GAUTENG DEPARTMENT OF EDUCATION

SENIOR CERTIFICATE EXAMINATION

TECHNIKA (MECHANICAL) HG

Possible Answers / Moontlike Antwoorde
Feb / Mar / Maart 2006

QUESTION 1

1.1.1 C_3H_8 Propane (2)

1.1.2 C_5H_{12} Pentane (2)

1.2 Cubic crystal, Pyramid crystal, Calcite crystal (3)

1.3 Body - centered cubic arrangement
Atoms = 9

Cubic face centered - arrangement
Atoms = 14

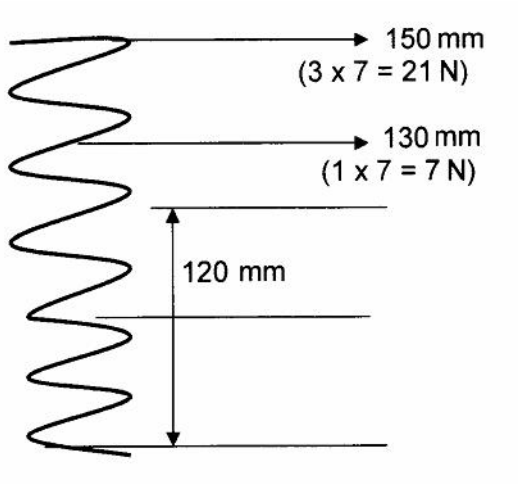
Close packed hexagonal form arrangement
Atoms = 17 (6)

1.4 $W = F \times s$

$W = \frac{21+7}{2} \times 0,2$

$W = 14 \times 0,2$

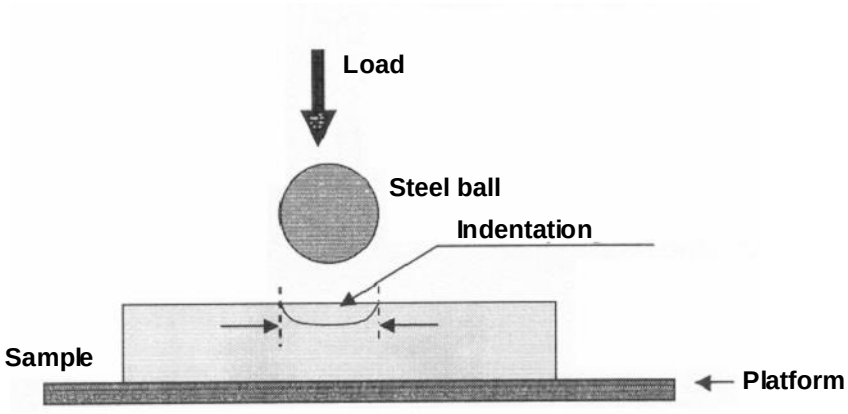
$W = 2,8$ J



(5)

1.5 **Brinell – hardness testing**

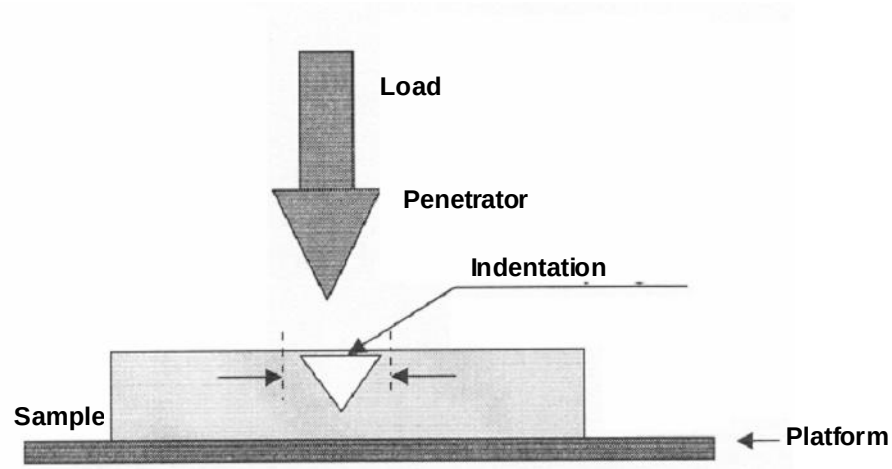
Place work-piece in position.
Choose the correct load for the type of material.
Activate the lever to force the steel ball into the material.
Calculate indentation by means of a microscope. (4)



