1. (a)	$2a + \frac{2}{5} + \frac{1}{10} = 1$	(or equivalent)	M1	
	$\underline{a = \frac{1}{4} \textbf{ or 0.25}}$		A1	2

Note

M1for a clear attempt to use $\sum$ P(X = x) = 1

Correct answer only 2/2.
NB Division by 5 in parts (b), (c) and (d) seen scores 0.
Do not apply ISW.

(b)	E(X) = **1**		B1	1

Note

B1 for 1

(c)	E(X^2) $= 1\times\frac{1}{5} + 1\times\frac{1}{10} + 4\times\frac{1}{4} + 9\times\frac{1}{5}$	(= 3.1)	M1	
	Var(X) = $3.1 - 1^2$,	**= 2.1 or** $\frac{21}{10}$ **oe**	M1 A1	3

Note

1st M1 for attempting $\sum x^2 \mathrm{P}(X = x)$ at least two terms correct.
Can follow through.
2nd M1 for attempting E(X^2) – [E(X)]^2 or allow subtracting 1 from their attempt at E(X^2) provided no incorrect formula seen.
Correct answer only 3/3.

(d)	Var(Y) = $(-2)^2$ Var(X),	= **8.4 or** $\frac{42}{5}$ **oe**	M1 A1	2

Note

M1 for $(-2)^2$ Var(X) or 4Var(X)
Condone missing brackets provided final answer correct for their Var(X).
Correct answer only 2/2.

(e)	$X \geq Y$ when X = 3 or 2, so probability = "$\frac{1}{4}$"$+\frac{1}{5}$		M1 A1ft	
		= $\frac{9}{20}$ **oe**	A1	3

Note

Allow M1 for distribution of $Y = 6 - 2X$ and correct attempt at E(Y^2) – [E(Y)]^2

M1 for identifying X = 2, 3
1st A1ft for attempting to find their P(X = 2) + P(X = 3)
2nd A1 for $\frac{9}{20}$ or 0.45

[11]

2. (a) $k + 4k + 9k = 1$ M1

$14k = 1$

$k = \frac{1}{14}$ * * given * * cso A1 2

Note

M1 for clear attempt to use $\sum \mathrm{p}(x) = 1$, full expression needed and the "1" must be clearly seen. This may be seen in a table.

A1cso for no incorrect working seen. The sum and "= 1" must be explicitly seen somewhere.

A verification approach to (a) must show addition for M1 and have a suitable comment e.g. "therefore $k = \frac{1}{14}$" for A1 cso

(b) $\mathrm{P}(X \geq 2) = 1 - \mathrm{P}(X = 1)$ or $\mathrm{P}(X = 2) + \mathrm{P}(X = 3)$ M1

$= 1 - k = \frac{13}{14}$ or 0.92857... **awrt 0.929** A1 2

Note

M1 for 1- P(X \≤ 1) or $\mathrm{P}(X = 2) + \mathrm{P}(X = 3)$

A1 for awrt 0.929. Answer only scores 2/2

(c) $\mathrm{E}(X) = 1\times k + 2\times k \times 4 + 3\times k \times 9$ or $36k$ M1

$= \frac{36}{14} = \frac{18}{7} \text{ or } 2\frac{4}{7}$ (or exact equivalent) A1 2

Note

M1 for a full expression for E(X) with at least two terms correct.

NB If there is evidence of division (usually by 3) then score M0

A1 for any exact equivalent – answer only scores 2/2

(d) Var(X) = $1\times k + 4 \times k \times 4 + 9 \times k \times 9, -\left(\frac{18}{7}\right)^2$ M1 M1

Var($1-X$) = Var(X) M1

$\frac{19}{49}$ or 0.387755... **awrt 0.388** A1 4

Note

1st M1 for clear attempt at E(X^2), need at least 2 terms correct in $1\times k + 4\times 4k + 9 \times 9k$ orE(X^2) = 7

2nd M1 for their E(X^2) – (their μ)^2

3rd M1 for clearly stating that Var($1 - X$) = Var(X), wherever seen

A1 accept awrt 0.388. All 3 M marks are required.

Allow 4/4 for correct answer only but must be for Var($1 - X$).

