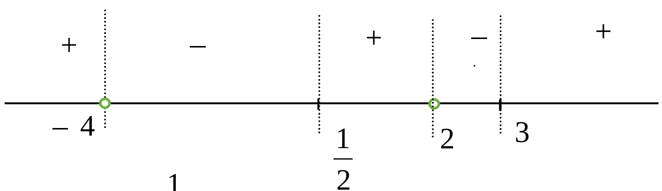
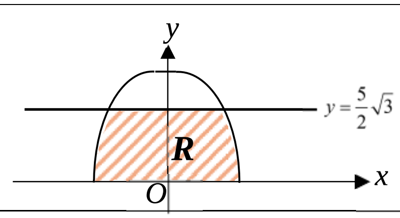
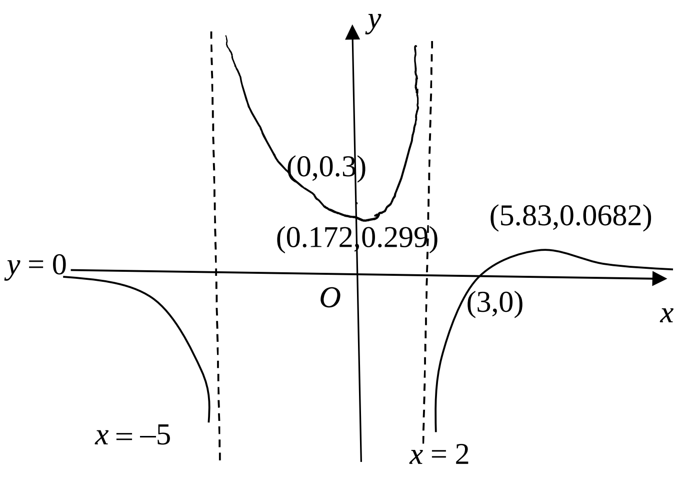
2024 JPJC J2 H2 Prelims Paper 1 Solutions

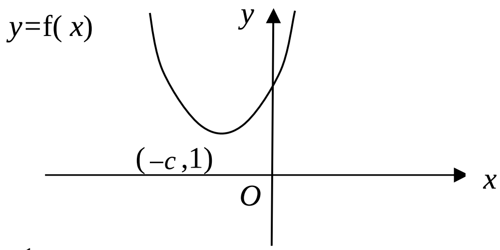
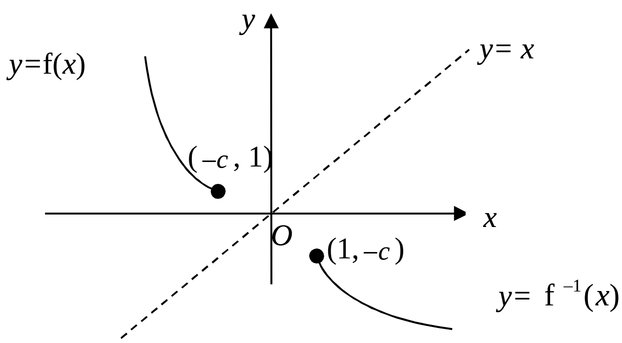
1	Let $v_n = an^3 + bn^2 + cn + d$ $v_1 = -9: a+b+c+d = -9 ---(1)$ $v_2 = 7: 8a+4b+2c+d = 7 ---(2)$ $v_3 = 47: 27a+9b+3c+d = 47 ---(3)$ $v_4 = 141: 64a+16b+4c+d = 141 ---(4)$ Use GC: $a = 5, b = -18, c = 35, d = -31$ $v_n = 5n^3 - 18n^2 + 35n - 31$

2	$\dfrac{11x-19}{x^2+2x-8} \le 2$ $\dfrac{11x-19}{x^2+2x-8} - 2 \le 0$ $\dfrac{11x-19-2x^2-4x+16}{x^2+2x-8} \le 0$ $\dfrac{-2x^2+7x-3}{x^2+2x-8} \le 0$ $\dfrac{(2x-1)(x-3)}{(x+4)(x-2)} \ge 0$  $x < -4$ or $\frac{1}{2} \le x < 2$ or $x \ge 3$ Replace x by e^{-x} $e^{-x} < -4$ or $\frac{1}{2} \le e^{-x} < 2$ or $e^{-x} \ge 3$ (no solution) , $\ln\frac{1}{2} \le -x < \ln 2$ or $-x \ge \ln 3$ $-\ln 2 < x \le \ln 2$ or $x \le -\ln 3$

