

Mark Scheme (Results)

Summer 2018

Pearson Edexcel GCE Mathematics
Statistics S1 Paper 6683_01

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Summer 2018
Publications Code 6683_01_1806_MS
All the material in this publication is copyright
© Pearson Education Ltd 2018

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 $\surd$ 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)	F(3) = P(X = 2) so ***a* = 0.2**	B1
	F(6) = P(X = 2) + P(X = 4) so $a + b = 0.8$ so ***b* = 0.6**	B1
	Sum of probs = 1 implies ***c* = 0.1**	B1ft
		(3)
(b)	F(7) = F(6) + 0.1 or $a + b + 0.1$ or $1 - c$ = **0.9**	B1
		(1)
		[Total 4]

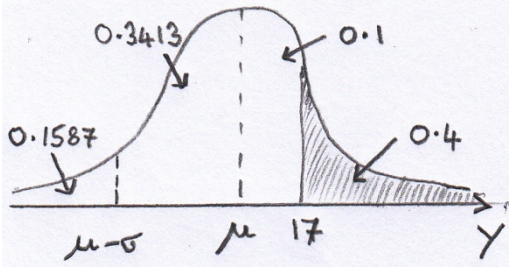
	Notes
(a)	1st B1 for $a = 0.2$ 2nd B1 for $b = 0.6$ 3rd B1 ft for $c = 0.1$ or a value of c so that their $a + b + c = 0.9$ provided a, b and c are probabilities The labels may not be explicit but it must be clear which is which
(b)	B1 for 0.9 only (no ft) If their answer is based on their values of a, b or c, these values must be probabilities and have $a + b = 0.8$ or $c = 0.1$ Just stating 0.9 with no justification is B1

Question Number	Scheme	Marks
2. (a)	(3 – 6) mins has width 4 and is 2cm, (11 – 15) mins has width 5 so is **2.5**(cm) (3 – 6) mins has frequency of 38 and area of 19 cm^2 so 2 people(per cm^2)(o.e.) or frequency density $= \frac{38}{4} = 9.5 =$ height (11 – 15) mins has area of $2.5 \times h$ cm^2 so $h = \frac{12}{2 \times 2.5} =$ **2.4** (cm) allow $\frac{12}{5}$	B1 M1 A1 (3)
(b)	$Q_2 = (6.5) + \frac{12}{25} \times 2$ or $(8.5) - \frac{13}{25} \times 2$ = awrt **7.46**	M1 A1 (2)
(c)	$\sum fx = 38 \times 4.5 + ... + 7 \times 18 = 811.5$ and $\bar{x} = \frac{811.5}{100}$, = awrt **8.12**	M1, A1 (2)
(d)	$\sigma = \sqrt{\frac{8096.25}{100} - \bar{x}^2} = \sqrt{80.9625 - "65.85..."} = \sqrt{15.1(0)...}$, = awrt **3.89**	M1, A1 (2)
(e)	Skewness $= \frac{3("8.12" - "7.46")}{"3.89"} = 0.5055\ldots =$ awrt **0.47 ~ 0.51**	B1 (1)
(f)	Skewness for Monday and Friday are different (o.e.) Suggests more longer delays on Friday (o.e.) [look for diagrams to support this.]	B1 B1 (2) **[Tot 12]**

	Notes
(a)	B1 for width of 2.5 (cm) allow $\frac{5}{2}$ M1 for 2 people per cm^2 or a correct numerical equ'n for h or their width × height = 6 A1 for height of 2.4 (cm) [If just see 2.4 and 2.5 it must be clear which is h and which w]
(b)	M1 for a correct expr'n with sign (ignoring end point). Condone 12.5 for use of $(n + 1)$ A1 for awrt 7.46 (or 7.5 if using $(n + 1)$ but must see evidence of $(n + 1)$ approach)
(c)	M1 for an attempt at Σfx (i.e. full expression or $650 < \Sigma fx < 950$) and division by 100 Σfx may be in the table. A1 for 8.115 or awrt 8.12 (allow 8.11) [May be in (d) but must be labelled e.g. $\bar{x} = ...$]
(d)	M1 for a correct expression (ft their mean) including $\sqrt{}$. Allow s leading to $\sqrt{15.26...}$ A1 for awrt 3.89 Allow use of $s =$ awrt 3.91 [Correct ans. only to (c) or (d) full marks]
(e)	B1 for a correct expression seen using their values (σ must be > 0) or awrt 0.47 ~ 0.51
(f)	1st B1 for a comment that skewness is different (only commenting on"correlation" is B0) If ans. to (e) > 0 allow B1 for e.g. "skewness on Fri is < 0"["on Fri" may be implied] 2nd B1 for a comment about length of delay e.g. "more long ones (on Fri.) or "longer delays on Fri."

