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Test / Exam Name: Polynomials **Standard: 9th** **Subject: Mathematics**

Instructions

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Q1. Verify that: **3 Marks**

$$x^3 + y^3 + z^3 - 3xyz = \frac{1}{2}(x + y + z)\left[(x - y)^2 + (y - z)^2 + (z - x)^2\right]$$

Ans: We know that,

$$x^3 + y^3 + z^3 - 3xyz = \frac{1}{2}(x + y + z)\left[(x - y)^2 + (y - z)^2 + (z - x)^2\right]$$
$$x^3 + y^3 + z^3 - 3xyz = \frac{1}{2}(x + y + z)2(x^2 + y^2 + z^2 - xy - yz - xz)$$
$$= \frac{1}{2}(x + y + z)(2x^2 + 2y^2 + 2z^2 - 2xy - 2yz - 2xz)$$
$$= \frac{1}{2}(x + y + z)\left[(x^2 + y^2 - 2xy) + (y^2 + z^2 - 2yz) + (x^2 + z^2 - 2xz)\right]$$
$$= \frac{1}{2}(x + y + z)\left[(x - y)^2 + (y - z)^2 + (z - x^2)\right]$$

Q2. Factorize the following expressions: **3 Marks**

$a^3 + 3a^2b + 3ab^2 + b^3 - 8$

Ans: $= (a + b)^3 - 8$

$\left[\therefore a^3 + 3a^2b + 3ab^2 + b^3 = (a + b)3\right]$

$= (a + b)^3 - 23$

$= (a + b - 2)((a + b)^2 + (a + b) \times 2 + 2^2)$

$= (a + b - 2)(a^2 + 2ab + b^2 + 2a + 2b + 4)$

$\therefore a^3 + 3a^2b + 3ab^2 + b^3 - 8 = (a + b - 2)(a^2 + 2ab + b^2 + 2a + 2b + 4)$

Q3. Write the following cubes in expanded form: **3 Marks**

$(2a - 3b)^3$

Ans: $(2a – 3b)^3$

Using identity, $(a - b)^3 = a^3 - b^3 - 3ab(a - b)$

$(2a – 3b)^3 = (2a)^3 - (3b)^3 - (3 \times 2a \times 3b)(2a - 3b)$

$= 8a^3 - 27b^3 - 18ab(2a - 3b)$

$= 8a^3 - 27b^3 - 36a^2b + 54ab^2$

Q4. If $a - b = 6$ and $ab = 20$, find the value of $a^3 - b^3$. **3 Marks**

Ans: We have,

$a^3 - b^3 = (a - b)(a^2 + ab + b^2)$

$= (a - b)(a^2 + ab + b^2 - 2ab + 2ab)$ [Adding and substracting 2ab in the second break]

$= (a - b)\left[(a^2 + b^2 - 2ab) + 3ab\right]$

$= (a - b)\left[(a - b)^2 + 3ab\right]$ $\left[\because (a - b)^2 = a^2 + b^2 - 2ab\right]$

$= 6 \times \left[(6)^2 + 3 \times 20\right]$ $\left[\because a - b = 6 \text{ and } ab = 20\right]$

$= 6 \times [36 + 60]$

$= 6 \times 96$

$= 576$

$\therefore a^3 - b^3 = 576$

Q5. Factorise: **3 Marks**

$(5a - 7b)^3 + (7b - 9c)^3 + (9c - 5a)^3$

Ans: Put $(5a - 7b) = x$, $(7b - 9c) = y$, $(9c - 5a) = z$.