3	$y = 5\sin\theta \Rightarrow \dfrac{dy}{d\theta} = 5\cos\theta$ $y = 0, \quad 0 = 5\sin\theta \Rightarrow \theta = 0$ $y = \frac{5}{2}\sqrt{3}, \quad \frac{5}{2}\sqrt{3} = 5\sin\theta \Rightarrow \sin\theta = \frac{\sqrt{3}}{2} \Rightarrow \theta = \frac{\pi}{3}$
	Volume $= \pi\int_0^{\frac{5\sqrt{3}}{2}} x^2 \, dy$ $= \pi\int_0^{\frac{5\sqrt{3}}{2}} \sqrt{25-y^2} \, dy$ 

	$= \pi \int_0^{\frac{\pi}{3}} \sqrt{25 - 25\sin^2\theta}\,(5\cos\theta)\,\mathrm{d}\theta$
	$= 5\pi \int_0^{\frac{\pi}{3}} \sqrt{25(1-\sin^2\theta)}\,\cos\theta\,\mathrm{d}\theta$
	$= 25\pi \int_0^{\frac{\pi}{3}} \sqrt{\cos^2\theta}\,\cos\theta\,\mathrm{d}\theta$
	$= 25\pi \int_0^{\frac{\pi}{3}} \cos^2\theta\,\mathrm{d}\theta$
	$= \frac{25}{2}\pi \int_0^{\frac{\pi}{3}} 1+\cos 2\theta\,\mathrm{d}\theta$
	$= \frac{25}{2}\pi \left[\theta + \frac{\sin 2\theta}{2}\right]_0^{\frac{\pi}{3}}$
	$= \frac{25}{2}\pi \left[\frac{\pi}{3} + \frac{1}{2}\sin\frac{2\pi}{3}\right]$
	$= \frac{25}{2}\pi \left[\frac{\pi}{3} + \frac{\sqrt{3}}{4}\right]$
	$= \frac{25}{6}\pi^2 + \frac{25}{8}\sqrt{3}\pi \quad (\text{exact})$

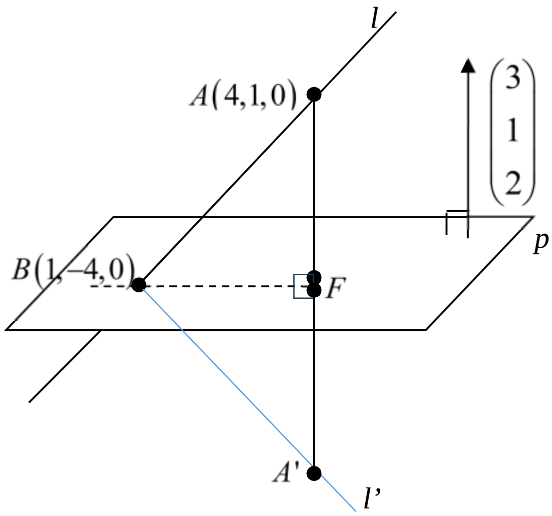
4(i)	
(ii)	$y = \mathrm{f}(x) = \frac{x-3}{(x-2)(x+5)}$ $\rightarrow\ y = \mathrm{f}(2x) = \frac{2x-3}{(2x-2)(2x+5)}$ $\rightarrow y = (2)\mathrm{f}(2x) = (2)\frac{2x-3}{(2x-2)(2x+5)}\ \ y = \frac{2x-3}{(x-1)(2x+5)}$ Scaling parallel to the x-axis by scale factor $\frac{1}{2}$. Scaling parallel to the y-axis by scale factor 2.

5(i)	 f^{-1} exists for $x \le -c$ $k=-c$
(ii)	$y=\mathrm{e}^{(x+c)^2}$ $(x+c)^2=\ln(y)$ $x+c=\pm\sqrt{\ln(y)}$ $x=-c\pm\sqrt{\ln(y)}$ Since $x \le -c, \quad x=-c-\sqrt{\ln(y)}$ $\mathrm{f}^{-1}(x)=-c-\sqrt{\ln x},\ x\ge 1$
(iii)	 Graphs of f and f^{-1} are reflections of each other about the line $y = x$
(iv)	Range of f = $[1,\ \infty)$ and Domain of g = $(0,\ \infty)$ Range of f $\subseteq$ Domain of g Hence gf exists gf(x)= $\ln\ \mathrm{e}^{(x+c)^2}$ $= \ (x+c)^2\ ,\ x\le -c$

