2.4 Polynomials: factor theorem and roots

Name: _____ Class: _____ Date: _____ **Total: 20 marks**

KEY WORDS polynomial • factor theorem • remainder theorem • root • repeated root • cubic

Objective

Build the skills to answer exam questions on **polynomials** : the factor and remainder theorems, factorising cubics, and the sum and product of roots.

You must be able to:

- use the factor and remainder theorems
- factorise a cubic and solve polynomial equations and inequalities
- use the sum and product of the roots of a polynomial
- sketch polynomial graphs, using repeated roots and end behaviour

1 Key knowledge and worked examples

■ Polynomials

result	statement
remainder theorem	$p(x) \div (x-a)$ leaves remainder $p(a)$
factor theorem	$(x-a)$ is a factor $\Leftrightarrow p(a)=0$
sum of roots of $a_n x^n + a_{n-1}x^{n-1} + \cdots + a_0$	$-\dfrac{a_{n-1}}{a_n}$
product of roots	$\dfrac{(-1)^n a_0}{a_n}$

Graphs: at a single root the graph crosses the axis; at a **double** root it **touches**; at a triple root it flattens as it crosses.

Worked example. $p(x) = x^3 - 2x^2 - 5x + 6$. $p(1) = 1 - 2 - 5 + 6 = 0$, so $(x-1)$ is a factor. Comparing coefficients:

$$p(x) = (x-1)(x^2 - x - 6) = (\mathbf{x-1})(\mathbf{x-3})(\mathbf{x+2})$$

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Check: sum of roots $1 + 3 - 2 = 2 = -\dfrac{-2}{1}$.

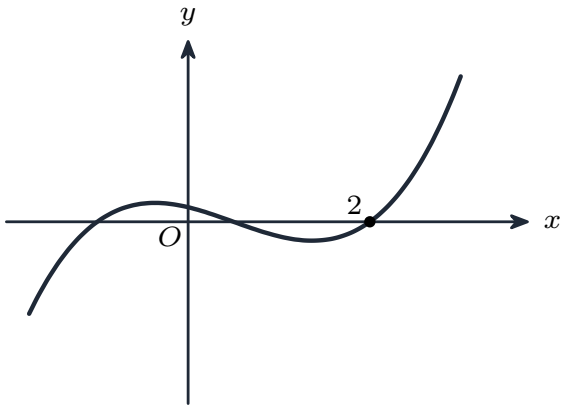
Answer shapes: show the value $p(a)$; for inequalities, use the roots and a sketch.

2 Practice

2.1 Find the remainder when $x^3 + 2x - 7$ is divided by $(x - 2)$. [2]

$$x - 2 \overline{\left| \, x^3 + 0x^2 + 2x - 7 \right.}$$

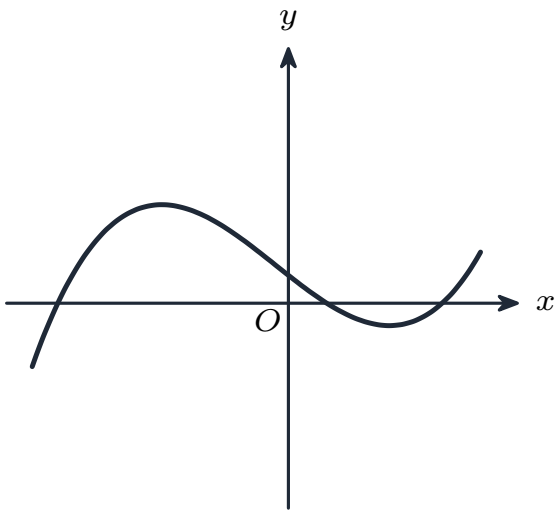
2.2 $p(x) = x^3 + ax^2 + bx - 6$. $(x - 2)$ is a factor of $p(x)$, and the remainder when $p(x)$ is divided by $(x + 1)$ is -12. Find a and b. [3]



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3 Exam-style questions

3.1 $p(x) = 2x^3 + x^2 - 13x + 6$.

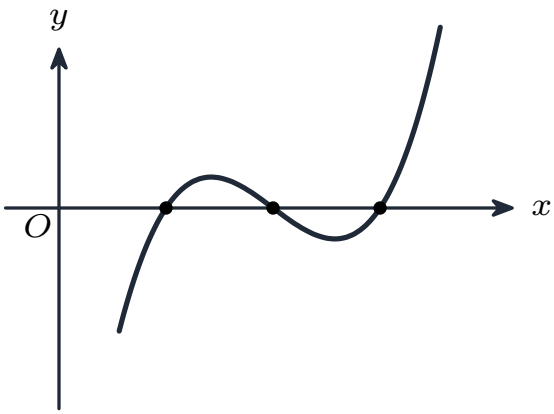


(a) Show that $(x - 2)$ is a factor of $p(x)$. [2]

(b) Factorise $p(x)$ fully. [3]

(c) Solve $p(x) < 0$. [2]

3.2 The equation $x^3 - 6x^2 + kx - 6 = 0$ has roots 1, 2 and γ.



(a) Use the sum of the roots to find γ. [2]

(b) Show that the product of the roots agrees with your answer to (a). [1]

(c) Find k. [2]

(d) Write down the y-intercept of $y = x^3 - 6x^2 + kx - 6$. [1]

(e) Solve $x^3 - 6x^2 + kx - 6 > 0$. [2]

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