(4)

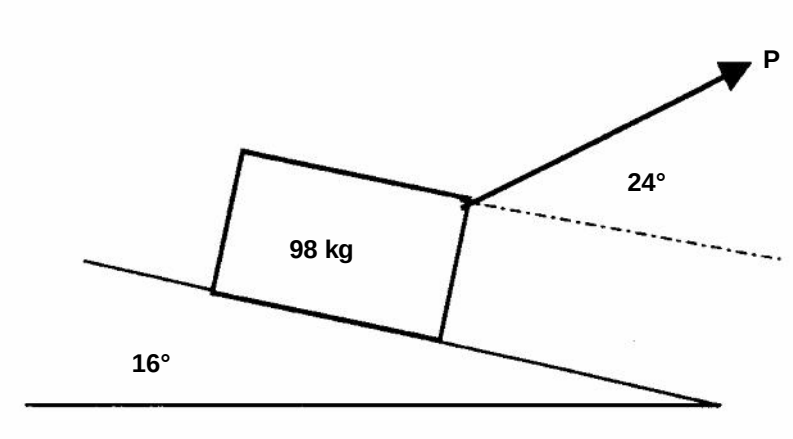
Rockwell-hardness testing

Bring work-piece in contact with penetrator.
Apply primary load.
Set meter reading to zero.
Apply secondary load and take final reading. (4)



(4)

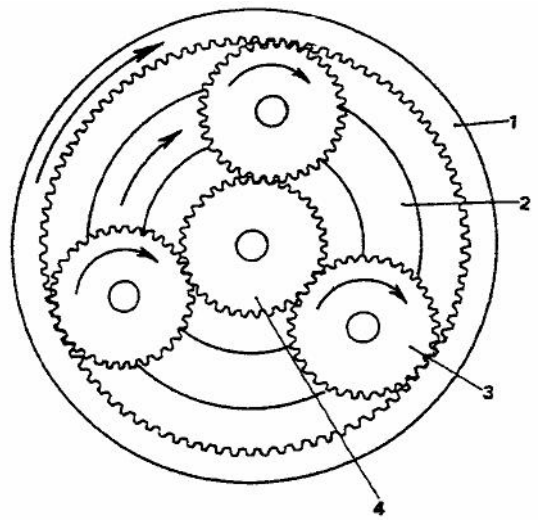
1.6



$F\mu = \mu R$

$P\cos 24°$	=	$F\mu - 980\sin 16°$	
$P\cos 24$	=	$\mu R - 980\sin 16°$	
	=	$0{,}36(980\cos 16° - P\sin 24°) - 980\sin 16°$	
	=	$0{,}36(942{,}036 - P0{,}4067) - 270$	
	=	$339{,}132 - P0{,}1464 - 270$	
$P0{,}914 + P0{,}1464$	=	$339{,}132 - 270$	
$P1{,}0604$	=	$69{,}132$	
P	=	**65,19 N**	(10)

1.7 Single epicyclical gear train



1. internal ring gear; 2. planetary carrier;
3. planet gear; 4. sun gear. (6)

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QUESTION 2

2.1 Stress $= \frac{F}{A}$

$= \frac{7\,000}{\pi\,(12{,}63)^2}$

$= 13{,}975$ MPa (4)

