# Edexcel GCE
# Core Mathematics C4
# Gold Level G3
# (Mark Scheme)


**Mr.S.V.Swarnaraja (Marking Examiner, Team Leader & Author)**
**www.swanash.com, Mobile: +94777304755 , email: swa@swanash.com**

| Question Number | Scheme | | Marks |
| --- | --- | --- | --- |
| | ** represents a constant | | |
| **1.** (a) | $f(x) = (3+2x)^{-3} = \underline{(3)^{-3}}\left(1+\frac{2x}{3}\right)^{-3} = \underline{\frac{1}{27}}\left(1+\frac{2x}{3}\right)^{-3}$ | Takes 3 outside the bracket to give any of $(3)^{-3}$ or $\frac{1}{27}$. **See note below.** | B1 |
| | $= \frac{1}{27}\left\{\underline{1+(-3)(**x);+\frac{(-3)(-4)}{2!}(**x)^2+\frac{(-3)(-4)(-5)}{3!}(**x)^3+...}\right\}$ | Expands $(1+**x)^{-3}$ to give a simplified or an un-simplified $1+(-3)(**x)$; | M1; |
| | **with** $** \neq 1$ | A correct simplified or an un-simplified $\{\underline{..........}\}$ expansion with candidate's followed thro' $(**x)$ | A1 $\sqrt{}$ |
| | $= \frac{1}{27}\left\{\underline{1+(-3)(\tfrac{2x}{3})+\frac{(-3)(-4)}{2!}(\tfrac{2x}{3})^2+\frac{(-3)(-4)(-5)}{3!}(\tfrac{2x}{3})^3+...}\right\}$ | | |
| | $= \frac{1}{27}\left\{1-2x+\frac{8x^2}{3}-\frac{80}{27}x^3+...\right\}$ | | |
| | $= \frac{1}{27}-\frac{2x}{27};+\frac{8x^2}{81}-\frac{80x^3}{729}+...$ | Anything that cancels to $\frac{1}{27}-\frac{2x}{27}$; Simplified $\frac{8x^2}{81}-\frac{80x^3}{729}$ | A1; A1 |
| | | | **[5]** |
| | | | **5 marks** |

| | | |
|---|---|---|
| **2.** | $\frac{du}{dx} = -\sin x$ | B1 |
| | $\int \sin x\, e^{\cos x+1} dx = -\int e^u du$ | M1 A1 |
| | $= -e^u$ ft sign error | A1ft |
| | $= -e^{\cos x+1}$ | |
| | $\left[-e^{\cos x+1}\right]_0^{\frac{\pi}{2}} = -e^1 - \left(-e^2\right)$ or equivalent with $u$ | M1 |
| | $= e(e-1)$ ∗ cso | A1 **(6)** |
| | | **[6]** |

| Question Number | Scheme | Marks |
|---|---|---|
| **3.** | | |
| | $\frac{9x^2+20x-10}{(x+2)(3x-1)} \equiv A + \frac{B}{(x+2)} + \frac{C}{(3x-1)}$ | |
| | $A = 3$ their constant term $= 3$ | B1 |
| | $9x^2+20x-10 \equiv A(x+2)(3x-1) + B(3x-1) + C(x+2)$ Forming a correct identity. | B1 |
| | Either $x^2: \quad 9 = 3A, \quad x: \ 20 = 5A + 3B + C$<br>constant: $\ -10 = -2A - B + 2C$<br>or<br>$x = -2 \Rightarrow 36 - 40 - 10 = -7B \Rightarrow -14 = -7B \Rightarrow B = 2$ Attempts to find the value of either one of their $B$ or their $C$ from their identity. | M1 |
| | $x = \frac{1}{3} \Rightarrow 1 + \frac{20}{3} - 10 = \frac{7}{3}C \Rightarrow -\frac{7}{3} = \frac{7}{3}C \Rightarrow C = -1$ Correct values for their $B$ and their $C$, which are found using a correct identity. | A1 |
| | | **[4]** |

