

Functions and Trigonometry Summer Work

2020

Instructions

This work consists of Algebra II concepts that you are expected to have mastered upon entering Functions and Trig.

All problems in this packet should be completed on lined notebook paper. Work should be shown for all problems. Your work will be collected during the first week of school in the fall, and you will be tested over this material.

At the beginning of each section you will find example problems and links to videos that you may find helpful.

Answers to all problems can be found at the end of this packet.

Section A – Evaluating Exponential Expressions

Exponential expressions are of the form a^n . The integer n is the exponent and a is the base.

Example 1 $4^3 = 4 \times 4 \times 4 = 64$

Example 2 $(-6)^2 = (-6)(-6) = 36$

Example 3 $-6^2 = -(6 \times 6) = -36$

Example 4 $4 \times 3^2 = 4 \times 3 \times 3 = 36$

Example 5 $(4 \times 3)^2 = 12^2 = 12 \times 12 = 144$

Video Link: <https://www.youtube.com/watch?v=vBVK2fkciaE>

Section A – Exercises

A1) -2^4 A2) -3^5 A3) $(-2)^4$ A4) -2^6

A5) $(-3)^5$ A6) $(-2)^5$ A7) $-2(3)^4$ A8) $-4(-5)^3$

Section B – Order of Operations

Step 1 – Work separately above and below a fraction bar

Step 2 – If there are parenthesis or square brackets start with the innermost set and work outward

Step 3 – Simplify all powers and roots working from left to right

Step 4 – Do any multiplication or division working from left to right

Step 5 – Do any addition or subtractions working from left to right

Example 1 $6 \div 3 + 2^3 (5) =$

$$2 + 8 (5) =$$

$$2 + 40 = 42$$

Example 2 $(8 + 6) \div 7(3) - 6 =$

$$14 \div 7(3) - 6 =$$

$$2(3) - 6 =$$

$$6 - 6 = 0$$

Example 3 $\frac{4+3^2}{6-5(3)} =$
 $\frac{4+9}{6-15} = -\frac{13}{9}$

Example 4

$$\frac{-(-3)^3 + (-5)}{2(-8) - 5(3)} =$$

$$\frac{-(-27) + (-5)}{-16 - 15} =$$

$$\frac{27 + (-5)}{-31} = \frac{22}{-31}$$

Video Link: <https://www.youtube.com/watch?v=zEnk8B7RkU4>

Section B – Exercises

B1) $-2 \times 5 + 12 \div 3$

B2) $-4(9 - 8) + (-7)(2)^3$

B3) $(4 - 2^3)(-2 + \sqrt{25})$

B4) $\left(-\frac{2}{9} - \frac{1}{4}\right) - \left[-\frac{5}{18} - \left(-\frac{1}{2}\right)\right]$

B5) $\frac{-8 + (-4)(-6) \div 12}{4 - (-3)}$

Section C – Simplifying Expressions

Follow order of operations. Combine like terms. Simplify fractions.

Example 1 $3(x + y) = 3x + 3y$

Example 2 $-(m - 4n) = -m + 4n$

Example 3 $\frac{1}{3}\left(\frac{4}{5}m - \frac{3}{2}n - 27\right) = \frac{4}{15}m - \frac{1}{2}n - 9$

Video Link: <https://www.youtube.com/watch?v=8Tyh2jzCpCE>

Section C – Exercises

C1) $\frac{10}{11}(22z)$

C2) $\left(\frac{3}{4}r\right)(-12)$

C3) $(m + 5) + 6$

C4) $8 + (a + 7)$

C5) $\frac{3}{8}\left(\frac{16}{9}y + \frac{32}{27}z - \frac{40}{9}\right)$

C6) $-\frac{1}{2}(20m + 8y - 32z)$

Section D – Evaluating Absolute Value Expressions

Absolute value can be thought of as distance. The absolute value of a number is that number's distance from 0. Absolute value is always positive, because distance is always positive. With regard to order of operations, absolute value is a grouping symbol, just like parenthesis.

Example 1 $\left| -\frac{5}{8} \right| = \frac{5}{8}$

Example 2 $-|8| = -8$

Example 3 $-|-2| = -2$

Video Link: <https://www.youtube.com/watch?v=F3aQCTtb4C4>

Section D – Exercises

D1) $|-10|$ D2) $|-15|$ D3) $-\left| \frac{4}{7} \right|$ D4) $-\left| \frac{7}{2} \right|$

Let $x = -4$ and $y = 2$.