Here,

x + y + z = 5a - 7b + 9c - 5a + 7b - 9c = 0
Thus,
We have:
$(5a - 7b)^3 + (9c - 5a)^3 + (7b - 9c)^3 = x^3 + z^3 + y^3$
= 3xyz [When x + y + z = 0, $x^3 + y^3 + z^3 = 3xyz$]
= 3(5a - 7b)(9c - 5a)(7b - 9c)

Q6. If x + y + z = 0, show that $x^3 + y^3 + z^3 = 3xyz$ **3 Marks**

Ans: We know that,
$x^3 + y^3 + z^3 - 3xyz = (x + y + z)(x^2 + y^2 + z^2 - xy - yz - xz)$
Now put (x + y + z) = 0,
$x^3 + y^3 + z^3 - 3xyz = (0)(x^2 + y^2 + z^2 - xy - yz - xz)$
$\Rightarrow x^3 + y^3 + z^3 - 3xyz = 0$

Q7. Factorise the following: **3 Marks**
$27p^3 - \frac{1}{216} - \frac{9}{2}p^2 + \frac{1}{4}$

Ans: $27p^3 - \frac{2}{216} - \frac{9}{2}p^2 + \frac{1}{4}p$
Using identity, $(a - b)^3 = a^3 - b^3 - 3a^2b + 3ab^2$
$27p^3 - \frac{2}{216} - \frac{9}{2}p^2 + \frac{1}{4}p$
$= (3p)^3 - \left(\frac{1}{6}\right)^3 - 3(3p)^2\left(\frac{1}{6}\right) + 3(3p)\left(\frac{1}{6}\right)^2$
$= \left(3p - \frac{1}{6}\right)^3$
$= \left(3p - \frac{1}{6}\right)\left(3p - \frac{1}{6}\right)\left(3p - \frac{1}{6}\right)$

Q8. If a + b + c = 9 and ab + bc + ca = 26, find $a^2 + b^2 + c^2$. **3 Marks**

Ans: We have that $(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + bc + 2ca$
$\Rightarrow (a + b + c)^2 = (a^2 + b^2 + c^2) + 2(ab + bc + ca)$
$\Rightarrow 9^2 = (a^2 + b^2 + c^2) + 2(26)$
[Putting the value of a + b + c and ab + bc + ca]
$\Rightarrow 81 = (a^2 + b^2 + c^2) + 52$
$\Rightarrow (a^2 + b^2 + c^2) = 81 - 52 = 29$

Q9. Evaluate the following: **3 Marks**
$(99)^3$

Ans: We know that $(a - b)^3 = a^3 - b^3 - 3ab(a - b)$
$\Rightarrow (99)^3$ can be written as $(100 - 1)^3$
Here, a = 100 and b = 1
$(99)^3 = (100 - 1)^3$
$= (100)^3 - (1)^3 - 3(100)(1)(100 - 1)$
= 1000000 - 1 - (300 × 99)
= 1000000 - 1 - 29700
= 1000000 - 29701
= 970299
The value of $(99)^3 = 970299$

Q10. Factorise: **3 Marks**
$2x^2 + y^2 + 8z^2 - 2\sqrt{2}xy + 4\sqrt{2}yz - 8zx$

Ans: $2x^2 + y^2 + 8z^2 - 2\sqrt{2}xy + 4\sqrt{2}yz - 8xz$
Using identity $(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2bc + 2ca$
$2x^2 + y^2 + 8z^2 - 2\sqrt{2}xy + 4\sqrt{2}yz - 8xz$
$= \left(-\sqrt{2}x\right)^2 + (y)^2 + \left(2\sqrt{2}z\right)^2 + \left(2 \times -\sqrt{2}x \times y\right)$
$+ \left(2 \times y \times 2\sqrt{2}z\right) + \left(2 \times 2\sqrt{2}z \times -\sqrt{2}x\right)$
$= \left(-\sqrt{2}x + y + 2\sqrt{2}z\right)^2$

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$= \left(- \sqrt{2}x + y + 2\sqrt{2}z \right) \left(- \sqrt{2}x + y + 2\sqrt{2}z \right)$