| Question Number | Scheme | | Marks |
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| **4** (a) | $\mathbf{d}_1 = -2\mathbf{i} + \mathbf{j} - 4\mathbf{k}$ , $\mathbf{d}_2 = q\mathbf{i} + 2\mathbf{j} + 2\mathbf{k}$ | | |
| | As $\left\{\mathbf{d}_1 \bullet \mathbf{d}_2 = \begin{pmatrix} -2 \\ 1 \\ -4 \end{pmatrix} \bullet \begin{pmatrix} q \\ 2 \\ 2 \end{pmatrix}\right\} = \underline{(-2\times q) + (1\times 2) + (-4\times 2)}$ | Apply dot product calculation between two direction vectors, ie. $\underline{(-2\times q) + (1\times 2) + (-4\times 2)}$ | M1 |
| | $\mathbf{d}_1 \bullet \mathbf{d}_2 = 0 \Rightarrow -2q + 2 - 8 = 0$<br>$-2q = 6 \Rightarrow \underline{q = -3}$ AG | Sets $\mathbf{d}_1 \bullet \mathbf{d}_2 = 0$ and solves to find $\underline{q = -3}$ | A1 **cso** |
| | | | (2) |
| (b) | Lines meet where: | | |
| | $\begin{pmatrix} 11 \\ 2 \\ 17 \end{pmatrix} + \lambda \begin{pmatrix} -2 \\ 1 \\ -4 \end{pmatrix} = \begin{pmatrix} -5 \\ 11 \\ p \end{pmatrix} + \mu \begin{pmatrix} q \\ 2 \\ 2 \end{pmatrix}$ | | |
| | First two of<br>$\mathbf{i}$: $11 - 2\lambda = -5 + q\mu$ (1)<br>$\mathbf{j}$: $2 + \lambda = 11 + 2\mu$ (2)<br>$\mathbf{k}$: $17 - 4\lambda = p + 2\mu$ (3) | Need to see equations (1) and (2). Condone one slip. (Note that $q = -3$.) | M1 |
| | **(1)** + 2**(2)** gives: $15 = 17 + \mu \Rightarrow \mu = -2$ | Attempts to solve (1) and (2) to find one of either $\lambda$ or $\mu$ | dM1 |
| | **(2)** gives: $2 + \lambda = 11 - 4 \Rightarrow \lambda = 5$ | Any one of $\underline{\lambda = 5}$ or $\underline{\mu = -2}$ | A1 |
| | | Both $\underline{\lambda = 5}$ and $\underline{\mu = -2}$ | A1 |
| | **(3)** $\Rightarrow 17 - 4(5) = p + 2(-2)$ | Attempt to substitute their $\lambda$ and $\mu$ into their $\mathbf{k}$ component to give an equation in $p$ alone. | ddM1 |
| | $\Rightarrow p = 17 - 20 + 4 \Rightarrow \underline{p = 1}$ | $\underline{p = 1}$ | A1 **cso** |
| | | | (6) |
| (c) | $\mathbf{r} = \begin{pmatrix} 11 \\ 2 \\ 17 \end{pmatrix} + 5\begin{pmatrix} -2 \\ 1 \\ -4 \end{pmatrix}$ or $\mathbf{r} = \begin{pmatrix} -5 \\ 11 \\ 1 \end{pmatrix} - 2\begin{pmatrix} -3 \\ 2 \\ 2 \end{pmatrix}$ | Substitutes their value of $\lambda$ or $\mu$ into the correct line $l_1$ or $l_2$. | M1 |
| | Intersect at $\mathbf{r} = \underline{\begin{pmatrix} 1 \\ 7 \\ -3 \end{pmatrix}}$ or $\underline{(1, 7, -3)}$ | $\underline{\begin{pmatrix} 1 \\ 7 \\ -3 \end{pmatrix}}$ or $\underline{(1, 7, -3)}$ | A1 |
| | | | (2) |

