GAUTENG DEPARTMENT OF EDUCATION
GAUTENGSE DEPARTEMENT VAN ONDERWYS
SENIOR CERTIFICATE EXAMINATION
SENIORSERTIFIKAAT-EKSAMEN

TECHNICA (MECHANICAL) HG
TECHNIKA (MEGANIES) HG

POSSIBLE ANSWERS / MOONTLIKE ANTWOORDE SUPP 2007

QUESTION / *VRAAG* 1

1.1 Organization / *Organisering*
Planning / *Beplanning*
Guidance / *Leiding*
Control / *Beheer* (4)

1.2 **Radian**: It is the angle that formed at the centre of a circle if the radius is marked off on the circumference.
Radiaal: Dit is die hoek wat by die middelpunt van ? sirkel gevorm word wanneer die radius op die omtrek afgemeet word. (4)

1.3 **M.E.P.**
It is the mean positive pressure exerted on the piston during one cycle.

G.E.D.
Dit is die <u>gemiddelde positiewe druk</u> wat tydens <u>een siklus</u> op die <u>suier uitgeoefen</u> word. (4)

Indicated power
It is the theoretical power that the engine should generate without considering any mechanical or other losses.

Aangeduide drywing
Dit is die teoretiese drywing wat binne die silinder van ? binnebrandenjin ontwikkel word sonder inagneming van enige verliese. (4)

1.4 **Advantages:** Strong drive
Easy to get different gear ratios

Voordele: *Sterk aandrywing*
Oorskakeling – verskillende ratverhoudings makliker (2)

Disadvantages Very expensive
Noisy
Difficult to maintain

Nadele: *Baie duur*
Raserig
Moeilik om in stand te hou (2)

1.5 **Angle indexing /** *Hoekindeksering*

$$\text{Hoekindeksering} = \frac{N}{9}$$

$$= \frac{3°}{9}$$

$$= \frac{\frac{11}{3}}{9}$$

$$= \frac{11 \times 1}{3 \times 9} = \frac{11}{27}$$

d.w.s. $\frac{11}{27} \times \frac{2}{2} = \frac{22}{54}$

Indexing = 22 holes on a 54 hole circle
Indeksering = 22 gate op ? 54-gat-sirkel (6)

1.6

1.6.1 Work done / *Arbeid* = F x s

= 9(48)

= 432 J (3)

1.6.2 Work done / *Arbeid* = F x s

= (12-9)48

= 3(48)

= 144 J (3)

1.6.3 Total work done

Totale Arbeid = 432 + 144

= 576 J or / of

Work done / *Arbeid* = 12(48)

= 576 J (3)

1.6.4 Power $\frac{\text{Work done}}{\text{time}}$ / Drywing $\frac{arbeid}{tyd}$

$$= \frac{576}{32}$$

= 18 W (3)

2

1.7   **Pitch** –   It is the distance perpendicular from one crest to a following crest.
        Steek –   *Dit is die afstand loodreg van een kruin tot by ? volgende kruin.*   (2)

        Lead –   is the distance a thread will advance, axially, in one complete revolution.
        Styging – *Dit is die afstand aksiaal van een kruin na ? volgende.*   (2)

