(a) (i) median = 104 grams A1

Note: Accept 105.

(ii) 30^{th} percentile = 90 grams A1

(b) 80 – 49 (M1)
= 31 A1

Note: Accept answers 30 to 32.

[4]

equation of journey of ship S_1

$$\boldsymbol{r}_1 = t\begin{pmatrix}10\\20\end{pmatrix}$$

equation of journey of speedboat S_2, setting off k minutes later

$$\boldsymbol{r}_2 = \begin{pmatrix}70\\30\end{pmatrix} + (t-k)\begin{pmatrix}-60\\30\end{pmatrix}$$ M1A1A1

Note: Award M1 for perpendicular direction, A1 for speed, A1 for change in parameter (e.g. by using $t-k$ or T, k being the time difference between the departure of the ships).

solve $t\begin{pmatrix}10\\20\end{pmatrix} = \begin{pmatrix}70\\30\end{pmatrix} + (t-k)\begin{pmatrix}-60\\30\end{pmatrix}$ (M1)

Note: *M* mark is for equating their two expressions.

$10t = 70 - 60t + 60k$
$20t = 30 + 30t - 30k$ M1

Note: *M* mark is for obtaining two equations involving two different parameters.

$7t - 6k = 7$
$-t + 3k = 3$

$k = \frac{28}{15}$ A1

latest time is 11:52 A1

for finding two of the following three vectors (or their negatives)

$\overrightarrow{AB} = \begin{pmatrix} 0 \\ 2 \\ -1 \end{pmatrix}, \overrightarrow{AC} = \begin{pmatrix} -2 \\ 2 \\ -2 \end{pmatrix}, \overrightarrow{BC} = \begin{pmatrix} -2 \\ 0 \\ -1 \end{pmatrix}$ (A1)(A1)

and calculating

EITHER

$\overrightarrow{AB} \times \overrightarrow{AC} = \begin{vmatrix} \boldsymbol{i} & \boldsymbol{j} & \boldsymbol{k} \\ 0 & 2 & -1 \\ -2 & 2 & -2 \end{vmatrix} = \begin{pmatrix} -2 \\ 2 \\ 4 \end{pmatrix}$ M1A1

area $\Delta ABC = \frac{1}{2}\left|\overrightarrow{AB} \times \overrightarrow{AC}\right|$ M1

OR

$\overrightarrow{BA} \times \overrightarrow{BC} = \begin{vmatrix} \boldsymbol{i} & \boldsymbol{j} & \boldsymbol{k} \\ 0 & -2 & 1 \\ -2 & 0 & -1 \end{vmatrix} = \begin{pmatrix} 2 \\ -2 \\ -4 \end{pmatrix}$ M1A1

area $\Delta ABC = \frac{1}{2}\left|\overrightarrow{BA} \times \overrightarrow{BC}\right|$ M1

OR

$\overrightarrow{CA} \times \overrightarrow{CB} = \begin{vmatrix} \boldsymbol{i} & \boldsymbol{j} & \boldsymbol{k} \\ 2 & -2 & 2 \\ 2 & 0 & 1 \end{vmatrix} = \begin{pmatrix} -2 \\ 2 \\ 4 \end{pmatrix}$ M1A1

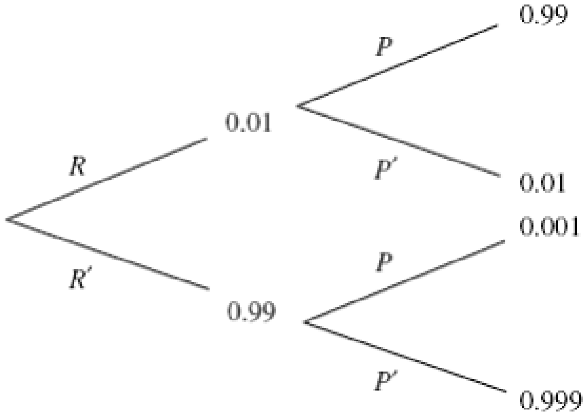
area $\Delta ABC = \frac{1}{2}\left|\overrightarrow{CA} \times \overrightarrow{CB}\right|$ M1

