# Factorization of the Coefficient of $x^{10}$

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var('x,a1,a2,a3,a4,b1,b2,b3,b4,p1,p2,p3,p4,q1,q2,q3,q4')
w0 = SR.wild(0)
sage_server.MAX_STDOUT_SIZE=250000
sage_server.MAX_OUTPUT=250000
#This defines our variables, sets up our wild card and increases max output for\
    the program.
(x, a1, a2, a3, a4, b1, b2, b3, b4, p1, p2, p3, p4, q1, q2, q3, q4)


E=(x-a1*a2*a3*a4)*(x-a1*a2*a3*b4)*(x-a1*a2*b3*a4)*(x-a1*a2*b3*b4)*(x-a1*b2*a3*\
    a4)*(x-a1*b2*a3*b4)*(x-a1*b2*b3*a4)*(x-a1*b2*b3*b4)*(x-b1*a2*a3*a4)*(x-b1*a2\
    *a3*b4)*(x-b1*a2*b3*a4)*(x-b1*a2*b3*b4)*(x-b1*b2*a3*a4)*(x-b1*b2*a3*b4)*(x-\
    b1*b2*b3*a4)*(x-b1*b2*b3*b4)
F=E.expand()
#Multiplication of the characteristic function, this is not show do to length.


f10=F.coefficient(x,10)
f10
#Gathering of the coefficent for x^10 from our expansion of the characteristic \
    function. The general way we work this out is first seperate the coefficient\
     by the numerical part of each term then seperate it further into managable \
    groups that have clear subusitution.
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a1^3*a2^4*a3^4*a4^6*b1^3*b2^2*b3^2 + a1^4*a2^3*a3^4*a4^6*b1^2*b2^3*b3^2 +
2*a1^3*a2^3*a3^4*a4^6*b1^3*b2^3*b3^2 + a1^2*a2^3*a3^4*a4^6*b1^4*b2^3*b3^2 +
a1^3*a2^2*a3^4*a4^6*b1^3*b2^4*b3^2 + a1^4*a2^4*a3^3*a4^6*b1^2*b2^2*b3^3 +
2*a1^3*a2^4*a3^3*a4^6*b1^3*b2^2*b3^3 + a1^2*a2^4*a3^3*a4^6*b1^4*b2^2*b3^3 +
2*a1^4*a2^3*a3^3*a4^6*b1^2*b2^3*b3^3 + 4*a1^3*a2^3*a3^3*a4^6*b1^3*b2^3*b3^3 +
2*a1^2*a2^3*a3^3*a4^6*b1^4*b2^3*b3^3 + a1^4*a2^2*a3^3*a4^6*b1^2*b2^4*b3^3 +
2*a1^3*a2^2*a3^3*a4^6*b1^3*b2^4*b3^3 + a1^2*a2^2*a3^3*a4^6*b1^4*b2^4*b3^3 +
a1^3*a2^4*a3^2*a4^6*b1^3*b2^2*b3^4 + a1^4*a2^3*a3^2*a4^6*b1^2*b2^3*b3^4 +
2*a1^3*a2^3*a3^2*a4^6*b1^3*b2^3*b3^4 + a1^2*a2^3*a3^2*a4^6*b1^4*b2^3*b3^4 +
a1^3*a2^2*a3^2*a4^6*b1^3*b2^4*b3^4 + a1^4*a2^4*a3^5*a4^5*b1^2*b2^2*b3*b4 +
2*a1^3*a2^4*a3^5*a4^5*b1^3*b2^2*b3*b4 + a1^2*a2^4*a3^5*a4^5*b1^4*b2^2*b3*b4 +
2*a1^4*a2^3*a3^5*a4^5*b1^2*b2^3*b3*b4 + 4*a1^3*a2^3*a3^5*a4^5*b1^3*b2^3*b3*b4 +
2*a1^2*a2^3*a3^5*a4^5*b1^4*b2^3*b3*b4 + a1^4*a2^2*a3^5*a4^5*b1^2*b2^4*b3*b4 +
2*a1^3*a2^2*a3^5*a4^5*b1^3*b2^4*b3*b4 + a1^2*a2^2*a3^5*a4^5*b1^4*b2^4*b3*b4 +
a1^4*a2^5*a3^4*a4^5*b1^2*b2*b3^2*b4 + 2*a1^3*a2^5*a3^4*a4^5*b1^3*b2*b3^2*b4 +
a1^2*a2^5*a3^4*a4^5*b1^4*b2*b3^2*b4 + a1^5*a2^4*a3^4*a4^5*b1*b2^2*b3^2*b4 +
7*a1^4*a2^4*a3^4*a4^5*b1^2*b2^2*b3^2*b4 + 12*a1^3*a2^4*a3^4*a4^5*b1^3*b2^2*b3^2*b4 +
7*a1^2*a2^4*a3^4*a4^5*b1^4*b2^2*b3^2*b4 + a1*a2^4*a3^4*a4^5*b1^5*b2^2*b3^2*b4 +
2*a1^5*a2^3*a3^4*a4^5*b1*b2^3*b3^2*b4 + 12*a1^4*a2^3*a3^4*a4^5*b1^2*b2^3*b3^2*b4 +
20*a1^3*a2^3*a3^4*a4^5*b1^3*b2^3*b3^2*b4 + 12*a1^2*a2^3*a3^4*a4^5*b1^4*b2^3*b3^2*b4 +
2*a1*a2^3*a3^4*a4^5*b1^5*b2^3*b3^2*b4 + a1^5*a2^2*a3^4*a4^5*b1*b2^4*b3^2*b4 +
7*a1^4*a2^2*a3^4*a4^5*b1^2*b2^4*b3^2*b4 + 12*a1^3*a2^2*a3^4*a4^5*b1^3*b2^4*b3^2*b4 +
7*a1^2*a2^2*a3^4*a4^5*b1^4*b2^4*b3^2*b4 + a1*a2^2*a3^4*a4^5*b1^5*b2^4*b3^2*b4 +
a1^4*a2*a3^4*a4^5*b1^2*b2^5*b3^2*b4 + 2*a1^3*a2*a3^4*a4^5*b1^3*b2^5*b3^2*b4 +
a1^2*a2*a3^4*a4^5*b1^4*b2^5*b3^2*b4 + 2*a1^4*a2^5*a3^3*a4^5*b1^2*b2*b3^3*b4 +
4*a1^3*a2^5*a3^3*a4^5*b1^3*b2*b3^3*b4 + 2*a1^2*a2^5*a3^3*a4^5*b1^4*b2*b3^3*b4 +
2*a1^5*a2^4*a3^3*a4^5*b1*b2^2*b3^3*b4 + 12*a1^4*a2^4*a3^3*a4^5*b1^2*b2^2*b3^3*b4 +

20*a1^3*a2^4*a3^3*a4^5*b1^3*b2^2*b3^3*b4 + 12*a1^2*a2^4*a3^3*a4^5*b1^4*b2^2*b3^3*b4 +
2*a1*a2^4*a3^3*a4^5*b1^5*b2^2*b3^3*b4 + 4*a1^5*a2^3*a3^3*a4^5*b1*b2^3*b3^3*b4 +
20*a1^4*a2^3*a3^3*a4^5*b1^2*b2^3*b3^3*b4 + 32*a1^3*a2^3*a3^3*a4^5*b1^3*b2^3*b3^3*b4 +
20*a1^2*a2^3*a3^3*a4^5*b1^4*b2^3*b3^3*b4 + 4*a1*a2^3*a3^3*a4^5*b1^5*b2^3*b3^3*b4 +
2*a1^5*a2^2*a3^3*a4^5*b1*b2^4*b3^3*b4 + 12*a1^4*a2^2*a3^3*a4^5*b1^2*b2^4*b3^3*b4 +
20*a1^3*a2^2*a3^3*a4^5*b1^3*b2^4*b3^3*b4 + 12*a1^2*a2^2*a3^3*a4^5*b1^4*b2^4*b3^3*b4 +
2*a1*a2^2*a3^3*a4^5*b1^5*b2^4*b3^3*b4 + 2*a1^4*a2*a3^3*a4^5*b1^2*b2^5*b3^3*b4 +
4*a1^3*a2*a3^3*a4^5*b1^3*b2^5*b3^3*b4 + 2*a1^2*a2*a3^3*a4^5*b1^4*b2^5*b3^3*b4 +
a1^4*a2^5*a3^2*a4^5*b1^2*b2*b3^4*b4 + 2*a1^3*a2^5*a3^2*a4^5*b1^3*b2*b3^4*b4 +
a1^2*a2^5*a3^2*a4^5*b1^4*b2*b3^4*b4 + a1^5*a2^4*a3^2*a4^5*b1*b2^2*b3^4*b4 +
7*a1^4*a2^4*a3^2*a4^5*b1^2*b2^2*b3^4*b4 + 12*a1^3*a2^4*a3^2*a4^5*b1^3*b2^2*b3^4*b4 +
7*a1^2*a2^4*a3^2*a4^5*b1^4*b2^2*b3^4*b4 + a1*a2^4*a3^2*a4^5*b1^5*b2^2*b3^4*b4 +
2*a1^5*a2^3*a3^2*a4^5*b1*b2^3*b3^4*b4 + 12*a1^4*a2^3*a3^2*a4^5*b1^2*b2^3*b3^4*b4 +
20*a1^3*a2^3*a3^2*a4^5*b1^3*b2^3*b3^4*b4 + 12*a1^2*a2^3*a3^2*a4^5*b1^4*b2^3*b3^4*b4 +
2*a1*a2^3*a3^2*a4^5*b1^5*b2^3*b3^4*b4 + a1^5*a2^2*a3^2*a4^5*b1*b2^4*b3^4*b4 +
7*a1^4*a2^2*a3^2*a4^5*b1^2*b2^4*b3^4*b4 + 12*a1^3*a2^2*a3^2*a4^5*b1^3*b2^4*b3^4*b4 +
7*a1^2*a2^2*a3^2*a4^5*b1^4*b2^4*b3^4*b4 + a1*a2^2*a3^2*a4^5*b1^5*b2^4*b3^4*b4 +
a1^4*a2*a3^2*a4^5*b1^2*b2^5*b3^4*b4 + 2*a1^3*a2*a3^2*a4^5*b1^3*b2^5*b3^4*b4 +
a1^2*a2*a3^2*a4^5*b1^4*b2^5*b3^4*b4 + a1^4*a2^4*a3*a4^5*b1^2*b2^2*b3^5*b4 +
2*a1^3*a2^4*a3*a4^5*b1^3*b2^2*b3^5*b4 + a1^2*a2^4*a3*a4^5*b1^4*b2^2*b3^5*b4 +
2*a1^4*a2^3*a3*a4^5*b1^2*b2^3*b3^5*b4 + 4*a1^3*a2^3*a3*a4^5*b1^3*b2^3*b3^5*b4 +
2*a1^2*a2^3*a3*a4^5*b1^4*b2^3*b3^5*b4 + a1^4*a2^2*a3*a4^5*b1^2*b2^4*b3^5*b4 +
2*a1^3*a2^2*a3*a4^5*b1^3*b2^4*b3^5*b4 + a1^2*a2^2*a3*a4^5*b1^4*b2^4*b3^5*b4 +
a1^3*a2^4*a3^6*a4^4*b1^3*b2^2*b4^2 + a1^4*a2^3*a3^6*a4^4*b1^2*b2^3*b4^2 +
2*a1^3*a2^3*a3^6*a4^4*b1^3*b2^3*b4^2 + a1^2*a2^3*a3^6*a4^4*b1^4*b2^3*b4^2 +
a1^3*a2^2*a3^6*a4^4*b1^3*b2^4*b4^2 + a1^4*a2^5*a3^5*a4^4*b1^2*b2*b3*b4^2 +
2*a1^3*a2^5*a3^5*a4^4*b1^3*b2*b3*b4^2 + a1^2*a2^5*a3^5*a4^4*b1^4*b2*b3*b4^2 +
a1^5*a2^4*a3^5*a4^4*b1*b2^2*b3*b4^2 + 7*a1^4*a2^4*a3^5*a4^4*b1^2*b2^2*b3*b4^2 +
12*a1^3*a2^4*a3^5*a4^4*b1^3*b2^2*b3*b4^2 + 7*a1^2*a2^4*a3^5*a4^4*b1^4*b2^2*b3*b4^2 +
a1*a2^4*a3^5*a4^4*b1^5*b2^2*b3*b4^2 + 2*a1^5*a2^3*a3^5*a4^4*b1*b2^3*b3*b4^2 +
12*a1^4*a2^3*a3^5*a4^4*b1^2*b2^3*b3*b4^2 + 20*a1^3*a2^3*a3^5*a4^4*b1^3*b2^3*b3*b4^2 +
12*a1^2*a2^3*a3^5*a4^4*b1^4*b2^3*b3*b4^2 + 2*a1*a2^3*a3^5*a4^4*b1^5*b2^3*b3*b4^2 +
a1^5*a2^2*a3^5*a4^4*b1*b2^4*b3*b4^2 + 7*a1^4*a2^2*a3^5*a4^4*b1^2*b2^4*b3*b4^2 +
12*a1^3*a2^2*a3^5*a4^4*b1^3*b2^4*b3*b4^2 + 7*a1^2*a2^2*a3^5*a4^4*b1^4*b2^4*b3*b4^2 +
a1*a2^2*a3^5*a4^4*b1^5*b2^4*b3*b4^2 + a1^4*a2*a3^5*a4^4*b1^2*b2^5*b3*b4^2 +
2*a1^3*a2*a3^5*a4^4*b1^3*b2^5*b3*b4^2 + a1^2*a2*a3^5*a4^4*b1^4*b2^5*b3*b4^2 +
a1^3*a2^6*a3^4*a4^4*b1^3*b3^2*b4^2 + a1^5*a2^5*a3^4*a4^4*b1*b2*b3^2*b4^2 +
7*a1^4*a2^5*a3^4*a4^4*b1^2*b2*b3^2*b4^2 + 12*a1^3*a2^5*a3^4*a4^4*b1^3*b2*b3^2*b4^2 +
7*a1^2*a2^5*a3^4*a4^4*b1^4*b2*b3^2*b4^2 + a1*a2^5*a3^4*a4^4*b1^5*b2*b3^2*b4^2 +
7*a1^5*a2^4*a3^4*a4^4*b1*b2^2*b3^2*b4^2 + 28*a1^4*a2^4*a3^4*a4^4*b1^2*b2^2*b3^2*b4^2 +
46*a1^3*a2^4*a3^4*a4^4*b1^3*b2^2*b3^2*b4^2 + 28*a1^2*a2^4*a3^4*a4^4*b1^4*b2^2*b3^2*b4^2 +
7*a1*a2^4*a3^4*a4^4*b1^5*b2^2*b3^2*b4^2 + a1^6*a2^3*a3^4*a4^4*b2^3*b3^2*b4^2 +
12*a1^5*a2^3*a3^4*a4^4*b1*b2^3*b3^2*b4^2 + 46*a1^4*a2^3*a3^4*a4^4*b1^2*b2^3*b3^2*b4^2 +
70*a1^3*a2^3*a3^4*a4^4*b1^3*b2^3*b3^2*b4^2 + 46*a1^2*a2^3*a3^4*a4^4*b1^4*b2^3*b3^2*b4^2 +
12*a1*a2^3*a3^4*a4^4*b1^5*b2^3*b3^2*b4^2 + a2^3*a3^4*a4^4*b1^6*b2^3*b3^2*b4^2 +
7*a1^5*a2^2*a3^4*a4^4*b1*b2^4*b3^2*b4^2 + 28*a1^4*a2^2*a3^4*a4^4*b1^2*b2^4*b3^2*b4^2 +
46*a1^3*a2^2*a3^4*a4^4*b1^3*b2^4*b3^2*b4^2 + 28*a1^2*a2^2*a3^4*a4^4*b1^4*b2^4*b3^2*b4^2 +
7*a1*a2^2*a3^4*a4^4*b1^5*b2^4*b3^2*b4^2 + a1^5*a2*a3^4*a4^4*b1*b2^5*b3^2*b4^2 +
7*a1^4*a2*a3^4*a4^4*b1^2*b2^5*b3^2*b4^2 + 12*a1^3*a2*a3^4*a4^4*b1^3*b2^5*b3^2*b4^2 +
7*a1^2*a2*a3^4*a4^4*b1^4*b2^5*b3^2*b4^2 + a1*a2*a3^4*a4^4*b1^5*b2^5*b3^2*b4^2 +
a1^3*a3^4*a4^4*b1^3*b2^6*b3^2*b4^2 + a1^4*a2^6*a3^3*a4^4*b1^2*b3^3*b4^2 +
2*a1^3*a2^6*a3^3*a4^4*b1^3*b3^3*b4^2 + a1^2*a2^6*a3^3*a4^4*b1^4*b3^3*b4^2 +
2*a1^5*a2^5*a3^3*a4^4*b1*b2*b3^3*b4^2 + 12*a1^4*a2^5*a3^3*a4^4*b1^2*b2*b3^3*b4^2 +
20*a1^3*a2^5*a3^3*a4^4*b1^3*b2*b3^3*b4^2 + 12*a1^2*a2^5*a3^3*a4^4*b1^4*b2*b3^3*b4^2 +
2*a1*a2^5*a3^3*a4^4*b1^5*b2*b3^3*b4^2 + a1^6*a2^4*a3^3*a4^4*b2^2*b3^3*b4^2 +
12*a1^5*a2^4*a3^3*a4^4*b1*b2^2*b3^3*b4^2 + 46*a1^4*a2^4*a3^3*a4^4*b1^2*b2^2*b3^3*b4^2 +
70*a1^3*a2^4*a3^3*a4^4*b1^3*b2^2*b3^3*b4^2 + 46*a1^2*a2^4*a3^3*a4^4*b1^4*b2^2*b3^3*b4^2 +
12*a1*a2^4*a3^3*a4^4*b1^5*b2^2*b3^3*b4^2 + a2^4*a3^3*a4^4*b1^6*b2^2*b3^3*b4^2 +
2*a1^6*a2^3*a3^3*a4^4*b2^3*b3^3*b4^2 + 20*a1^5*a2^3*a3^3*a4^4*b1*b2^3*b3^3*b4^2 +
70*a1^4*a2^3*a3^3*a4^4*b1^2*b2^3*b3^3*b4^2 + 104*a1^3*a2^3*a3^3*a4^4*b1^3*b2^3*b3^3*b4^2 +
70*a1^2*a2^3*a3^3*a4^4*b1^4*b2^3*b3^3*b4^2 + 20*a1*a2^3*a3^3*a4^4*b1^5*b2^3*b3^3*b4^2 +

