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Cambridge **TECHNICALS LEVEL 3**

ENGINEERING

Cambridge TECHNICALS

Combined feedback on the June 2016 Exam Paper

Unit 2 - Science for engineering

Version 1

ocr.org.uk/engineering

CONTENTS

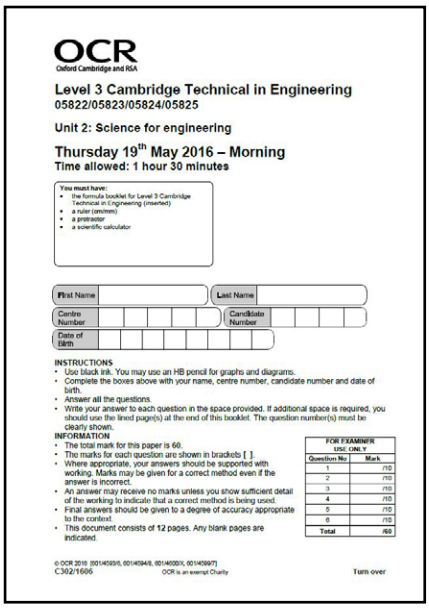
INTRODUCTION

This resource brings together the questions from the June 2016 examined unit (Unit 2), the marking guidance, the examiners comments and the exemplar answers into one place for easy reference.

The marking guidance and the examiner's comments are taken straight from the Report to Centre for this question paper.

The Question Paper, Mark Scheme and the Report to Centre are available from:

https://interchange.ocr.org.uk/



OCR
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Level 3 Cambridge Technical in Engineering
05822/05823/05824/05825

Unit 2: Science for engineering

Thursday 19th May 2016 – Morning
Time allowed: 1 hour 30 minutes

You must have:
- the formula booklet for Level 3 Cambridge Technical in Engineering (inserted)
- a ruler (cm/mm)
- a protractor
- a scientific calculator

First Name | Last Name
Centre Number | Candidate Number
Date of Birth

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number, candidate number and date of birth.
- Answer all the questions.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION
- The total mark for this paper is 60.
- The marks for each question are shown in brackets [ ].
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- An answer may receive no marks unless you show sufficient detail of the working to indicate that a correct method is being used.
- Final answers should be given to a degree of accuracy appropriate to the context.
- This document consists of 12 pages. Any blank pages are indicated.

FOR EXAMINER USE ONLY

Question No	Mark
1	/10
2	/10
3	/10
4	/10
5	/10
6	/10
Total	/60

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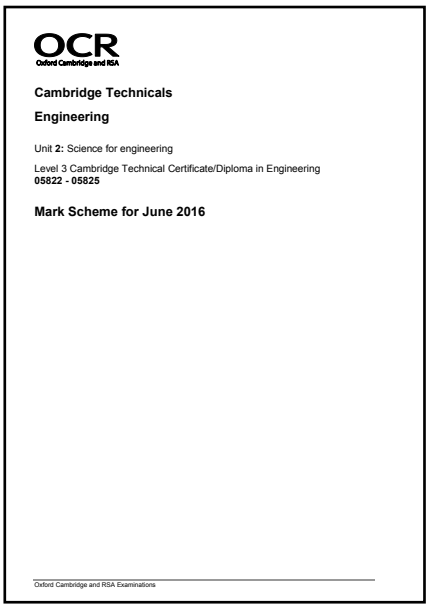

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Cambridge Technicals
Engineering

Unit 2: Science for engineering

Level 3 Cambridge Technical Certificate/Diploma in Engineering
05822 - 05825

Mark Scheme for June 2016

Oxford Cambridge and RSA Examinations

OCR
Oxford Cambridge and RSA

Cambridge Technicals
Engineering

Level 3 Cambridge Technicals Certificates in Engineering **05822, 05823**

Level 3 Cambridge Technicals Diplomas in Engineering **05824, 05825**

OCR Report to Centres June 2016

Oxford Cambridge and RSA Examinations

GENERAL EXAMINER COMMENTS ON THE PAPER

Candidates in general coped well with questions requiring calculations but sometimes did not include units in their final answer which in some cases meant that full marks could not be given. Centres should ensure that candidates know to always include units in their answers to these questions. Candidates seemed better equipped to answer questions covering learning outcomes 1 and 2, and seemed to struggle with using the correct scientific terminology for questions covering learning outcomes 4 and 5. Questions 1 and 3 were the highest scoring questions whilst questions 5 and 6 showed the greatest differentiation.

