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EDEXCEL A LEVEL FURTHER MATHEMATICS: QUESTIONS BY TOPIC

Discrete Probability Distributions (1)

Further Statistics 1 · Topic 1

9 questions · 88 marks · Mark schemes included

Pearson Edexcel A Level Further Mathematics (9FM0), June 2019 - June 2025

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HOW TO USE THIS BOOKLET

Questions are grouped by specification sub-topic and run from the lowest mark tariff to the highest within each one.

Click any row below to jump straight to that sub-topic or question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

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QUESTIONS

9 questions · 88 marks · 4 sub-topics



SUB-TOPIC 1.1

MEAN AND VARIANCE OF DISCRETE RANDOM VARIABLES

Sub-topic 1.1 · 4 questions · 32 marks · lowest tariff first



1. The discrete random variable X has the following probability distribution

x	-1	0	1	3	5
$P(X=x)$	0.2	0.1	0.2	0.25	0.25

(a) Find $\text{Var}(X)$

(3)

(b) Find $\text{Var}(X^2)$

(3)



Question 1 continued

(Total for Question 1 is 6 marks)



4. The discrete random variable X has the following probability distribution.

x	-5	-2	3	4
$P(X=x)$	$\frac{1}{12}$	$\frac{1}{6}$	$\frac{1}{4}$	$\frac{1}{2}$

(a) Find $\text{Var}(X)$

(3)

The discrete random variable Y is defined in terms of the discrete random variable X

When X is negative, $Y = X^2$

When X is positive, $Y = 3X - 2$

(b) Find $P(Y < 9)$

(3)

(c) Find $E(XY)$

(2)





(Total for Question 4 is 8 marks)



2. The discrete random variable X has probability distribution

x	-5	-1	0	5	b
$P(X=x)$	0.3	0.25	0.1	0.15	0.2

where b is a constant and $b > 5$

(a) Find $E(X)$ in terms of b

(1)

Given that $\text{Var}(X) = 34.26$

(b) find the value of b

(4)

(c) Find $P(X^2 < 2 - 3X)$

(4)



Question 2 continued

(Total for Question 2 is 9 marks)



Question 2 continued

SUB-TOPIC 2.2

MEAN AND VARIANCE OF BINOMIAL AND POISSON

Sub-topic 2.2 · 1 question · 4 marks · lowest tariff first



2. The discrete random variables W , X and Y are distributed as follows

$$W \sim \text{B}(10, 0.4) \qquad X \sim \text{Po}(4) \qquad Y \sim \text{Po}(3)$$

- (a) Explain whether or not $\text{Po}(4)$ would be a good approximation to $B(10, 0.4)$ (1)

- (b) State the assumption required for $X + Y$ to be distributed as $\text{Po}(7)$ (1)

Given the assumption in part (b) holds,

- (c) find $P(X + Y < \text{Var}(W))$

Question 2 continued

(Total for Question 2 is 4 marks)



SUB-TOPIC 7.1

PROBABILITY GENERATING FUNCTIONS

Sub-topic 7.1 · 2 questions · 27 marks · lowest tariff first



6. The discrete random variable X has probability generating function

$$G_X(t) = \frac{t^2}{(3-2t)^2}$$

- (a) Specify the distribution of X

(2)

A fair die is rolled repeatedly.

- (b) Describe an outcome that could be modelled by the random variable X

(1)

- (c) Use calculus and $G_X(t)$ to find

- (i) $E(X)$

- (ii) $\text{Var}(X)$

(7)

The discrete random variable Y has probability generating function

$$G_Y(t) = \frac{t^{10}}{(3 - 2t^3)^2}$$

- (d) Find the exact value of $P(Y = 19)$

(3)

Question 6 continued



Question 6 continued

Lined area for writing the answer to Question 6 continued.

Question 6 continued

(Total for Question 6 is 14 marks)

SUB-TOPIC 7.2

MEAN AND VARIANCE FROM PGFS

Sub-topic 7.2 · 2 questions · 25 marks · lowest tariff first



6. The discrete random variable X has probability generating function

$$G_X(t) = k \ln \left(\frac{2}{2-t} \right)$$

where k is a constant.