Q11. Factorise: **3 Marks**

$8a^3 - b^3 - 12a^2b + 6ab^2$

Ans: $8a^3 - b^3 - 12a^2b + 6ab^2$

Using identity, $(a - b)^3 = a^3 - b^3 - 3a^2b + 3ab^2$

$8a^3 - b^3 - 12a^2b + 6ab^2 = (2a)^3 - b^3 - 3(2a)^2b + 3(2a)(b)^2$

$= (2a - b)^3$

$= (2a - b)(2a - b)(2a - b)$

Q12. Evaluate the following using suitable identities: **3 Marks**

$(102)^3$

Ans: $(102)^3 = (100 + 2)^3$

Using identity, $(a + b)^3 = a^3 + b^3 + 3ab(a + b)$

$(100 + 2)^3 = (100)^3 + 2^3 + (3 \times 100 \times 2)(100 + 2)$

$= 1000000 + 8 + 600(100 + 2)$

$= 1000000 + 8 + 60000 + 1200$

$= 1061208$

Q13. Simplify: **3 Marks**

$\frac{173 \times 173 \times 173 + 127 \times 127 \times 127}{173 \times 173 - 173 \times 127 + 127 \times 127}$

Ans: $\frac{173 \times 173 \times 173 + 127 \times 127 \times 127}{173 \times 173 - 173 \times 127 + 127 \times 127}$

$= \frac{173^3 + 127^3}{173^2 - 173 \times 127 + 127^2}$

$= \frac{(173 + 127)(173^2 - 173 \times 127 + 127^2)}{173^2 - 173 \times 127 + 127^2}$

$\left[\therefore a^3 + b^3 = (a + b)(a^2 - ab + b^2) \right]$

$= (173 + 127)$

$= 300$

Q14. Factorize the following expressions: **3 Marks**

$8x^3 - 125y^3 + 180xy + 216$

Ans: $8x^3 - 125y^3 + 180xy + 216$

or, $8x^3 - 125y^3 + 216 + 180xy$

$= (2x)^3 + (-5y)^3 + 6^3 - 3 \times (2x)(-5y)(6)$

$= (2x + (-5y) + 6)((2x)^2 + (-5y)^2 + 6^2 - 2x(-5y) - (-5y)6 - 6(2x))$

$= (2x - 5y + 6)(4x^2 + 25y^2 + 36 + 10xy + 30y - 12x)$

$\therefore 8x^3 - 125y^3 + 180xy + 216$

$= (2x - 5y + 6)(4x^2 + 25y^2 + 36 + 10xy + 30y - 12x)$

Q15. Factorise: **3 Marks**

$x^3 + x^2 - 4x - 4$

Ans: Let $p(x) = x^3 + x^2 - 4x - 4$

Constant term of $p(x) = -4$

$\therefore$ Factors of -4 are $\pm 1, \pm 2, \pm 4$

By trial, we find that $p(-1) = 0$, so $(x + 1)$ is a factor of $p(x)$.

Now, we see that $x^3 + x^2 - 4x - 4$

$= x^2(x + 1) - 4(x + 1)$

$= (x + 1)(x^2 - 4)$ [taking $(x + 1)$ common factor]

Now, $x^2 - 4 = x^2 - 2^2$

$= (x + 2)(x - 2)$ [Using identity, $a^2 - b^2 = (a - b)(a + b)$]

