\frac{T_1}{T_2} = \begin{matrix} tension\ \ ratio \\ spanningsverhouding \end{matrix}$$

$$P = F_e \,.\, v$$

$$v = \pi \,.\, d \,.\, n$$

$$n = \frac{N}{60}$$

$$N_A \,.\, T_A = N_B \,.\, T_B$$

$$SV = \frac{N_A}{N_Z} = VR$$

$$E_p = m.g.h.$$

$$E_K = \frac{1}{2}.m.v^2$$

$$E_T = E_p + E_K$$

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

$$VV = \frac{S_E}{S_L} = DR$$

$$\frac{HV}{VV}.100\% = \eta = \frac{MA}{DR}.100\%$$

$$VV = \frac{2D}{(d_1 - d_2)} = DR$$

$$VV = \frac{2D}{(D - d)} = DR$$

$$Q = m \,.\, c \,.\, \Delta t$$

$$m.ww = Q = m.hv$$

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

$$\Delta l = l_o \,.\, \alpha \,.\, \Delta t$$

$$l_f = l_o \pm \Delta l$$

$$1\ m/s = 3{,}6\ km/h$$

$$s = u.t + \frac{1}{2}.a.t^2$$

$$v = u + a.t$$

$$v^2 = u^2 + 2as$$

$$\Sigma \uparrow F = \Sigma \downarrow F$$

$$\Sigma \curvearrowright M = \Sigma \curvearrowleft M$$

$$P_{ABS} = P_{ATM} + P_{MET}$$

$$p = \Delta.g.h$$

$$\frac{1}{R_{PAR}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n}$$

$$R_{SER} = R_1 + R_2 + \ldots + R_n$$

$$R = \frac{\rho \,.\, l}{a}$$

ENGINEERING

Copyright reserved

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

ENGINEERING SCIENCE N2

NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

19 NOVEMBER 2014

This marking guideline consists of 10 pages

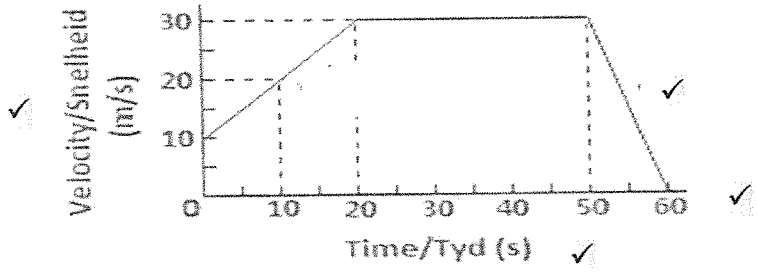
Copyright reserved

QUESTION 1

1.1 1.1.1 • Speed in a given direction✓ (1)

1.1.2 • The distance covered regardless of direction ✓ (1)

1.2 1.2.1



(2)

1.2.2 The gradient represents acceleration (1)

1.2.3 (a) $a = \frac{v - u}{t}$

$= \frac{30 - 10}{20}$

$= 1\ m/s^2$

(2)

(b) S tot = S rect + S triangle

= (20 x 10) + (1/2 x 1 x 20)

= 400m

(3)

(c) Time for deceleration (from graph) = 10 sh

(2)
[12]

QUESTION 2

2.1 2.1.1 Take moments about L

$\sum_{ACM} = \sum_{CM}$

R (8) = 100 (2) + 200 (6) + 7 (9)

R (8) = 200 + 1200 + 675

R = 259, 375 N

Take moments about R (3)

$\sum_{ACM} = \sum_{CM}$

200 (2) + 100 (6) = 75 (1) + L (8)

$L = \frac{1000 - 75}{8}$

L = 115, 625 N (3)

2.1.2 $\sum_{F\uparrow} = \sum_{F\downarrow}$

259, 375 + 115, 625 = 100 + 200 + 75

375 = 375 (1)

