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A Level

Mathematics

Session: 2000 June
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Oxford Cambridge and RSA Examinations

OCR

RECOGNISING ACHIEVEMENT

AS/A LEVEL
(former Cambridge linear syllabus)

A 9200
A 9220
AS 8473

MATHEMATICS/ FURTHER MATHEMATICS

MARK SCHEME FOR COMPONENTS
TAKEN IN JUNE 2000

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MATHEMATICS 9200

Component threshold marks

Component	Maximum Mark	A	B	C	D	E	N	U
1	120	82	71	61	51	42	33	0
2	120	89	79	68	58	48	38	0
3	120	85	75	66	57	49	41	0
4	120	91	82	72	62	53	44	0

Overall Threshold Marks

Option	Maximum Mark	A	B	C	D	E	N	U
A (1,2)	240	171	149	129	109	90	71	0
B (1,3)	240	164	144	125	107	89	71	0
C (1,4)	240	171	150	131	113	95	77	0

The percentage of candidates awarded each grade was as follows

Grade	A	B	C	D	E	N	U
%	36.8	16.1	13.3	12.7	8.6	7.1	5.3
Cumulative %	36.8	52.9	66.3	79.0	87.6	94.7	100.0

The total candidature was 1395

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RECOGNISING ACHIEVEMENT

Markscheme 9200/1
June 2000

Question Number	Mark scheme details		Part Mark
1	Obtains (r =) 5 OR $\sqrt{25}$; Obtains (centre) (0,1) AEF	B1 B1	2 2
2	Obtains $y = 3x - 1$	B1	1
	Substitutes correctly into own linear equation [$t/s^3 = 3(1/s) - 1$]	M1	
	Obtains $t = 3s^2 - s^3$ OR $t = -s^3 + 3s^2$ OR $t = s^2(3 - s)$ or other factorised form	A1	2 3
3	(i) Obtains correct graph with numerical evidence for correct stretch s.f. ½	B1	1
	(ii) Obtains correct reflection in x-axis of given graph with numerical evidence	B1	1
	(iii) Obtains correct reflection of given graph in line $y = x$ with numerical evidence	B1	1 3
4	(i) Obtains values 7,11,15	B1	1
	(ii) Substitutes numbers in $u_n = a + (n - 1)d$ OR $u_n = a + nd$	M1	
	Obtains (u_n =) $3 + 4(n - 1)$ OR $4n - 1$ AEF	A1	2
	(iii) States v_n convergent AND satisfactory reason such as		
	"u_n divergent" OR "v_n tends to zero" OR "u_n tends to infinity"	B1	1 4
5	Method to obtain 1 ± 6, with possible numerical or $x \leftrightarrow y$ errors only, seen or implied	M1	
	Obtains $-5 < y < 7$ OR "$-5 < y$ and $y < 7$" OR "$-5 < y$, $y < 7$" CWD AEF (M1 A0 for $-5 < x < 7$ etc.)	A1	2
	Method to obtain $x\ln 2 = \ln y$✓ OR $x\ln 2 < \ln y$✓ etc. OR $x\log 2 = \log y$✓	M1	
	Obtains $\ln y$✓ / $\ln 2$ with no intermediate step involving $\ln(y$✓$/2)$ (FT only on $y > 0$)	A1✓	
	Obtains $x < \ln 7/\ln 2$ ONLY having obtained positive and negative roots in first part	A1	3 5

Question Number	Mark scheme details		Part Mark
6	$2 - \tan 1 = 0.4$ AND $2.4 - \tan 1.2 = -0.2$ or better	B1	
	Clear identification of sign change AND deductive statement	M1	2
	$\{f'(x)=\}\ 2 - \sec^2 x$ AEF	B1	
	Attempts $1.1 - f(1.1)/f'(1.1)$	M1	
	Obtains 1.18 (=1.182243….)	A1	3
			5
7	Valid complete attempt to find partial fractions seen or implied	M1	
	Obtains $(1/2)/(x-2) - (1/2)/(x)$ AEF	A1	
	Integrates to form $A\ln(x-2) + B\ln x$ AEF	M1	
	Obtains $(1/2)\ln(x-2) - (1/2)\ln x$ or better	A1	
	Obtains $(1/2)\ln\lvert x-2\rvert - (1/2)\ln\lvert x\rvert + c$ OR $(1/2)\ln\lvert 1 - 2/x\rvert + c$ AEF	A1	5
			5
8	(i) Sine rule used AND attempt to obtain $\sin\theta$	M1	
	Obtains 0.4 OR 2/5	A1	2
	(ii) $\sin^2\theta + \cos^2\theta = 1$ OR Pythagorean equivalent used AND attempt to obtain $\cos\theta$	M1	
	Obtains $\sqrt{21}/5$ AEEF (exact working only)	A1	2
	(iii) Obtains cosBDC = 3/5 AND sinBDC = 4/5 AEEF	B1	1
	(iv) Indicates intention to use $\sin\theta\cos\phi \pm \cos\theta\sin\phi$	M1	
	Substitution of 3/5 (✓ for $\cos\phi$), 4/5 (✓ for $\sin\phi$) and own $\sin\theta$, $\cos\theta$ into attempted $\sin(\theta \pm \phi)$	M1	
	Obtains $(6 + 4\sqrt{21})/25$ AEEF	A1	3
			8
9	(a) Obtains $(A=)$ 4	B1	
	Sufficient equations for B, C, AND attempt to solve for B OR C	M1	
	Obtains $(B=)$ 5; $(C=)$ −1	A1 A1	4
	SR: only $B = 5$ or only $C = -1$ written down can score B1 for max B1 B1 M0 2/4		
	(b) Obtains $y = 2$	B1	
	Method to solve quadratic or cubic equation using correct formula or otherwise	M1	
	Obtains $y = 4/3$ OR 1.3; $y = 8/3$ OR 2.7	A1 A1	4
			8

Question Number	Mark scheme details		Part Mark
10	(i) Obtains scalar product ± 5.05 OR obtains three correct lengths^2 25.01, 5.25, 20.16 B1		
	Obtains cosAOB = ±(–3.1+4.2+0.1×0.5)/√[(-3)^2+4^2+0.1^2]√[1^2+2^2+0.5^2] (=0.4407..) M1		
	Obtains (AOB=) 63.851° with 3dp required (=63.85068)	A1	3
	(ii) Obtains (-3, 4, 0) AND (1, 2, 0) (allow position vectors or omission of 0)	B1	1
	(iii) Obtains cos$A'OB'$ = ±(–3.1+4.2)/√[(-3)^2+4^2]√[1^2+2^2]	B1	
	Obtains ($A'OB'$ =) 63° or better (=63.43494..)	B1	
	Method for ±(AOB – $A'OB'$) / $A'OB'$	M1	
	Obtains 0.66% **AG** (=0.6553… OR 0.6557…)	A1	4
			8
11	(i) Obtains (R =) 25; (α =) 74° (= 73.73979…)	B1 B1	2
	Attempt to use inverse sine to find one value of (θ + α) for sin(θ + α) = –3/R	M1	
	Obtains any θ satisfying sin(θ + α) = –3/R for own values of R and α	A1✓	
	Obtains (θ=) –81°; 113° (= –80.631…) (= 113.1523…)	A1 A1	4
	SR: –A1 mark for all extra solutions in range		
	(ii) (a) Method to add 10° to previous solution(s)	M1	
	Obtains (x =) θ✓ + 10 within range specified (= 123° = 123.1523…)	A1✓	2
	(b) Method for 90 – y = θ	M1	
	Obtains (y =) 90 – θ✓ within range specified (= 171° = 170.639…)	A1✓	2
	SR: Fresh starts for (a) and (b) earn M1 for full correct method, A1 correct answer		
			10
12	Uses dx = ±cosθ (dθ) correctly	M1	
	Obtains ±sin$^2\theta$ cos$^2\theta$ correctly	M1	
	Change of limits and use of double angle formula to obtain given integral **AG**	A1	3
	Obtains $\int a + b\cos 4\theta \ (d\theta)$	M1	
	Obtains $\frac{1}{8}\left(\theta - \frac{1}{4}\sin 4\theta\right)$ AEF	A1	
	Obtains (A =) $\frac{1}{8}\left(\frac{\pi}{6} - \frac{\sqrt{3}}{8}\right)$ AEEF (=0.038386)	A1	3
	Use of $\int y^2 dx$ where $y = x^2\sqrt{1-x^2}$	M1	
	$\pi \int x^4(1-x^2)\,(dx)$ seen	A1	
	Attempts to evaluate $\left[ax^5 + bx^7\right]_0^{\frac{1}{2}}$	M1	
	Obtains (V =) 23π/4480 AEEF	A1	4
			10

