

## Mathematical Techniques and Applications for Engineers

OCR Level 3 Certificate

H865/01 Component 1

### **Mark Schemes for June 2013**

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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**Annotations in scoris**

The following annotations are available:

- ✓ = correct response
- X = incorrect response
- Ecf = error carried forward
- Bod = benefit of doubt
- Yellow square to indicate work has been seen

Plus other items available on scoris toolbar

Highlighting is also available to highlight any particular points on the script.

Please send a brief report on the performance of candidates to your Team Leader (Supervisor) by the end of the marking period. The Assistant Examiner's Report Form (AERF) can be found on the RM Cambridge Assessment Support Portal.

Your report should contain notes on particular strength displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

Extra information provided June 2013

**ADDITIONAL OBJECTS:** You **must** annotate the additional objects for each script you mark. If no credit is to be awarded for the additional object, please use annotation as agreed at the SSU, likely to be 'seen' or the highlighting tool.

**CROSSED OUT, RUBRIC ERROR (OPTIONAL QUESTIONS) AND MULTIPLE RESPONSES**

**Crossed-out Responses:** Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

**Rubric Error Responses – Optional Questions:** Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

**Multiple Choice Question Responses:** When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).

*When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.*

**Contradictory Responses:** When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

**Short Answer Questions** (requiring only a list by way of a response, usually worth only **one mark per response**): Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

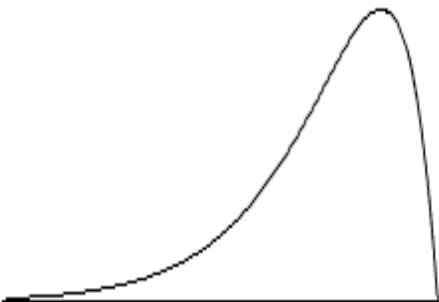
**Short Answer Questions** (requiring a more developed response, worth **two or more marks**): If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

**Longer Answer Questions** (requiring a developed response): Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

## Section A

Question	Answer	Marks	Guidance
1	$2(3x + 4) - 5x = 6x + 8 - 5x = x + 8$ $\begin{array}{r} x \\ +8 \end{array}$	1 1	
2	$x^2 + 5x + 6 = (x + 2)(x + 3)$ $\begin{array}{r} (x + 2) \\ (x + 3) \end{array}$	1 1	
3	$(x + 8)/2 - (x + 6)/5 = (5x + 40 - 2x - 12)/10$ $= (3x + 28)/10$ $\begin{array}{r} 3x + 28 \\ 10 \end{array}$	1 1	Accept 0.3x + 2.8 for 2 marks
4	$(-3x - 4)/5 = (2x + 6)/10 = -6x - 8 = 2x + 6$ $\begin{array}{r} 8x = -14 \\ x = -14/8 \end{array}$	1	
5	$\text{Subtended angle} = 180L/(\pi r) = (180 \times 800)/(\pi \times 200)$ $= 229.18^\circ$	1 1	Accept answers between 229 and 230
6	$\cos 60^\circ = AB/2.5$ $AB = 2.5 \cos 60^\circ$ $= 2.5 \times 0.5$ $= 1.25 \text{ m}$	1 1	Accept 1.25 for one mark without the unit
7	$\text{From } \tan \theta = 1/x \quad \text{Use right-angle triangle}$ $\text{Hypotenuse} = \sqrt{1^2 + x^2}$ $\text{So } \sin x = 1/\sqrt{1^2 + x^2}$	1 1	