$2*a2^3*a3^3*a4^4*b1^6*b2^3*b3^3*b4^2 + a1^6*a2^2*a3^3*a4^4*b2^4*b3^3*b4^2 +$
$12*a1^5*a2^2*a3^3*a4^4*b1*b2^4*b3^3*b4^2 + 46*a1^4*a2^2*a3^3*a4^4*b1^2*b2^4*b3^3*b4^2 +$
$70*a1^3*a2^2*a3^3*a4^4*b1^3*b2^4*b3^3*b4^2 + 46*a1^2*a2^2*a3^3*a4^4*b1^4*b2^4*b3^3*b4^2 +$
$12*a1*a2^2*a3^3*a4^4*b1^5*b2^4*b3^3*b4^2 + a2^2*a3^3*a4^4*b1^6*b2^4*b3^3*b4^2 +$
$2*a1^5*a2*a3^3*a4^4*b1*b2^5*b3^3*b4^2 + 12*a1^4*a2*a3^3*a4^4*b1^2*b2^5*b3^3*b4^2 +$
$20*a1^3*a2*a3^3*a4^4*b1^3*b2^5*b3^3*b4^2 + 12*a1^2*a2*a3^3*a4^4*b1^4*b2^5*b3^3*b4^2 +$
$2*a1*a2*a3^3*a4^4*b1^5*b2^5*b3^3*b4^2 + a1^4*a3^3*a4^4*b1^2*b2^6*b3^3*b4^2 +$
$2*a1^3*a3^3*a4^4*b1^3*b2^6*b3^3*b4^2 + a1^2*a3^3*a4^4*b1^4*b2^6*b3^3*b4^2 +$
$a1^3*a2^6*a3^2*a4^4*b1^3*b3^4*b4^2 + a1^5*a2^5*a3^2*a4^4*b1*b2*b3^4*b4^2 +$
$7*a1^4*a2^5*a3^2*a4^4*b1^2*b2*b3^4*b4^2 + 12*a1^3*a2^5*a3^2*a4^4*b1^3*b2*b3^4*b4^2 +$
$7*a1^2*a2^5*a3^2*a4^4*b1^4*b2*b3^4*b4^2 + a1*a2^5*a3^2*a4^4*b1^5*b2*b3^4*b4^2 +$
$7*a1^5*a2^4*a3^2*a4^4*b1*b2^2*b3^4*b4^2 + 28*a1^4*a2^4*a3^2*a4^4*b1^2*b2^2*b3^4*b4^2 +$
$46*a1^3*a2^4*a3^2*a4^4*b1^3*b2^2*b3^4*b4^2 + 28*a1^2*a2^4*a3^2*a4^4*b1^4*b2^2*b3^4*b4^2 +$
$7*a1*a2^4*a3^2*a4^4*b1^5*b2^2*b3^4*b4^2 + a1^6*a2^3*a3^2*a4^4*b2^3*b3^4*b4^2 +$
$12*a1^5*a2^3*a3^2*a4^4*b1*b2^3*b3^4*b4^2 + 46*a1^4*a2^3*a3^2*a4^4*b1^2*b2^3*b3^4*b4^2 +$
$70*a1^3*a2^3*a3^2*a4^4*b1^3*b2^3*b3^4*b4^2 + 46*a1^2*a2^3*a3^2*a4^4*b1^4*b2^3*b3^4*b4^2 +$
$12*a1*a2^3*a3^2*a4^4*b1^5*b2^3*b3^4*b4^2 + a2^3*a3^2*a4^4*b1^6*b2^3*b3^4*b4^2 +$
$7*a1^5*a2^2*a3^2*a4^4*b1*b2^4*b3^4*b4^2 + 28*a1^4*a2^2*a3^2*a4^4*b1^2*b2^4*b3^4*b4^2 +$
$46*a1^3*a2^2*a3^2*a4^4*b1^3*b2^4*b3^4*b4^2 + 28*a1^2*a2^2*a3^2*a4^4*b1^4*b2^4*b3^4*b4^2 +$
$7*a1*a2^2*a3^2*a4^4*b1^5*b2^4*b3^4*b4^2 + a1^5*a2*a3^2*a4^4*b1*b2^5*b3^4*b4^2 +$
$7*a1^4*a2*a3^2*a4^4*b1^2*b2^5*b3^4*b4^2 + 12*a1^3*a2*a3^2*a4^4*b1^3*b2^5*b3^4*b4^2 +$
$7*a1^2*a2*a3^2*a4^4*b1^4*b2^5*b3^4*b4^2 + a1*a2*a3^2*a4^4*b1^5*b2^5*b3^4*b4^2 +$
$a1^3*a3^2*a4^4*b1^3*b2^6*b3^4*b4^2 + a1^4*a2^5*a3*a4^4*b1^2*b2*b3^5*b4^2 +$
$2*a1^3*a2^5*a3*a4^4*b1^3*b2*b3^5*b4^2 + a1^2*a2^5*a3*a4^4*b1^4*b2*b3^5*b4^2 +$
$a1^5*a2^4*a3*a4^4*b1*b2^2*b3^5*b4^2 + 7*a1^4*a2^4*a3*a4^4*b1^2*b2^2*b3^5*b4^2 +$
$12*a1^3*a2^4*a3*a4^4*b1^3*b2^2*b3^5*b4^2 + 7*a1^2*a2^4*a3*a4^4*b1^4*b2^2*b3^5*b4^2 +$
$a1*a2^4*a3*a4^4*b1^5*b2^2*b3^5*b4^2 + 2*a1^5*a2^3*a3*a4^4*b1*b2^3*b3^5*b4^2 +$
$12*a1^4*a2^3*a3*a4^4*b1^2*b2^3*b3^5*b4^2 + 20*a1^3*a2^3*a3*a4^4*b1^3*b2^3*b3^5*b4^2 +$
$12*a1^2*a2^3*a3*a4^4*b1^4*b2^3*b3^5*b4^2 + 2*a1*a2^3*a3*a4^4*b1^5*b2^3*b3^5*b4^2 +$
$a1^5*a2^2*a3*a4^4*b1*b2^4*b3^5*b4^2 + 7*a1^4*a2^2*a3*a4^4*b1^2*b2^4*b3^5*b4^2 +$
$12*a1^3*a2^2*a3*a4^4*b1^3*b2^4*b3^5*b4^2 + 7*a1^2*a2^2*a3*a4^4*b1^4*b2^4*b3^5*b4^2 +$
$a1*a2^2*a3*a4^4*b1^5*b2^4*b3^5*b4^2 + a1^4*a2*a3*a4^4*b1^2*b2^5*b3^5*b4^2 +$
$2*a1^3*a2*a3*a4^4*b1^3*b2^5*b3^5*b4^2 + a1^2*a2*a3*a4^4*b1^4*b2^5*b3^5*b4^2 +$
$a1^3*a2^4*a4^4*b1^3*b2^2*b3^6*b4^2 + a1^4*a2^3*a4^4*b1^2*b2^3*b3^6*b4^2 +$
$2*a1^3*a2^3*a4^4*b1^3*b2^3*b3^6*b4^2 + a1^2*a2^3*a4^4*b1^4*b2^3*b3^6*b4^2 +$
$a1^3*a2^2*a4^4*b1^3*b2^4*b3^6*b4^2 + a1^4*a2^4*a3^6*a4^3*b1^2*b2^2*b4^3 +$
$2*a1^3*a2^4*a3^6*a4^3*b1^3*b2^2*b4^3 + a1^2*a2^4*a3^6*a4^3*b1^4*b2^2*b4^3 +$
$2*a1^4*a2^3*a3^6*a4^3*b1^2*b2^3*b4^3 + 4*a1^3*a2^3*a3^6*a4^3*b1^3*b2^3*b4^3 +$
$2*a1^2*a2^3*a3^6*a4^3*b1^4*b2^3*b4^3 + a1^4*a2^2*a3^6*a4^3*b1^2*b2^4*b4^3 +$
$2*a1^3*a2^2*a3^6*a4^3*b1^3*b2^4*b4^3 + a1^2*a2^2*a3^6*a4^3*b1^4*b2^4*b4^3 +$
$2*a1^4*a2^5*a3^5*a4^3*b1^2*b2*b3*b4^3 + 4*a1^3*a2^5*a3^5*a4^3*b1^3*b2*b3*b4^3 +$
$2*a1^2*a2^5*a3^5*a4^3*b1^4*b2*b3*b4^3 + 2*a1^5*a2^4*a3^5*a4^3*b1*b2^2*b3*b4^3 +$
$12*a1^4*a2^4*a3^5*a4^3*b1^2*b2^2*b3*b4^3 + 20*a1^3*a2^4*a3^5*a4^3*b1^3*b2^2*b3*b4^3 +$
$12*a1^2*a2^4*a3^5*a4^3*b1^4*b2^2*b3*b4^3 + 2*a1*a2^4*a3^5*a4^3*b1^5*b2^2*b3*b4^3 +$
$4*a1^5*a2^3*a3^5*a4^3*b1*b2^3*b3*b4^3 + 20*a1^4*a2^3*a3^5*a4^3*b1^2*b2^3*b3*b4^3 +$
$32*a1^3*a2^3*a3^5*a4^3*b1^3*b2^3*b3*b4^3 + 20*a1^2*a2^3*a3^5*a4^3*b1^4*b2^3*b3*b4^3 +$
$4*a1*a2^3*a3^5*a4^3*b1^5*b2^3*b3*b4^3 + 2*a1^5*a2^2*a3^5*a4^3*b1*b2^4*b3*b4^3 +$
$12*a1^4*a2^2*a3^5*a4^3*b1^2*b2^4*b3*b4^3 + 20*a1^3*a2^2*a3^5*a4^3*b1^3*b2^4*b3*b4^3 +$
$12*a1^2*a2^2*a3^5*a4^3*b1^4*b2^4*b3*b4^3 + 2*a1*a2^2*a3^5*a4^3*b1^5*b2^4*b3*b4^3 +$
$2*a1^4*a2*a3^5*a4^3*b1^2*b2^5*b3*b4^3 + 4*a1^3*a2*a3^5*a4^3*b1^3*b2^5*b3*b4^3 +$
$2*a1^2*a2*a3^5*a4^3*b1^4*b2^5*b3*b4^3 + a1^4*a2^6*a3^4*a4^3*b1^2*b3^2*b4^3 +$
$2*a1^3*a2^6*a3^4*a4^3*b1^3*b3^2*b4^3 + a1^2*a2^6*a3^4*a4^3*b1^4*b3^2*b4^3 +$
$2*a1^5*a2^5*a3^4*a4^3*b1*b2*b3^2*b4^3 + 12*a1^4*a2^5*a3^4*a4^3*b1^2*b2*b3^2*b4^3 +$
$20*a1^3*a2^5*a3^4*a4^3*b1^3*b2*b3^2*b4^3 + 12*a1^2*a2^5*a3^4*a4^3*b1^4*b2*b3^2*b4^3 +$
$2*a1*a2^5*a3^4*a4^3*b1^5*b2*b3^2*b4^3 + a1^6*a2^4*a3^4*a4^3*b2^2*b3^2*b4^3 +$
$12*a1^5*a2^4*a3^4*a4^3*b1*b2^2*b3^2*b4^3 + 46*a1^4*a2^4*a3^4*a4^3*b1^2*b2^2*b3^2*b4^3 +$
$70*a1^3*a2^4*a3^4*a4^3*b1^3*b2^2*b3^2*b4^3 + 46*a1^2*a2^4*a3^4*a4^3*b1^4*b2^2*b3^2*b4^3 +$
$12*a1*a2^4*a3^4*a4^3*b1^5*b2^2*b3^2*b4^3 + a2^4*a3^4*a4^3*b1^6*b2^2*b3^2*b4^3 +$
$2*a1^6*a2^3*a3^4*a4^3*b2^3*b3^2*b4^3 + 20*a1^5*a2^3*a3^4*a4^3*b1*b2^3*b3^2*b4^3 +$
$70*a1^4*a2^3*a3^4*a4^3*b1^2*b2^3*b3^2*b4^3 + 104*a1^3*a2^3*a3^4*a4^3*b1^3*b2^3*b3^2*b4^3 +$
$70*a1^2*a2^3*a3^4*a4^3*b1^4*b2^3*b3^2*b4^3 + 20*a1*a2^3*a3^4*a4^3*b1^5*b2^3*b3^2*b4^3 +$

