higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

MECHATRONIC SYSTEMS
NQF LEVEL 2

(6040102)

28 November 2023 (Y-paper)
13:00–16:00

This question paper consists of 7 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)
MECHATRONIC SYSTEMS
NQF LEVEL 2
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer all the questions.
2. Read all the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Start each question on a new page.
5. Use only a black or blue pen.
6. Write neatly and legibly.
7. Use g = 9,8 ms^{-2}.

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QUESTION 1

1.1

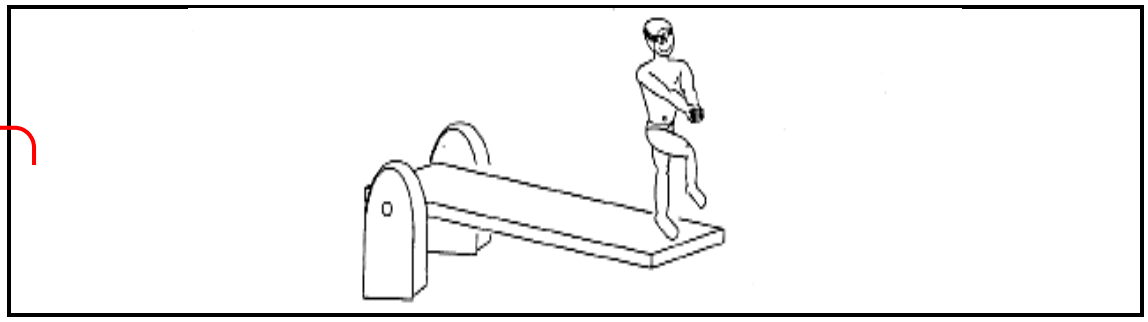


FIGURE 1

The Olympic diver in FIGURE 1 is standing on a diving board 10 m above the swimming pool.

1.1.1 Which form of energy does the diver possess? (1)

1.1.2 The diver moves upwards.

Which form of an energy does the diver now possess? (1)

1.1.3 When the diver is at the highest point of his dive, why does he not have any kinetic energy? (1)

1.2 Baggage handlers at an airport place suitcases onto a conveyor belt that lifts them to a height of 3,5 m to the storage hold of an aeroplane as shown in FIGURE 2.

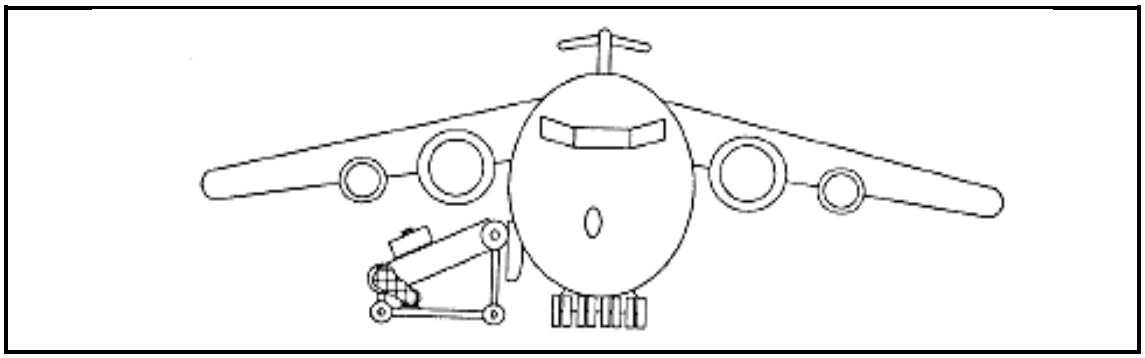


FIGURE 2

Calculate the potential energy stored in a suitcase weighing 20 kg when moved to the top of the conveyor belt. The answer must be in kJ.

HINT: Ep = mgh (3)

1.3 Differentiate between *nuclear fission* and *nuclear fusion*. (2 + 2) (4)

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1.4 A winch is used to haul up a car with a mass of 1 000 kg from a conveyor system on ground level to an overhead conveyor system moving through a distance of 20 m as shown in FIGURE 3.