Nearly all the questions were attempted by the majority of candidates.

Question 1

1 (a) The table below refers to the International System of units (SI units).
Complete the table.
The first row has been completed for you.

Quantity	Unit
	kilogram
inductance	
temperature	
	second

Quantity	Unit
Length	metre
Mass	
	henry
	kelvin
Time	

[4]

(b) In an electronics circuit a voltmeter is indicating a value of 11.7 V when the true value is known to be 12 V.

Determine:

(i) the absolute correction

Absolute Correction = True value – Indicated value / 12 – 11.7

= 0.3 (V)

[2]

(ii) the relative correction.

Relative Correction = Absolute correction/True Value / 0.3/12

= 0.025 or 2.5%

[2]

(c) Fig. 1 shows a single resistor R.

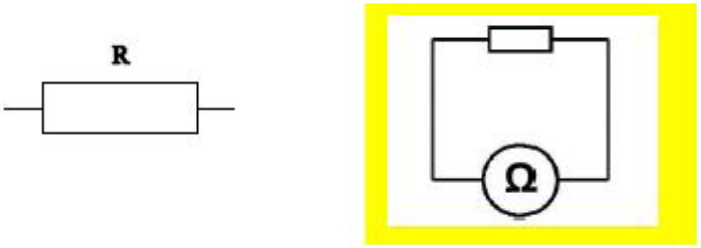


Fig. 1

Using the diagram in Fig.1, draw a labelled circuit diagram to show how the resistance of the resistor R can be measured using one instrument.

[2]

Mark scheme guidance

1 (a) Devices or actions are equally acceptable.

Award one mark for each correct response.

ACCEPT kg for kilogram (not kgs)

ACCEPT s for second.

No other abbreviations allowed.

1 (b) (i) EOR (evidence that correct rule is being used)

Negative value maximum one mark.

Unit V is not required, but an incorrect unit here would lose the second mark.

1 (b) (ii) EOR. Allow ecf from incorrect answer in b)i)

Correct answer has no units. If a unit is included one mark maximum.

1 (c) Award one mark for the use of a labelled multi-meter or ohm-meter.

Award one mark for the correct positioning of the instrument and nothing else.

Examiner comments

Q1(a) Most candidates showed familiarity with basic units for mass and time, and many correctly identified the unit for temperature correctly. However only a few correctly chose inductance for the unit henry. Common errors were capacitance, resistivity and voltage.

Q1(b) Most candidates correctly calculated both absolute correction and relative correction, but many showed misunderstanding of relative correction by including the unit V.

Q1(c) Many candidates misinterpreted this question and gave the incorrect response of using both an ammeter and a voltmeter in a circuit to find the resistance. Some candidates who used a multimeter incorrectly put a power source into the circuit as well.

Question 2

Question 2

2 (a) Give a practical example of:

Examples of scalar quantities are area, volume, time, speed, electric charge, temperature, length, distance, density, pressure, energy, work, power.
Examples of vector quantities are velocity, displacement, acceleration, force, momentum, lift, drag, thrust and weight.

(i) a scalar quantity

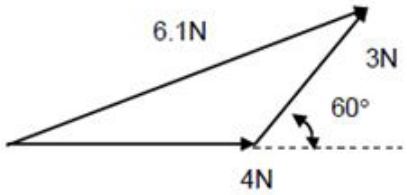
..... [1]

(ii) a vector quantity.

