OCR
RECOGNISING ACHIEVEMENT

Principal Learning

Engineering

OCR Level 3 Principal Learning in Engineering **H811**

Mark Schemes for the Units

June 2009

H811/MS/R/09

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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.

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Principal Learning

OCR Level 3 Principal Learning in Engineering H811

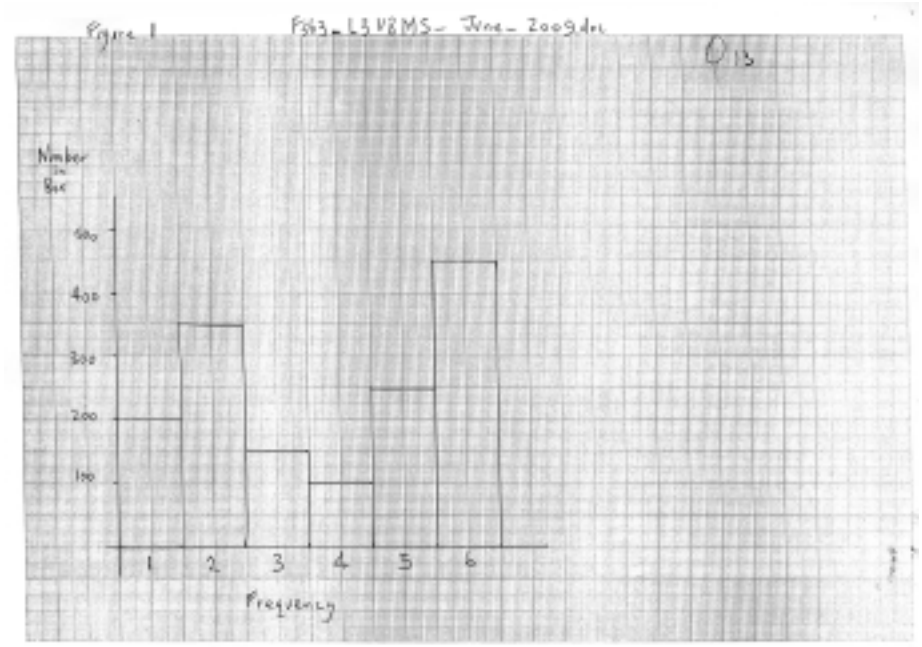
MARK SCHEMES FOR THE UNITS

F563 - Mathematical Techniques and Applications for Engineers

Section A

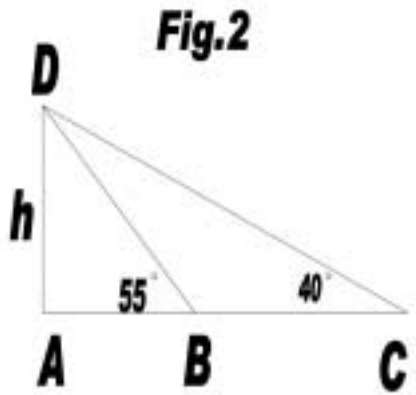
Question	Expected Answers	Marks	Rationale
1	$(x + 3)(x – 6) = x^2 – 6x + 3x – 18 = x^2 – 3x – 18$	**[2]**	$x^2 – 6x + 3x – 18$ (1 mark only for part answer) $x^2 – 3x – 18$ (2 marks)
2	$abc + acx = ac(b + x)$	**[2]**	ac (1 mark) (b + x) (1 mark) a(bc + cx) (incomplete solution - zero)
3	$(x + 2)/4 – (x + 5)/3 = (3x + 6 – 4x - 20)/12 = (–x – 14)/12$	**[2]**	(3x + 6 – 4x - 20)/12 (1 mark) (–x – 14)/12 (1 mark)
4	$6(4 + x) = 10x – 8$ $24 + 6x = 10x – 8$ $4x = 32$ $x = 32/4 = 8$	**[2]**	24 + 6x = 10x – 8 (1 mark) 4x = 32 x = 32/4 = 8 (1 mark)
5	Length of arc = $(\pi x^0 r)/180 = (\pi \times 65 \times 75)/180 = 85.085$mm correct to 2dp	**[2]**	$(\pi x^0 r)/180$ (1 mark) $(\pi \times 65 \times 75)/180 = 85.085$mm correct to 2dp (1 mark) Accept numerical answer with or without unit (2 marks)
6	$v = 180 \sin \theta = 180 \sin 45^o = 180 \times 0.7071 = 127.3$ volts correct to 1dp	**[2]**	$180 \sin 45^o = 180 \times 0.7071$ (1 mark) 127.3 volts correct to 1dp (1 mark) Accept numerical answer with or without unit (2 marks)

