Question	Scheme	Marks	AOs
3(a)	Uses one correct log law e.g. $\log_2(x+3)+\log_2(x+10)=\log_2(x+3)(x+10)$ $2=\log_2 4,\ \ 2\log_2 x=\log_2 x^2$	**M1**	1.1b
	$(x+3)(x+10)=4x^2$ oe	**dM1**	2.1
	$\Rightarrow 3x^2-13x-30=0$ *	**A1***	1.1b
		(3)	
(b)(i)	$(x=)\ 6,\ -\frac{5}{3}$	**B1**	1.1b
(ii)	$x\neq-\frac{5}{3}$ because $\log_{(2)}\left(-\frac{5}{3}\right)$ is not real	**B1**	2.4
		(2)	
			(5 marks)

Notes

(a)

M1: Uses one correct log law. The base does not need to be seen for this mark.
This mark is independent of any other errors they make.
Examples: $\log_2(x+3)+\log_2(x+10)=\log_2(x+3)(x+10)$, $2=\log_2 4$, $2\log_2 x=\log_2 x^2$

dM1: <u>Fully correct work</u> leading to a <u>correct</u> equation not containing logs that is not the printed answer. **Depends on the first mark.** Condone a spurious base e.g. 10 or e, so long as the log work is otherwise correct (i.e., they recover the base 2).
Examples (depending on their method): $(x+3)(x+10)=4x^2$, $\frac{(x+3)(x+10)}{x^2}=4$, $\frac{x+3}{x^2}=\frac{4}{x+10}$
or $1+\frac{13}{x}+\frac{30}{x^2}=4$
Allow recovery from invisible brackets but **not** from incorrect work e.g.

$$\log_2(x+3)+\log_2(x+10)=2+2\log_2 x\Rightarrow\log_2(x+3)(x+10)-\log_2 x^2=\log_2 4$$
$$\Rightarrow\frac{\log_2(x+3)(x+10)}{\log_2 x^2}=\log_2 4\Rightarrow\frac{(x+3)(x+10)}{x^2}=4$$

This scores M1dM0A0

A1*: Obtains $3x^2-13x-30=0$ with no processing errors but condone a spurious base e.g. 10 or e, so long as the log work is otherwise correct (i.e., they recover the base 2) and allow recovery from invisible brackets.

Note the following alternative which can follow the main scheme:

$\log_2(x+3)+\log_2(x+10)=2+2\log_2 x=2+\log_2 x^2$ **M1**

$2^{\log_2(x+3)+\log_2(x+10)}=2^{2+\log_2 x^2}\Rightarrow 2^{\log_2(x+3)}\times 2^{\log_2(x+10)}=2^2\times 2^{\log_2 x^2}\Rightarrow(x+3)(x+10)=4x^2$ **dM1**

$\Rightarrow 3x^2-13x-30=0$ * **A1**

<u>**Special Cases:**</u>

1. $(x+3)(x+10)=4x^2$ with no working leading to the correct answer scores **M1dM1A0**

2. $\log_2(x+3)+\log_2(x+10)=2+2\log_2 x\Rightarrow 2^{\log_2(x+3)+\log_2(x+10)}=2^{2+2\log_2 x}\Rightarrow(x+3)(x+10)=4x^2$

$\Rightarrow 3x^2-13x-30=0$ *

Also scores **M1(implied)dM1A0** (lack of working)

(b)(i)

B1: Both values correct: $(x =)\ 6,\ -\dfrac{5}{3}$

(b)(ii)

B1: e.g. $(x \neq) -\dfrac{5}{3}$ and $\log_{(2)}\left(-\dfrac{5}{3}\right)$ is not real

This mark requires the identification of the **correct** negative root **and** an acceptable explanation.

For the identification of the root allow e.g. $x \neq -\dfrac{5}{3},\ x = -\dfrac{5}{3},\ -\dfrac{5}{3}$ etc. as long as it is clear they have identified the correct value. Requires the correct negative root $\left(-\dfrac{5}{3}\right)$ but the other may not be 6 but must be positive.

Some examples for the explanation:

- you get $\log_{(2)}\left(-\dfrac{5}{3}\right)$ which is not possible
- $\log -\dfrac{5}{3}$ is not possible, can't be found, gives a math error, is not real, is undefined
- if $\left\{k = \log_2\left(-\dfrac{5}{3}\right),\right\}\ 2^k = -\dfrac{5}{3}$ which is not possible
- you get log of a negative number
- negative numbers can't be "logged"
- log of negative does not work

Do not allow e.g.

- you can't have a negative log, logs can't be negative (unless clarified further)
- "you get a math error" in isolation
- a log cannot have a negative value
- logs cannot be negative
- $-\dfrac{5}{3}$ is not a valid input (unless clarified further)
- "it doesn't work in the logs"
- log graph isn't negative
- log graph does not cross negative x–axis
- x is only positive & negative answer does not work

Allow an implied correct answer if they say e.g. 6 is the root because $\log_{(2)}\left(-\dfrac{5}{3}\right)$ is not possible