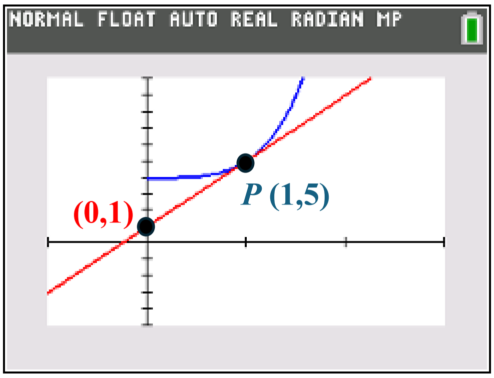
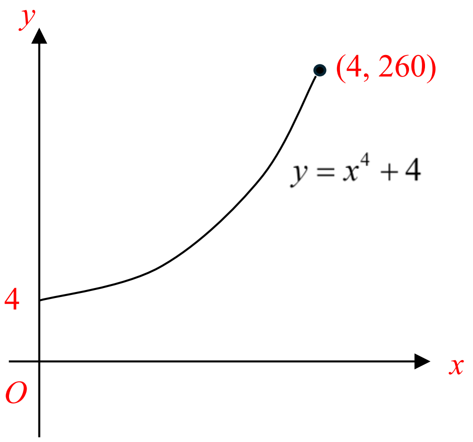
Qn	Solution
1(a) **[3]**	**Method 1** $y=\mathrm{f}(x)\xrightarrow{x\to x-1}y=\mathrm{f}(x-1)\xrightarrow{x\to 2x}y=\mathrm{f}(2x-1)$ $(a,\ b)$ $\quad$ $(a+1,\ b)$ $\quad$ $\left(\frac{1}{2}(a+1),\ b\right)$ **Method 2** $y=\mathrm{f}(x)\xrightarrow{x\to 2x}y=\mathrm{f}(2x)\xrightarrow{x\to 2\left(x-\frac{1}{2}\right)}y=\mathrm{f}(2x-1)$ $(a,\ b)$ $\quad$ $\left(\frac{1}{2}a,\ b\right)$ $\quad$ $\left(\frac{1}{2}a+\frac{1}{2},\ b\right)$ P becomes $P'\left(\frac{1}{2}p+\frac{1}{2},\ 0\right)$, Q becomes $Q'\left(\frac{1}{2}q+\frac{1}{2},\ 0\right)$ and R becomes $R'\left(\frac{1}{2},\ r\right)$.
1(b) **(i)** **[1]**	The required area $=-I$ or $\lvert I\rvert$. Transformation: Reflection of the graph about the x-axis. The area in question remains the same.
1(b) **(ii)** **[1]**	The required area $=-\frac{1}{2}I$ or $\frac{1}{2}\lvert I\rvert$. Transformations: Scaling of the graph parallel to the y-axis by scale factor $\frac{1}{2}$. The area in question is halved. Translation of the graph in the negative x-direction by 3 units. The area in question remains the same.
1(c) **[1]**	$\int_0^q \mathrm{f}'(x)\,\mathrm{d}x=\left[\mathrm{f}(x)\right]_0^q=\mathrm{f}(q)-\mathrm{f}(0)$ $=0-r$ $=-r$

2(i) **[3]**	$x=\sqrt{t}, \quad y=t^2+4$ $\frac{\mathrm{d}x}{\mathrm{d}t}=\frac{1}{2\sqrt{t}}, \quad \frac{\mathrm{d}y}{\mathrm{d}t}=2t$ $\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{2t}{\frac{1}{2\sqrt{t}}}=4t^{\frac{3}{2}}$ Note: $t=p$ The eqn of tangent to C at $P\left(\sqrt{p}, p^2+4\right)$: $y-\left(p^2+4\right)=4p^{\frac{3}{2}}\left(x-\sqrt{p}\right)$ $y=4p^{\frac{3}{2}}x-3p^2+4$
2(ii) **[2]**	The eqn of tangent of C at P passes through $(0,1)$ At $(0,1)$: $1=4p^{\frac{3}{2}}(0)-3p^2+4$ $3p^2=3$ $p=1$ (reject -1 $\because$ $p\geq 0$) When $p=1$ $x=1, y=5$ $P(1,5)$ 

<table>
<tr><td>2 (iii)
[2]</td><td>
</td></tr>
<tr><td>3(a)
[4]</td><td>

$z + 2z^* + w = 6 + \mathrm{i}$ ... (1)

$\mathrm{i}z - w = 3 \quad \Rightarrow \quad w = \mathrm{i}z - 3$ ... (2)

Substitute (2) into (1):

$z + 2z^* + \mathrm{i}z - 3 = 6 + \mathrm{i}$

$(1+\mathrm{i})z + 2z^* = 9 + \mathrm{i}$

Let $z = a + b\mathrm{i}$. Then, $z^* = a - b\mathrm{i}$.