1.8   Prony brake / *Die Prony-rem*
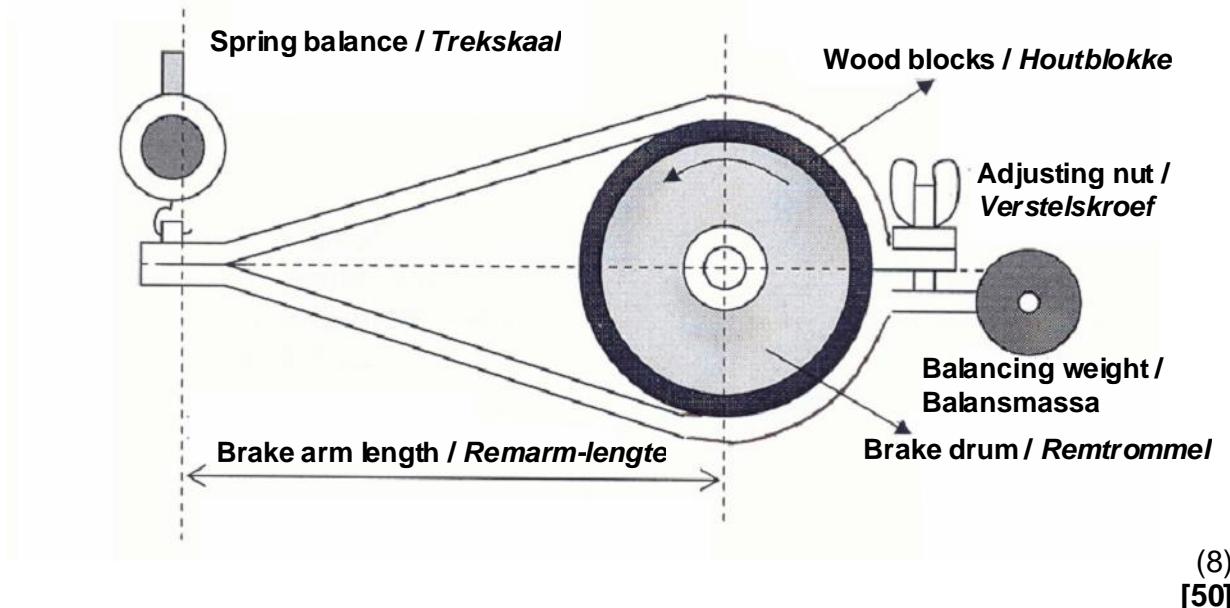
                (8)
                [50]

QUESTION / *VRAAG* 2

2.1.1 $u = 4\,m/s$; $v = 18\,m/s$; $t = 20\,s$

$$u + at = v$$
$$\therefore 4 + a(20) = 18$$
$$\therefore 20a = 18 -$$
$$\therefore a = \frac{18 - 4}{20}$$
$$= 0{,}7\ m/s^2 \qquad (3)$$

2.1.2 $s = ut + ½\,at^2$
          $= 4(20) + ½\,(0{,}7)(20)^2$
          $= 80 + 140$
          $= 220\ m$ (3)

2.1.3   Work done = force x distance / *Arbeid = drywing x afstand*
                 $= 490 \sin 15° \times 220$
                 $= 27{,}901\ kJ$ (3)

2.1.4 $F\mu = \mu R$
          $= 0{,}25\,(490 \cos 15°)$
      $F\mu = 118{,}326\ N$ (3)

2.1.5   Work done / $= F_\mu \times s$

        Arbeid $= 118,326 \times 220$

                       $= 26,032 \text{ kJ}$ (3)

2.1.6 $E_k = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

           $= \frac{1}{2}m(v^2 - u^2)$

           $= \frac{1}{2}(50)[18^2 - 4^2]$

           $= 7,7 \text{ kJ}$

        OR / *OF*

        $F = ma$

           $= 50(0,7)$

           $= 35 \text{ N}$

        Work done / $= F \times s$

        Arbeid $= 35 \times 220$

                      $= 7,7 \text{ kJ}$ (3)

2.1.7   Accelerating force (unbalanced force) /
        Versnellingskrag (ongebalanseerde krag)
        $= ma$

          $F_T - F_\mu - W \sin 15° = ma$

       $\therefore F_T - 118,326 - 126,821 = 50 (o,7)$

                 $\therefore F_T = 280,147 \text{ N}$

        Work done by F_T $= F_T \times 220$

        Arbeid verrig deur $= 280,147 \times 220$

                     $= 61,632 \text{ kJ}$

        $\dfrac{\text{Power (by } F_T)}{\text{Drywing (deur } F_T)} = \dfrac{\text{work done / } arbeid}{\text{time / } tyd}$

                  $= \dfrac{61,632}{20}$

                  $= 3,082 \text{ kW}$ (5)

2.2   Crest / *Kruin*
         Pitch / *Steek*
         Lead / *Styging*
         Root / *Wortel*
         Included angle / *Ingeslote hoek*
         Root diameter / *Worteldiameter*
         Crest diameter / *Kruindiameter*
         Depth / *Diepte*   any / *enige*   (5)

2.3   Cubic, Pyramidal, Calcite
         Kubies, Piramidaal, Kalsiet (3)

2.4   Body-centered cubic arrangement (9 atoms)
         Cubic face centered arrangement (14 atoms)
         Close packed hexagonal form arrangement (17 atoms)

         Kubiese digpakkingsatoom-rangskikking = 9 atome
         Kubiese vlakgesentreerdeatoom-rangskikking = 14 atome
         Heksagonale digpakkingsatoom-rangskikking = 17 atome *(6)*

2.5 AC_1 Lower critical point. Steel with a low carbon content has a short rest period. Although the same amount of heat is added, the temperature does not rise accordingly during the rest period.
               Heat is used by the steel for a structure change.

