education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY

EXEMPLAR 2008

MARKS: **200**

TIME: **3 hours**

This question paper consists of 17 pages and a 3-page formula sheet.

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INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the spaces provided on the ANSWER BOOK.
2. Answer ALL the questions.
3. Read ALL the questions carefully.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Write neatly and legibly.
6. Show ALL the calculations and units. Round off answers to TWO decimal places.
7. Candidates may use non-programmable scientific calculators, as well as drawing/mathematical instruments.
8. The value of the gravitational force should be taken as 10 m/s^2.
9. Use the criteria below to assist you in managing your time.

QUESTION	ASSESSMENT STANDARDS	CONTENTS COVERED	MARKS	TIME
1	1 – 9	Multiple-choice questions	20	18 minutes
2	6 and 8	Forces and systems and control	50	45 minutes
3	2	Tools and equipment	20	18 minutes
4	3	Materials	20	18 minutes
5	1, 4 and 5	Safety, terminology and joining methods	50	45 minutes
6	7 and 9	Maintenance and turbines	40	36 minutes
TOTAL			**200**	**180 minutes**

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

(**LEARNING OUTCOME 3: ASSESSMENT STANDARDS 1 – 9)**

Various possible options are provided as answers to the following questions. Choose the answer and write only the letter (A – D) next to the question number (1.1 – 1.20) in the ANSWER BOOK.

1.1 Which ONE of the following descriptions is a basic rule for the safe handling of oxy-acetylene equipment?

A Keep heat, flames and sparks away from combustibles
B Open the gas cylinder valves quickly
C Allow for oxygen and acetylene leaks
D Strike an arc on oxygen bottles

1.2 What safety measure is applicable to shears and the guillotine in terms of the Occupational Health and Safety Act?

A Do not use gloves when handling cut plates.
B Guards could be removed when cutting material.
C Use a fixed guard which prevents hands or fingers reaching through.
D Use the guillotine bed as an anvil.

1.3 Which of the following equipment is used to test the hardness of a material?

A Torsion tester
B Brinell tester
C Tensile tester
D Spring tester

1.4 Identify the advanced engineering equipment shown below.

A Gas analyser
B Spring tester
C Dial indicator
D Multimeter

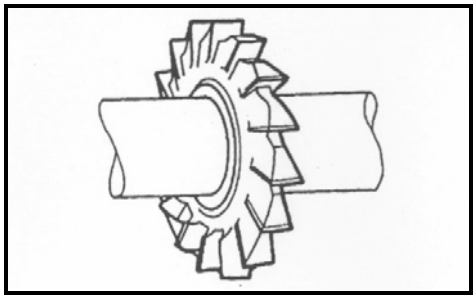
1.5 Bronze is an alloy of copper and …

A tin.
B zinc.
C aluminium.
D lead.

1.6 What is the common use of white metal?

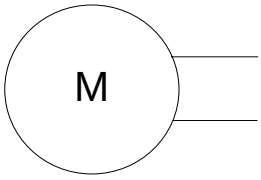
A Forgings
B Tubes
C Bearings
D Valves

1.7 Identify the type of milling cutter shown in the picture below.



A T-slot cutter
B Side and face cutter
C Nicked helical cutter
D Slotting cutter

1.8 What does the following symbol indicate relating to hydraulic and pneumatic systems?



A Valve
B Pump
C Filter
D Motor

1.9 What is the definition for *porosity*?

A Holes which occur in the weld metal due to trapped gases
B Small pinholes which occur in the weld metal
C A cavity which occurs at the end of the weld
D A groove melted into the base metal adjacent to the edge of the weld

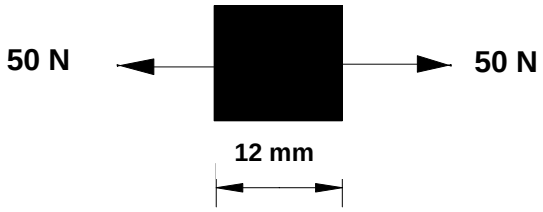
1.10 What is understood by the term *nick-break test*?

A Breaking the weld open for examination of internal defects
B Breaking the weld open for examination of external defects
C Checking of shear fracture of a weld
D Checking high frequency sound effect of a weld

1.11 X-ray testing is used to detect different defects such as cracking and corrosion where cracks show up …

A as echo blips on the screen.
B on the plasma arc.
C on the weld.
D on the film.