[10]

3. (a)

0	1	2	3
$3a$	$2a$	a	b

B1 1

Note

Condone a clearly stated in text but not put in table.

(b) $3a + 2a + a + b = 1$ or equivalent, using Sum of probabilities =1 M1

$2a + 2a + 3b = 1.6$ or equivalent, using E(X) =1.6 M1

$14a = 1.4$ Attempt to solve M1dep

$a = 0.1$ cao B1

$b = 0.4$ cao B1 5

Note

Must be attempting to solve 2 different equations so third M dependent upon first two Ms being awarded.

Correct answers seen with no working B1B1 only, 2/5

Correctly verified values can be awarded M1 for correctly verifying sum of probabilities

=1, M1 for using $E(X)$=1.6 M0 as no attempt to solve and B1B1 if answers correct.

	(c)	$P(0.5 < x < 3) = P(1) + P(2)$	3a or their $2a$+their a	M1	
		$= 0.2 + 0.1$			
		$= 0.3$	Require 0<3a<1 to award follow through	A1 ft	2
	(d)	$E(3X - 2) = 3E(X) - 2$		M1	
		$= 3 \times 1.6 - 2$			
		$= 2.8$	cao	A1	2
		<u>Note</u> 2.8 only award M1A1			
	(e)	$E(X^2) = 1\times 0.2 + 4 \times 0.1 + 9 \times 0.4\ (= 4.2)$		M1	
		Var (X) = "4.2" – 1.6^2		M1	
		$= 1.64$ * * given answer * *	cso	A1	3
		<u>Note</u> Award first M for at least two non-zero terms correct. Allow first M for correct expression with a and b e.g. $E(X^2) = 6a+9b$ Given answer so award final A1 for correct solution.			
	(f)	$\text{Var}(3X - 2) = 9\ \text{Var}(X)$		M1	
		$= 14.76$	awrt 14.8	A1	2
		<u>Note</u> 14.76 only award M1A1			

[15]

4.	(a)	$E(X) = 0 \times 0.4 + 1 \times 0.3 + ... + 3 \times 0.1, = 1$		M1, A1	2
		<u>Note</u> M1 for at least 3 terms seen. Correct answer only scores M1A1. Dividing by $k(\neq 1)$ is M0.			
	(b)	$F(1.5) = [P(X \leq 1.5) =]\ P(X \leq 1), = 0.4 + 0.3 = 0.7$		M1, A1	2
		<u>Note</u> M1 for $F(1.5) = P(X \leq 1)$.[**Beware**: $2 \times 0.2 + 3 \times 0.1 = 0.7$ but scores M0A0]			

(c) $E(X^2) = 0^2 \times 0.4 + 1^2 \times 0.3 + ... + 3^2 \times 0.1, = 2$ M1, A1

$\text{Var}(X) = 2 - 1^2, = 1$ (*) M1, A1cso 4

<u>Note</u>

1st M1 for at least 2 non-zero terms seen. $E(X^2) = 2$ alone is M0.
Condone calling $E(X^2) = \text{Var}(X)$.

ALT

1st A1 is for an answer of 2 or a fully correct expression.

2nd M1 for $-\mu^2$, condone $2 - 1$, unless clearly $2 - \mu$ Allow $2 - \mu^2$ with $\mu = 1$ even if $E(X) \neq 1$

2nd A1 for a fully correct solution with no incorrect working seen, **both** Ms required.

<u>$\Sigma (x - \mu)^2 \times P(X = x)$</u>

1st M1 for an attempt at a full list of $(x - \mu)^2$ values and probabilities.
1st A1 if all correct

2nd M1 for at least 2 non-zero terms of $(x - \mu)^2 \times P(X = x)$ seen. 2nd A1 for $0.4 + 0.2 + 0.4 = 1$

(d) $\text{Var}(5 - 3X) = (-3)^2 \text{Var}(X), = 9$ M1, A1 2

<u>Note</u>

M1 for use of the correct formula. $-3^2 \text{Var}(X)$ is M0 unless the final answer is >0.