Strain $= \frac{\text{Stress}}{E}$

$= \frac{13{,}975\,\text{MPa}}{2\,000\,\text{MPa}}$

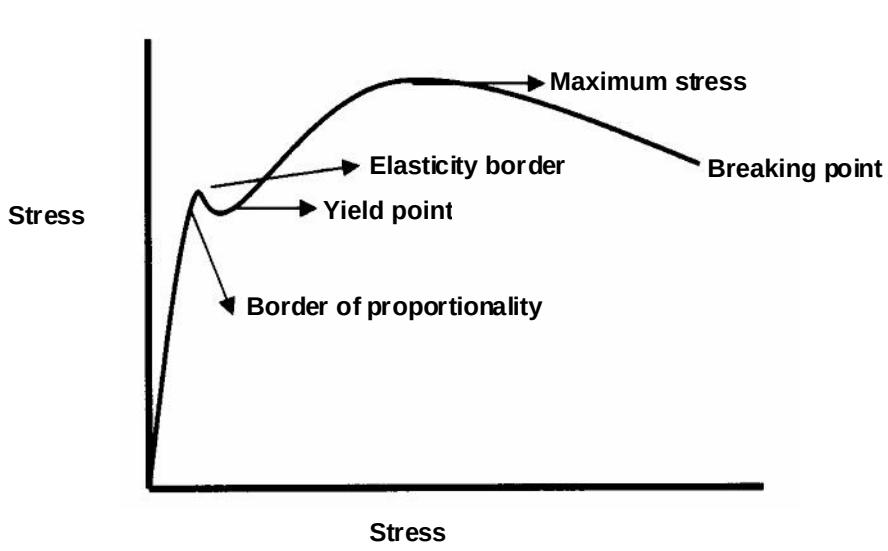
$= 0{,}00698$ (4)

C in length = Strain x original length

= 0,00698 x 25 000

= 174,69 mm (4)

2.2 Stress / strain graph for mild steel



(8)

2.3 RD = 2? NT

RD $= \frac{2 \times \pi \times 3200 \times 715}{60}$

RD = **239,477 kW** (5)

2.4.1 Temperature (1)

2.4.2 Austenite and Ferrite (1)

2.4.3 Pure Austenite (1)

2.4.4 Austenite and Sementite (1)

2.4.5 Ferrite and Perlite (1)

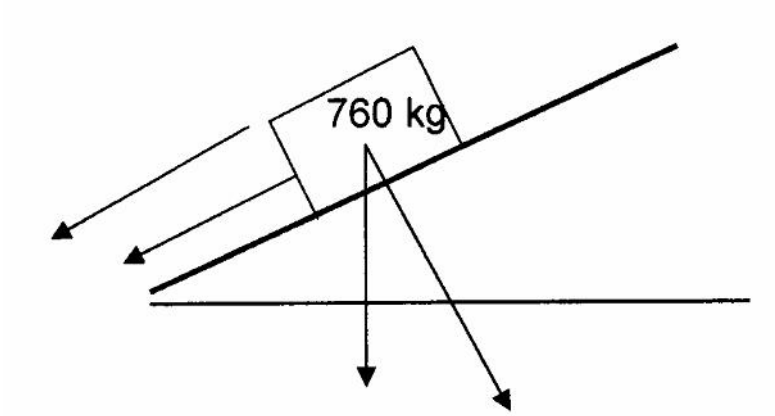
2.4.6 Perlite and Sementite (1)

2.4.7 Pure Perlite (1)

2.4.8 % Cabron (1)

2.4.9 ± 800° C (2)

2.5



2.5.1 $\text{Tan } Ø = \frac{1}{20}$

$= 0,5$

$= 2,86$

$v = u + at$

$25 = 0 + a8$

$a = 3,125 \text{ m/s}^2$

$S = ut + ½at^2$

$= (3,125)(8)^2 \times ½$

$= 100 \text{ m}$

Work = Force x Distance

= 250 x 100

= 25 kJ (5)

2.5.2 Gravitational component parallel to plain

= 760Sin 2,86

= 37,92 N

Work done = 37,92 x 100 m

= 3,792 kJ (3)

2.5.3 Seeing that the object moves upwards the resultant force is equal to:

F = 37,92 + 250 + accelerating force (m.a)
F = 37,92 + 250 + 760 x 3,125
F = 287,92 + 2 375
F = 2 662,92 N (5)

2.6 Velocity is the tempo of displacement. (2)

QUESTION 3

3.1 **IP = PLANn**

$$IP = 978 \times 10^3 \times 0,11 \times \frac{\pi \times 48 \times 48}{1000 \times 1000} \times \frac{3600 \times 6}{60 \times 2}$$

IP = 978 x 10^3 x 0,11 x 0,0072345 x 30 x 6

IP = 140,09 kW (7)

3.1.2 **Work done for one stroke.**

W = PLA

$$W = 978 \times 10^3 \times 0,11 \times \frac{\pi \times 48 \times 48}{1000 \times 1000}$$

