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Western Cape Education Department
Directorate: Curriculum FET

MECHANICAL TECHNOLOGY

FITTING AND MACHINING

REVISION BOOKLET

2023 TERM 3

Grade 12

This revision program is designed to assist you in revising the critical content and skills covered during the 3rd term. The purpose is to prepare you to understand the key concepts and to provide you with an opportunity to establish the required standard and the application of the knowledge necessary to succeed in the NCS examination.

The revision program covers the following topics:

Structure of question paper

Generic Topics

- Safety
- Materials

Specific Topics

- Systems and Control

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Structure of question paper

QUESTION	CONTENT	MARKS	TIME in minutes
	GENERICIS		
1	Multiple-choice Questions	6	6
2	Safety	10	10
3	Materials	14	14
	SPECIFICS		
4	Multiple-choice Questions	14	10
5	Terminology (Lathe and Milling Machine)	18	20
6	Terminology (Indexing)	28	25
7	Tools and Equipment	13	10
8	Forces	33	33
9	Maintenance	18	12
10	Joining Methods	18	12
11	Systems and Control (Drive Systems)	28	28
TOTAL		200	180

Instructions and Information

1. Read ALL the questions carefully.
2. Answer ALL the questions.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Start EACH question on a NEW page.
5. Show ALL calculations and units. Round off final answers to TWO decimal places.
6. Candidates may use non-programmable scientific calculators and drawing instruments.
7. The value of gravitational acceleration should be taken as 10 m/s.
8. All dimensions are in millimetres, unless stated otherwise in the question.
9. Write neatly and legibly.
10. A formula sheet is attached at the end of the question paper.

Final examination: At the end of each academic year every learner is required to write a final examination, which is compiled in such a way that it represents the entire theoretical content covered throughout the year. The final examination paper accounts for 50% of the learner's promotion mark and is externally set, marked and moderated.

Formal assessments should cater for a range of cognitive levels and learners' abilities as shown below:

Cognitive Levels	Percentage of Task
Lower order: knowledge	30%
Middle order: comprehension and application	50%
Higher order: analysis, evaluation and synthesis	20%

Below is a table of Bloom's taxonomy indicating the action verbs and also gives you the cognitive level of the learners' ability. Learners need to expect different levels of questioning.

MECHANICAL TECHNOLOGY - BLOOM'S TAXONOMY: GRADE 12		
Low	Knowledge: memorize and recall information: arrange, define, label, list, outline, repeat, order	30%
	Comprehension: (understanding) — interpret information in one's own words: describe, indicate, restate, review, summarize, classify	
Medium	Application: apply knowledge to new situations: apply, calculate, draw, explain, identify, illustrate, prepare, operate, practice, solve, sketch, use	50%
	Analysis: breakdown knowledge into parts and show relationship among parts: analyse, categorize, compare, distinguish, discuss, examine, investigate, and test	
High	Synthesis: bring together parts of knowledge to form a whole; build relationships for new situation: arrange, compose, formulate, organize, plan, assemble, construct	20 %
	Evaluation: make judgments on basis of criteria: appraise, assess, comment on, critically analyse, evaluate, conclude, interrogate, judge, predict, compare, and score	

Grade 12 Revision pack

Term 3

There are currently previous NSC examination question papers and marking guidelines available on line or ask your teacher to give them to you, either electronically or give you a hard copy so that you can familiarise yourself with the layout and work through them.

They are November 2018 up until November 2022.

Multiple-choice Questions (Generic)

QUESTION 1:

Various options are provided as possible answers to the following questions. This question requires you to choose the **one, correct** answer and write only the letter (A–D) next to the question numbers (1.1 to 1.6) in the ANSWER BOOK, e.g. 1.6 D.

Do not leave any one of these questions unanswered. If you are unsure, take an “intelligent guess” of the most likely possible answer.

Examples:

1.1 What is the purpose of the Occupational Health and Safety Act, 1993 (Act 85 of 1993) with regard to HIV/Aids awareness?