(e)

Total	Cases	Probability	
	$(X = 3)\cap(X = 1)$	$0.1 \times 0.3 = 0.03$	
4	$(X = 1)\cap(X = 3)$	$0.3 \times 0.1 = 0.03$	
	$(X = 2)\cap(X = 2)$	$0.2 \times 0.2 = 0.04$	B1B1B1
	$(X = 3)\cap(X = 2)$	$0.1 \times 0.2 = 0.02$	
5	$(X = 2)\cap(X = 3)$	$0.2 \times 0.1 = 0.02$	M1
6	$(X = 3)\cap(X = 3)$	$0.1 \times 0.1 = 0.01$	A1

Total probability = 0.03 + 0.03 + 0.04 +0.02 + 0.02 + 0.01 = 0.15 A1 6

<u>Note</u>

Can follow through their Var(X) for M1

ALT

1st B1 for all cases listed for a total of 4 or 5 or 6 . e.g. (2,2) counted twice for a total of 4 is B0

2nd B1 for all cases listed for 2 totals }

3rd B1 for a complete list of all 6 cases } These may be highlighted in a table

<u>Using Cumulative probabilities</u>

1st B1 for one or more cumulative probabilities used e.g.2 then 2

or more or 3 then 1 or more
2nd B1 for both cumulative probabilities used. 3rd B1 for a complete list 1, 3; 2, ≥2; 3, ≥1
M1 for one correct pair of correct probabilities multiplied
1st A1 for all 6 correct probabilities listed (0.03, 0.03, 0.04, 0.02, 0.02, 0.01) needn't be added.
2nd A1 for 0.15 or exact equivalent only as the final answer.

[16]

5. (a) $-1 \times p + 1 \times 0.2 + 2 \times 0.15 + 3 \times 0.15 = 0.55$ M1dM1
$p = 0.4$ A1
$p + q + 0.2 + 0.15 + 0.15 = 1$ M1
$q = 0.1$ A1 5

M1 for at least 2 correct terms on LHS
Division by constant e.g. 5 then M0
dM1 dependent on first M1 for equate to 0.55 and attempt to solve.
Award M1M1A1 for p=0.4 with no working
M1 for adding probabilities and equating to 1.
All terms or equivalent required e.g. $p + q = 0.5$
Award M1A1 for $q = 0.1$ with no working

(b) $\text{Var}(X) = (-1)^2 \times p + 1^2 \times 0.2 + 2^2 \times 0.15 + 3^2 \times 0.15, -0.55^2$ M1A1,M1
$= 2.55 - 0.3025 = 2.2475$ awrt 2.25 A1 4

M1 attempting $E(X^2)$ with at least 2 correct terms
A1 for fully correct expression or 2.55
Division by constant at any point e.g. 5 then M0
M1 for subtracting their mean squared
A1 for awrt 2.25
Award awrt 2.25 only with no working then 4 marks

(c) $E(2X - 4) = 2E(X) - 4$ M1
$= -2.9$ A1 2

M1 for 2x(their mean) –4
Award 2 marks for –2.9 with no working

[11]

6. (a) $F(4) = 1$
$(4 + k)^2 = 25$ M1
$k = 1$ as $k > 0$ A1 2

M1 for use of F(4) = 1 only If F(2) = 1 and / or F(3) = 1 seen then M0.
F(2) + F(3) + F(4) = 1 M0
A1 for $k = 1$ and ignore $k = -9$

(b)

x	2	3	4

$P(X = x)$	$\frac{9}{25}$	$\frac{7}{25}$	$\frac{9}{25}$

B1ftB1B1 3

B1ft follow through their k for $P(X = 2)$ either exact or 3sf between 0 and 1 inclusive.
B1 correct answer only or exact equivalent
B1 correct answer only or exact equivalent

[5]

7.	(a)	$p + q = 0.45$	B1	
		$\Sigma x\text{P}(X = x) = 4.5$	M1	
		$3p + 7q = 1.95$	A1	3

$0.55 + p + q = 1$ award B1. Not seen award B0.
$0.2 + 3p + 1 + 7q + 1.35 = 4.5$ or equivalent award M1A1
$3p + 7q + k = 4.5$ award M1.

