



Province of the
EASTERN CAPE
EDUCATION

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

SEPTEMBER 2010

MECHANICAL TECHNOLOGY

MARKS: 200

TIME: 3 hours



This question paper consists of 13 pages + a formula sheet and an answer sheet.

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers correctly, according to the numbering system used in this question paper.
4. Write neatly and legibly.
5. Show ALL the calculations and units.
6. Candidates are allowed to use non-programmable, scientific calculators and drawing/mathematical instruments.
7. The value of the gravitational acceleration constant should be taken as 10m/s^2 .
8. Use the criteria below to assist you in managing your time:

Question	Assessment Standards	Content covered	Marks	Time
1	1 – 9	Multiple-choice questions	20	18 minutes
2	6 and 8	Forces 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	Manufacturing Process Construction Joining Methods Safety Terminology	50	45 minutes
6	7 and 9	Turbines and Maintenance	40	36 minutes
		TOTAL	200	180 minutes

SECTION A**QUESTION 1: MULTIPLE-CHOICE QUESTIONS****(LEARNING OUTCOME 3: ASSESSMENT STANDARDS 1 – 9)**

Various options are provided as possible 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.

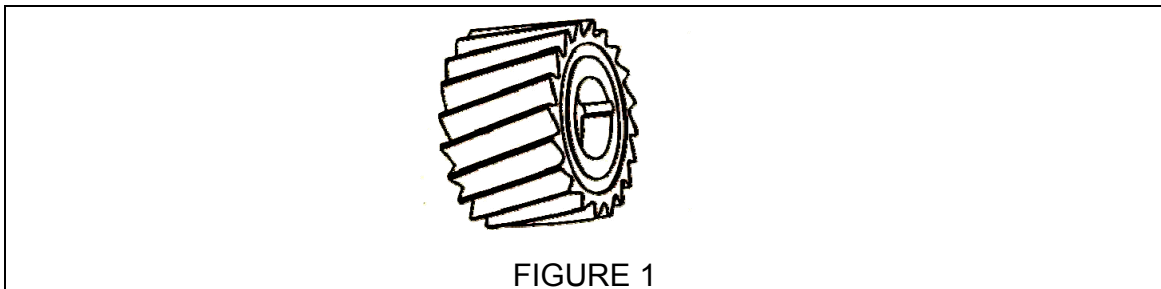
- 1.1 You have read a lot of hydraulic and mechanical pullers. What is the main use of pullers?
- A To remove gears, bearings or hubs from shafts.
 - B To hold components in place while work is being done.
 - C They are used to tighten and loosen screws.
 - D They are used to insert a piston into a cylinder by squeezing the rings closed. (1)
- 1.2 Which ONE of the following properties is typical of fibre glass?
- A Ductile.
 - B High strength to weight ratio.
 - C It rusts when in contact with water.
 - D Bad conductors of heat and electricity (1)
- 1.3 Give the constituents of brass as a non-ferrous metal.
- A Copper and Zinc
 - B Copper and Tin
 - C Tin and Aluminium
 - D Aluminium and Copper (1)
- 1.4 Why can low carbon steel not be hardened?
- A The carbon content or percentage is low.
 - B The carbon content or percentage is high.
 - C It has a low melting point. (1)
 - D It cannot be exposed to heat.
- 1.5 Choose among the listed a safety check to be carried out before operating a pneumatic tool.
- A All workers working near the machine must be in a possession of a valid first-aid certificate.
 - B Ensure that all air lines are in good condition and that there are no cuts, splits or crafting.
 - C Disconnect all power supply.
 - D Ensure that hose fittings, pipes and unions are loose. (1)

1.6 Select the carbon content for mild steel from the following:

- A 0,1% and 0,3%
- B 0,3% and 0,8%
- C 0,8% and 1,4%
- D 0,8% and 0,55%

(1)

1.7 Identify the cutting tool shown in the drawing below that is used on a milling machine when heavy cuts or large amounts of materials are to be removed.



- A Side and face cutter
- B Plain helical slab milling cutter
- C Dove-tail cutters
- D Nicked helical milling cutter

(1)

1.8 A thermostat is fitted to cooling systems to ...

- A provide a variable current in the temperature gauge circuit.
- B control circulation of coolant to help the system to warm up quickly.
- C act as a control to switch the cooling fan on and off.
- D operate the compressor on an air conditioning system.

