L4C1

THE INSTITUTION OF FIRE ENGINEERS

Founded 1918 • Incorporated 1924

IFE Level 4 Certificate in Fire Science and Fire Safety (HL)

Unit 1: Fire Engineering Science (Y/505/5931)

Thursday 12 March 2015

10:15 – 13:15

Instructions to Candidates

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

2. Candidates are to 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 responses.

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.

1

a) Explain Bernoulli's theorem and state Bernoulli's equation, defining each term.

(10 marks)

b) A section of 150mm pipe is supplying sea water to a fire hydrant on an oil rig. In a plant room, the pipe runs horizontally 1m from the ground, before turning up to run vertically for a short length. The pipe then turns again to run horizontally 1.8m from the ground and reduces in size to 100mm diameter. A mercury column manometer is being used to measure the pressure difference between the lower pipe at point 'A' and the higher pipe at point 'B'.
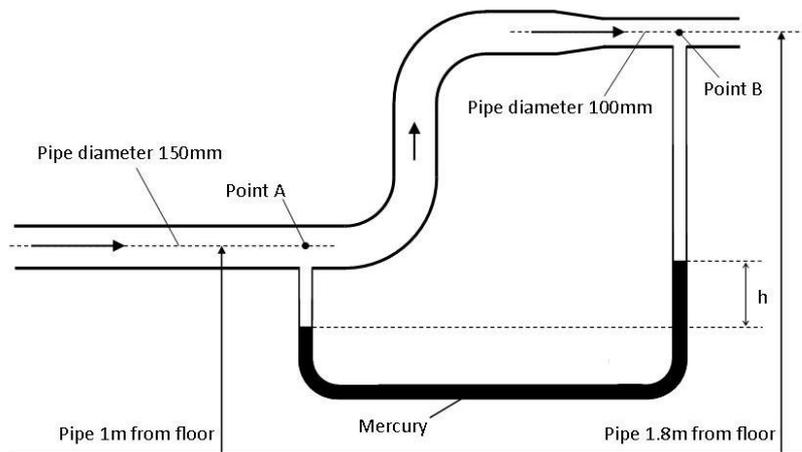
The flow of water through the pipe is 0.1m³/s. Using Bernoulli's formula, calculate the difference in pressure between points A and B, as would be indicated on the mercury column manometer. Show all calculations and any formulae used. Give your answer in millimetres-head.

(**Note:** The density of sea water is 1025kg/m³ and the density of mercury is 13,600kg/m³.)

(10 marks)

2

A jet of sea water 25mm in diameter strikes a fixed flat plate at a velocity of 8m/s.

a) Calculate the force exerted on the plate.

(**Note:** The density of sea water is 1025kg/m³)

(10 marks)

A fire boat requires 4150 Newtons for propulsion. The monitor used to drive the boat is 38mm in diameter.

b) What pressure in bar does the pump have to provide? Show all working, give your answer to two decimal places and explain each term in any formula used.

(8 marks)

c) Would the force be increased by siting the outlet below the waterline or directing the water stream onto the water surface? Give a reason for your answer.

(2 marks)

3

In most countries, electrical power is generated centrally at large power stations before being distributed around the country via a grid distribution system (often called the national grid).

a) Describe the main components of, and sketch, a power distribution system and national grid from the point of generation to the end consumers.

(15 marks)

Two heaters are connected in parallel to a 230 volt DC supply. Heater 'A' is rated at 2.5 Kw. The label is missing from heater 'B' but the resistance of the heating element is established with a test meter as being 21.16 Ohms.

b) Calculate the current being drawn from the supply when both heaters are switched on.

(5 marks)

4

a) Explain the term "Relative Vapour Density" (RVD).

(3 marks)

b) Explain the importance of Relative Vapour Density whilst attending an incident involving chemicals such as anhydrous Ammonia (NH_3) and Decane ($C_{10}H_{22}$). Illustrate your answer by demonstrating appropriate calculations.

(**Note:** atomic mass (AM) of Carbon = 12, AM of Nitrogen = 14, AM of Hydrogen = 1, RVD Air = 29).

(7 marks)

c) Using examples, explain the following terms:

i. Unconfined vapour cloud explosions

(5 marks)

ii. Confined vapour cloud explosions

(5 marks)

5

Explain how smouldering fires occur and how they transition to flaming fires.

(20 marks)

6

Explain the nature of plastics and the hazards they present to firefighters called to a fire at a plastics manufacturing site.

(20 marks)

[Please turn over]

7

An air cylinder with a water volume of 15 litres contains 2.28m^3 at 12^{0}C.

a) State Boyle's and Charles' laws and express each as a formula.

(4 marks)

b) What is the pressure of the air in the cylinder?

(5 marks)

c) The cylinder is exposed to heat raising the temperature to 185^{0}C. What is the pressure of the cylinder?

(6 marks)

d) The gas escapes from the cylinder. What volume, in litres, will it occupy before it cools?

(5 marks)

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8

a) Explain the difference between a premixed flame and a diffusion flame.

(10 marks)

b) Explain the progress of a flame through a pre-mix gas and air mixture.

(10 marks)

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