(b)	Attempt to solve equations in (a)	M1	
	$q = 0.15$	A1	
	$p = 0.30$	A1	3

Attempt to solve must involve 2 linear equations in 2 unkowns
Correct answers only for accuracy.
Correct answers with no working award 3/3

(c)	$P(4 < X < 7) = P(5) + P(7)$	M1	
	$= 0.2 + q = 0.35$	A1ft	2

Follow through accuracy mark for their q, $0 < q < 0.8$

(d)	$\text{Var}(X) = \text{E}(X^2) - [\text{E}(X)]^2 = 27.4 - 4.5^2$	M1	
	$= 7.15$	A1	2

Attempt to substitute <u>given</u> values <u>only</u> into correct formula for M1.
7.15 only for A1
7.15 seen award 2/2

(e)	$\text{E}(19 - 4X) = 19 - 4 \times 4.5 = 1$	B1	1

(f)	$\text{Var}(19 - 4X) = 16\text{Var}(X)$	M1	
	$= 16 \times 7.15 = 114.4$	A1	2

Accept 'invisible brackets' i.e. $-4^2\ \text{Var}(X)$ provided answer positive.
Anything that rounds to 114 for A1.

[13]

8. (a) E(X) = 3; B1

Var (X) = $\frac{25-1}{12}=2$ **AG**

Var (X) = $1^2\times\frac{1}{5}+2^2\times\frac{1}{5}+3^2\times\frac{1}{5}.....-3^3=11-9=2$ **AG** M1 A1 3

Accept (55 / 5) – as minimum evidence.

(b) E($3X$ – 2) = 3E(X) – 2 = 7 M1 A1ft 2

(c) Var (4 – 3x) = 3^2Var (X) = 18 M1 A1 2

[7]

9. (a) $p + q = 0.4$ B1

$2p + 4q = 1.3$ Consider with (b). M1 A1 3

(b) Attempt to solve M1

$p = 0.15, q = 0.25$ If both seen, award 3. A1 A1 3

(c) E(X^2) = $1^2 \times 0.10 + 2^2 \times 0.15 + ... + 5^2 \times 0.30 = 14$ M1A1ft

Var(X) = 14 – 3.5^2 = 1.75 M1A1 4

(d) Var(3 – $2X$) = 4Var(X) = 7.00 M1A1ft 2

[12]

10. (a) $k + 2k + 3k + 5k + 6k = 1$ M1

use of ΣP(X = x) = 1

$17k = 1$

$k = \frac{1}{17} = 0.0588$ A1 2

(b) E(X) = $1\times\frac{1}{17}+2\times\frac{2}{17}+\ldots+5\times\frac{6}{17}=\frac{64}{17}$ M1

use of ΣxP(X = x) and at least 2 prob correct

$= 3\frac{13}{17}$ A1 2

Do not ignore subsequent working

(c) E(X) = $1^2\times\frac{1}{17}+2^2\times\frac{2}{17}+\ldots+5^2\times\frac{6}{17}=\left(\frac{266}{17}=15.6\right)$ M1 A1 *use of $\Sigma x^2 P(X = x)$ and at least 2 prob correct*

		Var (X) = $\frac{266}{17} - \left(\frac{64}{17}\right)^2$	M1	
		use of $\Sigma x^2 P(X = x)$ –		
		$(\mathrm{E}(X))^2$ = 1.4740…	A1	4
		awrt 1.47		
	(d)	Var (4 – 3X) = 9 Var (X) = 9 × 1.47 = 13.23 ⇒ 13.2	M1 A1	2
		or 9 × 1.4740… = 13.266 ⇒ 13.3		
		cao 9 Var X		

[10]

11.	(a)	$k + 2k + 3k + 4k + 5k = 1$	M1	
		$15k = 1$		
		verification / use of $\Sigma P(X = x) = 1$		
		** $k = \frac{1}{15}$ **	A1	2
		cso		
	(b)	P(X < 4) = P(1) + P(2) + P(3) = $\frac{1}{15} + \frac{2}{15} + \frac{3}{15}$	M1	
		sum of 3 probabilities		
		$= \frac{2}{5}$	A1 seen (2)	2
		0.4 or $\frac{6}{15}$ or $\frac{2}{5}$		
	(c)	E(X) = 1 × $\frac{1}{15}$ +2 × $\frac{2}{15}$ +3 × $\frac{3}{15}$ + 4 × $\frac{4}{15}$ + 5 × $\frac{5}{15}$	M1	
		use of $\Sigma x P(X = x)$		
		$= \frac{11}{3}$	A1	2
		$\frac{55}{15}$ or $\frac{11}{3}$ or $3\frac{2}{3}$ or $3.\dot{6}$ or 3.67		