D5) $|x - y|$ D6) $|2x + 5y|$ D7) $\frac{2|y| - 3|x|}{|xy|}$ D8) $\frac{|-8y + x|}{-|x|}$

Section E – Product Rule for Exponents

When multiplying powers of like bases, keep the base and add the exponents.

$$(a^m)(a^n) = a^{m+n}$$

Example 1 $(y^4)(y^7) = y^{4+7} = y^{11}$

Example 2 $(6z^5)(9z^3)(2z^2) = (6)(9)(2)(z^{5+3+2}) = 108z^{10}$

Video Link: <https://www.youtube.com/watch?v=bDpl2u4TPGU>

Section E – Exercises

E1) $(9^3)(9^5)$ E2) $(4^2)(4^8)$ E3) $(-4x^2)(4x^2)$ E4) $(3y^4)(-6y^3)$ E5) $(n^6)(n^4)(n)$

E6) $(a^8)(a^5)(a)$ E7) $(-3m^4)(6m^2)(-4m^5)$ E8) $(-8t^3)(2t^6)(-5t^4)$

Section F – Power Rule for Exponents

To raise a power to a power, multiply exponents. Reminder – anything to the zero power is 1.

$$(a^m)^n = a^{mn}$$

Example 1 $(5^3)^2 = 5^6$

Example 2 $(3^4x^2)^3 = 3^{4(3)}x^{2(3)} = 3^{12}x^6$

Example 3 $\left(\frac{2^5}{b^4}\right)^3 = \frac{2^{5 \cdot 3}}{b^{4 \cdot 3}} = \frac{2^{15}}{b^{12}}$

Example 4 $\left(\frac{-2m^6}{t^2z}\right)^5 = \frac{(-2)^5(m^6)^5}{(t^2)^5z^5} = \frac{-32m^{30}}{t^{10}z^5}$

Video Link: <https://www.youtube.com/watch?v=7MZsfSgkV44>

Section F – Exercises

F1) $(2^2)^5$ F2) $(6^4)^3$ F3) $(-6x^2)^3$ F4) $(-2x^5)^5$ F5) $-(4m^3n^0)^2$

F6) $(2x^0y^4)^3$ F7) $\left(\frac{r^8}{s^2}\right)^3$ F8) $-\left(\frac{p^4}{q}\right)^2$ F9) $\left(\frac{-4m^2}{t}\right)^4$ F10) $\left(\frac{-5n^4}{r^2}\right)^3$

Section G – Adding and Subtracting Polynomials

Polynomials are added by adding (combining) like terms. When polynomials are subtracted, it is usually best to distribute the subtraction (distribute a negative 1) and then add.

Example 1 $(2y^4 - 3y^2 + y) + (4y^4 + 7y^2 + 6y) =$

$$2y^4 + 4y^4 + -3y^2 + 7y^2 + y + 6y =$$

$$6y^4 + 4y^2 + 7y$$

Example 2 $(-3m^3 - 8m^2 + 4) - (m^3 + 7m^2 - 3) =$

$$-3m^3 + -m^3 + -8m^2 + -7m^2 + 4 + 3 =$$

$$-4m^3 - 15m^2 + 7$$

Example 3 $4(x^2 - 3x + 7) - 5(2x^2 - 8x - 4) =$
 $4x^2 + -12x + 28 + -10x^2 + 40x + 20 =$
 $-6x^2 + 28x + 48$

Video Link: <https://www.youtube.com/watch?v=IDpnNnjFB1c>

Section G - Exercises

G1) $(5x^2 - 4x + 7) + (-4x^2 + 3x - 5)$

G2) $(3m^3 - 3m^2 + 4) + (-2m^3 - m^2 + 6)$

G3) $2(12y^2 - 8y + 6) - 4(3y^2 - 4y + 2)$

G4) $3(8p^2 - 5p) - 5(3p^2 - 2p + 4)$

Section H – Multiplying Polynomials

Every term in the first expression needs to be multiplied by every term in the second expression. (FOIL)

Example 1 $(6m + 1)(4m - 3) =$
 $23m^2 - 18m + 4m - 3 =$
 $23m^2 - 14m - 3$

Example 2 $(2x + 7)(2x - 7) =$
 $4x^2 - 14x + 14x - 49 =$
 $4x^2 - 49$

Example 3 $r^2(3r + 2)(3r - 2) =$
 $r^2(9r^2 - 6r + 6r - 4) =$
 $r^2(9r^2 - 4) =$
 $9r^4 - 4r^2$