Question	Answer	Marks	Guidance
8	Recognise that we have a right-angle triangle So Area = $\frac{1}{2}bh = \frac{1}{2} \times 6 \times 8 = 24 \text{ m}^2$ OR Area = $\sqrt{s(s-a)(s-b)(s-c)}$ $s = \frac{1}{2}(a+b+c) = \frac{1}{2}(6+8+10) = 12$ Area = $\sqrt{12(12-6)(12-8)(12-10)} = 24 \text{ m}^2$	   1 1	Accept any correct method of solution Accept 24 for one mark without the unit
9	$y = 2x^3 + \cos x$ $dy/dx = 6x^2 - \sin x$ $6x^2$ $-\sin x$	1  1	
10	$y = \sin x + 5 \ln(3x)$ $dy/dx = \cos x + 5/x$ $\cos x$ $5/x$	1 1	
11	$\int \sin 2x \, dx = (-\cos 2x)/2 + C$ $(-\cos 2x)/2$ $+C$	1 1	
12	$\int_1^2 5x^4 \, dx = \left[ x^5 \right]_1^2$ $= 2^5 - 1^5$ $= 31$	1   1	Award two marks for correct answer with or without working.
13	$x = 8$ because range is 7 $f = 5$ because $\Sigma f = 20$	1 1	

Question	Answer	Marks	Guidance
14		2	Award 0 or 2 marks
15	Packages delivered = $300 \times 0.8$ = 240	1 1	
	<b>Total</b>	<b>30</b>	

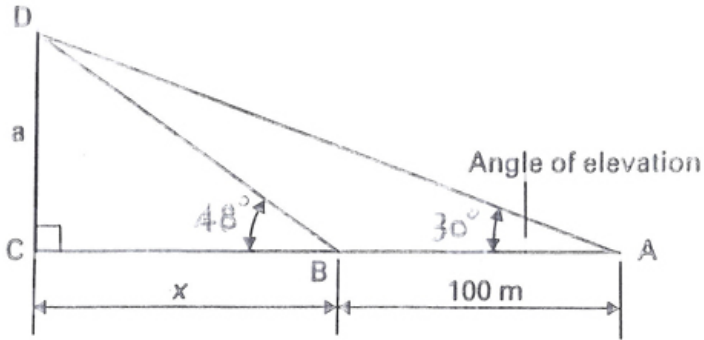
## Section B

Question		Answer	Marks	Guidance
1	(a)	Given $\tan \alpha = np/(\pi d)$ . Calculate the angle of the plane $\alpha$ when Substitute $n = 2$ , $p = 6$ and $d = 72$ Then $\tan \alpha = (2 \times 6)/(72\pi)$ $= 0.05305$ Then $\alpha = \text{inverse tan } 0.05305$ $= 3.037$	1 1 1 1	Accept answers between 3 and 3.1
	(b) (i)	Given $\tan \alpha = np/(\pi d)$ Multiply both sides by $d$ then $d \tan \alpha = np/ \pi$ Divide both sides by $\tan \alpha$ Then $d = np/(\pi \tan \alpha)$	1 1	
	(ii)	$n = 4$ , $p = 12$ and $\alpha = 6$ $d = np/\pi \tan \alpha$ So $d = (4 \times 12)/ (\pi \tan 6)$ $= 48/(0.1051\pi)$ $= 145.37$	1 1	Accept ecf  Accept answers between 145 and 146
	(c)	Given $V = (D/d)^2$ Square root both sides then $\sqrt{V} = D/d$ Multiply both sides by $d$ then $d\sqrt{V} = D$ Divide both sides by $\sqrt{V}$ then $d = D/\sqrt{V}$	1 1	
<b>Total</b>			<b>10</b>	