	(d)	$E(3X - 4) = 3E(X) - 4 = 11 - 4$	M1	
		$3 \times$ theirs-4		
		$= 7$	A1 seen (2)	
		(OR		
		$E(3X - 4) = -1 \times \frac{1}{15} + 2 \times \frac{2}{15} + 5 \times \frac{3}{15} + 8 \times \frac{4}{15} + 11 \times \frac{5}{15}$	M1	
		$\Sigma(3x - 4)kx$		
		$= 7$	A1	2
		cao		

[8]

12.	(a)	$0.5 + b + a = 1$	M1 A1	
		use of $\Sigma P(X = x) = 1$		
		$0.3 + 2b + 3a = 1.7$	M1 A1	
		use of $E(x) = \Sigma xP(X = x)$		
		$\therefore$ <u>$a = 0.4$ & $b = 0.1$</u>	B1	5
	(b)	$P(0 < X < 1.5) = P(X = 1) =$ <u>0.3</u>	B1	1
	(c)	$E(2X - 3) = 2E(X) - 3$	M1	
		Use of $E(aX + b)$		
		$= 2 \times 1.7 - 3 =$ <u>0.4</u>	A1	2
	(d)	$\text{Var}(X) = (1^2 \times 0.3) + (2^2 \times 0.1) + (3^2 \times 0.4) - 1.7^2$	M1	
		Use of $E(x^2) - \{E(x)\}^2$		
		$= 4.3 - 2.89$	A1ft	
		$=$ <u>1.41</u> (*)	A1	3
		cso		
	(e)	$\text{Var}(2X - 3) = 2^2\ \text{Var}(X)$	M1	
		Use of Var		
		$= 4 \times 1.41 =$ <u>5.64</u>	A1	2

[13]

13. (a) $P(1 < X \le 3) = P(X = 2) + P(X = 3)$ M1

$= \frac{1}{12} + \frac{1}{12} = \frac{2}{12} = \frac{1}{6}$ A1 2

$\frac{2}{12}$; $\frac{1}{6}$; 0.167; $0.16\dot{6}$; $0.1\dot{6}$

(b) $F(2.6) = P(X \le 2) = 1 - P(X = 3) = 1 - \frac{1}{12} = \frac{11}{12}$ B1 1

$\frac{11}{12}$; 0.917; $0.91\dot{6}$

(or: $P(X \le 2) = \frac{1}{3} + \frac{1}{2} + \frac{1}{12} = \frac{11}{12}$

(c) $E(X) = \left(0 \times \frac{1}{3}\right) + \ldots + \left(3 \times \frac{1}{12}\right) = \frac{11}{12}$

Use of $\Sigma xP(X = x)$ M1

$\frac{11}{12}$; AWRT 0.917 A1 2

(d) $E(2X - 3) = 2E(X) - 3$ M1

Use of E (ax + b)

$= 2 \times \frac{11}{12} - 3 = -\frac{14}{12} = -\frac{7}{6}$ A1 2

$-\frac{7}{6}$; $-1\frac{1}{6}$; AWRT –1.17

(e) $\text{Var}(X) = 1^2 \times \frac{1}{2} + \ldots + 3^2 \times \frac{1}{12} - \left(\frac{11}{12}\right)^2$

Use of $E(X^2) - \{E(X)\}^2$ M1

Correct substitution A1ft

$= \frac{107}{144}$

$\frac{107}{144}$; AWRT 0.743 A1 3

[10]

14. (a) P(scores 30 points) = P(hit, hit, hit,) = $0.6^3 = 0.216 = \frac{27}{125}$ 0.6^3 M1