Question	Expected Answers	Marks	Rationale
7	cos θ = 4/5. Recognise 3, 4, 5 triangle. tan θ = ¾	**[2]**	Recognise 3, 4, 5 triangle (1 mark) tan θ = ¾ (1 mark) OR tan θ = ¾ (2 marks)
8	Area of a triangle = ½ bh = ½ x 500 x 60 = 15000 mm^2	**[2]**	½ bh (1 mark) ½ x 500 x 60 = 15000 mm^2 (1 mark) Accept numerical answer with or without unit (2 marks)
9	$y = 4x^3 + 3x^2$ $dy/dx = 12x^2 + 6x$	**[2]**	$12x^2$ (1 mark) + 6x (1 mark)
10	y = 4 cos 3x $dy/dx = – (3 \times 4) \sin 3x = – 12 \sin 3x$	**[2]**	- 12 (1 mark) sin 3x (1 mark)
11	$\int_0^2 12x^3 . dx = [(12x^4)/4]^2_0 = [3x^4]^2_0 = 48 – 0 = 48$	**[2]**	$[3x^4]^2_0$ (1 mark) 48 (1 mark)
12	$\int 12 \sin 6x. dx = (– 12 \cos 6x)/6 + C = –2 \cos 6x + C$	**[2]**	–2 cos 6x (1 mark) + C (1 mark)

Question	Expected Answers	Marks	Rationale
13	Histogram Fig. 1  	[2]	One mark for correct x and y axis One mark for six correct rectangles
14	Mean diameter = (6.25 +6.10 + 6.00 + 6.40 + 6.60)/5 = 31.35/5 = 6.27	[2]	(6.25 +6.10 + 6.00 + 6.40 + 6.60)/5 (1 mark) 6.27 (1 mark)
15	The probability of something happening is the likelihood or chance of it happening so 1/3 means that out of every three tries at something it will happen correctly once.	[2]	out of every three tries at something (1 mark) it will happen correctly once (1 mark)

Section B

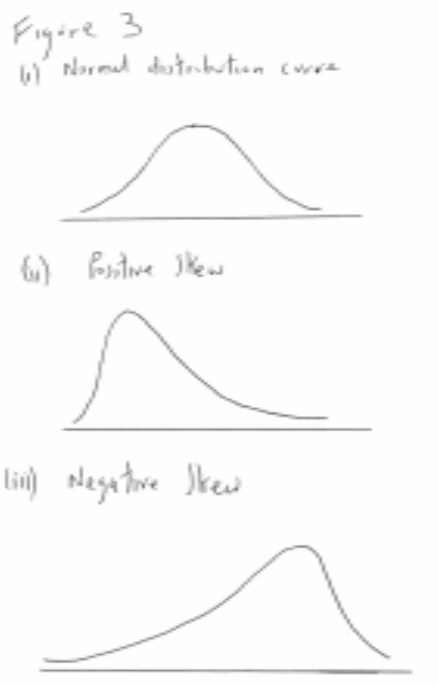
Question	Expected Answers	Mark	Rationale
1 (a)	Given equation $s = ut + ½at^2$ $ut = s - ½at^2$	(1 mark)	
(b) (i)	$u = (s - ½at^2)/t$ Given equation $s = ut + ½at^2$ Substituting s = 125 m and t = 6 s into given equation gives: $125 = 6u + ½a(6^2)$ $125 = 6u + 18a$ Equation 1 Substituting s = 394 m and t = 12 s into the given equation gives: $394 = 12u + ½a(12^2)$ $394 = 12u + 72\ a$ Equation 2 Multiply equation 1 by 2 $250 = 12u + 36a$ Equation 3 Subtract equation 3 from equation 2 $144 = 36a$ $a = 144/36$ $a = 4\ ms^{-2}$ Substitute $a = 4\ m/s^2$ into equation 1 $125 = 6u + 18a$ $125 = 6u + 72$ $6u = 53$ $u = 53/6$ $u = 8.83\ ms^{-1}$ The initial velocity is 8.83 ms^{-1} and the acceleration is 4 ms^{-2}	(1 mark) (1 mark) (1 mark) (1 mark) (1 mark) (1 mark) (1 mark) (1 mark)	