Question Number	Scheme	Marks
3. (a)	[P($\mu < Y < 17$) =] 0.5 – 0.4 = **0.1**	B1 (1)
(b)	P($Y > \mu - \sigma$) = P($Z > -1$)	M1
	= 0.841(3)	A1
	P($\mu - \sigma < Y < 17$) = 0.8413 – 0.4	dM1
	= **0.441**(3)	A1 (4)
ALT	P($Y > \mu - \sigma$) = P($Z > -1$)	M1
	P($Y > 17$) = 0.4 $\Rightarrow Z = \left[\frac{17-\mu}{\sigma}\right]$ = 0.25(33471...) so need P($-1 < Z <$ 0.25)	dM1
	Sight of P($-1 < Z <$ 0.253…)	1st A1
	= **0.441**(3)	2nd A1
		[Total 5]

	Notes
(a)	B1 for 0.1 as clearly their final answer or clear statement "P($\mu < Y < 17$) = 0.1"
	Ignore poor or incorrect notation if answers are correct
(b)	1st M1 for an attempt to standardise $\mu - \sigma$ allow for $\pm \frac{(\mu-\sigma)-\mu}{\sigma}$ can be un-simplified
	1st A1 for 0.841 or better (calc 0.84134473…) or 1 – 0.8413…= 0.1587 (accept 0.159)
	Sight of 0.841(3) or 0.1587 or 0.159 (or better) scores M1 A1
	May be statement e.g. P($Y > \mu - \sigma$) = 0.841(3) or on clearly labelled diagram.
	2nd dM1 (dep on 1st M1) for a correct use of their 0.8413 and the given 0.4
	or 0.341(3) + their (a)
	or 0.6 – their 0.1587
	2nd A1 for 0.441 or better (correct answer only 4/4)
ALT	Standardise $\mu - \sigma$ (and may get $z = -1$) scores 1st M1 as in scheme
	Use inv' normal to get $\frac{17-\mu}{\sigma}$ = 0.25(33471...) and write/ attempt P($-1 < Z <$ 0.25..) 2nd M1
	Write or attempt P($-1 < Z <$ 0.253…) also scores 1st A1 (need 0.253 or better)
	NB Just standardising and getting 0.2533 etc is no use unless it is part of a correct probability statement that would lead to the final answer.



Question Number	Scheme	Marks
4. (a)	$\mathrm{P}(G_1)+\mathrm{P}(R_1\cap G_2)+\mathrm{P}(Y_1\cap G_2)$ or $\mathrm{P}(GY)+\mathrm{P}(GR)+\mathrm{P}(RG)+\mathrm{P}(YG)$ (o.e.)	M1
	$=\frac{1}{64}+\frac{r}{64}\times\frac{1}{63}+\frac{y}{64}\times\frac{1}{63}=\frac{1}{64}+\frac{r+y}{64\times63}$ or $2\times\frac{r+y}{64\times63}$	A1
	$=\frac{1}{64}+\frac{63}{64\times63}$ or $\frac{2\times63}{64\times63}$ or $\frac{1}{64}+\frac{1}{64}$ or	M1
	$=\frac{1}{32}$ or 0.03125	A1
		(4)
(b)	$\mathrm{P}(R_1\cap R_2)=\frac{r}{64}\times\frac{r-1}{63}=\frac{5}{84}$	M1A1
	$r(r-1)=5\times64\times63\div84=240$ hence $r^2-r-240=0$ or $r^2-r=240$ (*)	A1cso
		(3)
(c)	$r^2-r-240=(r-16)(r+15)\{=0\}$ or $16^2-16-240=256-256$	M1
	or $\frac{16}{64}\times\frac{15}{63}=\frac{5}{84}$	
	so $r=16$ and rejecting -15 (*)	A1cso
		(2)
(d)	$\mathrm{P}(\geqslant1\,\text{red})=\mathrm{P}(RG)+\mathrm{P}(GR)+\mathrm{P}(RY)+\mathrm{P}(YR)+\mathrm{P}(RR)$ or $\frac{2}{252}+\frac{2y}{252}+\frac{15}{252}$ (o.e.)	M1,
	or $\mathrm{P}(R_1)+\mathrm{P}(R_1'\cap R_2)$ or $\frac{16}{64}+\frac{48}{64}\times\frac{16}{63}$ or $1-\frac{48}{64}\times\frac{47}{63}$, $=\frac{37}{84}$	A1
	Require: $\frac{\mathrm{P}(R_1\cap R_2)}{\mathrm{P}(\text{at least one red})}=\frac{\frac{5}{84}}{"\frac{37}{84}"}$ $,=\frac{5}{37}$ or $0.\dot{1}3\dot{5}$	M1, A1
		(4)
		[Total 13]