..... [1]

(b) (i) A force of 3 N and a force of 4 N act at a point and are inclined at 60° to one another.
Draw, to scale, a force diagram.

Force diagram, drawn to scale:



Two forces with arrows drawn at 60° (or labelled) to one another.

Force lines drawn to scale eg 3cm and 4cm long. Lengths can be ± 2mm.

[2]

Using your force diagram in 2 (b) (i), determine by measurement:

(ii) the magnitude of the resultant force

..... 6.1(N) ..... [1]

(iii) the angle between the resultant and the 4 N force.

..... 25(°) ..... [1]

(c) The velocity of a vehicle changes uniformly from 20 metres per second to 40 metres per second in 10 seconds.

(i) Use the grid in Fig. 2 to draw a velocity-time graph.

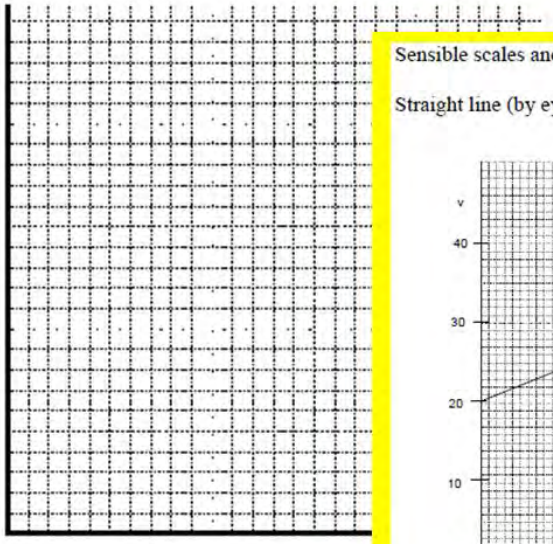
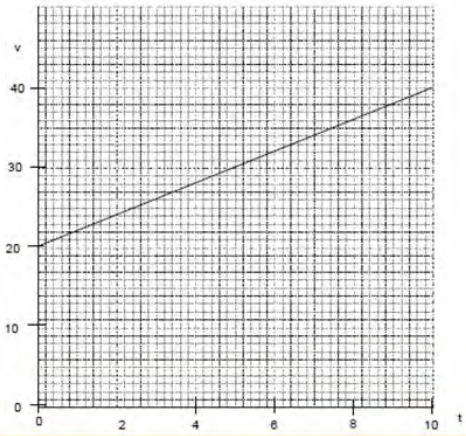


Fig.2

Sensible scales and labelled axes. Should use at least 4cm in x direction.

Straight line (by eye) from (0,20) to (10,40).



[2]

(ii) Using your graph in Fig.2, calculate the acceleration during the 10 second time period.

.....

Acceleration = gradient of graph

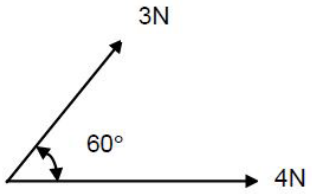
Acceleration = dv/dt = (40-20)/10 = 2 (m s^{-2})

..... [2]

Mark scheme guidance

2 (a) (i) (ii) If there is a list they must all be correct for the mark to be awarded in both cases.

2 (b) (i) The space diagram is shown for information.



Accept space diagram as above.

Vector triangle can be any orientation – ie rotated/mirror image etc.

2 (b) (ii) Award one mark for a magnitude of 6.1 ± 0.5N.

Do not accept error carried forward.

2 (b) (iii) Accept 25 ± 3°.

Do not accept error carried forward.

Examiner comments

Q2(a) Most candidates were able to correctly identify both a scalar and a vector quantity.

Q2(b) Most candidates were able to draw two forces at 60° to one another, but some omitted arrows to show that they were forces or were not drawn to scale. However many candidates were unable to add the two vectors correctly by drawing and measured the incorrect diagonal of their parallelogram. Those who calculated the magnitude of the resultant force using trigonometry usually got it right but many then gave the angle between the 3 N force and the resultant instead of the one between the 4 N force and the resultant.

