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) 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 2

a) Define the following terms and give the SI units for each:

i) work
ii) force
iii) momentum
iv) mass
v) weight

(10 marks)

b) A car travels from rest to a point 200m away at a constant acceleration for 10s. What is the rate of acceleration and final velocity of the car?

(4 marks)

c) The car continues to travel at this speed for another 300m. How long does it take to travel this distance?

(2 marks)

d) The car then decelerates at a constant speed of 10m/s. How long does it take the car to reach a complete stop and how far does it travel in this time?

(4 marks)

Question 3

a) Explain the term 'Jet Reaction'.

(2 marks)

b) When water leaves a nozzle, the maximum theoretical height of the water jet would be:

$$H = \frac{V^2}{2g}$$

However, in practice the jet will not achieve this height. Explain the factors that affect the practical height of the jet.

(4 marks)

c) A pump is 85% efficient and is driven by an engine of 112 Kw brake power.

i) What water power is the pump capable of developing?

(3 marks)

ii) When 5500 litres of water per minute are being taken from the pump, what is the pressure in bar at which the pump is operating?

(4 marks)

iii) The pump is delivering 5500 litres per minute through 2 lines of 150mm hose of 12 lengths each terminating in a monitor of identical nozzle size. The monitors are 8 metres above the water level. What nozzle size will be required at each monitor to deliver this quantity of water?

N.B. Assume friction losses in each line are 0.2 bar per length. Take the pressure value as calculated in part cii).

(7 marks)

Question 4

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)

[Please turn over]

Question 5

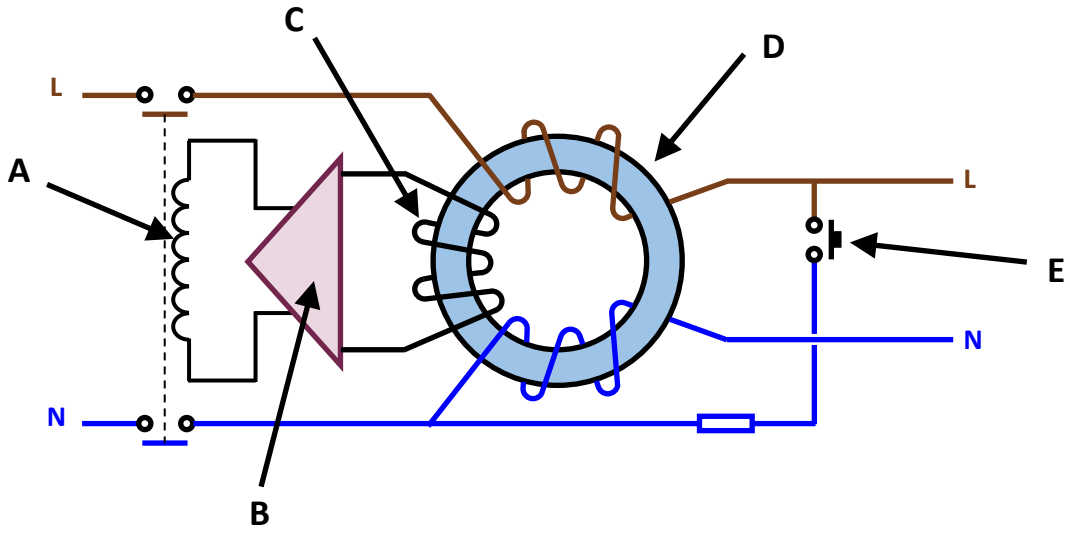
a) Explain what is meant by 'power' in an electrical circuit and annotate the formula for calculating power, including the units for each term.

(3 marks)

b) Explain what is meant by 'resistance' in an electrical circuit.

(3 marks)

c) The diagram below illustrates the operating mechanism of a circuit protective device. State the type of circuit protective device and state the components shown in the diagram labelled A, B, C, D and E. (Answers should be written in your answer book.)



(6 marks)

d) A two core copper cable is 65m long. At the far end there is a heater which draws 60 amps and the terminal voltage at the load is 230 volts. The maximum voltage available at the supply end of the cable is 237 volts.

i) What is the maximum practical resistance of the cable?

(3 marks)

ii) What is the smallest cross sectional area of copper which can be used? The resistivity of copper is 1.6×10^{-8} ohm metre. Express your answer in square millimetres.

(5 marks)

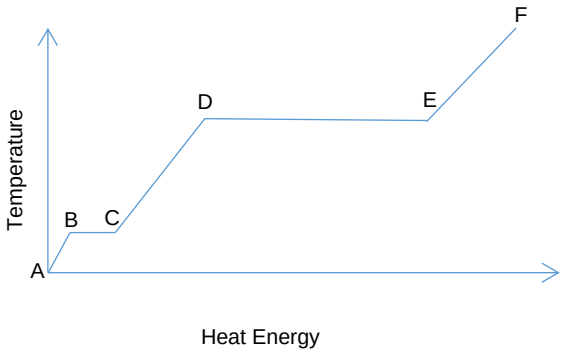
Question 6

a) Define:

i) absolute zero
ii) specific heat capacity
iii) latent heat
iv) thermal capacity of a body
v) linear expansion

(10 marks)

b) Below is a simplified state change diagram for water.



Briefly explain what is happening at the following points shown on the diagram above:

i) between A and B
ii) between B and C
iii) between C and D
iv) between D and E
v) between E and F

(10 marks)

Question 7

a) Define the term 'compound' and give an example of a compound.

(2 marks)

b) Describe the relationship between the number of electrons in the outer shell of an atom and the valency.

(6 marks)

c) Write a balanced equation for the combustion of propane in air.

(4 marks)

d) Calculate the mass of carbon dioxide produced by the complete combustion of 22kg of propane.

(8 marks)

[Please turn over]

Question 8

a) Describe the operating principles of an obscuration-type optical detector.

(4 marks)

b) One type of an obscuration-type optical detector is a linear beam detector. Describe the operating principles of a linear beam detector.

(4 marks)

c) Excluding the two detectors mentioned in parts a) and b), state a type of detector that can be used to detect each of the products stated below. Describe one advantage and one disadvantage of each detector stated.

i) Smoke
ii) Heat
iii) Radiation (flame)
iv) Combustion gases

(12 marks)