- A. The Act on safety states that all employers must make sure that the workplace is safe and that employees are not at risk of becoming infected with HIV at work.**
- B. The Act contains common guidelines on how employers, employees and trade unions should respond to HIV in the workplace.
- C. Employers may not demote or promote an employee based on his/her HIV status.
- D. Employers cannot simply dismiss a person who has HIV. (1)

1.2 Which ONE of the following items of personal protective equipment (PPE) is applicable when arc welding is performed on a work piece?

- A. Hard hat
- B. Welding goggles
- C. Welding helmet**
- D. Face shield (1)

1.3 Who is responsible for the provision of safety equipment in the workplace?

A. Employer

B. Employee

C. Customer

D. Foreman

(1)

1.4 Which ONE of the following properties of solid steel will change if the steel is subjected to a heat treatment process?

A. Length

B. Hardness

C. Size

D. Shape

(1)

1.5 The purpose of normalising steel is to ...

A. harden.

B. temper.

C. harden the core.

D. relieve internal stresses.

(1)

1.6 If a sound test is applied to high-carbon steel, which ONE of the following sounds will help one to identify the metal?

A. Loud and clear sound

B. Dull sound

C. Soft ringing sound

D. Low ringing sound

(1)

[6]

Various options are provided as possible answers to the following questions. This question requires you to choose the **one, correct** answer and write only the letter (A–D) next to the question numbers (4.1 to 4.14) in the ANSWER BOOK, e.g. 4.7 C.

Do not leave any one of these questions unanswered. If you are unsure, take an “intelligent guess” of the most likely possible answer.

This type of questions are the same as those in question 1, but it covers all the **specific topics**.

How to handle these questions:

- They could contain sketches, leave out missing words or even contain simple calculations.
- To correctly answer these questions you need to know the facts.
- Each question is worth one mark so do not stress and take too long to answer the question as you have about 10 minutes to complete this question.
- Carefully read the question and the possible answers, think about it, before making your choice of the correct answer.
- Do not write all the numbers and correct letters down. **Use the template** in the answer book and make a cross in the correct block. This will save some time.

Examples of types of questions to expect

4.1 Which ONE of the following is an advantage of the compound slide set-over method for taper turning on the centre lathe?

- A. Long tapers can be cut.
- B. Only internal tapers can be cut.
- C. Tapers with large angles can be cut.**
- D. Good finishing is obtained.

(1)

4.2 Identify the milling process in FIGURE 4.2 below.

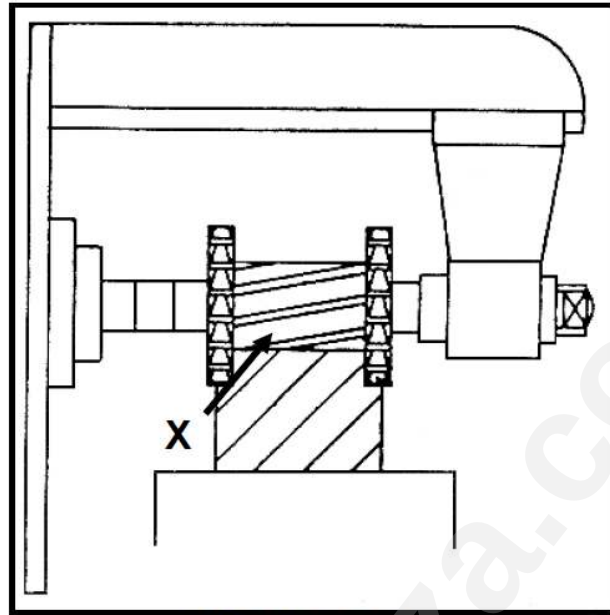


FIGURE 4.2

- A. **Gang milling**
- B. Slab milling
- C. Slot milling
- D. Straddle milling

(1)

4.3 Which indexing process uses change gears to do indexing?

- A. Rapid indexing
- B. Simple indexing
- C. Angular indexing
- D. **Differential indexing**

(1)

4.4 What is meant by the term incremental programming on a three-axis digital read-out system?

The point of reference is taken from ...

