OCR
Oxford Cambridge and RSA

Level 3 Certificate

Mathematical Techniques and Applications for Engineers

Unit **H865/01** Component 1

OCR Level 3 Certificate

Mark Schemes for June 2014

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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.

Annotations in scoris

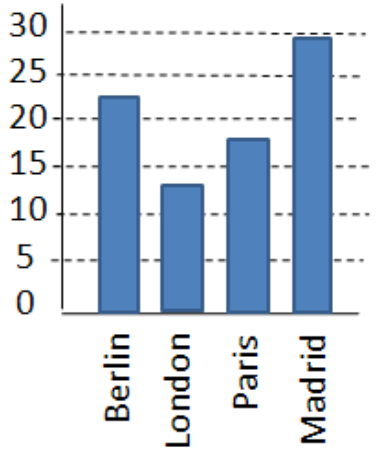
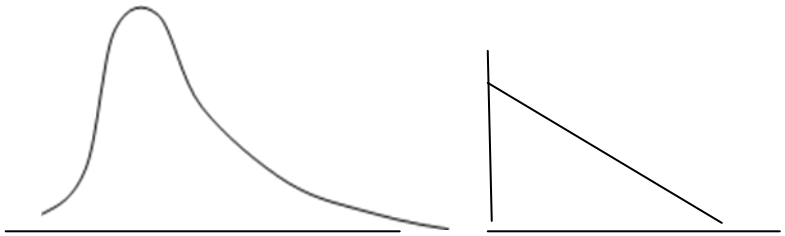
The following annotations are available:

BP	Blank Page – this annotation **must** be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
✓	correct response
✗	incorrect response
ecf	error carried forward
BOD	Benefit of doubt

Question			Expected Answer	Mark	Rationale/Additional Guidance
Section A					
1			$-4(3x-5)+2x = -12x+20+2x = -10x+20$ $-10x$ 20	**[1]** **[1]**	CAO
2			$x^2-7x+12=(x-3)(x-4)$ $(x-3)$ $(x-4)$	**[1]** **[1]**	CAO
3			$(2x-10)/3-(4x+5)/6=(4x-20-4x-5)/6=-25/6$ -25 $6.$	**[1]** **[1]**	Accept correct decimal – 4.17 or fraction answer for two marks
4			$(x+1)/2+(x+2)/3=(x+3)/6$ $3x+3+2x+4=x+3$ $4x=-4$ $x=-1$	**[1]** **[1]**	CAO
5			Angular speed $=(70\times 2\pi)/60$ $=7.33$ rad s^{-1}	**[1]** **[1]**	Award one mark for correct numerical result with or without the unit Accept $7\pi/3$ or answers between 7.3 and 7.4 rad s^{-1}

Question			Expected Answer	Mark	Rationale/Additional Guidance
Section A					
6		**(a)**	$v = 50 \sin x$ When $x = 30^o$ then $v = 50 \sin 30^o = 25$	**[1]**	
		(b)	When $x = 270^o$ then $v = 50 \sin 270^o = -50$	**[1]**	
7			Given $\sin^2 x + \cos^2 x = 1$ Substitute $x = 230^o$ then $\sin^2 230^o + \cos^2 230^o$ equals 0.5868 + 0.4132 equals 1 QED	**[1]** **[1]**	
8			Area = $\sqrt{s(s-a)(s-b)(s-c)}$ Substitute a, b and c to find s then $s = (5 + 8 + 10)/2 = 11.5$ So area = $\sqrt{11.5(11.5-5)(11.5-8)(11.5-10)}$ Area = 19.81 m^2	**[1]** **[1]**	Award one mark for correct numerical result with or without the unit
9			$y = 4 \cos x + 2 \sin x$ dy/dx $= -4 \sin x + 2 \cos x$ $-4 \sin x$ $2 \cos x$	**[1]** **[1]**	
10			$y = 4 \ln 2x + 2 e^{5x}$ $dy/dx = (4/x) + 10 e^{5x}$ $4/x$ $10 e^{5x}$	**[1]** **[1]**	

