



1145-530 JUNE 2023

Level 3 Advanced Technical Certificate in Engineering

Level 3 Advanced Technical Extended Diploma in Engineering (720)

Level 3 Engineering – Theory exam (1)

If provided, stick your candidate barcode label here.

**Wednesday 7 June 2023
09:30 – 12:30**

Candidate name (first, last)

First

Last

Candidate enrolment number

Date of birth (DDMMYYYY)

Gender (M/F)

Assessment date (DDMMYYYY)

Centre number

Candidate signature and declaration*

- If additional answer sheets are used, enter the additional number of pages in this box.
- Before taking the examination, **all candidates** must check that their barcode label is in the appropriate box. Incorrectly placed barcodes may cause delays in the marking process.
- Please ensure that you staple additional answer sheets to the **back** of this answer booklet, clearly labelling these with your full name, enrolment number, centre number and qualification number in BLOCK CAPITALS.
- All candidates need to use a **black/blue** pen. **Do not** use a pencil or gel pen, unless otherwise instructed.
- If provided with source documents, these documents **will not** be returned to City & Guilds, and will be shredded. Do not write on the source documents.

***I declare that I had no prior knowledge of the questions in this examination and that I will not divulge to any person any information about the questions.**

You should have the following for this examination

- a non-programmable scientific calculator

General instructions

- Use black or blue ballpoint pen. Use pencil for drawing only.
- Any pencil drawings **must** be bold and clear for scanning purposes.
- The marks for questions are shown in brackets.
- This examination contains 15 questions. Answer all questions.
- You must show **all** your working on calculation questions.
- Write **all** of your working out and answers in this booklet.
- Answer the questions in the spaces provided.
- Answers written in margins or on blank pages **cannot** be marked.
- Cross through any work you do **not** want to be marked.



- 1 a) Define the meaning of 'creep' when referring to a material. (1 mark)

- b) State the property that describes the tendency of a material to fracture without significant deformation when stress is applied suddenly. (1 mark)

2 Explain how the properties of an aluminium alloy are changed by precipitation hardening.

(4 marks)

3 List **two** different types of smart material, and for **each**, state their smart property.

a) i) Smart material: (1 mark)

ii) Smart property: (1 mark)

b) i) Smart material: (1 mark)

ii) Smart property: (1 mark)

4 a) State **three** defects that may be typically found in composite products. (3 marks)

b) Explain why a filler may be added when making a composite material. (4 marks)

5 a) Describe how doping affects the properties of a semiconductor.

(4 marks)

b) Define what is meant by 'dielectric material'.

(2 marks)

6 a) Describe how a plastic product is produced using vacuum forming.

(6 marks)

b) Describe the stages involved in joining two polymer products using ultrasonic welding.

(4 marks)

7 Explain **two** differences between the methods used for one-off production and batch production.

(4 marks)

8 A company is designing a helmet for use in engineering workshops, to protect against small items dropped from above. They plan to manufacture the helmet in batches of 1000.

Suggest a suitable named material from which the helmet could be made. Give reasons for your suggestion.

(4 marks)

- 9 a) The requirements in a specification may originate from several research activities or sources.

Identify a different type of design criteria that may be found by **each** of the research activities or sources listed in Table 2 below.
An example has been completed for you.

(4 marks)

Research activity or source	Type of design criteria found out by this activity or source
<i>Customer design brief</i>	<i>Target audience for the product</i>
Market research	
Product analysis	
Legislation and standards	
Design for manufacture	

Table 2

- b) Describe the structure of a decision tree used to evaluate design ideas.

(4 marks)

- 12 a) Reduce the following equation to its simplest form using the laws of indices:
 $(Y^{4/3} \times Y^3) / Y^5$

You must show all working.

(3 marks)

- b) An angle of 67.5° needs to be converted into radians to programme a CNC machine. Carry out this calculation.

You must show all working.

(2 marks)

- c) The output signal from a circuit at time t (seconds) is given by the equation

$$V = e^{2t/3}$$

Using logarithms, determine the time when $V = 10$ volts.

You must show all working.

(4 marks)

- d) Use the Remainder Theorem to find the remainder when $x^4 - 6x^3 - x^2 + 7x - 2$ is divided by $x - 7$

You must show all working.

(2 marks)

13 Table 3 shows the diameters of 15 shafts, in mm, measured for quality control. The nominal diameter of the shaft was 64 mm.

65.1	64.6	64.5	64.2	63.7
63.5	63.8	62.9	63.7	65.3
64.1	63.6	64.2	63.5	64.2

Table 3

a) State the median value of the measurements.

You must show all working.

(1 mark)

b) Calculate the mean length.

You must show all working.

(1 mark)

c) Calculate the standard deviation of the sample.

You must show all working.

(2 marks)

d) Determine the interquartile range of the measurements.

You must show all working.

(3 marks)
