

IFE Level 3 Diploma in Fire Safety and Fire Science

Unit 1 – Fire Engineering Science (Zone 1)

Examiner Report – March 2018

Introduction

55% of the candidates that sat this paper achieved a Pass.

Candidates generally performed best on question 8 but questions 2, 4 and 7 were also answered well. Candidates performed least well on question 3.

Candidates often omitted units of measurement from their responses. Candidates should be aware that marks are awarded for the identification of the correct units and therefore omitting this information meant that they were unable to secure the mark allocated for showing the correct unit.

Candidates are advised to show the formula and working out when they are carrying out calculations. This is because marks can be attained for the use of correct methods and intermediate calculations even where the final answer presented is incorrect; if working out is not shown then candidates are not able to attain the marks allocated to methods.

Question 1

- a) *State the equation and give the SI units for:*
- stress (2 marks)*
 - 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} .*
- Draw a diagram to illustrate these loads. (4 marks)*
 - Calculate how deep the water must be in order to balance the beam in equilibrium. (9 marks)*

Examiner Feedback

In responding to part a), few candidates identified the SI unit for stress – this unit is the Pascal.

Many candidates made errors in completing the calculations required by part c). In responding to c)i), Candidates did not appear to fully understand the placement of the water

container in relation to the fulcrum. The nearest side of the container was 5m from the fulcrum but the weight acts through the centre (ie 1.5m further along); as a result, the distance of 6.5m should have been used when balancing the loads.

To calculate the depth of the water, a number of steps were required. Once the force acting through the centre of the tank had been calculated, this should be converted to mass using gravity, then converted to capacity and then volume. This can be divided by the area of the tank to give the depth of water creating the initial force. Candidates should have presented their final answer using the correct units ie either cm or m.

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)*

Examiner Feedback

In responding to part a), the key facts to identify in relation to each of the terms were whether an ignition source was needed and whether combustion was sustained or not on ignition of the fuel vapours.

The four elements of the fire tetrahedron were generally well understood by candidates with most candidates giving concise descriptions of the four methods of extinction in relation to the four elements and providing relevant examples. Some candidates provided only the three elements of the fire triangle and omitted to reference chemical reaction in their response; some candidates omitted to explain that interrupting the chemical chain reaction was needed to tackle this element of the fire tetrahedron whilst others identified chemical reaction but omitted to provide a relevant example eg chemical extinguishers such as AFFF.

Part c) was often answered poorly. Candidates should be aware that:

- for flaming combustion to occur, a solid or liquid fuel must be converted into a vapour which then mixes with air and reacts with oxygen
- smouldering combustion involves a reaction between oxygen (from the air) and the surface of the fuel; this is a complex process and in general occurs only with solid fuels which char on heating.

Question 3

- a) Define the following terms:
- nuclear radiation (1 mark)
 - decay (1 mark)
 - half-life (1 mark)
- b) Explain the construction and properties of each of the following including their penetrating powers.
- alpha particles (3 marks)
 - beta particles (3 marks)
 - gamma radiation (3 marks)
- c) Describe the biological effects of radiation. (8 marks)

Examiner Feedback

Many candidates confused nuclear radiation with decay. Candidates should be aware that:

- nuclear radiation is radiation, especially ionizing radiation, that emanates from nuclear processes such as radioactive decay.
- decay is the process by which a nucleus of an unstable atom loses energy by emitting ionizing radiation.
- Half-life is the time required, probabilistically, for half of the unstable, radioactive atoms in a sample to undergo radioactive decay.

There were three marks available for each of the three elements of part b) which signalled that three relevant points were required for each element. However, many candidates provided only brief responses and many omitted to explain penetration powers.

The biological effects of radiation were not well understood. Candidates who attained high marks for this question were able to reference deterministic effects (ie those which occur at a relatively high dose and the severity of the effect is proportional to the dose) and stochastic effects (ie those where the probability of experiencing the effect is proportional to the dose but the severity of the effect is independent of the dose). Most candidates attained some marks for identifying effects such as cancer, infertility and nausea.

