Mark Scheme (Results)

January 2014

Pearson Edexcel International Advanced Level

Statistics 1 (WST01/01)

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.

- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.

- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.

- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.

- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.

- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.

- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS
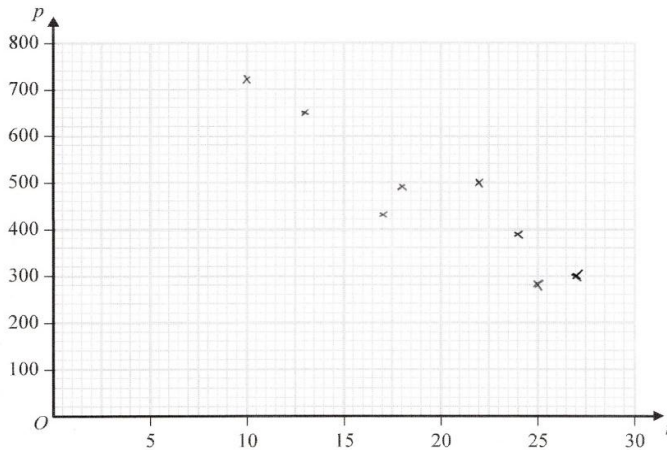
General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes.

- bod – benefit of doubt
- ft – follow through
- the symbol $\sqrt{}$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- ✱ The answer is printed on the paper
- ⌐ The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. If a candidate makes more than one attempt at any question:
   - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

Question Number	Scheme	Marks
1.(a)	$S_{cs} = 380 - \dfrac{111 \times 21}{6} = -8.5$ o.e.	M1A1
	$S_{ss} = 79 - \dfrac{21^2}{6} = 5.5$ o.e.	A1
		(3)
(b)	$r = \dfrac{S_{cs}}{\sqrt{S_{cc}S_{ss}}} = \dfrac{-8.5}{\sqrt{321.5 \times 5.5}} = -0.20214...$ awrt -0.202	M1A1
		(2)
(c)	No evidence of, or weak, correlation (between cost and satisfaction) from data <u>or</u> evidence of negative correlation. [Allow r close to zero or $r < 0$]	B1ft,
	Poor basis for a decision, Brad is wrong or equivalent, e.g. "paying more doesn't give a better service"	dB1ft
		(2)
		Total 7

	Notes	
(a)	M1 for a correct expression for S_{cs} or S_{ss} 1st A1 for $S_{cs} = -8.5$ (Condone $S_{xy} = ...$) accept $-\dfrac{17}{2}$ 2nd A1 for $S_{ss} = 5.5$ (Condone S_{yy} or even $S_{xx} = ...$) accept $\dfrac{11}{2}$	
(b)	M1 for attempt at correct formula, values must be substituted. Must have their S_{cs}, S_{ss} and given S_{cc} in the correct places. Condone missing "$-$" Award M1A0 for awrt -0.20 or even -0.2 with no expression seen M0 for $\dfrac{380}{\sqrt{79 \times 2375}}$ or $\dfrac{380}{\sqrt{79 \times 321.5}}$	
(c)	**If $|r| > 1$ score B0B0 in (c)** 1st B1 for a reason: no or weak (or negative) correlation (between cost and satisfaction) This may be implied by a contextual statement e.g. "as he pays more satisfaction decreases" 2nd d B1 dependent on suitable reason for saying that Brad's decision is wrong/bad/poor etc	
ft	**If $0.5 < r \le 1$ allow the following ft** 1st B1 for <u>positive</u> correlation 2nd dB1 for Brad's decision is a good one	