2.2
- Wing-nut ✓
- Tap
- Stock and die
- Wheel spanner

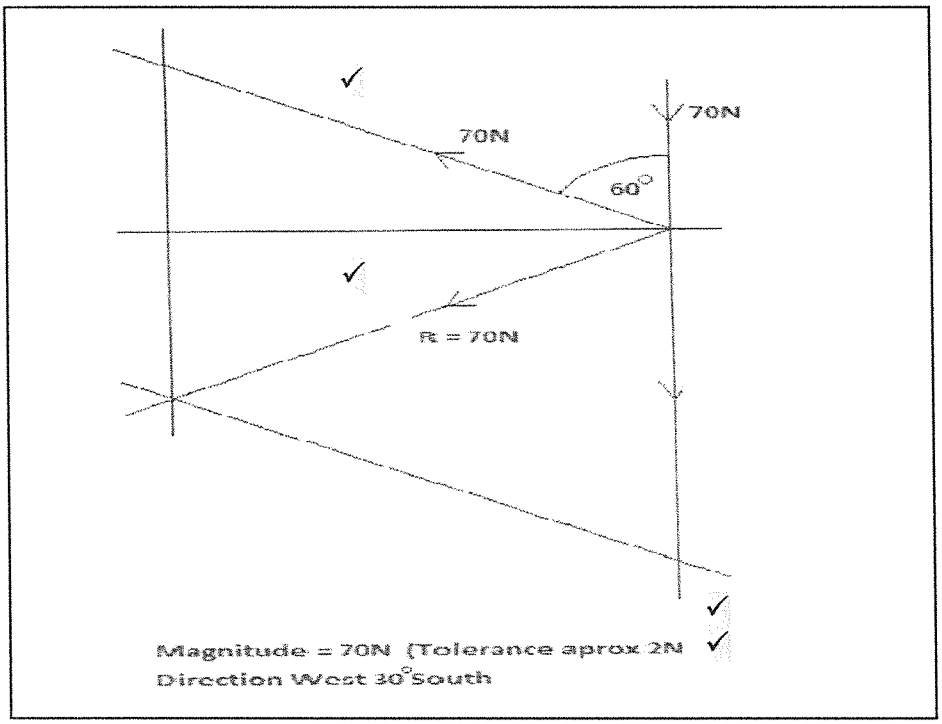
any one (1)

2.3 Fsin60° = 200

$F = \frac{200}{Sin60°}$

F = 230, 9 N (2)

2.4



(4)
[14]

QUESTION 3

3.1 The energy a body possesses due to its mass and height. (2)

3.2 3.2.1 PE = mg h
PE = 4 x 9,8 x 400
PE = 15680 J

OR

P_E = 15, 68 KJ (2)

3.2.2. Velocity with which the stone hits the ground
$Ek = ½ mv^2$

$$V = \sqrt{\frac{2\,Ek}{m}}$$

$$= \frac{\sqrt{2 \times 15680}}{4}$$

= 88, 544 m/s

OR

$$V = \sqrt{2gh}$$

$$= \sqrt{2 \times 9{,}8 \times 400}$$

= 88, 544 m/s (2)

3.2.3. Time

$V = u + at$

$$T = \frac{v - u}{a}$$

$$T = \frac{88,544 - 0}{9,8}$$

T = 9, 035 s (2)

3.3 Momentum is the product of the mass and velocity of an object. (2)

3.4 Momentum of truck
P = m x v

P = 2500 x 40

P = 100 000 kg. m/s (2)
[12]

QUESTION 4

4.1 Work done per second ✓✓or
Rate at which work is done (2)

4.2 4.2.1 Weight of cable per metre
W = w x L

4 000 = w x 100

W = 40 N/m (1)

4.2.2 Work done
WD tot = WD rect + WD triangle

= (10 000 x 100) (½ x 100 x 4 000) ✓

= 1 200 000 J ✓

OR

$\frac{1}{2} \sum 11 \times \perp h$

$= 100 \left(\frac{10\,000 + 14\,0000}{2} \right)$

= 1 200 000 J (2)

4.2.3 F cable = WL + Wc

= 10 000 + (40 X 50)

= 12 000 N

P = F X V

P = 12 000 X 12

P = 144 000 W (2)

4.3 4.3.1 T = F x r

T = 500 x 0,4

T = 200 Nm (2)

4.3.2 WD = F x π x D x n

WD = 500 x π x 0,8 x 200 ✓

WD = 251 327 J ✓ (2)
[11]

QUESTION 5

5.1
- Gear drives ✓
- Belt drives ✓
- Chain drives ✓ (3)

Copyright reserved

5.2
- More torque (power) ✓
- Last longer ✓
- Use less space
- Less stretch (any 2 x 1)

(2)

5.3 5.3.1 Load = m x g

= 400 x 9,8

= 3920 N

MA = L/E

= 3920/ 40 ✓

= 98 ✓ (2)

5.3.2 $\frac{VR}{1} = \frac{2}{(d1 - d2)}$

$= \frac{2 \times 400}{200 - 100}$ ✓ ✓

= 8 ✓ (3)

5.4 5.4.1 P = p x g x h

900 000 = 1030 x 9,8 x h ✓

H = 89, 1619 m ✓ (2)