         AC_1   *Laer kritieke punt, staal met ? lae koolstofinhoud ondervind ? kort rusperiode. Alhoewel dieselfde hoeveelheid hitte toegevoeg word, neem die temperatuur tydens hierdie rusperiode nie dienooreenkomstig toe nie. Hitte word deur die staal gebruik vir ? struktuurverandering.* (5)

         AC_2 Loses magnetic properties only

         AC_2   *Slegs magnetiese eienskappe word verloor.* (2)

         AC_3 Higher critical point, granular structure at its smallest, fully Austenite.

         AC_3   *Dit is die hoër kritieke punt, korrelstruktuur is op sy kleinste en is geheel en al Austeniet.* (3)

2.6   Circumference / *Omtrek* = 2*p* r

         Amount of radians / *Aantal radiale*   = $\dfrac{2p\ r}{r}$

                                           = 2p radians / *radiale* (3)

[50]

QUESTION / *VRAAG* 3

3.1

3.1.1   **Hooke's law**
For an elastic object, the strain is proportional to the stress producing it, provided the limit of proportionality is not exceeded.

Hooke se wet
Vir ? elastiese voorwerp is die vormverandering eweredig aan die spanning wat dit veroorsaak tot by die eweredigheidsgrens. (4)

3.1.2 **Boyles Law**
The volume of a given mass of gas is inversely proportional to the pressure on it, if the temperature remains constant.

Die Wet van Boyle
Die volume van ? gegewe gasmassa is omgekeerd eweredig aan die druk wat daarop uitgeoefen word indien die temperatuur konstant bly. (4)

3.1.3 **1 Joule**
1 Joule work is done if a force of 1 N is displaced through a distance of 1 m in the direction of the force.

1 joule
1 joule arbeid word verrig wanneer ? krag van 1 N oor ? afstand van 1 m aangewend word, in die rigting van die krag. (4)

3.2 Causes of belt slippage / *Bandglipoorsake*
Oil on belts / *Olie op bande*
Belts not tight / *Bande nie styf gestel nie*
Contact angle of belt too small / *Kontakhoek van band te klein*
Not enough belts on pulleys / *Te min bande op katrolle* (4)

3.3 To prevent relative movement between a shaft and a hole.
Temporally couple a shaft to a hole.

Om relatiewe draaiing tussen ? as en ? naaf te verhoed
Om as tydelik aan ? naaf te heg (2)

3.4
3.4.1 To calculate angular movement of part C.
Om hoekbeweging van C te bereken.

Velocity at A / *Snelheid by A*	Revolution at B / *Omwentelinge by B*

Velocity at A   Revolution at B
Snelheid by A   *Omwentelinge by B*

$V = \pi dn$ $V = \pi dn$

$\quad = \pi \times 0,23 \times 2$ $1,445 = \pi \times 0,620 \times n$

$\quad = 1,445$ m/s $\dfrac{1,445}{1,94778} = n$

$\qquad\qquad\qquad\qquad\qquad\qquad 0,7419 = n$

$\therefore$ Angular movement $= 0,7419 \times 360°$

Hoekbeweging $= 267,09°$

$\qquad\qquad\qquad\qquad\qquad\qquad = \dfrac{267,09}{57,3}$

$\qquad\qquad\qquad\qquad\qquad\qquad = 4,66$ rad (8)

6

3.4.2   (a) Power **/** *Drywing*   = $(T_1 - T_2)\,\pi\,dn$

$\dfrac{T_1}{T_2} = 2$ $P = (400 - 200)\,p\,0{,}23 \times \dfrac{1200}{60}$

$\dfrac{400}{T_2} = 2$ $= (200 \times p \times 0{,}23 \times 20)$

$\therefore T_2 = 200$ $= \underrightarrow{2{,}89\,kW}$ (7)

(b) Velocity ratio / *Snelheidsverhouding*

$VR = \dfrac{N_D}{N_G}$ or / *of* $VR = \dfrac{D_G}{D_D}$

$= \dfrac{2}{0{,}7419}$ $= \dfrac{620}{230}$

$= 2{,}7$ $= 2{,}7$ (3)

(c) $V = p\,Dn$

$= p \times 0{,}230 \times \dfrac{1200}{60}$

$= \underrightarrow{14{,}45\,m/s}$ (4)

3.5   **Velocity**
Is the rate of displacement undergone per time unit and is a vector quantity.

