# IFE Level 3 Diploma in Fire Safety and Fire Science

# Unit 1 – Fire Engineering Science (Zone 2)

## Examiner Report – March 2017

### Introduction

Candidates that sat this version of the paper performed well with 39% of the candidates achieving a Pass.

Candidates generally performed well on questions 2, 5 and 7. Candidates performed least well on question 4.

### Question 1

*a) Explain the three factors which determine the rise in temperature of an object to which a source of heat is applied. (6 marks)*

*b) Explain the three methods of heat transfer. (6 marks)*

*c) Briefly describe the electro-magnetic spectrum. (4 marks)*

*d) With the aid of a diagram, describe the inverse square law with regards to the spectrum. (4 marks)*

#### Examiner Feedback

Few candidates achieved full marks for their response to part a). The three factors that were required in response to part a) were the amount of heat supplied, the mass of the receiving object and the specific heat capacity of the object. Some candidates correctly identified the three factors but few candidates followed the instruction in the question to "explain" the three factors. Candidates who omitted to provide the explanation required were unable to obtain more than half of the marks available.

In response to part b), candidates were often able to list the methods correctly. However, candidates again failed to attain all of the marks available as they often omitted to explain the methods in sufficient detail.

There were many good responses to part c) with many candidates demonstrating some understanding of the electro-magnetic spectrum.

Part d) was usually answered poorly and few candidates attained high marks for their response to this element of the question.

## Question 2

*a) Describe the three primary sub-atomic particles. (5 marks)*

*b) Define the following terms:*
*i) half-life*

*ii) radioisotope*

*iii) ionising radiation*

*(6 marks)*

*c) Use the following data with a suitable graphical method to determine the half-life of the element shown. Clearly mark the first half-life on your graph. (9 marks)*

| *Time* | *0* | *15* | *30* | *45* | *60* | *75* | *90* | *105* | *120* | *135* | *150* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Disintegrations* | *556* | *438* | *357* | *291* | *230* | *180* | *150* | *128* | *100* | *88* | *80* |

**Examiner Feedback**

Candidates generally performed well on this question, with many candidates able to attain a high proportion of the marks available for part c)

In response to part a), the majority of candidates correctly identified and described protons, electrons and neutrons.

Part b) was the least well answered part of the question. Whilst candidates often managed to describe half-life correctly, there were many errors in descriptions of radioisotope and ionising radiation.

Part c) was generally answered well. Most candidates were able to plot the points using an appropriate scale and employ correct axis labelling. Some candidates lost marks for either failing to identify the first half-life correctly or for failing to identify it at all.

## Question 3

*a) Explain the purpose of a nozzle and describe the way this purpose is achieved in a firefighting smooth bore nozzle. (4 marks)*

*b) Define with regard to pumps:*
*i) Brake Power*
*ii) Efficiency* *(4 marks)*

*c) A pump with a brake power of 42kW and an efficiency of 78% discharges 2400 litres per minute. The operating pressure of this pump is 2 bar higher than the pressure of a second pump which has an efficiency of 80% and discharges 1800 litres per minute. Calculate the brake power of the second pump.* ***Show all formulae and calculations in your answer****. (12 marks)*

**Examiner Feedback**

Most candidates identified that a nozzle controls the direction and characteristics of a fluid flow (especially to increase velocity) but few made the link back to exiting/entering an enclosed chamber or pipe. Candidates generally achieved all of the marks available for identifying issues related to smooth bore nozzles.

Candidates generally provided good responses to part b) with most able to define the concepts correctly.

Responses to part c) were mixed. Some candidates successfully achieved all of the marks available whilst others attained only a few marks for identifying the correct formulae and transposing some relevant information. It was common for candidates to complete the calculations required in relation to the first pump correctly but to then make errors in relation to the second pump. Candidates who completed the task correctly identified that the break power of the second pump was 23212w (23.21kw).

## Question 4

*a) Elements may be classified as metals and non-metals. Describe five ways that the properties of each group differ. (5 marks)*

*b) Describe the metal reactivity series. (8 marks)*

*c) Explain the concept of valency. (4 marks)*

*d) State the chemical formulae for the following:*

*i) Tin IV (Stannic) Bromide*
*ii) Iron II (Ferrous) Hydroxide*
*iii) Aluminium Sulphate*

*(3 marks)*

**Examiner Feedback**

As on previous papers, few candidates chose the chemistry question. Those that did answer this question generally achieved fewer than six marks.

When responding to part a), few candidates met the requirement to compare five different properties. Candidates often correctly identified the state at room temperature as a property and explained the differences but few considered other properties such as density (metals have high density and non-metals have low density) or conduction of heat (metals are good conductors of heat whereas non-metals are poor conductors).