- A. **the previous point.**
- B. the zero point.
- C. a common point.
- D. any point.

(1)

In this section, work through the content. The things you need to know are the following:

- How to identify the different engineering materials by the different tests
(Sound, bending, filing, machining and spark tests)

Examiners will always include one of the tests or they will give you the following table and ask you to make a distinction between materials.

Different Type of Tests	Material			
	Cast iron	Cast Steel	Mild steel	HSS
Sound	Very dull sound.	High ringing sound.	Medium metallic sound.	Lower ring sound similar to mild steel.
Bend	Cannot bend. It will snap, break or fracture easily.	It tends to crack as it is brittle.	Bend easily.	It tends to crack as it is brittle.
Filing	It files easily.	Very difficult.	Files easily.	Very difficult.
Machining	Cuts easily, black, crumbly chips.	Hard to cut, cuttings break in sharp chips.	Turns easily curly chips.	Turns difficultly

- Heat treatment processes to enhance the properties of engineering materials.

Learners must be know how to draw the iron –carbon equilibrium diagram and know the labels. This drawing is a favorite question and has been asked frequently.

Types of heat treatment (Hardening, Tempering, Case-hardening, Annealing and Normalising)

Learners must know these types of heat treatment, their purposes and how the process is done. The examiner normally includes one or two of these processes in Question 3.

Examples of types of questions to expect:

Mechanical components

1. State TWO advantages of a belt drive system compared to a chain drive system. (2)
2. State TWO advantages of a gear drive system compared to a belt drive system. (2)
3. The driven pulley of a belt drive system must rotate at a speed of 80 r/min. The driven pulley has a diameter of 240 mm and the driver pulley a diameter of 75 mm.
Calculate the rotation frequency of the driver pulley in r/min. (4)
4. Study FIGURE 4.1 below. The gear box of a motor vehicle is in second gear. The input shaft rotates at 3 000 r/min. The input shaft is equipped with driver gear A with 20 teeth, which mesh with gear B with 35 teeth. The second acceleration gear C on the countershaft has 25 teeth and meshes with the final driven gear D with 30 teeth.

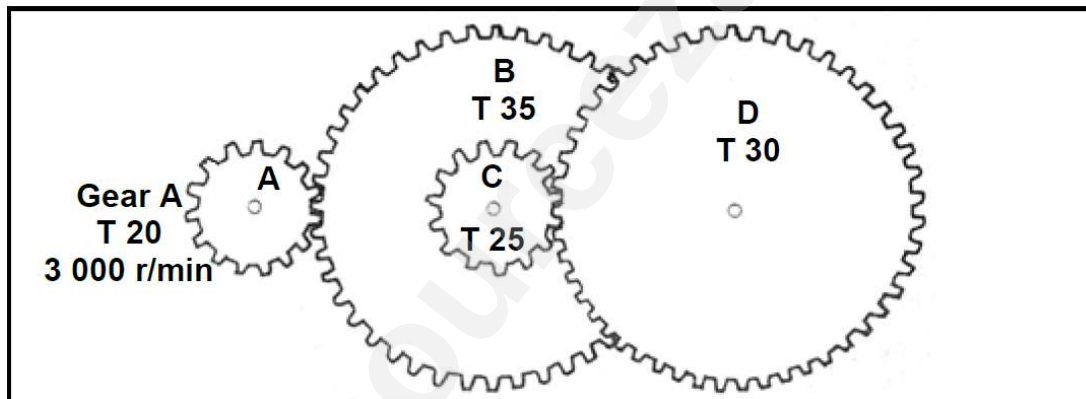


Figure 4.1

Calculate:

- 4.1.1 The rotation frequency of the output shaft in revolutions per second (6)
- 4.1.2 The gear ratio (3)
- 4.2 A force of 250 N moves an object over a distance of 15 m. Calculate the work done by this force. (2)
5. An electric motor with a 250 mm diameter driver pulley rotates at 24 r/s. The motor drives a pulley with a diameter of 350 mm with the help of a flat belt. The tensile force in the tight side of the belt is 300 N and in the slack side 120 N.
 - 5.1 Draw a neat labelled sketch of the system showing the driver and driven pulley. (2)
 - 5.2 Calculate the belt speed in m/s. (3)
 - 5.3 Calculate the power transmitted in kW. (4)
6. FIGURE 6.1 below shows a compound gear train. A driver gear on the axle of the electric motor has 30 teeth and meshes with a gear on the countershaft with 80 teeth.