1.12 What will be the stress in a 12 mm square bar, if a load of 50 N is applied on the square bar?

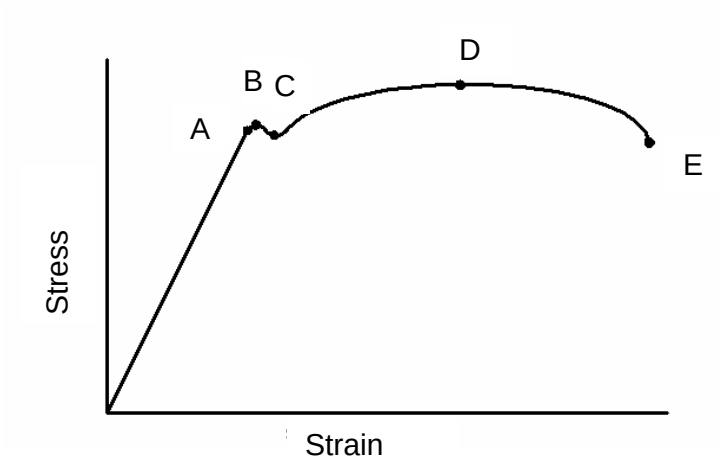


A 3,4722 MPa
B 2,4722 MPa
C 347,22 kPa
D 247,12 kPa

1.13 What is understood by *Young's modulus of elasticity*?

A Strain is directly proportional to the stress it causes
B Stress value required to produce unit strain in a tensile specimen of a particular material
C Maximum allowable stress in a material to prevent it from yielding
D The number of times with which the maximum stress is decreased to obtain a safe stress

1.14 What does point D denote in the following stress/strain diagram?



A Maximum stress
B Limit of proportionality
C Yield point
D Elastic limit

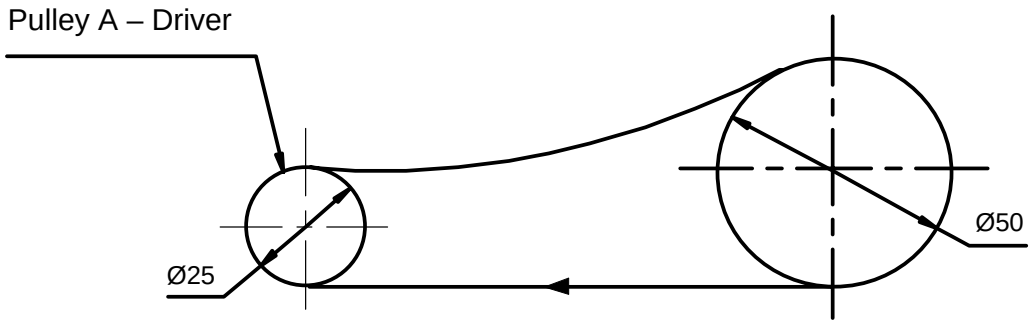
1.15 What does the acronym SAE denote in terms of lubricating oil?

A Society of American Engineers
B South African Engineers
C Society of Automotive Engineers
D South American Engineers

1.16 What is understood by the term *viscosity*?

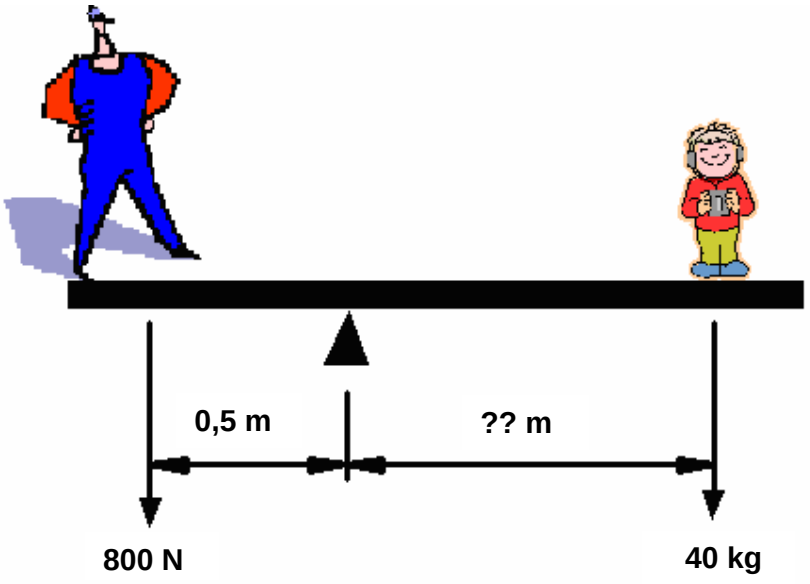
A Measure of the resistance of a fluid to deform under linear stress
B Measure of the resistance of a fluid to deform under tensile stress
C Measure of the resistance of a fluid to deform under compressive stress
D Measure of the resistance of a fluid to deform under shear stress