2*a2^3*a3^4*a4^3*b1^6*b2^3*b3^2*b4^3 + a1^6*a2^2*a3^4*a4^3*b2^4*b3^2*b4^3 +
12*a1^5*a2^2*a3^4*a4^3*b1*b2^4*b3^2*b4^3 + 46*a1^4*a2^2*a3^4*a4^3*b1^2*b2^4*b3^2*b4^3 +
70*a1^3*a2^2*a3^4*a4^3*b1^3*b2^4*b3^2*b4^3 + 46*a1^2*a2^2*a3^4*a4^3*b1^4*b2^4*b3^2*b4^3 +
12*a1*a2^2*a3^4*a4^3*b1^5*b2^4*b3^2*b4^3 + a2^2*a3^4*a4^3*b1^6*b2^4*b3^2*b4^3 +
2*a1^5*a2*a3^4*a4^3*b1*b2^5*b3^2*b4^3 + 12*a1^4*a2*a3^4*a4^3*b1^2*b2^5*b3^2*b4^3 +
20*a1^3*a2*a3^4*a4^3*b1^3*b2^5*b3^2*b4^3 + 12*a1^2*a2*a3^4*a4^3*b1^4*b2^5*b3^2*b4^3 +
2*a1*a2*a3^4*a4^3*b1^5*b2^5*b3^2*b4^3 + a1^4*a3^4*a4^3*b1^2*b2^6*b3^2*b4^3 +
2*a1^3*a3^4*a4^3*b1^3*b2^6*b3^2*b4^3 + a1^2*a3^4*a4^3*b1^4*b2^6*b3^2*b4^3 +
2*a1^4*a2^6*a3^3*a4^3*b1^2*b3^3*b4^3 + 4*a1^3*a2^6*a3^3*a4^3*b1^3*b3^3*b4^3 +
2*a1^2*a2^6*a3^3*a4^3*b1^4*b3^3*b4^3 + 4*a1^5*a2^5*a3^3*a4^3*b1*b2*b3^3*b4^3 +
20*a1^4*a2^5*a3^3*a4^3*b1^2*b2*b3^3*b4^3 + 32*a1^3*a2^5*a3^3*a4^3*b1^3*b2*b3^3*b4^3 +
20*a1^2*a2^5*a3^3*a4^3*b1^4*b2*b3^3*b4^3 + 4*a1*a2^5*a3^3*a4^3*b1^5*b2*b3^3*b4^3 +
2*a1^6*a2^4*a3^3*a4^3*b2^2*b3^3*b4^3 + 20*a1^5*a2^4*a3^3*a4^3*b1*b2^2*b3^3*b4^3 +
70*a1^4*a2^4*a3^3*a4^3*b1^2*b2^2*b3^3*b4^3 + 104*a1^3*a2^4*a3^3*a4^3*b1^3*b2^2*b3^3*b4^3 +
70*a1^2*a2^4*a3^3*a4^3*b1^4*b2^2*b3^3*b4^3 + 20*a1*a2^4*a3^3*a4^3*b1^5*b2^2*b3^3*b4^3 +
2*a2^4*a3^3*a4^3*b1^6*b2^2*b3^3*b4^3 + 4*a1^6*a2^3*a3^3*a4^3*b2^3*b3^3*b4^3 +
32*a1^5*a2^3*a3^3*a4^3*b1*b2^3*b3^3*b4^3 + 104*a1^4*a2^3*a3^3*a4^3*b1^2*b2^3*b3^3*b4^3 +
152*a1^3*a2^3*a3^3*a4^3*b1^3*b2^3*b3^3*b4^3 + 104*a1^2*a2^3*a3^3*a4^3*b1^4*b2^3*b3^3*b4^3
+ 32*a1*a2^3*a3^3*a4^3*b1^5*b2^3*b3^3*b4^3 + 4*a2^3*a3^3*a4^3*b1^6*b2^3*b3^3*b4^3 +
2*a1^6*a2^2*a3^3*a4^3*b2^4*b3^3*b4^3 + 20*a1^5*a2^2*a3^3*a4^3*b1*b2^4*b3^3*b4^3 +
70*a1^4*a2^2*a3^3*a4^3*b1^2*b2^4*b3^3*b4^3 + 104*a1^3*a2^2*a3^3*a4^3*b1^3*b2^4*b3^3*b4^3 +
70*a1^2*a2^2*a3^3*a4^3*b1^4*b2^4*b3^3*b4^3 + 20*a1*a2^2*a3^3*a4^3*b1^5*b2^4*b3^3*b4^3 +
2*a2^2*a3^3*a4^3*b1^6*b2^4*b3^3*b4^3 + 4*a1^5*a2*a3^3*a4^3*b1*b2^5*b3^3*b4^3 +
20*a1^4*a2*a3^3*a4^3*b1^2*b2^5*b3^3*b4^3 + 32*a1^3*a2*a3^3*a4^3*b1^3*b2^5*b3^3*b4^3 +
20*a1^2*a2*a3^3*a4^3*b1^4*b2^5*b3^3*b4^3 + 4*a1*a2*a3^3*a4^3*b1^5*b2^5*b3^3*b4^3 +
2*a1^4*a3^3*a4^3*b1^2*b2^6*b3^3*b4^3 + 4*a1^3*a3^3*a4^3*b1^3*b2^6*b3^3*b4^3 +
2*a1^2*a3^3*a4^3*b1^4*b2^6*b3^3*b4^3 + a1^4*a2^6*a3^2*a4^3*b1^2*b3^4*b4^3 +
2*a1^3*a2^6*a3^2*a4^3*b1^3*b3^4*b4^3 + a1^2*a2^6*a3^2*a4^3*b1^4*b3^4*b4^3 +
2*a1^5*a2^5*a3^2*a4^3*b1*b2*b3^4*b4^3 + 12*a1^4*a2^5*a3^2*a4^3*b1^2*b2*b3^4*b4^3 +
20*a1^3*a2^5*a3^2*a4^3*b1^3*b2*b3^4*b4^3 + 12*a1^2*a2^5*a3^2*a4^3*b1^4*b2*b3^4*b4^3 +
2*a1*a2^5*a3^2*a4^3*b1^5*b2*b3^4*b4^3 + a1^6*a2^4*a3^2*a4^3*b2^2*b3^4*b4^3 +
12*a1^5*a2^4*a3^2*a4^3*b1*b2^2*b3^4*b4^3 + 46*a1^4*a2^4*a3^2*a4^3*b1^2*b2^2*b3^4*b4^3 +
70*a1^3*a2^4*a3^2*a4^3*b1^3*b2^2*b3^4*b4^3 + 46*a1^2*a2^4*a3^2*a4^3*b1^4*b2^2*b3^4*b4^3 +
12*a1*a2^4*a3^2*a4^3*b1^5*b2^2*b3^4*b4^3 + a2^4*a3^2*a4^3*b1^6*b2^2*b3^4*b4^3 +
2*a1^6*a2^3*a3^2*a4^3*b2^3*b3^4*b4^3 + 20*a1^5*a2^3*a3^2*a4^3*b1*b2^3*b3^4*b4^3 +
70*a1^4*a2^3*a3^2*a4^3*b1^2*b2^3*b3^4*b4^3 + 104*a1^3*a2^3*a3^2*a4^3*b1^3*b2^3*b3^4*b4^3 +
70*a1^2*a2^3*a3^2*a4^3*b1^4*b2^3*b3^4*b4^3 + 20*a1*a2^3*a3^2*a4^3*b1^5*b2^3*b3^4*b4^3 +
2*a2^3*a3^2*a4^3*b1^6*b2^3*b3^4*b4^3 + a1^6*a2^2*a3^2*a4^3*b2^4*b3^4*b4^3 +
12*a1^5*a2^2*a3^2*a4^3*b1*b2^4*b3^4*b4^3 + 46*a1^4*a2^2*a3^2*a4^3*b1^2*b2^4*b3^4*b4^3 +
70*a1^3*a2^2*a3^2*a4^3*b1^3*b2^4*b3^4*b4^3 + 46*a1^2*a2^2*a3^2*a4^3*b1^4*b2^4*b3^4*b4^3 +
12*a1*a2^2*a3^2*a4^3*b1^5*b2^4*b3^4*b4^3 + a2^2*a3^2*a4^3*b1^6*b2^4*b3^4*b4^3 +
2*a1^5*a2*a3^2*a4^3*b1*b2^5*b3^4*b4^3 + 12*a1^4*a2*a3^2*a4^3*b1^2*b2^5*b3^4*b4^3 +
20*a1^3*a2*a3^2*a4^3*b1^3*b2^5*b3^4*b4^3 + 12*a1^2*a2*a3^2*a4^3*b1^4*b2^5*b3^4*b4^3 +
2*a1*a2*a3^2*a4^3*b1^5*b2^5*b3^4*b4^3 + a1^4*a3^2*a4^3*b1^2*b2^6*b3^4*b4^3 +
2*a1^3*a3^2*a4^3*b1^3*b2^6*b3^4*b4^3 + a1^2*a3^2*a4^3*b1^4*b2^6*b3^4*b4^3 +
2*a1^4*a2^5*a3*a4^3*b1^2*b2*b3^5*b4^3 + 4*a1^3*a2^5*a3*a4^3*b1^3*b2*b3^5*b4^3 +
2*a1^2*a2^5*a3*a4^3*b1^4*b2*b3^5*b4^3 + 2*a1^5*a2^4*a3*a4^3*b1*b2^2*b3^5*b4^3 +
12*a1^4*a2^4*a3*a4^3*b1^2*b2^2*b3^5*b4^3 + 20*a1^3*a2^4*a3*a4^3*b1^3*b2^2*b3^5*b4^3 +
12*a1^2*a2^4*a3*a4^3*b1^4*b2^2*b3^5*b4^3 + 2*a1*a2^4*a3*a4^3*b1^5*b2^2*b3^5*b4^3 +
4*a1^5*a2^3*a3*a4^3*b1*b2^3*b3^5*b4^3 + 20*a1^4*a2^3*a3*a4^3*b1^2*b2^3*b3^5*b4^3 +
32*a1^3*a2^3*a3*a4^3*b1^3*b2^3*b3^5*b4^3 + 20*a1^2*a2^3*a3*a4^3*b1^4*b2^3*b3^5*b4^3 +
4*a1*a2^3*a3*a4^3*b1^5*b2^3*b3^5*b4^3 + 2*a1^5*a2^2*a3*a4^3*b1*b2^4*b3^5*b4^3 +
12*a1^4*a2^2*a3*a4^3*b1^2*b2^4*b3^5*b4^3 + 20*a1^3*a2^2*a3*a4^3*b1^3*b2^4*b3^5*b4^3 +
12*a1^2*a2^2*a3*a4^3*b1^4*b2^4*b3^5*b4^3 + 2*a1*a2^2*a3*a4^3*b1^5*b2^4*b3^5*b4^3 +
2*a1^4*a2*a3*a4^3*b1^2*b2^5*b3^5*b4^3 + 4*a1^3*a2*a3*a4^3*b1^3*b2^5*b3^5*b4^3 +
2*a1^2*a2*a3*a4^3*b1^4*b2^5*b3^5*b4^3 + a1^4*a2^4*a4^3*b1^2*b2^2*b3^6*b4^3 +
2*a1^3*a2^4*a4^3*b1^3*b2^2*b3^6*b4^3 + a1^2*a2^4*a4^3*b1^4*b2^2*b3^6*b4^3 +
2*a1^4*a2^3*a4^3*b1^2*b2^3*b3^6*b4^3 + 4*a1^3*a2^3*a4^3*b1^3*b2^3*b3^6*b4^3 +
2*a1^2*a2^3*a4^3*b1^4*b2^3*b3^6*b4^3 + a1^4*a2^2*a4^3*b1^2*b2^4*b3^6*b4^3 +
2*a1^3*a2^2*a4^3*b1^3*b2^4*b3^6*b4^3 + a1^2*a2^2*a4^3*b1^4*b2^4*b3^6*b4^3 +
a1^3*a2^4*a3^6*a4^2*b1^3*b2^2*b4^4 + a1^4*a2^3*a3^6*a4^2*b1^2*b2^3*b4^4 +

