

Question	Scheme	Marks	AOs
2(i)	$p + q + r = 2, \quad pq + pr + qr = 4, \quad pqr = 5$	B1	3.1a
	$\frac{2}{p} + \frac{2}{q} + \frac{2}{r} = \frac{2(pq + pr + qr)}{pqr}$	M1	1.1b
	$= \frac{8}{5}$	A1ft	1.1b
		(3)	
	Alternative for part (i)		
	$x = \frac{2}{y} \Rightarrow \frac{8}{y^3} - \frac{8}{y^2} + \frac{8}{y} - 5 = 0 \Rightarrow 5y^3 - 8y^2 + 8y - 8 = 0$	B1	3.1a
	$\frac{2}{p} + \frac{2}{q} + \frac{2}{r} = -\frac{8}{5}$	M1	1.1b
	$= \frac{8}{5}$	A1ft	1.1b
		(3)	
(ii)	$(p-4)(q-4)(r-4) = (pq - 4p - 4q + 16)(r-4)$ $= pqr - 4pq - 4pr - 4qr + 16p + 16q + 16r - 64$	M1 A1	1.1b 1.1b
	$(= pqr - 4(pq + pr + qr) + 16(p + q + r) - 64)$		
	$= 5 - 4(4) + 16(2) - 64 = -43$	A1	1.1b
		(3)	
	Alternative for part (ii)		
	$(x+4)^3 - 2(x+4)^2 + 4(x+4) - 5 = 0$	M1	1.1b
	$= \dots 64 + \dots - 32 + \dots 16 + \dots - 5 = 43$	A1	1.1b
	$\therefore (p-4)(q-4)(r-4) = -43$	A1	1.1b
		(3)	
(iii)	E.g. $p^3 + q^3 + r^3 =$ $= (p+q+r)^3 - 3(p+q+r)(pq + pr + qr) + 3pqr$ or $= (p+q+r)((p+q+r)^2 - 2(pq + pr + qr) - pq - pr - qr) + 3pqr$ or $= 2((p+q+r)^2 - 2(pq + pr + qr)) - 4(p+q+r) + 3pqr$ $\Rightarrow p^3 + q^3 + r^3 = \dots$	M1	3.1a
	$= 2^3 - 3(2)(4) + 3(5) = -1$ $= 2(2^2 - 3(4)) + 3(5) = -1$ $= 2(2^2 - 2(4)) - 4(2) + 3(5) = -1$	A1	1.1b
		(2)	

	Alternative for part (iii)		
	$p^3 - 2p^2 + 4p - 5 = 0, q^3 - 2q^2 + 4q - 5 = 0, r^3 - 2r^2 + 4r - 5 = 0$ $p^3 + q^3 + r^3 - 2(p^2 + q^2 + r^2) + 4(p + q + r) - 15 = 0$ $p^3 + q^3 + r^3 = 2((p + q + r)^2 - 2(pq + pr + qr)) - 4(p + q + r) + 15$ $\Rightarrow p^3 + q^3 + r^3 = \dots$	M1	3.1a
	$= 2(2^2 - 2(4)) - 4(2) + 15 = -1$	A1	1.1b
		(2)	

(8 marks)

Notes

- (i)
 B1: Identifies the correct values for all 3 expressions (can score anywhere). Allow notation such as $\sum p$, $\sum pq$ for the sum and pair sum.
 M1: Uses a correct identity for the sum
 A1ft: Correct value (follow through their 2, 4 and 5)
Alternative:
 B1: Obtains the correct cubic in “y”
 M1: Uses a correct method
 A1ft: Correct value (follow through their 2, 4 and 5)
- (ii)
 M1: Attempt to expand – must have an expression that involves the sum, pair sum and product
 A1: Correct expansion
 A1: Correct value
Alternative:
 M1: Substitutes $x + 4$ for x in the given cubic
 A1: Calculates the correct constant term
 A1: Correct value
- (iii)
 M1: Establishes a correct identity that is in terms of the sum, pair sum and product and substitutes to reach a numerical expression for $p^3 + q^3 + r^3$
 A1: Correct value