- (a) Find the exact value of k (1)
- (b) Find the exact value of $\text{Var}(X)$ (7)
- (c) Find $P(X = 3)$ (4)

Question 6 continued

Question 6 continued

(Total for Question 6 is 12 marks)



6. A discrete random variable X has probability generating function given by

$$G_x(t) = \frac{1}{64} (a + bt^2)^2$$

where a and b are positive constants.

(a) Write down the value of $P(X = 3)$

(1)

Given that $P(X = 4) = \frac{25}{64}$

(b) (i) find $P(X = 2)$

(7)

(ii) find $E(X)$

(3)

The random variable $Y = 3X + 2$

(c) Find the probability generating function of Y

(2)





Question 6 continued

(Total for Question 6 is 13 marks)



MARK SCHEMES

official mark schemes



Qu	Scheme	Mark	AO
1 (a)	$E(X) = [-1 \times 0.2 + 0 + 1 \times 0.2] + 3 \times 0.25 + 5 \times 0.25 [= 2]$	M1	1.1b
	$E(X^2) = (-1)^2 \times 0.2 + 0 + 1 \times 0.2 + 3^2 \times 0.25 + 5^2 \times 0.25 [= 8.9]$	M1	1.1b
	$[\text{Var}(X) = 8.9 - 4 =]$ 4.9	A1	1.1b
		(3)	
	(b) $E(X^4) = (-1)^4 \times 0.2 + 0 + 1 \times 0.2 + 3^4 \times 0.25 + 5^4 \times 0.25 [= 176.9]$	M1	2.1
	$\text{Var}(X^2) = "176.9" - "8.9" ^2$	M1	1.1b
	$= 97.69$ awrt 97.7	A1	1.1b
		(3)	
		(6 marks)	
	Notes		



Question	Scheme	Marks	AOs															
4(a)	$[E(X) =](-5) \times \frac{1}{12} + (-2) \times \frac{1}{6} + (3) \times \frac{1}{4} + (4) \times \frac{1}{2} [= 2]$	M1	1.1b															
	$[E(X^2) =](-5)^2 \times \frac{1}{12} + (-2)^2 \times \frac{1}{6} + (3)^2 \times \frac{1}{4} + (4)^2 \times \frac{1}{2} [= 13] \text{ (oe)}$	M1	1.1b															
	$\text{Var}(X) = E(X^2) - [E(X)]^2 = 13 - 2^2 = \underline{9}$	A1	1.1b															
		(3)																
(b)	<table border="1"><tr><td>x</td><td>(-5)</td><td>-2</td><td>3</td><td>(4)</td></tr><tr><td>y</td><td>(25)</td><td>4</td><td>7</td><td>(10)</td></tr><tr><td>p</td><td>($\frac{1}{12}$)</td><td>$\frac{1}{6}$</td><td>$\frac{1}{4}$</td><td>($\frac{1}{2}$)</td></tr></table>	x	(-5)	-2	3	(4)	y	(25)	4	7	(10)	p	($\frac{1}{12}$)	$\frac{1}{6}$	$\frac{1}{4}$	($\frac{1}{2}$)	M1	3.1a
	x	(-5)	-2	3	(4)													
	y	(25)	4	7	(10)													
	p	($\frac{1}{12}$)	$\frac{1}{6}$	$\frac{1}{4}$	($\frac{1}{2}$)													
	$P(Y < 9) = P(X = -2) + P(X = 3) [= \frac{1}{6} + \frac{1}{4}]$	M1	1.1b															
$= \underline{\frac{5}{12}}$	A1	1.1b																
	(3)																	
(c)	$E(XY) = (-5)(25)\frac{1}{12} + (-2)(4) \times \frac{1}{6} + (3)(7) \times \frac{1}{4} + (4)(10) \times \frac{1}{2}$	M1	3.1a															
	$= \underline{13.5}$	A1	1.1b															
		(2)																
(8 marks)																		
Notes																		
(a)	M1: Attempt at $E(X)$ with at least 3 correct products seen M1: Attempt at $E(X^2)$ with at least 3 correct products seen A1: 9 cao																	
	Alternative M1: Attempt at $E(X)$ with at least 3 correct products seen M1: Attempt at expression for $E((X - \mu)^2) = (-5 - 2)^2 \times \frac{1}{12} + (-2 - 2)^2 \times \frac{1}{6} + (3 - 2)^2 \times \frac{1}{4} + (4 - 2)^2 \times \frac{1}{2}$ with at least 3 correct terms A1: 9 cao																	
(b)	M1: Finding distribution of Y M1: $P(X = -2) + P(X = 3)$ or $P(Y = 4) + P(Y = 7)$ A1: $\frac{5}{12}$ (condone awrt 0.417)																	
(c)	M1: Attempt at $E(XY)$ with at least 2 correct terms A1: 13.5																	