$\therefore x^3 + x^2 - 4x - 4 = (x + 1)(x - 2)(x + 2)$

Q16. Factorise: **2 Marks**

$6x^2 - 11x - 35$

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Ans: $6x^2 - 11x - 35$

$= 6x^2 - 21x + 10x - 35$

$= 3x(2x - 7) + 5(2x - 7)$

$= (2x - 7)(3x + 5)$

Q17. Evaluate the following products without multiplying directly: **2 Marks**

103×107

Ans: $103 \times 107 = (100 + 3)(100 + 7)$

Using identity, $(x + a)(x + b) = x^2 + (a + b)x + ab$

Here, $x = 100$, $a = 3$ and $b = 7$

$103 \times 107 = (100 + 3)(100 + 7) = (100)^2 + (3 + 7)10 + (3 \times 7)$

$= 10000 + 100 + 21$

$= 10121$

Q18. Find the following product: **2 Marks**

$\left(\frac{x}{2} + 2y\right)\left(\frac{x^2}{4} - xy + 4y^2\right)$

Ans: $\left(\frac{x}{2} + 2y\right)\left(\frac{x^2}{4} - xy + 4y^2\right)$

$= \left(\frac{x}{2} + 2y\right)\left\{\left(\frac{x}{2}\right)^2 - \left(\frac{x}{2}\right)(2y) + (2y)^2\right\}$

$= \left(\frac{x}{2}\right)^3 + (2y)^3 \left[\therefore (a + b)(a^2 - ab + b^2) = a^3 + b^3\right]$

$= \frac{x}{8}^3 + 8y^3$

Q19. Factorise: **2 Marks**

$x^2 - x - 156$

Ans: $x^2 - x - 156$

$= x^2 - 13x + 12x - 156$

$= x(x - 13) + 12(x - 13)$

$= (x - 13)(x + 12)$

Q20. Write the following in the expanded form: **2 Marks**

$(-3x + y + z)^2$

Ans: We have,

$(-3x + y + z)^2 = [(-3x)^2 + y^2 + z^2 + 2(-3x)y + 2yz + 2(-3x)z]$

$\left[\therefore (x + y + z)^2 = x^2 + y^2 + z^2 + 2xy + 2yz + 2xz\right]$

$9x^2 + y^2 + z^2 - 6xy + 2yz - 6xz$

$(-3x + y + z)^2 = 9x^2 + y^2 + z^2 - 6xy + 2xy - 6xz$

Q21. Factorise: **2 Marks**

$x^2 + 5\sqrt{5}x + 30$

Ans: $x^2 + 5\sqrt{5}x + 30$

$= x^2 + 2\sqrt{5}x + 3\sqrt{5}x + 30$

$= x(x + 2\sqrt{5}) + 3\sqrt{5}(x + 2\sqrt{5})$

$= (x + 2\sqrt{5})(x + 3\sqrt{5})$

Q22. Factorise: **2 Marks**

$x^2 - 32x - 105$

Ans: $x^2 - 32x - 105$

$= x^2 - 35x + 3x - 105$

$= x(x - 35) + 3(x - 35)$

$= x(x - 35)(x + 3)$

Q23. Factorise: **2 Marks**

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$81x^4 - y^4$

Ans: $81x^4 - y^4$

$= (9x^2)^2 - (y^2)^2$

$= (9x^2 - y^2)(9x^2 + y^2)$

$= [(3x)^2 - y^2](9x^2 + y^2)$

$= (3x - y)(3x + y)(9x^2 + y^2)$

Q24. Evaluate the following products without multiplying directly: **2 Marks**

95×96

Ans: $95 \times 96 = (90 + 5)(90 + 4)$

Using identity, $(x + a)(x + b) = x^2 + (a + b)x + ab$

Here, x = 90, a = 5 and b = 4

$95 \times 96 = (90 + 5)(90 + 4) = 90^2 + 90(5 + 6) + (5 \times 6)$

$= 8100 + (11 \times 90) + 30$

$= 8100 + 990 + 30$

$= 9120$

Q25. Factorise: **2 Marks**

$x^2 + 11x + 30$

Ans: $x^2 + 11x + 30$

$= x^2 + 6x + 5x + 30$

$= x(x + 6) + 5(x + 6)$

$= (x + 6)(x + 5)$

Q26. Without actually calculating the cubes, find the value of: **2 Marks**

$\left(\frac{1}{2}\right)^3 + \left(\frac{1}{3}\right)^3 - \left(\frac{5}{6}\right)^3$