W = 778,29 Joule (3)

3.1.3 Brake Power

RD = 2pN T

Where T = FR

T = 165 x 1,2

= 198 Nm

$$BP = 2 \times \pi \times \frac{3600}{60} \times 198$$

BP = 74,606 kW (4)

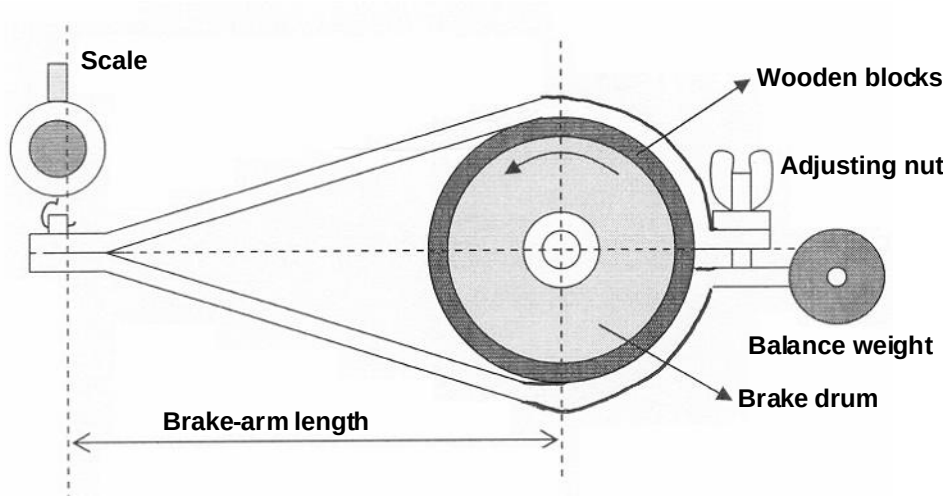
3.1.4 Mechanical efficiency

$$\text{Efficiency} = \frac{RD}{AD} \times 100$$

$$= \frac{74,606}{140,09} \times 100$$

$$= 53,26\ \%$$ (3)

3.2 The Prony-brake



(8)

3.3 **X-ray testing**

Is used to check for internal defects. An x-ray is a ray of energy which can be sent through most materials and record an image permanently on film or to be observe from a distance on a television screen. (4)

3.4.1 $P = (T_1 - T_2)pDn$ $\frac{T_1}{T_2} = 2,5$

$12\ 000 = (2,5T_2 - T_2)p(0,4)(3\ 200)$ Dws $T_1 = 2,5T_2$

$12\ 000 = 1,5T_2(p)(0,4)(53,33)$

$12\ 000 = 100,53T_2$

$\frac{12\ 000}{100,53} = T_2$

$119,36\ N = T_2$

$T_1 = 2,5T2$

$T_1 = 2,5\ (119,36)$

$T_1 = 298,42\ N$ (10)

3.4.2 $V = p\,Dn$
$V = p\ (0,4)(53,33)$
$V = 67$ m/s (3)

3.5 AC_1

Lower critical point. Steel with a low carbon con tent has a short res t period. Althoug h the sa me amount of heat is added , the tempe ratur e does not r ise according during the rest period. Head is used by the stee l for structure change. (5)

AC_3

Higher cr itical po int, granular structure at its sma llest, fully Austen ite. (3)
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QUESTION 4

4.1 Ergonomics

Ergonomics is the sys tematical study of the produc tivity of the worker in relation to his / her working environmen t. (4)

The purpose is to reduc e stress and tiredness of the worker, caused by the wrong man-machine ratio, in turn leading to low mor ale, errors of judge ment, and below average production. (4)

4.2 The service of a social worker can be incorporated for the welfare of an employee and his family. The work of the soc ial worker is to identify person al problems and to ad vise and he lp an emp loyee and his family. (2)

4.3 Must be well trained and intelligent
Must have initiative
Must have sound judgement
Must always be fair
Must maintain healthy human relations (4)

4.4 Facilities provided for personnel, such as rest-rooms toilets, lockers, change-rooms, kitchens, cafeteria, etc. should be adequate and in a clean, hygienic condition. (4)