Example 4 $(3p^2 - 4p + 1)(p^3 + 2p - 8) =$

$$3p^5 + 6p^3 - 24p^2 - 4p^4 - 8p^2 + 32p + p^3 + 2p - 8 =$$

$$3p^5 - 4p^4 + 7p^3 - 32p^2 + 34p - 8$$

Video Link:

https://www.youtube.com/watch?annotation_id=annotation_2909028083&feature=iv&src_vid=wUYa2NAV5t4&v=J18DrAkvaYg

Section H - Exercises

H1) $(4r - 1)(7r + 2)$ H2) $x^2 \left(3x - \frac{2}{3}\right) \left(5x + \frac{1}{3}\right)$ H3) $4x^2(3x^3 + 2x^2 - 5x + 1)$

H4) $(2z - 1)(-z^2 + 3z - 4)$ H5) $(m - n + k)(m + 2n - 3k)$

Section I – Factoring out the greatest common factor

First find the greatest common factor and divide every term by it.

Example 1 $9y^5 + y^2$ The greatest common factor is y^2

$$y^2(9y^3 + 1)$$

Example 2 $6x^2t + 8xt + 12t$ The greatest common factor is $2t$

$$2t(3x^2 + 4x + 6)$$

Video Link: <https://www.youtube.com/watch?v=3RJIPvX-3vg>

Section I Exercises

I1) $12m + 60$ I2) $8k^3 + 24k$ I3) $xy - 5xy^2$ I4) $-4p^3q^4 - 2p^2q^5$ I5) $4k^2m^3 + 8k^4m^3 - 12k^2m^4$

I6) $28r^4s^2 + 7r^3s - 35r^4s^3$

Section J – Factoring Trinomials

There are many methods for factoring trinomials. You may have been taught the box method, the AC method, guess and check, or something else. No matter what method you use, what you are doing is un-FOILing.

Example 1 $4y^2 - 11y + 6 = (y - 2)(4y - 3)$

Example 2 $6p^2 - 7p - 5 = (3p - 5)(2p + 1)$

Example 3 $2x^2 + 13x - 18 =$ cannot be factored

Example 4 $16y^3 + 24y^2 - 16y$ (pull out the greatest common factor first)

$$8y(2y^2 + 3y - 2) \text{ (now factor the trinomial)}$$

$$8y(2y - 1)(y + 2)$$

Video Link: Box Method <https://www.youtube.com/watch?v=WbCT-1VN8>

Another Method <https://www.youtube.com/watch?v=gqohYwpih8U>

AC Method <https://www.youtube.com/watch?v=NFZRoDDy2n8>

Section J Exercises

J1) $6a^2 - 11a + 4$ J2) $3m^2 + 14m + 8$ J3) $15p^2 + 24p + 8$ J4) $12a^3 + 10a^2 - 42a$

J5) $6k^2 + 5kp - 6p^2$ J6) $5a^2 - 7ab - 6b^2$ J7) $12x^2 - xy - y^2$ J8) $9m^2 - 12m + 4$

Section K – Simplifying Rational Expressions

You should always factor first, then factors can be cancelled. You can NEVER cancel terms.

Example 1
$$\frac{2p^2 + 7p - 4}{5p^2 + 20p} = \frac{(2p-1)(p+4)}{5p(p+4)} = \frac{2p-1}{5p}$$

Example 2
$$\frac{6-3k}{k^2-4} = \frac{3(2-k)}{(k+2)(k-2)} = \frac{3(-1)(k-2)}{(k+2)(k-2)} = \frac{-3}{k+2}$$

Video Link: <https://www.youtube.com/watch?v=MeS4FTGTb-c>

Section K Exercises

$$\text{K1)} \frac{8k+16}{9k+18} \quad \text{K2)} \frac{3(3-t)}{(t+5)(t-3)} \quad \text{K3)} \frac{8x^2+16x}{4x^2} \quad \text{K4)} \frac{m^2-4m+4}{m^2+m-6} \quad \text{K5)} \frac{8m^2+6m-9}{16m^2-9}$$

Section L – Multiplying and Dividing Rational Expressions

Again, ALWAYS factor first if possible.

If you can cancel anything, it will make the problem easier if you cancel factors first.