On the counter shaft is another driver gear with 40 teeth that mesh with a gear with 60 teeth. The rotation frequency is 120 r/min.

Calculate the rotation frequency of the electric motor.

(4)

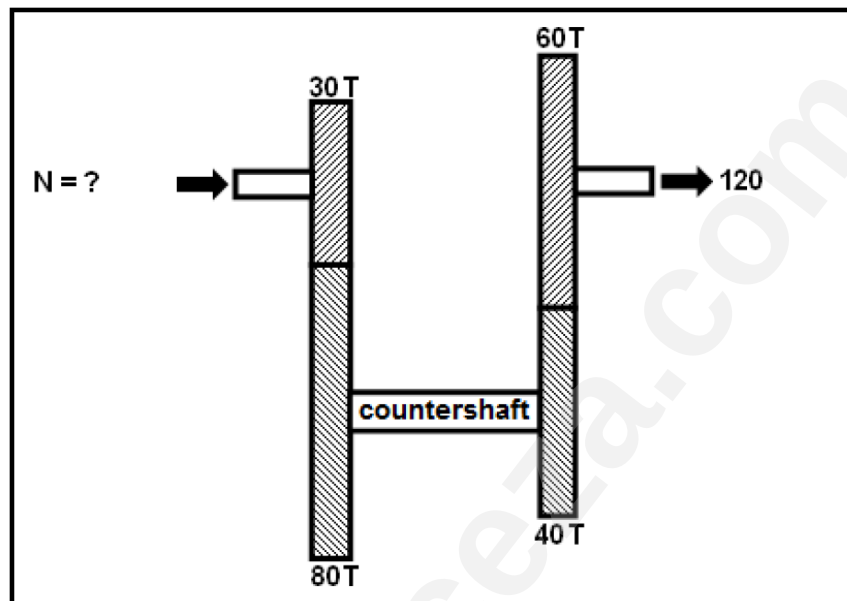


Figure 6.1

Hydraulics/ pneumatics

7.1 Study FIGURE 7.1 below. An artisan was instructed to design a hydraulic system that will be used to press out bearings. The force that should be exerted on the bearing is 18 kN. The maximum force exerted on the 32 mm plunger is 120 N.

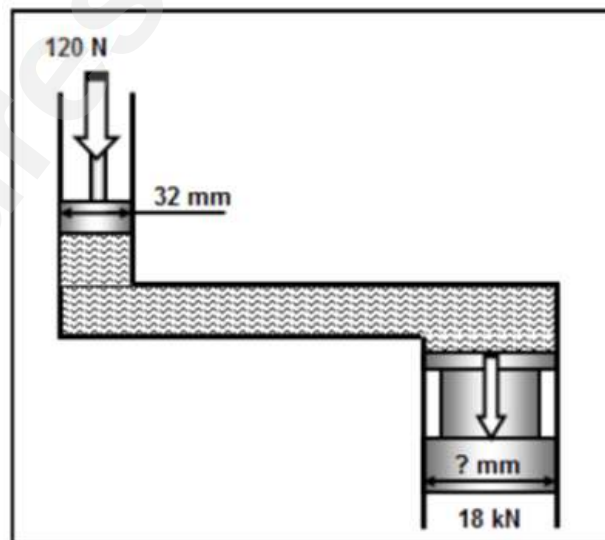


Figure 7.1

Calculating the following:

7.1.1 The fluid pressure in the hydraulic system

(4)

7.1.2 The diameter of the ram so that the maximum force of 18 kN can be exerted on the bearing. (6)

7.2 Draw the symbol for a one-way spring-loaded valve used in a hydraulic flow diagram. (1)

7.3 A hydraulic system is used to remove parts from a machine. The specifications of the system are indicated in FIGURE 7.3 below.