Qu	Scheme		Marks	AOs
	2ndA1	for $s = 37.5$		
SC	“B1”	If M0 scored but their values of r and s satisfy $2r + s = 87.5$ score as M0A0A1		
(b)	1st B1	Both hypotheses correct using the correct notation in at least one <u>or</u> written in full e.g. binomial with $n = 4$ and $p = 0.5$		
	M1	Calculating either $\frac{(O_i - E_i)^2}{E_i}$ or $\frac{O_i^2}{E_i}$ at least 4 correct. Implied by sight of awrt 10.6		
	1st A1	Allow 10.6 (from correct working)		
	2nd B1	Correct dof May be implied by CV of 9.48 or 9.49 or better		



Question	Scheme				Marks	AOs	
2(a)	$E(X) = -1 \times \frac{1}{2} + \frac{1}{4} \times a + \frac{1}{4} \times b$ $[E(X) =] \frac{1}{4}a + \frac{1}{4}b - \frac{1}{2}$				M1 A1	1.1b 1.1b	
					(2)		
(b)	$\text{Var}(Y) = b^2 \text{Var}(X)$				M1	1.1b	
	$b^2 = \frac{1}{4} \quad \rightarrow \quad b = \frac{1}{2}$				A1	1.1b	
	$E(Y) = a + bE(X)$		$\frac{a-b}{0.5}$	$\frac{a+ab}{0.25}$	$\frac{a+b^2}{0.25}$	B1	2.1
	$a + b\left(\frac{1}{4}a + \frac{1}{4}b - \frac{1}{2}\right) = \frac{5}{16}$	$\frac{1}{2}(a-b) + \frac{1}{4}(a+ab) + \frac{1}{4}(a+b^2) = \frac{5}{16}$			M1	1.1b	
	$a = \frac{4}{9}$				A1	1.1b	
	$E(X) = \frac{1}{4}\left(\frac{4}{9}\right) + \frac{1}{4}\left(\frac{1}{2}\right) - \frac{1}{2}$				M1	3.1a	
	$E(X) = -\frac{19}{72}$				A1	1.1b	
					(7)		
(9 marks)							
Notes:							
(a)	M1:	Attempt at $E(X)$, at least two terms correct					
	A1:	Full correct expression for $E(X)$, may be unsimplified					
(b)	M1:	Writing or using $\text{Var}(Y) = b^2 \text{Var}(X)$					
	A1:	For finding $b = \frac{1}{2}$					
	B1:	Writing using $E(Y) = a + bE(X)$, or writing a correct probability distribution for Y					
	M1:	Correct expression for $E(Y)$ in terms of a and b (or their value of b) and equating their expression to $\frac{5}{16}$					
	A1:	$a = \frac{4}{9}$ or exact equivalent					
	M1:	Substituting their values of a and b into their expression for $E(X)$ where $a, b \neq \frac{5}{16}$					
	A1:	$E(X) = -\frac{19}{72}$ or exact equivalent					