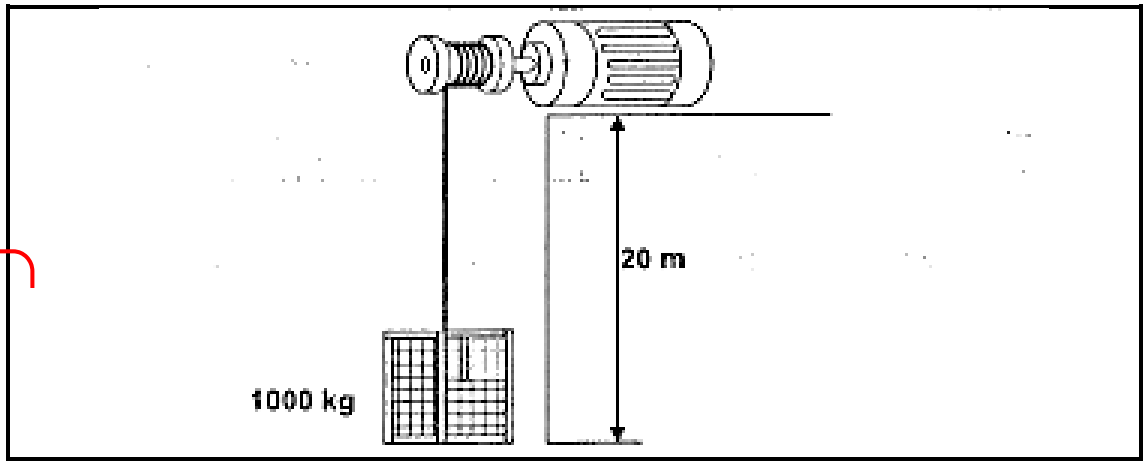


FIGURE 3

Calculate the minimum amount of work done by the winch. (4)

1.5 Draw a block diagram of an electric bulb that represents wasted energy losses. (3)

1.6 List THREE basic coupling systems found in technical systems. (3)

[20]

QUESTION 2

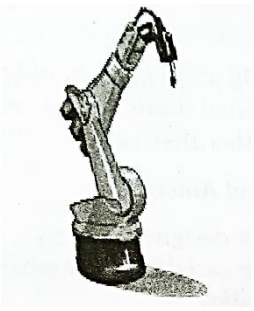
2.1 Explain the term *proximity sensor*. (2)

2.2 2.2.1 Explain the term *robot* as it is used in mechatronics. (2)

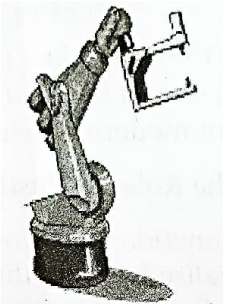
2.2.2 Name THREE types of jobs that robots are generally used for in industry. (3)

2.3 Identify each of the following operating tools:

2.3.1



2.3.2



2.3.3



(3 × 1) (3)

2.4 Read the operating instructions below and design the electrical circuit diagram. Clearly show the lamps, motor and switching symbols.

- When the system is switched on using the ON/OFF switch, the green standby light must come on.
- When the green start push-button is pressed, the amber run lamp and the motor must be energised and the green standby lamp must switch off.
- When the red stop push-button is pressed, the amber run lamp and the motor must switch off and the green standby lamp must come on again. (10)

[20]

QUESTION 3

3.1 A basic pneumatic system is made up of an air production system, an air distribution system and a consumer air working system.

Use a fully labelled, basic technical system block diagram to show the breakdown of a basic pneumatic system. (7)

3.2 Draw the symbol for each of the following types of pneumatic piping:

3.2.1 Flexible pipe

3.2.2 Pipe connector

3.2.3 Pipe crossing

(3 × 1) (3)

3.3 A flow-control valve can be either bidirectional or unidirectional as shown in FIGURE 4.

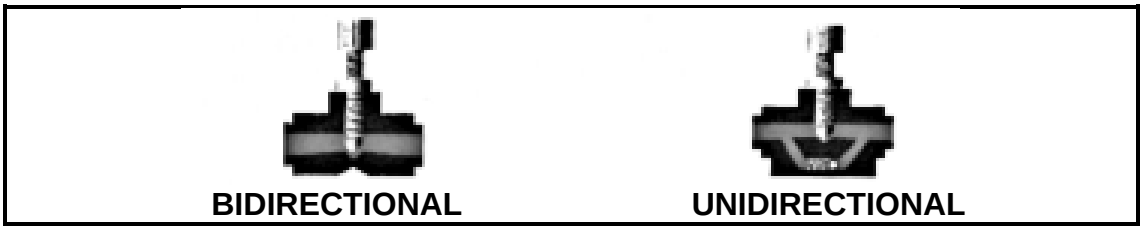


FIGURE 4

Differentiate between *bi-directional valves* and *unidirectional valves*. (2 + 2) (4)

3.4 Give FOUR disadvantages of pneumatics. (4)

3.5 Define the term *reciprocating motion*. (2)

[20]

QUESTION 4

4.1 Explain the term *motion control*. (2)

4.2 If a push-button (S1) is pressed momentarily, the piston rod of the double-acting cylinder extends and remains in the extended position for five seconds and then automatically returns to its normal position.