$(1+\mathrm{i})(a+b\mathrm{i}) + 2(a - b\mathrm{i}) = 9 + \mathrm{i}$

$a + b\mathrm{i} + a\mathrm{i} - b + 2a - 2b\mathrm{i} = 9 + \mathrm{i}$

$(3a - b) + (a - b)\mathrm{i} = 9 + \mathrm{i}$

Comparing corresponding real and imaginary parts:

$3a - b = 9$

$a - b = 1$

Solving the equations simultaneously:

$a = 4$ and $b = 3$

$\Rightarrow z = 4 + 3\mathrm{i}$

From (2),

$w = \mathrm{i}(4 + 3\mathrm{i}) - 3 = -6 + 4\mathrm{i}$

$\therefore z = 4 + 3\mathrm{i},\ w = -6 + 4\mathrm{i}$.

</td></tr>
<tr><td>3(b)
[4]</td><td>

<u>Method 1: Use conjugate root and factorisation</u>

All the coefficients of f(x) are real. Thus, $2 - \mathrm{i}$ is also a root of $\mathrm{f}(x) = 0$.

A quadratic factor of $\mathrm{f}(x)$ is:

$$\begin{aligned}[x - (2+\mathrm{i})][x - (2 - \mathrm{i})] &= [(x-2) - \mathrm{i}][(x-2) + \mathrm{i}] \\ &= (x-2)^2 - \mathrm{i}^2 \\ &= x^2 - 4x + 5\end{aligned}$$

</td></tr>
</table>

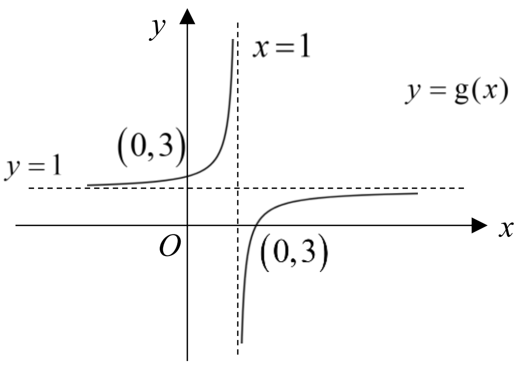
	$\mathrm{f}(x)=x^3+mx^2+nx+5=(x+c)(x^2-4x+5)$, where c is a real constant. Comparing constant term: $5c=5 \quad \Rightarrow \quad c=1$ $\therefore \mathrm{f}(x)=0 \quad \Rightarrow \quad x=-1$ or $2\pm\mathrm{i}$ $\therefore$ The coordinates of P is $(-1,\ 0)$. **Method 2: Apply Factor Theorem by substituting the given root directly.** $2+\mathrm{i}$ is a root of $\mathrm{f}(x)=0$. $\mathrm{f}(2+\mathrm{i})=0$ $(2+\mathrm{i})^3+m(2+\mathrm{i})^2+n(2+\mathrm{i})+5=0$ $2+11\mathrm{i}+m(3+4\mathrm{i})+2n+5+n\mathrm{i}=0$ $7+3m+2n+(11+4m+n)\mathrm{i}=0$ Comparing corresponding real and imaginary parts: $7+3m+2n=0 \quad \Rightarrow \quad 3m+2n=-7$ $11+4m+n=0 \quad \Rightarrow \quad 4m+n=-11$ Solving the equations simultaneously: $m=-3$ and $n=1$ $\Rightarrow \mathrm{f}(x)=x^3-3x^2+x+5$ Using GC to solve $\mathrm{f}(x)=0$, $x=-1$ or $2\pm\mathrm{i}$. --- ***Alternatively (instead of GC),*** All the coefficients of f(x) are real. Thus, $2-\mathrm{i}$ is also a root of $\mathrm{f}(x)=0$. A quadratic factor of $\mathrm{f}(x)$ is: $[x-(2+\mathrm{i})][x-(2-\mathrm{i})]=[(x-2)-\mathrm{i}][(x-2)+\mathrm{i}]$ $=(x-2)^2-\mathrm{i}^2$ $=x^2-4x+5$ $\Rightarrow \mathrm{f}(x)=x^3-3x^2+x+5=(x+1)(x^2-4x+5)$. $\therefore \mathrm{f}(x)=0 \quad \Rightarrow \quad x=-1$ or $2\pm\mathrm{i}$