(1)

1.9 The purchase of the water pump in a cooling system is to ...

- A pressurise the cooling system.
- B circulate the coolant.
- C eliminate the need for a radiator.
- D reduce heat loss.

(1)

1.10 A heat ray that emanates from the arc and welding flame is usually referred to as:

- A Infra-red and ultra-violet
- B Ultra-blue
- C Polarity
- D Sunrays

(1)

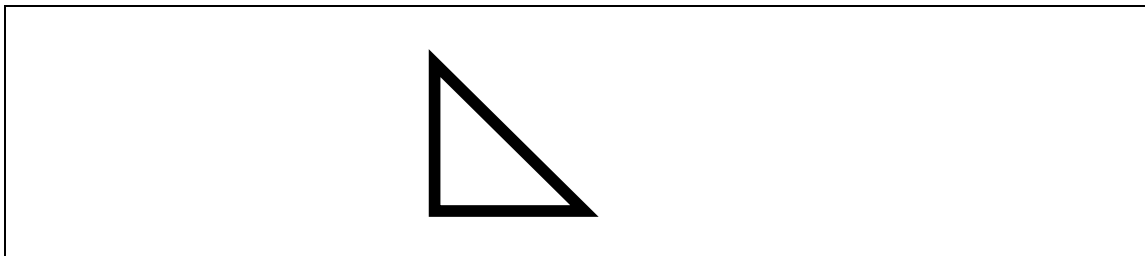
- 1.11 Select the definition of joint regarding welding joints from the following options.
- A The contour prepared on the edge of a member for welding.
 - B A joint between the edges of two or more parallel or nearly parallel members.
 - C The length of weld throughout which the correctly proportioned cross-section exists.
 - D A joint between two overlapping members. (1)
- 1.12 The advantage of a spur gear over a helical gear is that it is ...
- A easy to manufacture.
 - B one tooth is in contact at a time.
 - C repairable if damaged.
 - D smooth in operation at high speed. (1)
- 1.13 The function of the brake is to bring the vehicle to a stop safely within a safe distance. Indicate amongst the list below ONE part of the brake layout.
- A Master Cylinder
 - B Brake fluid cover
 - C Cup protector
 - D Boot
- 1.14 The driving efficiency of a belt is influenced by certain factors of which "belt slip" is one. One of the reasons for belt slip being:
- A Poor properties used during manufacturing of the belt
 - B Abrasive dirt on the belt
 - C Grease on belt
 - D Insufficient lubricating (1)
- 1.15 Turbocharged engines ...
- A are less efficient than naturally operated ones because power is absorbed in driving the turbocharger.
 - B are more efficient than naturally operated engines because they make use of energy in the exhaust gas that would otherwise be wasted.
 - C are normally diesel engines.
 - D have high fuel consumption. (1)
- 1.16 Colour coding is significant to combustible and non-combustible gas cylinders. How will you identify among other gas cylinders, acetylene?
- A Painted black
 - B Painted grey
 - C Painted maroon
 - D Painted green (1)

1.17 Welding in a confined space for example in a booth requires the welder to guard against the inhaling of the fumes from the weld. Which one of these mentioned personal protective clothing will serve the purpose?

- A Plain goggles
- B Safety boots
- C An overall
- D Respirator

(1)

1.18 Indicate the type of weld symbol shown below.



- A Vee
- B Bevel
- C Fillet
- D Groove

(1)

1.19 During welding, the base metal is melted to form a WELD POOL. The metal underneath the weld pool the does not melt is still affected by the heat from the arc and weld metal. This part of the joint is called the:

- A The penetration
- B Partial penetration
- C Heat Affected Zone
- D Weld pool

(1)

1.20 Which element when added to steel increase the steal hardness, resistance to corrosion and resistance to oxidation.

- A Manganese
- B Tungsten
- C Nickel
- D Chromium

(1)