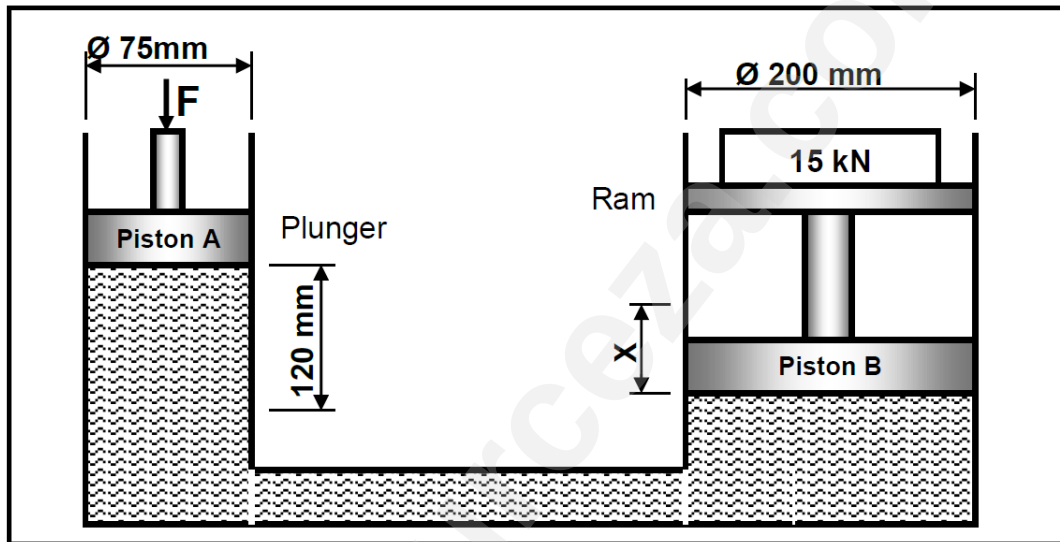


Figure 7.3

Calculate the following:

7.3.1 The fluid pressure in the hydraulic system in kPa (5)

7.3.2 Distance X, in millimetres, that piston B will move with ONE stroke of piston A (6)

7.4 State TWO advantages of pneumatics when compared with hydraulics. (2)

Learners need to be able to do mathematical calculations.

Take note of the following when doing calculations:

- Use your **own Calculator** and ensure that you are familiar with its operation.
- Ensure that you are able to identify the correct formula from the formula sheet (included in the question paper).
- Always write down the formula.
- Ensure that you know how to **change the subject of the formula**.
- Make it a habit to write down all the given information, ensure that is correctly captured before starting your calculation and establish exactly what you are required to calculate.

- Check and ensure that you are working with the correct units, e.g. r/min; Nm; etc.
- Ensure that you write down all the steps of the calculation. (marks are awarded, accordingly).
- Ensure that you write down the **correct SI unit next to the answer**. Ensure that you convert the unit to the correct Si unit as asked (if asked) in the question.
- Calculations are only mastered by practice and repetition. Try to do as many examples as possible.

Model answers

1. **Advantages of a belt drive system** compared to a chain drive system:

- Silent operation ✓
- Less expensive ✓
- Drive can take place over a longer distance ✓
- No lubrication needed ✓

(Any 2 x 1) (2)

2. **Advantages of a gear drive:**

- Compact assembly ✓
- More power can be transmitted/Stronger ✓
- No slip occurs ✓

(Any 2 x 1) (2)

3.

