

**ELC - Automation
T003**

Monday, 14/11/2016

08:30 – 11:30

WORKFORCE DEVELOPMENT AUTHORITY



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**ADVANCED LEVEL NATIONAL EXAMINATIONS, 2016,
TECHNICAL AND PROFESSIONAL STUDIES**

EXAM TITLE: Automation

OPTION: Electricity (ELC)

DURATION: 3hours

INSTRUCTIONS:

The paper is composed of **three (3) main Sections** as follows:

Section I: Fourteen (14) compulsory questions. 55 marks

Section II: Attempt any three (3) out of five questions. 30 marks

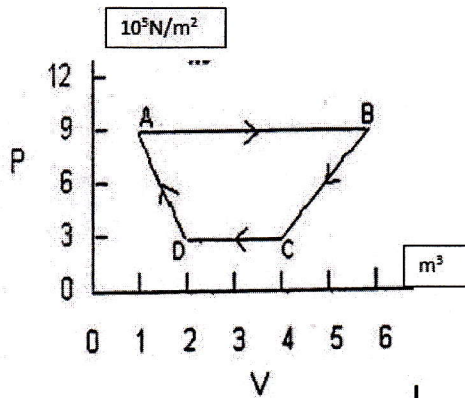
Section III: Attempt any one (1) out of three questions. 15 marks

The use of geometric material and scientific calculator is accepted

Note:

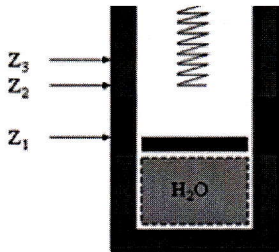
Every candidate is required to carefully comply with the above instructions. Penalty measures will be applied on their strict consideration

01. Give the properties of air. **3marks**
02. What is its temperature in Celsius when a gas has a volume of 25 liters, 203mol at 143.5 atm.? **2marks**
03. Find the work done, on or by, the gas during each of the four stages of the process, and the net work done in the cycle.

**7marks**

04. A tank of 2 m³ contains a compressed air at 7 Kgf and 50°C. A machine consumes 2 m³ of free air from this tank and the temperature decreases to 25°C. Calculate the final pressure of this tank. **6marks**
05. What are the criteria selections for a pipeline? **3marks**
06. A volume of 26.5 mL of nitrogen gas was collected in a tube at a temperature of 17° C and a pressure of 737 mm Hg. The next day the volume of the nitrogen was 27.1 mL with the barometer still reading 737 mm Hg. What was the temperature on the second day? **2marks**
07. An empty flask has a mass of 47.392 g and 47.816 g when filled with acetone vapor at 100°C and 745 mm Hg. If the volume of the flask is 247.3 mL, what is the molar mass of the acetone? **3marks**
08. What are **three** functions of direction control valves? **3marks**
09. Draw the following direction control valves:
- 5-way, 3 position, spring-centered solenoid, pilot-operated, cylinder ports open-center condition.
 - 5-way, 3 positions, spring-centered solenoid, pilot-operated, all ports blocked center condition.
 - 5-way, 3 positions, spring-centered pressure to cylinder ports, exhausts blocked center condition, solenoid-pilot operated.
- 3marks**
10. What is the information must be considered to size a hydraulic motor system? **4marks**
11. A double acting cylinder has a piston with a diameter of 25 mm. The piston rod is 5 mm in diameter. Pressure is supplied to the system at 4 N/mm. Calculate the force produced by the cylinder as it outstrokes and instrokes. **5marks**

12. A piston-cylinder device contains 50 kg of liquid water with a specific volume of $0.0010 \text{ m}^3/\text{kg}$. The cross-sectional area of the piston is 0.1 m^2 and it has a mass of 500 kg. Heat is now transferred to the water, causing part of it to evaporate and expand. When the volume reaches 0.2 m^3 , the piston reaches a linear spring whose spring constant is 100 kN/m . More heat is transferred to the water until the piston rises 20 cm more.



Find:

- a) The final pressure (P_3)
- b) The work done during this process ($W_{13, \text{out}}$).

5marks

13. State the importance of pumps used in hydraulic system.

4marks

14. Complete the following sentences: (NB: write the whole sentence)

5marks

- a) A relay is considered as an electro.....actuated switch
- b) When both start and stop buttons are pressed simultaneously circuits goes to OFF conditions in dominant.....circuit.
- c) Inductive sensors cannot be used to detect.....materials.
- d) Push buttons are operated manually whereas limit switches are operated.....
- e)switches are magnetically actuated proximity switch.

Section II. Choose and answer any three (3) questions

30marks

15. What is the purpose of sensor device in automation system?

10marks

16. Fill in table below with the designations and functions of Pneumatic valve according to symbols as shown.

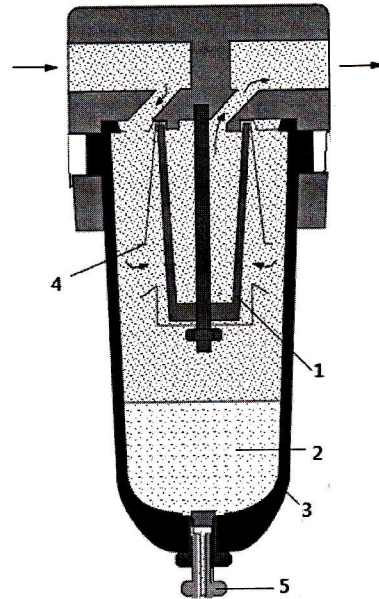
10marks

Symbol	Designation	Function

17. Explain the basic principles of drawing pneumatic circuit diagrams. **10marks**

18. A certain amount of gas is compressed from 1 bar and 0.1m³ to 5 bar and 0.03m³. The process is according to the law $pV^n = K$. Determine the magnitude and direction of work. **10marks**

19. Name (or label) the parts of compressed air filter indicated by lines on it as drawn below.



10marks

Section III. Choose and answer any one (1) question

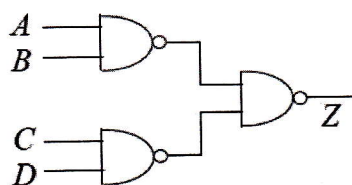
15marks

20. Give at least ten (10) Safety measures when using pneumatic control systems

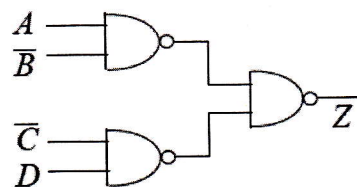
21. A double acting cylinder is hooked up to reciprocate. The relief valve setting is 70 bars. The piston area is 0.016 m² and the rod area is 0.0045 m². If the pump flow is 0.0013 m³/s, find the cylinder speed and load- carrying capacity for the:

- a. Extending stroke
- b. Retracting stroke.

22. Derive a Boolean expression and a truth table that describes the operation of each digital circuit shown here below:



(a)



(b)

and