

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 17 March 2017

10.30 – 13.30

Instructions to Candidates

1. The time allowed for this examination is **THREE** hours.
2. Candidates must 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 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) 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)
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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.

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

(9 marks)

Please write your candidate number clearly on the graph paper provided and place the graph paper in your answer book.

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)
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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)
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[Please turn over]

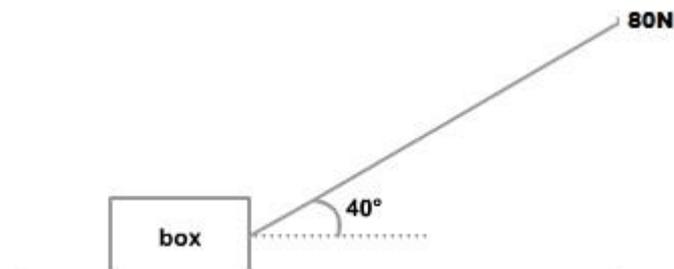
Question 5

- 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)

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)

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)
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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 $4180 \text{ J kg}^{-1} \text{ K}^{-1}$. Specific latent heat of vaporisation of water is 2260 kJ kg^{-1}).

(9 marks)