Q2(c) Many candidates were able to correctly draw and label both the axes and the line on the graph grid. However some candidates struggled with the scale and their x axis started at 1 s, so the line was then incorrectly drawn. A few candidates inverted the axes to put time on the y axis and velocity on the x axis. Most candidates were able to correctly calculate the acceleration.

Question 3

Question 3

3 (a) Explain what is meant by the term 'electrical resistance'.

Opposition

to flow / movement of electrons/charge/current. [2]

(b) Using Fig. 3, sketch a graph to show the relationship between potential difference across and current flowing through a metallic conductor at constant temperature.

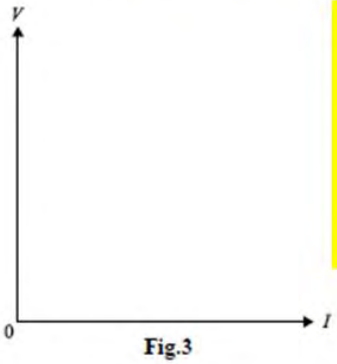
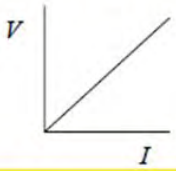


Fig.3

Straight line (by eye) with positive gradient.
Beginning at the origin.



[2]

(c) Two resistors connected in series give a total resistance of 900 Ω. If one resistor is of value 680 Ω calculate the value of the other resistor.

$R = R_1 + R_2$, so $R_2 = R - R_1$

$R_2 = 900 - 680$
$= 220\ \Omega$ [3]

(d) Calculate the current taken by an electric drill rated at 400 W used on a 230 V supply.

$P = VI$, so $I = P/V$

$I = 400/230$
$I = 1.7(4)$ A [3]

Mark scheme guidance

3 (a) NOT resistance.

ACCEPT restriction/prevention

IGNORE slow down/more difficulty

ALLOW resistance = voltage/current for both marks. If V/I used V and I must be defined.

3 (b) A curve at the end is incorrect so can only score the second marking point.

3 (c) No mark for quoting formula – rearrangement required.

Must include unit.

A raw answer of 220 with no unit or an incorrect unit maximum 2 marks.

3 (d) No mark for quoting formula – rearrangement required.

Must include unit and at least 2 sf..

Examiner comments

Q3(a) Most candidates were able to explain electrical resistance, either by defining it as potential difference divided by current or by referring to opposing electron flow. There were a few candidates who did not use correct terminology such as opposing electricity.

Q3(b) Most candidates correctly drew a straight line through the origin.

Q3(c) Most candidate correctly added the three resistance values to give the total resistance, but some omitted the unit. Some attempted to use the resistors in parallel rule.

Q3(d) Most candidates correctly calculated the current using the correct equation from the booklet, but again some omitted the unit or used an incorrect unit.

Question 4

4 (a) State Hooke's law with reference to materials.

Force is proportional to the extension/change in length

Provided the material is within its elastic limit

[2]

(b) Fig. 4 shows a graph of force-extension for a material.