	Notes
(a)	1st M1 for at least 2 correct cases. May be in symbols or probs. May be in tree diagram Use of $r=16$ or $y=47$ can score maximum of 1st M1 then A0M0A0
	1st A1 for all cases and their assosciated probs added
	2nd M1 for combining probabilities and using $r+y=63$
	2nd A1 for $\frac{1}{32}$ or an exact equivalent (correct answer only 4/4)
(b)	M1 for $\frac{r}{64}\times\mathrm{g}(r)=...$ where g(r) is any linear function of r
	1st A1 for any correct equation in r
	2nd A1cso for correctly simplifying to the given equation with no incorrect working seen. There should be at least 1 intermediate step seen
(c)	M1 for correct factors or completing square or use of formula or substitution
	A1cso for concluding $r=16$ and rejecting -15 (e.g. crossing out etc)
(d)	1st M1 for a correct expression for at least one red. May be in symbols or probs. or in a tree
	1st A1 for $\frac{37}{84}$ (o.e.) as a single fraction or awrt 0.440 [May be implied by correct answer]
	2nd M1 for a ratio of probabilities (denom may be in symbols) with numerator of $\frac{5}{84}$ (o.e.)
	2nd A1 for $\frac{5}{37}$ or an exact equivalent

Question Number	Scheme	Marks
5. (a)	The distribution is symmetric about the value 2 (o.e.) ["data" is B0]	B1 cso (1)
(b)	Sum of probs = 1 (or use of E(X) = 2) leading to **$3a + 2b = 1$**	B1 (1)
(c)	E(X^2) = $(-1)^2 b + 2^2 a + 4^2 a + 5^2 b$ [= $20a + 26b$ …condone $24b$]	M1
	$7.1 = 20a + $ "26"$b - 2^2$ or $7.1 = 20a + $ "26"$b - (6a + 4b)^2$ or $7.1 = 8a + 18b$	M1
	$11.1 = 20a + 26b$	A1 (3)
(d)	e.g. (b)×13 and subtract (c) yielding: $1.9 = 19a$	M1
	$a = 0.1$ and **$b = 0.35$**	A1, A1 (3)
(e)(i)	[E(Y) = $10 - 3$E(X) $= 10 - 3 \times 2$] **= 4**	B1
(ii)	[Var(Y)] = $(-3)^2$ Var(X)	M1
	= 63.9	A1 (3)
(f)	$Y > X$ gives: $10 - 3X > X$ leading to $10 > 3X + X$ or $X < 2.5$	M1
	$X < 2.5$ means $X = -1$, 0 and 2	A1
	P($Y > X$) = $2a + b$ = **0.55** or $\frac{11}{20}$ (o.e.)	A1ft (3) **[Total 14]**

Notes

(a) B1 for argument using symmetry "distribution is symmetric" B1
"probs are symmetric" B0 "it is symmetric" is B0
or a correct expression ($6a + 4b$) and use of sum of probs = 1

(b) B1 for $3a + 2b = 1$ (o.e.) (any equivalent correct equation, needn't be simplified)

(c) 1st M1 for a full expression for E(X^2). Condone $-1^2 b$ … or $20a + 26b$ or $20a + 24b$
Allow Var(X) called E(X^2). M0 for $\frac{20a+26b}{5}$ unless you see E(X^2) = $20a + 26b$ (o.e.) first.
2nd M1 for use of the correct formula to form an equation for a and b. ft their E(X^2)
A1 for $11.1 = 20a + 26b$ (or equivalent but must be only 3 non-zero terms)

(d) M1 for solving their 2 linear equations in a and b and reducing to an equ'n in one variable
Condone 1 arithmetic or sign error
1st A1 for $a = 0.10$ or an exact equivalent
2nd A1 for $b = 0.35$ or an exact equivalent
Ans only One correct value scores M1 and the relevant A1 and both correct scores 3/3