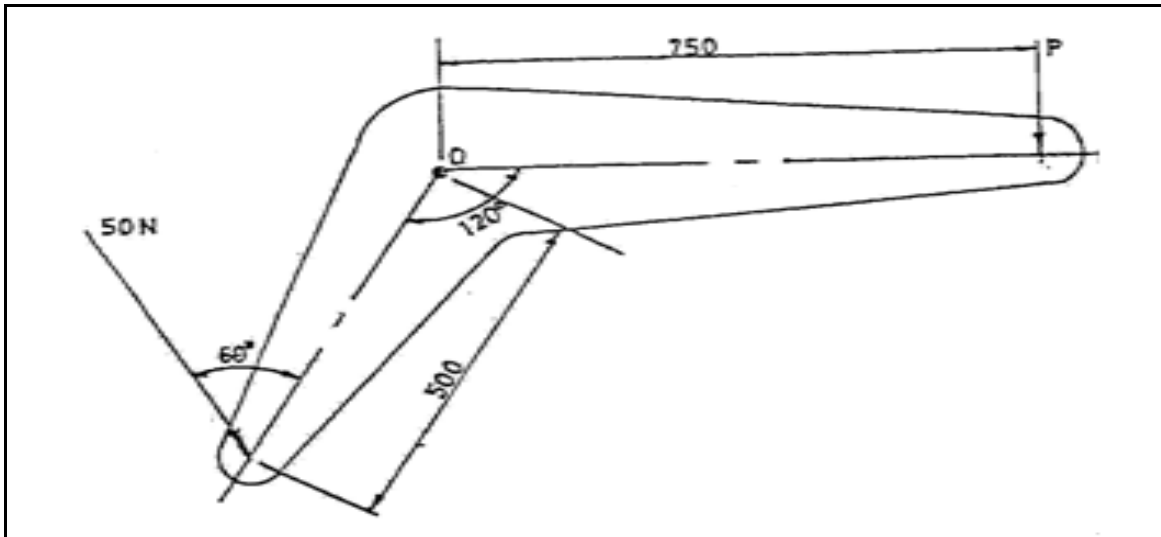
[20]

SECTION B

QUESTION 2

(LEARNING OUTCOME 3: ASSESSMENT STANDARDS 6 AND 8)

- 2.1 The diagram below is a crank arm. Determine the magnitude of the Force P which is necessary to keep the crank arm in equilibrium.



(6)

- 2.2 A differential wheel and axle lifting machine has a mechanical advantage of 4. A load of 1.4 kN is lifted when an effort is applied. The diameters of the pulleys are 210 mm, 160 mm and 140 mm respectively. Calculate:

2.2.1 Effort applied

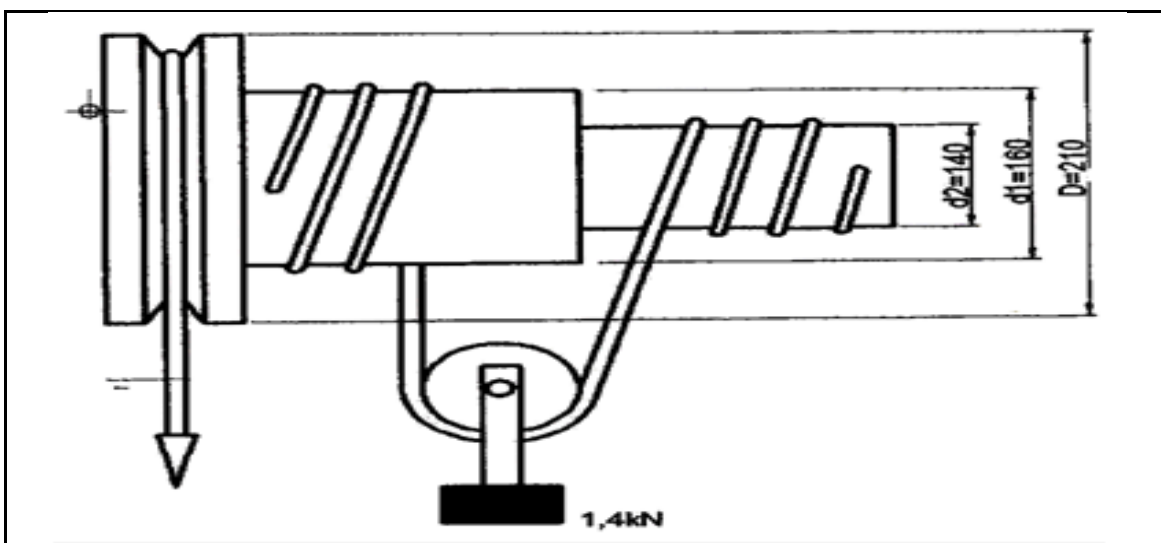
(3)

2.2.2 Velocity ratio

(4)

2.2.3 Mechanical efficiency

(2)



(9)

- 2.3 In a gear train two shafts are joined using single helical gears. The centre distance between the gears is 675 mm. The gears have a velocity ratio 4:1, and a module of 6.