5.4.2 Absolute pressure

Pabs = Pg + P atm

= 900 + 101,3 Kpa

= 1001.3 Kpa (1)
[13]

QUESTION 6

6.1
- Nature of surface
- Weight (2)

6.2 6.2.1 $\mu = \tan Q$

$\mu = \tan 20°$

$\mu = 0, 364$ (1)

6.2.2 $F = mg \cos \theta$

$= 40 \times 9,8 \times \cos 20°$

$= 368, 36 N$ (2)

6.2.3 $Fs = mg \sin \theta$

$= 40 \times 9,8 \times \sin 20°$

$= 130, 07 N$ (2)

6.2.4 $Fup = Fs + F\mu$

$= 134, 07 + 134, 07$

$= 268, 14 N$

$F\mu = \mu (NR)$

$= 0,364 X 368, 37$

$= 134, 07 N$ (3)
[10]

QUESTION 7

7.1 The amount of heat energy released when 1 kg of a fuel is completely burnt. (2)

7.2 $\Delta T = T_H - T_L$

$= 80 - 0$

$= 80°C$

$Q = m \times c \times \Delta t$

$Q = 6 \times 4187 \times 80$

$Q = 2009\ 760$

$Q = 2009, 76 kJ$

(3)

7.3 Heat lost = Heat gained

$M \times c \times \Delta t = M \times c \times \Delta t$

$6 \times 500 \times 55 = m \times 4187 \times 20$

$M = 1,97$ kg (3)

7.4 The amount by which a material will expand ✓when heated by 1°C. ✓
The increase in length of a substance per unit length when its temperature is increased by 1°C any one (2)

7.5 $\Delta L = Lo \times \infty \times \Delta t$

$\Delta L = 450\ 000 \times 0,000012 \times (500 - 22)$

$\Delta L = 2581,2$mm (2)
[12]

QUESTION 8

8.1 8.1.1 • Positive
8.1.2 • Negative
8.1.3 • Neutral (3)

8.2 An electrolyte is a solution able to conduct electric current (1)

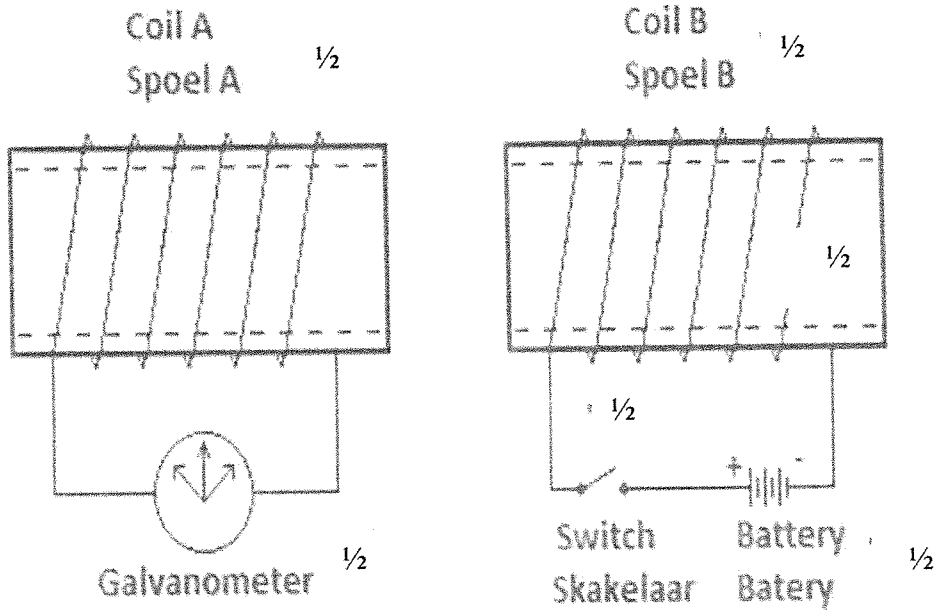
8.3 • Electroplating
• Electrorefining (2)
[6]

QUESTION 9

9.1 A coulomb is the quantity of electric charge that passes any point in a circuit in one second when a steady current of one ampere is flowing. (2)

Copyright reserved

9.2



(3)

9.3
- Resistivity
- Length
- Area
- Temperature

(Any 2 x 1)

(2)

9.4 $R_p = \frac{R1 \times R2}{R1 + R2}$

$= \frac{3 \times 3}{3 + 3}$

$= 1,5\ \Omega$

$R_{total} = R_p + R_3$

$= 1,5\ \Omega + 4$

$= 5,5\ \Omega$

(3)
[10]

TOTAL: 100