



Level 3 Certificate

Mathematics for Engineering

OCR Level 3 Certificate

H860/01 Paper 1

Mark Scheme for June 2012

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

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Question			Answer	Mark	Guidance
1	(a)	(i)	Length of steel for stage i is $5\left(\frac{1}{2}\right)^{i-1}$	1 [1]	Candidates should recognise this as a geometric series and use the appropriate formulae in MF1. Accept ar^{i-1} provided that correct values for a and/or r are given.
1	(a)	(ii)	<p>Total length of steel at stage n is $\frac{5\left(1-\left(\frac{1}{2}\right)^n\right)}{1-\frac{1}{2}} = 10\left(1-\left(\frac{1}{2}\right)^n\right)$ metres</p> <p>Total length of steel at stage 10 = $10\left(1-\left(\frac{1}{2}\right)^{10}\right) = 9.9902$ metres</p>	3 [3]	<p>Allow 1 mark for $\frac{a(1-r^n)}{1-r}$ if given without values for a and r and without any final answer.</p> <p>Allow reasonable attempts at manually summing ten values. Award 3 marks if answer is correct to 1 dp. Award 2 marks if ten individual values are correct but sum is wrong. Award 1 mark for ten reasonable (decreasing) individual values seen summed.</p> <p>NOTE: The question did not state that the formulae in MF1 MUST be used.</p>
1	(a)	(iii)	Limit as $n \rightarrow \infty \left\{ 10\left(1-\left(\frac{1}{2}\right)^n\right) \right\} = 10$ metres	2 [2]	Allow 1 mark for $\frac{a}{1-r}$
1	(b)	(i)	$t_i = 1 + 4(i-1)$ or $t_i = 4i - 3$	2 [2]	<p>Allow 1 mark for $a + (n-1)d$ seen without values for a and d.</p> <p>Allow 1 mark for $t_i = t_i + 4$ OE</p>
1	(b)	(ii)	$t_{10} = 37$	1 [1]	CAO allow answer with no working

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Question			Answer	Mark	Guidance
1	(b)	(iii)	$\sum_{i=1}^n t_i = \frac{1}{2}n(2 + 4(n-1)) = \frac{1}{2}n(4n-2)$ $\sum_{i=1}^{10} t_i = \frac{1}{2}10(40-2) = 190$	1 1 [2]	
2			Information given $A'.B'.C' = 50$ $A = 60$ and therefore $A' = 140$ $B = 80$ and therefore $B' = 120$ $C = 105$ and therefore $C' = 95$ $A.B'.C' = 15$ $A'.B.C' = 20$ $A'.B'.C = 40$ $A.B.C = 20$		
2	(a)	(i)	Required $A'.B.C$ Since $A'.B.C + A'.B'.C + A'.B.C' + A'.B'.C' = A' = 140$ $A'.B.C = 140 - A'.B'.C - A'.B.C' - A'.B'.C' = 140 - 40 - 20 - 50 = 30$	2 [2]	Accept answers shown in a Venn diagram OE
2	(a)	(ii)	Required $A.B.C'$ Since $A.B.C' + A.B.C + A'.B.C' + A'.B.C = B = 80$ $A.B.C' = 80 - A.B.C - A'.B.C' - A'.B.C = 80 - 20 - 20 - 30 = 10$	2 [2]	Accept answers shown in a Venn diagram OE