<table>
<tr><td>4(a)
[1]</td><td colspan="2">Given that $T_{n+2} = T_{n+1} + T_n$, and $T_1 = 3,\ T_2 = 1$

Sub $n = 1,\ T_3 = T_2 + T_1 = 1 + 3 = 4$

Sub $n = 2,\ T_4 = T_3 + T_2 = 4 + 1 = 5$</td></tr>
<tr><td>4(b)
[2]</td><td colspan="2">Given $r_n = \dfrac{T_{n+1}}{T_n}$
$\Rightarrow r_{n+1} = \dfrac{T_{n+1+1}}{T_{n+1}} = \dfrac{T_{n+2}}{T_{n+1}}$
$r_{n+1} = \dfrac{T_{n+1} + T_n}{T_{n+1}}$
$r_{n+1} = 1 + \dfrac{T_n}{T_{n+1}}$
$r_{n+1} = 1 + \dfrac{1}{r_n}$ (shown)</td></tr>
<tr><td>4(c)
[3]</td><td colspan="2">Since r_n is convergent to L, it implies that as $n \to \infty$, $r_n \to L$ and $r_{n+1} \to L$.
Hence,
$r_{n+1} = 1 + \dfrac{1}{r_n} \Rightarrow L = 1 + \dfrac{1}{L}$ as $n \to \infty$

$L^2 - L - 1 = 0$
$L = \dfrac{-(-1) \pm \sqrt{(-1)^2 - 4(1)(-1)}}{2(1)}$
$L = \dfrac{1 \pm \sqrt{5}}{2}$
$L = \dfrac{1 + \sqrt{5}}{2}$ (rej $\dfrac{1 - \sqrt{5}}{2}$ as $r_n > 0$)</td></tr>
<tr><td>4(d)
[2]</td><td><u>Method 1</u>
$\sum_{k=1}^{n} u_k > 930$
$\frac{n}{2}[2(5) + (n-1)(2)] > 930$
$n(n+4) > 930$
From GC
<table><tr><td>n</td><td>$n(n+4)$</td></tr><tr><td>28</td><td>896</td></tr><tr><td>29</td><td>957</td></tr></table>
Least $n = 29$</td><td><u>Method 2</u>
$\sum_{k=1}^{n} u_k > 930$
$\sum_{k=1}^{n} (5 + 2(k-1)) > 930$
From GC
<table><tr><td>n</td><td>$\sum_{k=1}^{n} (5 + 2(k-1))$</td></tr><tr><td>28</td><td>896</td></tr><tr><td>29</td><td>957</td></tr></table>
Least $n = 29$</td></tr>
</table>

<table>
<tr><td>5(i)
[3]</td><td>
</td></tr>
<tr><td>5(ii)
[1]</td><td>Every horizontal line $y=k$, where $k\in\mathbb{R}$, cuts the graph of $y=\mathrm{g}(x)$ at most once. g is a one-one function.
$\therefore \mathrm{g}^{-1}$ exists.</td></tr>
<tr><td>5(iii)
[3]</td><td>Let $y=\mathrm{g}(x)=\dfrac{x-3}{x-1}$.
$y(x-1)=x-3$
$(y-1)x=y-3$
$x=\dfrac{y-3}{y-1} \quad\Rightarrow\quad \mathrm{g}^{-1}(y)=\dfrac{y-3}{y-1}$
$\therefore \mathrm{g}^{-1}(x)=\dfrac{x-3}{x-1}$
From graph in part (i), $\mathrm{R_g}=(-\infty,\ 1)\cup(1,\ \infty)$
$\therefore \mathrm{D}_{\mathrm{g}^{-1}}=\mathrm{R_g}=(-\infty,\ 1)\cup(1,\ \infty)$</td></tr>
<tr><td>5(iv)
[1]</td><td>For $x\in \mathrm{D_g}$, $\mathrm{g}(x)=\dfrac{x-3}{x-1}$ and $\mathrm{g}^{-1}(x)=\dfrac{x-3}{x-1}$