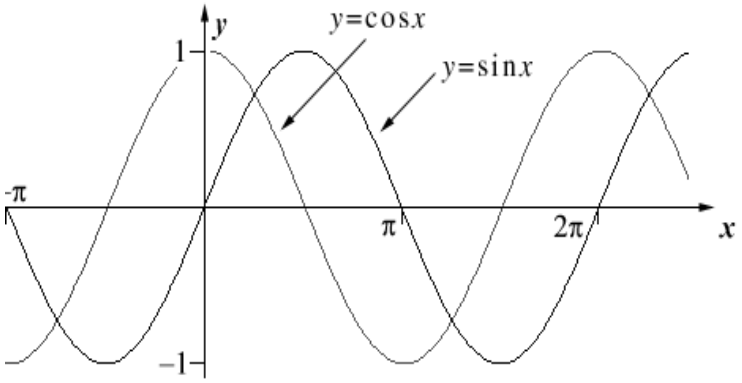
Question	Expected Answer	Mark	Rationale/Additional Guidance
Section A			
11	$\int \sqrt{x}\ dx = \int x^{1/2}\ dx = (2/3)\ x^{3/2} + C = [(2/3)\ \sqrt{x^3}] + C$ $[(2/3)\ \sqrt{x^3}]$ C	**[1]** **[1]**	Accept $(2/3)\ x^{3/2}$ for one mark
12	$\int_2^4 3x^2\ dx = [x^3]_2^4 = 4^3 - 2^3 = 56$ $[x^3]_2^4$ 56	**[1]** **[1]**	Award one mark for x^3

Question			Expected Answer	Mark	Rationale/Additional Guidance
Section A					
13				**[2]**	Award one mark for correct vertical and horizontal axis and one mark for correct plotting of bars.
14	**a**		7/12 or 0.583	**[1]**	
	b		6/11 or 0.545	**[1]**	
15				**[2]**	Award one mark for any reasonable closed shape with a tail (smooth, triangular etc.) plus one mark for the tail on the right hand side.
			Total	**[30]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
Section B					
1	**(a)**		Given that $L_t = L_o(1 + \alpha t)$ Open bracket, then $L_t = L_o + L_o \alpha t$ Subtract L_o from both sides, then $L_o \alpha t = L_t - L_o$ Divide both sides by $L_o \alpha$, then $t = (L_t - L_o)/L_o \alpha$	**[1]** **[1]** **[1]**	Accept any alternative correct response
1	**(b)**		Given that $v^2 = u^2 + 2as$ Subtract $2as$ from both sides, then $u^2 = v^2 - 2as$ Square root both sides, then $u = \sqrt{(v^2 - 2as)}$	**[1]** **[1]**	
1	**(c)**		Given that $i = nE/(R + nr)$ Cross multiply, then $i(R + nr) = nE$ Open brackets, then $iR + inr = nE$ Subtract inr from both sides, then $iR = nE - inr$ Use a bracket, then $n(E - ir) = iR$ Divide both sides by $E - ir$ then $n = iR/(E - ir)$	**[1]** **[1]** **[1]** **[1]** **[1]**	Accept any alternative correct response
			Total	**[10]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
2	(a)		Let S =number of supervisors Let T = number of technicians So 1S + 5T = 1750 and 6S +9T = 5250	 [1] [1]	
2	(b)		Given (x – 1)/[(3x – 5)(x – 3)] So (x – 1)/[(3x – 5)(x – 3)] = [A/(3x – 5)] + [B/(x – 3)] Multiply both sides by (3x – 5)(x – 3) then (x – 1) = [A/(x – 3)] + [B/(3x – 5)] Because (x – 3) = 0 then x =3 Substituting gives 2 = 4B so B = 0.5 Because (3x – 5) = 0 then x = 5/3 Substituting gives (5/3) – 1 = A[(5/3) – 3] Then A = – 0.5	 [2] [4] [2]	 Accept A/(3x-5) +B/(x-3) for two marks and then A = – 0.5 (or B = 0.5) for four marks and then (A = – 0.5) or B = 0.5 for two marks Accept any alterative correct response
			Total	**[10]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
3	(a)	(i)	Angle C = $180^o - 80^o - 30^o$ so C = 70^o	[1]	
3	(a)	(ii)	From the sine rule: $a/\sin 80^o = 200/\sin 30^o$ so $a = (200 \sin 80^o)/\sin 30^o$ so a = 393.92 mm	[1] [1] [1]	Accept answers between 393 and 394 mm Award one mark for correct numerical result with or without the unit
3	(b)	(i)	Cosine rule: $p^2 = q^2 + r^2 - 2qr \cos P$ In this case q =120 mm, r = 200 mm and Angle P = 50^o $p^2 = 120^2 + 200^2 - 2(120 \times 200) \cos 50^o$ p = 153.45 mm	[1] [1] [1]	Accept answers between 153 and 154 mm Award one mark for correct numerical result with or without the unit
3	(b)	(ii)	In this case p = 153.45, q =120 mm, r = 200 mm $\cos Q = (p^2 + r^2 - q^2)/2ac$ $\cos Q = (153.45^2 + 200^2 - 120^2)/(2 \times 153.45 \times 200)$ So Angle $Q = \cos^{-1} (153.45^2 + 200^2 - 120^2)/(2 \times 153.45 \times 200)$ $Q = 36.80^o$	[1] [1] [1]	Accept ecf. for side p Accept any alternative method that gives a correct solution Accept answers between 36 and 37^o Award one mark for correct numerical result with or without the unit
			Total	[10]	