Question 4

- a) State the chemical symbol, the atomic number and briefly describe the properties and significant hazards of the following substances:
- Hydrogen (4 marks)
 - Sodium (4 marks)
 - Chlorine (4 marks)
- b) Calculate the mass of sodium hydroxide produced when 20g of sodium reacts with water. (8 marks)

Examiner Feedback

In response to part a), most candidates were able to identify some relevant information about each of the substances but few candidates were able to provide all of the information required in relation to each of the three substances and secure all of the marks available.

In response to part b), few candidates were able to produce a balanced equation and even fewer were able to use this information to calculate the mass of the sodium hydroxide produced (ie 34.8g).

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)*

Examiner Feedback

Part a) was usually answered well. However, some candidates provided only a list of factors rather than the full rule eg candidates stated only “diameter” whereas the question required “friction loss varies inversely with the diameter”. Marks were not awarded unless all relevant information was provided.

Part b) required an understanding of the specific relationship between friction loss and velocity. Many candidates did not recognise that a reduction to half the flow rate results in a reduction in frictional loss of one quarter of the original.

In response to part c) a similar understanding of the specific relationship between friction loss and diameter was required. In this case, the frictional loss will be 1/32 of the original when the hose size is doubled.

The calculations required by part d) were largely completed well. However common mistakes included the use of the diameter of the nozzle instead of the diameter of the hose in part i) and the use of the flow formula instead of the formula for jet reaction when responding to parts iii) and iv). Some candidates failed to appreciate that part iv) asked for the **change** in jet reaction rather than the new value for jet reaction. Many candidates omitted to include relevant units in their final answers and this meant that they lost the opportunity to secure the marks allocated for the use of correct units.

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°C to 194°C; the coefficient of linear expansion of steel is 0.000012. (6 marks)*

Examiner Feedback

Part a) was generally answered well. For full marks candidates needed to explain the relationship between each factor and the change in temperature eg the larger the amount of energy supplied to the body the greater the increase in temperature.

Few candidates provided enough detail in their response to secure all of the marks available for part b).

In responding to part c), candidates showed a good understanding of how to calculate the increase in volume. However, candidates frequently failed to include an annotated formula as required in the question and this limited the marks that could be awarded.

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)*

Examiner Feedback

This was a popular option for candidates and some candidates were able to secure very high marks for their responses.

Part a) was generally answered well. However, candidates frequently failed to appreciate that they were analysing durations and therefore failed to show their answer in minutes.

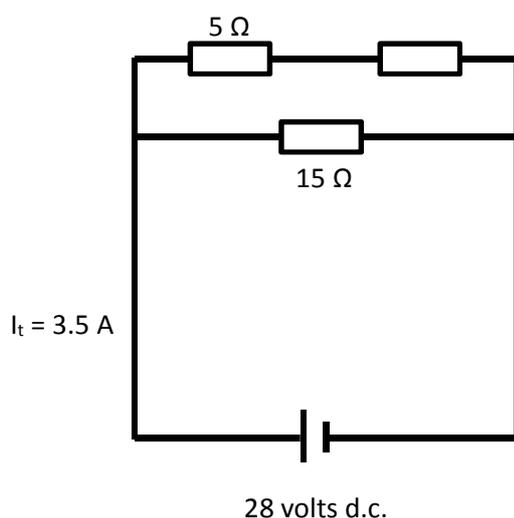
The definition of the Law of Pressures provided in response to part b) was often good.

Part c) was often answered well. However, candidates sometimes failed to ensure that temperature was identified in Kelvin (K).

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 15Ω 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)

Examiner Feedback

This question was a popular option and was generally answered well.

The least well answered part of the question was part a); few candidates attained full marks for their definitions. However, the calculations required by part b) and part c) were usually answered well.