THEN

area $\Delta ABC = \frac{\sqrt{24}}{2}$ A1

$= \sqrt{6}$ AG N0

R is 'rabbit with the disease'
P is 'rabbit testing positive for the disease'



(a) $P(P) = P(R \cap P) + P(R' \cap P)$

$= 0.01 \times 0.99 + 0.99 \times 0.001$ M1

$= 0.01089$ $(= 0.0109)$ A1

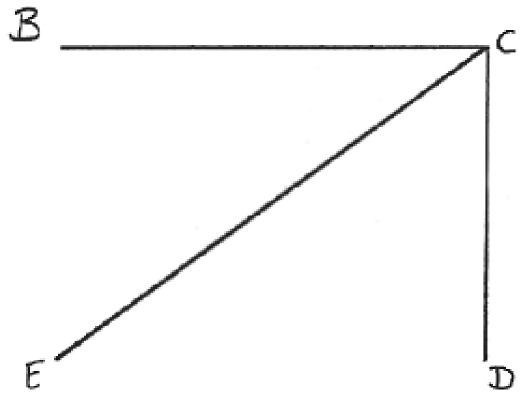
Note: Award M1 for a correct tree diagram with correct probability values shown.

(b) $P(R'|P) = \dfrac{0.001 \times 0.99}{0.001 \times 0.99 + 0.01 \times 0.99} \left(= \dfrac{0.00099}{0.01089}\right)$ M1A1

$\dfrac{0.00099}{0.01089} < \dfrac{0.001}{0.01} = 10\ \%$ (or other valid argument) R1

[5]

(a) using any method, the minimum spanning tree is (M1)



A2

Note: Accept MST = {BC, EC, DC} or {BC, EB, DC}

Note: In graph, line CE may be replaced by BE.

lower bound = weight of minimum spanning tree + 2 smallest weights connected to A (M1)

$= 11 + 13 + 14 + 10 + 15 = 63$ A1

(b) weight of ADCBEA $= 10 + 14 + 11 + 13 + 15 = 63$ A1

(c) the conclusion is that ADCBEA gives a solution to the travelling salesman problem A1

[7]

(a)	$P(x = 0) = 0.607$	A1
(b)	**EITHER**	
	Using $X \sim Po(3)$	(M1)
	OR	
	Using $(0.6065...)^6$	(M1)
	THEN	
	$P(X = 0) = 0.0498$	A1
(c)	$X \sim Po(0.5t)$	(M1)
	$P(x \geq 1) = 1 - P(x = 0)$	(M1)
	$P(x = 0) < 0.01$	A1
	$e^{-0.5t} < 0.01$	A1
	$-0.5t < \ln(0.01)$	(M1)
	$t > 9.21$ months	
	therefore 10 months	A1N4

Note: Full marks can be awarded for answers obtained directly from GDC if a systematic method is used and clearly shown.

(d)	(i)	P(1 or 2 accidents) = 0.37908…	A1
		$E(B) = 1000 \times 0.60653... + 500 \times 0.37908...$	M1A1
		= \$796 (accept \$797 or \$796.07)	A1
	(ii)	P(2000) = P(1000, 1000, 0) + P(1000, 0, 1000) + P(0, 1000, 1000) + P(1000, 500, 500) + P(500, 1000, 500) + P(500, 500, 1000)	(M1)(A1)

Note: Award M1 for noting that 2000 can be written both as $2 \times 1000 + 1 \times 0$ and $2 \times 500 + 1 \times 1000$.

$= 3(0.6065...)^2(0.01437...) + 3(0.3790...)^2(0.6065...)$	M1A1
= 0.277 (accept 0.278)	A1

[18]