2*a1^3*a2^3*a3^6*a4^2*b1^3*b2^3*b4^4 + a1^2*a2^3*a3^6*a4^2*b1^4*b2^3*b4^4 +
a1^3*a2^2*a3^6*a4^2*b1^3*b2^4*b4^4 + a1^4*a2^5*a3^5*a4^2*b1^2*b2*b3*b4^4 +
2*a1^3*a2^5*a3^5*a4^2*b1^3*b2*b3*b4^4 + a1^2*a2^5*a3^5*a4^2*b1^4*b2*b3*b4^4 +
a1^5*a2^4*a3^5*a4^2*b1*b2^2*b3*b4^4 + 7*a1^4*a2^4*a3^5*a4^2*b1^2*b2^2*b3*b4^4 +
12*a1^3*a2^4*a3^5*a4^2*b1^3*b2^2*b3*b4^4 + 7*a1^2*a2^4*a3^5*a4^2*b1^4*b2^2*b3*b4^4 +
a1*a2^4*a3^5*a4^2*b1^5*b2^2*b3*b4^4 + 2*a1^5*a2^3*a3^5*a4^2*b1*b2^3*b3*b4^4 +
12*a1^4*a2^3*a3^5*a4^2*b1^2*b2^3*b3*b4^4 + 20*a1^3*a2^3*a3^5*a4^2*b1^3*b2^3*b3*b4^4 +
12*a1^2*a2^3*a3^5*a4^2*b1^4*b2^3*b3*b4^4 + 2*a1*a2^3*a3^5*a4^2*b1^5*b2^3*b3*b4^4 +
a1^5*a2^2*a3^5*a4^2*b1*b2^4*b3*b4^4 + 7*a1^4*a2^2*a3^5*a4^2*b1^2*b2^4*b3*b4^4 +
12*a1^3*a2^2*a3^5*a4^2*b1^3*b2^4*b3*b4^4 + 7*a1^2*a2^2*a3^5*a4^2*b1^4*b2^4*b3*b4^4 +
a1*a2^2*a3^5*a4^2*b1^5*b2^4*b3*b4^4 + a1^4*a2*a3^5*a4^2*b1^2*b2^5*b3*b4^4 +
2*a1^3*a2*a3^5*a4^2*b1^3*b2^5*b3*b4^4 + a1^2*a2*a3^5*a4^2*b1^4*b2^5*b3*b4^4 +
a1^3*a2^6*a3^4*a4^2*b1^3*b3^2*b4^4 + a1^5*a2^5*a3^4*a4^2*b1*b2*b3^2*b4^4 +
7*a1^4*a2^5*a3^4*a4^2*b1^2*b2*b3^2*b4^4 + 12*a1^3*a2^5*a3^4*a4^2*b1^3*b2*b3^2*b4^4 +
7*a1^2*a2^5*a3^4*a4^2*b1^4*b2*b3^2*b4^4 + a1*a2^5*a3^4*a4^2*b1^5*b2*b3^2*b4^4 +
7*a1^5*a2^4*a3^4*a4^2*b1*b2^2*b3^2*b4^4 + 28*a1^4*a2^4*a3^4*a4^2*b1^2*b2^2*b3^2*b4^4 +
46*a1^3*a2^4*a3^4*a4^2*b1^3*b2^2*b3^2*b4^4 + 28*a1^2*a2^4*a3^4*a4^2*b1^4*b2^2*b3^2*b4^4 +
7*a1*a2^4*a3^4*a4^2*b1^5*b2^2*b3^2*b4^4 + a1^6*a2^3*a3^4*a4^2*b2^3*b3^2*b4^4 +
12*a1^5*a2^3*a3^4*a4^2*b1*b2^3*b3^2*b4^4 + 46*a1^4*a2^3*a3^4*a4^2*b1^2*b2^3*b3^2*b4^4 +
70*a1^3*a2^3*a3^4*a4^2*b1^3*b2^3*b3^2*b4^4 + 46*a1^2*a2^3*a3^4*a4^2*b1^4*b2^3*b3^2*b4^4 +
12*a1*a2^3*a3^4*a4^2*b1^5*b2^3*b3^2*b4^4 + a2^3*a3^4*a4^2*b1^6*b2^3*b3^2*b4^4 +
7*a1^5*a2^2*a3^4*a4^2*b1*b2^4*b3^2*b4^4 + 28*a1^4*a2^2*a3^4*a4^2*b1^2*b2^4*b3^2*b4^4 +
46*a1^3*a2^2*a3^4*a4^2*b1^3*b2^4*b3^2*b4^4 + 28*a1^2*a2^2*a3^4*a4^2*b1^4*b2^4*b3^2*b4^4 +
7*a1*a2^2*a3^4*a4^2*b1^5*b2^4*b3^2*b4^4 + a1^5*a2*a3^4*a4^2*b1*b2^5*b3^2*b4^4 +
7*a1^4*a2*a3^4*a4^2*b1^2*b2^5*b3^2*b4^4 + 12*a1^3*a2*a3^4*a4^2*b1^3*b2^5*b3^2*b4^4 +
7*a1^2*a2*a3^4*a4^2*b1^4*b2^5*b3^2*b4^4 + a1*a2*a3^4*a4^2*b1^5*b2^5*b3^2*b4^4 +
a1^3*a3^4*a4^2*b1^3*b2^6*b3^2*b4^4 + a1^4*a2^6*a3^3*a4^2*b1^2*b3^3*b4^4 +
2*a1^3*a2^6*a3^3*a4^2*b1^3*b3^3*b4^4 + a1^2*a2^6*a3^3*a4^2*b1^4*b3^3*b4^4 +
2*a1^5*a2^5*a3^3*a4^2*b1*b2*b3^3*b4^4 + 12*a1^4*a2^5*a3^3*a4^2*b1^2*b2*b3^3*b4^4 +
20*a1^3*a2^5*a3^3*a4^2*b1^3*b2*b3^3*b4^4 + 12*a1^2*a2^5*a3^3*a4^2*b1^4*b2*b3^3*b4^4 +
2*a1*a2^5*a3^3*a4^2*b1^5*b2*b3^3*b4^4 + a1^6*a2^4*a3^3*a4^2*b2^2*b3^3*b4^4 +
12*a1^5*a2^4*a3^3*a4^2*b1*b2^2*b3^3*b4^4 + 46*a1^4*a2^4*a3^3*a4^2*b1^2*b2^2*b3^3*b4^4 +
70*a1^3*a2^4*a3^3*a4^2*b1^3*b2^2*b3^3*b4^4 + 46*a1^2*a2^4*a3^3*a4^2*b1^4*b2^2*b3^3*b4^4 +
12*a1*a2^4*a3^3*a4^2*b1^5*b2^2*b3^3*b4^4 + a2^4*a3^3*a4^2*b1^6*b2^2*b3^3*b4^4 +
2*a1^6*a2^3*a3^3*a4^2*b2^3*b3^3*b4^4 + 20*a1^5*a2^3*a3^3*a4^2*b1*b2^3*b3^3*b4^4 +
70*a1^4*a2^3*a3^3*a4^2*b1^2*b2^3*b3^3*b4^4 + 104*a1^3*a2^3*a3^3*a4^2*b1^3*b2^3*b3^3*b4^4 +
70*a1^2*a2^3*a3^3*a4^2*b1^4*b2^3*b3^3*b4^4 + 20*a1*a2^3*a3^3*a4^2*b1^5*b2^3*b3^3*b4^4 +
2*a2^3*a3^3*a4^2*b1^6*b2^3*b3^3*b4^4 + a1^6*a2^2*a3^3*a4^2*b2^4*b3^3*b4^4 +
12*a1^5*a2^2*a3^3*a4^2*b1*b2^4*b3^3*b4^4 + 46*a1^4*a2^2*a3^3*a4^2*b1^2*b2^4*b3^3*b4^4 +
70*a1^3*a2^2*a3^3*a4^2*b1^3*b2^4*b3^3*b4^4 + 46*a1^2*a2^2*a3^3*a4^2*b1^4*b2^4*b3^3*b4^4 +
12*a1*a2^2*a3^3*a4^2*b1^5*b2^4*b3^3*b4^4 + a2^2*a3^3*a4^2*b1^6*b2^4*b3^3*b4^4 +
2*a1^5*a2*a3^3*a4^2*b1*b2^5*b3^3*b4^4 + 12*a1^4*a2*a3^3*a4^2*b1^2*b2^5*b3^3*b4^4 +
20*a1^3*a2*a3^3*a4^2*b1^3*b2^5*b3^3*b4^4 + 12*a1^2*a2*a3^3*a4^2*b1^4*b2^5*b3^3*b4^4 +
2*a1*a2*a3^3*a4^2*b1^5*b2^5*b3^3*b4^4 + a1^4*a3^3*a4^2*b1^2*b2^6*b3^3*b4^4 +
2*a1^3*a3^3*a4^2*b1^3*b2^6*b3^3*b4^4 + a1^2*a3^3*a4^2*b1^4*b2^6*b3^3*b4^4 +
a1^3*a2^6*a3^2*a4^2*b1^3*b3^4*b4^4 + a1^5*a2^5*a3^2*a4^2*b1*b2*b3^4*b4^4 +
7*a1^4*a2^5*a3^2*a4^2*b1^2*b2*b3^4*b4^4 + 12*a1^3*a2^5*a3^2*a4^2*b1^3*b2*b3^4*b4^4 +
7*a1^2*a2^5*a3^2*a4^2*b1^4*b2*b3^4*b4^4 + a1*a2^5*a3^2*a4^2*b1^5*b2*b3^4*b4^4 +
7*a1^5*a2^4*a3^2*a4^2*b1*b2^2*b3^4*b4^4 + 28*a1^4*a2^4*a3^2*a4^2*b1^2*b2^2*b3^4*b4^4 +
46*a1^3*a2^4*a3^2*a4^2*b1^3*b2^2*b3^4*b4^4 + 28*a1^2*a2^4*a3^2*a4^2*b1^4*b2^2*b3^4*b4^4 +
7*a1*a2^4*a3^2*a4^2*b1^5*b2^2*b3^4*b4^4 + a1^6*a2^3*a3^2*a4^2*b2^3*b3^4*b4^4 +
12*a1^5*a2^3*a3^2*a4^2*b1*b2^3*b3^4*b4^4 + 46*a1^4*a2^3*a3^2*a4^2*b1^2*b2^3*b3^4*b4^4 +
70*a1^3*a2^3*a3^2*a4^2*b1^3*b2^3*b3^4*b4^4 + 46*a1^2*a2^3*a3^2*a4^2*b1^4*b2^3*b3^4*b4^4 +
12*a1*a2^3*a3^2*a4^2*b1^5*b2^3*b3^4*b4^4 + a2^3*a3^2*a4^2*b1^6*b2^3*b3^4*b4^4 +
7*a1^5*a2^2*a3^2*a4^2*b1*b2^4*b3^4*b4^4 + 28*a1^4*a2^2*a3^2*a4^2*b1^2*b2^4*b3^4*b4^4 +
46*a1^3*a2^2*a3^2*a4^2*b1^3*b2^4*b3^4*b4^4 + 28*a1^2*a2^2*a3^2*a4^2*b1^4*b2^4*b3^4*b4^4 +
7*a1*a2^2*a3^2*a4^2*b1^5*b2^4*b3^4*b4^4 + a1^5*a2*a3^2*a4^2*b1*b2^5*b3^4*b4^4 +
7*a1^4*a2*a3^2*a4^2*b1^2*b2^5*b3^4*b4^4 + 12*a1^3*a2*a3^2*a4^2*b1^3*b2^5*b3^4*b4^4 +
7*a1^2*a2*a3^2*a4^2*b1^4*b2^5*b3^4*b4^4 + a1*a2*a3^2*a4^2*b1^5*b2^5*b3^4*b4^4 +
a1^3*a3^2*a4^2*b1^3*b2^6*b3^4*b4^4 + a1^4*a2^5*a3*a4^2*b1^2*b2*b3^5*b4^4 +
2*a1^3*a2^5*a3*a4^2*b1^3*b2*b3^5*b4^4 + a1^2*a2^5*a3*a4^2*b1^4*b2*b3^5*b4^4 +