1.17 Calculate the velocity ratio of the pulley system shown below if pulley A is the driver.



A 1:1
B 3:1
C 1:2
D 2:1

1.18 At what distance should the small boy stand to balance the see-saw shown below?



A 1,0 m
B 0,6 m
C 1,5 m
D 0,5 m (1)

1.19 How are turbochargers different from superchargers?

A Turbochargers are driven by gears
B Turbochargers are driven by pulleys
C Turbochargers are driven by exhaust gases
D Turbochargers are driven by inlet gases (1)

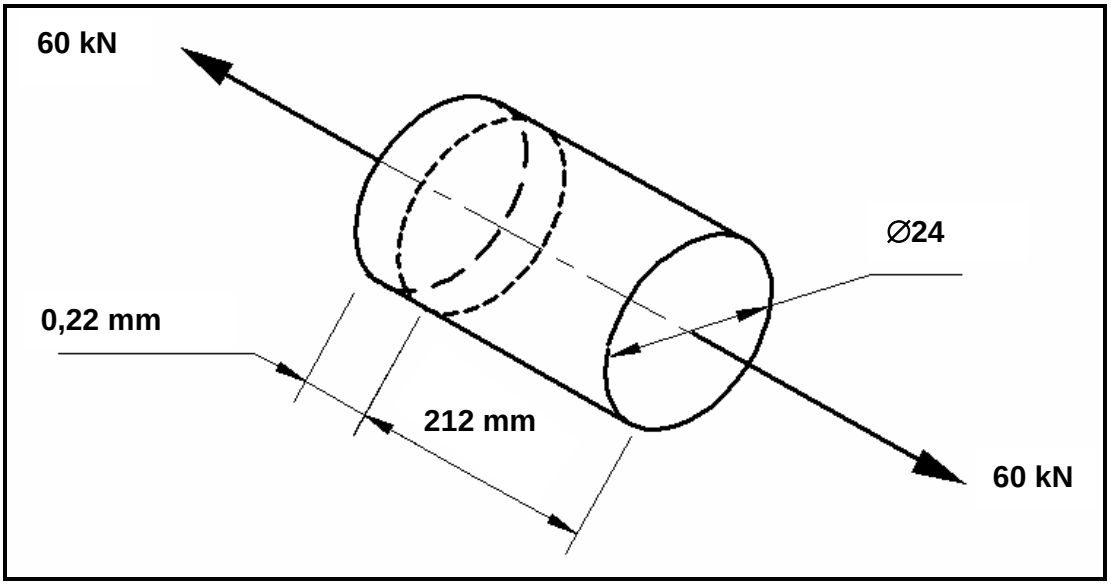
1.20 What is understood by the term *scavenging* in internal combustion engines?

A Removal of air from the outlet valve
B Removal of burnt gases and filling the combustion chamber with air
C Removal of fuel from the inlet valve
D Removal of air and fuel mixture **(20 x 1) [20]**

QUESTION 2: FORCES AND SYSTEMS AND CONTROL

(LEARNING OUTCOME 3: ASSESSMENT STANDARDS 6 AND 8)

2.1 The Mechanical Technology learners are performing a tensile test using a mild steel bar with a diameter of 24 mm. When a load of 60 kN is applied to the steel bar it causes an extension of 0,22 mm. The original length is 212 mm.



Calculate the following:

2.1.1 Stress in the mild steel bar (3)

2.1.2 Strain in the mild steel bar (2)

2.1.3 Young's modulus (2)

2.1.4 If the same test is carried out on a softer material, how will this affect Young's modulus? (2)

2.2 You are an engineer in a local design company. A client has asked you to recommend the belt lengths for both the open- and crossed-belt drive systems. The following specifications were given:

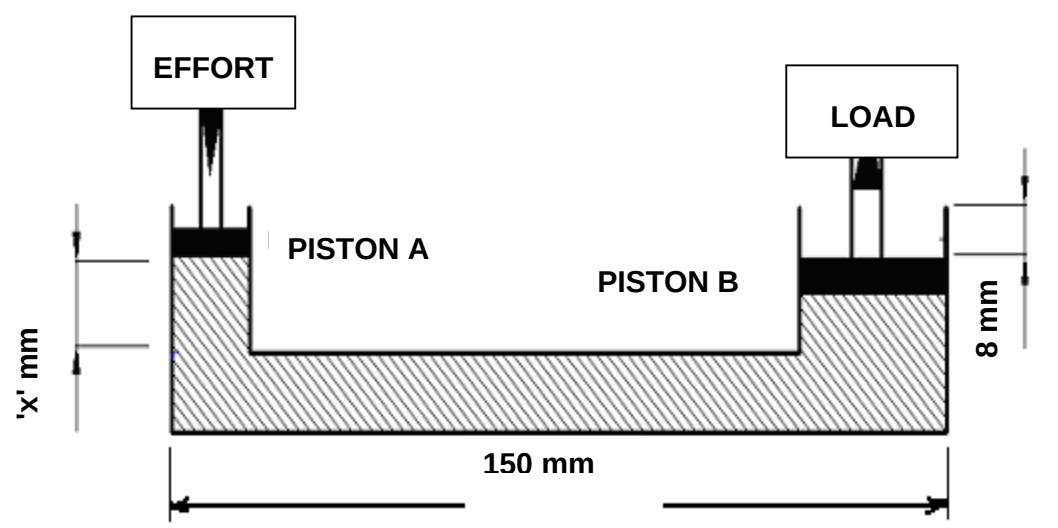
- The diameter of the driving pulley is 600 mm.
- The diameter of the driven pulley is 300 mm.
- The centre distance between the pulleys is 850 mm.

2.2.1 Calculate the length of the belt on an open drive in millimetres. (3)

2.2.2 Which of the drive systems would you recommend to the client if maximum power transmission is required? Motivate your answer. (3)

2.3 Ms Realeboga needs an electric motor rated at 6 kW at a speed of 1 500 r/min to pump water into a tank on her farm. An electric motor that generates a torque of 40 Nm at 1 500 r/min is available. Does this motor satisfy the requirements of Ms Realeboga? Motivate your answer. (3)

2.4 In the figure below the load applied on piston B induces a force of 800 N on this piston in a hydraulic press. Piston B moves 8 mm upwards. The area of piston A is 0,015 m^2 and that of piston B is 0,16 m^2.



Calculate the following:

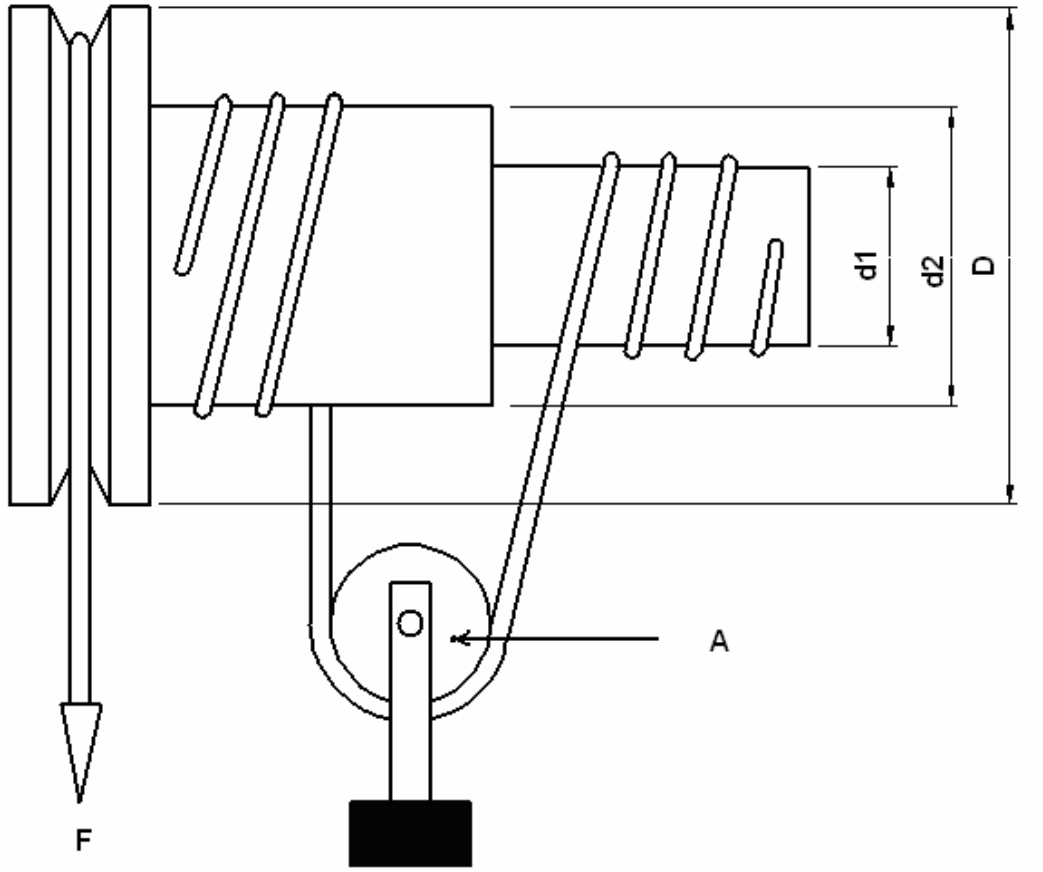
2.4.1 The force applied in piston A (4)