$\therefore$ $\mathrm{g}(x)=\mathrm{g}^{-1}(x)$ and hence g is self-inverse.</td></tr>
<tr><td>5(v)
[2]</td><td>Since g is self-inverse, $\mathrm{g}^2(x)=\mathrm{g}^{-1}\mathrm{g}(x)=\mathrm{g}\mathrm{g}^{-1}(x)=x$.
$\therefore \mathrm{g}^2(x)=-\mathrm{g}^{-1}(x) \ \Rightarrow x=-\dfrac{x-3}{x-1}$

$x=-\dfrac{x-3}{x-1}$
$x^2-x=-x+3$
$x^2=3$
$x=\pm\sqrt{3}$</td></tr>
</table>

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<tr><td>

6(i)
[3]

</td><td>

Let X be the waiting time to get pastries from the popular bakery of a randomly chosen customer. $X \sim \mathrm{N}\left(\mu,\ \sigma^2\right)$

Given $\mathrm{P}\left(X < 5\right) = \mathrm{P}\left(X > 25\right) = 0.10$.

<u>Method 1</u>

By symmetry, $\mu = \dfrac{5+25}{2} = 15$

$\mathrm{P}\left(X > 25\right) = 0.10$

$\mathrm{P}\left(Z > \dfrac{25-15}{\sigma}\right) = 0.10$

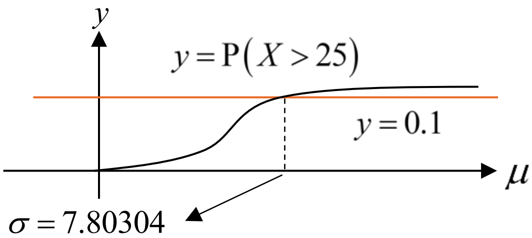
$\dfrac{10}{\sigma} = 1.28155$

$\sigma = 7.80305$

Alternatively,

$\mathrm{P}\left(X > 25\right) = 0.10$

Using GC,



$\sigma = 7.80304$

$\therefore\ \mu = 15,\ \sigma = 8$ (to the nearest minute).

<u>Method 2</u>

$\mathrm{P}\left(X > 25\right) = 0.10$ $\mathrm{P}\left(X < 5\right) = 0.10$

$\mathrm{P}\left(Z > \dfrac{25-\mu}{\sigma}\right) = 0.10$ $\mathrm{P}\left(Z < \dfrac{5-\mu}{\sigma}\right) = 0.10$

$\dfrac{25-\mu}{\sigma} = 1.28155$ $\dfrac{5-\mu}{\sigma} = -1.28155$

$\mu + 1.28155\sigma = 25$ ... (1) $\mu - 1.28155\sigma = 5$ ... (2)

Solving (1) and (2) simultaneously,

$\mu = 15,\ \sigma = 7.80305$.

$\therefore\ \mu = 15,\ \sigma = 8$ (to the nearest minute).