$$a_1^5 a_2^4 a_3 a_4^2 b_1 b_2^2 b_3^5 b_4^4 + 7 a_1^4 a_2^4 a_3 a_4^2 b_1^2 b_2^2 b_3^5 b_4^4 +$$
$$12 a_1^3 a_2^4 a_3 a_4^2 b_1^3 b_2^2 b_3^5 b_4^4 + 7 a_1^2 a_2^4 a_3 a_4^2 b_1^4 b_2^2 b_3^5 b_4^4 +$$
$$a_1 a_2^4 a_3 a_4^2 b_1^5 b_2^2 b_3^5 b_4^4 + 2 a_1^5 a_2^3 a_3 a_4^2 b_1 b_2^3 b_3^5 b_4^4 +$$
$$12 a_1^4 a_2^3 a_3 a_4^2 b_1^2 b_2^3 b_3^5 b_4^4 + 20 a_1^3 a_2^3 a_3 a_4^2 b_1^3 b_2^3 b_3^5 b_4^4 +$$
$$12 a_1^2 a_2^3 a_3 a_4^2 b_1^4 b_2^3 b_3^5 b_4^4 + 2 a_1 a_2^3 a_3 a_4^2 b_1^5 b_2^3 b_3^5 b_4^4 +$$
$$a_1^5 a_2^2 a_3 a_4^2 b_1 b_2^4 b_3^5 b_4^4 + 7 a_1^4 a_2^2 a_3 a_4^2 b_1^2 b_2^4 b_3^5 b_4^4 +$$
$$12 a_1^3 a_2^2 a_3 a_4^2 b_1^3 b_2^4 b_3^5 b_4^4 + 7 a_1^2 a_2^2 a_3 a_4^2 b_1^4 b_2^4 b_3^5 b_4^4 +$$
$$a_1 a_2^2 a_3 a_4^2 b_1^5 b_2^4 b_3^5 b_4^4 + a_1^4 a_2 a_3 a_4^2 b_1^2 b_2^5 b_3^5 b_4^4 +$$
$$2 a_1^3 a_2 a_3 a_4^2 b_1^3 b_2^5 b_3^5 b_4^4 + a_1^2 a_2 a_3 a_4^2 b_1^4 b_2^5 b_3^5 b_4^4 +$$
$$a_1^3 a_2^4 a_4^2 b_1^3 b_2^2 b_3^6 b_4^4 + a_1^4 a_2^3 a_4^2 b_1^2 b_2^3 b_3^6 b_4^4 +$$
$$2 a_1^3 a_2^3 a_4^2 b_1^3 b_2^3 b_3^6 b_4^4 + a_1^2 a_2^3 a_4^2 b_1^4 b_2^3 b_3^6 b_4^4 +$$
$$a_1^3 a_2^2 a_4^2 b_1^3 b_2^4 b_3^6 b_4^4 + a_1^4 a_2^4 a_3^5 a_4 b_1^2 b_2^2 b_3 b_4^5 +$$
$$2 a_1^3 a_2^4 a_3^5 a_4 b_1^3 b_2^2 b_3 b_4^5 + a_1^2 a_2^4 a_3^5 a_4 b_1^4 b_2^2 b_3 b_4^5 +$$
$$2 a_1^4 a_2^3 a_3^5 a_4 b_1^2 b_2^3 b_3 b_4^5 + 4 a_1^3 a_2^3 a_3^5 a_4 b_1^3 b_2^3 b_3 b_4^5 +$$
$$2 a_1^2 a_2^3 a_3^5 a_4 b_1^4 b_2^3 b_3 b_4^5 + a_1^4 a_2^2 a_3^5 a_4 b_1^2 b_2^4 b_3 b_4^5 +$$
$$2 a_1^3 a_2^2 a_3^5 a_4 b_1^3 b_2^4 b_3 b_4^5 + a_1^2 a_2^2 a_3^5 a_4 b_1^4 b_2^4 b_3 b_4^5 +$$
$$a_1^4 a_2^5 a_3^4 a_4 b_1^2 b_2 b_3^2 b_4^5 + 2 a_1^3 a_2^5 a_3^4 a_4 b_1^3 b_2 b_3^2 b_4^5 +$$
$$a_1^2 a_2^5 a_3^4 a_4 b_1^4 b_2 b_3^2 b_4^5 + a_1^5 a_2^4 a_3^4 a_4 b_1 b_2^2 b_3^2 b_4^5 +$$
$$7 a_1^4 a_2^4 a_3^4 a_4 b_1^2 b_2^2 b_3^2 b_4^5 + 12 a_1^3 a_2^4 a_3^4 a_4 b_1^3 b_2^2 b_3^2 b_4^5 +$$
$$7 a_1^2 a_2^4 a_3^4 a_4 b_1^4 b_2^2 b_3^2 b_4^5 + a_1 a_2^4 a_3^4 a_4 b_1^5 b_2^2 b_3^2 b_4^5 +$$
$$2 a_1^5 a_2^3 a_3^4 a_4 b_1 b_2^3 b_3^2 b_4^5 + 12 a_1^4 a_2^3 a_3^4 a_4 b_1^2 b_2^3 b_3^2 b_4^5 +$$
$$20 a_1^3 a_2^3 a_3^4 a_4 b_1^3 b_2^3 b_3^2 b_4^5 + 12 a_1^2 a_2^3 a_3^4 a_4 b_1^4 b_2^3 b_3^2 b_4^5 +$$
$$2 a_1 a_2^3 a_3^4 a_4 b_1^5 b_2^3 b_3^2 b_4^5 + a_1^5 a_2^2 a_3^4 a_4 b_1 b_2^4 b_3^2 b_4^5 +$$
$$7 a_1^4 a_2^2 a_3^4 a_4 b_1^2 b_2^4 b_3^2 b_4^5 + 12 a_1^3 a_2^2 a_3^4 a_4 b_1^3 b_2^4 b_3^2 b_4^5 +$$
$$7 a_1^2 a_2^2 a_3^4 a_4 b_1^4 b_2^4 b_3^2 b_4^5 + a_1 a_2^2 a_3^4 a_4 b_1^5 b_2^4 b_3^2 b_4^5 +$$
$$a_1^4 a_2 a_3^4 a_4 b_1^2 b_2^5 b_3^2 b_4^5 + 2 a_1^3 a_2 a_3^4 a_4 b_1^3 b_2^5 b_3^2 b_4^5 +$$
$$a_1^2 a_2 a_3^4 a_4 b_1^4 b_2^5 b_3^2 b_4^5 + 2 a_1^4 a_2^5 a_3^3 a_4 b_1^2 b_2 b_3^3 b_4^5 +$$
$$4 a_1^3 a_2^5 a_3^3 a_4 b_1^3 b_2 b_3^3 b_4^5 + 2 a_1^2 a_2^5 a_3^3 a_4 b_1^4 b_2 b_3^3 b_4^5 +$$
$$2 a_1^5 a_2^4 a_3^3 a_4 b_1 b_2^2 b_3^3 b_4^5 + 12 a_1^4 a_2^4 a_3^3 a_4 b_1^2 b_2^2 b_3^3 b_4^5 +$$
$$20 a_1^3 a_2^4 a_3^3 a_4 b_1^3 b_2^2 b_3^3 b_4^5 + 12 a_1^2 a_2^4 a_3^3 a_4 b_1^4 b_2^2 b_3^3 b_4^5 +$$
$$2 a_1 a_2^4 a_3^3 a_4 b_1^5 b_2^2 b_3^3 b_4^5 + 4 a_1^5 a_2^3 a_3^3 a_4 b_1 b_2^3 b_3^3 b_4^5 +$$
$$20 a_1^4 a_2^3 a_3^3 a_4 b_1^2 b_2^3 b_3^3 b_4^5 + 32 a_1^3 a_2^3 a_3^3 a_4 b_1^3 b_2^3 b_3^3 b_4^5 +$$
$$20 a_1^2 a_2^3 a_3^3 a_4 b_1^4 b_2^3 b_3^3 b_4^5 + 4 a_1 a_2^3 a_3^3 a_4 b_1^5 b_2^3 b_3^3 b_4^5 +$$
$$2 a_1^5 a_2^2 a_3^3 a_4 b_1 b_2^4 b_3^3 b_4^5 + 12 a_1^4 a_2^2 a_3^3 a_4 b_1^2 b_2^4 b_3^3 b_4^5 +$$
$$20 a_1^3 a_2^2 a_3^3 a_4 b_1^3 b_2^4 b_3^3 b_4^5 + 12 a_1^2 a_2^2 a_3^3 a_4 b_1^4 b_2^4 b_3^3 b_4^5 +$$
$$2 a_1 a_2^2 a_3^3 a_4 b_1^5 b_2^4 b_3^3 b_4^5 + 2 a_1^4 a_2 a_3^3 a_4 b_1^2 b_2^5 b_3^3 b_4^5 +$$
$$4 a_1^3 a_2 a_3^3 a_4 b_1^3 b_2^5 b_3^3 b_4^5 + 2 a_1^2 a_2 a_3^3 a_4 b_1^4 b_2^5 b_3^3 b_4^5 +$$
$$a_1^4 a_2^5 a_3^2 a_4 b_1^2 b_2 b_3^4 b_4^5 + 2 a_1^3 a_2^5 a_3^2 a_4 b_1^3 b_2 b_3^4 b_4^5 +$$
$$a_1^2 a_2^5 a_3^2 a_4 b_1^4 b_2 b_3^4 b_4^5 + a_1^5 a_2^4 a_3^2 a_4 b_1 b_2^2 b_3^4 b_4^5 +$$
$$7 a_1^4 a_2^4 a_3^2 a_4 b_1^2 b_2^2 b_3^4 b_4^5 + 12 a_1^3 a_2^4 a_3^2 a_4 b_1^3 b_2^2 b_3^4 b_4^5 +$$
$$7 a_1^2 a_2^4 a_3^2 a_4 b_1^4 b_2^2 b_3^4 b_4^5 + a_1 a_2^4 a_3^2 a_4 b_1^5 b_2^2 b_3^4 b_4^5 +$$
$$2 a_1^5 a_2^3 a_3^2 a_4 b_1 b_2^3 b_3^4 b_4^5 + 12 a_1^4 a_2^3 a_3^2 a_4 b_1^2 b_2^3 b_3^4 b_4^5 +$$
$$20 a_1^3 a_2^3 a_3^2 a_4 b_1^3 b_2^3 b_3^4 b_4^5 + 12 a_1^2 a_2^3 a_3^2 a_4 b_1^4 b_2^3 b_3^4 b_4^5 +$$
$$2 a_1 a_2^3 a_3^2 a_4 b_1^5 b_2^3 b_3^4 b_4^5 + a_1^5 a_2^2 a_3^2 a_4 b_1 b_2^4 b_3^4 b_4^5 +$$
$$7 a_1^4 a_2^2 a_3^2 a_4 b_1^2 b_2^4 b_3^4 b_4^5 + 12 a_1^3 a_2^2 a_3^2 a_4 b_1^3 b_2^4 b_3^4 b_4^5 +$$
$$7 a_1^2 a_2^2 a_3^2 a_4 b_1^4 b_2^4 b_3^4 b_4^5 + a_1 a_2^2 a_3^2 a_4 b_1^5 b_2^4 b_3^4 b_4^5 +$$
$$a_1^4 a_2 a_3^2 a_4 b_1^2 b_2^5 b_3^4 b_4^5 + 2 a_1^3 a_2 a_3^2 a_4 b_1^3 b_2^5 b_3^4 b_4^5 +$$
$$a_1^2 a_2 a_3^2 a_4 b_1^4 b_2^5 b_3^4 b_4^5 + a_1^4 a_2^4 a_3 a_4 b_1^2 b_2^2 b_3^5 b_4^5 +$$
$$2 a_1^3 a_2^4 a_3 a_4 b_1^3 b_2^2 b_3^5 b_4^5 + a_1^2 a_2^4 a_3 a_4 b_1^4 b_2^2 b_3^5 b_4^5 +$$
$$2 a_1^4 a_2^3 a_3 a_4 b_1^2 b_2^3 b_3^5 b_4^5 + 4 a_1^3 a_2^3 a_3 a_4 b_1^3 b_2^3 b_3^5 b_4^5 +$$
$$2 a_1^2 a_2^3 a_3 a_4 b_1^4 b_2^3 b_3^5 b_4^5 + a_1^4 a_2^2 a_3 a_4 b_1^2 b_2^4 b_3^5 b_4^5 +$$
$$2 a_1^3 a_2^2 a_3 a_4 b_1^3 b_2^4 b_3^5 b_4^5 + a_1^2 a_2^2 a_3 a_4 b_1^4 b_2^4 b_3^5 b_4^5 +$$
$$a_1^3 a_2^4 a_3^4 b_1^3 b_2^2 b_3^2 b_4^6 + a_1^4 a_2^3 a_3^4 b_1^2 b_2^3 b_3^2 b_4^6 +$$
$$2 a_1^3 a_2^3 a_3^4 b_1^3 b_2^3 b_3^2 b_4^6 + a_1^2 a_2^3 a_3^4 b_1^4 b_2^3 b_3^2 b_4^6 +$$
$$a_1^3 a_2^2 a_3^4 b_1^3 b_2^4 b_3^2 b_4^6 + a_1^4 a_2^4 a_3^3 b_1^2 b_2^2 b_3^3 b_4^6 +$$
$$2 a_1^3 a_2^4 a_3^3 b_1^3 b_2^2 b_3^3 b_4^6 + a_1^2 a_2^4 a_3^3 b_1^4 b_2^2 b_3^3 b_4^6 +$$
$$2 a_1^4 a_2^3 a_3^3 b_1^2 b_2^3 b_3^3 b_4^6 + 4 a_1^3 a_2^3 a_3^3 b_1^3 b_2^3 b_3^3 b_4^6 +$$
$$2 a_1^2 a_2^3 a_3^3 b_1^4 b_2^3 b_3^3 b_4^6 + a_1^4 a_2^2 a_3^3 b_1^2 b_2^4 b_3^3 b_4^6 +$$
$$2 a_1^3 a_2^2 a_3^3 b_1^3 b_2^4 b_3^3 b_4^6 + a_1^2 a_2^2 a_3^3 b_1^4 b_2^4 b_3^3 b_4^6 +$$
$$a_1^3 a_2^4 a_3^2 b_1^3 b_2^2 b_3^4 b_4^6 + a_1^4 a_2^3 a_3^2 b_1^2 b_2^3 b_3^4 b_4^6 +$$
$$2 a_1^3 a_2^3 a_3^2 b_1^3 b_2^3 b_3^4 b_4^6 + a_1^2 a_2^3 a_3^2 b_1^4 b_2^3 b_3^4 b_4^6 +$$

a1^3*a2^2*a3^2*b1^3*b2^4*b3^4*b4^6


```
c2=sum(f10.find(2*w0))
c2
#This finds all our terms in f10 that have a 2 in them and then adds them \
    together. The first set of groups we form will have two of the four a \
    variables to the third power and either a third a variable or its \
    corresponding b variable to the fourth power.
```