When multiplying, multiply straight across. In other words, multiply the numerators and then multiply the denominators.

When dividing, you will multiply by the reciprocal of the second fraction.

$$\text{Example 1} \quad \frac{2y^2}{9} \cdot \frac{27}{8y^5} = \frac{\cancel{2}y^{\cancel{2}}}{9} \cdot \frac{9 \cdot \cancel{3}}{\cancel{2}y^{\cancel{2}} \cdot 4y^3} = \frac{3}{4y^3}$$

$$\text{Example 2} \quad \frac{3m^2-2m-8}{3m^2+14m+8} \cdot \frac{3m+2}{3m+4} = \frac{(m-2)\cancel{(3m+4)}}{(m+4)\cancel{(3m+2)}} \cdot \frac{\cancel{3m+2}}{\cancel{3m+4}} = \frac{m-2}{m+4}$$

$$\begin{aligned} \text{Example 3} \quad \frac{3p^2+11p-4}{24p^3-8p^2} \div \frac{9p+36}{24p^4-36p^3} &= \frac{(p+4)(3p-1)}{8p^2(3p-1)} \div \frac{9(p+4)}{12p^3(2p-3)} = \frac{(p+4)\cancel{(3p-1)}}{8p^2\cancel{(3p-1)}} \div \frac{9(p+4)}{12p^3(2p-3)} = \\ &= \frac{\cancel{p+4}}{8p^2} \cdot \frac{4p^3(2p-3)}{3\cancel{(p+4)}} = \frac{p(2p-3)}{6} \end{aligned}$$

Video Link: <https://www.youtube.com/watch?v=WbvLjmK4Kmc>

Section L Exercises

$$\begin{aligned} \text{L1)} \quad & \frac{15p^3}{9p^2} \div \frac{6p}{10p^2} & \text{L2)} \quad & \frac{2k+8}{6} \div \frac{3k+12}{2} & \text{L3)} \quad & \frac{x^2+x}{5} \cdot \frac{25}{xy+y} & \text{L4)} \quad & \frac{4a+12}{2a-10} \div \frac{a^2-9}{a^2-a-20} \\ \text{L5)} \quad & \frac{p^2-p-12}{p^2-2p-15} \cdot \frac{p^2-9p+20}{p^2-8p+16} & \text{L6)} \quad & \frac{m^2+3m+2}{m^2+5m+4} \div \frac{m^2+5m+6}{m^2+10m+24} \end{aligned}$$

Section M – Adding and Subtracting Rational Expressions

To add or subtract two fractions (rational expressions), find the least common denominator and change each fraction (**multiply the top and the bottom**) to one with the least common denominator. Add or subtract the numerators, keep the denominator.

Example 1 $\frac{5}{9x^2} + \frac{1}{6x} = \frac{5(2)}{9x^2(2)} + \frac{1(3x)}{6x(3x)} = \frac{10}{18x^2} + \frac{3x}{18x^2} = \frac{10+3x}{18x^2}$

Example 2 $\frac{y}{y-2} + \frac{8}{2-y} = \frac{y}{y-2} + \frac{8(-1)}{(2-y)(-1)} = \frac{y}{y-2} + \frac{-8}{y-2} = \frac{y-8}{y-2}$

Example 3 $\frac{3}{(x-1)(x+2)} - \frac{1}{(x+3)(x-4)} = \frac{3(x+3)(x-4)}{(x-1)(x+2)(x+3)(x-4)} - \frac{1(x-1)(x+2)}{(x+3)(x-4)(x-1)(x+2)} =$
 $\frac{3(x^2-x-12)}{(x-1)(x+2)(x+3)(x+4)} + \frac{-1(x^2+x-2)}{(x-1)(x+2)(x+3)(x+4)} = \frac{3x^2-3x-36-x^2-x+2}{(x-1)(x+2)(x+3)(x+4)} =$
 $\frac{2x^2-4x-34}{(x-1)(x+2)(x+3)(x+4)}$

Video Link: <https://www.youtube.com/watch?v=d3xr5a4cIn0>

Section M Exercises

M1) $\frac{3}{2k} + \frac{5}{3k}$ M2) $\frac{1}{6m} + \frac{2}{5m} + \frac{4}{m}$ M3) $\frac{1}{a} - \frac{b}{a^2}$ M4) $\frac{5}{12x^2y} - \frac{11}{6xy}$ M5) $\frac{17y+3}{9y+7} - \frac{-10y-18}{9y+7}$