Question	Expected Answers	Mark	Rationale
(ii)	Substitute into equation 1 time (t) = 9 s, initial velocity (u) = 8.83 ms^{-1} and acceleration (a) = 4 ms^{-2} Distance travelled (s) = (8.83 x 9) + (½ x 4 x 9^2) s = 79.5 + 162 s = 241.5 m The distance travelled after 9 s is 241.5 m. Note: (a) If an error is carried forward (ecf) marks can be awarded for using the error correctly to determine a value for initial velocity (u) and acceleration (a) (b) Accept any correct solution that is presented by using the method of substitution (c) Accept any correct solution that is presented by the learner determining a value for initial velocity (u) before acceleration (a)	(1 mark) **[10]**	
2	Fig. 2  		The revised diagram does not affect the marking of this question

Question	Expected Answers	Mark	Rationale
(a)	Distance BC = 70 m Triangle ADC: tan 40^0 = h/AC so h = AC tan 40^0 (1 mark) But AC = AB + 70 so h = (AB + 70) tan 40^0 Equation 1 (1 mark) Triangle ABD: tan 55^0 = h/AB so h = AB tan 55^0 Equation 2 (1 mark) But Equation 2 equals Equation 1 so AB tan 55^0 = (AB + 70) tan 40^0 (1 mark) AB tan 55^0 = AB tan 40^0 + 70 tan 40^0 (1 mark) 1.4281 AB = 0.8391 AB + 58.737 AB (1.4281 – 0.8391) = 58.737 (1 mark) 0.589 AB = 58.737 AB = 58.727/0.589 AB = 99.71 m (1 mark)		Accept any correct alternative solution
(b)	Substitute AB = 99.71 m into Equation 1 so h = (AB + 70) tan 40^0 h = (99.71 + 70) 0.8391 (1 mark) h = 169.71 x 0.8391 h = 142.4 m (1 mark)		

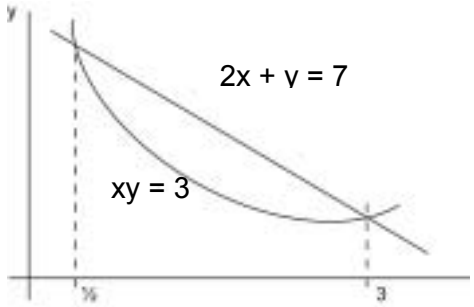
Question	Expected Answers	Marks	Rationale
(c)	Height of pole = 142.4 + 1.6 = 144 m (1 mark) The height of the pole is 144 metres.	[10]	
3 (a)	Given equation is $s = 2t^3 - 4t^2 - 6t + 8$. Velocity = ds/dt $ds/dt = 6t^2 - 8t - 6$ (1 mark) When t = 3 s $ds/dt = 6(3^2) - 8(3) - 6$ $= 54 - 24 - 6$ $= 24$ (1 mark) Velocity when time (t) is 3 s is 24 ms^{-1}		

Question	Expected Answers	Marks	Rationale
(b)	When the velocity is zero ds/dt = 0 $ds/dt = 6t^2 - 8t - 6$ $0 = 6t^2 - 8t - 6$ (1 mark) Solution of quadratic equation by formulae $t = [-b \pm \sqrt{(b^2 - 4ac)}]/2a$ where a = 6, b = – 8 and c = 6 (1 mark) so $t = [8 \pm \sqrt{(8^2 + 4 \times 6 \times 6)}]/(2 \times 6)$ $t = [8 \pm \sqrt{(64 + 144)}]/12$ (1 mark) $t = [8 \pm \sqrt{(208)}]/12$ $t = [8 \pm 14.42]/12$ $t = 22.42/12$ or $t = -6.42/12$ t = 1.868 s or – 0.535 s (1 mark) The time taken when the velocity is zero is 1.868 s (1 mark)		
(c)	Given equation is $s = 2t^3 - 4t^2 - 6t + 8$ Acceleration $= d^2s/dt^2$ $d^2s/dt^2 = 12t - 8$ (1 mark) When t = 4 s $d^2s/dt^2 = 12(4) - 8$ $= 48 - 8$ $= 40\ ms^{-2}$ (1 mark)		