Question	Scheme	Marks	AOs
2(a)	requires large n /small p so not a good approximation	B1	3.5b
		(1)	
(b)	X and Y must be independent	B1	2.4
		(1)	
(c)	$P(X + Y < 2.4)$ from $Po(7)$ [$P(X + Y \leq 2)$]	M1	3.4
	$= 0.029636...$ awrt <u>0.0296</u>	A1	1.1b
		(2)	
(4 marks)			
Notes			
(a)	B1: Correct reason why the model would not be appropriate and correct conclusion. Condone e.g. ' p is close to 0.5' for p is not small. Mean is not equal to variance on its own in B0.		
(b)	B1: Correct explanation mentioning independence (oe). Ignore extraneous comments.		
(c)	M1: Using $Po(7)$ with 2.4 A1: awrt 0.0296		
Question	Scheme	Marks	AOs

Qu6	Scheme	Marks	AO
(a)	NegBin(r, p) has pgf $\left[\frac{pt}{1-(1-p)t} \right]^r$ and identify the connection NegBin($2, \frac{1}{3}$)	M1 A1 (2)	2.1 2.2a
(b)	e.g. no. of rolls to achieve 5 or 6 (so that $p = \frac{1}{3}$) <u>twice</u> (oe)	B1ft (1)	3.3
(c)(i)	$G'_X(t) = \frac{2t(3-2t)^2 - (-2) \times 2(3-2t)t^2}{(3-2t)^4}$ <u>or</u> $\frac{6t}{(3-2t)^3}$ $E(X) = G'_X(1) = \underline{6}$	M1 A1 A1	2.1 1.1b 1.1b
(ii)	$G''_X(t) = \frac{6(3-2t)^3 - (-2) \times 3(3-2t)^2 \times 6t}{(3-2t)^6}$ <u>or</u> $\frac{18+24t}{(3-2t)^4}$ $G''_X(1) = 42$ $\text{Var}(X) = "42" + "6" - "6"2$ $= \underline{12}$	M1 A1 A1 (7)	2.1 1.1b 1.1b 1.1b
(d)	$G_Y(t) = t^{10} \times \frac{1}{9} \left[1 - \frac{2}{3}t^3 \right]^{-2} = \frac{t^{10}}{9} \left[1 + \dots \frac{(-2)(-3)(-4)}{3!} \left(-\frac{2}{3} \right)^3 t^9 \dots \right]$ $P(Y=19) = \frac{32}{243}$	M1 A1 A1 (3)	2.1 1.1b 1.1b
ALT	Identify that $Y = 3X + 4$ $(Y = 19 \text{ requires } X = 5 \text{ so }) P(X=5) = \binom{4}{1} \left(\frac{1}{3} \right) \left(\frac{2}{3} \right)^3 \left(\frac{1}{3} \right)$	M1 A1 (13 marks)	
Notes			
(a)	M1 for identifying the NegBin distribution (allow NB for NegBin) A1 for $r = 2$ and $p = \frac{1}{3}$		
(b)	B1ft for identifying a suitable definition for X using a (fair) die, with $p = \frac{1}{3}$ and the second occurrence of the event, only ft their NegBin distribution in (a). A finite number of rolls is B0		
(c)(i)	1 st M1 for attempt to differentiate quotient or product. At least one uv' style term correct. 1 st A1 for a fully correct first derivative (needn't be simplified) 2 nd A1 for $E(X) = 6$ NB this A1 depends on M1 only but M1A0A1 is possible		
(ii)	2 nd M1 for attempt to diff' quotient or product again. At least one uv' style term correct. 3 rd A1 for 42 (may be given for incorrect G'' provided their $G''(1)$ gives 42 and M1 scored) Note all powers of $(3-2t)$ equal 1 when $t = 1$ is substituted so can be used as a check 3 rd M1 for correct use of pgf to find $\text{Var}(X)$ 4 th A1 dep on M3 for 12		
(d)	M1 for writing pgf in suitable form to carry out binomial expansion 1 st A1 for a correct expression for coefficient of t^{19} 2 nd A1 for $\frac{32}{243}$ or exact equivalent		

