4 Given that $f(x) = x^4 - 1$:

(a) write down the value of $f(-1)$; *(1 mark)*

(b) show that $f(-1 + h) = -4h + 6h^2 - 4h^3 + h^4$; *(3 marks)*

(c) hence find the value of $f'(-1)$. *(2 marks)*

4(a)	$f(-1) = 0$	B1	1	
(b)	$(-1 + h)^4 = 1 - 4h + 6h^2 - 4h^3 + h^4$	M1A1		M1 for two correct terms
	Hence result	A1	3	ag convincingly shown
(c)	$\frac{f(-1+h) - f(-1)}{(-1+h) - (-1)} = -4$ + terms in h	M1		
	So $f'(-1) = -4$	A1	2	
	Total		**6**	

4 The function f is defined for all real values of x by

$$f(x) = x^3 + x$$

(a) Express $f(2 + h) - f(2)$ in the form

$$ph + qh^2 + rh^3$$

where p, q and r are integers. *(5 marks)*

(b) Use your answer to part (a) to find the value of $f'(2)$. *(2 marks)*

4(a)	$(2 + h)^3 = 8 + ah + bh^2 + h^3$	M1		
	$(2 + h)^3 = 8 + 12h + 6h^2 + h^3$	A1A1		A1 for each of a, b ; PI
	$f(2 + h) - f(2) = 13h + 6h^2 + h^3$	m1A1F	5	Ft one coeff. wrong
(b)	Divide by h and let $h \to 0$	M1		NMS B1F
	$f'(2) = p = 13$	A1F	2	ft wrong value of p
	Total		**7**	

4 For each of the following improper integrals, find the value of the integral **or** explain briefly why it does not have a value:

(a) $\int_2^\infty 8x^{-3}\,\mathrm{d}x$; *(3 marks)*

(b) $\int_2^\infty (8x^{-3}+1)\,\mathrm{d}x$; *(1 mark)*

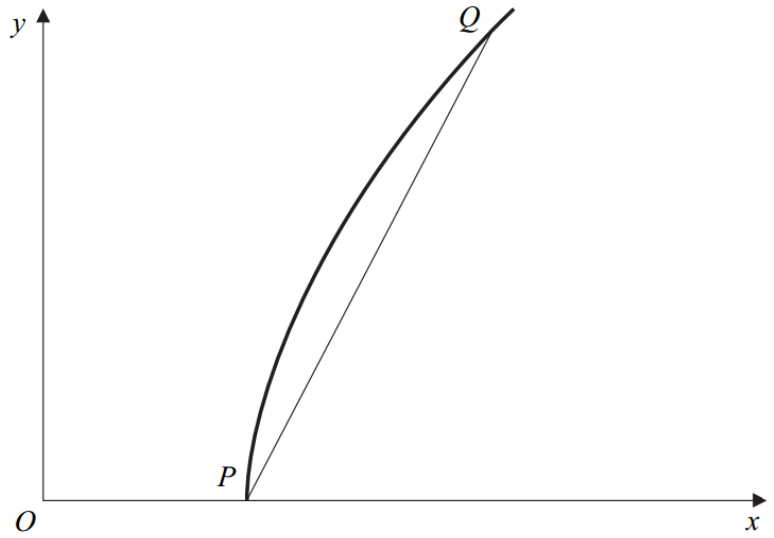
(c) $\int_2^\infty 8x^{-3}(x+1)\,\mathrm{d}x$. *(3 marks)*

Q	Solution	Marks	Totals	Comments
4(a)	$\int x^{-3}\,\mathrm{d}x = kx^{-2}(+c)$	M1		
	$x^{-n} \to 0$ as $x \to \infty$	M1		
	Improper integral has value 1	A1	3	
(b)	No value as x term tends to ∞	B1	1	OE
(c)	$\int x^{-2}\,\mathrm{d}x = kx^{-1}(+c)$	M1		
	$x^{-1} \to 0$ as $x \to \infty$	m1		
	Improper integral has value 5	A1	3	
	Total		**7**	

8 The diagram shows a part of the curve

$$\frac{x^2}{4} - \frac{y^2}{6} = 1$$

and a chord PQ of the curve, where P lies on the x-axis.



(a) Write down the coordinates of P. *(1 mark)*

(b) The gradient of the chord PQ is 2. Find the coordinates of Q. *(7 marks)*

8(a)	P is (2, 0)	B1	1	
(b)	PQ is $y = 2(x - 2)$	M1A1F		ft wrong value for x_P
	Elimination of y (or of x)	m1A1F		ft numerical error
	$(x - 2)(5x - 22) = 0$	A1		
	Q is (4.4, 4.8)	A1A1	7	
	Total		**8**	