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Question			Answer	Mark	Guidance
2	(b)	(i)	Required P (A.B'.C) Since $A.B.C + A.B'.C + A.B.C' + A.B'.C' = A = 60$ $A.B'.C = 60 - A.B.C - A.B.C' - A.B'.C' = 60 - 20 - 10 - 15 = 15$ $15/200 = 3/40$	2 [2]	Allow 1 mark here OR in part (b)(ii) if 200 seen as the denominator.
2	(b)	(ii)	Required P ((A.B.C') + (A.B'.C) + (A'.B.C)) $(10 + 15 + 30)/200 = 55/200 = 11/40$	2 [2]	See note above.
2	(c)		Required $P\{(A.B)/B\} = (A.B.C' + A.B.C)/B = (10 + 20)/80 = 3/8$	2 [2]	Allow 1 mark if reasonable attempt seen for conditional probability.
3	(a)		$-4 + R_1 I_1 - 8 + R_2 (I_1 - I_2) = 0 \quad (R_1 + R_2)I_1 - R_2 I_2 = 12$ $10 + R_3 I_2 + R_2 (I_2 - I_1) + R_4 I_2 = 0 \quad -R_2 I_1 + (R_2 + R_3 + R_4)I_2 = -10$ OR $10I_1 - 2I_2 = 12$ $5I_1 - I_2 = 6$ OR $-2I_1 + 12I_2 = -10$ OR $-I_1 + 6I_2 = -5$	1 1 [2]	Also allow $10I_1 - 2I_2 - 12 = 0$ OE Also allow $-2I_1 + 12I_2 + 10 = 0$ OE
3	(b)		$\begin{bmatrix} 10 & -2 \\ -2 & 12 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 12 \\ -10 \end{bmatrix} \quad \mathbf{A} \mathbf{I} = \mathbf{b}$	1 [1]	Correct matrix notation MUST be used

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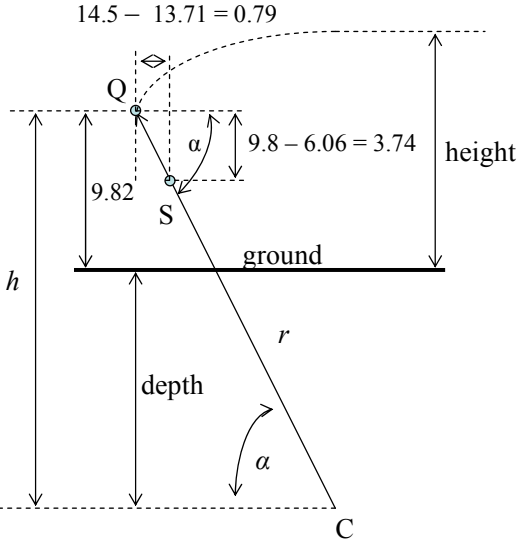
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Question			Answer	Mark	Guidance
4	(a)		$(r - SQ)^2 + SR^2 = r^2$ $r^2 - 2SQr + SQ^2 + SR^2 = r^2$ $2SQr = SQ^2 + SR^2$ $r = \frac{SQ^2 + SR^2}{2SQ}$	1 1 1 [3]	Answer must clearly show correct reasoning
4	(b)	(i)	$PR = \sqrt{29^2 + (9.12 - 3)^2} = 29.6387 \text{ m}$	1 [1]	
4	(b)	(ii)	S at $(29/2, 3 + (9.12 - 3)/2) = (14.5, 6.06)$ $SQ = \sqrt{(14.5 - 13.71)^2 + (9.8 - 6.06)^2} \approx 3.82 \text{ m}$	2 [2]	Allow alternative solution with ECF: $SR = PR/2 = 14.8194$ $QR^2 = (29 - 13.17)^2 - (9.8 - 9.12)^2$ $= 233.3217$ or $QR = 15.2749$ Then $SQ = \sqrt{QR^2 - SR^2} \approx 3.83$
4	(b)	(iii)	$r = \frac{3.8225^2 + \left(\frac{PR}{2}\right)^2}{2 \times 3.8225} = 30.6376 \text{ m}$	1 [1]	Allow ECF

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Question	Answer	Mark	Guidance
<p>4 (b) (iv)</p>	 <p> $14.5 - 13.71 = 0.79$ $9.8 - 6.06 = 3.74$ h 9.82 S $ground$ $depth$ r C α α </p> <p> $\alpha = \tan^{-1} \frac{3.74}{0.79} = 1.363 \text{ rads} = 78.07^\circ$ $h = r \sin \alpha = 29.9759$ </p>	<p>1</p> <p>1</p> <p>[2]</p>	<p>Diagram not required for full marks</p>
<p>4 (b) (v)</p>	<p> $depth = h - 9.8 = 20.1759$ $height = r - depth = 30.6376 - 20.1759 = 10.4617 \text{ m}$ </p>	<p>1</p> <p>1</p> <p>[2]</p>	