Question Number	Scheme		Marks
2. (a)	$a = \dfrac{77 \times 1 + 82 \times 2 + \dots}{15} = \dfrac{1385}{15} = \dfrac{277}{3} = 92.\dot{3}$	**awrt 92.3**	M1 A1
	$b = [89.5 +] \dfrac{7.5 - 5}{9 - 5}(94.5 - 89.5) = 92.625$	**awrt 92.6**	M1 A1
	$c = \dfrac{1 \times 77^2 + 2 \times 82^2 \dots}{15} - 92.\dot{3}^2 = 64.88\dots$	**awrt 64.9**	M1 A1
			(6)
(b)	Median in 2010 (92.6 kg) > Median in 1990 (82.0 kg)		
	Mean in 2010 (92.3 kg) > Mean in 1990 (83.0 kg) either		B1
	Rugby coach's claim supported. dep		dB1
			(2)
			Total 8
	Notes		
(a)	**Correct answer only in part (a) scores full marks and answers must be decimals not fractions**		
	NB mid points are: 77, 82, 87, 92, 97, 102, 107		
a	1st M1 for attempt to use correct midpoints in an expression for mean.		
	Accept $\dfrac{\sum fx}{15}$ with at least 3 correct fx products seen and intention to add		
	<u>or</u> $1300 < \sum fx < 1400$		
	1st A1 for awrt 92.3 (don't insist on 3 sf)		
b	2nd M1 for $\dfrac{7.5 - 5}{9 - 5}(94.5 - 89.5)$ or $\dfrac{8 - 5}{9 - 5}(94.5 - 89.5)$		
From above	May see them come down from the top of the interval, look out for:		
	$[94.5 -] \dfrac{9 - 7.5}{9 - 5}(94.5 - 89.5)$ or $[94.5 -] \dfrac{9 - 8}{9 - 5}(94.5 - 89.5)$		
	Correct end point and [..] not needed for M1 i.e. M1 is for correct fraction x correct class width		
	2nd A1 for awrt 92.6 For $n + 1$ case (gives 93.25 so allow awrt 93.3) Don't insist on 3 sf		
	The correct answer must <u>not</u> follow from an incorrect expression.		
c	3rd M1 for a fully correct expression ft their a e.g. $\dfrac{128855}{15} - a^2$ or $\dfrac{25771}{3} - a^2$		
	3rd A1 for awrt 64.9 (Accept $s^2 = 69.5238\dots$ or awrt 69.5) Don't insist on 3 sf		
(b)	1st B1 for a suitable reason i.e. identifying an increase in mean or median		
	Ignore any comment about variance.		
	2nd dB1 dependent on a suitable reason for stating that the coach's claim is supported		
	Allow these marks provided both their $a > 83.0$ <u>and</u> their $b > 82.0$		
	If it is **NOT** the case that both $a > 83.0$ <u>and</u> $b > 82.0$ then allow a ft <u>provided M1 scored for both a and b in part (a)</u>		

Question Number	Scheme	Marks
3. (a)		B2/1/0 −1eeoo (2)
(b)	'Negative correlation' or 'as t increases, p decreases' or 'Points close to a straight line' or 'linear correlation'	B1 (1)
(c)	$b = \dfrac{S_{tp}}{S_{tt}} = \dfrac{-6080}{254} (= -23.937)$ $a = \bar{p} - b\bar{t} = 470 + 23.937 \times 19.5 = 936.7717$ $p = 936.7717 - 23.937t$ **awrt $p = 937 - 23.9t$**	M1 M1, A1 A1 (4)
(d)	$p = 937.7717 - 23.937 \times 20, = 458.0315$ **awrt (£) 458**	M1, A1 (2)
(e)	Extrapolation <u>or</u> 39 (or it's) outside the range of data (or table) <u>BUT</u> B0 if they calculate p and say this is outside the range of the data Not a good decision <u>or</u> the prediction would be unreliable	B1 dB1 (2)
		Total 11
	Notes	
(a)	1st B1 for at least 7 points plotted correctly (i.e. within (not on) the circles on the overlay) 2nd B1 for all 8 points plotted correctly (i.e. within (not on) the circles on the overlay)	
(b)	B1 for a suitable comment conveying the idea of linear correlation NB "negative relationship" or "skew" scores B0 but apply ISW if a correct ans. is seen	
(c)	1st M1 for a correct expression for gradient b or awrt -24 Allow fractions e.g. $-\frac{3040}{127}$ 2nd M1 for a correct method for a. Follow through their value for b Allow sign slip on b only if a correct formula for a is seen 1st A1 for $a = $ awrt 937 2nd A1 for a correct equation in p and t (not x, y) with $a = $ awrt 937 and $b = $ awrt -23.9 <u>No fractions</u>	
(d)	M1 for substituting $t = 20$ in their equation A1 for awrt 458 [NB use of 3sf for a and b will give awrt £459 but scores A0 here]	
(e)	1st B1 for a suitable reason that would lead to stating that the decision was poor/bad/wrong Stating that 39 is an "outlier" is B0 2nd dB1 dependent on a suitable reason and stating, or implying, it is <u>not</u> a sensible decision	