Calculate the following:

- | | | |
|-------|------------------------------------|-----|
| 2.3.1 | Circular pitch of the teeth | (2) |
| 2.3.2 | The number of teeth for both gears | (5) |
| 2.3.3 | Tooth height or cutting depth | (2) |
| 2.3.4 | Addendum | (1) |
| 2.3.5 | Dedendum | (1) |
| 2.3.6 | Clearance | (1) |

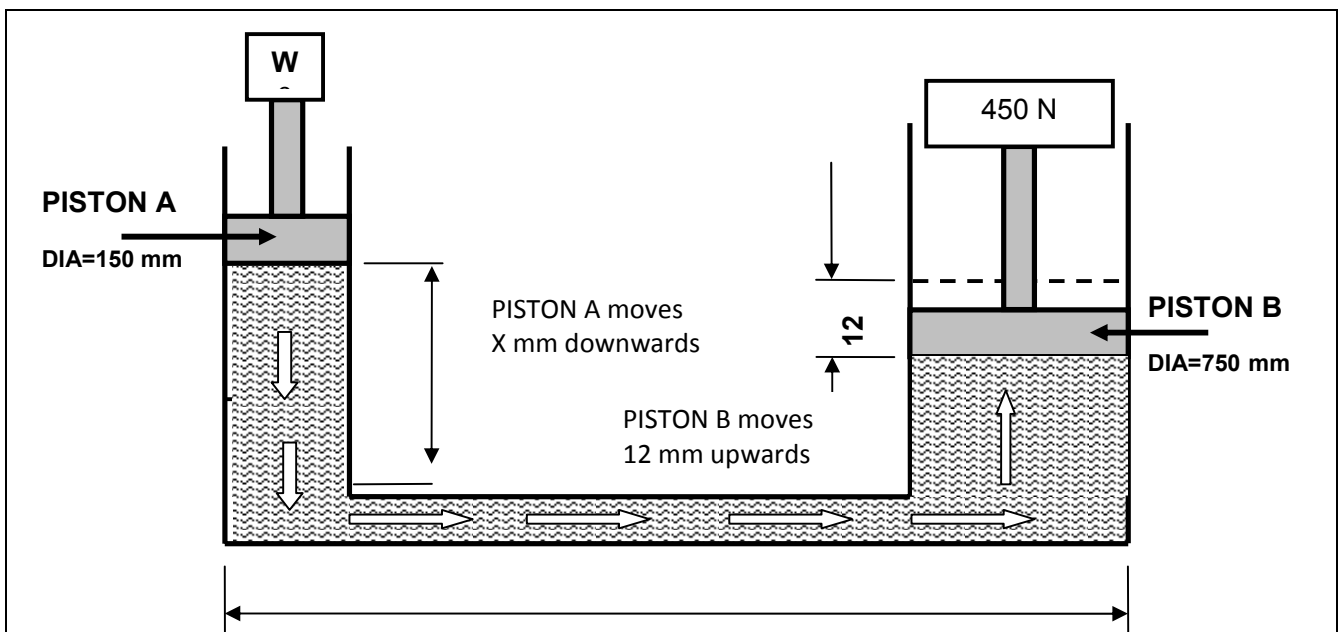
- 2.4 You're an engineer in a local design company. A client has asked you to recommend the belt lengths for both the open and crossed belt drive systems. The following specifications were given:

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

- 2.4.1 Calculate the length of the belt on an open drive system in mm. (3)

- 2.4.2 Which of the drive systems would you recommend to the client if maximum power transmission is required? Motivate your answer. (2)

- 2.5 The drawing below illustrates a hydraulic press. A force applied on piston "A" induces a force of 450 N on piston "B" of the hydraulic press. This causes piston "B" to move 12 mm upwards. The diameter of piston "A" is 150 mm and piston "B" is 750 mm.