</td></tr>
</table>

6(ii) **[1]**	Consider $X \sim \mathrm{N}\left(15,\ 8^2\right)$. $\mathrm{P}\left(X<0\right)=0.0303$. (or 0.02728 if we use $\sigma=7.80305$) The waiting times cannot be negative but $\mathrm{P}\left(X<0\right)$ is about 3%, which is not insignificant. Thus, the normal distribution is not a suitable model. **Note:** For normal distribution: $\mathrm{P}\left(\mu-3\sigma<X<\mu-3\sigma\right)\approx 0.997$ i.e. 99.7%. Hence, whenever the probability of obtaining unreasonable values of x exceeds 0.003, we can conclude that the normal distribution is not suitable
7(i) **[1]**	The **probability** of obtaining a card of **one colour** depends **solely on the colour** and **not any other factors**. Or The **probability** of obtaining a card of **one colour** is **exactly the same** as the probability of obtaining another card **of the same colour** in the same deck.
7(ii) **[4]**	<u>**Method 1**</u> $\mathrm{P}\left(G=2\right)=\dfrac{{}^{2}C_{2}\,{}^{10}C_{1}}{{}^{12}C_{3}}=\dfrac{1}{22}$ (shown) $\mathrm{P}\left(G=1\right)=\dfrac{{}^{2}C_{1}\,{}^{10}C_{2}}{{}^{12}C_{3}}=\dfrac{9}{22}$ $\mathrm{P}\left(G=0\right)=\dfrac{{}^{10}C_{3}}{{}^{12}C_{3}}=\dfrac{12}{22}=\dfrac{6}{11}$ --- ***Alternatively,*** $\mathrm{P}\left(G=0\right)=1-\dfrac{1}{22}-\dfrac{9}{22}=\dfrac{6}{11}$ --- <u>**Method 2**</u> $\mathrm{P}\left(G=2\right)=\left(\dfrac{2}{12}\right)\left(\dfrac{1}{11}\right)\left(\dfrac{10}{10}\right)\times\dfrac{3!}{2!}=\dfrac{1}{22}$ (shown) $\mathrm{P}\left(G=1\right)=\left(\dfrac{2}{12}\right)\left(\dfrac{10}{11}\right)\left(\dfrac{9}{10}\right)\times\dfrac{3!}{2!}=\dfrac{1}{22}$ $\mathrm{P}\left(G=0\right)=\left(\dfrac{10}{12}\right)\left(\dfrac{9}{11}\right)\left(\dfrac{8}{10}\right)=\dfrac{6}{11}$ --- ***Alternatively,*** $\mathrm{P}\left(G=0\right)=1-\dfrac{1}{22}-\dfrac{9}{22}=\dfrac{6}{11}$

<table>
<tr><td>7(iii)
[2]</td><td>

G (4 pt)	S (1 pt)	Score	Probability
0	3	3	$\frac{12}{22}=\frac{6}{11}$
1	2	6	$\frac{9}{22}$
2	1	9	$\frac{1}{22}$

Probability Distribution of X

x	3	6	9
$\mathrm{P}(X=x)$	$\frac{12}{22}=\frac{6}{11}$	$\frac{9}{22}$	$\frac{1}{22}$

</td></tr>
<tr><td>7(iv)
[1]</td><td>

$\mathrm{E}(\text{winnings})=10(3)\times\frac{6}{11}+10(6)\times\frac{9}{22}+10(9)\times\frac{1}{22}=45$

$\therefore$ The expected winnings is \$45.

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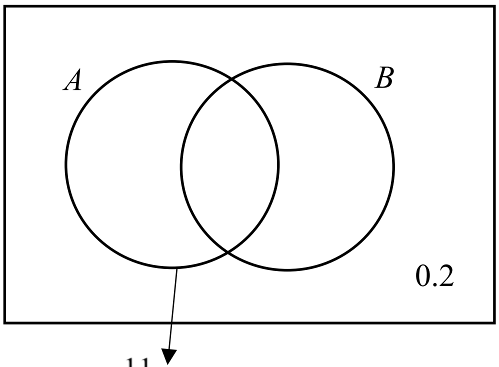