Question			Expected Answer	Mark	Rationale/Additional Guidance
4	(a)			[4]	Award one mark for any one and a half cycle between $-\pi$ and 2π Award one mark for one graph in correct position Award one mark for another graph in correct position. Award one mark for correct labels .
4	(b)		Given equation $2\cos x = 0.8$ Then $\cos x = 0.4$ so $x = \cos^{-1} 0.4$ $x = 66.42^o$ and $x = 293.58^o$	[1] [1] [1]	Award one mark for correct numerical results with or without the unit Accept answers between 66 and 67^o Accept answers between 293 and 294^o
4	(c)		Given equation $2\cos x = \sin x$ Then $2 = \sin x/\cos x$ Then $\tan x = 2$ so $x = \tan^{-1} 2$ $x = 63.43^o$ and $x = 243.43^o$	[1] [1] [1]	Award one mark for correct numerical results with or without the unit Accept answers between 63 and 64^o Accept answers between 243 and 244^o
			Total	[10]	

Question			Expected Answer	Mark	Rationale/Additional Guidance
5	(a)		Given equation $y = x^3 + 1.5x^2 – 18x$ $dy/dx = 3x^2 + 3x – 18$ $dy/dx = 0$ for zero gradient so $3x^2 + 3x – 18 = 0$ $3(x^2 + x – 6) = 0$ $(x + 3)(x – 2) = 0$ So $x = + 2$ or $x = –3$	**[1]** **[1]** **[1]** **[1]**	
5	(b)		When $x = + 2$ $y = = x^3 + 1.5x^2 – 18x$ $y =(2)^3 + 1.5(2)^2 – 18(2)$ $y = – 22$ When $x = – 3$ $y = (– 3)^3 + 1.5(– 3)^2 – 18(– 3)$ $y = 40.5$	**[1]** **[2]**	.