| Question Number | Scheme | Marks |
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| (d) | Let $\overrightarrow{OX} = \mathbf{i} + 7\mathbf{j} - 3\mathbf{k}$ be point of intersection | |
| | $\overrightarrow{AX} = \overrightarrow{OX} - \overrightarrow{OA} = \begin{pmatrix}1\\7\\-3\end{pmatrix} - \begin{pmatrix}9\\3\\13\end{pmatrix} = \begin{pmatrix}-8\\4\\-16\end{pmatrix}$ Finding vector $\overrightarrow{AX}$ by finding the difference between $\overrightarrow{OX}$ and $\overrightarrow{OA}$. Can be ft using candidate's $\overrightarrow{OX}$. | M1 $\sqrt{}$ ± |
| | $\overrightarrow{OB} = \overrightarrow{OA} + \overrightarrow{AB} = \overrightarrow{OA} + 2\overrightarrow{AX}$ | |
| | $\overrightarrow{OB} = \begin{pmatrix}9\\3\\13\end{pmatrix} + 2\begin{pmatrix}-8\\4\\-16\end{pmatrix}$ $\quad \begin{pmatrix}9\\3\\13\end{pmatrix} + 2\left(\text{their } \overrightarrow{AX}\right)$ | dM1 $\sqrt{}$ |
| | Hence, $\overrightarrow{OB} = \underline{\begin{pmatrix}-7\\11\\-19\end{pmatrix}}$ or $\overrightarrow{OB} = \underline{-7\mathbf{i} + 11\mathbf{j} - 19\mathbf{k}}$ $\quad \underline{\begin{pmatrix}-7\\11\\-19\end{pmatrix}}$ or $\underline{-7\mathbf{i} + 11\mathbf{j} - 19\mathbf{k}}$ or $\underline{(-7, 11, -19)}$ | A1 |
| | | (3) |
| | | **[13]** |
| **5.** (a) | $\dfrac{dx}{dt} = -4\sin 2t$, $\dfrac{dy}{dt} = 6\cos t$ | B1, B1 |
| | $\dfrac{dy}{dx} = -\dfrac{6\cos t}{4\sin 2t}$ $\left(= -\dfrac{3}{4\sin t}\right)$ | M1 |
| | At $t = \dfrac{\pi}{3}$, $m = -\dfrac{3}{4 \times \frac{\sqrt{3}}{2}} = -\dfrac{\sqrt{3}}{2}$ accept equivalents, awrt $-0.87$ | A1 (4) |
| (b) | Use of $\cos 2t = 1 - 2\sin^2 t$ | M1 |
| | $\cos 2t = \dfrac{x}{2}$, $\sin t = \dfrac{y}{6}$ | |
| | $\dfrac{x}{2} = 1 - 2\left(\dfrac{y}{6}\right)^2$ | M1 |
| | Leading to $y = \sqrt{(18 - 9x)}$ $\left(= 3\sqrt{(2 - x)}\right)$ cao | A1 |
| | $-2 \le x \le 2$ $\quad k = 2$ | B1 (4) |
| (c) | $0 \le f(x) \le 6$ either $0 \le f(x)$ or $f(x) \le 6$ | B1 |
| | Fully correct. Accept $0 \le y \le 6$, $[0, 6]$ | B1 (2) |
| | | **(10 marks)** |