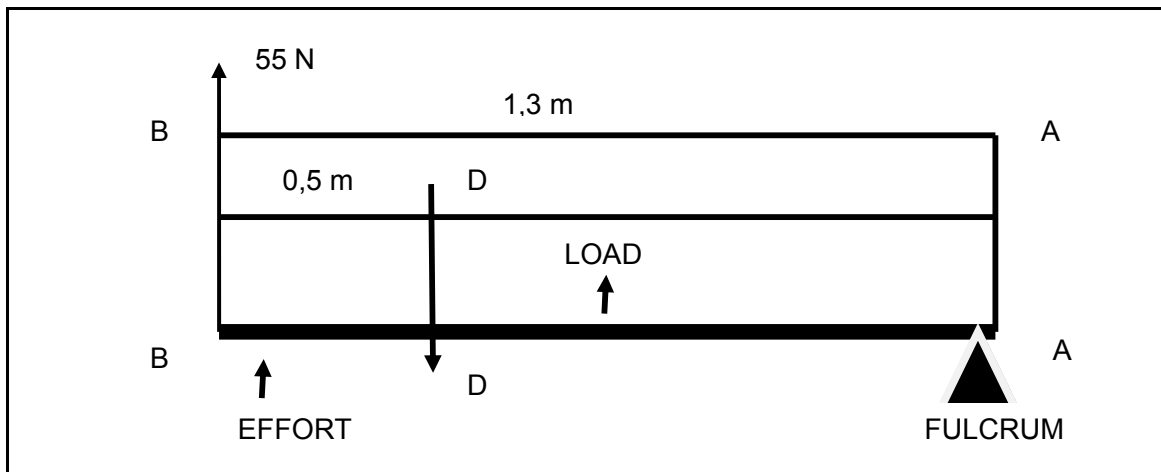
Calculate the following:

2.5.1 Force applied on piston "A" (4)

2.5.2 Volume displaced by piston "B" (2)

2.5.3 The distance the piston "A" moves downwards in mm. (3)

2.6 A beam is pivoted at point A. An effort of 55 N is applied at point B. The distance from point A to point B is 1,3 m. A load at point D is placed 0,5 m from point B.



CALCULATE:

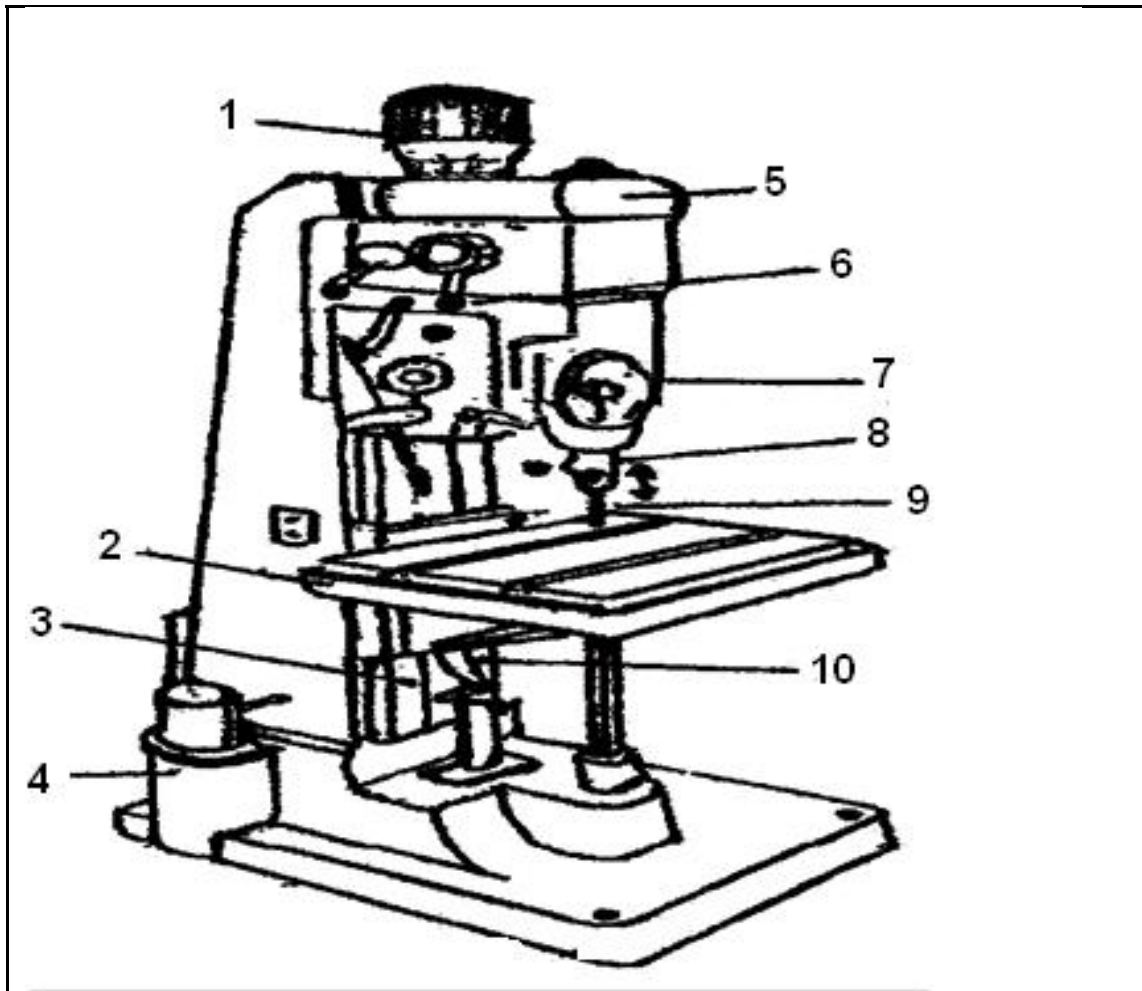
2.6.1 Load at point D (6)