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Question		Answer	Mark	Guidance
5	(a)	$\sin A + \sin B = 2 \sin\left(\frac{A+B}{2}\right) \cos\left(\frac{A-B}{2}\right)$ $S_1 = \sin(2\pi ft) \quad \text{and} \quad S_2 = \sin(2\pi ft + \phi)$ $S_1 + S_2 = 2 \sin\left(\frac{2\pi ft + 2\pi ft + \phi}{2}\right) \cos\left(\frac{2\pi ft - 2\pi ft - \phi}{2}\right) =$ $2 \sin\left(2\pi ft + \frac{\phi}{2}\right) \cos\left(-\frac{\phi}{2}\right) = 2 \sin\left(2\pi ft + \frac{\phi}{2}\right) \cos\left(\frac{\phi}{2}\right)$ <p>i</p> $\text{When } \phi = \frac{2\pi}{3} \quad S_1 + S_2 = 2 \sin\left(2\pi ft + \frac{\pi}{3}\right) \cos\left(\frac{\pi}{3}\right) = \sin\left(2\pi ft + \frac{\pi}{3}\right)$ <p>ii</p> $\text{When } \phi = \pi \quad S_1 + S_2 = 2 \sin\left(2\pi ft + \frac{\pi}{2}\right) \cos\left(\frac{\pi}{2}\right) = 0$	2 2 1 [5]	Award 2 marks for a response that uses $\cos\left(-\frac{\phi}{2}\right)$ or $\cos\left(\frac{\phi}{2}\right)$ Answer must cancel 2 and $\cos\left(\frac{\pi}{3}\right)$ CAO
5	(b)	$\sin A + \sin B = 2 \sin\left(\frac{A+B}{2}\right) \cos\left(\frac{A-B}{2}\right) =$ $\sin 2\pi f_1 t + \sin 2\pi f_2 t = 2 \sin\left(\frac{2\pi f_1 t + 2\pi f_2 t}{2}\right) \cos\left(\frac{2\pi f_1 t - 2\pi f_2 t}{2}\right) =$ $2 \sin\left(\left(\frac{f_1 + f_2}{2}\right) 2\pi t\right) \cos\left(\left(\frac{f_1 - f_2}{2}\right) 2\pi t\right) =$ $2 \cos(\pi(f_1 - f_2)t) \sin(\pi(f_1 + f_2)t)$	2 [2]	

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Question			Answer	Mark	Guidance
5	(c)		$\frac{f_1 + f_2}{2} = 50$ $\frac{f_1 - f_2}{2} = 5$ $f_1 + f_2 = 100$ $f_1 - f_2 = 10$ $2f_1 = 110$ $f_1 = 55 \text{ Hz and } f_2 = 45 \text{ Hz}$	2 [2]	Award 1 each for 55 and 45 seen
6	(a)		Period = 2 s Frequency = 0.5 Hz	1 [1]	
6	(b)		$g(t) = t/2$	1 [1]	
6	(c)		$\int uv' = uv - \int vu'$ $\int t \sin at dt = -\frac{t \cos at}{a} - \int -\frac{\cos at}{a} dt =$ $-\frac{t \cos at}{a} + \frac{\sin at}{a^2} + c =$ $\frac{\sin at}{a^2} - \frac{t \cos at}{a} + c$	1 2 1 [4]	1 mark for use of correct formula 1 mark for $-t \cos at - \int -\cos at dt$

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Question			Answer	Mark	Guidance
6	(d)	(i)	$c = \frac{2}{T} \int_0^T g(t) dt \Rightarrow c = \frac{2}{2} \int_0^2 \frac{t}{2} dt = \left[\frac{t^2}{4} \right]_0^2 = 1$	2 [2]	Accept ECF
6	(d)	(ii)	$a_n = \frac{2}{T} \int_0^T g(t) \sin 2\pi f n t \, dt = \frac{2}{2} \int_0^2 \frac{t}{2} \sin 2\pi \frac{1}{2} n t \, dt = \frac{1}{2} \int_0^2 t \sin \pi n t \, dt =$ $\frac{1}{2} \left[\frac{\sin \pi n t}{(\pi n)^2} - \frac{t \cos \pi n t}{\pi n} \right]_0^2 =$ $\frac{1}{2} \left[\left(0 - \frac{2}{\pi n} \right) - (0 - 0) \right] = -\frac{1}{\pi n}$	1 1 2 [4]	Accept ECF From given result in part c

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