Question	Expected Answers	Marks	Rationale
(d)	When the acceleration is zero $d^2s/dt^2 = 0$ $d^2s/dt^2 = 12t - 8$ $0 = 12t - 8$ $12t = 8$ $t = 8/12$ $t = 0.67$ s (1 mark)	**10**	
4 **(a)**	Fig. 3. Sketches of		
(i)	normal distribution curve		Equal distribution either side of a centre line
(ii)	negative skew (1 mark		Distribution concentrated on the left hand side of the x axis
(iii)	 Normal distribution (1 mark) Positive skew (1 mark) Negative skew (1 mark)		Distribution concentrated on the right hand side of the x axis

Question	Expected Answers	Mark	Rationale
(b)	Raw score (x) Frequency (f) fx x – mean (x – mean)2 f(x – mean)2 4.0 4 16 -2.16 4.6656 18.6624 5.0 6 30 - 1.16 1.3456 8.0736 6.0 22 132 - 0.16 0.0256 0.5632 7.0 14 98 0.84 0.7056 9.8784 8.0 4 32 1.84 3.3856 13.5424 50.72 ∑f = 50 (1 mark) ∑ fx = 308 (1 mark) Mean = 308/50 = 6.16 (1 mark) ∑ f(x – mean)^2 = 50.72 (1 mark) Variance = [∑ f(x – mean) ^{2}]/ ∑f (1 mark) = 50.72/50 = 1.0144 (1 mark) Standard Deviation = √ variance = √ 1.0144 = 1.007 correct to 3 dp (1 mark)	**[10]**	All numbers in the table are exact as shown

Question	Expected Answers	Mark	Rationale
5 (a)	Given equation: $W = \int_a^b F.\,ds.$ $W = \int_6^8 (6s^2 + 2s)\,ds$ (1 mark) $W = [2s^3 + s^2]_6^8$ (1 mark) $W = (2 \times 512 + 64) - (2 \times 216 + 36)$ (1 mark) $W = 1088 - 468$ $W = 620$ J (1 mark)		
(b)	Given data = $2x + y = 7$ and $xy = 3$ From $2x + y = 7$ $y = 7 - 2x$ From $xy = 3$ $y = 3/x$ The line cuts the curve where $7 - 2x = 3/x$ So $2x + 3/x - 7 = 0$ Multiply through by x $2x^2 - 7x + 3 = 0$ $(2x - 1)(x - 3) = 0$ $x = ½$ or $x = 3$ (1 mark)		

Question	Expected Answers	Mark	Rationale
	Graphs are 		
	Area under straight line $= \int_{½}^{3} (7 - 2x)\,dx$		
	$= [7x - x^2]_{½}^{3}$ (1 mark)		
	$= (21 - 9) - (3.5 - 0.25)$		
	$= 8.75$ (1 mark)		
	Area under curve $= \int_{½}^{3} 3/x\,dx$		
	$= 3\,[\ln x]_{½}^{3}$ (1 mark)		
	$= 3\,[\ln 3 - \ln 0.5]$		
	$= 3\,[\ln 6]$		
	$= 5.375$ (1 mark)		

Question	Expected Answers	Mark	Rationale
	Enclosed area = 8.75 – 5.375 = 3.375 square units (1 mark)	10	
6 (a)	From the equation $\Theta = 100 - 80\ e^{-0.2t}$ the value which the heater temperature approaches is 100^0 C (1 mark)		
(b)	Given equation $\Theta = 100 - 80\ e^{-0.2t}$ When $\Theta = 60^0$ C then $60 = 100 - 80\ e^{-0.2t}$ (1 mark) Then $80\ e^{-0.2t} = 100 - 60$ (1 mark) $80\ e^{-0.2t} = 40$ $e^{-0.2t} = 40/80$ $= 0.5$ (1 mark) So $-0.2\ t = \ln 0.5$ $= -0.6931$ (1 mark) $t = -0.6931 / -0.2$ $= 3.466$ minutes (1 mark) The time taken for the heater to reach 60^0 C is 3.466 minutes.		