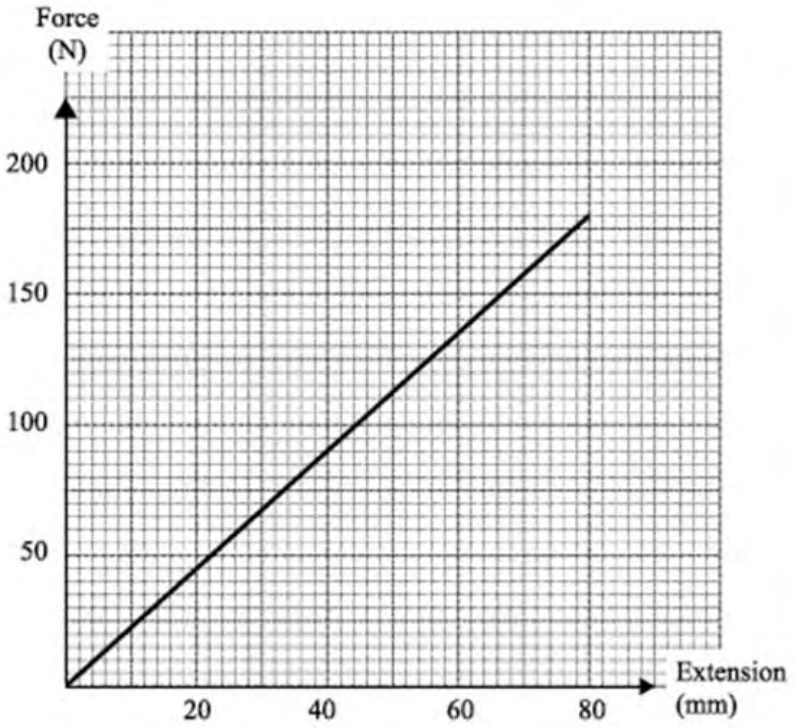


Fig.4

Calculate the strain energy by using data taken from the graph in Fig.4

Calculate the strain energy by using data taken from the graph in Fig.4

Strain energy = Area under the straight line graph / $(180 \times 80 \times 10^{-3})/2$
= 7.2 (J)

[2]

(c) Choose the correct material property from the following list for each of the definitions shown in the table below.

- Brittleness
- Ductility
- Endurance
- Hardness
- Stiffness
- Toughness

Definition	Property of material
	ductility
	hardness
	toughness

Definition	Property of material
The ability of a material to deform, generally by stretching along its length.	
The ability of a material to resist wear, scratching and indentation.	
The ability of a material to withstand blows or sudden shocks without breaking.	

[3]

(d) State what is meant by the term 'ultimate tensile stress'.

Maximum/greatest/largest (tensile) stress the material can withstand before rupture/breaking/failure. [2]

(e) Explain why you would use a 'non-destructive test' on a material.

It is used to test a material without causing damage to the material. [1]

Mark scheme guidance

4 (a) Accept F α Δx in symbols provided it is obvious that it is a change in length.

Accept stress is proportional to strain.

wtte.

4 (b) Max 1 mark for POT error.

4 (c) Award one mark for each correct response.

4 (d) NOT maximum force. ACCEPT force per unit area for stress.

Stress at failure' scores both marks.

4 (e) Accept so it does not break the material.

Accept so the material/component can be reused/re-tested.

Examiner comments

Q4(a) Few candidates achieved both marks in this question, and there was a wide variety of incorrect responses. Some candidates did not know that Hooke's Law was to do with materials, and some gave an explanation of elastic deformation.

Q4(b) Very few candidates answered this question correctly. Many calculated the gradient of the graph or attempted to calculate strain. Candidates who understood the term 'strain energy' were able to answer this question.

Q4(c) Most candidates got at least one of the properties correct, with ductility being the most common correct response. Some candidates got toughness and hardness the wrong way round and some confused endurance and hardness.

Q4(d) Many candidates correctly answered this question. There were two fairly common errors; to explain that it was the maximum force rather than maximum stress, and instead of material failure some candidates put plastically deforming or yielding.

Q4(e) This question was also well answered, but some candidates' explanations were unclear.

Question 5

Question 5

5 (a) Explain what is meant by 'turbulent flow' in a fluid.

particles move
in (very) irregular/haphazard/random paths [2]

(b) Given that atmospheric pressure = absolute gas pressure – gauge pressure.
Calculate the absolute gas pressure when the gauge pressure is 350 kN m^{-2} and the atmospheric pressure is 100 kN m^{-2}.

absolute pressure = atmospheric pressure + gauge pressure /100 + 350
= 450 kNm^{-2} [2]

(c) A force of 120 N is acting on a surface area of 2.5 m^2.
Calculate the pressure acting on the surface.