$\frac{11}{20}=0.55$

</td></tr>
<tr><td>8(i)
(a)
[3]</td><td>

$\mathrm{P}(B|A)=\frac{\mathrm{P}(A\cap B)}{\mathrm{P}(A)}=\frac{4}{11}$

$\mathrm{P}(A\cap B)=\frac{4}{11}\mathrm{P}(A)$

$\mathrm{P}(A\cap B)=\frac{4}{11}\left(\frac{11}{20}\right)=0.2$

$\mathrm{P}(A\cup B)=\mathrm{P}(A)+\mathrm{P}(B)-\mathrm{P}(A\cap B)$

$0.8=0.55+\mathrm{P}(B)-0.2$

$\mathrm{P}(B)=0.45$

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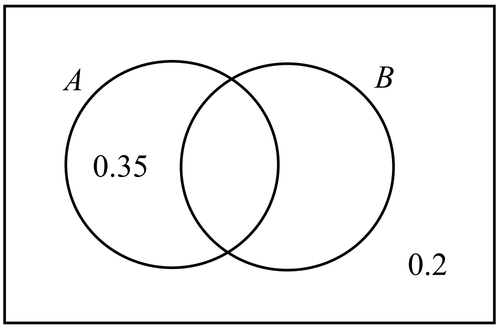
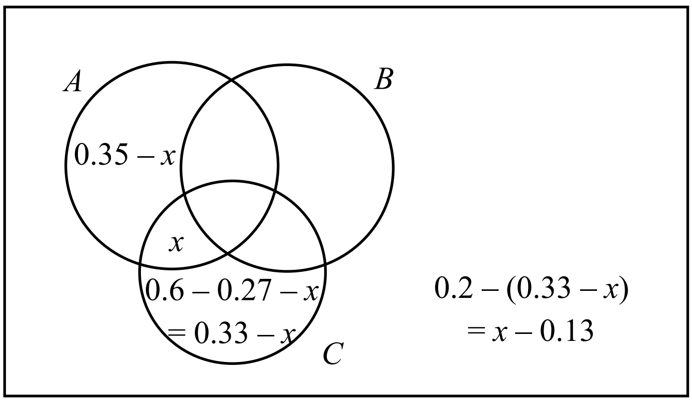
</table>

8(i) (b) [1]	**Method 1** $\mathrm{P}(A\cap B')=\mathrm{P}(A\cup B)-\mathrm{P}(B)=0.8-0.45=0.35$ **Method 2** $\mathrm{P}(A\cap B')=\mathrm{P}(A)-\mathrm{P}(A\cap B)=0.55-0.2=0.35$
8(ii) [1]	From part **(i)(b)**, $\mathrm{P}(A\cap B')=0.35\neq 0.$ $\therefore$ A and B' are not mutually exclusive.
8(iii) [1]	Since B and C are independent, $\mathrm{P}(B\cap C)=\mathrm{P}(B)\mathrm{P}(C)=(0.45)(0.6)=0.27$
8(iv) [2]	From our work so far, the relevant regions are shown below.  **Method 1** Let $\mathrm{P}(A\cap B'\cap C)=x$. 

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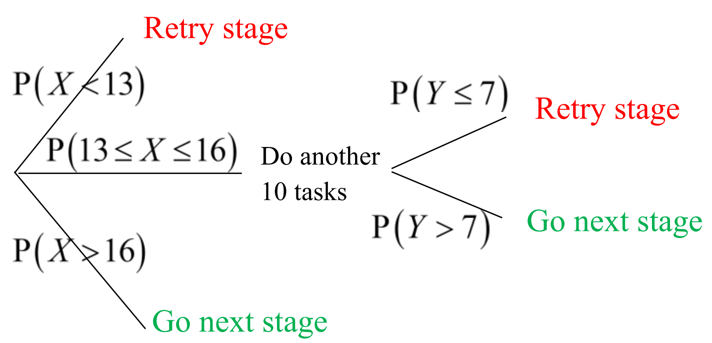
<td>
Probability cannot be negative i.e.
$0.35 - x \geq 0 \quad \Rightarrow \quad x \leq 0.35$

$x \geq 0$
$0.33 - x \geq 0 \quad \Rightarrow \quad x \leq 0.33$
$x - 0.13 \geq 0 \quad \Rightarrow \quad x \geq 0.13$

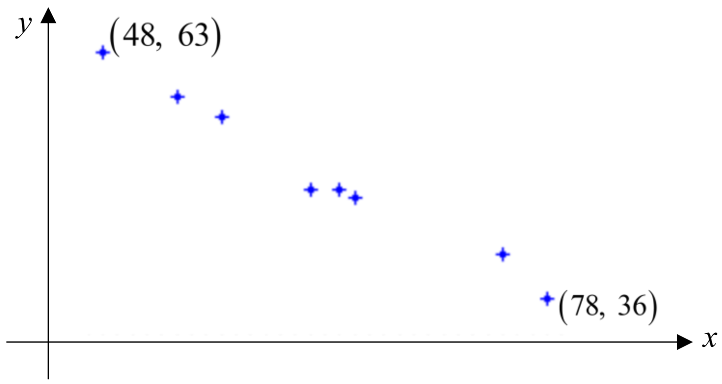
$\therefore 0.13 \leq \mathrm{P}(A \cap B' \cap C) \leq 0.33$.
</td>
</tr>
<tr>
<td>9(i)
[2]</td>
<td>
The two assumptions:
1. For each task, whether it is completed or not, is independent of that of the other tasks.
2. The probability that the player completes a task is the same for each task.
</td>
</tr>
<tr>
<td>9(ii)
[2]</td>
<td>
$X \sim \mathrm{B}(20,\ 0.7)$
The required probability $= \mathrm{P}(13 \leq X \leq 16)$
$= \mathrm{P}(X \leq 16) - \mathrm{P}(X \leq 12)$
$= 0.66518$
$= 0.665$ (3 s.f.)
</td>
</tr>
<tr>
<td>9(iii)
(a)
[3]</td>
<td>
$Y \sim \mathrm{B}(10,\ 0.8)$