| Question Number | Scheme | | Marks |
|---|---|---|---|
| **6.** (a) | $\overrightarrow{OA}=\begin{pmatrix}2\\6\\-1\end{pmatrix}$ & $\overrightarrow{OB}=\begin{pmatrix}3\\4\\1\end{pmatrix}$ | | |
| | $\overrightarrow{AB}=\overrightarrow{OB}-\overrightarrow{OA}=\begin{pmatrix}3\\4\\1\end{pmatrix}-\begin{pmatrix}2\\6\\-1\end{pmatrix}=\underline{\begin{pmatrix}1\\-2\\2\end{pmatrix}}$ | Finding the difference between $\overrightarrow{OB}$ and $\overrightarrow{OA}$.<br>Correct answer. | M1 ±<br>A1 |
| | | | **[2]** |
| (b) | $l_1:\ \mathbf{r}=\begin{pmatrix}2\\6\\-1\end{pmatrix}+\lambda\begin{pmatrix}1\\-2\\2\end{pmatrix}$ or $\mathbf{r}=\begin{pmatrix}3\\4\\1\end{pmatrix}+\lambda\begin{pmatrix}1\\-2\\2\end{pmatrix}$<br><br>$l_1:\ \mathbf{r}=\begin{pmatrix}2\\6\\-1\end{pmatrix}+\lambda\begin{pmatrix}-1\\2\\-2\end{pmatrix}$ or $\mathbf{r}=\begin{pmatrix}3\\4\\1\end{pmatrix}+\lambda\begin{pmatrix}-1\\2\\-2\end{pmatrix}$ | An expression of the form $(\text{vector})\pm\lambda(\text{vector})$<br>$\mathbf{r}=\overrightarrow{OA}\pm\lambda(\text{their }\overrightarrow{AB})$ or<br>$\mathbf{r}=\overrightarrow{OB}\pm\lambda(\text{their }\overrightarrow{AB})$ or<br>$\mathbf{r}=\overrightarrow{OA}\pm\lambda(\text{their }\overrightarrow{BA})$ or<br>$\mathbf{r}=\overrightarrow{OB}\pm\lambda(\text{their }\overrightarrow{BA})$<br>(**r** is needed.) | M1<br><br>A1 $\sqrt{}$ aef |
| | | | **[2]** |
| (c) | $l_2:\ \mathbf{r}=\begin{pmatrix}0\\0\\0\end{pmatrix}+\mu\begin{pmatrix}1\\0\\1\end{pmatrix}\ \Rightarrow\ \mathbf{r}=\mu\begin{pmatrix}1\\0\\1\end{pmatrix}$ | | |
| | $\overrightarrow{AB}=\mathbf{d}_1=\mathbf{i}-2\mathbf{j}+2\mathbf{k}$, $\mathbf{d}_2=\mathbf{i}+0\mathbf{j}+\mathbf{k}$ & $\theta$ is angle | | |
| | $\cos\theta=\dfrac{\overrightarrow{AB}\bullet\mathbf{d}_2}{\left(\lvert\overrightarrow{AB}\rvert.\lvert\mathbf{d}_2\rvert\right)}=\dfrac{\begin{pmatrix}1\\-2\\2\end{pmatrix}\bullet\begin{pmatrix}1\\0\\1\end{pmatrix}}{\left(\sqrt{(1)^2+(-2)^2+(2)^2}.\sqrt{(1)^2+(0)^2+(1)^2}\right)}$ | ← Considers dot product between $\mathbf{d}_2$ and their $\overrightarrow{AB}$. | M1 $\sqrt{}$ |
| | $\cos\theta=\dfrac{1+0+2}{\sqrt{(1)^2+(-2)^2+(2)^2}.\sqrt{(1)^2+(0)^2+(1)^2}}$ | Correct followed through expression or **equation**. | A1 $\sqrt{}$ |
| | $\cos\theta=\dfrac{3}{3.\sqrt{2}}\Rightarrow\underline{\theta=45^\circ\text{ or }\tfrac{\pi}{4}\text{ or awrt }0.79}$. | $\underline{\theta=45^\circ\text{ or }\tfrac{\pi}{4}\text{ or awrt }0.79}$ | A1 **cao** |
| | | | **[3]** |

This means that $\cos\theta$ does not necessarily have to be the subject of the equation. It could be of the form $3\sqrt{2}\cos\theta=3$.

| Question Number | Scheme | | Marks |
|---|---|---|---|
| **6.** (d) | If $l_1$ and $l_2$ intersect then: $\begin{pmatrix}2\\6\\-1\end{pmatrix}+\lambda\begin{pmatrix}1\\-2\\2\end{pmatrix}=\mu\begin{pmatrix}1\\0\\1\end{pmatrix}$ | | |
| | $\mathbf{i}: \quad 2+\lambda=\mu \quad (1)$<br>$\mathbf{j}: \quad 6-2\lambda=0 \quad (2)$<br>$\mathbf{k}: -1+2\lambda=\mu \quad (3)$ | **Either** seeing equation (2) written down correctly with or without any other equation **or** seeing equations (1) and (3) written down correctly. | M1 $\sqrt{}$ |
| | (2) yields $\lambda=3$<br>Any two yields $\lambda=3, \quad \mu=5$ | Attempt to solve either equation (2) or simultaneously solve any two of the three equations to find … | dM1 |
| | | either one of $\lambda$ or $\mu$ correct. | A1 |
| | $l_1: \mathbf{r}=\begin{pmatrix}2\\6\\-1\end{pmatrix}+3\begin{pmatrix}1\\-2\\2\end{pmatrix}=\underline{\begin{pmatrix}5\\0\\5\end{pmatrix}}$ *or* $\mathbf{r}=5\begin{pmatrix}1\\0\\1\end{pmatrix}=\underline{\begin{pmatrix}5\\0\\5\end{pmatrix}}$ | $\underline{\begin{pmatrix}5\\0\\5\end{pmatrix}}$ or $5\mathbf{i}+5\mathbf{k}$<br>Fully correct solution & no incorrect values of $\lambda$ or $\mu$ seen earlier. | A1 **cso** |
| | | | **[4]** |