Question Number	Scheme	Marks
4. (a)	$a + \dfrac{1}{10} + \dfrac{1}{5} + \dfrac{3}{10} + b = 1$ or $a + b = \dfrac{2}{5}$	M1
	$-a + 0 + \dfrac{1}{5} + \dfrac{6}{10} + 3b = \dfrac{9}{5}$ or $3b - a = 1$	M1
	Solving gives $a = \dfrac{1}{20}, b = \dfrac{7}{20}$	M1A1
		(4)

	x	-1	0	1	2	3	
(b)	[F(x)]	$\dfrac{1}{20}$	$\dfrac{3}{20}$	$\dfrac{7}{20}$	$\dfrac{13}{20}$	1	B1B1 −1eeoo
		0.05	0.15	0.35	0.65	1	

(2)

(c) $P(X < 2.5) = F(2) = \dfrac{13}{20}$ <u>or</u> 0.65 B1

(1)

(d)

$E(X^2) = 1 \times 0.05 + 0 + 1 \times 0.2 + 4 \times 0.3 + 9 \times 0.35 \left[= 4.6 \text{ or } \frac{23}{5} \right]$ M1

$\text{Var}(X) = E(X^2) - 1.8^2 \quad [= 1.36 \text{ or } \frac{34}{25}]$ M1

$\text{Var}(3 - 2X) = (-2)^2 \text{Var}(X)$ M1

$\quad\quad = 4 \times 1.36 = 5.44$ **5.44**   A1

(4)

Total 11

	Notes	

(a)
1st M1   for a correct linear equation in a and b based on sum of probs. = 1
2nd M1   for an attempt at a second linear equation in a and b based on E(X) = 1.8 Allow one slip.
3rd M1   for an attempt to solve their 2 linear equations. Must reduce to a linear equation in one variable. May be implied by 1st M1 and 2nd M1 followed by correct answers.
A1   dependent on all 3 Ms scored for $a = 0.05$ and $b = 0.35$ or exact fraction equivalents

ALT   State a and b correctly
1st M1   for explicitly showing that sum of probs. = 1
2nd M1   for explicitly showing that E(X) = 1.8
3rd M1   for an overall comment "therefore $a = $ …and $b = $ …" No comment loses this mark and A1

(b)
1st B1   for at least 4 correct values for F(x)
2nd B1   for all values of F(x) correct
     Condone no F(x) or even P(x) if in a correct table. If not in a table they must state F(-1) = 0.05 etc

(d)
1st M1   for an attempt to find E(X^2). At least 3 correct terms or sight of 4.6 or correct Var(X)

     NB $\dfrac{4.6}{5}$ loses the M1 for E(X^2) and the next M1 for Var(X) too

2nd M1   for an attempt to find Var(X). Follow through their "4.6" but must see -1.8^2 or 1.36
3rd M1   for correct use of Var($aX + b$) formula. Condone -2^2 if this later becomes +4