6(i)	$\overrightarrow{AB}=\underset{\sim}{b}-\underset{\sim}{a}$ $\overrightarrow{AC}=\left(m\underset{\sim}{a}+n\underset{\sim}{b}\right)-\underset{\sim}{a}=(m-1)\underset{\sim}{a}+n\underset{\sim}{b}$ Area of triangle ABC $=\frac{1}{2}\left\|\overrightarrow{AB}\times\overrightarrow{AC}\right\|$ $=\frac{1}{2}\left\|\left(\underset{\sim}{b}-\underset{\sim}{a}\right)\times\left((m-1)\underset{\sim}{a}+n\underset{\sim}{b}\right)\right\|$

	$=\frac{1}{2}\left\|(m-1)\left(\underset{\sim}{b}\times\underset{\sim}{a}\right)+n\left(\underset{\sim}{b}\times\underset{\sim}{b}\right)-(m-1)\left(\underset{\sim}{a}\times\underset{\sim}{a}\right)-n\left(\underset{\sim}{a}\times\underset{\sim}{b}\right)\right\|$ $=\frac{1}{2}\left\|(m-1)\left(\underset{\sim}{b}\times\underset{\sim}{a}\right)+\underset{\sim}{0}+\underset{\sim}{0}+n\left(\underset{\sim}{b}\times\underset{\sim}{a}\right)\right\|$ $=\frac{1}{2}(m+n-1)\left\|\underset{\sim}{b}\times\underset{\sim}{a}\right\|$ $=\frac{1}{2}(m+n-1)\left\|\underset{\sim}{b}\right\|\left\|\underset{\sim}{a}\right\|\sin 30^{\circ}$ $=\frac{1}{2}(m+n-1)\left\|\underset{\sim}{b}\right\|\left(4\left\|\underset{\sim}{b}\right\|\right)\left(\frac{1}{2}\right)$ $=(m+n-1)\left\|\underset{\sim}{b}\right\|^{2}$
(ii)	$\overrightarrow{OD}=\frac{1}{2}\underset{\sim}{a}$ $\quad \overrightarrow{OE}=\frac{3}{5}\underset{\sim}{b}$
(iii)	$l_{BD}:\underset{\sim}{r}=\underset{\sim}{b}+\lambda_1\overrightarrow{BD}$ $=\underset{\sim}{b}+\lambda_1\left(\underset{\sim}{d}-\underset{\sim}{b}\right)$ $=\underset{\sim}{b}+\lambda_1\left(\frac{1}{2}a-\underset{\sim}{b}\right)$ $=\underset{\sim}{b}+\lambda\left(\underset{\sim}{a}-2\underset{\sim}{b}\right)$, where $\lambda=\frac{\lambda_1}{2}$ $=\lambda\underset{\sim}{a}+\left(1-2\lambda\right)\underset{\sim}{b}$ (shown) $l_{AE}:\underset{\sim}{r}=\underset{\sim}{a}+\mu_1\overrightarrow{AE}$ $=\underset{\sim}{a}+\mu_1\left(\underset{\sim}{e}-\underset{\sim}{a}\right)$ $=\underset{\sim}{a}+\mu_1\left(\frac{3}{5}\underset{\sim}{b}-\underset{\sim}{a}\right)$ $=\underset{\sim}{a}+\mu\left(3\underset{\sim}{b}-5\underset{\sim}{a}\right)$, where $\mu=\frac{\mu_1}{5}$ $=\left(1-5\mu\right)\underset{\sim}{a}+3\mu\underset{\sim}{b}$ Since lines *BD* and *AE* meet, $\lambda\underset{\sim}{a}+\left(1-2\lambda\right)\underset{\sim}{b}=\left(1-5\mu\right)\underset{\sim}{a}+3\mu\underset{\sim}{b}$ Comparing coefficients of $\underset{\sim}{a}$, $\lambda=1-5\mu\Rightarrow\lambda+5\mu=1$ --- (1) Comparing coefficients of $\underset{\sim}{b}$, $1-2\lambda=3\mu\Rightarrow 2\lambda+3\mu=1$ --- (2) Using GC, $\lambda=\frac{2}{7},\mu=\frac{1}{7}$ $\overrightarrow{OF}=\frac{2}{7}\underset{\sim}{a}+\left[1-2\left(\frac{2}{7}\right)\right]\underset{\sim}{b}$ $=\frac{2}{7}\underset{\sim}{a}+\frac{3}{7}\underset{\sim}{b}$

