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) State the equation and give the SI units for:

i) stress

(2 marks)

ii) strain

(2 marks)

b) Describe the relationship between stress and strain during elastic deformation to determine Young's modulus.

(3 marks)

c) A steel beam resting on a fulcrum point has two loads on one side. One load is 1.5kN and is 6m from the fulcrum. The second load is 2.7kN and is 3.5m from the fulcrum. A water container 3m x 3m and 1m deep is placed on the other side of the beam with its closest edge 5m from the fulcrum. Take gravity to be $9.81ms^{-2}$.

i) Draw a diagram to illustrate these loads.

(4 marks)

ii) Calculate how deep the water must be in order to balance the beam in equilibrium.

(9 marks)

Question 2

a) Define the following terms:

i) flashpoint (2 marks)
ii) fire point (2 marks)
iii) spontaneous ignition temperature (2 marks)

b) With reference to the fire tetrahedron, briefly describe the four methods of extinction, giving an example of each.

(8 marks)

c) Describe the difference between flaming and smouldering combustion.

(6 marks)

Question 3

a) Define the following terms:

i) nuclear radiation

(1 mark)

ii) decay

(1 mark)

iii) half-life

(1 mark)

b) Explain the construction and properties of each of the following including their penetrating powers.

i) alpha particles

(3 marks)

ii) beta particles

(3 marks)

iii) gamma radiation

(3 marks)

c) Describe the biological effects of radiation.

(8 marks)

Question 4

a) State the chemical symbol, the atomic number and briefly describe the properties and significant hazards of the following substances:

i) Hydrogen

(4 marks)

ii) Sodium

(4 marks)

iii) Chlorine

(4 marks)

b) Calculate the mass of sodium hydroxide produced when 20g of sodium reacts with water.

(8 marks)

[Please turn over]

Question 5

a) State the five rules that apply to friction loss in respect of water flowing in a pipe.

(5 marks)

b) When pumping water through fire hose over a given distance, the effect of twinning the hose lines is to half the velocity of the water through each line of hose. Explain what effect this has on the frictional loss in the hose.

(4 marks)

c) If water is flowing through a 50mm diameter pipe at a fixed flow rate, and the pipe is replaced with a pipe of twice the diameter (100mm), by calculation, compare the pressure lost due to friction between the 50mm diameter pipe and the 100mm diameter pipe. All other factors remain constant.

(4 marks)

d) Water is flowing through a line of 70mm hose 225 metre long at 200 l/m feeding a 20mm nozzle. The friction factor is 0.005.

i) Calculate the loss of pressure due to friction.

(2 marks)

ii) Calculate the pressure the pump should generate in order to maintain a nozzle pressure of 4 bar.

(1 mark)

iii) Calculate the jet reaction through the nozzle.

(2 marks)

iv) Calculate the change in the jet reaction if a 12.5mm nozzle is used.

(2 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)

i) Define ‘electricity’.

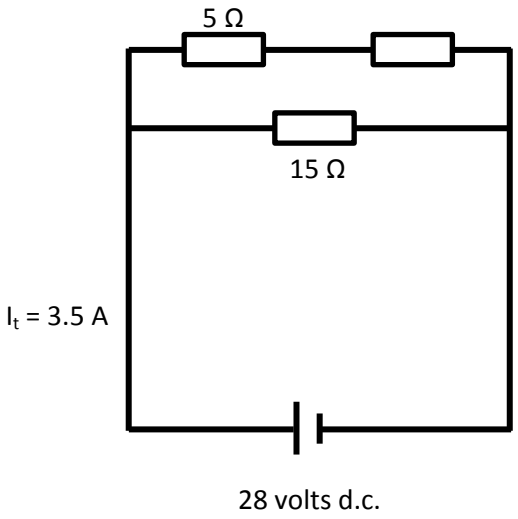
(2 marks)

ii) Describe the flow of electricity in a cable.

(2 marks)

iii) Define ‘voltage’.

(2 marks)



b) Referring to the circuit diagram above, calculate:

i) the value of the third resistor in the circuit. Express your answer in ohms.

(8 marks)

ii) the current flowing in the 15 Ω resistor. (2 marks)

iii) the total power flowing on the circuit. (2 marks)

c) Assuming the overall resistance remains unchanged, calculate the current flowing in the circuit if the battery in the circuit is replaced by a 24v vehicle battery.

(2 marks)