(e)(ii) M1 for correct use of the Var($aX + b$) formula. Condone -3^2 if it later becomes +9
or [E(Y^2)] = 79.9 **and** [Var(Y)] = 79.9 – their (E(Y))^2
A1 for 63.9

(f) M1 for an attempt to solve the linear inequality leading to $10 > 3X + X$ or $Y > 2.5$ or $Y \geqslant 4$
A1 for the correct 3 values of X or prob. dist. for Y and y = 4, 10, 13 or P($X < 2.5$) = $2a + b$
A1ft for an answer = their $2a + b$ provided a, b and $2a + b$ are probabilities. Must be a value

NB(e/f)

x	–1	0	2	4	5
y	13	10	4	– 2	– 5

Correct answer only for their a and b is 3/3
BUT $2a + b$ only is M0

Question Number	Scheme	Marks
6. (a)	$(S_{th}) = 31070 - \frac{61\times 6370}{8}$ <u>or</u> $31070 - 48571.25$; $(S_{tt}) = 693 - \frac{61^2}{8}$ <u>or</u> $693 - 465.125$	M1; M1
	$(S_{th}) = -17\,501.25$ **and** $(S_{tt}) = 227.875$ (*)	A1cso
		(3)
(b)	$\lvert r\rvert$ close to 1 <u>or</u> r is close to -1 therefore it does support the linear model	B1
		(1)
(c)	$\left[r = \frac{S_{yx}}{\sqrt{S_{yy}\times S_{xx}}} \right]$ so $r = \frac{S_{th}}{\sqrt{S_{tt}\times S_{hh}}}$ <u>or</u> $r^2 = \frac{(S_{th})^2}{S_{tt}\times S_{hh}}$ <u>or</u> $S_{hh} = \frac{(S_{th})^2}{r^2\times S_{tt}}$ <u>or</u> substitute 1 value	M1
	e.g. $\pm 0.985 = \frac{\pm 17501.25}{\sqrt{227.875\times S_{hh}}}$ <u>or</u> $S_{hh} = \frac{(\pm 17501.25)^2}{(\pm 0.985)^2\times 227.875}$ o.e. ,(= 1 385 380.258)	A1,
	= awrt **1 390 000**	A1
	$b = \frac{-17501.25}{1385380.258} = -0.0126328...$, = awrt -0.013	M1, A1
	[NB $\bar{t} = 7.625$, $\bar{h} = 796.25$] $a = \frac{61}{8} - "-0.0126..."\times \frac{6370}{8}$ [= 17.6838…]	M1
	So ***t* = 17.7 – 0.0126*h***	A1
		(7)
(d)	a is an estimate of the <u>temperature</u> at <u>sea level</u> is (17.7 ºC)	B1
		(1)
(e)	$(\mp)\, 150\times b$ (o.e. e.g. [17.7 – 0.0126h] – [17.7 – 0.0126(h + 150)])	M1
	= 1.89 awrt **<u>2 (ºC)</u>**	A1
		(2)
		[Tot 14]

Notes

(a)

1st M1 for a correct expression for S_{th} | Allow 1 slip e.g. 6730 | 61×6370 <u>or</u> 388570 | Consistent use of $n \neq 8$ M0M1

2nd M1 for a correct expression for S_{tt} | | 61^2 <u>or</u> 3721 |

A1cso for both answers correct and both Ms scored.

(b)

B1 for correct and relevant comment about the value of r <u>and</u> saying it does support or "yes"
Allow " it is.."<u>strong</u>" or "<u>near perfect</u>" correlation BUT B0 for "perfect"or "highly negative"

In (c) condone *x* for *h* and *y* for *t* except in 4th A1

(c)

1st M1 for the sight of the formula for r <u>and</u> an attempt to do something useful with it

1st A1 for a correct numerical expr'n in S_{hh} or $\sqrt{S_{hh}}$ Accept with 3sf values (ignore – signs)

2nd A1 for awrt 1 390 000 (3sf gives 1 384 422.948 but scores 1st A1 and 2nd A0)

2nd M1 for a correct expression for b seen (ft their values to 3sf) Use of $S_{tt} \rightarrow -76.8$ is M0

3rd A1 for awrt -0.013 (candidates using 3sf for S_{hh} should therefore get this)

Beware $\frac{S_{tt}}{S_{th}} = \frac{227.875}{-17501.25} = -0.0130...$ but is 2nd M0 3rd A0 Ans only of $-0.0126..$is M1A1A1M1A1