M6) $\frac{1}{x+z} + \frac{1}{x-z}$ M7) $\frac{3}{a-2} - \frac{1}{2-a}$ M8) $\frac{x+y}{2x-y} - \frac{2x}{y-2x}$ M9) $\frac{3x}{x^2+x-12} - \frac{x}{x^2-16}$

Section N – Negative Exponents and the Quotient Rule

If a number or variable has a negative exponent attached, the negative on the exponent means take the reciprocal. After you take the reciprocal, the negative is gone.

$$a^{-n} = \frac{1}{a^n}$$

When dividing powers of like bases, keep the base and subtract the exponents.

$$\frac{a^m}{a^n} = a^{m-n}$$

Remember that anything to the zero power is 1.

Example 1 $\frac{12^5}{12^3} = 12^3$

Example 2 $\frac{a^5}{a^{-8}} = a^{5-(-8)} = a^{13}$

Example 3 $\frac{16m^{-9}}{12m^{11}} = \frac{4}{3m^{20}}$

Example 4 $\frac{25r^7z^5}{10r^9z} = \frac{5z^4}{2r^2}$

Example 5 $3x^{-2}(4^{-1}x^{-5})^2 = 3x^{-2}4^{-2}x^{-10} = 3x^{-12}4^{-2} = \frac{3}{16x^{12}}$

Video Link: <https://www.youtube.com/watch?v=c4aiYf3fzVQ>

Section N Exercises

N1) $(-4)^{-3}$ N2) -5^{-4} N3) $\left(\frac{1}{3}\right)^{-2}$ N4) $(4x)^{-2}$ N5) $4x^{-2}$ N6) $-a^{-3}$

N7) $\frac{4^8}{4^6}$ N8) $\frac{x^{12}}{x^8}$ N9) $\frac{r^7}{r^{10}}$ N10) $\frac{6^4}{6^{-2}}$ N11) $\frac{4r^{-3}}{6r^{-6}}$ N12) $\frac{16m^{-5}n^4}{12m^2n^{-3}}$

N13) $-4r^{-2}(r^4)^2$ N14) $(5a^{-1})^4(a^2)^{-3}$ N15) $\frac{(p^{-2})^0}{5p^{-4}}$ N16) $\frac{(3pq)q^2}{6p^2q^4}$

N17) $\frac{4a^5(a^{-1})^3}{(a^{-2})^{-2}}$

Section O – Rational Exponents

$a^{1/n}$ is the same as the n th root of a .

Example 1 $36^{1/2} = \sqrt{36} = 6$

Example 5 $(-1296)^{1/4} = \text{non real}$

Example 2 $-100^{1/2} = -10$

Example 6 $-1296^{1/4} = -6$

Example 3 $-(225)^{1/2} = -15$

Example 7 $(-27)^{1/3} = -3$

Example 4 $625^{1/4} = 5$

Example 8 $-32^{1/5} = -2$

Video Link: <https://www.youtube.com/watch?v=3YbwhlqlvPs>

Section O Exercises

O1) $169^{1/2}$ O2) $121^{1/2}$ O3) $16^{1/4}$ O4) $625^{1/4}$ O5) $\left(-\frac{64}{27}\right)^{1/3}$ O6) $\left(\frac{8}{27}\right)^{1/3}$

O7) $(-4)^{1/2}$ O8) $(-64)^{1/4}$

Section P = More with rational exponents

If you have an expression like $a^{m/n}$, m is a power, n is a root. It is usually easier if you evaluate the root first and then apply the power.

Example 1 $125^{2/3} = 5^2 = 25$

Example 4 $(-27)^{2/3} = (-3)^2 = 9$

Example 2 $32^{7/5} = 2^7 = 128$

Example 5 $(16)^{-3/4} = (2)^{-3} = \frac{1}{8}$

Example 3 $-81^{3/2} = -9^3 = -729$

Video Link: <https://www.youtube.com/watch?v=ry-oYLDi4L8>

Section P Exercises

P1) $8^{2/3}$ P2) $100^{3/2}$ P3) $-81^{3/4}$ P4) $\left(\frac{27}{64}\right)^{-4/3}$ P5) $3^{1/2} \cdot 3^{3/2}$