Question Number	Mark scheme details		Part Mark
13	(i) Obtains $y - 6 = m(x + 1)$ for some m	M1	
	Obtains $m = -2$	B1	
	Obtains $\pm(2x + y - 4) = 0$	A1	3
	(ii) Complete method to solve equations l and l' simultaneously	M1	
	Obtains $x = 3$ AND $y = -2$	A1	2
	(iii) Complete method for magnitude of displacement from P to intersection (ii)	M1	
	Obtains correctly $4\sqrt{5}$ **AG** $(=\sqrt{[4^2 + 8^2]})$	A1	2
	(iv) Obtains $(QR =)\ \sqrt{320}$ AEEF	B1	
	Any complete method for area of triangle PQR	M1	
	Obtains 80 by an exact method	A1	3
	OR Any complete exact method for area of triangle	M1	
	Obtains $A = 16 \times 13 - 3 \times 13 - 5 \times 5 - 8 \times 8$ AEEF or $A = \frac{1}{2}((-1 \times -7) + (-7 \times 1) + (9 \times 6) - (6 \times -7) - (-7 \times 9) - (1 \times -1))$ AEEF	A1	
	Obtains 80 by an exact method	A1	3
			10
14	$dm/dt = ; -km$ OR km with $k < 0$ stated AEF	B1 B1	2
	NB: Allow B1 B0 if finds dm/dt from **AG**		
	Separation of variables and attempt to integrate	M1	
	Obtains $\ln m = \pm kt + c$ consistent with first part	A1	
	Obtains $c = \pm \ln m_0$ or equivalent and attempts to substitute and exponentiate correctly	M1	
	Obtains correctly $m = m_0 e^{-kt}$ **AG**	A1	4
	OR Uses $dm/dt \pm km = 0$ and find integrating factor $e^{\pm kt}$	M1	
	Obtains $me^{\pm kt} = c$	A1	
	Obtains $c = m_0$ and rearranges	M1	
	Obtains correctly $m = m_0 e^{-kt}$ **AG**	A1	4
	SR: Obtains $m = e^{-kt}$ can score B1 B1 M1 B1 max. 4/6		
	(i) Graph with positive gradient and gradient decreasing	B1	
	Graph passes through $M(0) > 0$ and limiting from below (ignore all labels)	B1	2
	(ii) States that M tends to A	B1	1
	(iii) Uses $dM/dt = -dm/dt$ or equivalent	M1	
	Complete correct substitution to obtain given differential equation **AG**	A1	2
			11

Question Number	Mark scheme details		Part Mark
15	Uses $r^2\theta/2$ and two radii	M1	
	Obtains (A =) 14 θ (cm^2)	A1	2
	(i) Attempts to differentiate own A with respect to t and use 0.1	M1	
	Obtains 1.4 (cm^{2}s^{-1}) CWD	A1	2
	(ii) (P =) 2+2+8θ+6θ OR 4 + 14θ OR NP + MQ = 14θ and MN, PQ constant	M1	
	Obtains 1.4 (cm s^{-1}) from correct P CWD	A1	2
	(iii) Uses completely correct cosine rule in triangle including θ and L	M1	
	Obtains $L^2 = 100 - 96\cos\theta$ **AG**	A1	2
	Uses $\frac{dL}{dt} = \frac{dL}{d\theta}\frac{d\theta}{dt}$	M1	
	Obtains $2L$ in denominator or $\frac{1}{2}(100 - 96\cos\theta)^{-½}$	B1	
	Obtains $96\sin\theta\, d\theta/dt$ OR $96\sin\theta(0.1)$ AEF	B1	
	Substituting for θ, $d\theta/dt$	M1	
	Obtains $(6\sqrt{39})/65$ OR 0.58 (= 0.57646…) (cm s^{-1})	A1	5
			13
16	(i) (a) Obtains $4p + 16q = 1$	B1	1
	(dy/dx =) $2px + 4qx^3$	B1	
	Substitutes to obtain $\sqrt{2}$ ($a(4p + 16q)$)	B1	
	Demonstrates using $4p + 16q = 1$ that $2p(\sqrt{2}) + 4q(\sqrt{2})^3 = \sqrt{2}/2$ **AG**	B1	3
	(b) Obtains a = 5/36 OR 0.14 (=0.13888…)	B1	1
	Obtains first term ax^2 ✓ (= $5x^2/36 = 0.14\,x^2$)	B1✓	
	Obtains second non zero term $ax^4/9$ ✓ (= $5x^4/324 = 0.015\,x^4$)	B1✓	2
	(c) Obtains $k = 0.181$ (= 0.181015…)	B1	1
	Attempt to substitute up to x^4 term for e^x AND, using $-x$, for e^{-x}	M1	
	Obtains $kx^2 + kx^4/12 + \ldots$ or better (= $0.181\,x^2 + 0.0151\,x^4$)	A1	2
	(ii) Show clearly that 40 comes from 2 × 20 (where 20 can be assumed)	B1	
	Expands series with e^x and **states** $x = 0.1r$		
	OR Shows sum of individual terms at start (before seeing summation sign) ie see $e^{0.1} + e^{0.2} + \ldots + e^{-0.1} + e^{-0.2} + \ldots$	B1	2
	Identifies a G.P. and its common ratio correctly	M1	
	Attempts valid method for both summations with 'r' = $e^{0.1}$ AND $e^{-0.1}$	M1	
	Obtains (sum =) 6.4 (= 6.40…)	A1	3
			15

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RECOGNISING ACHIEVEMENT

Markscheme 9200/2
June 2000

1	EITHER: Attempt quotient rule (or equivalent) allowing sign errors for this mark (products reversed only)	M1	
	Obtain any correct unsimplified expression, e.g. $\frac{(2x+1)\times1-(x-2)\times2}{(2x+1)^2}$	A1	
	Obtain simplified answer $\frac{5}{(2x+1)^2}$ correctly	A1	
	[Product rule also requires chain rule (both applied correctly for M1)]		
	OR: Express the function as $\frac{1}{2}-\frac{5}{2(2x+1)}$	B1	
	Use chain rule to differentiate $k(2x+1)^{-1}$ (result $-k(2x+1)^{-2}$ is M0)	M1	
	Obtain simplified answer $\frac{5}{(2x+1)^2}$ correctly	A1	3
	[Accept final answer in the form $\frac{5}{4x^2+4x+1}$.]		
2	EITHER: State or imply correct cosine rule (in any form) involving 2, 3, 4 and either B or C	M1*	
	Obtain $\cos B = -\frac{1}{4}$ (aef) or $B = 104.5°$ or $104°$ or $105°$ or $\cos C = \frac{7}{8}$ (aef) or $C = 29°$	A1	
	State or imply correct formula for AD^2 involving 2, 4 and their numerical $\cos B$ or 1, 4 and their numerical $\cos(180 - C)$ or $-\cos C$	M1 (dep *)	
	Obtain answer $\sqrt{24}$ or $2\sqrt{6}$ or 4.9	A1	
	OR: [E is the foot of the perpendicular from A to CB produced]		
	Use Pythagoras in triangles ACE and ABE to obtain an equation for BE or AE	M1*	
	Obtain $BE = \frac{1}{2}$ or $AE^2 = \frac{15}{4}$	A1	
	Apply Pythagoras (or trig) with numerical BE and/or AE to find AD^2 (or AD)	M1 (dep *)	
	Obtain answer $\sqrt{24}$ or $2\sqrt{6}$ or 4.9	A1	4
3	(i) Multiply two relevant probabilities for a 'Yes' branch	M1*	
	Add the two relevant two-factor cases, i.e. $\frac{2}{3}p+\frac{1}{3}(1-p)$	M1 (dep *)	
	Obtain given answer $\frac{1}{3}(1+p)$ correctly	A1	3
	(ii) (Solve $\frac{1}{3}(1+p)$ and) find $p = 0.05$	B1	1
	Divide attempted P('No' and 'Truthful') by P('No')	M1	
	State or imply answer is $\frac{\frac{2}{3}(1-0.05)}{1-0.35}$	A1 ft	
	Obtain answer 0.97 or $\frac{38}{39}$ or equivalent fraction	A1	3
	[M1 is for a fraction with numerical numerator $\frac{2}{3}(1-p)$ or denominator $1 - 0.35$ (or equivalent); ft only if $0 < p < 1$]		