Question	Scheme	Marks	AOs
6(a)	$G_v(t) = \frac{9}{25}t^2 + \frac{12}{25}t^3 + \frac{4}{25}t^4$ <u>or</u> $t^2\left(\frac{9}{25} + \frac{12}{25}t + \frac{4}{25}t^2\right)$	M1	1.1b
	$= t^2\left(\frac{2}{5}t + \frac{3}{5}\right)^2$ *	A1* cso (2)	2.1
(b)(i)	$G_w'(t) = 2t\left(\frac{2}{5}t + \frac{3}{5}\right)^4 + \left(\frac{2}{5}t + \frac{3}{5}\right)^5$	M1	2.1
	$\left[G_w'(1) = \right]$ <u>3</u>	A1	1.1b
	$G_w''(t) = 2\left(\frac{2}{5}t + \frac{3}{5}\right)^4 + \frac{16}{5}t\left(\frac{2}{5}t + \frac{3}{5}\right)^3 + 2\left(\frac{2}{5}t + \frac{3}{5}\right)^4$ oe	M1	2.1
	$G_w''(1) = \frac{36}{5}$	A1	1.1b
	$\text{Var}(W) = \frac{36}{5} - \left(\frac{3}{5}\right)^2$	M1	2.1
	$= \frac{6}{5}$	A1	1.1b
		(6)	
(c)	$G_x(t) = t^2\left(\frac{2}{5}t + \frac{3}{5}\right)^2 \times t\left(\frac{2}{5}t + \frac{3}{5}\right)^5$	M1	3.1a
	$= t^3\left(\frac{2}{5}t + \frac{3}{5}\right)^7$	A1	1.1b
		(2)	
(d)	$G_y(t) = t^3 \times \left(t^2\right)^3 \times \left(\frac{2}{5}t^2 + \frac{3}{5}\right)^7$	M1	3.1a
	$= t^9\left(\frac{2}{5}t^2 + \frac{3}{5}\right)^7$	A1	1.1b
		(2)	
(e)	$P(Y = 15)$ is coefficient of t^{15} ie $\dots + t^9 \times {}^7C_3\left(\frac{2}{5}t^2\right)^3\left(\frac{3}{5}\right)^4 + \dots$ <u>or</u> $P(X = 6)$ need coefficient of t^6 i.e. $\dots + t^3 \times {}^7C_3\left(\frac{2}{5}t\right)^3\left(\frac{3}{5}\right)^4 + \dots$	M1	1.1b
	$\left[P(Y = 15) = \right] \frac{22680}{78125} = \frac{4536}{15625} = 0.290304$	A1	1.1b
		(2)	
(14 marks)			

Notes:		
(a)	M1 A1*	A correct un-simplified pgf based on $\sum t^v P(V=v)$ cso must see an un-simplified version i.e. M1 scored and no incorrect working seen
(b) (i)	M1 A1	Differentiating using the product rule to find $G_w'(t)$ Allow un-simplified e.g. $5 \times \frac{2}{5}t$ Need two terms added and at least one correct. If they expand we need 3 correct. 3 from a correct derivative
(ii)	1stM1 1stA1 2ndM1 2ndA1	Attempt $G_w''(t)$ ft their $G_w'(t)$ [must be at least 2 terms or a product], one correct ft term, same rule for differentiating a product $\frac{36}{5}$ or 7.2 from a correct derivative $G_w''(1) + G_w'(1) - (G_w'(1))^2$ ft their $G_w''(t)$ if different from $G_w'(t)$ and $G_w(t)$ Dep on M3A2 $\frac{6}{5}$ or 1.2
(c)	M1 A1	Realising the need to use $G_x(t) = G_v(t) \times G_w(t)$ $t^3 \left(\frac{2}{5}t + \frac{3}{5} \right)^7$
(d)	M1 A1	Realising the need to multiply through by t^3 <u>or</u> substitute t^2 for t <u>or</u> sight of $t^3 G_x(t^2)$ $t^9 \left(\frac{2}{5}t^2 + \frac{3}{5} \right)^7$ oe Need not be in its simplest form
(e)	M1 A1	Attempting to find correct coefficient of t^n <u>or</u> identify $Y = 2J + 9$ where $J \sim B(7, 0.4)$ Need an expression can ft their $G_Y(t)$ or $G_x(t)$ of the form $t^n (at^m + b)^k$ Allow a statement that $P(Y=15) = 0$ if it follows from their pgf For a correct exact answer or allow awrt 0.2903 Allow 0.29 from correct expression