2.4.2 The distance 'x' in millimetres, that piston A moves downwards (5)

2.4.3 The effect it will have on the distance 'x' if the length of the hydraulic press is doubled. Motivate your answer. (2)

2.4.4 Give another example where this type of lay-out is used. (2)

2.5 The mechanical advantage of a differential wheel and axle lifting machine used in an overhead crane at the local steel merchant is 4. A load of 1,4 kN is lifted when an effort 'F' is applied. The diameters of the pulleys are 210 mm (D), 160 mm (d2) and 130 mm (d1) respectively.



Calculate the following:

2.5.1 The magnitude of the applied effort 'F' (2)

2.5.2 The velocity ratio (2)

2.5.3 The percentage with which the efficiency of the system will increase if pulley A is replaced by another pulley twice its size (2)

2.6 A plough broke down on a farm. A three-start square thread with a crest diameter of 55 mm and a pitch of 10 mm is to be cut on a shaft on a centre lathe to repair the depth control on the plough. Assume a clearance angle for the cutting tool of 3°.

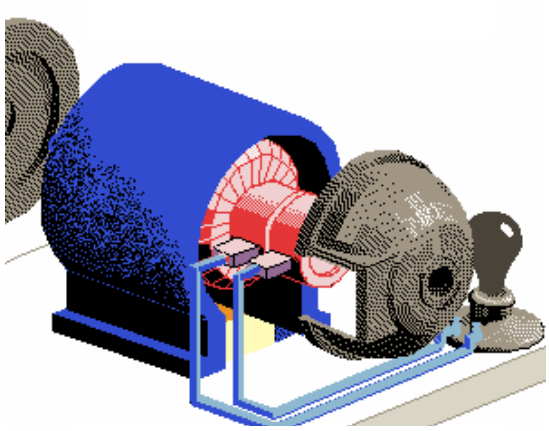
Calculate the following:

2.6.1 The helix angle of the thread (4)

2.6.2 The leading angle of the cutting tool (2)

2.6.3 The farmer wanted more travel for the same number of turns to plough deeper. Advise the farmer on what to do. Motivate your answer. (4)

2.7 A single-plate friction clutch with an effective diameter of 0,15 m is used to transmit 41,23 kW of power at 3 000 r/min in an engine/generator combination. The clutch plate has a friction material on both sides. The friction coefficient is 0,35. The total applied force on the pressure plate is 2,5 kN. During a test it was discovered that the engine only delivered 20 kW.



Alternating current generator

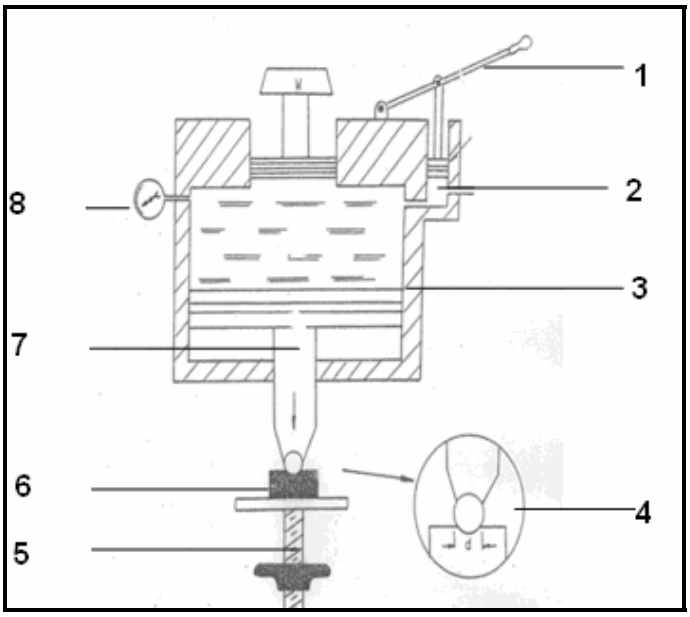
List the possible causes for the difference in power output. (3)

[50]