2*a1^3*a2^3*a3^4*a4^6*b1^3*b2^3*b3^2 + 2*a1^3*a2^4*a3^3*a4^6*b1^3*b2^2*b3^3 +
2*a1^4*a2^3*a3^3*a4^6*b1^2*b2^3*b3^3 + 2*a1^2*a2^3*a3^3*a4^6*b1^4*b2^3*b3^3 +
2*a1^3*a2^2*a3^3*a4^6*b1^3*b2^4*b3^3 + 2*a1^3*a2^3*a3^2*a4^6*b1^3*b2^3*b3^4 +
2*a1^3*a2^4*a3^5*a4^5*b1^3*b2^2*b3*b4 + 2*a1^4*a2^3*a3^5*a4^5*b1^2*b2^3*b3*b4 +
2*a1^2*a2^3*a3^5*a4^5*b1^4*b2^3*b3*b4 + 2*a1^3*a2^2*a3^5*a4^5*b1^3*b2^4*b3*b4 +
2*a1^3*a2^5*a3^4*a4^5*b1^3*b2*b3^2*b4 + 2*a1^5*a2^3*a3^4*a4^5*b1*b2^3*b3^2*b4 +
2*a1*a2^3*a3^4*a4^5*b1^5*b2^3*b3^2*b4 + 2*a1^3*a2*a3^4*a4^5*b1^3*b2^5*b3^2*b4 +
2*a1^4*a2^5*a3^3*a4^5*b1^2*b2*b3^3*b4 + 2*a1^2*a2^5*a3^3*a4^5*b1^4*b2*b3^3*b4 +
2*a1^5*a2^4*a3^3*a4^5*b1*b2^2*b3^3*b4 + 2*a1*a2^4*a3^3*a4^5*b1^5*b2^2*b3^3*b4 +
2*a1^5*a2^2*a3^3*a4^5*b1*b2^4*b3^3*b4 + 2*a1*a2^2*a3^3*a4^5*b1^5*b2^4*b3^3*b4 +
2*a1^4*a2*a3^3*a4^5*b1^2*b2^5*b3^3*b4 + 2*a1^2*a2*a3^3*a4^5*b1^4*b2^5*b3^3*b4 +
2*a1^3*a2^5*a3^2*a4^5*b1^3*b2*b3^4*b4 + 2*a1^5*a2^3*a3^2*a4^5*b1*b2^3*b3^4*b4 +
2*a1*a2^3*a3^2*a4^5*b1^5*b2^3*b3^4*b4 + 2*a1^3*a2*a3^2*a4^5*b1^3*b2^5*b3^4*b4 +
2*a1^3*a2^4*a3*a4^5*b1^3*b2^2*b3^5*b4 + 2*a1^4*a2^3*a3*a4^5*b1^2*b2^3*b3^5*b4 +
2*a1^2*a2^3*a3*a4^5*b1^4*b2^3*b3^5*b4 + 2*a1^3*a2^2*a3*a4^5*b1^3*b2^4*b3^5*b4 +
2*a1^3*a2^3*a3^6*a4^4*b1^3*b2^3*b4^2 + 2*a1^3*a2^5*a3^5*a4^4*b1^3*b2*b3*b4^2 +
2*a1^5*a2^3*a3^5*a4^4*b1*b2^3*b3*b4^2 + 2*a1*a2^3*a3^5*a4^4*b1^5*b2^3*b3*b4^2 +
2*a1^3*a2*a3^5*a4^4*b1^3*b2^5*b3*b4^2 + 2*a1^3*a2^6*a3^3*a4^4*b1^3*b3^3*b4^2 +
2*a1^5*a2^5*a3^3*a4^4*b1*b2*b3^3*b4^2 + 2*a1*a2^5*a3^3*a4^4*b1^5*b2*b3^3*b4^2 +
2*a1^6*a2^3*a3^3*a4^4*b2^3*b3^3*b4^2 + 2*a2^3*a3^3*a4^4*b1^6*b2^3*b3^3*b4^2 +
2*a1^5*a2*a3^3*a4^4*b1*b2^5*b3^3*b4^2 + 2*a1*a2*a3^3*a4^4*b1^5*b2^5*b3^3*b4^2 +
2*a1^3*a3^3*a4^4*b1^3*b2^6*b3^3*b4^2 + 2*a1^3*a2^5*a3*a4^4*b1^3*b2*b3^5*b4^2 +
2*a1^5*a2^3*a3*a4^4*b1*b2^3*b3^5*b4^2 + 2*a1*a2^3*a3*a4^4*b1^5*b2^3*b3^5*b4^2 +
2*a1^3*a2*a3*a4^4*b1^3*b2^5*b3^5*b4^2 + 2*a1^3*a2^3*a4^4*b1^3*b2^3*b3^6*b4^2 +
2*a1^3*a2^4*a3^6*a4^3*b1^3*b2^2*b4^3 + 2*a1^4*a2^3*a3^6*a4^3*b1^2*b2^3*b4^3 +
2*a1^2*a2^3*a3^6*a4^3*b1^4*b2^3*b4^3 + 2*a1^3*a2^2*a3^6*a4^3*b1^3*b2^4*b4^3 +
2*a1^4*a2^5*a3^5*a4^3*b1^2*b2*b3*b4^3 + 2*a1^2*a2^5*a3^5*a4^3*b1^4*b2*b3*b4^3 +
2*a1^5*a2^4*a3^5*a4^3*b1*b2^2*b3*b4^3 + 2*a1*a2^4*a3^5*a4^3*b1^5*b2^2*b3*b4^3 +
2*a1^5*a2^2*a3^5*a4^3*b1*b2^4*b3*b4^3 + 2*a1*a2^2*a3^5*a4^3*b1^5*b2^4*b3*b4^3 +
2*a1^4*a2*a3^5*a4^3*b1^2*b2^5*b3*b4^3 + 2*a1^2*a2*a3^5*a4^3*b1^4*b2^5*b3*b4^3 +
2*a1^3*a2^6*a3^4*a4^3*b1^3*b3^2*b4^3 + 2*a1^5*a2^5*a3^4*a4^3*b1*b2*b3^2*b4^3 +
2*a1*a2^5*a3^4*a4^3*b1^5*b2*b3^2*b4^3 + 2*a1^6*a2^3*a3^4*a4^3*b2^3*b3^2*b4^3 +
2*a2^3*a3^4*a4^3*b1^6*b2^3*b3^2*b4^3 + 2*a1^5*a2*a3^4*a4^3*b1*b2^5*b3^2*b4^3 +
2*a1*a2*a3^4*a4^3*b1^5*b2^5*b3^2*b4^3 + 2*a1^3*a3^4*a4^3*b1^3*b2^6*b3^2*b4^3 +
2*a1^4*a2^6*a3^3*a4^3*b1^2*b3^3*b4^3 + 2*a1^2*a2^6*a3^3*a4^3*b1^4*b3^3*b4^3 +
2*a1^6*a2^4*a3^3*a4^3*b2^2*b3^3*b4^3 + 2*a2^4*a3^3*a4^3*b1^6*b2^2*b3^3*b4^3 +
2*a1^6*a2^2*a3^3*a4^3*b2^4*b3^3*b4^3 + 2*a2^2*a3^3*a4^3*b1^6*b2^4*b3^3*b4^3 +
2*a1^4*a3^3*a4^3*b1^2*b2^6*b3^3*b4^3 + 2*a1^2*a3^3*a4^3*b1^4*b2^6*b3^3*b4^3 +
2*a1^3*a2^6*a3^2*a4^3*b1^3*b3^4*b4^3 + 2*a1^5*a2^5*a3^2*a4^3*b1*b2*b3^4*b4^3 +
2*a1*a2^5*a3^2*a4^3*b1^5*b2*b3^4*b4^3 + 2*a1^6*a2^3*a3^2*a4^3*b2^3*b3^4*b4^3 +
2*a2^3*a3^2*a4^3*b1^6*b2^3*b3^4*b4^3 + 2*a1^5*a2*a3^2*a4^3*b1*b2^5*b3^4*b4^3 +
2*a1*a2*a3^2*a4^3*b1^5*b2^5*b3^4*b4^3 + 2*a1^3*a3^2*a4^3*b1^3*b2^6*b3^4*b4^3 +
2*a1^4*a2^5*a3*a4^3*b1^2*b2*b3^5*b4^3 + 2*a1^2*a2^5*a3*a4^3*b1^4*b2*b3^5*b4^3 +
2*a1^5*a2^4*a3*a4^3*b1*b2^2*b3^5*b4^3 + 2*a1*a2^4*a3*a4^3*b1^5*b2^2*b3^5*b4^3 +
2*a1^5*a2^2*a3*a4^3*b1*b2^4*b3^5*b4^3 + 2*a1*a2^2*a3*a4^3*b1^5*b2^4*b3^5*b4^3 +
2*a1^4*a2*a3*a4^3*b1^2*b2^5*b3^5*b4^3 + 2*a1^2*a2*a3*a4^3*b1^4*b2^5*b3^5*b4^3 +
2*a1^3*a2^4*a4^3*b1^3*b2^2*b3^6*b4^3 + 2*a1^4*a2^3*a4^3*b1^2*b2^3*b3^6*b4^3 +
2*a1^2*a2^3*a4^3*b1^4*b2^3*b3^6*b4^3 + 2*a1^3*a2^2*a4^3*b1^3*b2^4*b3^6*b4^3 +
2*a1^3*a2^3*a3^6*a4^2*b1^3*b2^3*b4^4 + 2*a1^3*a2^5*a3^5*a4^2*b1^3*b2*b3*b4^4 +
2*a1^5*a2^3*a3^5*a4^2*b1*b2^3*b3*b4^4 + 2*a1*a2^3*a3^5*a4^2*b1^5*b2^3*b3*b4^4 +
2*a1^3*a2*a3^5*a4^2*b1^3*b2^5*b3*b4^4 + 2*a1^3*a2^6*a3^3*a4^2*b1^3*b3^3*b4^4 +
2*a1^5*a2^5*a3^3*a4^2*b1*b2*b3^3*b4^4 + 2*a1*a2^5*a3^3*a4^2*b1^5*b2*b3^3*b4^4 +

2*a1^6*a2^3*a3^3*a4^2*b2^3*b3^3*b4^4 + 2*a2^3*a3^3*a4^2*b1^6*b2^3*b3^3*b4^4 +
2*a1^5*a2*a3^3*a4^2*b1*b2^5*b3^3*b4^4 + 2*a1*a2*a3^3*a4^2*b1^5*b2^5*b3^3*b4^4 +
2*a1^3*a3^3*a4^2*b1^3*b2^6*b3^3*b4^4 + 2*a1^3*a2^5*a3*a4^2*b1^3*b2*b3^5*b4^4 +
2*a1^5*a2^3*a3*a4^2*b1*b2^3*b3^5*b4^4 + 2*a1*a2^3*a3*a4^2*b1^5*b2^3*b3^5*b4^4 +
2*a1^3*a2*a3*a4^2*b1^3*b2^5*b3^5*b4^4 + 2*a1^3*a2^3*a4^2*b1^3*b2^3*b3^6*b4^4 +
2*a1^3*a2^4*a3^5*a4*b1^3*b2^2*b3*b4^5 + 2*a1^4*a2^3*a3^5*a4*b1^2*b2^3*b3*b4^5 +
2*a1^2*a2^3*a3^5*a4*b1^4*b2^3*b3*b4^5 + 2*a1^3*a2^2*a3^5*a4*b1^3*b2^4*b3*b4^5 +
2*a1^3*a2^5*a3^4*a4*b1^3*b2*b3^2*b4^5 + 2*a1^5*a2^3*a3^4*a4*b1*b2^3*b3^2*b4^5 +
2*a1*a2^3*a3^4*a4*b1^5*b2^3*b3^2*b4^5 + 2*a1^3*a2*a3^4*a4*b1^3*b2^5*b3^2*b4^5 +
2*a1^4*a2^5*a3^3*a4*b1^2*b2*b3^3*b4^5 + 2*a1^2*a2^5*a3^3*a4*b1^4*b2*b3^3*b4^5 +
2*a1^5*a2^4*a3^3*a4*b1*b2^2*b3^3*b4^5 + 2*a1*a2^4*a3^3*a4*b1^5*b2^2*b3^3*b4^5 +
2*a1^5*a2^2*a3^3*a4*b1*b2^4*b3^3*b4^5 + 2*a1*a2^2*a3^3*a4*b1^5*b2^4*b3^3*b4^5 +
2*a1^4*a2*a3^3*a4*b1^2*b2^5*b3^3*b4^5 + 2*a1^2*a2*a3^3*a4*b1^4*b2^5*b3^3*b4^5 +
2*a1^3*a2^5*a3^2*a4*b1^3*b2*b3^4*b4^5 + 2*a1^5*a2^3*a3^2*a4*b1*b2^3*b3^4*b4^5 +
2*a1*a2^3*a3^2*a4*b1^5*b2^3*b3^4*b4^5 + 2*a1^3*a2*a3^2*a4*b1^3*b2^5*b3^4*b4^5 +
2*a1^3*a2^4*a3*a4*b1^3*b2^2*b3^5*b4^5 + 2*a1^4*a2^3*a3*a4*b1^2*b2^3*b3^5*b4^5 +
2*a1^2*a2^3*a3*a4*b1^4*b2^3*b3^5*b4^5 + 2*a1^3*a2^2*a3*a4*b1^3*b2^4*b3^5*b4^5 +
2*a1^3*a2^3*a3^4*b1^3*b2^3*b3^2*b4^6 + 2*a1^3*a2^4*a3^3*b1^3*b2^2*b3^3*b4^6 +
2*a1^4*a2^3*a3^3*b1^2*b2^3*b3^3*b4^6 + 2*a1^2*a2^3*a3^3*b1^4*b2^3*b3^3*b4^6 +
2*a1^3*a2^2*a3^3*b1^3*b2^4*b3^3*b4^6 + 2*a1^3*a2^3*a3^2*b1^3*b2^3*b3^4*b4^6

