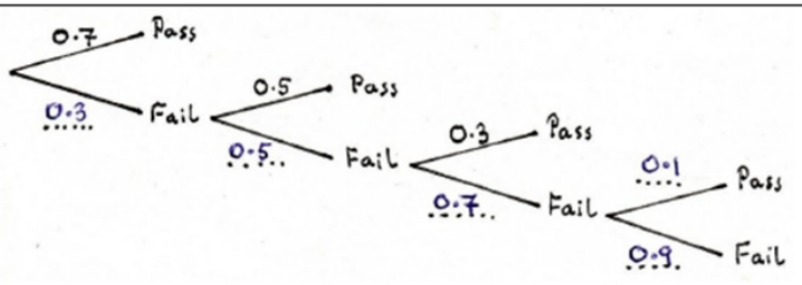
Question 1 (11 marks)

Question Number	Scheme	Marks
(a)		B1 B1 (2)
(b)	$1-0.3\times0.5\times0.7\times0.9$ or $0.7+(0.3\times0.5)+(0.3\times0.5\times0.3)+(0.3\times0.5\times0.7\times0.1)$ $=\underline{0.9055}$	M1 A1 (2)
(c)	$[\mathrm{P}(P_1\cup P_2 \mid \text{Pass})=]\ \dfrac{0.7+"0.3"\times0.5}{(b)},\ =\dfrac{0.85}{"0.9055"}$ $=0.938707\ldots=$ awrt $\underline{0.939}$	M1, A1ft A1 (3)
(d)	$p+(1-p)(p-0.2)$ or $1-(1-p)(1.2-p)$ (o.e.) e.g. $p+p-p^2+0.2p-0.2=0.95\ \rightarrow p^2-2.2p+1.15=0$ (*)	M1 dM1A1cso (3)

	Notes
(a)	1st B1 for correctly placing 0.3 and 0.5 2nd B1 for correctly placing 0.7, 0.1 and 0.9
	Apart from (d), a correct answer with no incorrect working scores full marks.
(b)	M1 for a correct expression (ft from their tree diagram) A1 for 0.9055 or exact equivalent e.g. $\frac{1811}{2000}$ Accept 0.906 only if correct expr' seen
(c)	M1 for a correct ratio of probs ft their 0.3 and their answer to (b)[if < 1]. Num > Den M0 A1ft for correct numerator and their part (b) on denominator A1 for awrt 0.939 or accept exact fraction eg $\frac{1206}{1111}$
(d)	1st M1 for a correct expression for P(pass) in terms of p[condone $p-(p-1)(p-0.2)$ etc] 2nd dM1 dep. on 1st M1 for expanding brackets and forming an equation in p Allow one slip A1cso correct processing leading to printed answer. No incorrect working seen.

Part (e) p=awrt 0.86 **only**

Q2 (7 marks)

Question Number	Scheme	Marks
(a)	Width = 0.5 (cm)	B1
	$1cm^2$ rep's 4 babies or $0.25cm^2$ rep's 1 baby or their $h \times w = 3.5$ or area = 3.5 cm^2	M1
	Height $= \frac{14}{16} \times 4 \div 0.5 = 7$ (cm)	A1
		(3)
a	Lower Quartile $= [2.5] + \frac{\frac{98}{4} - 16}{24} \times 0.5 \quad = [2.5] + \frac{8.5}{24} \times 0.5$	M1
	$= 2.50 + 0.177\ldots$ = awrt **2.68**	A1
		(2)
(c)	$Q_2 - Q_1 =$ "3.14" − "2.68" = 0.46 > 0.41 = 3.55 − 3.14 = $Q_3 - Q_2$	M1
	So negative skew	A1
		(2)
b	$\bar{w} = \frac{311.5}{98} = 3.17857\ldots$ = awrt **3.18**	B1
	$\sigma_w = \sqrt{\frac{1051.125}{98} - \bar{w}^2} = \sqrt{0.622448\ldots}$; = 0.78895… = awrt **0.789**	M1
		A1
		(3)
(e)	$\frac{3("3.18" - 3.14)}{"0.789"} = 0.152\ldots$ awrt **0.15**	M1A1
		(2)
c (i)	49th value now 3.25 [or median in group $3.25 \leqslant w < 3.50$] so median increases	B1
(ii)	more higher values or Σfx increases … so mean increases	B1
		(2)

	Notes
(a)	B1 0.5 only
	M1 may be implied by correct height
	A1 correct height of 7(cm)
a	M1 for any correct equation leading to correct fraction as part of $m = \ldots$ or $(m - [2.5]) = \ldots$ Ignore incorrect end point and watch out for "working down" Using 25 for 24.5 is M0
	A1 awrt 2.68 allow exact fraction e.g. $\frac{257}{96}$ (allow 8.75 for 8.5 [or $\frac{515}{192}$] if n +1 used)
(c)	M1 for use of $Q_2 - Q_1$ and $Q_3 - Q_2$ (o.e.) ft their Q_1 [or correct inequality and –ve skew] or a correct quartile inequality and statement that negative skew
	A1 for correctly concluding negative skew from their values. Their ft calc should be correct
b	B1 for awrt 3.18 (allow $\frac{89}{28}$)
	M1 for a correct expression (including square root) ft their mean ($\frac{\sqrt{122}}{14}$ scores M1)
	A1 for awrt 0.789 (accept $s = 0.79301\ldots$ = awrt 0.793)
(e)	M1 for correct substitution (ft their values and condone missing 3)
	A1 for awrt 0.15
c (ii)	1st B1 for median increases with a suitable reason to support this (must mention the 3.25)
	2nd B1 for mean increases with a suitable reason to support this (Recalc of $\bar{x} = 3.196\ldots$ is B0)

