

Mathematical Techniques and Applications for Engineers

OCR Level 3 Certificate

H865/01 Component 1

Mark Schemes for June 2012

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, OCR Nationals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

© OCR 2012

Any enquiries about publications should be addressed to:

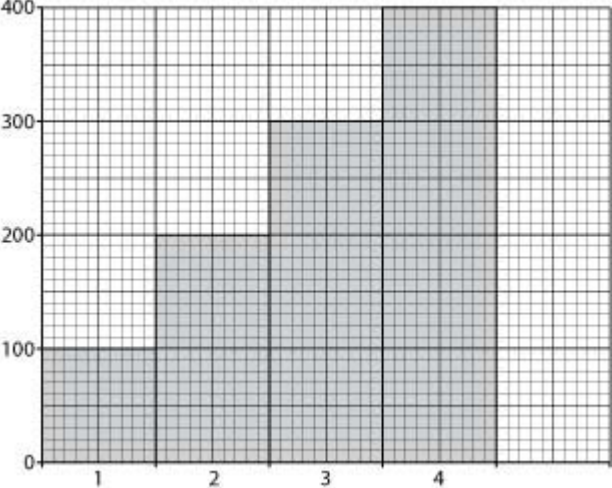
OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

Section A

Question	Answer	Marks	Guidance
1	$-5(ab - cd) = -5ab + 5cd$ $-5ab$ $+5cd$	1 1	
2	$abc - ade = a(bc - de)$ a $(bc - de)$	1 1	
3	$Mv + mu = MV + mU$ $Mv - MV = mU - mu$ $M(v - V) = m(U - u)$ $M = m(U - u)/(v - V)$	1 1	
4	$3(x + 2) = 6x + 12$ $3x + 6 = 6x + 12$ $6x - 3x = 6 - 12$ $x = -2$	1 1	
5	$5/(x^2 + x - 6) = 1/(x - 2) - 1/(x + 3)$ $1/(x - 2)$ $- 1/(x + 3)$	1 1	Allow one mark for factors $(x - 2)$ and $(x + 3)$ if seen
6	Convert 128° to radians. $180^\circ = \pi$ radians $1^\circ = \pi / 180$ radians $128^\circ = (128^\circ \pi) / 180^\circ$ $= 2.23$ radians correct to 2 dp	1 1	
7	$\sin 30^\circ + \cos 60^\circ + \tan 45^\circ = 2$ $0.5 + 0.5 + 1 = 2$ $2 = 2 \text{ QED}$	1 1	

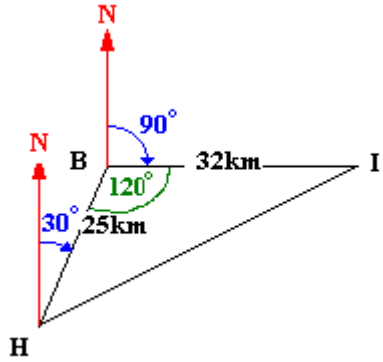
Question	Answer	Marks	Guidance
8	Area of a triangle ABC = $\frac{1}{2} bc \sin A$ $= \frac{1}{2} \times 6 \times 10 \times \sin 70^\circ$ $= 28.19 \text{ m}^2$ correct to 2 dp	1 1	
9	Gradient = $dy/dx = 10x^4 + 12x^3$ When $x = 2$ Gradient = $10(2^4) + 12(2^3)$ $= 256$	1 1	
10	$y = e^{-4x} + \ln(5x)$ $dy/dx = -4e^{-4x} + 1/x$ $-4e^{-4x}$ $+ 1/x$	1 1	
11	Integrate \sqrt{t} with respect to t . $\int \sqrt{t} dt = \int t^{1/2} dt$ $= \frac{2}{3} t^{1.5} + C$ $\frac{2}{3} t^{1.5}$ $+ C$	1 1	
12	$\int_4^5 8x dx = \left[4x^2 \right]_4^5$ $= (4)(5^2) - (4)(4^2)$ $= 36$	1 1	

Question	Answer	Marks	Guidance
13		2	<p>One mark for correct x and y axes</p> <p>One mark for four correct attempt positions</p>
14	<p>Determine the mode and median for the set of given values: 8, 11, 9, 13, 10, 12, and 8</p> <p>Mode = Number occurring most frequently = 8</p> <p>Median = point in a set of values that divides the set into two parts</p> <p>8, 8, 9, <u>10</u>, 11, 12, 13</p> <p>Median = 10</p>	<p>1</p> <p>1</p>	
15	(i)	1	<p>Probability that the electrician chooses: a steel screw or a brass screw = $(5 + 6)/(5 + 6 + 9) = 11/20$</p>
	(ii)	1	<p>a brass screw or an aluminium screw = $(6 + 9)/(5 + 6 + 9) = 15/20$ or $\frac{3}{4}$</p>