3rd M1 for a correct use of $\bar{t}$ and $\bar{h}$ to find a ft their b (allow letter b or even $b = -0.985$)

4th A1 for a correct equation with a = awrt 17.7 and b = awrt – 0.0126 [No y and x]

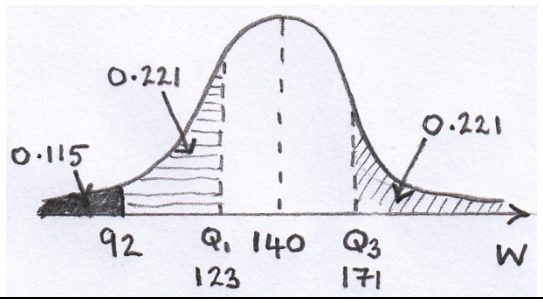
(d)

B1 for stating or implying that it is the <u>temperature</u> (value not needed) at <u>sea level</u>

(e)

M1 for a correct expression equivalent to $(\mp)$ 150b. Can use letter b or ft their value(s).

A1 for awrt 2 (ºC not required) Allow <u>±</u> can give if "a" incorrect or "b" from M0A0 in (c)
Common wrong answer of 11520 can score M1A0 even if no working seen.

Question Number	Scheme	Marks
7.	$[W \sim \text{N}(140, 40^2)]$	
(a)	$\text{P}(W < 92) = \text{P}\left(Z < \dfrac{92-140}{40}\right) = \left[\text{P}(Z < -1.2)\right]$	M1
	$= 1 - 0.8849$ = awrt **11.5** (%) or **0.115**	dM1,A1 (3)
(b)	$[\text{P}(W > q_3) = \text{P}(W > 92) \times \text{P}(W > q_3 \mid W > 92) =]$ $(1 - \text{(a)}) \times 0.25 = 0.8849 \times 0.25$	M1
	$= 0.221225$ = awrt **0.221**	A1 (2)
(c)	$\text{P}(W < q_1 \mid W > 92) = 0.25$ or $\text{P}(W > q_1 \mid W > 92) = 0.75$	M1
	$\text{P}(92 < W < q_1) = 0.25 \times 0.8849 = \text{"0.221.."}$ or $\text{P}(W > q_1) = 0.75 \times 0.8849 = 0.663675$	M1
	$\text{P}(W < q_1) = 0.221225 + 0.115$ = awrt **0.336** or $\text{P}(W > q_1) = 0.663675$ = awrt **0.664**	A1
	$\dfrac{q_1 - 140}{40} = -0.42$ (calculator gives $-0.422513 \sim -0.423404$)	M1
	so $q_1 = 123.2$ = awrt **123** (g)	A1 (5)
(d)		
	$\dfrac{1}{4} \times \dfrac{1}{4} \times \dfrac{1}{2} \times 3!$	M1M1
	$= \dfrac{3}{16}$ or 0.1875	A1 (3)
		[Tot 13]

	Notes
	Condone poor use of notation etc e.g. "P > q_1" for P($W > q_1$) etc
(a)	1st M1 for standardising attempt with 92 or 188, 140 and 40 (o.e.) Accept $\pm$ ignore inequality 2nd dM1 dependent on 1st M1, for attempting $1 - p$ where $0.5 < p < 1$ A1 for awrt 11.5 (%) or 0.115
(b)	M1 for (1 – their (a)) × 0.25 or $1 - \left[(1-(a)) \times 0.75 + (a)\right] = 1 - \left[0.8849 \times 0.75 + 0.1151\right]$ A1 for awrt 0.221
(c)	1st M1 for a correct conditional prob. statement with q_1, 92 and 0.25 or 0.75 2nd M1 for either correct probability statement and 0.25 or 0.75 × (1 – their (a)) 1st A1 for P($W < q_1$) = awrt 0.336 or P($W > q_1$) = awrt 0.664 NB May be standardised Award M1M1A1 for either probability clearly stated or marked on a correct sketch. 3rd M1 for standardising with q_1, 140 and 40 and setting equal to z where $0.40 < \lvert z \rvert < 0.45$ 2nd A1 for awrt 123 (condone minor slips in working if correct answer obtained)
(d)	1st M1 for $0.25 \times 0.25 \times 0.5$ (o.e.) e.g. $\frac{1}{32}$ may be seen as decimals or fractions 2nd M1 for $\times 3!$ or $\times 6$ or adding all 6 cases. Must be multiplying probabilities. A1 for $\frac{3}{16}$ or any exact equivalent

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom