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City & Guilds

1145-530 APRIL 2017
Level 3 Advanced Technical Certificate in Engineering/ Level 3 Advanced Technical Diploma in Engineering (540)/ Level 3 Advanced Technical Extended Diploma in Engineering (720)

Level 3 Engineering – Theory Exam (1)

If provided, stick your candidate barcode label here.

Monday 24 April 2017
09:00 – 12:00

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 any additional answer sheets are used, enter the additional number of pages in this box. 0 0
- Please ensure that you **staple** additional answer sheets to the **back** of this answer booklet, clearly labelling them 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.
- 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 assessment and that I will not divulge to any person any information about the questions.**

You should have the following for this examination
- non-programmable calculator
- pen with black or blue ink

General instructions
- Use black or blue ball-point pen.
- The marks for questions are shown in brackets.
- There are **13 questions** in this examination paper. Answer **all** questions.
- Answer the questions in the spaces provided. Answers written in margins will not be marked.
- Cross through any work you do not want to be marked.
- Round numbers to three significant figures where appropriate.
- Show **all** calculations. If you use a calculator, show sufficient steps to justify your answer.
- Write all your working out and answers in this booklet.
- If extra space is required then the blank pages at the back of the pack should be used, clearly identifying the question.

The test specifications for the 2018 exams have changed.
The content sampled will vary from this paper.
See the latest qualification handbook for the updated test specification.

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1 a) State the mechanical property that is the ability of a material to absorb energy from an impact and plastically deform without fracturing. (1 mark)

b) State the word that means the potential to improve the resistance to penetration of a material by heat treatment. (1 mark)

(Total marks 2)

2 Explain how annealing changes the properties of an aluminium alloy. (5 marks)

(Total marks 5)

3 For **each** of the following types of mechanical testing, state the material property that it measures.
Complete the table below with your responses. (4 marks)

Mechanical test	**Property measured**
Tensile	
Brinell / Rockwell / Vickers	
Izod / Charpy	
Wohler	

(Total marks 4)

4 Identify **two** different risks to health and safety when manufacturing composite products.
For **each**, state an action that may be taken to reduce the risk.
Complete the table below with your responses. (4 marks)

Health and safety risk	**Action to reduce risk**

(Total marks 4)

5 a) i) State the function of a resistor in a circuit. (1 mark)

ii) Describe how colour code bands are used to determine the value of a resistor. (4 marks)

b) Figure 1 shows a combination of an AND gate and an EX-OR gate.

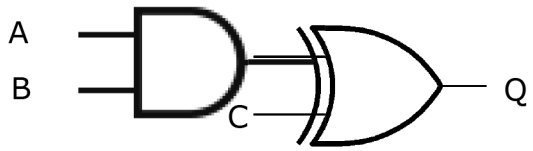

Figure 1

Complete the truth table for this combination. (2 marks)

Input			Output
A	**B**	**C**	**Q**
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	

c) Explain how open and closed loop control affect the output of a system. (4 marks)

d) Explain how photonic devices are used in industrial instrumentation. (4 marks)

(Total marks 15)

6 a) State what is meant by

i) velocity ratio (1 mark)

ii) moment of inertia. (1 mark)

b) State the definition of a newton. (1 mark)

(Total marks 3)

7 Figure 2 shows the P-V diagram for the diesel cycle in an engine.

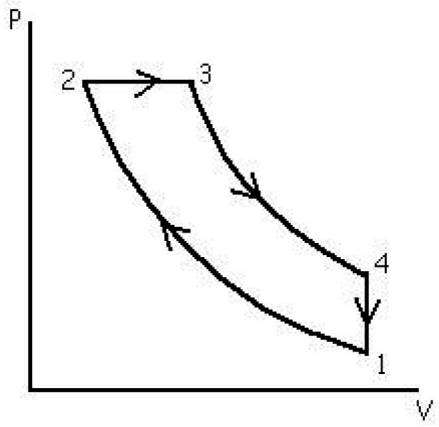

Figure 2

Explain the energy changes that are happening in the system during the cycle. (8 marks)

(Total marks 8)

8 a) State **two** precision casting techniques used for metals. (2 marks)

b) A manufacturer is checking parts for a helicopter. The parts are made in batches of 20.
Explain why the manufacturer may use sampling rather than 100 % inspection. (4 marks)

(Total marks 6)

9 a) State **three** types of need that are normally included in a product design specification. (3 marks)

b) Discuss the advantages and limitations of using rapid prototypes to test ideas. (5 marks)

c) Discuss how the development of steelmaking has contributed to social and economic development. (9 marks)

(Total marks 17)

10 a) A piece of metal needs to be marked out for cutting. It is the shape of a right angled triangle as shown in Figure 3.

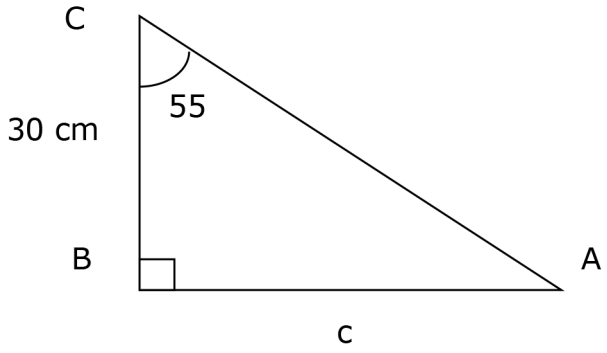

Figure 3

Calculate length c. (2 marks)

b) A container holds 8 kg of plastic pellets.
An injection moulding machine uses 0.62 kg of the pellets for each product that it makes.
Estimate how many containers of pellets would be needed to make 390 products, showing your working. (2 marks)

c) An engineer is designing a structure to support a machine. The machine has a mass M of 1640 newtons.
If the safety factor for the structure is 4, calculate the mass that the structure should be designed to support. (2 marks)

(Total marks 6)

11 a) Multiply the complex numbers (3 + 2j) and (2 + 4j). (3 marks)

b) The velocity (m s^{-1}) of a piston in an engine is given by the equation $x = -2 \cos (50t)$.
Using differentiation, find the acceleration of the piston after 0.8 seconds. (3 marks)

c) The output signal V (volts) from an electronic circuit can be calculated at time t (seconds) using the equation $V = e^{t/5}$.
Using logarithms, determine the time t when the signal V = 12 volts. (3 marks)

(Total marks 9)

12 Table 1 shows the diameter of 30 products. The data has a normal distribution.

17.5	18	18.2	18.9	17.9	17.7	18.4	17.6	17.6	18.3
18.6	18.1	18.2	17.9	18.1	17.8	17.9	18.3	18.2	18.4
17.3	17.6	17.1	17.4	17.9	17.3	17.8	17.4	18.2	17.3

Table 1

a) Calculate the mean diameter. (2 marks)

b) The standard deviation of the sample is 0.434.
Calculate the probability that a part will have a diameter of > 18.4 mm.
The following standard normal (z) data may be useful when determining the answer. (7 marks)

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.981

(Total marks 9)

13 Discuss how developments in microcontrollers have affected the design and manufacture of electronic products. (12 marks)

(Total marks 12)

Additional space

End of examination