Ans: Given, $\left(\frac{1}{2}\right)^3 + \left(\frac{1}{3}\right)^3 - \left(\frac{5}{6}\right)^3$ or $\left(\frac{1}{2}\right)^3 + \left(\frac{1}{3}\right)^3 + \left(-\frac{5}{6}\right)^3$

Here, we see that, $\frac{1}{2} + \frac{1}{3} - \frac{5}{6} = \frac{3+2-5}{6} = \frac{5-5}{6} = 0$

$\therefore \left(\frac{1}{2}\right)^3 + \left(\frac{1}{3}\right)^3 - \left(\frac{5}{6}\right)^3 = 3 \times \frac{1}{2} \times \frac{1}{3} \times \left(-\frac{5}{6}\right) = -\frac{5}{12}$

[Using identity, if a + b + c = 0, then $a^3 + b^3 + c^3 = 3abc$]

Q27. Expand: **2 Marks**

$\left(\frac{1}{2}a - \frac{1}{4}b + 2\right)^2$

Ans: $\left(\frac{1}{2}a - \frac{1}{4}b + 2\right)^2 = \left[\left(\frac{a}{2}\right) + \left(-\frac{b}{4}\right) + (2)\right]^2$

$= \left(\frac{a}{2}\right)^2 + \left(-\frac{b}{4}\right)^2 + (2)^2$

$+ 2\left(\frac{a}{2}\right) \times \left(\frac{-b}{4}\right)(2) + 2\left(\frac{a}{2}\right)(2)$

$= \frac{a^2}{4} + \frac{b^2}{16} + 4 - \frac{ab}{4} - b + 2a$

Q28. Factorize the following expressions: **2 Marks**

$64a^3 - b^3$

Ans: $64a^3 - b^3$

$= (4a)^3 - b^3$

$= (4a - b)((4a)^2 + 4a \times b + b^2)$

$\therefore [a^3 - b^3 = (a - b)(a^2 + ab + b^2)]$

$= (4a - b)(16a^2 + 4ab + b^2)$

$\therefore 64a^3 - b^3 = (4a - b)(16a^2 + 4ab + b^2)$

Q29. Expand the following: **2 Marks**

$\left(\frac{1}{x} + \frac{y}{3}\right)^3$

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Ans: $\left(\frac{1}{x}+\frac{y}{3}\right)^3=\left(\frac{1}{x}\right)^3+\left(\frac{y}{3}\right)^3+3\left(\frac{1}{x}\right)\left(\frac{y}{3}\right)\left(\frac{1}{x}+\frac{y}{3}\right)$

[Using identity, $(a - b)^3 = a^3 - b^3 + 3a(-b)(a - b)$]

$=\frac{1}{x^3}+\frac{y^3}{27}+\frac{y}{x}=\left(\frac{1}{x}+\frac{y}{3}\right)$

$=\frac{1}{x^3}+\frac{y^3}{27}+\frac{y}{x^2}+\frac{y^2}{3x}$

Q30. Factorise the following: **2 Marks**

$$\left(2x+\frac{1}{3}\right)^2-\left(x-\frac{1}{2}\right)^2$$

Ans: $\left(2x+\frac{1}{3}\right)^2-\left(x-\frac{1}{2}\right)^2$

$=\left[\left(2x+\frac{1}{3}\right)-\left(x-\frac{1}{2}\right)\right]\left[\left(2x+\frac{1}{3}\right)+\left(x-\frac{1}{2}\right)\right]$

[Using identity, $a^2 - b^2 = (a - b)(a + b)$]

$=\left(2x-x+\frac{1}{3}+\frac{1}{2}\right)\left(2x+x+\frac{1}{3}-\frac{1}{2}\right)$

$=\left(x+\frac{2+3}{6}\right)\left(3x+\frac{2-3}{6}\right)$

$=\left(x+\frac{5}{6}\right)\left(3x-\frac{1}{6}\right)$

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