Question			Expected Answer	Mark	Rationale/Additional Guidance
5	(c)		$dy/dx = 3x^2 + 3x - 18$ $d^2y/dx^2 = 6x + 3$ When $x = +2$ then $d^2y/dx^2 = (6 \times 2) + 3 = +15$ i.e. Minimum turning point When $x = -3$ then $d^2y/dx^2 = (6 \times -3) + 3 = -15$ i.e. Maximum turning point	**[1]** **[1]** **[1]**	
			Total	**[10]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
6	(a)		$\int 4 \sin 5x \, dx$ $= (-4/5 \cos 5x) + C$ $-4/5$ $\cos 5x$	**[1] [1]**	Do not award any marks for constant C. This has been tested in section A
6	(b)		Given $y = \cos x$ Then area $= \int_0^{\pi/2} \cos x \, dx$ $= [\sin x]_0^{\pi/2}$ $= (\sin \pi/2) - (\sin 0)$ $= 1 - 0 = 1$ square unit	**[1]** **[1]** **[1]** **[1]**	Award one mark for correct numerical results with or without the unit
6	(c)		Given $v = -0.5t^2 - 3t + 40$ $s = \int_{t^1}^{t^2} v \, dt = \int_3^6 -0.5t^2 - 3t + 40 \, dt$ So $s = [(-0.5 \times t^3)/3 - (3t^2)/2 + 40t]_3^6$ $s = (-36 - 54 + 240) - (-4.5 - 13.5 + 120) = 48$ m	**[1]** **[1]** **[1]** **[1]**	Award one mark for correct numerical results with or without the unit
			Total	**[10]**	

<table>
<tr><th colspan="3">Question</th><th>Expected Answer</th><th>Mark</th><th>Rationale/Additional Guidance</th></tr>
<tr><td>7</td><td>(a)</td><td>(i)</td><td>Given data: 12 14 14 16 18 18 20
Range = 20 – 12 =8</td><td>[1]</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>By inspection median is the centre value ie. 16</td><td>[1]</td><td></td></tr>
<tr><td></td><td></td><td>(iii)</td><td>Consider first three values then lower quartile is 14
Consider last three values then upper quartile is 18</td><td>[1]</td><td></td></tr>
<tr><td></td><td></td><td>(iv)</td><td>Interquartile range = 18 – 14 = 4</td><td>[1]</td><td></td></tr>
<tr><td>7</td><td>(b)</td><td>(i)</td><td>Mean $\bar{x}$ = (78 +92 + 102 + 72)/4 = 344/4 = 86</td><td>[1]</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td><table><tr><th>Values x</th><th>x – $\bar{x}$</th><th>(x – $\bar{x}$)^2</th></tr><tr><td>78</td><td>–8</td><td>64</td></tr><tr><td>92</td><td>6</td><td>36</td></tr><tr><td>102</td><td>16</td><td>256</td></tr><tr><td>72</td><td>–14</td><td>196</td></tr><tr><td></td><td></td><td>Σ = 552</td></tr></table></td><td>[3]</td><td>.

Accept ecf for summation

7(b)(ii) Award one mark for each correct column and one mark for Σ = 552</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>Standard deviation = √(552/4)
= 11.75</td><td>[1]
[1]</td><td>Accept ecf from 7(b)(ii)</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>[10]</td><td></td></tr>
</table>

Question			Expected Answer	Mark	Rationale/Additional Guidance
8	(a)		The probability of something happening is the likelihood or chance of it happening.	[1]	
8	(b)		Two events are independent if the outcome of one has no effect on the outcome of the other	[2]	
8	(c)		Events are mutually exclusive if they cannot happen at the same time	[2]	
8	(d)		P(x and y) = P(x) x P(y)	[1]	Accept x $_{x}$ y
8	(e)		P(x or y) = P(x) + P(y)	[1]	Accept x $_{+}$ y
8	(f)	(i)	Probability = 14/40 or 7/20 or 0.35	[1]	
		(ii)	Probability = 26/40 or 13/20 or 0.65	[1]	
		(iii)	Probability = 32/40 or 0.8	[1]	
			Total	[10]	

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