A1   for 5.44 Accept $\dfrac{136}{25}$ or exact equivalent

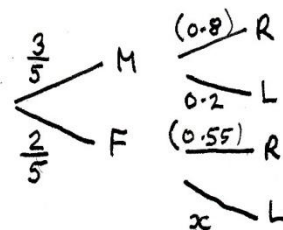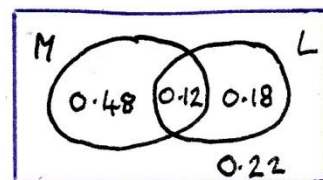| Question Number	Scheme	Marks
5. (a)		B1 B1 B1 B1
		(4)
(b)	F and S or R and S	B1
		(1)
(c)	$P\left(\left[F\cup R\cup S\right]'\right)=\dfrac{33}{100}$ or **0.33**	B1
		(1)
(d)	$P(R)=\dfrac{30+12}{100}=\dfrac{21}{50}$ or **0.42**	B1
		(1)
(e)	$P\left(F\cup S\right)=\dfrac{30+25}{100}=\dfrac{11}{20}$ or **0.55**	B1
		(1)
(f)	$\left[P\left(F\,|\,R\right)\right]=\dfrac{P\left(F\cap R\right)}{P(R)}=\dfrac{"0.30"}{"0.42"}$	M1
	$=\dfrac{30}{42}$ or $\dfrac{5}{7}$ (o.e.)	A1
		(2)
		Total 10
	Notes	
(a)	**In the diagram do not treat a blank space as zero. Allow probabilities or integers** 1st B1 for 3 labelled loops and a box. The 33 is not required for any marks in (a) 2nd B1 for $F\subset R$ or indicated by zeros 3rd B1 for 30 and 12 correctly placed and n(F) = 30 and $n\left(F'\cap R\right)=12$ 4th B1 for S a separate loop, or indicated by zeros, and the 25	
(b)	B1 for a correct pair. If there is more than one pair then each pair must be correct. Do not allow P(F) etc or e.g. P($R\cap S$) = 0	
(c),(d),(e)	B1 cao for each answer. Accept any exact equivalent (fractions or decimals) for the probabilities	
(f)	M1 ft their "30" and their answer to (d). For a correct ratio of their probabilities or a correct ratio expression and at least one correct probability. If num > den score M0 A1 for $\dfrac{5}{7}$ or any exact equivalent. Must be proper fraction not $\dfrac{0.3}{0.42}$ NB $\dfrac{0.3}{0.42}=0.714$ is A0 since it is not a proper fraction and the answer is not exact Condone P(R|F) = $\frac{30}{42}$ and allow M1A1 for the correct answer but $P(R\,|\,F)=\dfrac{P(R\cap F)}{P(F)}=\dfrac{0.30}{0.42}=\dfrac{30}{42}$ is M0A0	

Question Number	Scheme	Marks
6. (a)	$\left[X \sim N(1.04,\ 0.17^2) \right]$	
	$P(X<1)=P\left(Z < \dfrac{1-1.04}{0.17} \right)$	M1
	$\quad = P(Z < -0.23529...)$	
	$\quad = 1 - 0.5948 = 0.4052 \qquad$ (Accept 0.405-0.407)	M1A1
		(3)
(b)	$P(Y<1) = 0.05 \qquad \left[Y \sim N(\mu,\ 0.17^2) \right]$	
	$\dfrac{1-\mu}{0.17} = -1.6449$	M1 B1
	$\mu = 1 + 1.6449 \times 0.17 = 1.2796\ldots \qquad$ awrt 1.28	A1
		(3)
(c)	$P(S<1) = 0.01 \qquad \left[S \sim N(1.04,\ \sigma^2) \right]$	
	$\dfrac{1-1.04}{\sigma} = -2.3263$	M1B1
	$\sigma = \dfrac{0.04}{2.3263} = 0.0171946... \qquad$ awrt 0.0172	A1
		(3)
		Total 9
	Notes	
(a)	1st M1 for attempting to standardise with 1, 1.04 and 0.17 Allow $\pm$ 2nd M1 for attempting $1-p$ where $(0.5 < p < 0.6)$ A1 for answers in the range $0.405 \sim 0.407$ (Calc gives 0.4069902…)	

