

# L3D1



THE INSTITUTION OF FIRE ENGINEERS  
Founded 1918 • Incorporated 1924

**IFE Level 3 Diploma in Fire Science and Fire Safety**

## **Unit 1: Fire Engineering Science (A/505/6005)**

**Friday 13 March 2020**

**10.30 – 13.30**

### **Instructions to Candidates**

1. The time allowed for this examination is **THREE** hours.
2. Candidates must answer **SIX** questions from the total of **EIGHT** questions set for this examination.
3. All questions carry equal marks and may be answered in any order. Candidates should follow the instructions provided in the question when composing their answers.
4. Candidates should record all of their answers in the answer book provided.
5. The question paper must be handed in with the answer book.

### Question 1

- a) With the aid of a diagram, identify the components of a single phase double wound transformer. (6 marks)
- b) Explain the purpose and operating principle of an isolating transformer. (4 marks)
- c) A transformer with an output of 12 volts and 0.48 amps is supplying a lamp using a 37.5m, 1mm<sup>2</sup> aluminium two-core cable. Calculate the resistance of the lamp. Note: the resistivity of aluminium is 28 μΩmm. (10 marks)
- 

### Question 2

- a) Describe:
- i) Newton's First Law (Law of Inertia) (2 marks)
  - ii) the difference between scalar and vector measures (2 marks)
- b) Explain the following terms:
- i) elastic deformation (2 marks)
  - ii) plastic deformation (2 marks)
  - iii) yield point (2 marks)
- c) Describe Hooke's Law. (3 marks)
- d) Young's modulus for a given steel is 196GPa. Calculate the extension of a steel wire 2.8 m long with a cross-sectional area 1.0 x 10<sup>-3</sup> cm<sup>2</sup> when the wire is stretched by a load of 0.5 kg. (Take g to equal 10) (7 marks)
-

### Question 3

- a) Explain the principle and components of the fire tetrahedron. (5 marks)
- b) Explain the difference between flaming and smouldering combustion. (6 marks)
- c) Name and give the simple chemical formulae for the first three members of the alkane group and describe the trend in their relative melting points, boiling points and densities. (9 marks)
- 

### Question 4

- a) Define the following terms:
- i) half life (2 marks)
  - ii) radioactive decay (2 marks)
  - iii) isotope (2 marks)
- b) Briefly describe the difference between non-ionising and ionising radiation and identify one type of non-ionising radiation and one type of ionising radiation. (4 marks)
- c) Describe gamma decay and explain how gamma decay differs from alpha and beta decay. Include a comparison of the differing ionising potential and penetrating powers in your response. (10 marks)
- 

**[Please turn over]**

### Question 5

- a) Calculate the pump pressure required to supply a branch delivering 400 litres/minute at 4 bars pressure operating at a height of 27 metres above the pump outlet and located at the end of 6 x 25 metre lengths of 45mm hose (friction factor 0.005). Show all formulae and calculations. (6 marks)
- b) Explain, including a description of the physical laws involved, all the factors contributing to the required pump pressure calculated in part a) above. (11 marks)
- c) Comment upon the results of the calculation from part a) above, identifying any practical problems and suggesting solutions. (3 marks)
- 

### Question 6

- a) Explain the difference between the thermal capacity of a substance and its specific heat capacity. State the units for each. (9 marks)
- b) Define the term latent heat of vaporisation and state the units. (3 marks)
- c) Define the term phase change (phase transition). (3 marks)
- d) How much heat energy is required to convert 2.5 kg of ice at  $-2^{\circ}\text{C}$  to water at  $0^{\circ}\text{C}$ ? (SHC of water is  $2108 \text{ J kg}^{-1} \text{ K}^{-1}$ . Specific latent heat of fusion of water is  $3.34 \times 10^5 \text{ J kg}^{-1}$ ) Show all formulae and calculations used. (5 marks)
-

### Question 7

- a) Describe the properties and hazards of carbon monoxide. (6 marks)
- b) Write a balanced chemical equation for the incomplete combustion of methane. (4 marks)
- c) The production of carbon monoxide is one physical characteristic of combustion that provides an operating principle for detectors. Another characteristic is flame. Describe the forms of radiant energy in a flame and explain how they are detected to produce a fire alarm. (10 marks)
- 

### Question 8

- a) Describe the three primary sub-atomic particles that make up an atom. (5 marks)
- b) Describe the relationship between the number of electrons in an atom and valency. (5 marks)
- c)
- i) Identify the chemical structure of organic peroxides. (4 marks)
- ii) Describe the particular hazards of these materials. (6 marks)
-