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 9 March 2018

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) Define:

i) the volt

(2 marks)

ii) the ohm

(2 marks)

iii) electric current

(2 marks)

b) Explain:

i) how current depends on whether resistances are connected in parallel or in series.

(2 marks)

ii) how potential difference depends on whether resistances are connected in parallel or in series.

(2 marks)

c) A 4 ohm and a 6 ohm resistance are connected in parallel and then connected in series with a 2 ohm resistance. A current of 2.5 amps is passed through the circuit. Calculate:

i) the current through each resistance.

(5 marks)

ii) the potential difference across the circuit.

(5 marks)

Question 2

a) Briefly describe the operating principle and uses of thermocouples.

(7 marks)

b) Briefly describe the operating principle and uses of thermistors.

(7 marks)

c) Describe the operating principles of a rate of rise heat detector using thermistors.

(6 marks)

Question 3

a) Define:

i) force

(2 marks)

ii) moment

(2 marks)

b) State and annotate the force equation (Newton's Second Law) and state the SI unit for force.

(3 marks)

c) A simple beam, supported at both ends, is 9 metres long. A point load of 2kN is located 3 metres from the right end of the beam and an evenly distributed load of 800N/m is spread along the length of the beam.

i) Draw a diagram showing the loads and support points.

(4 marks)

ii) Indicate on the diagram the position of the point where the distributed load can be said to act.

(1 mark)

iii) Calculate and check the moments about each support point.

(8 marks)

[Please turn over]

Question 4

a) Define the following terms:

i) flashpoint

(2 marks)

ii) fire point

(2 marks)

iii) spontaneous ignition temperature

(2 marks)

b) Describe a chemical reaction and briefly explain combustion as a form of a chemical reaction.

(8 marks)

c) State the general chemical formulae for:

i) alkanes

(1 mark)

ii) alcohols

(1 mark)

d) Write a balanced chemical formula for the combustion of Butane in air.

(4 marks)

Question 5

a) Describe the laws which govern the loss of pressure due to friction in pipes and hoses and provide an annotated equation for the derived formula.

(6 marks)

b)

i) Calculate the pressure loss due to friction of 300 lpm flowing through 150 metres of:

a. 70 mm hose

(2 marks)

b. twinned 70 mm hose

(2 marks)

ii) Describe the results and their fireground implications.

(4 marks)

c) Describe the effects on pressure, flow rate and nature of the flow of water through a pipe in which the diameter abruptly reduces from its initial value to a smaller value before abruptly increasing again to original value. Include one example of where the effects may be found.

(6 marks)

Question 6

a) Describe the three factors which determine the rise in temperature of a body when heat is added.

(6 marks)

b) Define the coefficient of linear expansion and explain the relationship between linear, superficial (area) and cubical thermal expansion.

(8 marks)

c) Write down the annotated formula and calculate the increase in volume of a hollow steel box with external dimensions 2m by 1.4m by 1.2m where the following conditions apply: the temperature of the steel has risen from 17^0C to 194^0C; the coefficient of linear expansion of steel is 0.000012.

(6 marks)

Question 7

a) A number of breathing apparatus wears last for the following durations in minutes:
59, 65, 61, 62, 53, 55, 60, 70, 64, 56, 58, 58, 62, 62, 68, 65, 56, 59, 68, 61, 67

i) Explain how to identify the mean, median and mode durations.

(6 marks)

ii) Calculate the mean and median of the above values.

(4 marks)

b) Define the Law of Pressures (Gay-Lussac's Law).

(3 marks)

c) Explain the Combined Gas Law and provide an annotated formula for the law.

(7 marks)

[Please turn over]

Question 8

a) The nucleus of an atom can be represented as:

$${}^{A}_{Z}X$$

Where: A = atomic mass, Z = atomic number, X = chemical symbol (as shown on the Periodic Table).

Describe the effect of alpha and beta decay on the nucleus and complete the following generic equations:

Alpha decay $${}^{219}_{86}\mathbf{X} \longrightarrow$$

Beta decay $${}^{14}_{6}\mathbf{X} \longrightarrow$$

(10 marks)

b) 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)