QUESTION 3: TOOLS AND EQUIPMENT

(LEARNING OUTCOME 3: ASSESSMENT STANDARD 2)

3.1 The drawing below shows a Brinell hardness tester. Label the parts numbered 1 to 8.



(4)

3.2 Formulate a test procedure to test and set the air/fuel ratio of an internal combustion engine. (7)

3.3 Distinguish between the similarities and differences of a pressure tester and a cylinder leakage tester (for internal combustion engines). (6)

3.4 Name the THREE operating rules in the use of multimeters. (3)

[20]

QUESTION 4: MATERIALS

(LEARNING OUTCOME 3: ASSESSMENT STANDARD 3)

Non-ferrous alloys and polymers are used broadly in industry today for manufacturing various components due to their composition and properties.

4.1 In table format compare and contrast the following non-ferrous metals with reference to composition, properties and uses:

4.1.1 Phosphor bronze (3)

4.1.2 Duralumin (3)

4.1.3 Solder (3)

4.1.4 Silver solder (3)

4.2 Teflon is used in engineering because of specific properties it possesses. List THREE such properties. (3)

4.3 List THREE properties of nylon as a material. (3)

4.4 What does the abbreviation PVC stand for? (2)

[20]

QUESTION 5: SAFETY, TERMINOLOGY AND JOINING METHODS

(LEARNING OUTCOME 3: ASSESSMENT STANDARDS 1, 4 AND 5)

5.1 Mary is step turning a shaft on a lathe and the high-speed steel cutting tool becomes blunt. In order to rectify this, the tool needs to be sharpened on a pedestal grinding machine. What advice would you give Mary before she works with the grinding machine? (4)

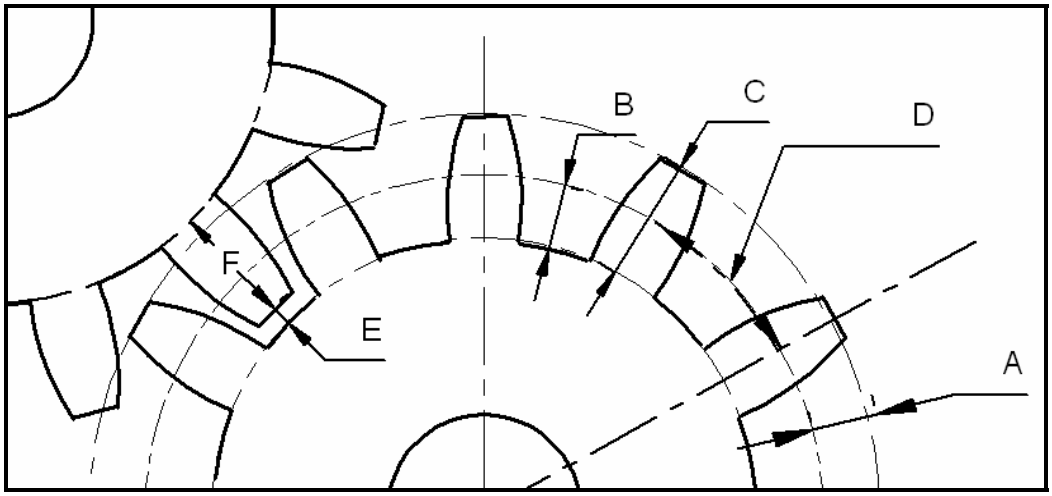
5.2 Sipho is cutting a solid 25 mm diameter mild steel bar using a power saw. The operating environment of the machine is well maintained. Which safety measures does Sipho need to take when using the power saw? (4)

5.3 Why must oil and grease never be used on or near the oxy-acetylene regulator? (2)

5.4 Name FOUR methods of indexing when using the milling machine. (4)

5.5 A gear with 117 teeth must be machined on a milling machine. Calculate the required indexing and change gears for cutting the gear. Use the Cincinnati dividing head and the given change gears. (Use N = 120.) (10)

5.6 The drawing below shows the cross-sectional view of a spur gear. Label the terms A to F.



(6)

5.7 When arc welding mild steel there are certain possible welding defects that may occur during the welding process. State TWO possible causes and ONE correction method for each of the following welding defects:

5.7.1 Incomplete penetration (3)

5.7.2 Undercutting (3)

5.7.3 Slag inclusion (3)

5.8 Compare the nick-break test with the nick-bend test. (4)

5.9 Mr Thabo is a non-destructive testing inspector for Kelly NDT inspectorate. He was requested to perform a dye penetrate test on the weld. Formulate the test procedure. (7)

[50]

QUESTION 6: MAINTENANCE AND TURBINES

(LEARNING OUTCOME 3: ASSESSMENT STANDARDS 7 AND 9)

6.1 Study the photograph with caption below and explain the term *viscosity* of oil.

Alaska Oil Pipeline

The Alaskan oil pipeline brings crude oil from the Prudhoe Bay oil field on the North Slope to tanker ships docked in southern Alaska. Traversing 1,270 km (789 mi) of Alaskan wilderness, the pipeline carries up to 2 million barrels of oil per day from the Arctic coast to the Gulf of Alaska.

