L3D1

THE INSTITUTION OF FIRE ENGINEERS
Founded 1918 • Incorporated 1924

IFE Level 3 Diploma in Fire Science and Fire Safety (VRQ)

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

Friday 11 March 2016

10.30 – 13.30

Instructions to Candidates

1. The time allowed for this examination is **THREE** hours.

2. Candidates should answer **SIX** questions from the total of **TEN** 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 the following:

i) Boyle's Law

(3 marks)

ii) Charles' Law

(3 marks)

b)

i) A breathing apparatus cylinder has a pressure of 208 bar and a water volume of 9 litres. Calculate the maximum amount of air in the cylinder at this pressure. Show all formulae and all calculations in your answer.

(2 marks)

ii) A breathing apparatus cylinder has a pressure of 198 bar at 23°C. If the pressure in the cylinder rises to 208 bar, calculate the temperature of the air. Give the answer in ^{o}C and show all formulae and all calculations in your answer.

(9 marks)

c) Identify three factors that affect the duration of breathing apparatus worn at incidents.

(3 marks)

Question 2

a) State five of the principal characteristics of pressure in liquids in open vessels.

(5 marks)

b) State and name the SI unit of pressure and name the unit used in practical fire service calculations. Describe the relationship between the two units and explain why the practical unit and not the SI unit is used.

(6 marks)

c) What pressure is needed at a pump supplying water at a rate of 925 litres/minute when 7 bar pressure is required at the end of 175 metres of 90 millimetre hose sited 23 metres above the pump outlet? Friction factor = 0.007. Show all formulae and all calculations in your answer.

(9 marks)

Question 3

a) Define the following:

i) atom

(2 marks)

ii) molecule

(2 marks)

b) State the name of the substance and the name and the number of atoms of each element that make up the following formulae:

i) H_2SO_3

(2 marks)

ii) Na_2CO_3

(2 marks)

c) Write a balanced chemical equation for the complete combustion of propane in air.

(6 marks)

d) From the above equation, if 200 grams of propane is burned, how many grams of water are produced? Molar masses: Propane is 44.10 g/mol. Water is 18.02 g/mol. Show all formulae and all calculations in your answer.

(6 marks)

Question 4

a) State the different effect on potential difference (voltage) and current in electrical circuits connected in parallel or series.

(4 marks)

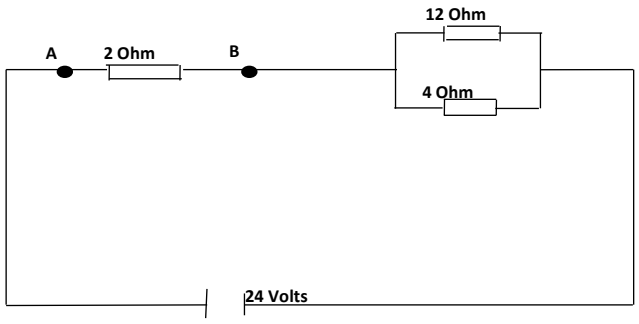
b) For the circuit shown below, calculate (showing all formulae and all calculations) the following:

i) The current flowing from the source.

(12 marks)

ii) The voltage drop across AB.

(4 marks)



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Question 5

a) Define Newton's three Laws of Motion.

(6 marks)

b) A steel beam 18 metres long at equilibrium resting on a central fulcrum point has four loads acting on it. Two are on one side: 1.8 kN which is acting 5 metres from the fulcrum and 2.2 kN which is acting 3.5 metres from the fulcrum. On the other side of the fulcrum a load of 0.5 kN is acting 0.5 metres from the end of the beam and an unknown load is acting 3 metres from the end of the beam.

i) Draw a diagram to illustrate these loads.

(6 marks)

ii) Calculate (showing all formulae used and all calculations) the unknown load.

(5 marks)

ii) The load at 5 metres from the fulcrum is increased to 2.6 kN. What load needs to be added at the point 3 metres from the opposite end to balance this increase? Show all formulae and all calculations used.

(3 marks)

Question 6

In relation to radiation:

a) Define the following terms:

i) half life

(2 marks)

ii) radioactive decay

(2 marks)

iii) isotope

(2 marks)

iv) ionising radiation

(2 marks)

b) Describe two types of radioactive particle.

(6 marks)

c) Explain three ways in which personnel can be protected from the effects of radiation.

(6 marks)

Question 7

a) Describe how an ionisation smoke detector works.

(5 marks)

b) Draw a diagram of an ionisation detector in the fire condition indicating the main parts.

(5 marks)

c) In relation to heat detectors, describe a bi-metallic strip and how it can work to raise an alarm.

(3 marks)

d) Explain, with the aid of diagram(s), the operating principles of a bi-metallic strip 'rate of rise heat detector' indicating the main parts.

(7 marks)

Question 8

a) Define the following terms:

i) monomer

(2 marks)

ii) polymer

(2 marks)

iii) thermosetting plastics

(2 marks)

iv) thermoplastics

(2 marks)

b) Explain the difference between addition and condensation polymerisation and give an example of a polymer from each process.

(8 marks)

c) Describe the main fire hazards with regard to plastics.

(4 marks)

Question 9

a) Explain, with the aid of a diagram, the design and operating principles of a siphon.

(10 marks)

b) The theoretical lift of water due to atmospheric pressure is approximately 10 metres. Describe the practical factors which reduce this.

(10 marks)

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Question 10

Write down the chemical formulae and describe the properties and significant hazards of the following substances:

a) Sodium

(5 marks)

b) Ammonia

(5 marks)

c) Phosgene

(5 marks)

d) Sulphuric acid

(5 marks)