Surname	Centre Number	Candidate Number
First name(s)		2

GCE AS/A LEVEL

2601U10-1

Z22-2601U10-1

MONDAY, 16 MAY 2022 – AFTERNOON

DESIGN AND TECHNOLOGY – AS unit 1
Engineering Design

2 hours

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**8**	
2.	**8**	
3.	**8**	
4.	**8**	
5.	**8**	
6.	**40**	
Total	**80**	

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ADDITIONAL MATERIALS

A calculator, ruler, pencil and coloured pencils.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Answer **all** questions.

Write your name, centre number and candidate number in the spaces at the top of this page.

Write your answers in the spaces provided in this booklet. If you run out of space, use the continuation page at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question. You are advised to divide your time accordingly.

The total number of marks available is 80.

You are reminded of the need for good English and orderly, clear presentation in your answers. The quality of your written communication, including appropriate use of punctuation and grammar, will be assessed in your answer to question **5**.

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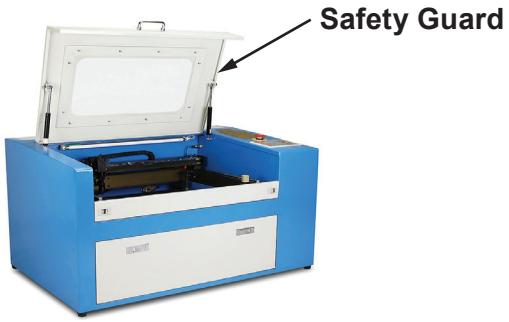
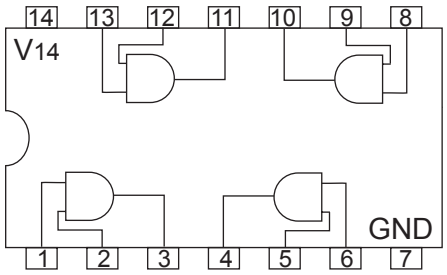
1. Laser cutters like the one shown below must include a number of features to ensure that they are safe to use.



(a) The laser cutter should not operate until the **Safety Guard** has been closed and the **extraction system** has been turned on.

The Quad Input AND gate integrated circuit (IC) is shown below.



In the box below draw a circuit diagram that uses this IC to ensure that the machine will not operate until two sensors have been activated. [4]

Examiner only

(b) Explain why ICs that contain NAND gates are often used in preference to those that contain AND, OR and NOT gates. [2]

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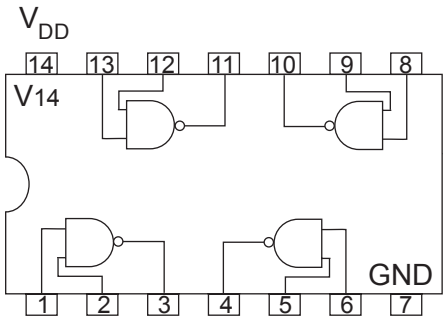
(c) The pinout diagram for a Quad NAND gate IC is shown below.



Complete the truth table below for a NAND Gate. [2]

Input A	Input B	Output Q
0	0	1
1	0	1

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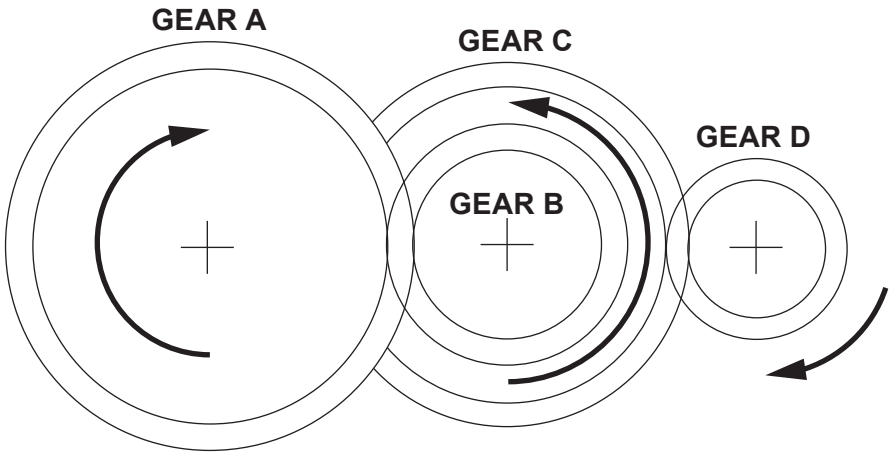
2. The illustration shows a compound gear train that is used to drive the headstock of a metal turning lathe.