4.5 1 Radian = 57,3°

There are 2p radians in 1 revolution

IE 2p rad = 360°

$$1\,\text{rad} = \frac{360}{2\pi}$$

1 rad = 57,3° (3)

4.6.1 $180\ \text{rpm} = \frac{2\pi 180}{60}$ $2\,340\ \text{rpm} = \frac{2\pi\, 2\,340}{60}$

= 18,84 rad/s = 245,04 rad/s

$$a = \frac{? - ?}{t}$$

$$= \frac{245,04 - 18,84}{8}$$

$= 28,275\ \text{rad/s}^2$ (4)

4.6.2 $T = mk^2a$

$= 72 \times 0,3302 \times 28,275$

$= 221,69\ \text{Nm}$ (3)

4.6.3 $I = mk^2$

$= 72 \times 0,330^2$

$= 7,84\ \text{kg.m}^2$ (4)

4.6.4 $Ek = \frac{1}{2}mk^2?$

$= \frac{1}{2} \times 72 \times 0,33^2 \times 245,04^2$

= 235,398 kJ (5)

4.7 $$\text{Sin}\frac{f}{2} = \frac{\frac{R-r}{M-n}}{2} + r - R$$

Where $R = \frac{1{,}01 \times 6}{2}$ $r = \frac{0{,}5 \times 6}{2}$

$= 3{,}03$ $= 1{,}5$

$$\frac{M-n}{2} = \left(\frac{R-r}{\text{Sin}\,\phi}\right) - r + R$$

$$= \frac{3{,}03 - 1{,}5}{\text{Sin } 35{,}1^\circ} - 1{,}5 + 3{,}03$$

$$= \frac{1{,}53}{0{,}575} - 1{,}5 + 3{,}03$$

$$= 2{,}661 - 1{,}5 + 3{,}03$$

M - n = 2 (4,191)

= 8,38 mm (10)

4.8 For the 26H7-g6 fit

	Hole	Shaft
High	26 + 0,021 = 26,043 mm	26 – 0,007 = 25,993
Low	26 + 0 = 26,00 mm	26 – 0,02 = 26,980 mm

(4)

Type of fit: Clearance fit (2)

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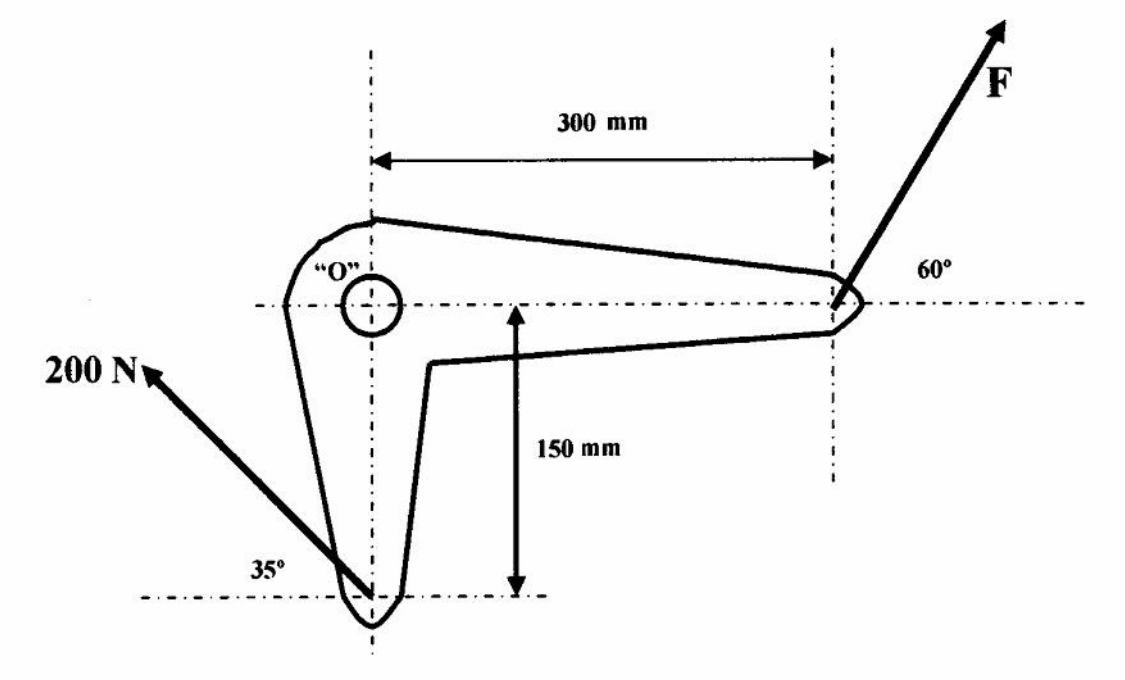
QUESTION 5