Snelheid
Dit is die verplasing per tydseenheid en is ? vektorhoeveelheid.   (3)

Vector
A vector is a physical quantity which possesses magnitude and direction.

Vektor
? Vektor is ? fisiese hoeveelheid wat ? bepaalde grootte en rigting besit.   (2)

Power
Power is the rate at which work is done.

Drywing
Drywing is die tempo waarteen arbeid verrig word.   (2)

Thermodynamics

Thermodynamics is the branch of physics involved with the relationship
between heat and work done.

Termodinamika
*Termodinamika is die vertakking van fisika wat gemoeid is met die verband
tussen warmte en arbeid.*   (3)

[50]

QUESTION / *VRAAG* 4

4.1
$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$T_2 = \frac{T_1 \times P_2 \times V_2}{P_1 \times V_1}$$

$$T_2 = \frac{298 \times 580\,000 \times 0,8}{137\,000 \times 3,2}$$

$$= 315,4$$

Final temperature $t = K - 273$

Finale temperatuur $= 315,4 - 273$

$$= 42,4^oC \tag{5}$$

4.2

(12)

4.3

150 mm

160 mm (8 x 1 = 8 N)

210 mm (8 x 6 = 48 N)
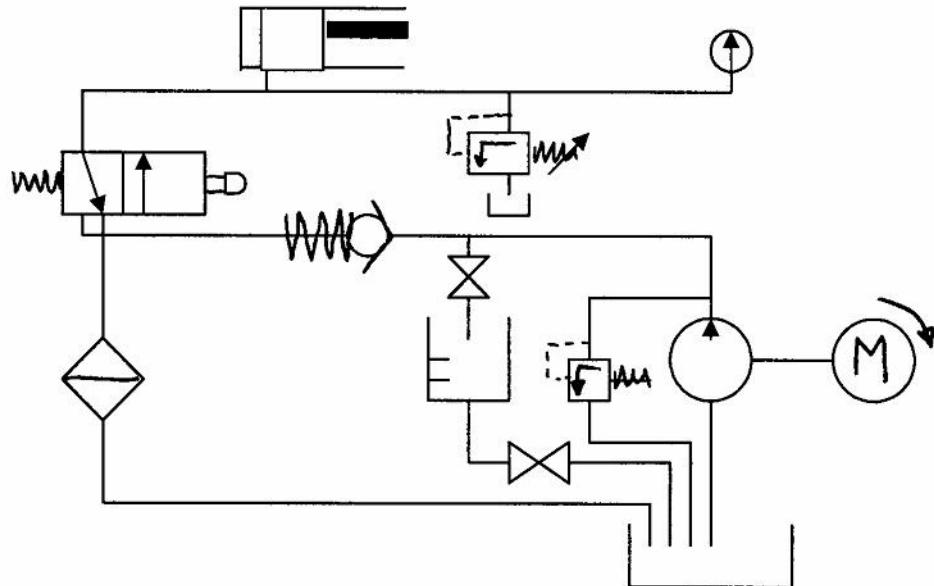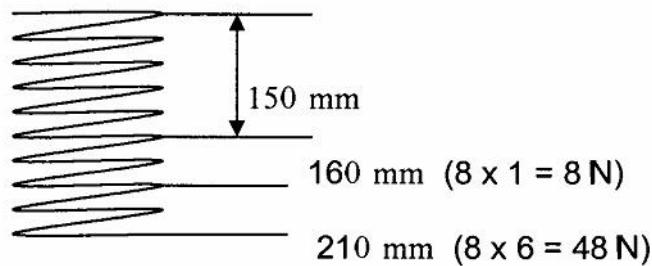
Work done = $\frac{8 + 48}{2}$ x 0,05
Arbeid

= 1,4 J

(5)