**Statistics for C4 Practice Paper G3**

| | | | | Mean score for students achieving grade: | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Qu** | **Max score** | **Modal score** | **Mean %** | **ALL** | **A*** | **A** | **B** | **C** | **D** | **E** | **U** |
| **1** | 5 | | 78 | 3.88 | | 4.59 | 4.06 | 3.64 | 3.00 | 2.30 | 1.38 |
| **2** | 6 | | 64 | 3.81 | 5.84 | 5.13 | 4.00 | 2.69 | 1.71 | 0.94 | 0.36 |
| **3** | 4 | 1 | 57 | 2.26 | 3.53 | 2.49 | 2.09 | 1.73 | 1.58 | 1.50 | 1.15 |
| **4** | 13 | | 61 | 7.94 | | 10.15 | 7.19 | 4.59 | 3.25 | 1.74 | 0.58 |
| **5** | 10 | | 54 | 5.38 | | 7.41 | 5.34 | 3.97 | 2.72 | 1.64 | 0.63 |
| **6** | 11 | | 57 | 6.30 | | 8.66 | 5.80 | 4.15 | 3.11 | 1.68 | 1.27 |
| **7** | 12 | | 54 | 6.42 | 10.86 | 8.23 | 6.15 | 4.39 | 3.01 | 2.02 | 1.02 |
| **8** | 14 | | 36 | 5.09 | | 8.99 | 3.90 | 1.81 | 0.80 | 0.35 | 0.09 |
| | **75** | | **55** | **41.08** | | **55.65** | **38.53** | **26.97** | **19.18** | **12.17** | **6.48** |

| Question | Scheme | Marks | |
|---|---|---|---|
| **7.** | (a) **j** components $3+2\lambda=9 \quad \Rightarrow \lambda=3$ $\quad (\mu=1)$ | M1 A1 | |
| | Leading to $C:(5, 9, -1)$ accept vector forms | A1 | **(3)** |
| | (b) Choosing correct directions or finding $\overrightarrow{AC}$ and $\overrightarrow{BC}$ | M1 | |
| | $\begin{pmatrix}1\\2\\1\end{pmatrix}.\begin{pmatrix}5\\0\\2\end{pmatrix}=5+2=\sqrt{6}\sqrt{29}\cos\angle ACB$ use of scalar product | M1 A1 | |
| | $\angle ACB=57.95°$ awrt $57.95°$ | A1 | **(4)** |
| | (c) $A:(2, 3, -4) \quad B:(-5, 9, -5)$ | | |
| | $\overrightarrow{AC}=\begin{pmatrix}3\\6\\3\end{pmatrix}, \quad \overrightarrow{BC}=\begin{pmatrix}10\\0\\4\end{pmatrix}$ | | |
| | $AC^2=3^2+6^2+3^2 \quad \Rightarrow \quad AC=3\sqrt{6}$ | M1 A1 | |
| | $BC^2=10^2+4^2 \quad \Rightarrow \quad BC=2\sqrt{29}$ | A1 | |
| | $\triangle ABC=\frac{1}{2}AC\times BC\sin\angle ACB$ | | |
| | $=\frac{1}{2}3\sqrt{6}\times 2\sqrt{29}\sin\angle ACB\approx 33.5$ $\quad 15\sqrt{5}$, awrt 34 | M1 A1 | **(5)** |
| | | | **[12]** |