5.1



Take moments about "A"

?LH M = ?RH M

(FSin60° x 300) = (200Cos35° x 150)

F259.98 = 24 574,56

$$F = \frac{24574,56}{259,98}$$

F = 94,53 N

Set the sum of the VC = 0

Y + 200Sin35° + 94,53Sin60° = 0

Y + 114,715 + 81,865 = 0

Y = 196,58 N

Set the sum of the HC = 0

X – 200Sin35° + 94,53Cos60° = 0

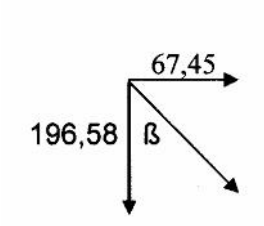
X – 114,715 + 47,265 = 0

X = 67,45 N

$= \sqrt{196,58^2 + 67,45^2}$

$R = \sqrt{38643,696 + 4549,5}$

$R = 207,83\,N$



$\text{Tan } \beta = \frac{67,45}{196,58}$

$\beta = 18,94°$ (16)

5.2.1 $\text{Indexing} = \frac{40}{A} = \frac{40}{140} = \frac{4}{14}\ \frac{(x2)}{x2}$ = 8 holes on a 28 hole circle (2)

5.2.2 $\text{Change gears: } \frac{\text{Driver}}{\text{Driven}} = \frac{(A - N) \times 40}{A}$

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

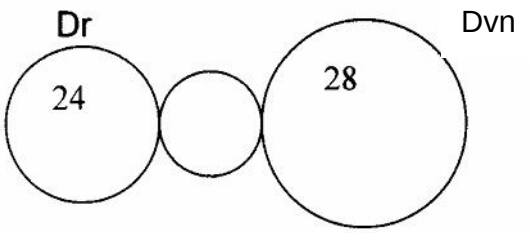
$= \frac{3 \times 4}{14}$

$= \frac{12 \times 2}{14 \times 2}$

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

5.2.3 Positive rotation (2)

5.2.4



(4)

5.3.1 **Potential energy**

Potential energy is the energy a body possesses because of gravitation and the relative position of the body to a specific reference plane. (3)

5.3.2 **Kinetic energy**

The energy that a body possesses due to its motion is called kinetic energy. (3)

5.4 $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$T_2 = \frac{T_1 \text{ x } P_2 \text{ x } V_2}{P \text{ x } V}$

$T_2 = \frac{293 \text{ x } 750\,000 \text{ x } 2{,}1}{138\,000 \text{ x } 3{,}6}$

= 928,89 K

Final temperature t = K – 273

= 928,89 – 273

= 655,89° C (5)

5.5 **Boyle's law:**

The volume of a given mass of gas is inversely proportional to the Pressure on it, if the temperature remains constant. (4)

5.6 **Pascal's law:**

The Pascal is the pressure that arises when a force of 1N is applied Over, and perpendicular to, an area of $1m^2$ (4)

5.7 **Termodynamics** involves working with the relationship between heat and work. (2)