4.4
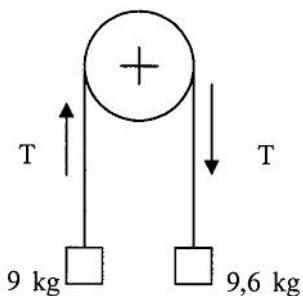
Consider the 9 kg mass / *Beskou die 9 kg massa*

T > 90

T - 90 = ma

T - 90 = 9a…….……1

Consider the 9,6 kg mass / *Beskou die 9,6 kg mass a*

96 > T

96 – T = ma

96 – T = 9,6a……..…..2

1 + 2: 6 = 18,6a

$$a = \frac{6}{18,6} = 0,325 \text{ m/s}$$

Substitute a in 1 or 2 to get T.	From 1:	T – 90 = 9a
Vervang a in 1 of 2 om T te kry.	*Uit 1*:	T – 90 = 9 x 0,325
		T = 90 + 2,925
		T = 92,925 N (8)

4.5
4.5.1   **28H7 – p6**

	Hole / *Gat*	Shaft / *As*
Hoë	28 + 0,021 \ 28,021	28 + 0,035 \ 28,035
Lae	28 + 0,0 \ 28 mm	28 + 0,022 \ 28,022

(4)

4.5.2   Interference fit / *Stuitpassing*   (1)

4.5.3   Allowance = High limit of the shaft – low limit of the hole
Toelating = *Hoë grens van die as – lae grens van die gat*
= 28,035 – 28
= 0,035 mm   (3)

4.6
$$\frac{\sin\varnothing}{2} = \frac{R-r}{\frac{M-n}{2}+r-R}$$

Where / *Waar* $R = \dfrac{1,01 \times 6}{2}$

$= 3,03$

$r = \dfrac{0,505 \times 6}{2}$

$= 1,515$

$$\frac{M-n}{2} = \left(\frac{R-r}{\frac{\sin\varnothing}{2}}\right) - r + R$$

$$= \frac{3,03 - 1,515}{\sin 34°} - 1,515 + 3,03$$

$$= \frac{1,515}{0,559} - 1,515 + 3,03$$

$$= 2,709 - 1,515 + 3,03$$

$M - n = 2\,(4,224)$

$= 8,448$ mm　　　　　　　　　　　　　　　　　　　　　(10)

4.7　Organic chemistry – is the science of the hydro carbon compounds.
　　Organiese chemie – dit is die wetenskap van die koolwaterstofverbindings.　　(2)

[50]

QUESTION / *VRAAG* 5

5.1

5.1.1　$\dfrac{\text{Indexing}}{Indeksering} = \dfrac{40}{A} = \dfrac{40}{140} = \dfrac{4\,(\times 2)}{14 \times 2} = \dfrac{\text{8 holes in a 28 hole circle}}{8 \, gate \, op \, 'n \, 28 - gat - sirkel}$　　(2)

5.1.2　$\dfrac{\text{Change gears}}{Wisselratte} : \dfrac{\text{Drywer}}{\text{Gedrewe}} = \dfrac{(A-N) \times 40}{A}$

$$= \frac{(140-137) \times 40}{140}$$

$$= \frac{3 \times 4}{14} = \frac{12\,(\times 2)}{14\,(\times 2)}$$

$$= \frac{24}{28}$$
　　　　　　　　　　　　　　　　　　　　　　　　　　　　(5)

5.1.3　Positive direction of rotation (same direction as the index lever)
　　Draairigting is positief (dieselfde rigting as die indeksslinger)　　(2)

5.1.4
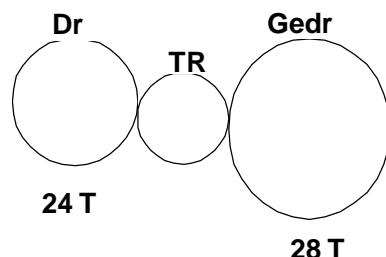
(4)

5.2 **Ultrasonic testing**

High frequency sound waves are sent through the metal with short intervals. The sending of sound waves is then stopped. The combined sender-receiver unit is used to capture the reflected sound waves. The cycle is repeated at a tempo of half a million to 5 million cycles per second. Each wave is then displayed on an oscilloscope which is calibrated to indicate the distance between the unit and the fault.