2*a1^3*a2^3*a3^4*a4^6*b1^3*b2^3*b3^2 + 2*a1^3*a2^3*a3^2*a4^6*b1^3*b2^3*b3^4 +
2*a1^3*a2^3*a3^4*b1^3*b2^3*b3^2*b4^6 + 2*a1^3*a2^3*a3^2*b1^3*b2^3*b3^4*b4^6
2*(a4^4 - a4^2*b4^2 + b4^4)*(a3^2 + b3^2)*(a4^2 + b4^2)*a1^3*a2^3*a3^2*b1^3*b2^3*b3^2
2*((p4^2 + 2*q4)^2 - 3*q4^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^3*q3^2

2*a1^3*a2^3*a3^6*a4^4*b1^3*b2^3*b4^2 + 2*a1^3*a2^3*a4^4*b1^3*b2^3*b3^6*b4^2 +
2*a1^3*a2^3*a3^6*a4^2*b1^3*b2^3*b4^4 + 2*a1^3*a2^3*a4^2*b1^3*b2^3*b3^6*b4^4
2*(a3^4 - a3^2*b3^2 + b3^4)*(a3^2 + b3^2)*(a4^2 + b4^2)*a1^3*a2^3*a4^2*b1^3*b2^3*b4^2
2*((p3^2 + 2*q3)^2 - 3*q3^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^3*q4^2

2*a1^3*a2^4*a3^3*a4^6*b1^3*b2^2*b3^3 + 2*a1^3*a2^2*a3^3*a4^6*b1^3*b2^4*b3^3 +
2*a1^3*a2^4*a3^3*b1^3*b2^2*b3^3*b4^6 + 2*a1^3*a2^2*a3^3*b1^3*b2^4*b3^3*b4^6
2*(a4^4 - a4^2*b4^2 + b4^4)*(a2^2 + b2^2)*(a4^2 + b4^2)*a1^3*a2^2*a3^3*b1^3*b2^2*b3^3
2*((p4^2 + 2*q4)^2 - 3*q4^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^3*q2^2*q3^3

```
s2134=2*((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^3*q3^3*q4^2
s2134
```
#This is the sum of the terms with a1^3, a3^3, and either a4^4 or b4^4, its \
    factorization, and its substitution.
```
2*a1^3*a2^6*a3^3*a4^4*b1^3*b3^3*b4^2 + 2*a1^3*a3^3*a4^4*b1^3*b2^6*b3^3*b4^2 +
2*a1^3*a2^6*a3^3*a4^2*b1^3*b3^3*b4^4 + 2*a1^3*a3^3*a4^2*b1^3*b2^6*b3^3*b4^4
2*(a2^4 - a2^2*b2^2 + b2^4)*(a2^2 + b2^2)*(a4^2 + b4^2)*a1^3*a3^3*a4^2*b1^3*b3^3*b4^2
2*((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^3*q3^3*q4^2

c2142=sum(c2.find(a1^3*a4^3*a2^4*w0))+sum(c2.find(a1^3*a4^3*b2^4*w0))
c2142
c2142.factor()
s2142=2*((p3^2 + 2*q3)^2 - 3*q3^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^3*q2^2*q4^3
s2142
```
#This is the sum of the terms with a1^3, a4^3, and either a2^4 or b2^4, its \
    factorization, and its substitution.
```
2*a1^3*a2^4*a3^6*a4^3*b1^3*b2^2*b4^3 + 2*a1^3*a2^2*a3^6*a4^3*b1^3*b2^4*b4^3 +
2*a1^3*a2^4*a4^3*b1^3*b2^2*b3^6*b4^3 + 2*a1^3*a2^2*a4^3*b1^3*b2^4*b3^6*b4^3
2*(a3^4 - a3^2*b3^2 + b3^4)*(a2^2 + b2^2)*(a3^2 + b3^2)*a1^3*a2^2*a4^3*b1^3*b2^2*b4^3
2*((p3^2 + 2*q3)^2 - 3*q3^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^3*q2^2*q4^3

c2143=sum(c2.find(a1^3*a4^3*a3^4*w0))+sum(c2.find(a1^3*a4^3*b3^4*w0))
c2143
c2143.factor()
s2143=2*((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^3*q3^2*q4^3
s2143
```
#This is the sum of the terms with a1^3, a4^3, and either a3^4 or b3^4, its \
    factorization, and its substitution.
```
2*a1^3*a2^6*a3^4*a4^3*b1^3*b3^2*b4^3 + 2*a1^3*a3^4*a4^3*b1^3*b2^6*b3^2*b4^3 +
2*a1^3*a2^6*a3^2*a4^3*b1^3*b3^4*b4^3 + 2*a1^3*a3^2*a4^3*b1^3*b2^6*b3^4*b4^3
2*(a2^4 - a2^2*b2^2 + b2^4)*(a2^2 + b2^2)*(a3^2 + b3^2)*a1^3*a3^2*a4^3*b1^3*b3^2*b4^3
2*((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^3*q3^2*q4^3

c2231=sum(c2.find(a2^3*a3^3*a1^4*w0))+sum(c2.find(a2^3*a3^3*b1^4*w0))
c2231
c2231.factor()
s2231=2*((p4^2 + 2*q4)^2 - 3*q4^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2^3*q3^3
s2231
```
#This is the sum of the terms with a2^3, a3^3, and either a1^4 or b1^4, its \
    factorization, and its substitution.
```
2*a1^4*a2^3*a3^3*a4^6*b1^2*b2^3*b3^3 + 2*a1^2*a2^3*a3^3*a4^6*b1^4*b2^3*b3^3 +
2*a1^4*a2^3*a3^3*b1^2*b2^3*b3^3*b4^6 + 2*a1^2*a2^3*a3^3*b1^4*b2^3*b3^3*b4^6
2*(a4^4 - a4^2*b4^2 + b4^4)*(a1^2 + b1^2)*(a4^2 + b4^2)*a1^2*a2^3*a3^3*b1^2*b2^3*b3^3
2*((p4^2 + 2*q4)^2 - 3*q4^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2^3*q3^3

c2234=sum(c2.find(a2^3*a3^3*a4^4*w0))+sum(c2.find(a2^3*a3^3*b4^4*w0))
c2234
c2234.factor()
s2234=2*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q2^3*q3^3*q4^2
s2234
```
#This is the sum of the terms with a2^3, a3^3, and either a4^4 or b4^4, its \
    factorization, and its substitution.
```
2*a1^6*a2^3*a3^3*a4^4*b2^3*b3^3*b4^2 + 2*a2^3*a3^3*a4^4*b1^6*b2^3*b3^3*b4^2 +
2*a1^6*a2^3*a3^3*a4^2*b2^3*b3^3*b4^4 + 2*a2^3*a3^3*a4^2*b1^6*b2^3*b3^3*b4^4
2*(a1^4 - a1^2*b1^2 + b1^4)*(a1^2 + b1^2)*(a4^2 + b4^2)*a2^3*a3^3*a4^2*b2^3*b3^3*b4^2
2*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q2^3*q3^3*q4^2

c2241=sum(c2.find(a2^3*a4^3*a1^4*w0))+sum(c2.find(a2^3*a4^3*b1^4*w0))
c2241
c2241.factor()
s2241=2*((p3^2 + 2*q3)^2 - 3*q3^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2^3*q4^3
```

s2241

#This is the sum of the terms with a2^3, a4^3, and either a1^4 or b4^1, its \
    factorization, and its substitution.
2*a1^4*a2^3*a3^6*a4^3*b1^2*b2^3*b4^3 + 2*a1^2*a2^3*a3^6*a4^3*b1^4*b2^3*b4^3 +
2*a1^4*a2^3*a4^3*b1^2*b2^3*b3^6*b4^3 + 2*a1^2*a2^3*a4^3*b1^4*b2^3*b3^6*b4^3
2*(a3^4 - a3^2*b3^2 + b3^4)*(a1^2 + b1^2)*(a3^2 + b3^2)*a1^2*a2^3*a4^3*b1^2*b2^3*b4^3
2*((p3^2 + 2*q3)^2 - 3*q3^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2^3*q4^3

c2243=sum(c2.find(a2^3*a4^3*a3^4*w0))+sum(c2.find(a2^3*a4^3*b3^4*w0))
c2243
c2243.factor()
s2243=2*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q2^3*q3^2*q4^3
s2243
#This is the sum of the terms with a2^3, a4^3, and either a3^4 or b3^4, its \
    factorization, and its substitution.
2*a1^6*a2^3*a3^4*a4^3*b2^3*b3^2*b4^3 + 2*a2^3*a3^4*a4^3*b1^6*b2^3*b3^2*b4^3 +
2*a1^6*a2^3*a3^2*a4^3*b2^3*b3^4*b4^3 + 2*a2^3*a3^2*a4^3*b1^6*b2^3*b3^4*b4^3
2*(a1^4 - a1^2*b1^2 + b1^4)*(a1^2 + b1^2)*(a3^2 + b3^2)*a2^3*a3^2*a4^3*b2^3*b3^2*b4^3
2*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q2^3*q3^2*q4^3

c2341=sum(c2.find(a3^3*a4^3*a1^4*w0))+sum(c2.find(a3^3*a4^3*b1^4*w0))
c2341
c2341.factor()
s2341=2*((p2^2 + 2*q2)^2 - 3*q2^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q3^3*q4^3
s2341
#This is the sum of the terms with a3^3, a4^3, and either a1^4 or b1^4, its \
    factorization, and its substitution.
2*a1^4*a2^6*a3^3*a4^3*b1^2*b3^3*b4^3 + 2*a1^2*a2^6*a3^3*a4^3*b1^4*b3^3*b4^3 +
2*a1^4*a3^3*a4^3*b1^2*b2^6*b3^3*b4^3 + 2*a1^2*a3^3*a4^3*b1^4*b2^6*b3^3*b4^3
2*(a2^4 - a2^2*b2^2 + b2^4)*(a1^2 + b1^2)*(a2^2 + b2^2)*a1^2*a3^3*a4^3*b1^2*b3^3*b4^3
2*((p2^2 + 2*q2)^2 - 3*q2^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q3^3*q4^3

c2342=sum(c2.find(a3^3*a4^3*a2^4*w0))+sum(c2.find(a3^3*a4^3*b2^4*w0))
c2342
c2342.factor()
s2342=2*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q2^2*q3^3*q4^3
s2342
#This is the sum of the terms with a3^3, a4^3, and either a1^4 or b1^4, its \
    factorization, and its substitution.
2*a1^6*a2^4*a3^3*a4^3*b2^2*b3^3*b4^3 + 2*a2^4*a3^3*a4^3*b1^6*b2^2*b3^3*b4^3 +
2*a1^6*a2^2*a3^3*a4^3*b2^4*b3^3*b4^3 + 2*a2^2*a3^3*a4^3*b1^6*b2^4*b3^3*b4^3
2*(a1^4 - a1^2*b1^2 + b1^4)*(a1^2 + b1^2)*(a2^2 + b2^2)*a2^2*a3^3*a4^3*b2^2*b3^3*b4^3
2*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q2^2*q3^3*q4^3

c02=c2-c2123-c2124-c2132-c2134-c2142-c2143-c2231-c2234-c2241-c2243-c2341-c2342
c02
#This gets all the terms from c2 that have not been assigned to a group. The \
    groups we form will have one of the four a variables to the third power and \
    either a second a variable or its corresponding b variable to the forth \
    power.
2*a1^3*a2^4*a3^5*a4^5*b1^3*b2^2*b3*b4 + 2*a1^4*a2^3*a3^5*a4^5*b1^2*b2^3*b3*b4 +
2*a1^2*a2^3*a3^5*a4^5*b1^4*b2^3*b3*b4 + 2*a1^3*a2^2*a3^5*a4^5*b1^3*b2^4*b3*b4 +
2*a1^3*a2^5*a3^4*a4^5*b1^3*b2*b3^2*b4 + 2*a1^5*a2^3*a3^4*a4^5*b1*b2^3*b3^2*b4 +
2*a1*a2^3*a3^4*a4^5*b1^5*b2^3*b3^2*b4 + 2*a1^3*a2*a3^4*a4^5*b1^3*b2^5*b3^2*b4 +
2*a1^4*a2^5*a3^3*a4^5*b1^2*b2*b3^3*b4 + 2*a1^2*a2^5*a3^3*a4^5*b1^4*b2*b3^3*b4 +
2*a1^5*a2^4*a3^3*a4^5*b1*b2^2*b3^3*b4 + 2*a1*a2^4*a3^3*a4^5*b1^5*b2^2*b3^3*b4 +
2*a1^5*a2^2*a3^3*a4^5*b1*b2^4*b3^3*b4 + 2*a1*a2^2*a3^3*a4^5*b1^5*b2^4*b3^3*b4 +
2*a1^4*a2*a3^3*a4^5*b1^2*b2^5*b3^3*b4 + 2*a1^2*a2*a3^3*a4^5*b1^4*b2^5*b3^3*b4 +
2*a1^3*a2^5*a3^2*a4^5*b1^3*b2*b3^4*b4 + 2*a1^5*a2^3*a3^2*a4^5*b1*b2^3*b3^4*b4 +
2*a1*a2^3*a3^2*a4^5*b1^5*b2^3*b3^4*b4 + 2*a1^3*a2*a3^2*a4^5*b1^3*b2^5*b3^4*b4 +
2*a1^3*a2^4*a3*a4^5*b1^3*b2^2*b3^5*b4 + 2*a1^4*a2^3*a3*a4^5*b1^2*b2^3*b3^5*b4 +