7(a)	$l: \underset{\sim}{r} = \begin{pmatrix} 4 \\ 1 \\ 0 \end{pmatrix} + t\begin{pmatrix} 3 \\ 5 \\ 0 \end{pmatrix}, t \in \mathbb{R}$ ---(1) For plane p, $\underset{\sim}{n} = \begin{pmatrix} 1 \\ -5 \\ 1 \end{pmatrix} \times \begin{pmatrix} -3 \\ a \\ 1 \end{pmatrix} = \begin{pmatrix} -5-a \\ -4 \\ a-15 \end{pmatrix}$ Since l and p do not meet in a unique point, $\begin{pmatrix} -5-a \\ -4 \\ a-15 \end{pmatrix} \bullet \begin{pmatrix} 3 \\ 5 \\ 0 \end{pmatrix} = 0$ $3(-5-a) - 20 = 0$ $-3a = 35$ $a = -\frac{35}{3}$
(b)(i)	Given $a = 7$, $\underset{\sim}{n} = \begin{pmatrix} -5-7 \\ -4 \\ 7-15 \end{pmatrix} = -4\begin{pmatrix} 3 \\ 1 \\ 2 \end{pmatrix}$ p: $\underset{\sim}{r} \bullet \begin{pmatrix} 3 \\ 1 \\ 2 \end{pmatrix} = \begin{pmatrix} -3 \\ 0 \\ 4 \end{pmatrix} \bullet \begin{pmatrix} 3 \\ 1 \\ 2 \end{pmatrix} = -1$ --- (2) Subst. (1) into (2): $\left[\begin{pmatrix} 4 \\ 1 \\ 0 \end{pmatrix} + t\begin{pmatrix} 3 \\ 5 \\ 0 \end{pmatrix}\right] \bullet \begin{pmatrix} 3 \\ 1 \\ 2 \end{pmatrix} = -1$ $13 + 14t = -1$ $t = -1$ Position vector of the point of intersection, $B = \begin{pmatrix} 4 \\ 1 \\ 0 \end{pmatrix} - \begin{pmatrix} 3 \\ 5 \\ 0 \end{pmatrix} = \begin{pmatrix} 1 \\ -4 \\ 0 \end{pmatrix}$ $\therefore B(1, -4, 0)$

(ii)	 To find *F*, the foot of perpendicular from *A* to *p*: $l_{AF}:\ \underset{\sim}{r}=\begin{pmatrix}4\\1\\0\end{pmatrix}+s\begin{pmatrix}3\\1\\2\end{pmatrix}, s\in\mathbb{R}$ $\left[\begin{pmatrix}4\\1\\0\end{pmatrix}+s\begin{pmatrix}3\\1\\2\end{pmatrix}\right]\bullet\begin{pmatrix}3\\1\\2\end{pmatrix}=-1$ $13+14s=-1$ $s=-1$ $\overrightarrow{OF}=\begin{pmatrix}4\\1\\0\end{pmatrix}-\begin{pmatrix}3\\1\\2\end{pmatrix}=\begin{pmatrix}1\\0\\-2\end{pmatrix}$ Since *F* is the mid-point of *AA*', $\overrightarrow{OF}=\dfrac{\overrightarrow{OA}+\overrightarrow{OA'}}{2}$ $\overrightarrow{OA'}=2\overrightarrow{OF}-\overrightarrow{OA}$ $=2\begin{pmatrix}1\\0\\-2\end{pmatrix}-\begin{pmatrix}4\\1\\0\end{pmatrix}=\begin{pmatrix}-2\\-1\\-4\end{pmatrix}$ $\overrightarrow{BA'}=\begin{pmatrix}-2\\-1\\-4\end{pmatrix}-\begin{pmatrix}1\\-4\\0\end{pmatrix}=\begin{pmatrix}-3\\3\\-4\end{pmatrix}$ $l':\ \underset{\sim}{r}=\begin{pmatrix}1\\-4\\0\end{pmatrix}+\alpha\begin{pmatrix}-3\\3\\-4\end{pmatrix}, \alpha\in\mathbb{R}$ $\dfrac{1-x}{3}=\dfrac{y+4}{3}=-\dfrac{z}{4}$