4	(a) (i) State 'pie chart' or 'bar chart' or 'pictogram' or 'line diagram'	B1	1
	(ii) State 'histogram' or 'stem and leaf diagram' or 'frequency polygon' or 'cumulative frequency diagram'	B1	1
	(iii) State 'double bar chart' or 'two bar charts with common scales on a single diagram'	B1	1
	(b) (i) Read off at least one relevant result	M1	
	Obtain any one answer 32, 38, 43	A1	
	Obtain all three correct values of the median and quartiles, identifying the median	A1	
	State interquartile range is 11	A1 ft	4
	(ii) Show linear scale from 0 to 60 with 0 and 60 marked and with ends of whiskers located at 5 and 60	B1	
	Show box extending between their quartile values	B1 ft	
	Show median line in box at their median value	B1 ft	3
	[Location of 5, medians and quartiles to be reasonably consistent with a linear scale.]		
5	EITHER: Use the connected formula $s = ut + \frac{1}{2}at^2$	M1 *	
	Obtain equation $6 = 15t - \frac{1}{2}gt^2$	A1	
	Solve a quadratic equation for t	M1 (dep *)	
	Obtain roots 0.47 and 2.6	A1	
	OR: Use the correct formula $v^2 = u^2 + 2as$ to find v	M1 *	
	State correct expression $\sqrt{(15^2 - 2g \times 6)}$ for speed at height 6m	A1	
	Use a correct formula to evaluate a relevant time	M1 (dep *)	
	Obtain answers 0.47 and 2.6	A1	4
	[Treat 'time above 6m' as a MR and give maximum possible on scheme.]		
6	(i) Show three corrected line segments with 2 correctly signed gradients	B1	
	Show or imply t and v axes with relevant points (10, 40), (15, 30) and (20, 0) identified and graph of correct shape	B1	
	Carry out complete method for the area calculation, e.g. two triangles and one trapezium (or equivalent use of constant acceleration formulas)	M1	
	Obtain answer 450	A1	4
	(ii) Sketch a graph starting at O having positive, decreasing gradient	B1	1
7	Equate total momentum before and after	M1	
	State or imply a correct equation $20000 \times 1.5 + 10000 \times 1 = (20000 + 10000)v$	A1	
	Obtain answer $\frac{4}{3}$, or equivalent, correctly	A1	3
	(i) State either $5000 = (\pm)30000a$ or both of $5000 - P = (\pm)10000a$ and $P = (\pm)20000a$	M1	
	Obtain answer $(\pm)\frac{1}{6}$, or equivalent, for the deceleration	A1	2
	(ii) Use a Newton II equation for one of the trucks with their numerical a (or numerical v and t) to find P	M1	
	Obtain answer $(\pm)3333\frac{1}{3}$ or 3300 only	A1	2
	[if g appears in the momentum equation deduct A1 but allow A1 for answer $\frac{4}{3}$ or equivalent.]		

8	Resolve vertically, i.e. $2T\cos\theta = W$ or use trig in correct triangle or use Lami	M1	
	Obtain answer 41° following correct use of $T = \frac{2}{3}W$	A1	2
	EITHER: Attempt a resolving equation, with 3 terms	M1*	
	Obtain a correct equation in T and trig ratios of one angle, e.g. one of $T\cos\theta + T\sin\theta = W$, $T\cos\theta - T\sin\theta = \frac{1}{2}W$, $T = \frac{1}{2}W\cos\theta + W\sin\theta$, $T = W\cos\theta - \frac{1}{2}W\sin\theta$ (allow $\cos(90 - \theta)$ for $\sin\theta$ etc)		
	Attempt a second independent 3-term resolving equation	A1	
	Obtain a second correct equation in T and trig ratios of previous angle	M1*	
	Obtain an equation in θ (or T) only	A1	
	Obtain angle 18° or 72°	M1 (dep *)	
	Obtain $T = 0.79W$ or equivalent	A1	
	OR: State resultant of W forces has magnitude $\frac{\sqrt{5}}{2}W$ or equivalent	A1	
	Combine T forces and equate resultants	B1	
	Obtain a correct equation, e.g. $2T\cos45° = \frac{\sqrt{5}}{2}W$	M1	
	Obtain $T = 0.79W$ or equivalent	A1	
	State resultant of W forces makes $\tan^{-1}\left(\frac{1}{2}\right)$ with the vertical or $\tan^{-1}(2)$ with the horizontal	A1	
	Equate directions and obtain an equation in θ, using 45° or 135°	B1	
	Obtain angle 18° or 72°	M1	
	[SR: Use of Wg for the weight W can score M1 A0 then M3 and an A1.]	A1	7
9	EITHER: State a correct equation from which T or $\frac{1}{2}T$ can be found,		
	e.g. $0 = V\sin\theta t - \frac{1}{2}gt^2$ or $0 = V\sin\theta - gt$	M1	
	Obtain any correct expression for R in terms of V, θ and g	A1	
	Obtain given answer $R = \frac{V^2\sin2\theta}{g}$ correctly	A1	
	OR: Using the equation of trajectory, state or imply equation		
	$0 = R\tan\theta - \frac{gR^2}{2V^2\cos^2\theta}$, or equivalent	M1	
	Obtain any correct expression for R in terms of V, θ and g	A1	
	Obtain given answer $R = \frac{V^2\sin2\theta}{g}$ correctly	A1	3
	State any one suitable assumption, e.g. no air resistance, constant acceleration, etc	B1	1
	(i) State both $D - 100 = \frac{U^2\sin60°}{g}$ and $D + 100 = \frac{U^2\sin90°}{g}$ or equivalent	B1	
	Eliminate D and solve for U^2	M1	
	Obtain given answer 121 correctly	A1	3
	(ii) Obtain $D = 1400$ (1392.82)	B1	
	Substitute values of U and D in range equation and solve for $\sin2\theta$	M1	
	Obtain answer 34° (34.4547…) or 35°	A1	3
	[SR: use of GA to show $U = 121$ and $D = 1400$ are consistent can get B1 M0 A0 B1 M1 A1.]		