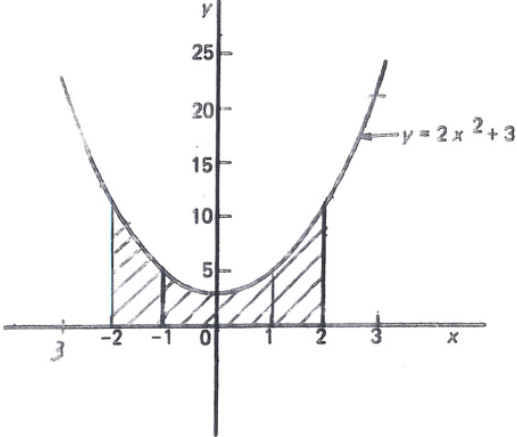


Question		Answer	Marks	Guidance
2	(a)	$10A + 4B = 450$ Eqn. 1 $8A + 2B = 270$ Eqn. 2	1 1	
	(b)	$\text{Eqn. 2} \times 2$ $16A + 4B = 540$ Eqn. 3 $\text{Eqn. 1} \times 1$ $10A + 4B = 450$ Subtract Eqn. 1 from Eqn. 3 $6A = 90$ $A = 90/6 = 15$	1 1 1	
	(c)	Substitute $A = 15$ into Eqn. 1 $10A + 4B = 450$ $150 + 4B = 450$ $4B = 450 - 150$ $4B = 300$ $B = 300/4 = 75$	1 1 1 1	
	(d)	Substitute $A = 15$ and $B = 75$ into Eqn. 2. $8A + 2B = 270$ Eqn. 2 $120 + 150 = 270$ QED Substitute $A = 15$ and $B = 75$ into Eqn. 1 $10A + 4B = 450$ Eqn. 1 $150 + 300 = 450$ QED	1	
<b>Total</b>			<b>10</b>	

Question		Answer	Marks	Guidance
3	(a)	Cosine rule:		
		$b^2 = a^2 + c^2 - 2ac \cos B$	1	Accept ecf
		In this case $a = 6$ m, $c = 8$ m and Angle $B = 50^\circ$		
		$b^2 = 6^2 + 8^2 - 2(6 \times 8) \cos 50^\circ$	1	
		$b^2 = 36 + 64 - 2(6 \times 8) 0.6428$	1	
		$b^2 = 100 - 61.71$	1	
		$b^2 = 38.29$	1	
		$b = 6.19$ m		Accept answers between 6 and 6.4 m without the unit
	(b)	Sine Rule		
		$c/\sin C = b/\sin B$		
		$\sin C = c \sin B/b$	1	Allow ecf
		Using $a = 6$ m, $b = 6.19$ m, $c = 8$ m and Angle $B = 50^\circ$		
		$\sin C = 8 \sin 50^\circ / 6.19$		
		$= (8 \times 0.766)/6.19$	1	
		$= 0.99$	1	
		Angle $C = \text{Inverse sin } 0.99$	1	Accept answers between 81 and 83 without the unit
		$= 81.88^\circ$		
	(c)	Angle $A = 180^\circ - \text{Angle } B - \text{Angle } C$	1	Accept answers between 48 and 49 without the unit
		$= 180^\circ - 50^\circ - 81.88^\circ$		Allow ecf
		$= 48.12^\circ$		
<b>Total</b>			<b>10</b>	

Question	Answer	Marks	Guidance
4 (a)		2	<p>Award 1 mark for the <math>48^\circ</math> triangle and 1 mark for the <math>30^\circ</math> triangle.</p> <p>Accept a horizontal line that uses A, C and B.</p>
(b)	<p>Triangle CBD. <math>\tan 48^\circ = a/x</math> so <math>a = x \tan 48^\circ</math>            Triangle CAD. <math>\tan 30^\circ = a/(x + 100)</math> so <math>a = (x + 100) \tan 30^\circ</math>            Therefore <math>x \tan 48^\circ = (x + 100) \tan 30^\circ</math>  <math>1.1106 x = 0.5774(x + 100)</math>  <math>1.1106 x = 0.5774x + 57.74</math>  <math>1.1106 x - 0.5774x = 57.74</math>  <math>0.5332 x = 57.74</math>  <math>x = 57.74/0.5332</math>  <math>x = 108.29 \text{ m}</math></p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>Be aware that if a candidate corrects <math>\tan 48^\circ</math> and <math>\tan 30^\circ</math> other than to 4 dp the answer for 'x' and 'a' will be different to those printed but the height of the mast will still work out to be between a 120 and 121 m.</p> <p>Accept any other correct solutions.</p> <p>Accept answers between 108 and 109 without the unit</p>
(c)	<p>Substitute <math>x = 108.29 \text{ m}</math> into <math>a = x \tan 48^\circ</math>            Then height of mast = <math>a = 108.29 \tan 48^\circ</math>  <math>a = 108.29 \times 1.1106</math>  <math>a = 120.27 \text{ m}.</math></p>	<p>1</p> <p>1</p> <p>1</p>	<p>Accept answers between 120 and 121 without the unit</p>
	<b>Total</b>	<b>10</b>	



