Question Number	Scheme	Marks
4.(i)	Writes $\sqrt{128}$ as $2^{\frac{7}{2}}$ or 16 as 2^4	B1
	Attempts both powers of 2 and uses subtraction law $\Rightarrow \left(2^{3p-5} =\right) 2^{\frac{7}{2}-4}$	M1
	$\Rightarrow 3p-5=-\frac{1}{2} \Rightarrow p=\frac{3}{2}$	A1
		(3)
(ii)	$\left(x^2-2\right)^2 = x^2+18 \Rightarrow x^4-4x^2+4=x^2+18$	
	$\Rightarrow x^4-5x^2-14=0$	M1, A1
	$\Rightarrow \left(x^2-7\right)\left(x^2+2\right)=0 \Rightarrow x^2=...$	dM1
	$\Rightarrow x=\pm\sqrt{7}$	A1
		(4)
		(7 marks)

(i) Note B0M1A1 is possible
Note that they may rearrange the equation first. In such cases both the lhs and rhs will need to be written as powers of 2 (or e.g. 4)

B1: Correctly writes (not implied) either

- $\sqrt{128}$ as $2^{\frac{7}{2}}$ or $8\sqrt{2}$
- 16 as 2^4 (or may see $\frac{1}{16}$ written as 2^{-4})

Note they may write these numbers as e.g. $4^{...}$ which is an alternative method

M1: Proceeds to write $\frac{1}{16}\times\sqrt{128}$ as 2^n. The index does not need to be evaluated for this mark but must be correct e.g. $2^{\frac{7}{2}-4}$. This cannot be implied by $\left(3p-5=\right)-\frac{1}{2}$ but condone e.g. $3p-5=-4+\frac{7}{2}$ which shows they have added the powers and not relied on the use of a calculator.
May alternatively attempt to write both sides as powers of another number e.g. 4 or 8 which is acceptable.
Ignore the use of logs provided M1 is scored.

A1: $p=\frac{3}{2}$ oe provided M1 has been scored. If a calculator has clearly been relied on to solve then send to review.

(ii) Note they may work in another variable which is acceptable

M1: Multiplies out and simplifies to a 3TQ equation in x^2. The constant may be left on the other side of the equation. If terms are collected on one side then condone the omission of = 0

A1: Correct 3TQ equation in x^2 The constant may be left on the other side of the equation. The = 0 may be implied by further work.

dM1: Attempts to solve their 3TQ equation in x^2 by either factorisation, the formula or completing the square. See usual rules for solving a quadratic. It cannot be for just stating the roots via a calculator. It is dependent on the previous method mark.

A1: $x = \pm\sqrt{7}$ and no other solutions

Question Number	Scheme	Marks
5 (a)	$y = x^3 + 2x + 3 \Rightarrow \dfrac{\mathrm{d}y}{\mathrm{d}x} = 3x^2 + 2$ Gradient at $x = 2$ is $3 \times 2^2 + 2 = 14$	M1, A1 **(2)**
(b)	$y_Q = (2+h)^3 + 2(2+h) + 3 = 15 + 14h + 6h^2 + h^3$ Gradient PQ = $\dfrac{y_Q - y_P}{x_Q - x_P} = \dfrac{(15+14h+6h^2+h^3)-15}{2+h-2} = \dfrac{h^3+6h^2+14h}{h} = h^2 + 6h + 14$	M1, A1 dM1, A1 **(4)**
(c)	States as $h \to 0$ gradient of PQ tends to gradient of tangent	B1 **(1)** **(7 marks)**

(a) Note that no algebraic differentiation seen scores M0A0

M1: Attempts to substitute $x = 2$ into $\dfrac{\mathrm{d}y}{\mathrm{d}x} = ax^2 + b$. It can only be implied by 14 provided a correct derivative is seen.

A1: 14 provided M1 is scored. Minimum acceptable e.g. $3x^2 + 2 = 14$ Do not isw if e.g. they change 14 to $-\dfrac{1}{14}$

(b)

M1: Attempts to substitute $2 + h$ into $x^3 + 2x + 3$ and expand so that all brackets have been removed. Condone slips in expanding and any miscopying slips provided the intention is clear.

A1: $15 + 14h + 6h^2 + h^3$ but allow if the terms are not collected. May be implied by further work.

dM1: Dependent on the previous method mark.

Scored for attempting $\dfrac{y_Q - y_P}{x_Q - x_P} = \dfrac{('15+14h+6h^2+h^3')-15}{2+h-2}$ oe i.e. they must be subtracting the correct way round consistently for both the numerator and denominator.

The expression is sufficient and condone invisible brackets provided the intention is clear. May be implied by further work i.e. if all terms are divided by h already.

A1: $h^2 + 6h + 14$