10	(a) (i) State any one Newton II equation, e.g. $0.3g - T = 0.3a$, $T - 0.2g = 0.2a$, $0.1g = 0.5a$	M1	
	State two of the above equations correctly	A1	
	Solve a relevant pair of equations to find T	M1	
	Obtain answer $T = 2.4$	A1	4
	(ii) State or use $a = \frac{1}{5}g$ in this part of the question	B1	
	Use $v = u + at$ with $u = 0$ and $a \neq g$ to find t	M1	
	Obtain answer $t = 2.0$	A1	3
	[Answers to (i) and (ii) left as $6g/25$ and $20/g$ are penalised once, scoring A0 A1]		
	[NB: if g is omitted only the M marks are available.]		
	(b) EITHER: State equation or inequality, with 3 force terms, for motion parallel to the plane for either particle	M1	
	Resolve perpendicular to the plane for either particle, and use $F = \mu R$	M1	
	State one correct equation/inequality, e.g. $0.3g\sin30° - 0.3\mu g\cos30° - T = 0.3a$ (or > 0 or $= 0$)	A1	
	State a second correct equation/inequality, e.g. $T - 0.2g\sin30° - 0.2\mu g\cos30° = 0.2a$ (or > 0 or $= 0$)	A1	
	Eliminate T from a pair of equations or inequalities and solve for μ	M1	
	Obtain the given inequality $\mu < \frac{1}{5\sqrt{3}}$ correctly and not via decimals	A1	
	OR: State 'system' equation or inequality involving both weight components and both friction forces	M1	
	Resolve perpendicular to the plane for both particles, and use $F = \mu R$	M1	
	State any correct equation/inequality, e.g. $0.1g\sin30° - 0.5\mu g\cos30° = 0.5a$ (or > 0 or $= 0$)	A2	
	Solve this equation/inequality for μ	M1	
	Obtain given inequality $\mu < \frac{1}{5\sqrt{3}}$ correctly and not via decimals	A1	6
11	State procedure A is better	B1	
	Indicate that early customers may not be typical of customers in general	B1	2
	[for the justification mark, it's no good *merely* saying 'not random' or 'biased'.]		
	State any sensible idea, involving e.g. useful criticisms from people who don't use her shop, useful ideas for attracting new customers, etc, etc.	B1	1
	[For this mark it is not enough *merely* saying 'to be more random' or 'to avoid bias']		
12	Form an expression for $\Sigma x^2 p$	M1*	
	Subtract $(\Sigma xp)^2$ from the above	M1 (dep*)	
	Obtain correct expression $6p - 16p^2$ for the variance	A1	
	Equate variance (not s.d.) to $\frac{1}{2}$ and solve for p	M1	
	Obtain values $p = \frac{1}{4}$ and $p = \frac{1}{8}$	A1	
	Deduce both values 1 and $\frac{1}{2}$ for E(X)	A1 ft	6
	[The ft is only on 2 p values with $0 < p < 1$]		
13	(i) State or imply one of the two binomial terms, $\binom{50}{1}(0.88)^{49}(0.12)$ and $\binom{50}{2}(0.88)^{48}(0.12)^2$	M1	
	Add the correct three binomial terms (and no others)	M1	
	Obtain answer 0.051	A1	3
	(ii) State or imply $\mu = 50 \times 0.12$	B1	
	State or imply value $50 \times 0.12 \times 0.88$ relating to variance/s.d.	B1	
	Evaluate $\frac{9.5-6}{\sqrt{(5.28)}}$ and use tables	M1	
	Obtain answer 0.064	A1	4
	[The M1 is not lost for missing continuity correction, or for cc of on the wrong side, but the denominator must be $\sqrt{(npq)}$ not npq.]		
	[Use of exact binomial terms scores M0; incorrect use of Poisson approximation can score B1 for $\mu = 6$ and is allowed B1 for final answer 0.084.]		
	[Treat the use of $p = \frac{12}{50}$ as a MR.]		
	[If p, q interchanged, all M marks and a B1 are available.]		

14	(i) State value 8900 for $\hat{\mu}$	B1	
	State or imply expression $\frac{1}{74}\left(5.978\times10^{9}-\frac{\left(6.675\times10^{5}\right)^{2}}{75}\right)$, or equivalent	M1	
	Obtain answer 503000 for $\hat{\sigma}^2$	A1	3
	[If done by calculator with no working shown, the mark for the variance estimate is effectively B2 or B0. The biased estimate gets 0/2]		
	(ii) Use of $\hat{\mu}\pm z\times\sqrt{\left(\frac{\hat{\sigma}^2}{75}\right)}$, with numerical values throughout	M1	
	Use of correct z-value, i.e. 1.96	B1	
	Obtain correct interval correctly $8740 < \mu < 9060$ (allow 8900 ± 160)	A1	3
	[The M mark can also be earned for $\sqrt{\left(\frac{s^2}{74}\right)}$, where s^2 is the biased variance estimate; for this mark, z must be numerical tabular value. However the use of $\sqrt{\left(\frac{s^2}{75}\right)}$ can only earn M1 B1 A0.]		
	State or use the correct z-value $-1.28(2)$	B1	
	Form an equation $\frac{a-8900}{\sqrt{(503000)}}=z$, where z is a tabular value (ignore a sign error in z here)	M1	
	Obtain answer 7990	A1	3
15	Show evidence of substituting relevant numbers into a correct formula	M1	
	Obtain answer 0.99 correctly	A2	3
	[If done by calculator with no working, the marks are B3 or B0]		
	Make a sensible comment, e.g. consistent with a linear relationship, strong positive correlation	B1	1
	Use the d-v data correctly to find the line of d on v	M1	
	Obtain equation $d = -25.5 + 1.64v$	A1	2
	[If done by calculator with no working, the marks are B2 or B0]		
	Show axes with required scaling	B1	
	Show the six points plotted correctly	B1	
	Show the calculated line correctly	B1 ft	3
	[For the final B mark check that he v-intercept and ordinate at $v = 40$ are accurate to $\pm\frac{1}{2}$ square, or make a similar check]		
	Use the equation or plot of the regression line and obtain $d = 65$ or 64 completely correctly	B1	1
	Make any sensible comment, e.g. plot of data shows evidence of a non-linear relationship. Regression line overestimates d when $v = 55$ OR value of coefficient (or data plot) suggests use of line will be suitable	B1	1

16	(i) State numerical expression of the form $\left(\frac{3}{4}\right)^n\left(\frac{1}{4}\right)$, with $n = 3$ or 4	M1	
	Obtain answer $\frac{27}{256}$ or 0.11	A1	2
	(ii) EITHER: Attempt addition of relevant terms $\left(\frac{3}{4}\right)^7\left(\frac{1}{4}\right)$	M1	
	Obtain answer $\frac{21087}{65536}$ or 0.32	A1	
	OR: Attempt relevant subtraction $\left(\frac{3}{4}\right)^3-\left(\frac{3}{4}\right)^8$	M1	
	Obtain answer $\frac{21087}{65536}$ or 0.32	A1	2
	(iii) State expression $\left(\frac{3}{4}\right)^2\left(\frac{1}{4}\right)^2$ for one case	B1	
	Add probabilities for the two cases FSS, SFS (or equivalent)	M1	
	Obtain answer $\frac{3}{32}$ or 0.094	A1	3
	State or imply value 4 for mean μ of X	B1	
	State or imply value 12 for variance σ^2 of X	B1	
	Show numerical calculation $\frac{5-\mu}{\text{st.error}}$ where the attempted denominator involves both their 12 and 60	M1	
	Show correct expression $\frac{5-4}{\sqrt{\left(\frac{12}{60}\right)}}$	A1 ft	
	Obtain answer 0.013 correctly	A1	5