Photo Researchers, Inc./Pat and Tom Leeson

Microsoft ® Encarta ® Premium Suite 2005. © 1993-2004 Microsoft Corporation. All rights reserved.

(2)

6.2 Bearing failure in machines makes maintenance very expensive. State FOUR reasons for the failure of bearings. (4)

6.3 Explain the importance of oil seals in an internal combustion engine. (2)

6.4 Name the type of oil and its grading that is used in the following operating systems:

6.4.1 Internal combustion engine (2)

6.4.2 Manual transmission (2)

6.4.3 Automatic transmission (2)

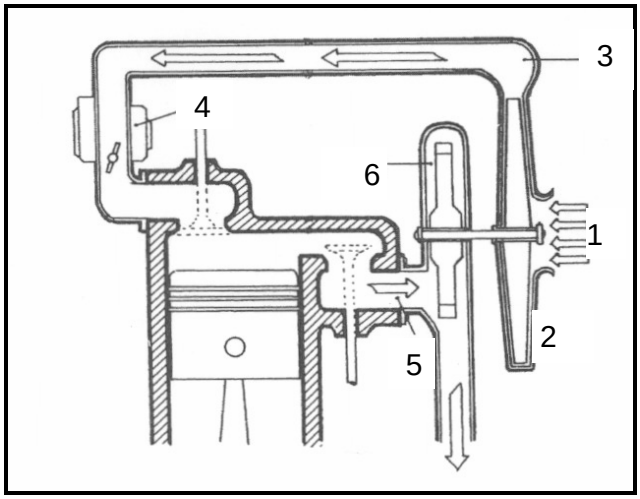
6.5 You are required to turn a shaft in a lathe. Your educator reminded you to use cutting fluid. State TWO reasons for using cutting fluid. (2)

6.6 You are busy changing oil in your father's car. Your sister asks you why you have to change it. How will you respond to your sister's question? (2)

6.7 Explain the procedure of changing the oil of your dad's car and replacing it with new oil. (7)

6.8 State the purpose and function of a Roots blower as used in internal combustion engines. (3)

6.9 The diagram below shows a sectional view of an engine equipped with a blower.

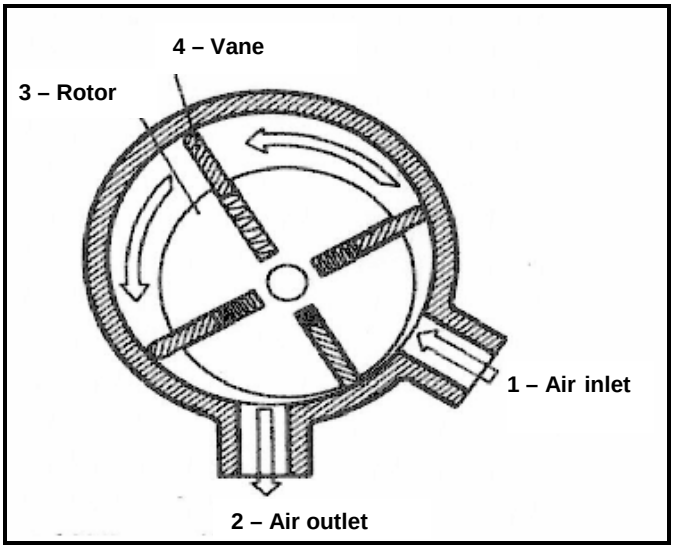


6.9.1 Name the type of blower attached to the engine. (1)

6.9.2 Label the parts numbered 1 to 6. (6)

6.9.3 State TWO advantages of this type of blower. (2)

6.10 The drawing below shows a vane-type blower. Explain in point form the operation of this blower.



(3)
[40]

TOTAL: 200

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MECHANICAL TECHNOLOGY – GRADE 12 FORMULA SHEET

1. BELT DRIVES

1.1 $Belt\ speed = \frac{\pi DN}{60}$

1.2 $Speed\ ratio = \frac{Diameter\ of\ driven\ pulley}{Diameter\ of\ driver\ pulley}$