8 (i)

Month	Amount owed at beginning of the month	Amount owed at the end of the month
1	$200000(1.005)$	$200000(1.005) - x$
2	$200000(1.005)^2 - (1.005)x$	$200000(1.005)^2 - (1.005)x - x$
3	$200000(1.005)^3 - (1.005)^2x - (1.005)x$	$200000(1.005)^3 - (1.005)^2x - (1.005)x - x$

Amount owed at the end of n months

$= 200000(1.005)^n - (1.005)^{n-1}x - (1.005)^{n-2}x - \ldots - 1.005x - x$

$= 200000(1.005)^n - x\left[1 + 1.005 + \ldots + (1.005)^{n-2} + (1.005)^{n-1}\right]$

$= 200000(1.005)^n - \dfrac{x\left[1 - 1.005^n\right]}{1 - 1.005}$

$= 200000(1.005)^n - 200x\left[1.005^n - 1\right]$

(ii)

$200000(1.005)^n - 200x\left[1.005^n - 1\right] \le 0$

$200000(1.005)^n - 200(1500)\left[1.005^n - 1\right] \le 0$

$300000 - 100000(1.005)^n \le 0$

$(1.005)^n \ge 3$

$n \ge \dfrac{\ln 3}{\ln 1.005}$

$n \ge 220.27$

Alternatively,
Use GC table

n	$200000(1.005)^n - 200(1500)\left[1.005^n - 1\right]$
219	1896.19
220	405.67 > 0
221	–1092.30 < 0

$n = 221$

At the end of 220 months, Selena owed
$200000(1.005)^{220} - 200(1500)\left[1.005^{220} - 1\right] = \$405.67$

Last repayment amount to be repaid on the 221st month
$= \$405.67 \times 1.005 = \underline{\$407.70}$ (2d.p.)

221 months = 18 years 5 months
Full repayment on: 31 May 2043

(iii)

$200000(1.005)^{120} - 200x\left[1.005^{120} - 1\right] \le 0$

$363879.3468 - 163.8793468x \le 0$

$x \ge 2220.410039$

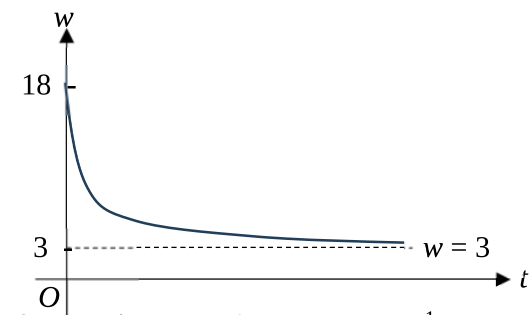
$2220.42 (2d.p.) [$2220.41 not accepted]

9(a)	Sub. $z=1+2\mathrm{i}$ into $z^4-z^3-9z^2+sz+t=0$ $(1+2\mathrm{i})^4-(1+2\mathrm{i})^3-9(1+2\mathrm{i})^2+s(1+2\mathrm{i})+t=0$ $(-7-24\mathrm{i})-(-11-2\mathrm{i})-9(-3+4\mathrm{i})+s(1+2\mathrm{i})+t=0$ $(31+s+t)+(2s-58)\mathrm{i}=0$ Comparing imaginary parts, $2s-58=0$ $\underline{\underline{s=29}}$ Comparing real parts, $31+s+t=0$ $t=-31-s$ $=\underline{\underline{-60}}$ Now $z^4-z^3-9z^2+29z-60=0$ Using GC the other roots are $\underline{\underline{1-2\mathrm{i}, 3, -4}}$. **<u>Alternative solution</u>** Since $z^4-z^3-9z^2+sz+t=0$ is a polynomial equation with real coefficients and $1+2\mathrm{i}$ is a root, $1-2\mathrm{i}$ is another root. Quadratic factor = $[z-(1+2\mathrm{i})][z-(1-2\mathrm{i})]$ $=[(z-1)-2\mathrm{i}][(z-1)+2\mathrm{i}]$ $=(z-1)^2-(2\mathrm{i})^2$ $=z^2-2z+5$ Let $z^4-z^3-9z^2+sz+t=(z^2-2z+5)(z^2+az+b)$. By comparing coefficients, $z^3:\quad -1=a-2 \qquad \Rightarrow a=1$ $z^2:\quad -9=b-2a+5 \qquad \Rightarrow b=-12$ $z:\quad s=-2b+5a=29$ $\text{constant term}:\quad t=5b=-60$ Now $z^4-z^3-9z^2+29z-60=0$ Using GC (polyroot finder), the other roots are $\underline{\underline{1-2\mathrm{i}, 3, -4}}$.
(b)	$\arg\left(\frac{w^3}{\mathrm{i}w^*}\right)=\arg w^3-\arg(\mathrm{i}w^*)$ $=3\arg w-(\arg i+\arg w^*)$ $=3\arg w-\left(\frac{\pi}{2}-\arg w\right)$ $=4\arg w-\frac{\pi}{2}$