OCR

RECOGNISING ACHIEVEMENT

Markscheme 9200/3
June 2000

1	EITHER: Attempt quotient rule (or equivalent) allowing sign errors for this mark (products reversed only)	M1	
	Obtain any correct unsimplified expression, e.g. $\frac{(2x+1)\times1-(x-2)\times2}{(2x+1)^2}$	A1	
	Obtain simplified answer $\frac{5}{(2x+1)^2}$ correctly	A1	
	[Product rule also requires chain rule (both applied correctly for M1)]		
	OR: Express the function as $\frac{1}{2}-\frac{5}{2(2x+1)}$	B1	
	Use chain rule to differentiate $k(2x+1)^{-1}$ (result $-k(2x+1)^{-2}$ is M0)	M1	
	Obtain simplified answer $\frac{5}{(2x+1)^2}$ correctly	A1	3
	[Accept final answer in the form $\frac{5}{4x^2+4x+1}$.]		
2	EITHER: State or imply correct cosine rule (in any form) involving 2, 3, 4 and either B or C	M1*	
	Obtain $\cos B = -\frac{1}{4}$ (aef) or $B = 104.5°$ or $104°$ or $105°$ or $\cos C = \frac{7}{8}$ (aef) or $C = 29°$	A1	
	State or imply correct formula for AD^2 involving 2, 4 and their numerical $\cos B$ or 1, 4 and their numerical $\cos(180 - C)$ or $-\cos C$	M1 (dep *)	
	Obtain answer $\sqrt{24}$ or $2\sqrt{6}$ or 4.9	A1	
	OR: [E is the foot of the perpendicular from A to CB produced]		
	Use Pythagoras in triangles ACE and ABE to obtain an equation for BE or AE	M1*	
	Obtain $BE = \frac{1}{2}$ or $AE^2 = \frac{15}{4}$	A1	
	Apply Pythagoras (or trig) with numerical BE and/or AE to find AD^2 (or AD)	M1 (dep *)	
	Obtain answer $\sqrt{24}$ or $2\sqrt{6}$ or 4.9	A1	4
3	(i) Multiply two relevant probabilities for a 'Yes' branch	M1*	
	Add the two relevant two-factor cases, i.e. $\frac{2}{3}p+\frac{1}{3}(1-p)$	M1 (dep *)	
	Obtain given answer $\frac{1}{3}(1+p)$ correctly	A1	3
	(ii) (Solve $\frac{1}{3}(1+p)$ and) find $p = 0.05$	B1	1
	Divide attempted P('No' and 'Truthful') by P('No')	M1	
	State or imply answer is $\frac{\frac{2}{3}(1-0.05)}{1-0.35}$	A1 ft	
	Obtain answer 0.97 or $\frac{38}{39}$ or equivalent fraction	A1	3
	[M1 is for a fraction with numerical numerator $(1 - p)$ or denominator $1 - 0.35$ (or equivalent); ft only if $0 < p < 1$]		

4	(a) (i) State 'pie chart' or 'bar chart' or 'pictogram' or 'line diagram'	B1	1
	(ii) State 'histogram' or 'stem and leaf diagram' or 'frequency polygon' or 'cumulative diagram'	B1	1
	(iii) State 'double bar chart' or 'two bar charts with common scales on a single diagram'	B1	1
	(b) (i) Read off at least one relevant result	M1	
	Obtain any one answer 32, 38, 43	A1	
	Obtain all three correct values of the median and quartiles, identifying the median	A1	
	State interquartile range is 11	A1 ft	4
	(ii) Show linear scale from 0 to 60 with 0 and 60 marked with ends of whiskers located at 5 and 60	B1	
	Show box extending between their quartile values	B1 ft	
	Show median line in box at their median value	B1 ft	3
	[Location of 5, medians and quartiles to be reasonably consistent with a linear scale.]		
5	EITHER: Use the correct formula $s = ut + \frac{1}{2}at^2$	M1 *	
	Obtain equation $6 = 15t - \frac{1}{2}gt^2$	A1	
	Solve a quadratic equation for t	M1 (dep *)	
	Obtain roots 0.47 and 2.6	A1	
	OR: Use the correct formula $v2 = u2 + 2as$ to find v	M1 *	
	State correct expression $\sqrt{(15^2 - 2g \times 6)}$ for speed at height 6m	A1	
	Use a correct formula to evaluate a relevant time	M1 (dep *)	
	Obtain answers 0.47 and 2.6	A1	4
	[Treat 'time above 6m' as a MR and give maximum possible on scheme.]		
6	(i) Show three corrected line segments with 2 correctly signed gradients	B1	
	Show or imply t and v axes with relevant points (10, 40), (15, 30) and (20, 0) identified and graph of correct shape	B1	
	Carry out complete method for the area calculation, e.g. two triangles and one trapezium (or equivalent use of constant acceleration formulas)	M1	
	Obtain answer 450	A1	4
	(ii) Sketch a graph starting at O having positive, decreasing gradient	B1	1
7	(i) State moments equation about A: $F \times 2\sin BAC = W \times \frac{1}{2}AC$, or equivalent	M1	
	State or imply any correct trig result, e.g. $\tan BAC = \frac{1}{2}$, or perp distance from B to $AC = \frac{2}{\sqrt{5}}$, or equivalent	B1	
	Obtain answer $F = \frac{5}{4}W$ correctly	A1	3
	(ii) Obtain $\tan\theta = \frac{W}{\frac{5}{4}W}$ $\left(\text{or} = \frac{\text{perp distance from } B \text{ to } AC}{\frac{1}{2}AC}\right)$	B1 ft	
	Obtain $R = \sqrt{\left(\frac{25}{16}W^2 + W^2\right)}$ (or from $R = \frac{F}{\cos\theta}$)	B1 ft	
	Obtain R $\frac{W\sqrt{41}}{4}$ $(= 1.6W)$ AND $\theta = 39°$ (with R clearly in the correct direction)	B1	3
8	Equate total momentum before and after	M1	
	State or imply a correct equation $20000 \times 1.5 + 10000 \times 1 = (20000 + 10000)v$	A1	
	Obtain answer $\frac{4}{3}$, or equivalent, correctly	A1	3
	(i) State either $5000 = (\pm)30000a$ or both of $5000 - P = (\pm)10000a$ and $P = (\pm)20000a$	M1	
	Obtain answer $(\pm)\frac{1}{6}$, or equivalent, for the deceleration	A1	2
	(ii) Use a Newton II equation for one of the trucks with their numerical a (or numerical v and t) to find P	M1	
	Obtain answer $(\pm)3333\frac{1}{3}$ or 3300 only	A1	2
	[if g appears in the momentum equation deduct A1 but allow A1 for answer or equivalent.]		

9	Use Hooke's law in equilibrium equation $0.5g = \frac{1.2\lambda}{0.6}$	M1	
	Obtain $\lambda = \frac{1}{4}g$ or 2.5(2.4525)	A1	2
	State energy equation involving KE and at least one of EE, PE	M1	
	Show correct PE term $0.5 \times g \times 1.8$	B1	
	Show correct EE term $\frac{\frac{1}{4}g \times 1.2^2}{2 \times 0.6}$ $(= 0.3g)$	B1 ft	
	State unsimplified equation, e.g. $0.25v^2 + 0.3g = 0.9g$ (signs correct)	A1 ft	
	Obtain answer $v = 4.8$ or 4.9 correctly	A1	5
	[For the B marks for the PE and EE terms, ignore signs.]		
10	Resolve vertically, i.e. $2T\cos\theta = W$ or use trig in correct triangle or use Lami	M1	
	Obtain answer 41° following correct use of $T = \frac{2}{3}W$	A1	2
	EITHER: Attempt a resolving equation, with 3 terms	M1*	
	Obtain a correct equation in T and trig ratios of one angle, e.g. one of $T\cos\theta + T\sin\theta = W$, $T\cos\theta - T\sin\theta = \frac{1}{2}W$, $T = \frac{1}{2}W\cos\theta + W\sin\theta$,		
	$T = W\cos\theta - \frac{1}{2}W\sin\theta$ (allow $\cos(90 - \theta)$ for $\sin\theta$ etc)	A1	
	Attempt a second independent 3-term resolving equation	M1*	
	Obtain a second correct equation in T and trig ratios of previous angle	A1	
	Obtain an equation in θ (or T) only	M1 (dep *)	
	Obtain angle 18° or 72°	A1	
	Obtain $T = 0.79W$ or equivalent	A1	
	OR: State resultant of W forces has magnitude $\frac{\sqrt{5}}{2}W$ or equivalent	B1	
	Combine T forces and equate resultants	M1	
	Obtain a correct equation, e.g. $2T\cos45° = \frac{\sqrt{5}}{2}W$	A1	
	Obtain $T = 0.79W$ or equivalent	A1	
	State resultant of W forces makes $\tan^{-1}\left(\frac{1}{2}\right)$ with the vertical or $\tan^{-1}(2)$ with the horizontal	B1	
	Equate directions and obtain an equation in θ, using 45° or 135°	M1	
	Obtain angle 18° or 72°	A1	7
	[SR: Use of Wg for the weight W can score M1 A0 then M3 and as A1.]		
11	EITHER: State a correct equation from which T or $\frac{1}{2}T$ can be found,		
	e.g. $0 = V\sin\theta t - \frac{1}{2}gt^2$ or $0 = V\sin\theta - gt$	M1	
	Obtain any correct expression for R in terms of V, θ and g	A1	
	Obtain given answer $R = \frac{V^2\sin2\theta}{g}$ correctly	A1	
	OR: Using the equation of trajectory, state or imply equation		
	$0 = R\tan\theta - \frac{gR^2}{2V^2\cos^2\theta}$, or equivalent	M1	
	Obtain any correct expression for R in terms of V, θ and g	A1	
	Obtain given answer $R = \frac{V^2\sin2\theta}{g}$ correctly	A1	3
	State any one suitable assumption, e.g. no air resistance, constant acceleration, etc	B1	1
	(i) State both $D - 100 = \frac{U^2\sin60°}{g}$ and $D + 100 = \frac{U^2\sin90°}{g}$ or equivalent	B1	
	Eliminate D and solve for U^2	M1	
	Obtain given answer 121 correctly	A1	3
	(ii) Obtain $D = 1400$ (1392.82)	B1	
	Substitute values of U and D in range equation and solve for $\sin2\theta$	M1	
	Obtain answer 34° (34.4547…) or 35°	A1	3
	[SR: use of GA to show $U = 121$ and $D = 1400$ are consistent can get B1 M0 A0 B1 M1 A1.]		