Pressure = force / area / = 120/2.5
= 48 Nm^{-2} or 48 Pa [2]

(d) Explain what is meant by the term 'viscosity'.

Resistance / ability to resist
to flow / to shear forces. [2]

(e) State what happens to the kinematic viscosity of:

(i) a liquid when its temperature rises

decreases [1]

(ii) a gas when its temperature rises.

increases [1]

Mark scheme guidance

5 (a) ACCEPT molecules

Allow this second marking point to be awarded for labelled diagram.

5 (b) Award one mark for transposing formula correctly.

Must have correct unit. If incorrect or no unit then max one mark.

5 (c) One mark for use of correct substitution into formula.

Must include unit. If incorrect or no unit then max one mark..

Examiner comments

Q5(a) Many candidates achieved one mark in this question for identifying that particles within a fluid move, but the description of how they move was not often well explained.

Q5(b) This was a fairly straightforward question which most candidates answered correctly. There were a few candidates who did not include a unit.

Q5(c) A straightforward question, but some candidates used the wrong calculation and some omitted the correct units.

Q5(d) Many candidates answered this question correctly, but a common error was to say that viscosity was a measure of the ability to flow, rather than a ability to resist flow.

Q5(e) Many candidates answered both parts of this question correctly.

Question 6

Question 6

6 (a) A mass of gas has a volume of 0.05 m^3 at a temperature of 80 °C.
Calculate the temperature for the same mass of gas when its volume is 0.1 m^3.

Convert temperature to Kelvin 80°C = 273 + 80 = 353 K

$\frac{V_1}{T_1} = \frac{V_2}{T_2} / T_2 = \frac{T_1 V_2}{V_1} / = (353 \times 0.1)/0.05$

= 706 (K)

[3]

(b) A mass of gas has a pressure of 250 kN m^{-2} when occupying a volume of 0.004 m^3.
Calculate the volume that the same mass of gas will occupy when its pressure is 500 kN m^{-2} if there is no change in temperature.

$P_1V_1 = P_2V_2$ rearranged to give $V_2 = (P_1V_1)/P_2$

$= (250 \times 0.004)/500$

$= 0.002\ m^3$

[3]

(c) Explain what is meant by the term 'latent heat'.

Heat / energy (absorbed or emitted) during a change of state / does not cause a change in temperature

[1]

(d) A mass of 0.5 kg of water is heated from 10 °C to 70 °C.
Calculate the sensible heat generated if the specific heat capacity of water is taken as 4000 J kg^{-1} K^{-1}.

$Q = mC\Delta T$
$\Delta T = 70 - 10 = 60$ °C
$Q = 0.5 \times 4000 \times (70 - 10)$
$= 120000$ J or 120 kJ

[3]

Mark scheme guidance

6 (a) Award one mark for rearranging formula correctly.

Accept 700 K. Conversion to 433°C is aso acceptable.

If used °C (which gives 160°C), maximum one mark awarded.

6 (b) Award one mark for rearranging formula correctly.

Must include correct unit.

6 (d) No mark for quoting formula.

Substitution mark. Allow incorrect ΔT ecf.

Must include unit..

Examiner comments

Q6(a) Many candidates showed that they were able to use the relationship that temperature is proportional to volume of a gas. However many candidates did not realise that this relationship is only true for temperatures measured in Kelvin so they did not convert the temperature in Celsius to Kelvin.

Q6(b) Many candidates were able to correctly calculate the new volume, but the working was not always laid out well, so if there was an error in calculation they were unable to gain any credit.

Q6(c) This question was well answered with most candidates answering correctly.

Q6(d) Many candidates were able to carry out this calculation correctly but often used an incorrect unit. However, many candidates did attempt to convert the temperature gain of 60°C into Kelvin in this part of the question where it was incorrect to do so.

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