| Question Number | Scheme | | Marks |
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| | | | |
| Number | | | |
| **8.** (c) | $\frac{\mathrm{d}P}{\mathrm{d}t} = \lambda P \cos \lambda t$ and $t = 0,\ P = P_0$ (1) | | |
| **8.** (a) | $\frac{\mathrm{d}P}{\mathrm{d}t} = kP$ and $t = 0,\ P = P_0$ (1) | | |
| | $\int \frac{\mathrm{d}P}{P} = \int k\ \mathrm{d}t$ | Separates the variables with $\int \frac{\mathrm{d}P}{P}$ and $\int k\,\mathrm{d}t$ on either side with integral signs not necessary. | M1 |
| | $\ln P = kt\,;(+\,c)$ | Must see $\ln P$ and $kt$; Correct equation with/without + c. | A1 |
| | When $t = 0,\ P = P_0 \Rightarrow \ln P_0 = c$<br>$\left(\text{or } P = Ae^{kt} \Rightarrow P_0 = A\right)$ | Use of boundary condition (1) to attempt to find the constant of integration. | M1 |
| | $\ln P = kt + \ln P_0 \quad \Rightarrow e^{\ln P} = e^{kt + \ln P_0} = e^{kt}.e^{\ln P_0}$ | | |
| | Hence, $\underline{P = P_0 e^{kt}}$ | $\underline{P = P_0 e^{kt}}$ | A1 |
| | | | **[4]** |
| (b) | $P = 2P_0$ & $k = 2.5 \quad \Rightarrow \underline{2P_0 = P_0 e^{2.5t}}$ | Substitutes $P = 2P_0$ into an expression involving $P$ | M1 |
| | $e^{2.5t} = 2 \Rightarrow \underline{\ln e^{2.5t} = \ln 2}$ or $\underline{2.5t = \ln 2}$<br>…or $e^{kt} = 2 \Rightarrow \underline{\ln e^{kt} = \ln 2}$ or $\underline{kt = \ln 2}$ | Eliminates $P_0$ and takes ln of both sides | M1 |
| | $\Rightarrow \quad t = \frac{1}{2.5}\ln 2 = 0.277258872\ldots$ days | | |
| | $t = 0.277258872\ldots \times 24 \times 60 = 399.252776\ldots$ minutes | | |
| | $t = \underline{399\,\text{min}}$ or $t = \underline{6\text{ hr } 39\text{ mins}}$ (to nearest minute) | awrt $t = \underline{399}$ or $\underline{6\text{ hr } 39\text{ mins}}$ | A1 |
| | | | **[3]** |

| | | | |
|---|---|---|---|
| | $\int \frac{dP}{P} = \int \lambda \cos \lambda t \, dt$ | Separates the variables with $\int \frac{dP}{P}$ and $\int \lambda \cos \lambda t \, dt$ on either side with integral signs not necessary. | M1 |
| | $\ln P = \sin \lambda t ; (+c)$ | Must see $\ln P$ and $\sin \lambda t$; Correct equation with/without + c. | A1 |
| | When $t=0,\ P=P_0 \Rightarrow \ln P_0 = c$ <br> $\left(\text{or } P = Ae^{\sin \lambda t} \Rightarrow P_0 = A\right)$ | Use of boundary condition (1) to attempt to find the constant of integration. | M1 |
| | $\ln P = \sin \lambda t + \ln P_0 \quad \Rightarrow e^{\ln P} = e^{\sin \lambda t + \ln P_0} = e^{\sin \lambda t}.e^{\ln P_0}$ | | |
| | Hence, $\underline{P = P_0 e^{\sin \lambda t}}$ | $\underline{P = P_0 e^{\sin \lambda t}}$ | A1 |
| | | | **[4]** |
| (d) | $P = 2P_0$ & $\lambda = 2.5 \quad \Rightarrow 2P_0 = P_0 e^{\sin 2.5t}$ | | |
| | $e^{\sin 2.5t} = 2 \Rightarrow \underline{\sin 2.5t = \ln 2}$ <br> …or … $e^{\lambda t} = 2 \Rightarrow \underline{\sin \lambda t = \ln 2}$ | Eliminates $P_0$ and makes $\sin \lambda t$ or $\sin 2.5t$ the subject by taking ln's | M1 |
| | $\underline{t = \frac{1}{2.5}\sin^{-1}(\ln 2)}$ | Then rearranges to make *t* the subject. (must use $\sin^{-1}$) | dM1 |
| | $t = 0.306338477...$ | | |
| | $t = 0.306338477... \times 24 \times 60 = 441.1274082...$ minutes | | |
| | $t = \underline{441\text{min}}$ or $t = \underline{7 \text{ hr } 21 \text{ mins}}$ (to nearest minute) | awrt $t = \underline{441}$ or $\underline{7 \text{ hr } 21 \text{ mins}}$ | A1 |
| | | | **[3]** |
| | | | **14 marks** |