$\frac{27}{125}$; 0.216 A1 2

(b)

x	0	10	20	30
	0.4	0.6×0.4	$0.6^2 \times 0.4$	
P ($X = x$)	0.4	0.24	0.144	(0.216)
	$\frac{4}{10}$	$\frac{6}{25}$	$\frac{18}{225}$	

x = 0, 10, 20, 30 B1
One correct
P($X = x$) M1
0.4; 0.24; 0.144 A1; A1; A1 5

(c) E(X) = (0 × 0.4) + … + (30 × 0.216) = <u>11.76</u>

$\Sigma x P(X = x)$
Their distribution M1
AWRT 11.8 A1

E(X^2) = (10^2 × 0.24) + … + (30^2 × 0.216) = 276 B1

Std Dev = $\sqrt{276 - 11.76^2}$ = 11.7346… $\sqrt{\mathrm{E}(X^2) - (\mathrm{E}(X))^2}$ M1

3 s.f. 11.7 A1 5

(d) P (Linda scores more in round 2 than in round 1)
= P(X_1 = 0 & X_2 = 10, 20, 30) $X_2 > X_1$ M1
+ P(X_1 = 10 & X_2 = 20, 30)

Can be implied

All possible A1

+P(X_1 = 20 & X_2 = 30) A1
= 0.4 × (0.24 + 0.144 + 0.216) = 0.24 A1 ft
+ 0.24 × (0.144 + 0.216) = 0.0864 A1
+ (0.144 × 0.216) = 0.031104 A1 ft
<u>= 0.357504</u> A1 6

AWRT 0.358

[18]

15. (a) $E(X) = \Sigma x \times P(X = x)$ $= \frac{1}{n} + \frac{2}{n} + \ldots\ldots + \frac{n}{n}$ *Use of E(X)* M1

Accept Verify

i.e: - $= \frac{1}{n}\{1 + 2\ldots + n\}$

$\frac{1}{9} + \frac{2}{9} + \ldots + \frac{9}{9} = \frac{45}{9} = 5$

or $\frac{n+1}{2} = 5$ $= \frac{1}{n} \cdot \frac{1}{2} n(n+1) = \frac{n+1}{2}$ M1

Use of $\frac{1}{2}n(n + 1)$

$\therefore \frac{n+1}{2} = 5 \Rightarrow \underline{n = 9}$ A1 3

Must state n = 9 for final A1
c.s.o.

(b) $P(X < T) = \frac{1}{9} \times 6 = \frac{2}{3}$ M1 A1 2

$P(X \leq 6)$

Use of $E(X^2)$

(c) $\text{Var}(X) = E(X^2) - \{E(X)\}^2$ A1

$\frac{95}{3} : \frac{285}{9} : 31\frac{2}{3}$

$= \frac{1^2}{9} + \frac{2^2}{9} + \ldots + \frac{9^2}{} - 5^2$ M1

Use of Var(X)

$= \frac{1}{9} \times \frac{1}{6} \times 9 \times 10 \times 19 - 5^2$ M1

$= \underline{\frac{20}{3}}$ A1 4

$6\frac{2}{3}$; $6.6\dot{6}$; 6.67; $\frac{20}{30}$

OR

$\text{Var}(X) = \frac{n^2 - 1}{12} = \frac{80}{12} = \frac{20}{3}$ M2 A1 A1

[9]

16. (a) $k(16 - 9) + k(25 - 9) + k(36 - 9) = 1$ M1 A1

$\therefore\ 7k + 16k + 27k = 1 \Rightarrow k = \frac{1}{50}$ A1 3

x	4	5	6
$P(X = x)$	$\frac{7}{50}$	$\frac{16}{50}$	$\frac{27}{50}$

(b) $E(X) = (4 \times \frac{7}{50}) + (5 \times \frac{16}{50}) + (6 \times \frac{27}{50}) = \frac{270}{50} = 5.4$

$E(X^2) = (4^2 \times \frac{7}{50}) + (5^2 \times \frac{16}{50}) + (6^2 \times \frac{27}{50}) = \frac{1484}{50} = 29.68$

$\therefore\ \text{Var}(X) = 29.68 - 5.4^2 = \frac{13}{25} = 0.52$

$\Sigma xP(X = x)$ M1

$\frac{27}{5}$ or 5.4 A1

$\Sigma x^2P(X = x)$ M1

29.68 A1

Use of $E(X^2) - \{E(x)\}^2$ M1

0.52 A1 6

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

$= 4 \times 0.52 = \underline{2.08}$

Use of $Var(x) = a^2\ Var(x)$ M1

+ve variance A1 ft 2

[11]