P(go to the next stage)
$= \mathrm{P}(X > 16) + \mathrm{P}(13 \leq X \leq 16)\mathrm{P}(Y > 7)$
$= 1 - \mathrm{P}(X \leq 16) + 0.66518[1 - \mathrm{P}(Y \leq 7)]$
$= 0.55795$
$= 0.558$ (3 s.f.)
</td>
</tr>
</table>

9(iii) (b) [2]	The required probability $= \mathrm{P}\left(X = 15 \mid \text{don't progress to next stage}\right)$ $= \dfrac{\mathrm{P}\left(X = 15 \text{ and don't progress to next stage}\right)}{\mathrm{P}\left(\text{don't progress to next stage}\right)}$ $= \dfrac{\mathrm{P}\left(X = 15 \text{ and retry the second stage}\right)}{\mathrm{P}\left(\text{don't progress to next stage}\right)}$ $= \dfrac{\mathrm{P}\left(X = 15\right)\mathrm{P}\left(Y \le 7\right)}{\mathrm{P}\left(\text{don't progress to next stage}\right)}$ $= \dfrac{0.17886 \times 0.32220}{1 - 0.52209}$ $= 0.13037$ $= 0.130$ (3 s.f.)
10	Let X and Y be the mass of a randomly chosen apple and pear respectively. $X \sim \mathrm{N}\left(0.2,\ 0.05^2\right)$, $Y \sim \mathrm{N}\left(0.3,\ 0.08^2\right)$
10(i) (a) [1]	The required probability $= \mathrm{P}\left(X > 0.25\right)\mathrm{P}\left(Y < 0.25\right)$ $= \left(0.15866\right)\left(0.26599\right)$ $= 0.042188$ $= 0.0422$ (3 s.f.)
10(i) (b) [4]	The required probability $= \mathrm{P}\left(\lvert X - Y \rvert \le 0.075\right)$ $= \mathrm{P}\left(-0.075 \le X - Y \le 0.075\right)$ $\mathrm{E}\left(X - Y\right) = 0.2 - 0.3 = -0.1$ $\mathrm{Var}\left(X - Y\right) = 0.05^2 + 0.08^2 = 0.0089$ $X - Y \sim \mathrm{N}\left(-0.1,\ 0.0089\right)$ The required probability $= 0.36371 = 0.364$ (3 s.f.)
10(ii) [4]	The required probability $= \mathrm{P}\left[5\left(X_1 + X_2 + \ldots + X_{10}\right) + 7\left(Y_1 + Y_2 + \ldots + Y_5\right) > 22\right]$ $= \mathrm{P}\left[C > 22\right]$ $\mathrm{E}\left(C\right) = 5\left[10\left(0.2\right)\right] + 7\left[5\left(0.3\right)\right] = 20.5$ $\mathrm{Var}\left(C\right) = 5^2\left[10\left(0.05^2\right)\right] + 7^2\left[5\left(0.08^2\right)\right] = 2.193$ $C \sim \mathrm{N}\left(20.5,\ 2.193\right)$ The required probability $= 0.15555 = 0.156$ (3 s.f.)

11(i)
[1]



11(ii)
[2]

Using GC, $r = -0.991$ (3 s.f.).

The **value of *r* is close to -1.** Thus, a **strong negative linear correlation** between the resting heart rate (x) and VO_2 max (y) is indicated.