Ultrasoniesetoets

Hoëfrek wensie-klankgolwe word deur die metaal gestuur met baie kort tussenposes. Die stuur van klankgolwe word dan stopgesi t. Die gekombineerde sender-ontvanger-eenheid word gebruik om weerkaatste golwe op te vang. Die siklus word herhaal teen ? tempo van ? half miljoen tot 5 miljoen keer per sekonde. Elke golf word op ? ossilloskoop weergegee wat gekalibreer is om die afstand tussen die foutopspooreenheid en enige fout uit te wys.

(6)

5.3
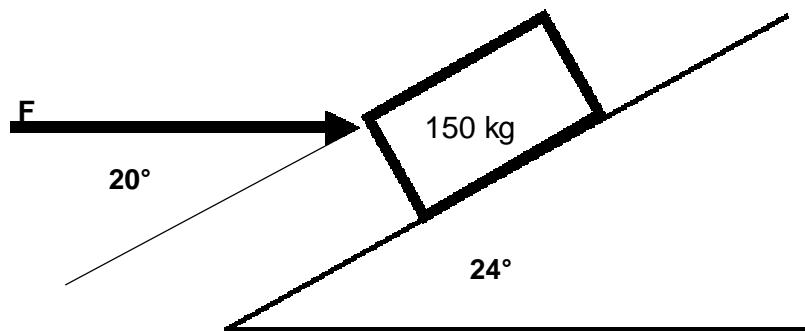
FCos20 = Fµ + 1 500Sin24

FCos 20 = µR + 1 500Sin24

FCos 20 = 0,4(1 500Cos24 + FSin20) + 1 500Sin24

P0,939 = 0,4(1 370,3 + P0,342) + 610

P0,939 = 548,12 + P0,1368 + 610

P0,939 – P0,1368 = 1 158,12

P0,802 = 1 158,12

P = $\dfrac{1\ 158,12}{0,802}$ P = 1 44 N

(10)

5.4   Brake power / Remdrywing $= 2p$FRN

$$= 2p \times 180 \times 1{,}3 \times \frac{3\,600}{60}$$

$$= 88{,}22 \text{ kW} \tag{5}$$

$$\frac{\text{Mechanical efficiency}}{\text{Meganiese doeltreffendheid}} = \frac{\text{RD} / \text{BP}}{\text{AD} / \text{IP}} \times \frac{100}{1}$$

$$= \frac{88{,}22}{140} \times 100$$

$$= 63\% \tag{3}$$

5.5
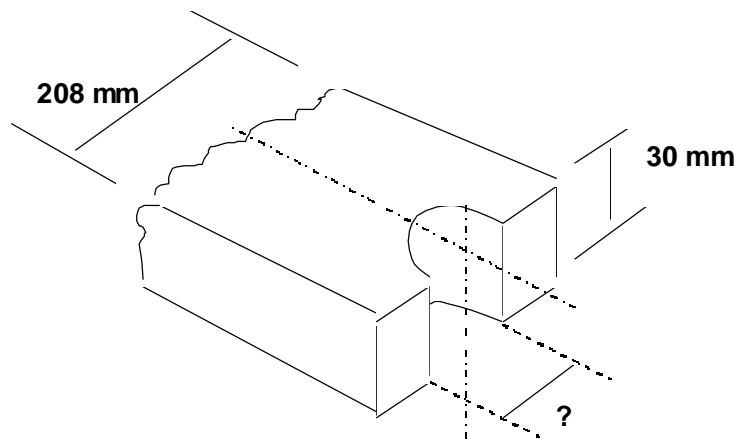
Area of pull bar without hole: Area = Length x width
Area van trekstang sonder gat:
Area / (Oppervlakte) = Lengte x breedte   = 208 x 30
                                              = 6 240 mm^2

Area needed to carry tention / *Area benodig om spanning te dra*

$$\text{Area} = \frac{\text{Force} / \textit{Krag}}{\text{Stress} / \textit{Spanning}}$$

$$= \frac{230 \times 10^3}{60}$$

$$= 3\,833{,}3 \text{ mm}^2$$

To calculate the size of the rivet hole /

Om die grootte van die klinknaelgat te bereken

6 240 – 3 833,3 = 2 406,67 mm²

D.w.s.   l x b = 2 406,67 mm²

        30 x b = 2 406,67 mm²

            b = 80,22 mm

The maximum size of the rivet hole

Die maksimum deursnee van die klinknaelgat = 80,22 mm   (10)