Design and draw a fully labelled, working circuit and a control circuit for this scenario. (10)

4.3 Give THREE disadvantages of direct control in electropneumatics. (3)

4.4 List FOUR types of injuries from electrical contact. (4)

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4.5 FIGURE 5 shows the circuit diagram of a dominant ON latching circuit.

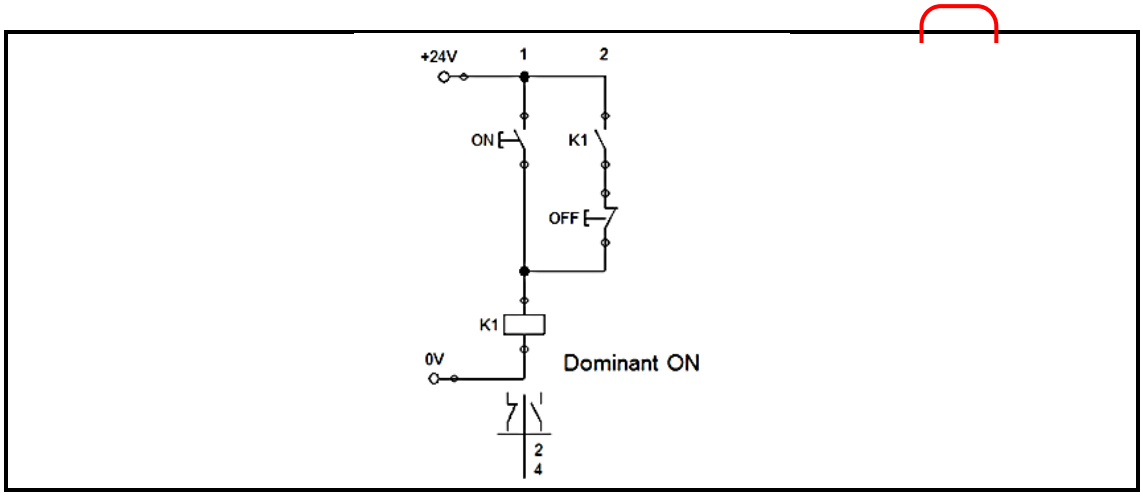


FIGURE 5

Briefly explain the operation of the circuit diagram. (2)
[21]

QUESTION 5

5.1 Give TWO common faults that can occur in mechanical limit switches. (2)

5.2 List THREE faults that can be encountered when commissioning the *hardware* of a PLC. (3)

5.3 List the steps to follow when using the *Half-Cut* method when troubleshooting. (5)

5.4 FIGURE 6 shows a working pneumatic circuit. When the push-button is activated, the cylinder is suppose to extend.

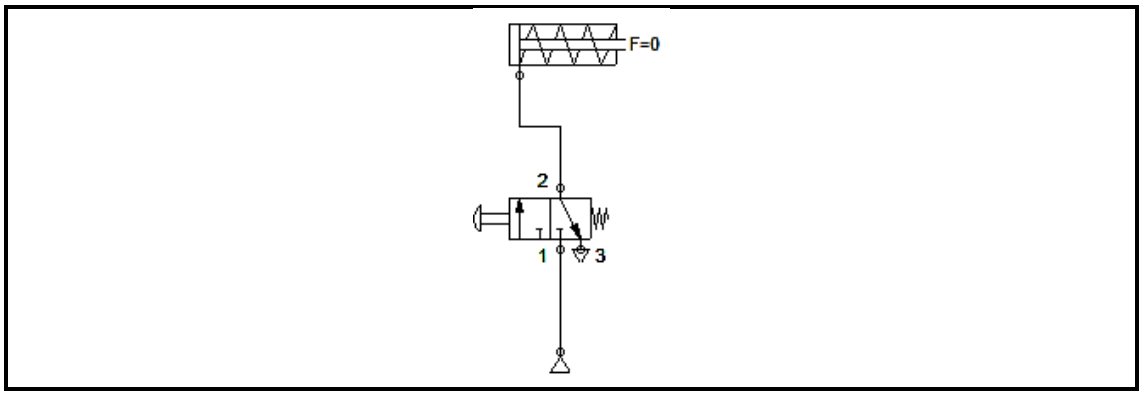


FIGURE 6

Use a flow chart diagram to troubleshoot the circuit if the cylinder does not extend when the push-button is activated. (9)
[19]

TOTAL: 100

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