	For $\frac{w^3}{\mathrm{i}w^*}$ to be purely imaginary, $\arg\left(\frac{w^3}{\mathrm{i}w^*}\right)=\pm\frac{\pi}{2},\pm\frac{3\pi}{2},\pm\frac{5\pi}{2},...$ $4\arg(w)-\frac{\pi}{2}=\pm\frac{\pi}{2},\pm\frac{3\pi}{2},\pm\frac{5\pi}{2},...$ $4\arg(w)=0,\ \pi,\ 2\pi,\ -\pi,\ 3\pi,-2\pi$ $\arg(w)=\frac{\pi}{4},0,\ \frac{\pi}{2},\frac{-\pi}{4},\frac{3\pi}{4},-\frac{\pi}{2}$ Since $w=a+\mathrm{i}b$ and a and b are positive real numbers, $0<\arg(w)<\frac{\pi}{2}$. $\therefore \arg(w)=\frac{\pi}{4}$ $\tan^{-1}\left(\frac{b}{a}\right)=\frac{\pi}{4}$ $\frac{b}{a}=1$ $b=a$ $w=a+\mathrm{i}a$

10(i)	$\frac{\mathrm{d}v}{\mathrm{d}t}=2\mathrm{e}^{-0.1t}$ $v=\int 2\mathrm{e}^{-0.1t}\ \mathrm{d}t$ $v=2\left(\frac{\mathrm{e}^{-0.1t}}{-0.1}\right)+c$ $v=-20\mathrm{e}^{-0.1t}+c$ When t = 0, v = 0 $0=-20\mathrm{e}^{0}+c$ $c=20$ $v=20-20\mathrm{e}^{-0.1t}$ Subt $v=10$ $10=20-20\mathrm{e}^{-0.1t}$ $20\mathrm{e}^{-0.1t}=10$ $\mathrm{e}^{-0.1t}=\frac{1}{2}$ $-0.1t=\ln\frac{1}{2}$ $t=-10\ln\frac{1}{2}=10\ln 2$ (exact)
(ii)	As $t\to\infty,\mathrm{e}^{-0.1t}\to 0, v\to 20$ Eventually, the speed <u>increases</u> and <u>tend to 20 ms^{-1}</u>