Alternative for (b)

(b)	$W = P + 1$ where $P \sim B(5, 0.4)$ so $\text{Var}(W) = \text{Var}(P)$		
(i)	$G_p'(t) = 2 \left(\frac{2}{5}t + \frac{3}{5} \right)^4$	M1	2.1
	$G_w'(1) = 2 + 1 = 3$	A1	1.1b
(ii)	$G_p''(t) = \frac{16}{5} \left(\frac{2}{5}t + \frac{3}{5} \right)^3$; $G_p''(1) = \frac{16}{5}$	M1; A1	2.1 1.1b
	$\text{Var}(W) = \frac{16}{5} - 2^2 = \frac{6}{5}$; $= \frac{6}{5}$	M1; A1	2.1 1.1b
SC	MR They use $G_v(t)$ instead of $G_w(t)$ Provided some correct differentiation seen: Award B1 for $E(V) = \frac{14}{5}$ and B1 for $\text{Var}(V) = \frac{12}{25}$ score as M0A1M0A0M0A1		

Qu	Scheme	Marks	AO
6 (a)	$G(1) = 1 \Rightarrow k \ln 2 = 1$ so $k = \frac{1}{\ln 2}$	B1	2.1
(b)	$\left\{ G(t) = \frac{1}{\ln 2} [\ln 2 - \ln(2-t)] \right\} \Rightarrow G'(t) = \frac{1}{\ln 2} \left[\frac{1}{2-t} \right]$ or $\frac{1}{\ln 2} (2-t)^{-1}$ $[E(X) =] G'(1) = \frac{1}{\ln 2}$ $G''(t) = \frac{1}{\ln 2} \times \left[\frac{1}{(2-t)^2} \right]$ $\text{Var}(X) = G''(1) + G'(1) - [G'(1)]^2 = \frac{1}{\ln 2} + \frac{1}{\ln 2} - \left(\frac{1}{\ln 2} \right)^2$ $= \frac{1}{\ln 2} \left(2 - \frac{1}{\ln 2} \right)$	(1) M1 A1 A1 M1 A1 M1 A1	2.1 1.1b 1.1b 2.1 1.1b 2.1 1.1b
(c)	$P(X = 3) = \text{coefficient of } t^3 \text{ by Maclaurin need } G'''(0)$ $G'''(t) = \frac{1}{\ln 2} \frac{2}{(2-t)^3}$ $P(X = 3) = \frac{G'''(0)}{3!}$ $= \frac{\frac{1}{4 \ln 2}}{6} = \frac{1}{24 \ln 2} = 0.0601122... \text{ awrt } \underline{0.0601}$	(7) M1 A1ft M1 A1 (4)	3.1a 1.1b 3.2a 1.1b
Notes			
(a)	B1 for finding k (must be exact)		
(b)	1 st M1 for an attempt to differentiate $G(t)$ e.g. $A(2-t)^{-1}$ (o.e.) 1 st A1 for a correct first derivative (condone k or use of $\frac{1}{\ln 2} = \text{awrt } 1.44$) 2 nd A1 for correct $E(X)$ or $G'(1)$ (allow awrt 1.44 calc: 1.442695...but not k) seen anywhere 2 nd M1 for attempting second derivative (ft their $G'(t)$) 3 rd A1 for a correct 2 nd derivative (condone k or use of $\frac{1}{\ln 2} = \text{awrt } 1.44$) 3 rd M1 for a correct method for $\text{Var}(X)$ (some substitution into the correct formula) 4 th A1 for $\frac{1}{\ln 2} \left(2 - \frac{1}{\ln 2} \right)$ o.e. but must simplify i.e. collect like terms [Mark final answer – penalise incorrect log work etc] NB 0.8040211.. is A0 unless exact answer seen		
(c)	1 st M1 for a suitable strategy to solve the problem (finding link with Maclaurin) Need mention of coefficient of t^3 and $[G'''(t) \text{ or } G'''(0)]$ (condone $G'''(1)$) 1 st A1ft for 3 rd derivative, ft their 2 nd derivative in (b) (provided $G''(t)$ not const) Correct $G'''(t)$ or $G'''(0)$ scores 1 st M1 1 st A1ft 2 nd M1 for translating Maclaurin to probability (a correct expression) 2 nd A1 for $\frac{1}{24 \ln 2}$ or awrt 0.0601		