Section B

Question		Answer	Marks	Guidance
1	(a)	$\text{Given } V = (\pi R^2 h)/3$ $= (\pi \times 10^2 \times 30)/3$ $= 3141.59 \text{ m}^3 \text{ correct to 2 dp}$	1 1	Accept 1000π
	(b) (i)	$\text{Given } V = (\pi R^2 h)/3$ $\text{Then } 3V = \pi R^2 h$ $\text{Then } R^2 = 3V/(\pi h)$ $\text{So } R = \sqrt{[3V/(\pi h)]}$	1 1 1	
	(ii)	$\text{Given } R = \sqrt{[(3V/(\pi h))]}$ $\text{Then } R = \sqrt{[(3 \times 100)/(25 \pi)]}$ $= 1.95 \text{ m correct to 2 dp}$	1 1	
	(c)	$\text{Given } D = \sqrt[3]{(6V/\pi)}$ $\text{Then } D^3 = 6V/\pi$ $\text{And } \pi D^3 = 6V$ $\text{So } V = (\pi D^3)/6$	1 1 1	

Question			Answer	Marks	Guidance
2	(a)	(i)	<p>Given $R = R_0 (1 + \alpha t)$</p> <p>When $R = 40 \Omega$ at 60°C equation 1 becomes $40 = R_0 (1 + 60\alpha)$</p> <p>When $R = 20 \Omega$ at 100°C equation 2 becomes $20 = R_0 (1 + 100\alpha)$</p> <p>Divide eqn. 1 by eqn. 2</p> <p>Then $40/20 = [R_0 (1 + 60\alpha)]/[R_0 (1 + 100\alpha)]$</p> <p>So $2 = (1 + 60\alpha)/(1 + 100\alpha)$</p> <p>Cross multiply gives $2(1 + 100\alpha) = (1 + 60\alpha)$</p> <p>So $2 + 200\alpha = 1 + 60\alpha$</p> $200\alpha - 60\alpha = 1 - 2$ $140\alpha = -1$ $\alpha = -1/140$	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>Accept any alternative method that gives the correct solution</p> <p>Accept a correct decimal answer</p>

Question	Answer	Marks	Guidance
(b) (i)		2	Award one mark for 25 km and 32 km seen. Award one mark for 30° and 90° with correct shape of triangle.
(ii)	<p>Total distance travelled = 25 + 32 + distance IH</p> <p>Cosine rule: $a^2 = b^2 + c^2 - 2bc \cos A$ In this case $a = \text{distance IH}$, $b = 25 \text{ km}$, $c = 32 \text{ km}$ and angle $A = 120^\circ$ $IH^2 = 25^2 + 32^2 - 2(25 \times 32) \cos 120^\circ$ $IH^2 = 625 + 1024 - (-800)$ $IH^2 = 625 + 1024 + 800$ $IH^2 = 2449$ $IH = 49.49 \text{ km}$ Total distance = 25 + 32 + 49.49 = 106.49 km correct to 2 dp</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>Award one mark for 120° seen.</p> <p>Award one mark for the use of the cosine formula.</p> <p>Award one mark for $IH^2 = 625 + 1024 - (-800)$</p> <p>Accept answers between 103 and 108 km.</p>
4 (a)	<p>Given $\sin^2 x + \cos^2 x = 1$ When $x = 60^\circ$ Then $\sin^2 60^\circ + \cos^2 60^\circ = 0.866^2 + 0.5^2$ $= 0.75 + 0.25$ $= 1 \text{ QED}$</p>	<p>1</p> <p>1</p>	

Question		Answer	Marks	Guidance
	(b)	Known sec $A = 1/\cos A$ Known cosec $A = 1/\sin A$ So sec A/cosec $A = (1/\cos A)/(1/\sin A)$ $= \sin A/\cos A$ But $\sin A/\cos A = \tan A$ QED	1 1 1	
	(c)	Length of minor arc $= (\pi \times r^0)/180$ $= (\pi \times 50 \times 200)/180$ $= 174.53$ mm correct to 2dp Length of major arc = circumference of circle – length of minor arc $= 2 \pi r - 174.53$ $= (2 \pi \times 200) - 174.53$ $= 1082.11$ mm	1 1 1 1 1	Accept answers between 1082 and 1082.5
5	(a)	$A = \pi R^2 + 2 \pi Rh$	1	