5.6   **Qualities of an ideal gas:**
- The molecules are identical
- Distance between molecules are very big
- Gas only takes up volume because of movement and collisions of molecules.
- No forces between molecules except between collisions
- Collisions are fully elastic.   Any 3

Eienskappe van ? ideale gas:
- *Die molekules is identies aan mekaar.*
- *Afstand tussen molekules is baie groot*
- *Gas beslaan slegs volume a.g.v. die beweging en botsings van die molekules.*
- *Geen kragte tussen molekules behalwe tussen botsings.*
- *Botsings is volkome elasties.*   *Enige 3*   *(3)*
[50]

QUESTION / *VRAAG* 6

6.1
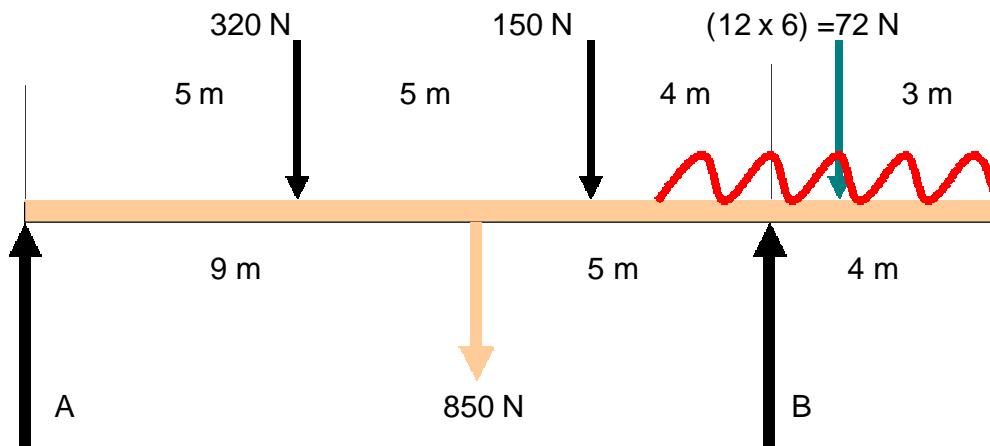
Take moments about A / *Neem momente om A*

S LHM = SRHM

B x 14 = (320 x 5) + (850 x 9) + (150 x 10) + (72 x 15)
 B14 = 1 600 + 7 650 + 1 500 + 1 080
 B14 = 11 830
 B = 845 N

Take moments about B / *Neem momente om B*

S RHM = S LHM

(A x 14) + (72 x 1) = (150 x 4) + (850 x 5) + (320 x 9)
 A14 = 600 N + 4 250 + 2 880 - 72
 A14 = 7658 N
 A = 547 N

Test / *Toets*:

Forces upwards = forces downwards / *Opwaartse F = Afwaartse F*

845 + 547 = 320 + 150 + 850 + 72
 1 392 N = 1 392 N   (14)

6.2 **Law of moments**
 A body is in equilibrium if the sum of the left hand moments is equal to the
 sum of the right hand moments around the same point.

 Wet van Momente
 *? Liggaam is in ewewig as die som van die linksom momente gelyk is aan die
 som van die regsom momente om dieselfde punt.*   *(4)*

6.3 Stress-strain graph for mild steel / *Spanning-vormveranderingsgrafiek vir
 sagtestaal*
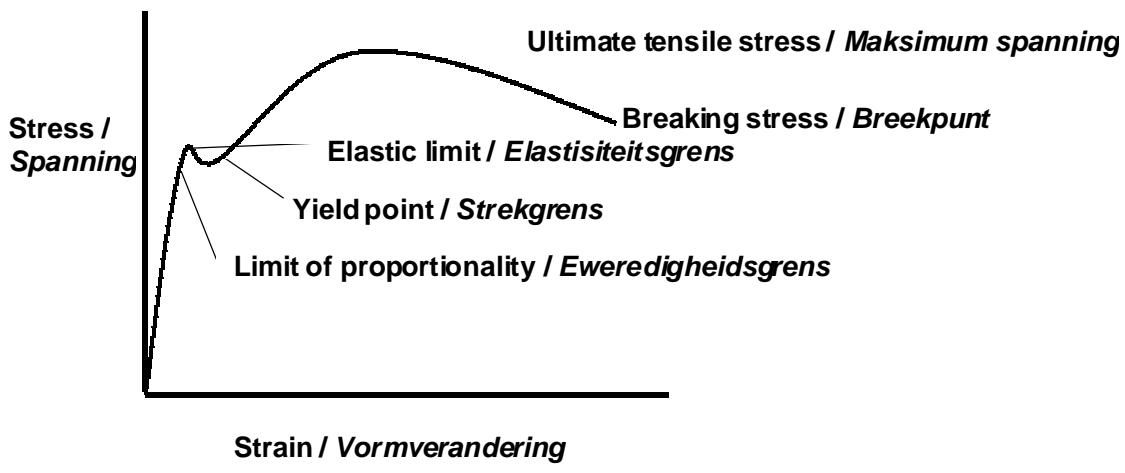
                                                                                    (8)