Question	Scheme	Marks	AOs
6(a)	$P(X = 3) = \underline{0}$	B1	1.1b
		(1)	
(b)(i)	Coefficient of $t^4 = \frac{1}{64}b^2$	M1	2.1
	$\frac{1}{64}b^2 = \frac{25}{64}$	M1	1.1b
	$b = 5$ (reject $b = -5$ since $b > 0$)	A1	2.3
	$G_X(1) = 1$ $\frac{1}{64}(a + 5)^2 = 1$	M1	2.1
	$a = 3$ (reject $a = -13$ since $a > 0$)	A1	1.1b
	$P(X = 2) = \text{coefficient of } t^2 = \frac{1}{64}(2ab)$	M1	3.4
	$= \frac{15}{32}$	A1	1.1b
		(7)	
(ii)	$E(X) = G'_X(1)$	M1	2.1
	$G'_X(t) = \frac{2}{64}("3" + "5"t^2) \times "10"t$ or $G'_X(t) = \frac{1}{64}("60"t + "100"t^3)$	M1	1.1b
	$G'_X(1) = 2.5$	A1ft	1.1b
		(3)	
(c)	$G_Y(t) = t^2 G_X(t^3) [= \frac{t^2}{64}(a + b(t^3)^2)^2]$	M1	3.1a
	$G_Y(t) = \frac{t^2}{64}("3" + "5"t^6)^2$	A1ft	1.1b
		(2)	
(13 marks)			
Notes			
(a)	B1: 0 (Since there is no term in t^3)		
(b)(i)	M1: Realising that $\frac{1}{64}b^2$, the coefficient of t^4 , is needed M1: Equating their coefficient of t^4 to $\frac{25}{64}$ with an attempt to find b A1: $b = 5$ only M1: Realising that $G_X(1) = 1$ is required A1: $a = 3$ only M1: Finding coefficient of t^2 with their $a > 0$ and $b > 0$ A1: $\frac{15}{32}$ (condone awrt 0.469)		
(b)(ii)	M1: Realising $G'_X(1)$ is needed M1: Attempt to differentiate $G_X(t)$ with their values of a and b A1ft: 2.5 (ft (3sf) their values of a and b , $a > 0$ and $b > 0$) $E(X) = \frac{ab+b^2}{16}$ Alternative: M1: Realising $X = 0, 2$ and 4 only M1: $[0 \times P(X = 0)] + 2 \times P(X = 2) + 4 \times P(X = 4)$		
(c)	M1: either $G_X(t^3)$ or $\times t^2$ or using $Y = 2, 8, 14$ A1ft: ft their values of a and b , $a > 0$ and $b > 0$ $G_Y(t) = \frac{t^2}{64}("3" + "5"t^6)^2$ or $G_Y(t) = \frac{t^2}{64}("9" + "30"t^6 + "25"t^{12})$ or $G_Y(t) = \frac{1}{64}("9t^2" + "30"t^8 + "25"t^{14})$		