Question	Answer	Marks	Guidance																
6 (a)	Complete the table for the equation $y = 2x^2 + 3$ from $x = -3$ to $x = +3$ . <table border="1" data-bbox="421 280 1039 421" style="margin-left: auto; margin-right: auto;"> <tr> <td>x</td> <td>-3</td> <td>-2</td> <td>-1</td> <td>0</td> <td>1</td> <td>2</td> <td>3</td> </tr> <tr> <td>y</td> <td>21</td> <td>11</td> <td>5</td> <td>3</td> <td>5</td> <td>11</td> <td>21</td> </tr> </table>	x	-3	-2	-1	0	1	2	3	y	21	11	5	3	5	11	21	1	
x	-3	-2	-1	0	1	2	3												
y	21	11	5	3	5	11	21												
(b)		3	Accept ecf One mark for the x and y axes Two marks for the shape																
(c)	$\begin{aligned} \text{Shaded area} &= \int_{-2}^2 y \, dx \\ &= \int_{-2}^2 (2x^2 + 3) \, dx \\ &= [2x^3/3 + 3x]_{-2}^2 \\ &= (16/3 + 6) - (-16/3 - 6) \\ &= 16/3 + 6 + 16/3 + 6 \\ &= 22\frac{2}{3} \text{ square units} \end{aligned}$	1 1 1 1 1 1	Accept answers between 22 and 23 without the unit																
<b>Total</b>		<b>10</b>																	

Question		Answer	Marks	Guidance
7	(a)	Cumulative frequency – a running total of the frequencies Mode – most common data value Median – middle value when the data is listed in order of magnitude Mean – sum of data divided by number in sample	1 1 1 1	
	(b)	Lower quartile = 26 Median = 29 Upper quartile = 34	1 1 1	Lower quartile – accept answers between 25 and 27 Median – accept answers between 28 and 30 Upper quartile – accept answers between 33 and 35  If there is a BOD situation accept: Lower quartile = $\frac{1}{4} \times 50 = 12.5$ Median = $\frac{1}{2} \times 50 = 25$ Upper quartile = $\frac{3}{4} \times 50 = 37.5$
	(c)	Number of components from curve: Lower quartile = $\frac{1}{4} \times 50 = 12.5$ Median = $\frac{1}{2} \times 50 = 25$ Upper quartile = $\frac{3}{4} \times 50 = 37.5$	1 1 1	
<b>Total</b>			<b>10</b>	

Question			Answer	Marks	Guidance
8	(a)	(i)	People owning a laptop or mobile phone or both $= 215 + 165 - 125$ $= 255$	3	Award up to three marks for understanding shown Accept any alternative correct responses
	(a)	(ii)	Probability of owning a mobile or laptop but not both $= 255/255 - 125/255$ $= 130/255 (0.5098)$	1 1	In all cases accept correct decimal answers
	(b)		Probability of owning a laptop, given that they own a mobile phone $= (125/255)/(215/255)$ $= 125/215 (0.5814)$	2 1	In all cases accept correct decimal answers
	(c)		Number owning a laptop = $165 - 125 = 40$ Probability of not owning a mobile phone, but they own a Laptop = $(40/255)/(165/255)$ $= 40/165 (0.2424)$	1 1	In all cases accept correct decimal answers
<b>Total</b>				<b>10</b>	

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