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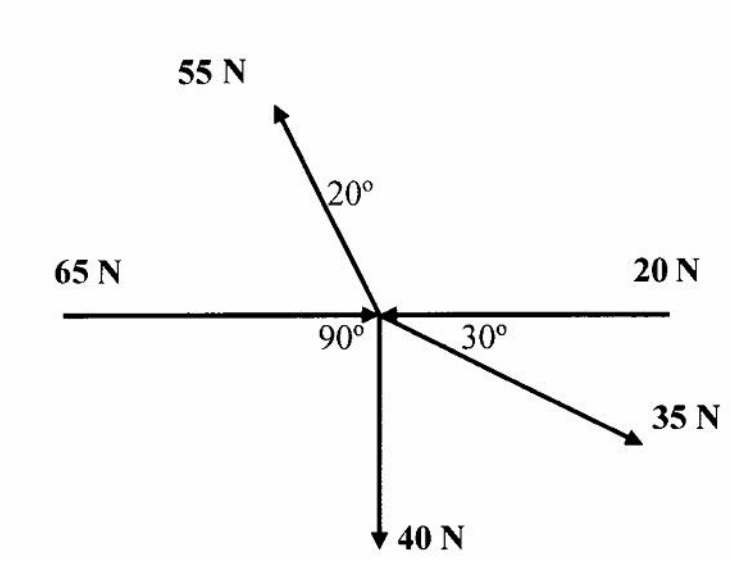
6.1



Sum of the VK

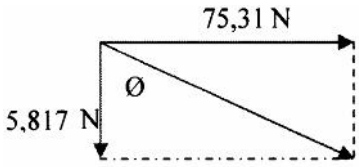
VK = 55Sin70 – 40 – 35Sin30
= 51,683 – 40 – 17,5
= 5,817 N ↓

Sum of the HC

HC = 35Cos 30 + 65 – 20
= 30,31 + 65 – 20
= 95,31 – 20
= 75,31 N →

$R = \sqrt{(5,817)^2 + (75,31)^2}$

$R = \sqrt{33,837 + 5671,5961}$



$\text{Tan}Ø = \frac{75,31}{5,871}$

= 12,985

R = 75,53 N South 85,6° East

Ø = 85,6°

E = 75,53N NORTH 85°6 WEST (18)

6.2 **Equilibrium force**:

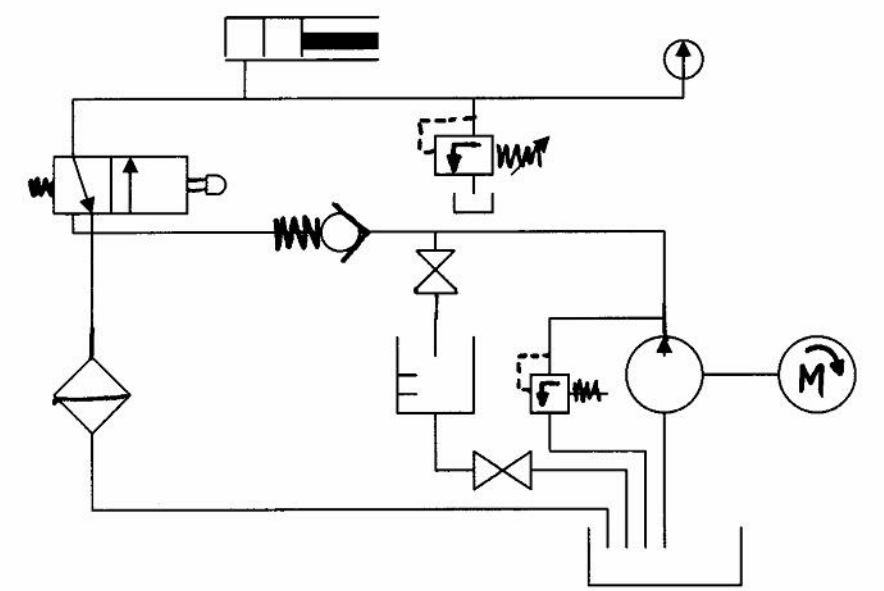
It is that single force that will balance a system of forces. It is the same size as the resultant force but work in the opposite direction. (4)

6.3 **Pressure Relief valve:**

Control pressure in the system. (1)

6.4 Reservoir, oil gear pump, electric motor. (3)

6.5



(12)

6.6 **Disengaging**

- The thrust bearing is moved by the operator in the direction of the Fly wheel.
- The disengaging moving around the support point pulls the pressure plate against the tension of the springs and away from the flywheel.
- The clutch plate is released and is no longer in contact with the flywheel or the pressure plate.
- The lead bearing comes into operation and enables the flywheel to rotate around the stationary output axle (clutch plate). (8)

6.7 There must

1. be a force applied.
2. be movement.
3. be resistance. (3)

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TOTAL: 300