1.3 *Corrected power per belt = (basic power per belt x speed ratio power increment) + correction factor*

1.4 $Number\ of\ belts = \frac{Design\ power}{Corrected\ power}$

1.5 *Design power = Power (electric motor) x service factor*

1.6 *Belt length (flat) = [(D + d) x 1,57] + (2 x centre distance)*

1.7 $Open\text{–}belt\ length = \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4c} + 2c$

1.8 $Crossed\text{–}belt\ length = \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4c} + 2c$

1.9 $Power\ (P) = \frac{2\pi NT}{60}$

2. FRICTION CLUTCHES

2.1 $Torque\ (T) = \mu WnR$

μ = *coefficient of friction*
W = *total force*
π = *number of friction surfaces*
R = *effective radius*

2.2 $Power\ (P) = \frac{2\pi\pi N}{60}$

3. STRESS AND STRAIN

3.1 $Stress = \frac{Force}{Area}\ or\ \ (\sigma = \frac{F}{A})$

3.2 $Strain\ (\varepsilon) = \frac{Change\ in\ length\ (\Delta L)}{Original\ length\ (L)}$

3.3 $Young's\ modulus\ (E) = \frac{Stress}{Strain}\ \ of\ \ (\frac{\sigma}{\varepsilon})$

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4. HYDRAULICS

4.1 $Pressure\ (P) = \frac{Force\ (F)}{Area\ (A)}$

4.2 $Volume = Cross\text{–}sectional\ area\ x\ Stroke\ length\ (l\ or\ s)$

5. WHEEL AND AXLE

5.1 $Velocity\ ratio\ (VR) = \frac{Effort\ distance}{Load\ distance} = \frac{2D}{d_1 - d_2}$

5.2 $Mechanical\ advantage\ (MA) = \frac{Load\ (W)}{Effort\ (F)}$

5.3 $Mechanical\ efficiency\ (\eta_{mech}) = \frac{MA}{VR}\ x\ 100\%$

6. LEVERS

6.1 $Mechanical\ advantage\ (MA) = \frac{Load\ (W)}{Effort\ (F)}$

6.2 *Input movement (IM) = Effort x Distance moved by effort*

6.3 *Output movement (OM) = Load x Distance moved by load*

6.4 $Velocity\ ratio\ (VR) = \frac{Input\ movement}{Output\ movement}$

7. GEAR DRIVES

7.1 $Power\ (P) = \frac{2\pi NT}{60}$

7.2 $Gear\ ratio = \frac{Number\ of\ teeth\ on\ driven\ gear}{Number\ of\ teeth\ on\ driving\ gear}$

7.3 *Torque (T) = Force x Radius*

7.4 *Torque transmitted = Gear ratio x Input torque*

7.5 $Module\ (m) = \frac{Pitch\text{–}circle\ diameter\ (PCD)}{Number\ of\ teeth\ (T)}$

7.6 $Pitch\text{–}circle\ diameter\ (PCD) = \frac{Circular\ pitch\ (CP)\ x\ Number\ of\ teeth\ (T)}{\pi}$

7.7 *Outside diameter (OD) = PCD + 2module*

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7.8 $Addendum\ (a) = Module\ (m)$

7.9 $Dedendum\ (b) = 1{,}25\ m$

7.10 $Cutting\ depth\ (h) = 2{,}25\ m$

7.11 $Clearance\ (c) = 0{,}25\ m$

7.12 $Cicular\ pitch\ (CP) = m\ x\ \pi$

8. SCREW THREADS

8.1 $Pitch\ diameter = Outside\ diameter - \frac{1}{2}\ pitch$

8.2 $Pitch\ circumference = \pi\ x\ Pitch\ diameter$

8.3 $Lead = Pitch\ x\ Number\ of\ starts$

8.4 $Heliks\ angle: \tan\theta = \frac{Lead}{Pitch\ circumference}$

8.5 $Leading\ angle = 90° - (Helix\ angle\ - Clearance\ angle)$

8.6 $Following/Trailing\ angle = 90° + (Helix\ angle - Clearance\ angle)$

9. CINCINNATI DIVIDING HEAD TABLE FOR THE MILLING MACHINE

Side 1	*24*	*25*	*28*	*30*	*34*	*37*	*38*	*39*	*41*	*42*	*43*
Side 2	*46*	*47*	*49*	*51*	*53*	*54*	*57*	*58*	*59*	*62*	*66*

Standard change gears with the following number of teeth are used:										
24 x 2	*28*	*32*	*40*	*44*	*48*	*56*	*64*	*72*	*86*	*100*

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