Question	Answer	Marks	Guidance
(b) (i)	<p>So $A = \pi r^2 + 2 \pi r h$ Eqn 1 There are two variables in this equation – we need to replace h But $V = \pi r^2 h$ $4 = \pi r^2 h$ So $h = 4 / \pi r^2$ Substitute h into eqn. 1 So $A = \pi r^2 + (4 / \pi r^2) 2 \pi r$ $A = \pi r^2 + 8/r$ Differentiate A $dA/dr = 2 \pi r - 8r^{-2}$ and $d^2A/dr^2 = 2 \pi + 16r^{-3}$ For a turning point $dA/dr = 0$ So $0 = 2 \pi r - 8r^{-2}$ Then $0 = 2 \pi r - 8/r^2$ Solve for r $2 \pi r = 8/r^2$ Then $r^3 = 4 / \pi$ So $r = 1.08$ correct to 2 dp Use $d^2A/dr^2 = 2 \pi + 16r^{-3}$ to test for a minimum Because $r = +1.08$ m this gives d^2A/dr^2 a positive value then r is the minimum value</p>	<p>1 1 1 1 1 1 1</p>	
	<p>(ii) To find a value for h we use $h = 4 / \pi r^2$ where $r = 1.08$ m So $h = 4 / \pi (1.08)^2$ $h = 1.09$ m correct to 2 dp So for a minimum amount of sheet metal the radius is 1.08 m and the height is 1.09 m</p>	1	

Question		Answer	Marks	Guidance
6	(a)	$\text{Given mean value} = \frac{1}{(b-a)} \int_a^b i \cdot d\theta$ $\text{Then mean value} = \frac{1}{(\pi-0)} \int_0^\pi 20 \sin \theta \cdot d\theta$ $= \frac{20}{\pi} [-\cos \theta]_0^\pi$ $= \frac{20}{\pi} [(-\cos \pi) - (-\cos 0)]$ $= \frac{20}{\pi} (-(-1) - (-1))$ $= \frac{40}{\pi}$ $= 12.73 \text{ A}$	<p>1</p> <p>1</p> <p>1</p>	
	(b) (i)	$\text{Constant} = PV^2$ $= 250 \times 0.3^2$ $= 22.5$	1	
	(ii)	<p>Given $PV^2 = \text{constant}$</p> <p>Then $P = \text{constant}/V^2$</p>	1	

Question		Answer	Marks	Guidance																
	(iii)	$\text{work done} = \int_{0.3}^{0.45} P. dV$ $\text{Given work done} = \int_{0.3}^{0.45} P. dV$ $\text{Then work done} = \int_{0.3}^{0.45} \text{constant}/V^2 .dV$ $\text{work done} = 22.5 \int_{0.3}^{0.45} V^{-2}. dV$ $\text{work done} = 22.5 [V^{-1}/-1]$ $\text{work done} = -22.5 [1/V]$ $= -22.5 (1/0.45 - 1/0.3)$ $= 25 \text{ J}$	 1 1 1 1 1																	
7	(a)	<table border="1"> <thead> <tr> <th>Type of fuel</th> <th>Large engine</th> <th>Small engine</th> <th>Total</th> </tr> </thead> <tbody> <tr> <td>Unleaded</td> <td>160 (1)</td> <td>575</td> <td>735 (1)</td> </tr> <tr> <td>Other</td> <td>40 (1)</td> <td>205</td> <td>245</td> </tr> <tr> <td>Total</td> <td>200</td> <td>780 (1)</td> <td>980</td> </tr> </tbody> </table>	Type of fuel	Large engine	Small engine	Total	Unleaded	160 (1)	575	735 (1)	Other	40 (1)	205	245	Total	200	780 (1)	980	 1 1 1 1	
Type of fuel	Large engine	Small engine	Total																	
Unleaded	160 (1)	575	735 (1)																	
Other	40 (1)	205	245																	
Total	200	780 (1)	980																	

Question		Answer	Marks	Guidance
	(b) (i)	205/980	1	Accept answer as percentage
	(ii)	575/980	1	Accept answer as percentage
	(iii)	40/980	1	Accept answer as percentage
	(iv)	160/980	1	Accept answer as percentage
	(v)	(735/980) + (205/980) or 940/980	2	Accept answer as percentage
8	(a)		3	<p>Award one mark for x axis Award one mark for y axis Award one mark for correct graph shape</p>

Question		Answer	Marks	Guidance
	(b) (i)	34 (Accept 33 to 35)	1	
	(ii)	$50 - 48 = 2$	1	Because two people are 35 or more but not necessarily 37 or more accept an answer of 1 also.
	(iii)	23.5 years (Accept 23 to 24)	1	
	(iv)	20.25 years (Accept 20 to 21)	1	
	(v)	28.75 years (Accept 27.75 to 29.75)	1	
	(vi)	$28.75 - 20.25 = 8.5$ years (Accept any numbers used in part e and f)	2	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning

Telephone: 01223 553998

Facsimile: 01223 552627

Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2012