6.4
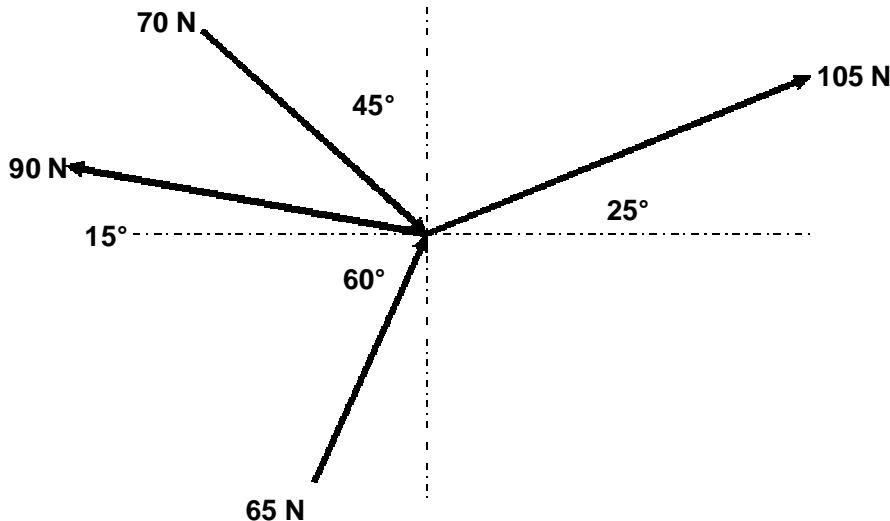
Sum of the VC / *Som van die VK*

VC / *VK* = 65 Sin 60° + 105 Sin 25° + 90 Sin 15° - 70 Sin 45°

= 56,29 + 44,37 + 23,29 – 49,5

= 74,45 N ↑

Sum of the HC / *Som van die HK*

HC / *HK* = 105 Cos 25° + 65 Cos 60 + 70 Cos 45 – 90 Cos 15°
= 95,16 + 32,5 + 49,5 – 86,93
= 90,23 →

$R = \sqrt{(74,45)^2 + (90,23)^2}$
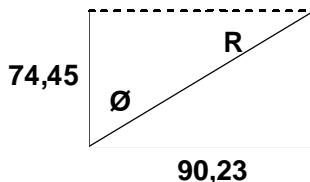
$= \sqrt{5542,8 + 8141,45}$

$= \sqrt{13684,25}$

= 116,98 N

$Tan\,Ø = \dfrac{90,23}{74,45}$

= 1,2119

Ø = 50,47°

R = 116,98 N N 50,47°O
East

(18)

6.5   **Causes of industrial illness.**

- Deafness - noise.
- Dermatitis (skin disease) - irritating materials and allergies.
- Tuberculosis - insufficient ventilation.
- Blindness - insufficient safety precautions.
- Heat exertion - insufficient ventilation.
- Poisoning - insufficient control measures.
- Radiation - insufficient control measures.   Any 3

Bedryfsiektes

- *Doofheid : geraas*
- *Dermatitis (velsiektes): irriterende stowwe en allergieë*
- *Tering: onvoldoende ventilasie*
- *Blindheid : gebrekkige veiligheidsmaatreëls*
- *Hitte-uitputting: gebrekkige ventilasie*
- *Vergiftiging: onvoldoende beheermaatreëls*
- *Bestraling : onvoldoende beheermaatreëls*   *Enige 3*   *(6)*

[50]
300