IFE Level 4 Certificate in Fire Safety and Fire Science

Unit 1 - Fire Engineering Science

Examiner Report – March 2015

Introduction

Candidates performed better than in previous years with 38% of candidates achieving a Pass.

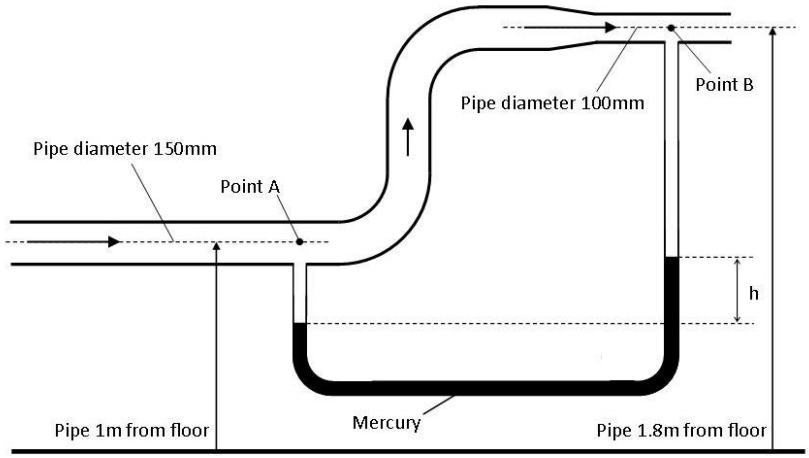
The examination questions tested topics from across the syllabus. Candidates who achieved a Pass generally demonstrated a broad range of understanding across different subjects.

As in previous years, there were many errors in calculations; candidates often failed to use appropriate formulae and often omitted stages or units when carrying out calculations and presenting answers.

Question 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 0.1m^3/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/m^3 and the density of mercury is 13,600kg/m^3.) (10 marks)*

Examiner Feedback

Successful candidates were able to explain the theory of the conservation of energy in a steady streamline flow and list the three types of energy (ie pressure, potential and kinetic) present.

Unsuccessful candidates were unable to provide a valid version of Bernoulli's equation or to apply it appropriately to the calculations. Many candidates were unable to transpose Bernoulli's equation to find the required values. Some candidates failed to give their answer in mm-head as was specifically required by the question.

Question 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/m^3) (10 marks)*

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

Examiner Feedback

This question was a popular choice for candidates and many achieved high marks.

Successful candidates were able to calculate the force of the water hitting the plate but many did not recognise that the fire boat utilises the principle of jet reaction to propel it. The simplest way of finding the pressure of the pump was to use a recognised formula for jet reaction.

Some candidates failed to realise that they needed to explain the underlying science (Newton's Third Law) in order to answer part c).

Question 3

a) 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). 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)

b) 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. Calculate the current being drawn from the supply when both heaters are switched on (5 marks)

Examiner Feedback

This was a popular choice with candidates. Many candidates provided good responses to part a) and demonstrated a broad knowledge of power generation and distribution systems.

Less successful candidates were unable to complete the calculations required in Part b) of the question. There were many different methods available for calculating the required values. Many candidates demonstrated poor knowledge of series and parallel circuit theory.

Question 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)

Examiner Feedback

Candidates demonstrated a reasonable working knowledge of vapour densities and the application of this when determining whether certain flammable substances were heavier (decane) or lighter (anhydrous ammonia) than air.

Responses to part c) of the question were often poor with few candidates demonstrating a good knowledge of the science behind unconfined and confined vapour explosions; many candidates wrongly described a BLEVE which attracted no marks.

Question 5

Explain how smouldering fires occur and how they transition to flaming fires. (20 marks)

Examiner Feedback

Responses to this question were generally poor with few candidates able to describe the science behind the transition from smouldering to flaming combustion.

Successful candidates were able to describe both ventilation controlled smouldering fires and fires controlled by restricted heat flux output. A detailed knowledge of the burning mechanisms of a smouldering fire was required (ie pyrolysis zone, char zone, residual char or ash).

Some candidates discussed the various stages of fire development, including backdraught and flashover, but failed to explain the transition specified in the question so scored few marks for this.

Question 6

Explain the nature of plastics and the hazards they present to firefighters called to a fire at a plastics manufacturing site. (20 marks)

Examiner Feedback

This question was a popular option for candidates. However, responses were often poor and few candidates achieved high marks.

Successful candidates wrote about the chemical composition of plastics and referenced different types such as thermos-plastic and thermos-sets.

Candidates who followed the instruction in the question and explained the hazards to firefighters often achieved good marks for this element of the response; other candidates wrote at length about firefighting procedures when tackling fires involving plastics; these candidates did not achieve marks as the response did not answer the question set.

Question 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)

Examiner Feedback

Successful candidates demonstrated a good understanding of the gas laws and applied their knowledge correctly in carrying out the calculations.

Some candidates mixed up the gas laws and over-complicated the calculations by attempting to apply the general gas law when a simpler calculation was possible. It appeared that some did not read the question carefully. Marks were often lost in the response to part d) where candidates omitted to give their answers in litres as required by the question.

Question 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)

Examiner Feedback

Responses to part a) were often good with many candidates able to explain the difference between pre-mixed and diffusion flames; some candidates enhanced their responses by providing examples.

Responses to part b) were generally poor with few candidates achieving many marks. Candidates were expected to cover flame speed, pressure wave and burning velocity in their responses.