12	EITHER: State $mg = T\cos\alpha$	B1	
	Equate $T\sin\alpha$ to $m \times$ circular acceleration formula	M1	
	State correct equation $T\sin\alpha = m\omega^2 l\sin\alpha$	A1	
	Eliminate T and obtain given answer $\cos\alpha = \frac{g}{\omega^2 l}$ correctly	A1	
	OR: Equate $mg\sin\alpha$ to $m \times$ circular acceleration formula $\times \cos\alpha$	M1	
	State correct equation $mg\sin\alpha = m\omega^2 l\sin\alpha\cos\alpha$	A2	
	Obtain given answer $\cos\alpha = \frac{g}{\omega^2 l}$ correctly	A1	4
	(i) Use Hooke's law to express T_{PQ} in terms of m, g, l, θ	M1	
	Cancel l and obtain correct expression $mg(2\sin\theta - 1)$ or equivalent	A1	2
	(ii) State a 3-term Newton II equation $T_{OP}\sin\theta + T_{PQ} = mr \times \frac{2g}{l}$ (ie $w^2 = \frac{2g}{l}$ used)	M1*	
	Use $T_{OP}\cos\theta = mg$ and eliminate both tensions	M1 (dep *)	
	State correct equation involving m, g, l, θ only (at most), e.g. $\frac{mg}{\cos\theta}\sin\theta + \frac{mg(l\sin\theta - \frac{1}{2}l)}{\frac{1}{2}l} = ml\sin\theta \times \frac{2g}{l}$ (FT on T_{PQ})	A1 ft	
	Simplify and obtain answer $\theta = \frac{1}{4}\pi$ or 45° correctly	A1	4
13	State or imply no sliding if $W\sin\alpha \leqslant \mu W\cos\alpha$ (or =)	M1	
	Obtain given answer $\mu \geqslant \frac{3}{4}$ correctly	A1	2
	[For a direct quote of $\mu \geqslant \tan\alpha$ allow B2]		
	Resolve parallel to the plane for 'sliding up' (allow sign and trig errors)	M1	
	Obtain $P = W\sin\alpha + \mu W\cos\alpha$	A1	
	Obtain given answer $P = \frac{1}{5}(3 + 4\mu)W$ correctly	A1	3
	Take moments about bottom right for 'toppling up' (allow trig errors) (R and F must act through bottom right)	M1	
	Obtain $Pl = \frac{1}{2}Wl\sin\alpha + \frac{1}{2}Wl\cos\alpha$ or $Pl = W\left(\frac{1}{2}l\sqrt{2}\right)\cos(45° - \alpha)$ (or equiv in P, W, l, α)	A1	
	Substitute for α (allow use of cos 8.1301...°) and obtain given answer $P = \frac{7}{10}W$	A1	3
	EITHER: Find the least possible value of P for sliding and compare with $\frac{7}{10}W$	M1	
	State that as $\frac{7}{10}W < \frac{6}{5}W$, toppling occurs first	A1	
	OR: Find the least possible value of μ for toppling to occur before sliding and compare with $\frac{3}{4}$	M1	
	State that as $\frac{1}{8} < \frac{3}{4}$, toppling occurs first	A1	2

14	(a) (i) State any one Newton II equation, e.g. $0.3g - T = 0.3a$, $T - 0.2g = 0.2a$, $0.1g = 0.5a$	M1	
	State two of the above equations correctly	A1	
	Solve a relevant pair of equations to find T	M1	
	Obtain answer $T = 2.4$	A1	4
	(ii) State or use $a = \frac{1}{5}g$ in this part of the question	B1	
	Use $v = u + at$ with $u = 0$ and $a \neq g$ to find t	M1	
	Obtain answer $t = 2.0$	A1	3
	[Answer to (I) and (ii) left as $6g/26$ and $20/g$ are penalised once, scoring A0 A1]		
	[NB: if g is omitted only the M marks are available.]		
	(b) EITHER: State equation or inequality, with 3 force terms, for motion parallel to the plane for either particle	M1	
	Resolve perpendicular to the plane for either particle, and use $F = \mu R$	M1	
	State one correct equation/inequality, e.g. $0.3g\sin30° - 0.3\mu g\cos30° - T = 0.3a$ (or > 0 or $= 0$)	A1	
	State a second correct equation/inequality, eg $T - 0.2g\sin30° - 0.2\mu g\cos30° = 0.2a$ (or > 0 or $= 0$)	A1	
	Eliminate T from a pair of equations or inequalities and solve for μ	M1	
	Obtain the given inequality $\mu < \frac{1}{5\sqrt{3}}$ correctly and not via decimals	A1	
	OR: State 'system' equation or inequality involving both weight components and both friction forces	M1	
	Resolve perpendicular to the plane for both particles, and use $F = \mu R$	M1	
	State any correct equation/inequality, e.g. $0.1g\sin30° - 0.5\mu g\cos30° = 0.5a$ (or > 0 or $= 0$)	A2	
	Solve this equation/inequality for μ	M1	
	Obtain given inequality $\mu < \frac{1}{5\sqrt{3}}$ correctly and not via decimals	A1	6
15	(i) State driving force $= \frac{10000}{25}$	B1	
	State 3-term Newton II equation $\frac{10000}{25} - 200 = 400a$	M1	
	Obtain answer $a = \frac{1}{2}$	A1	3
	(ii) Obtain answer 20 $\left(\text{i.e.}\frac{10}{\text{answer (i)}}\right)$	B1 ft	1
	(iii) Use $a = \frac{dv}{dt}$ to set up DE, and attempt separation of variables	M1	
	Obtain $\int\frac{2v}{50-v}dv = \int dt$, or equally integrable equivalent	A1	
	Obtain both $2\{-v - 50\ln(50 - v)\}$ and t correctly	A1 ft	
	Obtain given answer 20.5 correctly, either via limits or $+ c$	A1	4
	[Follow through on wrong factor of 2 only]		
	(iv) Set up and separate new DE: $\int\frac{2v^2}{50-v}ds = \int ds$, or equally integrable equivalent	M1	
	Obtain $2\{-\frac{1}{2}v^2 - 50v - 50^2\ln(50 - v)\}$ and s correctly	A1 ft	
	Obtain answer 527	A1	3
	[Follow through on wrong factor of 2 only]		
	(v) State equation involving WD by engine, WD against resistance, KE	M1	
	State or imply work done by engine is $10\,000t$	B1	
	State or imply work done against resistance is $200s$	B1	
	Prove given answer correctly	A1	4