Rotation frequency of the drive pulley:

$$N_{DR} D_{DR} = N_{DN} D_{DN} \quad \checkmark$$

$$N_{DR} = \frac{N_{DN} \times D_{DN}}{D_{DR}} \quad \checkmark$$

$$= \frac{80 \times 240}{75} \quad \checkmark$$

$$= 256 \text{ r/min} \quad \checkmark$$

(4)

4.1.1

Rotation frequency of the output:

$$\frac{N_A}{N_D} = \frac{\text{Product of Driven gears}}{\text{Product of Driver gears}}$$

$$\frac{N_D}{N_A} = \frac{T_A \times T_C}{T_B \times T_D} \quad \checkmark$$

$$\frac{N_D}{N_A} = \frac{T_A \times T_C \times N_A}{T_B \times T_D} \quad \checkmark$$

$$N_D = \frac{T_A \times T_C \times N_A}{T_B \times T_D}$$

$$= \frac{20 \times 25 \times 3000}{35 \times 30} \quad \checkmark$$

$$N_D = \frac{1428,57 \text{ r/min}}{60} \quad \checkmark$$

$$= 23,81 \text{ r/sec} \quad \checkmark$$

(6)

4.1.2

Gear ratio:

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

$$= \frac{35}{20} \times \frac{30}{25} \quad \checkmark$$

$$= 2,1 : 1 \quad \checkmark$$

(3)

4.2

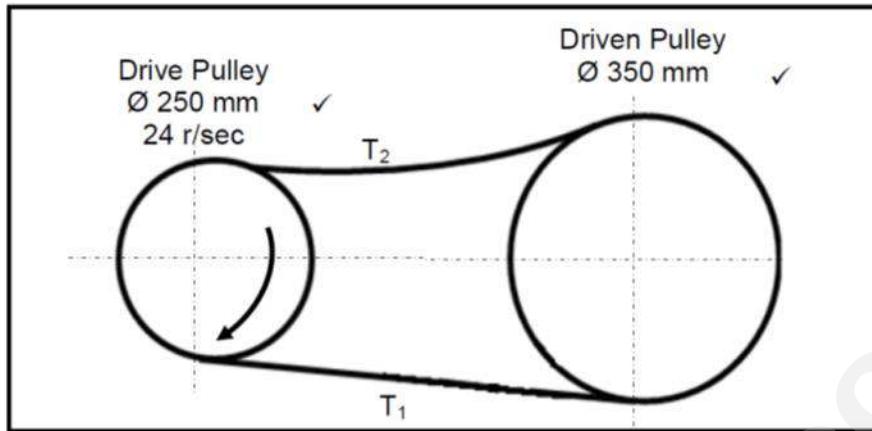
Work done:

$$\text{Work done} = F \times s \quad \checkmark$$

$$= 250 \times 15$$

$$= 3750 \text{ Joule or N.m} \quad \checkmark$$

(2)



(2)

5.1.2

Belt speed:

$$v = \pi D n \quad \checkmark$$

$$= \pi \times 0,25 \times 24 \quad \checkmark$$

$$v = 18,85 \text{ m.s}^{-1} \quad \checkmark$$

(3)

5.1.3

Power transmitted:

$$P = (T_1 - T_2) v \quad \checkmark$$

$$= (300 - 120) 18,85 \quad \checkmark$$

$$= 180 \times 18,85 \quad \checkmark$$

$$= 3393 \text{ Watt} \quad \checkmark$$

$$= 3,39 \text{ kW} \quad \checkmark$$

(4)

6.

Gear drive system:

Number of teeth on gear C:

$$\frac{N_A}{N_D} = \frac{T_B \times T_D}{T_A \times T_C} \quad \checkmark$$

$$N_A = \frac{T_B \times T_D \times N_D}{T_A \times T_C} \quad \checkmark$$

$$= \frac{80 \times 60 \times 120}{30 \times 40} \quad \checkmark$$

$$= 480 \text{ r/min} \quad \checkmark$$

(4)