11(iii)
[3]

The regression line of y on x:

$y = -0.85860x + 103.39$

$y = -0.859x + 103$ (3 s.f.)

When $x = 60$,

$y = -0.85860(60) + 103.39 = 51.874$

$\therefore$ The VO_2 max = 52 (to the nearest integer).

$x = 60$ is within the given data range of x $(48 \le x \le 78)$ and the value of $|r|$ is close to 1. Thus, the estimate is reliable.

11(iv)
[1]

When $x = 125$, $y = -3.935$. The predicted VO2 max is negative, which is not reasonable. Moreover, the resting heart rate of 125 is not reasonable for a typical person. Thus, extrapolation is not advisable.

11(v)
[3]

The value of r remains the same. $r = -0.991$ (3 s.f.)

Let the adjusted resting heart rate be w.

$w = x + v \quad \Rightarrow \quad x = w - v$

$y = -0.85860(w - v) + 103.39$

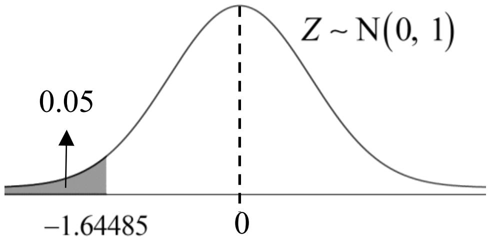
$y = -0.85860w + 0.85860v + 103.39$

$y = -0.859w + 0.859v + 103$ (3 s.f.)

$\therefore$ The required gradient $= -0.859$ (3 s.f.) and

the required y-intercept $= 0.859v + 103$ (3 s.f.).

12(i) **[2]**	Unbiased estimate of population mean, $\bar{x}=\frac{\sum(x-200)}{50}+200=\frac{2159.62}{50}+200=243.1924$ Unbiased estimate of population variance, $s^2=\frac{1}{50-1}\left[\sum(x-200)^2-\frac{\left(\sum(x-200)\right)^2}{50}\right]$ $=\frac{1}{49}\left[112081.09-\frac{(2159.62)^2}{60}\right]$ $=383.71$ $=384$ (3 s.f.)
12(ii) **[5]**	Let X be the reaction time, in milliseconds, of a randomly chosen student, and μ be **the population mean** reaction time of the students at Supernova School. $\mathrm{H}_0:\mu=250$ $\mathrm{H}_1:\mu<250$ Under H_0, since ***n* = 50 is large**, by **Central Limit Theorem**, $\bar{X}\sim \mathrm{N}\left(250,\ \frac{383.71}{50}\right)$ approximately. Use z-test at $\alpha=0.01$. From GC, p-value = 0.0069972 = 0.00700 (3 s.f.). Since $p\text{-value}=0.00700<0.01$, we reject H_0. There is sufficient evidence at 1% level of significance that the mean reaction time is reduced from 250 milliseconds.
12(iii) **[1]**	The sample size of 10 may not be sufficiently large for Central Limit Theorem to apply. $\bar{X}$ may not follow a normal distribution closely enough. Hence, the test in part **(ii)** may not be appropriate.
12(iv) **[4]**	Let Y be the reaction time, in milliseconds, of a randomly chosen student at Galaxy School. <u>**Method 1**</u> $\mathrm{H}_0:\mu=\mu_0$ $\mathrm{H}_1:\mu<\mu_0$ Under H_0, $\bar{Y}\sim \mathrm{N}\left(\mu_0,\ \frac{153}{40}\right)$. Test statistic, $Z=\frac{\bar{Y}-\mu_0}{\sqrt{\frac{153}{40}}}\sim \mathrm{N}(0,\ 1)$. -----

	Corresponding test statistic value: $z = \dfrac{241-\mu_0}{\sqrt{\dfrac{153}{40}}}$ Critical value: -1.64485 Rejection region: $z \le -1.64485$  ------ Conclusion of test: The reflex training programme was **not successful** i.e. H_0 is **not rejected** (test statistic value **does not lie in** critical region). $\Rightarrow \dfrac{241-\mu_0}{\sqrt{\dfrac{153}{40}}} > -1.64485$ $\mu_0 < 244.22$ $\mu_0 < 244$ (3 s.f.) The test is on finding out if the mean reaction time is reduced. $\therefore \mu_0 < 244$ (3 s.f.).