2.6.2 Is the system according to your calculations in equilibrium? (3)

[50]

QUESTION 3: TOOLS AND EQUIPMENT**(LEARNING OUTCOME 3: ASSESSMENT STANDARD 2)**

3.1 Identify the equipment shown below.



(2)

3.2 Name the parts of the equipment shown from 1 to 10.

(10)

3.3 How does a pillar drilling machine differ from a pedestal drilling machine?

(2)

3.4 Name SIX safety precautions you would take before, during and after drilling operation on a pedestal drill.

(6)

[20]

QUESTION 4: MATERIALS**(LEARNING OUTCOME 3: ASSESSMENT STANDARD 3)**

Heat treatment of metals is the heating and cooling of metals (under controlled conditions) in their solid state so as to change their properties.

4.1 Identify FIVE basic heat-treatment processes. (5)

4.2 The hardness that can be achieved from a specific heat-treatment depends on what factors? (4)

4.3 The table below indicate the hardness of various tools as related to their code colours, approximate temperature, and the article for which it is suitable. COLUMN A is the colours. Write only the letter (A – E) next to the question number (4.3.1 – 4.3.8) in your answer book, for example 4.3.1 – E.

No.	COLUMN A (Colour of oxide)		COLUMN B (Tools)
4.3.1	Pale blue	A	Tools that requires maximum hardness, lathe centres, cutting tools for lathe and shapers
4.3.2	Purple	B	Shear blades, hammer faces, rivets set, wood and cold chisels
4.3.3	Straw	C	Punches, taps and dies and hacksaw blades
4.3.4	Gold	D	Axes, wood cutting tools and striking faces of tools
4.3.5	Very light yellow	E	Springs

(5)

4.4 Mention TWO properties each of the following materials:

4.4.1 Low carbon steel

4.4.2 Medium carbon steel

4.4.3 High carbon steel

(6)
[20]

QUESTION 5: SAFETY, TERMINOLOGY AND JOINING METHODS**(LEARNING OUTCOME 3: ASSESSMENT STANDARDS 1, 4 AND 5)**

5.1 Define the term *arc welding*. (2)

5.2 Complete the table below :
Identify TWO causes and TWO remedies each of welding defects.

DESCRIPTIVE	CAUSES	REMEDY
1. Poor appearance		
2. Undercutting		
3. Excessive spatter		
4. Brittle weld		

(16)

5.3 Briefly explain with the aid of a sketch the nick break test. (2)

5.4 Explain what the following terms mean:

5.4.1 Root gap (2)

5.4.2 Weld symbol (2)

5.4.3 Peening (2)

5.5 Mention TWO safety precautions when working with gear drives. (2)

5.6 Discuss factors to be considered for the correct installation of chain drives under the following headings:

5.6.1 Shaft alignment (4)

5.6.2 Sprocket alignment (4)

5.6.3 Correct mounting of the chain (4)

5.7 Mention THREE factors that determine the correct meshing of gear teeth. (3 x 2) (6)

5.8 Mention TWO advantages of gear drive in comparison with a belt and chain drive. (2)

5.9 Mention TWO disadvantages of gear drive in comparison with a belt and chain drive. (2)

[50]

QUESTION 6**(LEARNING OUTCOME 3: ASSESSMENT STANDARDS 7 AND 9)**

6.1 The lubricating system is mostly pressurised and consists of the following main components.

6.1.1 Oil pump

6.1.2 Relief valve

6.1.3 Sump

6.1.4 Oil galleries

6.1.5 Oil pressure indicator

6.1.6 Oil filter

Indicate the functions of each component.