Question	Expected Answers	Mark	Rationale
(c)	Given equation $\Theta = 100 - 80\ e^{-0.2t}$ Rate of increase of temperature is $d\Theta/dt$ (1 mark) So $d\Theta/dt = (-80 \times -0.2)\ e^{-0.2t}$ (1 mark) $= 16\ e^{-0.2t}$ At a time of t = 3.466 minutes Then $d\Theta/dt = 16\ e^{(-0.2 \times 3.466)}$ (1 mark) $= 16 \times 0.5$ $= 8^0$ C/minute (1 mark) The rate of temperature increase is 8^0 C per minute.	**[10]**	
7 (a) (i)	Given data: b = 7.2 m, c = 8.6 m, Angle B = 52^0 Sine Rule: c/sin C = b/sin B (1 mark) So sin C = c sin B/b $= (8.6 \times \sin 52^0)/7.2$ = 0.9412 (1 mark) Angle C = $\sin^{-1}$ 0.9412 $= 70.26^0$ (1 mark)		
(ii)	Angle A + Angle B + Angle C = 180^0 (1 mark) So Angle A = 180^0 – Angle B – Angle C $= 180^0 - 52^0 - 70.26^0$ $= 57.74^0$ (1 mark)		

Question	Expected Answers	Mark	Rationale
(iii)	Sine Rule: $a/\sin A = b/\sin B$ (1 mark) $a = (b \sin A)/\sin B$ $a = (7.2 \times \sin 57.74^0)/\sin 52^0$ $a = 7.73$ m (1 mark)		
(b)	Given data: $a = 8$ cm, $b = 9$ cm and $c = 3$ cm Cosine Rule: $a^2 = b^2 + c^2 - 2bc \cos A$ (1 mark) $\cos A = (b^2 + c^2 - a^2)/2bc$ (1 mark) $= (9^2 + 3^2 - 8^2)/(2 \times 9 \times 3)$ $= 26/54$ $= 13/27$ QED (1 mark)	[10]	
8 (a)	The addition law of probability is recognised by the word "OR" joining the probabilities. Let p_x be the probability of event x happening and let p_y be the probability of event y happening. (1 mark) Then the probability of event x or event y happening is given by $p_x + p_y$. (1 mark) The multiplication law of probability is recognised by the word "AND" joining the probabilities. Let p_x be the probability of event x happening and let p_y be the probability of event y happening. (1 mark) Then the probability of event x and event y happening is given by $p_x \times p_y$. (2 marks) (1 mark)		

Question	Expected Answers	Mark	Rationale
(b) (i)	The probability of selecting at random a five ampere fuse, p, is given by the ratio: Number of five ampere fuses/Total number of fuses p = Number of five ampere fuses/Total number of fuses (1 mark) = 36/(36 + 39 + 25) = 36/100 or 9/25 or 0.36:1 (1 mark)		
(ii)	The probability of selecting at random a ten ampere fuse, q, is given by the ratio: Number of ten ampere fuses/Total number of fuses q = Number of ten ampere fuses/Total number of fuses (1 mark) = 39/(36 + 39 +25) = 39/100 or 0.39:1 (1 mark)		
(iii)	The probability of selecting neither a five ampere fuse or a ten ampere fuse is $1 - [\ (36+39)/100\ ]$ (1 mark) = 1 – 0.75 = 0.25 (1 mark)	**[10]**	

Grade Thresholds

OCR Level 3 Principal Learning in Engineering H811
June 2009 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	A*	A	B	C	D	E	U
F556	Raw	60	48	42	36	30	24	18	0
	Points	14	12	10	8	6	4	2	0
F557	Raw	60	48	42	36	30	24	18	0
	Points	14	12	10	8	6	4	2	0
F563	Raw	60	48	42	36	30	24	18	0
	Points	14	12	10	8	6	4	2	0

Specification Aggregation Results

No learners aggregated this series. Aggregation is not available for this specification until June 2010.

For additional guidance on the points awarding system, please refer to the Admin Guide for Diplomas at:
http://www.ocr.org.uk/administration/documents.html?section=general

Statistics are correct at the time of publication.

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