OCR

RECOGNISING ACHIEVEMENT

Markscheme 9200/4
June 2000

1	EITHER: Attempt quotient rule (or equivalent) allowing sign errors for this mark (products reversed only)	M1	
	Obtain any correct unsimplified expression, e.g. $\frac{(2x+1)\times1-(x-2)\times2}{(2x+1)^2}$	A1	
	Obtain simplified answer $\frac{5}{(2x+1)^2}$ correctly	A1	
	[Product rule also requires chain rule (both applied correctly for M1)]		
	OR: Express the function as $\frac{1}{2}-\frac{5}{2(2x+1)}$	B1	
	Use chain rule to differentiate $k(2x+1)^{-1}$ (result $-k(2x+1)^{-2}$ is M0)	M1	
	Obtain simplified answer $\frac{5}{(2x+1)^2}$ correctly	A1	3
	[Accept final answer in the form $\frac{5}{4x^2+4x+1}$.]		
2	EITHER: State or imply correct cosine rule (in any form) involving 2, 3, 4 and either B or C	M1*	
	Obtain $\cos B = -\frac{1}{4}$ (aef) or $B = 104.5°$ or $104°$ or $105°$ or $\cos C = \frac{7}{8}$ (aef) or $C = 29°$	A1	
	State or imply correct formula for AD^2 involving 2, 4 and their numerical $\cos B$ or 1, 4 and their numerical $\cos(180 - C)$ or $-\cos C$	M1 (dep *)	
	Obtain answer $\sqrt{24}$ or $2\sqrt{6}$ or 4.9	A1	
	OR: [E is the foot of the perpendicular from A to CB produced]		
	Use Pythagoras in triangles ACE and ABE to obtain an equation for BE or AE	M1*	
	Obtain $BE = \frac{1}{2}$ or $AE^2 = \frac{15}{4}$	A1	
	Apply Pythagoras (or trig) with numerical BE and/or AE to find AD^2 (or AD)	M1 (dep *)	
	Obtain answer $\sqrt{24}$ or $2\sqrt{6}$ or 4.9	A1	4
3	(i) Multiply two relevant probabilities for a 'Yes' branch	M1*	
	Add the two relevant two-factor cases, i.e. $\frac{2}{3}p+\frac{1}{3}(1-p)$	M1 (dep *)	
	Obtain given answer $\frac{1}{3}(1+p)$ correctly	A1	3
	(ii) (Solve $\frac{1}{3}(1+p)$ and) find $p = 0.05$	B1	1
	Divide attempted P('No' and 'Truthful') by P('No')	M1	
	State or imply answer is $\frac{\frac{2}{3}(1-0.05)}{1-0.35}$	A1 ft	
	Obtain answer 0.97 or $\frac{38}{39}$ or equivalent fraction	A1	3
	[M1 is for a fraction with numerical numerator $\frac{2}{3}(1-p)$ or denominator $1 - 0.35$ (or equivalent); ft only if $0 < p < 1$]		

4	(a) (i) State 'pie chart' or 'bar chart' or 'pictogram' or 'line diagram'	B1	1
	(ii) State 'histogram' or 'stem and leaf diagram' or 'frequency polygon' or 'cumulative frequency diagram'	B1	1
	(iii) State 'double bar chart' or 'two bar charts with common scales on a single diagram'	B1	1
	(b) (i) Read off at least one relevant result	M1	
	Obtain any one answer 32, 38, 43	A1	
	Obtain all three correct values of the median and quartiles, identifying the median	A1	
	State interquartile range is 11	A1 ft	4
	(ii) Show linear scale from 0 to 60 with 0 and 60 marked and with ends of whiskers located at 5 and 60	B1	
	Show box extending between their quartile values	B1 ft	
	Show median line in box at their median value	B1 ft	3
	[Location of 5, medians and quartiles to be reasonably consistent with a linear scale.]		
5	State procedure A is better	B1	
	Indicate that early customers may not be typical of customers in general	B1	2
	[For the justification mark, it's no good *merely* saying 'not random' or biased.]		
	State any sensible idea, involving e.g. useful criticisms from people who don't use her shop, useful ideas for attracting new customers, etc, etc.	B1	1
	[not enough to say 'not random' or 'to avoid bias']		
6	Form an expression for $\Sigma x^2 p$	M1 *	
	Subtract $(\Sigma xp)^2$ from the above	M1 (dep *)	
	Obtain correct expression $6p - 16p^2$ for the variance	A1	
	Equate variance (not s.d.) to $\frac{1}{2}$ and solve for p	M1	
	Obtain values $p = \frac{1}{4}$ and $p = \frac{1}{8}$	A1	
	Deduce both values 1 and $\frac{1}{2}$ for E(X) The ft is only 2 p values $0 < p < 1$	A1 ft	6
7	(i) State or imply one of the 2 binomial terms $\binom{50}{1}(0.88)^{49}(0.12)$		
	or $\binom{50}{2}(0.88)^{48}(0.12)^2$	M1	
	Add the correct three binomial terms (and no others)	M1	
	Obtain answer 0.051	A1	3
	(ii) State or imply $\mu = 50 \times 0.12$	B1	
	State or imply value $50 \times 0.12 \times 0.88$ relating to variance/s.d.	B1	
	Evaluate $\frac{9.5-6}{\sqrt{(5.28)}}$ and use tables	M1	
	Obtain answer 0.064	A1	4
	[The M1 is not lost for missing continuity correction, or for c.c. of $\frac{1}{2}$ on the wrong side, but the denominator must be $\sqrt{(npq)}$ not npq.]		
	SR1 Incorrect use of Poisson could score B1 for $\mu = 6$ and B1 for final answer 0.084		
	SR2 If p/q interchanged can score M1 M1 A0 B0 B1 M1 A0		
	NB_1 use of Binomial in (ii) scores M0		
	NB_2 in (i) and (ii) treat $p = \frac{12}{50}$ as MR		
8	(i) Use correct Poisson formula with $\mu = 4$, i.e. $e^{-4}\frac{4^3}{3!}$	M1	
	Obtain answer 0.20	A1	2
	(ii) Add correct Poisson cases 0, 1, 2	M1	
	Obtain answer 0.24	A1	2
	State or imply Poisson with $\mu = 5$ is a suitable model OR if 2 distributions considered separately, consider *all* cases	B1	
	Calculate 1 – {P(0) + P(1) + P(2) + P(3)}	M1	
	Obtain answer 0.73 or 0.74 (0.73497…)	A1	3

9	(i) EITHER: Express $C > 40$ in terms of X (the number of hours)	M1	
	State or imply that equivalent inequality if $X > \frac{1}{2}$	A1	
	Calculate $\pm\frac{(0.5-0.9)}{0.2}$ and use tables	M1	
	Obtain answer 0.98	A1	
	OR: Evaluate mean and s.d. of $30 + 20X$	M1	
	Obtain 48 and 4	A1	
	Calculate $\pm\frac{(40-48)}{4}$ and use tables	M1	4
	Obtain answer 0.98	A1	
	OR: Evaluate mean and s.d. of $20X$		
	Obtain 18 and 4		
	Calculate $\pm\frac{(10-18)}{4}$ and use tables		
	Obtain answer 0.98		
	(ii) EITHER: State or imply that $E(T) = 480$ (or 180)	B1	
	State or imply calculation of $10 \times 20^2 \times 0.2^2$	B1	
	Calculate $\pm\frac{(500-480)}{\sqrt{160}}\left(\text{OR } \pm\frac{200-180}{\sqrt{160}}\right)$ and use tables	M1	
	Obtain answer 0.057	A1	
	OR: State or imply $E(T) = 48$	B1	
	State or imply calculation $0.1 \times 20^2 \times 0.2^2$	B1	
	Calculate $\pm\frac{50-48}{\sqrt{1.6}}$ and use tables	M1	
	Obtain answer 0.057	A1	
	OR: State or imply that $E(H) = 9$	B1	
	State or imply calculation of 10×0.2^2	B1	
	Calculate $\pm\frac{(10-9)}{\sqrt{0.4}}$ and use tables	M1	
	Obtain answer 0.057	A1	
	OR: State or imply that $E(H) = 0.9$	B1	
	State or imply calculation 0.1×0.2^2	B1	
	Calculate $\pm\frac{(1-0.9)}{\sqrt{0.004}}$ and use tables	M1	
	Obtain answer 0.057	A1	4
10	(i) State value 8900 for $\hat{\mu}$	B1	
	State or imply expression $\frac{1}{74}\left(5.978\times10^9 - \frac{(6.675\times10^5)^2}{75}\right)$, or equivalent	M1	
	Obtain answer 503 000 for $\hat{\sigma}^2$	A1	3
	[If done by calculator with no working shown, the mark for the variance estimate is effectively B2 or B0. The biased estimate gets 0/2]		
	(ii) Use of $\hat{\mu} \pm z \times \sqrt{\left(\frac{\hat{\sigma}^2}{75}\right)}$, with numerical values throughout	M1	
	Use of correct z-value, i.e. 1.96	B1	
	Obtain correct interval $8740 < \mu < 9060$	A1	3
	[The M mark can also be earned for $\sqrt{\left(\frac{s^2}{74}\right)}$, where s^2 is the biased variance estimate; for this mark, z must be a numerical tabular value]		
	SR If $\frac{s^2}{75}$ used allow M1 B1 A0		
	State or use the correct z-value – 1.28(2)	B1	
	Form an equation $\frac{a-8900}{\sqrt{(503000)}} = z$, where z is a tabular value (ignore a sign error in z here)	M1	
	Obtain answer 7990	A1	3