Most candidates were able to explain that a reactivity series is a list of elements with the most reactive at the top and least reactive at the bottom. However, few expanded their responses beyond this. Candidates with a good understanding identified where elements would be positioned on a list eg potassium at the top and platinum at the bottom.

The concept of valency was often described but not explained in depth.

Few candidates were able to give the formulae required for part d). The forumulae required were $SnBr_4$, $FE(OH)_2$ and $Al_2(SO_4)_3$.

## Question 5

*a) Describe the factors on which the resistance of an electrical circuit depends. (8 marks)*

*b) Explain why protective devices are fitted in consumer electrical circuits.(4 marks)*

*c) Outline the main functional and operational features of the following:*

*i) a miniature circuit breaker*
*ii) a residual current device (8 marks)*

### Examiner Feedback

This question was often answered well. However, candidates often provided only minimal information in their responses; higher marks could have been obtained for fuller descriptions/explanations.

Most candidates were able to identity the four factors and attained marks for this. However, many omitted to describe how the factors affected resistance and therefore were able to attain only half of the marks available. For example, candidates correctly cited that the length of the conductor was a factor but then omitted to explain that an increase in length results in an increase in resistance.

Part b) was generally answered well.

In responding to part c), candidates again limited the marks they could attain by presenting only brief responses. Candidates should use the marks available as a guide to the amount of points that they need to present in their response.

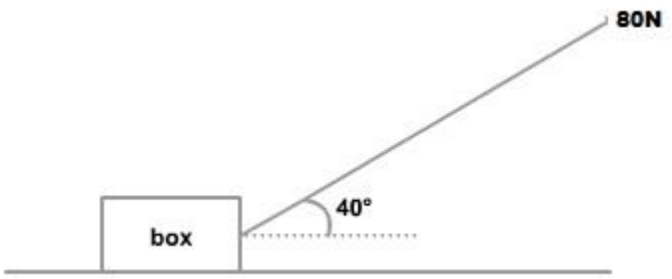
## Question 6

*a) Explain the difference between scalar and vector measurement. Give an example of each type of measurement in your answer. (4 marks)*

*b) Define and explain the relationship and distinction between the terms:*
*i) speed*
*ii) velocity*
*iii) acceleration (7 marks)*

*c) Write annotated equations and state the SI units for:*
*i) velocity*
*ii) acceleration (4 marks)*

*d) A force of 80 N acts on the box as shown below. Calculate the horizontal and vertical components of this force.* (5 marks)




**Examiner Feedback**

Candidates that understood that a scalar measurement has a magnitude only whereas a vector measurement has magnitude and direction were usually able to provide appropriate examples and achieve full marks for their response to this question.

Parts b) and c) were often answered well with candidates able to provide at least some relevant information.

Part d) was often omitted completely from responses and few candidates were able to complete the calculations correctly.

## Question 7

*a) Draw and label a schematic diagram of the components of an infra-red flame detector. (6 marks)*

*b) Smoke detectors operate using either an ionisation or optical (photo-electric) principle. Explain these two operating principles. (10 marks)*

*c) Explain the reasons for recommending an optical smoke detector over an ionisation smoke detector and vice versa. (4 marks)*

**Examiner Feedback**

Candidates that attempted this questions generally presented good responses.

In response to part a), most candidates presented diagrams that included all six of the required components in an appropriate sequence ie infra-red radiation, lens and filter, phot-electric cell, filter/amplifier, integrator/time and alarm.

Although candidates were usually able to provide one or two basic points about the detectors, responses usually lacked sufficient detail to secure a high proportion of the marks available.

Part c) was often answered poorly with candidates frequently confusing situations where the different types of detector would be most appropriate.

## Question 8

*a) Explain the term 'latent heat' and define the term 'specific latent heat'. (7 marks)*

*b) Explain the term 'change of state'. (4 marks)*

*c) Water at 18°C is applied to cool a fire in a building at the rate of 850 litres per minute. 20% of this water is converted to steam. Assuming all the water is raised to 100°C, calculate the total energy involved in raising the temperature of 2 minutes delivery of water and converting the percentage to steam. Give your answer in megajoules. State all other assumptions made and show all calculations and formulae used. (Specific heat capacity of water is 4180 J $kg^{-1}$ $K^{-1}$. Specific latent heat of vaporisation of water is 2260 kJ $kg^{-1}$). (9 marks)*

### Examiner Feedback

Responses to part a) often lacked sufficient detail to secure high marks. However, candidates generally attained most, and often all, of the marks available for part b).

Few candidates completed the calculation required by part c) correctly. The correct answer to the calculation was 1351.09 MJ.