17. (a) Discrete uniform B1 1

(b) $P(X = x) = \frac{1}{6},\ x = 1, 2, \ldots, 6$

$\therefore\ E(X) = \Sigma x\ P(X = x) = \frac{1}{6} + \frac{2}{6} + \ldots + \frac{6}{6} = \frac{21}{6} = 3.5$ B1

or $E(X) = \frac{k+1}{2} = \frac{7}{2} = 3.5$

$\text{Var}(X) = \Sigma x^2\ P(X = x) - \{E(X)\}^2$ M1

$= \frac{1}{6} + \frac{4}{6} + \ldots + \frac{36}{6} - (\frac{21}{6})^2$

$= \frac{105}{36} = \frac{35}{12} = 2\frac{11}{12} = 2.91\dot{6}$ A1 3

$\frac{35}{12}$, $2\frac{11}{12}$, 2.92

Or $\text{Var}(X) = \frac{k^2 - 1}{12} = \frac{36 - 1}{12} = \frac{35}{12}$ etc

(c) $P(\text{three 6s}) = (\frac{1}{6})^3 = \frac{1}{216}$ M1 A1 2

(d) $16 \Rightarrow (6, 5, 5); (5, 6, 5); (5, 5, 6)$ B1 B1

$(6, 6, 4); (6, 4, 6); (4, 6, 6)$ B1 B1 4

	(e)	$P(16) = \frac{6}{216} = \frac{1}{36}$	M1 A1	2
				[12]
18.	(a)	$2k + k + 0 + k = 1$	M1	
		$\therefore 4k = 1 \Rightarrow k = 0.25$ **(*)**	A1	2

(b)

x	0	1	2	3
$P(X = x)$	0.5	0.25	0	0.25
$xP(X = x)$	0	0.25	0	0.75
$x^2P(X = x)$	0	0.25	0	2.75

$E(X) = \Sigma xP(X = x) = 0 + 0.25 + 0 + 0.75 = 1$	M1 A1	
$E(X^2) = 0 + 0.25 + 0 + 2.25 = 2.5$ **(*)**	M1 A1	4

(c)	$\text{Var}(3X - 2) = 3^2\ \text{Var}(X)$	M1	
	$= 9(2.5 - 1^2) = 13.5$	M1 A1	3
(d)	$P(X_1 + X_2) = P(X_1 = 3 \cap X_2 = 2) + P(X_1 = 2 \cap X_2 = 3) = 0 + 0 = 0$	B1	1
(e)	Let $Y = X_1 + X_2$		

y	0	1	2	3	4	5	6	
$P(Y = y)$	0.25	0.25	0.0625	0.25	0.125	(0)	0.0625	B1 B2 3

(f)	$P(1.3 \le X_1 + X_2 \le 3.2) = P(X_1 + X_2 = 2) + P(X_1 + X_2 = 3)$	M1	
	$= 0.0625 + 0.25 = 0.3125$	A1 ft, A1 ft	3
			[16]

19.	(a)	P(correct at third attempt) $= 0.4 \times 0.4 \times 0.6$	M1	
		$= 0.096$	A1	2

(b)

a	1	2	3	4
$P(A = a)$	0.6	0.24	0.096	0.064

	a = 1, 2, 3, 4	B1	
	All P(A = a) correct	B1	2
(c)	P(correct number) $= 1 - (0.4)^4$	M1	
	$= 0.9744$		
	(accept awrt 0.974)	A12	

(d)	$E(A) = \Sigma\, a\, P(A = a) = (1 \times 0.6) + \ldots + (4 \times 0.064)$	M1	
	$= 1.624$		
	(accept awrt 1.62)	A1	
	$E(A^2) = \Sigma\, a^2\, P(A = a) = (1^2 \times 0.6) + \ldots + (4^2 \times 0.064)$	M1	
	$= 3.448$	A1	
	$\therefore\ \text{Var}(A) = 3.448 - (1.624)^2$	M1	
	$= 0.810624$		
	(accept awrt 0.811)	A1	6
	$F(1 + E(A)) = P(A \le 1 + E(A))$		
	$= P(A \le 2.624)$	M1	
	$= 0.84$	A1	2

[14]