7.1.1

Fluid pressure:

$$A_A = \frac{F^2}{4} \quad \checkmark$$

$$= \frac{F(0,032)^2}{4}$$

$$= 0,8 \times 10^{-3} \text{ m}^2 \quad \checkmark$$

$$p = \frac{F_A}{A_A} \quad \checkmark$$

$$= \frac{120}{0,8 \times 10^{-3}}$$

$$= 0,1492 \times 10^6 \text{ Pa}$$

$$= 0,15 \text{ MPa or } 149207,76 \text{ Pa} \quad \checkmark$$

(NO UNIT – NO MARK)

(4)

7.1.2

Diameter of the ram:

$$p = \frac{F_A}{A_A} \quad \checkmark$$

$$A_B = \frac{F_B}{p}$$

$$= \frac{18 \times 10^3}{0,15 \times 10^6} \quad \checkmark$$

$$= 0,12 \text{ m}^2 \quad \checkmark$$

$$A_B = \frac{F^2}{4} \quad \checkmark$$

$$d = \sqrt{\frac{4A}{F}}$$

$$= \sqrt{\frac{4 \times 0,12}{F}} \quad \checkmark$$

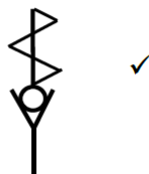
$$= 0,39088 \text{ m} \quad \checkmark$$

$$= 390,88 \text{ mm}$$

(6)

7.2

Hydraulic symbols: One-way valve



(1)

7.3.1

Fluid pressure:

$$A_B = \frac{\pi D_B^2}{4} \quad \checkmark$$

$$= \frac{\pi (0,2)^2}{4}$$

$$= 3,142 \times 10^{-2} \text{ m}^2 \quad \checkmark$$

$$P = \frac{F_B}{A_B}$$

$$= \frac{15 \times 10^3}{3,142 \times 10^{-2}} \quad \checkmark$$

$$= 477707,01 \text{ Pa} \quad \checkmark$$

$$= 477,71 \text{ kPa} \quad \checkmark$$

(5)

7.3.2

Distance 'X':

$$A_A = \frac{\pi D_A^2}{4}$$

$$= \frac{\pi (0,075)^2}{4}$$

$$= 4,42 \times 10^{-3} \text{ m}^2 \quad \checkmark$$

$$V_B = V_A \quad \checkmark$$

$$A_B \times L_B = A_A \times L_A \quad \checkmark$$

$$L_B = \frac{A_A \times L_A}{A_B} \quad \checkmark$$

$$= \frac{(4,42 \times 10^{-3}) \times (0,12)}{(3,142 \times 10^{-2})} \quad \checkmark$$

$$= 16,89 \times 10^{-3} \text{ m}$$

$$= 16,89 \text{ mm} \quad \checkmark$$

(6)

7.4

Advantages of pneumatics:

- Compressed air is easy and cheap to generate. ✓
- Leakages are not messy – no oil spills. ✓
- Positive and negative pressure can be generated. ✓ (Any 2 x 1) (2)

General comments on the answering of questions

- (a) Learners must always start each question on a new page as indicated in the instructions.
- (b) Learners need to ensure that they **number** the answers on their script **correctly**. Even if a learner writes down the correct answer, but the number to the question on his/her script is incorrect, it is technically incorrect.
- (c) Learners have difficulty expressing themselves when responding to describe/explain type of questions. It is important for learners to explain or describe concepts in a logical sequence, e.g. Explain the procedure to replace the chain on a chain drive system.
- (d) Learners should be careful not to give general responses that are incorrect instead of specific responses. Example, learners avoid responses that are not specific i.e. "the workers should wear PPE" instead of a specific item, like a safety goggles.
- (e) The **mark allocation** will indicate how much information you are required to provide in your response.
- (f) Your responses should be clear and concise and guided by the mark allocation.
- (g) If a question counts two marks, learners should provide at least two facts.
- (h) Learners should not only rely on activities that are in the textbooks but alternative questions on all cognitive levels for all the topics should be developed by themselves.
- (i) It is important that all topics should be covered sufficiently by learners in order to prepare themselves for any type of questions on a specific topic.
- (j) It is important that labels should always be indicated on all drawings.
- (k) Learners have difficulty explaining practical applications theoretically.

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