(6 x 2) (12)

6.2 Comparison of air- and water-cooled systems:

6.2.1 List FIVE advantages of air cooling system engines.

(5 x 1) (5)

6.2.2 List FIVE advantages and FIVE disadvantages of water cooling system engines.

(5 x 1) (5)

6.3 What are the TWO important factors which determine the choice of oil?

(2)

6.4 6.4.1 Describe the operating principle of a steam turbine.

(5)

6.4.2 Explain the operation of a roots blower.

(5)

6.4.3 What is the purpose and function of the supercharger?

(6)

[40]

TOTAL: 200

FORMULA SHEET**1. BELT DRIVES**

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

$$1.2 \quad \text{Belt speed} = \frac{\pi (D+t) \times N}{60} \quad (t = \text{belt thickness})$$

$$1.3 \quad \text{Belt mass} = \text{Area} \times \text{length} \times \text{density}$$

$$1.4 \quad \text{Speed ratio} = \frac{\text{Diameter of driven pulley}}{\text{Diameter of drive pulley}}$$

$$1.5 \quad N_1 D_1 = N_2 D_2$$

$$1.6 \quad \text{Open-belt length} = \frac{\pi (D+d)}{2} + \frac{(D-d)^2}{4c} + 2c$$

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

$$1.8 \quad \text{Power (P)} = \frac{2\pi NT}{60}$$

$$1.9 \quad \text{Ratio of tight side to slack side} = \frac{T_1}{T_2}$$

$$1.10 \quad \text{Power} = \frac{(T_1 - T_2) \pi DN}{60} \quad \text{where } T_1 = \text{force in the tight side}$$

$$1.11 \quad \text{Width} = \frac{T_1}{\text{Permissible tensile force}}$$

2. FRICTION CLUTCHES

$$2.1 \quad \text{Torque (T)} = \mu W n R$$

μ = coefficient of friction

W = total force

n = number of friction surfaces

R = effective radius

$$2.2 \quad \text{Power (P)} = \frac{2\pi NT}{60}$$

3. GEAR DRIVES

$$3.1 \quad \text{Power (P)} = \frac{2\pi NT}{60}$$

$$3.2 \quad \text{Gear ratio} = \frac{\text{Product of the number of teeth on driven gears}}{\text{Product of the number of teeth on driving gears}}$$

$$3.3 \quad \frac{N_{\text{input}}}{N_{\text{output}}} = \frac{\text{Product of the number of teeth on driven gears}}{\text{Product of the number of teeth on driving gears}}$$

$$3.4 \quad \text{Torque} = \text{force} \times \text{radius}$$

$$3.5 \quad \text{Torque transmitted} = \text{gear ratio} \times \text{input torque}$$

$$3.6 \quad \text{Module (m)} = \frac{\text{Pitch-circle diameter (PCD)}}{\text{Number of teeth (T)}}$$

$$3.7 \quad N_1 T_1 = N_2 T_2$$

$$3.8 \quad \text{Pitch-circle diameter (PCD)} = \frac{\text{circular pitch (CP)} \times \text{number of teeth (T)}}{\pi}$$

$$3.9 \quad \text{Outside diameter (OD)} = \text{PCD} + 2 \text{ module}$$

$$3.10 \quad \text{Addendum (a)} = \text{module (m)}$$

$$3.11 \quad \text{Dedendum (b)} = 1, 157 m \quad \text{OR} \quad \text{Dedendum (b)} = 1, 25 m$$

$$3.12 \quad \text{Cutting depth (h)} = 2, 15 \quad \text{OR} \quad \text{Cutting depth (h)} = 2, 157 m$$

$$3.13 \quad \text{Clearance (c)} = 0, 157 m \quad \text{OR} \quad \text{Clearance (c)} = 0, 157 m$$

$$3.14 \quad \text{Circular pitch (CP)} = m \times \pi$$

4. CALCULATIONS OF FEED

$$4.1 \quad \text{Feed (f)} = f_1 \times T \times N$$

Where: f = feed in millimetres per minute
 f_1 = feed per tooth in millimetres
 T = number of teeth on cutter
 N = number of revolutions of cutter per minute

$$4.2 \quad \text{Cutting speed (V)} = \pi \times D \times N$$

Where; D = diameter of the cutter in meters