P6) $\frac{64^{5/3}}{64^{4/3}}$ P7) $y^{7/3} \cdot y^{-4/3}$

Section Q – Simplifying Radicals

Example 1 $\sqrt{175} = \sqrt{25 \cdot 7} = 5\sqrt{7}$

Example 2 $-3\sqrt[5]{32} = -3 \cdot 2 = -6$

Example 3 $\sqrt[3]{81x^5y^7z^6} = \sqrt[3]{27 \cdot 3 \cdot x^3 \cdot x^2 \cdot y^6 \cdot y \cdot z^6} = 3xy^2z^2\sqrt[3]{3x^2y}$

Video Link: <https://www.youtube.com/watch?v=pZSuMBXzEic>

Section Q Exercises

Q1) $\sqrt[3]{16(-2)^4(2)^8}$ Q2) $\sqrt[3]{25(3)^4(5)^3}$ Q3) $\sqrt{8x^5z^8}$ Q4) $\sqrt{24m^6n^5}$ Q5) $\sqrt{\frac{x^5y^3}{z^2}}$

Q6) $\sqrt{\frac{g^3h^5}{r^3}}$ Q7) $\sqrt[3]{\frac{8}{x^2}}$ Q8) $\sqrt[4]{\frac{32x^5}{y^5}}$

Section R – Review

Perform the indicated operations.

$$\text{R1)} (x^2 - 3x + 2) - (x - 4x^2) + 3x(2x + 1)$$

$$\text{R2)} (6r - 5)^2$$

$$\text{R3)} (t + 2)(3t^2 - t + 4)$$

$$\text{R4)} \frac{2x^3 - 11x^2 + 28}{x - 5}$$

Factor completely.

$$\text{R5)} 6x^2 - 17x + 7$$

$$\text{R6)} x^4 - 16$$

$$\text{R7)} 24m^3 - 14m^2 - 24m$$

Perform the indicated operations.

$$\text{R8)} \frac{5x^2 - 9x - 2}{30x^3 + 6x^2} \cdot \frac{2x^8 + 6x^7 + 4x^6}{x^4 - 3x^2 - 4}$$

$$\text{R9)} \frac{x}{x^2 + 3x + 2} + \frac{2x}{2x^2 - x - 3}$$

$$\text{R10)} \frac{a+b}{2a-3} - \frac{a-b}{3-2a}$$

Simplify so there are no negative exponents

$$\text{R11)} \left(\frac{x^{-2}y^{-1/3}}{x^{-5/3}y^{-2/3}} \right)^3$$

Evaluate

$$\text{R12)} \left(-\frac{64}{27} \right)^{-2/3}$$

Simplify

$$\text{R13)} \sqrt{18x^5y^8}$$

$$\text{R14)} \sqrt{32x} + \sqrt{2x} - \sqrt{18x}$$

Answers

A1) -16 A2) -243 A3) 16 A4) -64

A5) -243 A6) -32 A7) -162 A8) 500

B1) -6 B2) -60 B3) -12 B4) $-\frac{25}{36}$ B5) $-\frac{6}{7}$

C1) $20z$ C2) $-9r$ C3) $m + 11$ C4) $15 + a$ C5) $\frac{2}{3}y + \frac{4}{9}z - \frac{5}{3}$

C6) $-5m - 2y + 8z$

D1) 10 D2) 15 D3) $-\frac{4}{7}$ D4) $-\frac{7}{2}$ D5) 6 D6) 2

D7) -1 D8) -5

E1) 9^8 E2) 4^{10} E3) $-16x^4$ E4) $-18y^7$ E5) n^{11} E6) a^{14}

E7) $72m^{11}$ E8) $80t^{13}$

F1) 2^{10} F2) 6^{12} F3) $-216x^6$ F4) $-32x^{25}$ F5) $-16m^6$ F6) $8y^4$

F7) $\frac{r^{24}}{s^6}$ F8) $-\frac{p^8}{q^2}$ F9) $\frac{256m^8}{t^4}$ F10) $\frac{-125n^{12}}{r^6}$

G1) $x^2 - x + 2$ G2) $m^3 - 4m^2 + 10$ G3) $12y^2 + 4$ G4) $9p^2 - 5p - 20$

H1) $28r^2 + r - 2$ H2) $15x^4 - \frac{7}{3}x^3 - \frac{2}{9}x^2$ H3) $12x^5 + 8x^4 - 20x^3 + 4x^2$