(b)	Allow any alternative letters to μ and σ in parts (b) and (c)
	 M1 for an attempt to standardise (allow $\pm$) with 1, 0.17 and μ and set $= \pm$ any z value ($|z| > 1$)
	 B1 for $z = \pm 1.6449$ (or better. Calc gives 1.6448536..) used as a z value. Do not allow $1 - 1.6449$
	      [May be implied by answer that rounds to 1.2796]
	 A1 for awrt 1.28 (can be scored for using a z value of 1.64 or 1.65)
	      Must follow from correct working but a range of possible z values are OK	

Ans only	If answer is awrt 1.28 score M1B0A1 (unless of course z = 1.6449 seen) but awrt 1.2796 scores 3/3	
(c)	M1 for an attempt to standardise with 1, 1.04 and σ and set $= \pm$ any z value ($|z| > 2$) B1 for $z = \pm 2.3263$ (or better) (Calc gives 2.3263478…) used as a z value If B0 scored in (b) for using a value in [1.64, 1.65] but not 1.6449 or better, allow awrt 2.32 or 2.33 here A1 for awrt 0.0172 Must follow from correct working but a range of possible z values are OK	
Ans only	If answer is awrt 0.0172 score M1B0A1 (unless of course z = 2.3263 or better is seen) If B1 scored in (b) and z = 2.3263 or better is <u>not</u> seen here then require an answer in the range $0.17194 < \sigma < 0.17195$ to award 3/3	

Question Number	Scheme	Marks
7. (a)	$[P(M \mid L) =] \dfrac{P(M \cap L)}{P(L)} = \dfrac{\frac{3}{5} \times \frac{1}{5}}{\frac{3}{10}}$	M1
	$= \underline{\mathbf{0.40}}$ (o.e)	A1
		(2)
(b)	$x = \left[P(L \mid F)\right] = \dfrac{P(L \cap F)}{P(F)} = \dfrac{\frac{3}{10} - \frac{3}{5} \times \frac{1}{5}}{1 - \frac{3}{5}}$ or $\dfrac{3}{5} \times \dfrac{1}{5} + \left(1 - \dfrac{3}{5}\right) \times x = \dfrac{3}{10}$	M1
	$x = \dfrac{0.3 - 0.12}{0.40}$ or $0.4x = 0.3 - 0.12$	M1
	$x = \underline{\mathbf{0.45}}$ (o.e.)	A1
		(3)
(c)	$\left[P(M \cap R)\right] = 0.6 - P(M \cap L)$ or $0.6 \times (1 - 0.2)$	M1
	$= \underline{\mathbf{0.48}}$ (o.e.)	A1
		(2)
(d)	P(one is left handed and the other right handed) $= 2 \times \dfrac{3}{10} \times \dfrac{7}{10}, = \dfrac{21}{50}$ or $\underline{\mathbf{0.42}}$	M1, A1
		(2)
		Total 9

	Notes	
(a)	M1 for a fully correct ratio e.g. $\frac{0.12}{0.30}$ or a correct ratio expression and one correct prob. If numerator > denominator then M0 A1 for 0.40 or any exact equivalent	
(b)	1st M1 for an equation for x with at least 2 of : $\left(\frac{3}{5} \times \frac{1}{5}\right)$ or $\frac{3}{10}$ or $(1 - \frac{3}{5})$ correct BUT $\dfrac{\frac{2}{5} \times \frac{3}{10}}{\frac{2}{5}}$ is M0 or allow M1 for $P(L \cap F) = 0.18$ 2nd M1 for a fully correct expression for $x = \ldots$ or $0.4x = \ldots$ A1 for 0.45 or any exact equivalent	
(c)	M1 for a correct expression with 0.6 follow through their $P(M \cap L) = 0.12$ A1 for 0.48 or any exact equivalent	
(d)	M1 for a fully correct expression including the 2. Allow $1 - 0.3$ instead of 0.7 A1 for 0.42 or any exact equivalent **NB You may see Venn or tree diagram drawn but marks are given when values are <u>used</u> in correct expressions as above**	