11	Show evidence of correct binomial term $\binom{24}{2}(0.8)^{22}(0.2)^2$	B1	
	Add the three relevant terms for 0, 1, 2 sufferers or 1 – (0, 1, 2 sufferers)	M1	
	Obtain value 0.11 (consistent with comparison to 0.1) or obtain value 0.89 (consistent with comparison to 0.9)	A1	
	Compare 0.11 to 0.1 or compare 0.89 to 0.9 and accept NH, i.e. can't reject $p = 0.2$	A1 ft	4
	EITHER: State or use 0.2 and $\sqrt{\left(\frac{0.2\times0.8}{40}\right)}$ as normal mean and s.d.	B1	
	State observed proportion is $\frac{12}{40} = 0.3$	B1	
	Calculate $\frac{\pm(0.3-0.2)}{\sqrt{0.004}}$ and use tables for this z value *or* use tables for 0.1	M1	
	Obtain tail probability 0.057 or obtain 1.58 for test statistic and 1.28(2)		
	Compare tail probability to 0.1 OR compare 1.58 to 1.28(2) and reject NH; i.e. accept $p > 0.2$	A1	
	[strictly speaking the observed proportion should be taken as $\frac{11.5}{40}=0.2875$; the conclusion is unchanged.]	A1 ft	
	OR: State or use 40×0.2 as the mean for a normal distribution	B1	
	State or use $\sqrt{(40\times0.2\times0.8)}$ as the s.d.	B1	
	Calculate $\frac{\pm(11.5-8)}{\sqrt{6.4}}$ and use tables for this z value *or* use tables for 0.1	M1	
	Obtain tail probability 0.083 or obtain 1.38 for test statistic and 1.28(2)		
	Compare tail probability to 0.1 *or* compare 1.38 to 1.28(2) and reject NH, i.e. accept $p > 0,2$	A1	
	[NB no cc or wrong cc can still gain M mark]	A1 ft	
	OR: If binomial test carried out:		
	One correct Binomial term	B1	
	Calculate $1 - \Sigma$ relevant terms 0 … 11 (allow 12 error)	M1	
	Obtain value 0.087 or 0.088	A2	
	Compare to 0.1 and reject NH	A1 ft	5
12	(i) State that the data must be a sample from a normal population	B1	1
	(ii) State or use $\bar{x}=27.5$	B1	
	Show correct expression for either unbiased or biased variance estimate	B1	
	Calculate $\frac{\pm(27.5-36)}{\text{attempted s.e.}}$	M1	
	Show correct value $\frac{27.5-36}{\sqrt{\left(\frac{36.28}{10}\right)}}$ or $\frac{27.5-36}{\sqrt{\left(\frac{32.65}{9}\right)}}$ (= –4.46)	A1 ft	
	State or imply 9 degrees of freedom	B1	
	Demonstrate the given result via comparison 4.46 > 4.297	A1	6
	Equate $\frac{27.5-\mu}{\text{attempted s.e.}}$ to numerical t-value	M1	
	State or use t = -1.833	B1	
	Obtain answer 31	A1	3

13	Show evidence of substituting relevant numbers into a correct formula	M1	
	Obtain answer 0.99 correctly	A1	3
	[If done by calculator with no working, the marks are B3 or B0]		
	make a sensible comment, e.g. consistent with a linear relationship, strong positive correlation	B1	1
	use the d-v data correctly to find the line of d on v	M1	
	obtain equation $d = -25.5 + 1.64v$	A1	2
	[If done by calculator with no working, the marks are B2 or B0]		
	Show axes with required scaling	B1	
	Show the six points plotted correctly	B1	
	Show the calculated line correctly – check v intercept accuracy $\pm \frac{1}{2}$ square – check $v = 40$ ($d = 40.1$) accuracy $\pm \frac{1}{2}$ square or similar	B1 ft	3
	Use the equation or plot of the regression line and obtain $d = 65$ or 64 completely correctly	B1	1
	Make any sensible comment, e,g, plot of data shows evidence of a non-linear relationship, regression line overestimates d when $v = 55$, value of coefficient (or data plot) suggests line will be suitable	B1	1
14	(i) State numerical expression of the form $\left(\frac{3}{4}\right)^n\left(\frac{1}{4}\right)$, with $n = 3$ or 4	M1	
	Obtain answer $\frac{27}{256}$ or 0.11	A1	2
	(ii) EITHER: Attempt addition of relevant terms $\left(\frac{3}{4}\right)^r\left(\frac{1}{4}\right)$	M1	
	Obtain answer $\frac{21087}{65536}$ or 0.32	A1	
	OR: Attempt relevant subtraction $\left(\frac{3}{4}\right)^3 - \left(\frac{3}{4}\right)^8$	M1	
	Obtain answer $\frac{21087}{65536}$ or 0.32	A1	2
	(iii) State expression $\left(\frac{3}{4}\right)\left(\frac{1}{4}\right)^2$ for one case	B1	
	Add probabilities for the two cases FSS, SFS (or equivalent)	M1	
	Obtain answer $\frac{3}{32}$ or 0.094	A1	3
	State or imply value 4 for mean μ of X	B1	
	State or imply value 12 for variance σ^2 of X	B1	
	Show numerical calculation $\frac{5-\mu}{\text{st.error}}$ where the denominator involves their 12 and 60	M1	
	Show correct expression $\frac{5-4}{\sqrt{\left(\frac{12}{60}\right)}}$	A1 ft	
	Obtain answer 0.013 correctly	A1	5
15	(i) Calculate all expected frequencies	M1	
	Obtain all values 117.03 50.29 15.04 5.64 131.97 56.71 16.96 6.36	A2	
	Carry out correct method for calculation of χ^2	M1	
	Obtain value 3.29 for χ^2	A1	
	State or imply 3 degrees of freedom	B1 ft	
	Compare 3.29 with 7.815 and conclude there's no association	A1 ft	7
	[If 6 or 7 of the expected frequencies are correct, allow A1. For accuracy only to 2 s.f. or nearest whole number allow A1 for *all* correct to this accuracy]		
	(ii) State or use $\frac{207}{400}$=0.5175 or 0.52 for Poisson mean	B1	
	Use Po(0.5175) to calculate four expected frequencies	M1	
	Obtain values 238.40, 123.36 or 123.37, 31.92, 6.30 to 6.32 (for 3 or more)	A1	
	Carry out correct method for calculation of χ^2	M1	
	Obtain value 7.75 to 7.80	A1	
	State or imply 2 degrees of freedom	B1 ft	
	Compare 7.80 with 5.99 and conclude it doesn't fit	A1 ft	7
	[Special case: candidates whose fourth frequency is 5.51 (for 3) and who incorrectly use this instead of the frequency for 3 or more can score B1 M1 A0 M1 A0 B1 and A1 ft for comparing their $\chi^2 \approx 10.29$ with 5.99]		