H4) $-2z^3 + 7z^2 - 11z + 4$ H5) $m^2 + mn - 2n^2 - 2km + 5kn - 3k^2$

I1) $12(m + 5)$ I2) $8k(K^2 + 3)$ I3) $xy(1 - 5y)$ I4) $-2p^2q^4(2p + q)$ I5) $4k^2m^3(1 + 2k^2 - 3m)$

$$I6) -3z^3w^2(z^2 + 6w^2)$$

$$J1) (2a - 1)(3a - 4) \quad J2) (3m + 2)(m + 4) \quad J3) \text{prime} \quad J4) 2a(3a + 7)(2a - 3)$$

$$J5) (3k - 2p)(2k + 3p) \quad J6) (5a + 3b)(a - 2b) \quad J7) (4x + y)(3x - y) \quad J8) (3m - 2)^2$$

$$K1) \frac{8}{9} \quad K2) \frac{-3}{t+5} \quad K3) \frac{2x+4}{x} \quad K4) \frac{m-2}{m+3} \quad K5) \frac{2m+3}{4m+3}$$

$$L1) \frac{25p^2}{9} \quad L2) \frac{2}{9} \quad L3) \frac{5x}{y} \quad L4) \frac{2(a+4)}{a-3} \quad L5) 1 \quad L6) \frac{m+6}{m+3}$$

$$M1) \frac{19}{6k} \quad M2) \frac{137}{30m} \quad M3) \frac{a-b}{a^2} \quad M4) \frac{5-22x}{12x^2y} \quad M5) 3 \quad M6) \frac{2x}{(x+z)(x-z)}$$

$$M7) \frac{4}{a-2} \quad M8) \frac{3x+y}{2x-y} \quad M9) \frac{2x^2-9x}{(x-3)(x+4)(x-4)}$$

$$N1) -\frac{1}{64} \quad N2) -\frac{1}{625} \quad N3) 9 \quad N4) \frac{1}{16x^2} \quad N5) \frac{4}{x^2} \quad N6) -\frac{1}{a^3}$$

$$N7) 16 \quad N8) x^4 \quad N9) \frac{1}{r^3} \quad N10) 6^6 \quad N11) \frac{2r^3}{3} \quad N12) \frac{4n^7}{3m^7}$$

$$N13) -4r^6 \quad N14) \frac{5^4}{a^{10}} \quad N15) \frac{p^4}{5} \quad N16) \frac{1}{2pq} \quad N17) \frac{4}{a^2}$$

$$O1) 13 \quad O2) 11 \quad O3) 2 \quad O4) 5 \quad O5) -\frac{4}{3} \quad O6) \frac{2}{3}$$

$$O7) \text{nonreal} \quad O8) \text{nonreal}$$

$$P1) 4 \quad P2) 1000 \quad P3) -27 \quad P4) \frac{256}{81} \quad P5) 9 \quad P6) 4 \quad P7) y$$

$$Q1) 32^3\sqrt{2} \quad Q2) 15^3\sqrt{75} \quad Q3) 2x^2z^4\sqrt{2x} \quad Q4) 2m^3n^2\sqrt{6n} \quad Q5) \frac{x^2y\sqrt{xy}}{z}$$

$$Q6) \frac{gh^2}{r} \sqrt{\frac{gh}{r}} \quad Q7) \frac{2^3\sqrt{x}}{x} \quad Q8) \frac{2x}{y} \sqrt[4]{\frac{2x}{y}}$$

$$\text{R1)} 11x^2 - x + 2$$

$$\text{R2)} 36r^2 - 60r + 25$$

$$\text{R3)} 3t^3 + 5t^2 + 2t + 8$$

$$\text{R4)} 2x^2 - x - 5 + \frac{3}{x-5}$$

$$\text{R5)} (3x - 7)(2x - 1)$$

$$\text{R6)} (x^2 + 4)(x - 2)(x + 2)$$

$$\text{R7)} 2m(4m + 3)(3m - 4)$$

$$\text{R8)} \frac{x^4(x+1)}{3(x^2+1)}$$

$$\text{R9)} \frac{x(4x+1)}{(x+2)(x+1)(2x-3)}$$

$$\text{R10)} \frac{2a}{2a-3}$$

$$\text{R11)} \frac{y}{x}$$

$$\text{R12)} \frac{9}{16}$$

$$\text{R13)} 3x^2y^4\sqrt{2x}$$

$$\text{R14)} 2\sqrt{2x}$$