Question Number	Scheme	Marks
8. (a)	Total area of bars = 400 small squares	B1
	Area required $= 40 \times 4 + 20 \times 6 + 6 \times 10 = 340$ small squares	B1
	No of staff $= "340" \times \dfrac{40}{"400"}, = 34$	M1, A1
		(4)
(b)	Median is $(2+)\dfrac{4}{12} \times 3 = 3$ $\underline{or}$ $(5-)\dfrac{8}{12} \times 3 = 3$	M1A1
		(2)
(c)	Mean is $\dfrac{\sum fx}{40} = \dfrac{1 \times 16 + 3.5 \times 12 + 7.5 \times 6 + 15 \times 4 + 25 \times 2}{40} =, \dfrac{213}{40} = 5.325$	M1,A1
		(2)
(d)	(Positive) skew but not negative $\underline{or}$ there are outliers (which affect mean)	B1
	Median	dB1
		(2)
		Total 10

	Notes	
(a)	1st B1 for a correct attempt to calculate the whole area (400 small squares o.e.) Accept 160+120+60+40+20 $\underline{or}$ 80+60+30+20+10=200 $\underline{or}$ frequencies:16 + 12 + 6 + 4 + 2 $\quad$ $\underline{or}$ cm^2 $\quad$ 6.4 + 4.8 + 2.4 + 1.6 + 0.8 = 16 $\underline{or}$ key: 10 small squares = 1 person (o.e.) 2nd B1 for a correct attempt to calculate required area (Accept 160 + 120 + 60) $\quad$ $\underline{or}$ frequencies: 16 + 12 + 6 $\underline{or}$ cm^2 6.4 + 4.8 + 2.4 = 13.6 M1 $\quad$ for a correct expression using their 400 and their 340 A1 $\quad$ for 34 $\quad$ If using frequencies they get M1A1 together when 34 is seen. $\quad$ An answer of 34 will usually score 4/4 unless there is incorrect working seen **NB frequencies are: 16, 12, 6, 4, 2 and mid-points are: 1, 3.5, 7.5, 15, 25**	
(b)	M1 $\quad$ for $\dfrac{20-16}{12} \times (5-2)$ or $\dfrac{20.5-16}{12} \times (5-2)$ or similar expressions working down $\quad$ Look out for methods based on areas should have 1st bar + $\frac{1}{3}$ (2nd bar) if working up $\underline{or}$ $\quad$ (5th + 4th + 3rd bars) + $\frac{2}{3}$ (2nd bar) if working down. E.g. $16 + 4(x - 2) = 20$ A1 $\quad$ for 3 or (if using n + 1 accept 3.125 or awrt 3.13)	
(c)	M1 $\quad$ for an attempt at $\dfrac{\sum fx}{40}$ where at least 3 correct products of $\sum fx$ are seen $\quad$ $\underline{or}$ $\sum fx =$ awrt 200 (1 sf) A1 $\quad$ for 5.325 or any exact equivalent e.g. $\dfrac{213}{40}$ and accept 5.33 $\quad$ Accept 5 h 19 mins or 5h 20 mins	
(d)	1st B1 $\quad$ for a reason e.g. that the data is skewed $\quad$ Allow mention of "extreme values" or "outliers" $\quad$ Do not allow for $\underline{negative}$ skew or "anomalies" 2nd dB1 dependent on mentioning skew for choosing $\underline{median}$	
SC	$\quad$ Allow B0B1 for "Choose median since the data has negative skew" o.e.	