(iii)	$-2\frac{\mathrm{d}w}{\mathrm{d}t}=(w-3)(w+2)$ $\frac{1}{(w-3)(w+2)}\frac{\mathrm{d}w}{\mathrm{d}t}=-\frac{1}{2}$ $\int\frac{1}{(w-3)(w+2)}\,\mathrm{d}w=\int-\frac{1}{2}\,\mathrm{d}t$
	<u>Method 1: Partial fractions</u> $\frac{1}{(w-3)(w+2)}=\frac{A}{(w-3)}+\frac{B}{(w+2)}$ $1=A(w+2)+B(w-3)$ $1=-5B\Rightarrow B=-\frac{1}{5}$ $1=5A\Rightarrow A=\frac{1}{5}$ $\frac{1}{5}\int\frac{1}{(w-3)}-\frac{1}{(w+2)}\,\mathrm{d}w=\int-\frac{1}{2}\,\mathrm{d}t$ <u>Method 2: Completing the square</u> $\int\frac{1}{w^2-w-6}\,\mathrm{d}w=\int-\frac{1}{2}\,\mathrm{d}t$ $\int\frac{1}{\left(w-\frac{1}{2}\right)^2-\left(\frac{5}{2}\right)^2}\,\mathrm{d}w=\int-\frac{1}{2}\,\mathrm{d}t$ $\frac{1}{2(\frac{5}{2})}\ln\left\|\frac{w-\frac{1}{2}-\frac{5}{2}}{w-\frac{1}{2}+\frac{5}{2}}\right\|=\int-\frac{1}{2}\,\mathrm{d}t$
	$\frac{1}{5}\left[\ln\|w-3\|-\ln\|w+2\|\right]=-\frac{1}{2}t+c$ $\frac{1}{5}\ln\left\|\frac{w-3}{w+2}\right\|=-\frac{1}{2}t+c$ $\ln\left\|\frac{w-3}{w+2}\right\|=-\frac{5}{2}t+5c$ $\left\|\frac{w-3}{w+2}\right\|=\mathrm{e}^{-\frac{5}{2}t+5c}$ $\frac{w-3}{w+2}=\pm\mathrm{e}^{-\frac{5}{2}t+5c}$ $\frac{w-3}{w+2}=A\mathrm{e}^{-\frac{5}{2}t},\quad A=\pm\mathrm{e}^{5c}$ Sub w = 18, $\frac{18-3}{18+2}=A\mathrm{e}^{0}$ $A=\frac{15}{20}=\frac{3}{4}$ $\frac{w-3}{w+2}=\frac{3}{4}\mathrm{e}^{-\frac{5}{2}t}$ $w-3=\frac{3}{4}w\mathrm{e}^{-\frac{5}{2}t}+\frac{3}{2}\mathrm{e}^{-\frac{5}{2}t}$

	$w-\frac{3}{4}we^{-\frac{5}{2}t}=3+\frac{3}{2}e^{-\frac{5}{2}t}$ $w=\frac{3+\frac{3}{2}e^{-\frac{5}{2}t}}{1-\frac{3}{4}e^{-\frac{5}{2}t}}$ $w=\frac{12+6e^{-\frac{5}{2}t}}{4-3e^{-\frac{5}{2}t}}$
(iv)	 The speed will not fall below 3 ms^{-1}.

11(i)	$y=x\tan\theta-\frac{10x^2}{2u^2\cos^2\theta}$ $-1.8=15\tan\left(\frac{\pi}{4}\right)-\frac{10(15)^2}{2u^2\cos^2\left(\frac{\pi}{4}\right)}$ $-1.8=15(1)-\frac{10(15)^2}{2u^2\left(\frac{1}{2}\right)}$ $\frac{10(15)^2}{u^2}=15+1.8$ $u^2=\frac{10(15)^2}{16.8}$ $u=11.6$
(ii)	$y=x\tan\theta-\frac{10x^2}{2(10)^2\cos^2\theta}$ When $y=-1.8$ $\therefore \quad -1.8=x\tan\theta-\frac{x^2}{20\cos^2\theta}$ $-36\cos^2\theta=20x\tan\theta\cos^2\theta-x^2$ $x^2-20x\sin\theta\cos\theta-36\cos^2\theta=0$ $x^2-10x\sin2\theta-18(1+\cos2\theta)=0$ $x^2-10x\sin2\theta-18\cos2\theta-18=0$ (Shown)

(iii)	Differentiate w.r.t. θ, we have $2x\frac{\mathrm{d}x}{\mathrm{d}\theta}-10\frac{\mathrm{d}x}{\mathrm{d}\theta}\sin 2\theta-20x\cos 2\theta+36\sin 2\theta=0$ At stationary value of x, $\frac{\mathrm{d}x}{\mathrm{d}\theta}=0$ $-20x\cos 2\theta+36\sin 2\theta=0$ $36\sin 2\theta=20x\cos 2\theta$ $x=\frac{36\sin 2\theta}{20\cos 2\theta}$ $x=\frac{9}{5}\tan 2\theta$
(iv)	Sub into equation, we have $\left(\frac{9}{5}\tan 2\theta\right)^2-10\left(\frac{9}{5}\tan 2\theta\right)\sin 2\theta-18\cos 2\theta-18=0$ $\frac{81}{25}\tan^2 2\theta-18\tan 2\theta\sin 2\theta-18\cos 2\theta-18=0$ $81\tan^2 2\theta-450\sin 2\theta\tan 2\theta-450\cos 2\theta-450=0$ Using GC, $\theta=0.70883\approx 0.71$ (2 decimal places), $\frac{\pi}{2}$ (reject) Therefore, stationary value of $x=\frac{9}{5}\tan 2(0.70883)=11.7$