Q3(9 marks)

Question	Scheme	Marks	AOs
3(a)	$\log_{10} x = \log_{10} a + \log_{10} b^T$	M1	2.1
	$\log_{10} x = \log_{10} a + T\log_{10} b$	M1	1.1b
	$\log_{10} x = \log_{10} a + T\log_{10} b$	A1	1.1b
		(3)	
(b)	$\log b = 0.0348$ or $\log a = 2.0827$	M1	1.1b
	$a = 120.97$ ... awrt 121	A1	1.1b
	$b = 1.0834$ ... awrt 1.08	A1	1.1b
		(3)	
(c)	The data is from 1963 to 2000 so this would be extrapolation and therefore unreliable.	B1	2.4
		(1)	
(d)	$x = 121 \times 1.08^{(1970-1950)} [= 563.975]$	M1	3.4
	$= 564$	A1	1.1b
Alternative method			
	$Y = 0.0348 \times (1970 - 1950) + 2.0827$ (=2.7787) and $x = 10^{2.7787}$	M1	3.4
	$= 601$	A1	1.1b
		(2)	
			(9 marks)

Q4 (10 marks)

Question	Scheme	Marks	AOs
11(a)	(Discrete) Uniform distribution	B1	1.2
		(1)	
(b)	$4 \times \left(\frac{1}{4}\right)^3$	M1	3.4
	$= \frac{1}{16}$	A1	1.1b
		(2)	
(c)	use of P(two the same) = 1– P(3 different) – P(3 same)	M1	3.1b
	P(3 different) = $1 \times \frac{3}{4} \times \frac{1}{2} = \frac{3}{8}$	M1	2.1
	P(two the same) = $1 - \frac{3}{8} - \frac{1}{16} = \frac{9}{16}$	A1	1.1b
		(3)	
(d)	$X \sim \text{Bin}(200, 0.5)$	B1	1.1b
		(1)	
(e)	e.g. All ducks equally likely to be hooked oe	B1	2.4
		(1)	
(f)	$\text{P}(X \geq 110) = 1 - \text{P}(X \leq 109)$	M1	3.1b
	$= 1 - 0.91051797 \ldots$		
	$= 0.08948202 \ldots$ awrt 0.0895	A1	1.1b
		(2)	

Notes

(a)
B1 condone Uniform, but not continuous uniform or rectangular distribution.

(b)
M1 use of p^3 (where $0 < p < 1$)
A1 1/16 oe

(c)
2nd M1 any attempt at P(3 different) e.g. $m \times \frac{1}{4} \times \frac{1}{4} \times \frac{1}{4}$ (where m is an integer)
Alt
e.g. P(getting k, k, not k in any order for 4 possible doubles) = $3 \times \frac{1}{4} \times \frac{1}{4} \times \frac{3}{4} \times 4$
1st M1 $\frac{1}{4} \times \frac{1}{4} \times \frac{3}{4}$ seen or implied
2nd M1 multiplies by 3 or multiplies by 4
A1 9/16 oe

(e)
B1 must be suitable comment in context

(f)
M1 correct method
A1 awrt 0.0895

Question 5 (Total 13 marks)

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	$\frac{27.29-28}{\sigma} = -1.6449$	M1	This mark is given for standardising as part of a method to find σ
	$\sigma = 0.4316$	A1	This mark is given for a correct value of σ
	$P(D > K) = 0.6$ or $P(D < K) = 0.4$	B1	This mark is given for finding two probablilties
	$\frac{k-28}{\sigma} = \frac{k-28}{0.4316} = 0.2533$	M1	This mark is given for using a normal model to find the probability
	$k = 28.11$	A1	This mark is given for a correct value for k
(b)	$Y \sim B(200, 0.55)$ so $W \sim N(110, 49.5)$	B1	This mark is given for setting up the normal distribution approximation of the binomial
	$P(Y < 100) \approx P(W < 99.5) = P\left(Z < \frac{99.5-110}{\sqrt{49.5}}\right)$	M1	This mark is given for using the normal model with a continuity correction
	$= 0.0678$	A1	This mark is given for finding a correct value of the probability
(c)	$H_0 : \mu = 28$ $H_1 : \mu < 28$	B1	This mark is given for both hypotheses in terms of μ found correctly
	$\overline{D} \sim N\left(28, \frac{0.7^2}{20}\right)$	M1	This mark is given for a method to set up the normal distribution
	$P(\overline{D} < 27.72) = 0.0368$	A1	This mark is given for using the model to find a correct p-value
	$p = 0.0368 < 0.05$, so reject H_0	M1	This mark is given for a correct comparison and non-contextual conclusion

	There is sufficient evidence to support Hannah's belief that the mean amount of liquid put in each bottle is less than 28 ml	A1	This mark is given for a correct conclusion in context stated