GEAR A	GEAR B	GEAR C	GEAR D
120 Teeth	40 Teeth	80 Teeth	20 Teeth

(a) The driven **GEAR A** rotates in a clockwise direction at 180 rpm. In the space below calculate the Velocity Ratio (VR) for the compound gear train and the Rotational Velocity (RV) of the driver **GEAR D**. [6]

Show all your workings.

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(b) Each gear needs to be secured to its shaft so that it will not slip when subjected to a rotational force. Use the space below to show how this can be achieved. [2]

Examiner only

3. When developing new products engineers often use morphological analysis and reverse engineering. To develop the product shown below Dyson UK used an iterative process, producing over 600 prototypes.

Explain how morphological analysis and reverse engineering benefits the iterative development process. [8]

Examiner only

4. The bespoke training shoe shown below has been custom made for a client using Computer Aided Design (CAD) and Computer Aided Manufacture (CAM).

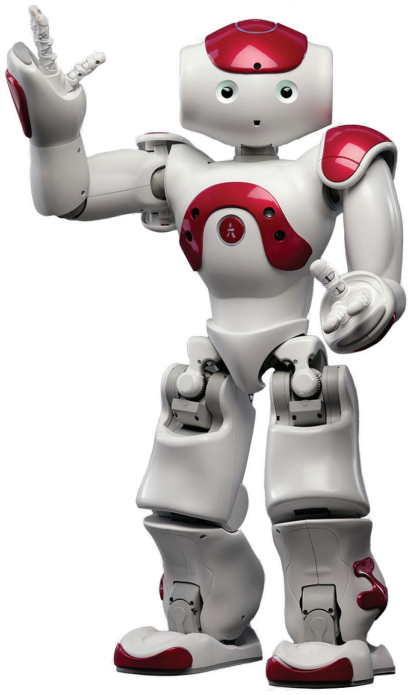
Evaluate the advantages to the client and the manufacturer of using CAD and CAM to produce bespoke custom made products [8]

Examiner only

5. Electronic products that interact with the environment are increasingly used to benefit consumers. Piezoelectric transducers can be used to measure changes in pressure, acceleration, temperature, strain, or force by converting signals into an electrical charge.

Describe how this type of technology may have been used to improve the performance of **the two** named products shown below and opposite. 2 x [4]

Humanoid Robot



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Examiner only

Voice Controlled Smart Speaker

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Examiner only

6. The images below show a traditional mobility scooter and a modern revitalised scooter that has been created to replace the traditional product.

(a) Analyse the modern revitalised scooter on the right and discuss **four** specification points that have led to the design of this product. [12]

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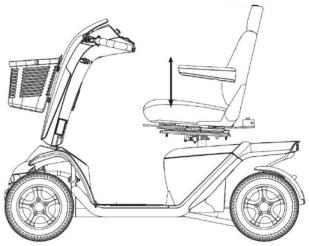
(b) The mobility scooter shown below is to be available for loan from a shop mobility centre. As it will be used by a wide range of people the seat must be easily adjusted both horizontally and vertically.



In the box below draw a detailed annotated diagram of a mechanical system that when activated would allow the seat to be moved and securely locked in position.

Marks will be awarded for:

(i) An appropriate method for adjusting the height. [4]
(ii) An appropriate proposal for horizontal adjustment. [4]
(iii) A suitable method for locking the seat in position. [2]
(iv) Justified selection of materials. [2]

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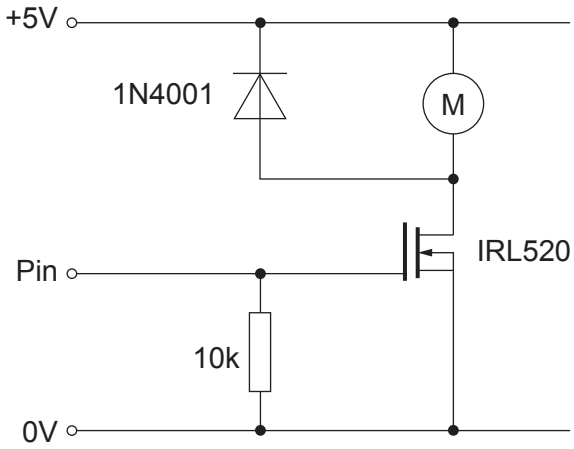
(c) The mobility scooter is to be powered by a 24 Volt DC motor which is controlled by outputs from a Microcontroller. The circuit shown uses a MOSFET Transistor to control a 5 Volt Motor.



In the box below draw a circuit diagram that uses a relay switch to link the 5 Volt microcontroller circuit to a 24 Volt Motor. [10]

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(d) If the mobility scooter was to be used by more severely disabled people it would need further modifications. Discuss **three** electronic or mechanical systems that could be added to the scooter to meet the needs of people with specific disabilities. 3 x [2]

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For continuation only.