2*a1^2*a2^3*a3*a4^5*b1^4*b2^3*b3^5*b4 + 2*a1^3*a2^2*a3*a4^5*b1^3*b2^4*b3^5*b4 +
2*a1^3*a2^5*a3^5*a4^4*b1^3*b2*b3*b4^2 + 2*a1^5*a2^3*a3^5*a4^4*b1*b2^3*b3*b4^2 +
2*a1*a2^3*a3^5*a4^4*b1^5*b2^3*b3*b4^2 + 2*a1^3*a2*a3^5*a4^4*b1^3*b2^5*b3*b4^2 +
2*a1^5*a2^5*a3^3*a4^4*b1*b2*b3^3*b4^2 + 2*a1*a2^5*a3^3*a4^4*b1^5*b2*b3^3*b4^2 +
2*a1^5*a2*a3^3*a4^4*b1*b2^5*b3^3*b4^2 + 2*a1*a2*a3^3*a4^4*b1^5*b2^5*b3^3*b4^2 +
2*a1^3*a2^5*a3*a4^4*b1^3*b2*b3^5*b4^2 + 2*a1^5*a2^3*a3*a4^4*b1*b2^3*b3^5*b4^2 +
2*a1*a2^3*a3*a4^4*b1^5*b2^3*b3^5*b4^2 + 2*a1^3*a2*a3*a4^4*b1^3*b2^5*b3^5*b4^2 +
2*a1^4*a2^5*a3^5*a4^3*b1^2*b2*b3*b4^3 + 2*a1^2*a2^5*a3^5*a4^3*b1^4*b2*b3*b4^3 +
2*a1^5*a2^4*a3^5*a4^3*b1*b2^2*b3*b4^3 + 2*a1*a2^4*a3^5*a4^3*b1^5*b2^2*b3*b4^3 +
2*a1^5*a2^2*a3^5*a4^3*b1*b2^4*b3*b4^3 + 2*a1*a2^2*a3^5*a4^3*b1^5*b2^4*b3*b4^3 +
2*a1^4*a2*a3^5*a4^3*b1^2*b2^5*b3*b4^3 + 2*a1^2*a2*a3^5*a4^3*b1^4*b2^5*b3*b4^3 +
2*a1^5*a2^5*a3^4*a4^3*b1*b2*b3^2*b4^3 + 2*a1*a2^5*a3^4*a4^3*b1^5*b2*b3^2*b4^3 +
2*a1^5*a2*a3^4*a4^3*b1*b2^5*b3^2*b4^3 + 2*a1*a2*a3^4*a4^3*b1^5*b2^5*b3^2*b4^3 +
2*a1^5*a2^5*a3^2*a4^3*b1*b2*b3^4*b4^3 + 2*a1*a2^5*a3^2*a4^3*b1^5*b2*b3^4*b4^3 +
2*a1^5*a2*a3^2*a4^3*b1*b2^5*b3^4*b4^3 + 2*a1*a2*a3^2*a4^3*b1^5*b2^5*b3^4*b4^3 +
2*a1^4*a2^5*a3*a4^3*b1^2*b2*b3^5*b4^3 + 2*a1^2*a2^5*a3*a4^3*b1^4*b2*b3^5*b4^3 +
2*a1^5*a2^4*a3*a4^3*b1*b2^2*b3^5*b4^3 + 2*a1*a2^4*a3*a4^3*b1^5*b2^2*b3^5*b4^3 +
2*a1^5*a2^2*a3*a4^3*b1*b2^4*b3^5*b4^3 + 2*a1*a2^2*a3*a4^3*b1^5*b2^4*b3^5*b4^3 +
2*a1^4*a2*a3*a4^3*b1^2*b2^5*b3^5*b4^3 + 2*a1^2*a2*a3*a4^3*b1^4*b2^5*b3^5*b4^3 +
2*a1^3*a2^5*a3^5*a4^2*b1^3*b2*b3*b4^4 + 2*a1^5*a2^3*a3^5*a4^2*b1*b2^3*b3*b4^4 +
2*a1*a2^3*a3^5*a4^2*b1^5*b2^3*b3*b4^4 + 2*a1^3*a2*a3^5*a4^2*b1^3*b2^5*b3*b4^4 +
2*a1^5*a2^5*a3^3*a4^2*b1*b2*b3^3*b4^4 + 2*a1*a2^5*a3^3*a4^2*b1^5*b2*b3^3*b4^4 +
2*a1^5*a2*a3^3*a4^2*b1*b2^5*b3^3*b4^4 + 2*a1*a2*a3^3*a4^2*b1^5*b2^5*b3^3*b4^4 +
2*a1^3*a2^5*a3*a4^2*b1^3*b2*b3^5*b4^4 + 2*a1^5*a2^3*a3*a4^2*b1*b2^3*b3^5*b4^4 +
2*a1*a2^3*a3*a4^2*b1^5*b2^3*b3^5*b4^4 + 2*a1^3*a2*a3*a4^2*b1^3*b2^5*b3^5*b4^4 +
2*a1^3*a2^4*a3^5*a4*b1^3*b2^2*b3*b4^5 + 2*a1^4*a2^3*a3^5*a4*b1^2*b2^3*b3*b4^5 +
2*a1^2*a2^3*a3^5*a4*b1^4*b2^3*b3*b4^5 + 2*a1^3*a2^2*a3^5*a4*b1^3*b2^4*b3*b4^5 +
2*a1^3*a2^5*a3^4*a4*b1^3*b2*b3^2*b4^5 + 2*a1^5*a2^3*a3^4*a4*b1*b2^3*b3^2*b4^5 +
2*a1*a2^3*a3^4*a4*b1^5*b2^3*b3^2*b4^5 + 2*a1^3*a2*a3^4*a4*b1^3*b2^5*b3^2*b4^5 +
2*a1^4*a2^5*a3^3*a4*b1^2*b2*b3^3*b4^5 + 2*a1^2*a2^5*a3^3*a4*b1^4*b2*b3^3*b4^5 +
2*a1^5*a2^4*a3^3*a4*b1*b2^2*b3^3*b4^5 + 2*a1*a2^4*a3^3*a4*b1^5*b2^2*b3^3*b4^5 +
2*a1^5*a2^2*a3^3*a4*b1*b2^4*b3^3*b4^5 + 2*a1*a2^2*a3^3*a4*b1^5*b2^4*b3^3*b4^5 +
2*a1^4*a2*a3^3*a4*b1^2*b2^5*b3^3*b4^5 + 2*a1^2*a2*a3^3*a4*b1^4*b2^5*b3^3*b4^5 +
2*a1^3*a2^5*a3^2*a4*b1^3*b2*b3^4*b4^5 + 2*a1^5*a2^3*a3^2*a4*b1*b2^3*b3^4*b4^5 +
2*a1*a2^3*a3^2*a4*b1^5*b2^3*b3^4*b4^5 + 2*a1^3*a2*a3^2*a4*b1^3*b2^5*b3^4*b4^5 +
2*a1^3*a2^4*a3*a4*b1^3*b2^2*b3^5*b4^5 + 2*a1^4*a2^3*a3*a4*b1^2*b2^3*b3^5*b4^5 +
2*a1^2*a2^3*a3*a4*b1^4*b2^3*b3^5*b4^5 + 2*a1^3*a2^2*a3*a4*b1^3*b2^4*b3^5*b4^5

c0212=sum(c02.find(a1^3*a2^4*w0))+sum(c02.find(a1^3*b2^4*w0))
c0212
c0212.factor()
s0212=-2*((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*q1\
    ^3*q2^2*q3*q4
s0212
#This is the sum of the terms with a1^3 and either a2^4 or b2^4, its \
    factorization, and its substitution.
2*a1^3*a2^4*a3^5*a4^5*b1^3*b2^2*b3*b4 + 2*a1^3*a2^2*a3^5*a4^5*b1^3*b2^4*b3*b4 +
2*a1^3*a2^4*a3*a4^5*b1^3*b2^2*b3^5*b4 + 2*a1^3*a2^2*a3*a4^5*b1^3*b2^4*b3^5*b4 +
2*a1^3*a2^4*a3^5*a4*b1^3*b2^2*b3*b4^5 + 2*a1^3*a2^2*a3^5*a4*b1^3*b2^4*b3*b4^5 +
2*a1^3*a2^4*a3*a4*b1^3*b2^2*b3^5*b4^5 + 2*a1^3*a2^2*a3*a4*b1^3*b2^4*b3^5*b4^5
2*(a3^4 + b3^4)*(a4^4 + b4^4)*(a2^2 + b2^2)*a1^3*a2^2*a3*a4*b1^3*b2^2*b3*b4
-2*((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*q1^3*q2^2*q3*q4

c0213=sum(c02.find(a1^3*a3^4*w0))+sum(c02.find(a1^3*b3^4*w0))
c0213
c0213.factor()
s0213=-2*((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p3^2 + 2*q3)*q1\
    ^3*q2*q3^2*q4
s0213
#This is the sum of the terms with a1^3 and either a3^4 or b2^4, its \
    factorization, and its substitution.

2*a1^3*a2^5*a3^4*a4^5*b1^3*b2*b3^2*b4 + 2*a1^3*a2*a3^4*a4^5*b1^3*b2^5*b3^2*b4 +
2*a1^3*a2^5*a3^2*a4^5*b1^3*b2*b3^4*b4 + 2*a1^3*a2*a3^2*a4^5*b1^3*b2^5*b3^4*b4 +
2*a1^3*a2^5*a3^4*a4*b1^3*b2*b3^2*b4^5 + 2*a1^3*a2*a3^4*a4*b1^3*b2^5*b3^2*b4^5 +
2*a1^3*a2^5*a3^2*a4*b1^3*b2*b3^4*b4^5 + 2*a1^3*a2*a3^2*a4*b1^3*b2^5*b3^4*b4^5
2*(a2^4 + b2^4)*(a4^4 + b4^4)*(a3^2 + b3^2)*a1^3*a2*a3^2*a4*b1^3*b2*b3^2*b4
-2*((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p3^2 + 2*q3)*q1^3*q2*q3^2*q4

c0214=sum(c02.find(a1^3*a4^4*w0))+sum(c02.find(a1^3*b4^4*w0))
c0214
c0214.factor()
s0214=-2*((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p4^2 + 2*q4)*q1\
    ^3*q2*q3*q4^2
s0214
#This is the sum of the terms with a1^3 and either a4^4 or b4^4, its \
    factorization, and its substitution.
2*a1^3*a2^5*a3^5*a4^4*b1^3*b2*b3*b4^2 + 2*a1^3*a2*a3^5*a4^4*b1^3*b2^5*b3*b4^2 +
2*a1^3*a2^5*a3*a4^4*b1^3*b2*b3^5*b4^2 + 2*a1^3*a2*a3*a4^4*b1^3*b2^5*b3^5*b4^2 +
2*a1^3*a2^5*a3^5*a4^2*b1^3*b2*b3*b4^4 + 2*a1^3*a2*a3^5*a4^2*b1^3*b2^5*b3*b4^4 +
2*a1^3*a2^5*a3*a4^2*b1^3*b2*b3^5*b4^4 + 2*a1^3*a2*a3*a4^2*b1^3*b2^5*b3^5*b4^4
2*(a2^4 + b2^4)*(a3^4 + b3^4)*(a4^2 + b4^2)*a1^3*a2*a3*a4^2*b1^3*b2*b3*b4^2
-2*((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p4^2 + 2*q4)*q1^3*q2*q3*q4^2

c0221=sum(c02.find(a2^3*a1^4*w0))+sum(c02.find(a2^3*b1^4*w0))
c0221
c0221.factor()
s0221=-2*((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*q1\
    ^2*q2^3*q3*q4
s0221
#This is the sum of the terms with a2^3 and either a1^4 or b1^4, its \
    factorization, and its substitution.
2*a1^4*a2^3*a3^5*a4^5*b1^2*b2^3*b3*b4 + 2*a1^2*a2^3*a3^5*a4^5*b1^4*b2^3*b3*b4 +
2*a1^4*a2^3*a3*a4^5*b1^2*b2^3*b3^5*b4 + 2*a1^2*a2^3*a3*a4^5*b1^4*b2^3*b3^5*b4 +
2*a1^4*a2^3*a3^5*a4*b1^2*b2^3*b3*b4^5 + 2*a1^2*a2^3*a3^5*a4*b1^4*b2^3*b3*b4^5 +
2*a1^4*a2^3*a3*a4*b1^2*b2^3*b3^5*b4^5 + 2*a1^2*a2^3*a3*a4*b1^4*b2^3*b3^5*b4^5
2*(a3^4 + b3^4)*(a4^4 + b4^4)*(a1^2 + b1^2)*a1^2*a2^3*a3*a4*b1^2*b2^3*b3*b4
-2*((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*q1^2*q2^3*q3*q4

c0223=sum(c02.find(a2^3*a3^4*w0))+sum(c02.find(a2^3*b3^4*w0))
c0223
c0223.factor()
s0223=-2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p3^2 + 2*q3)*q1\
    *q2^3*q3^2*q4
s0223
#This is the sum of the terms with a2^3 and either a3^4 or b3^4, its \
    factorization, and its substitution.
2*a1^5*a2^3*a3^4*a4^5*b1*b2^3*b3^2*b4 + 2*a1*a2^3*a3^4*a4^5*b1^5*b2^3*b3^2*b4 +
2*a1^5*a2^3*a3^2*a4^5*b1*b2^3*b3^4*b4 + 2*a1*a2^3*a3^2*a4^5*b1^5*b2^3*b3^4*b4 +
2*a1^5*a2^3*a3^4*a4*b1*b2^3*b3^2*b4^5 + 2*a1*a2^3*a3^4*a4*b1^5*b2^3*b3^2*b4^5 +
2*a1^5*a2^3*a3^2*a4*b1*b2^3*b3^4*b4^5 + 2*a1*a2^3*a3^2*a4*b1^5*b2^3*b3^4*b4^5
2*(a1^4 + b1^4)*(a4^4 + b4^4)*(a3^2 + b3^2)*a1*a2^3*a3^2*a4*b1*b2^3*b3^2*b4
-2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p3^2 + 2*q3)*q1*q2^3*q3^2*q4

c0224=sum(c02.find(a2^3*a4^4*w0))+sum(c02.find(a2^3*b4^4*w0))
c0224
c0224.factor()
s0224=-2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p4^2 + 2*q4)*q1\
    *q2^3*q3*q4^2
s0224
#This is the sum of the terms with a2^3 and either a4^4 or b4^4, its \
    factorization, and its substitution.
2*a1^5*a2^3*a3^5*a4^4*b1*b2^3*b3*b4^2 + 2*a1*a2^3*a3^5*a4^4*b1^5*b2^3*b3*b4^2 +

2*a1^5*a2^3*a3*a4^4*b1*b2^3*b3^5*b4^2 + 2*a1*a2^3*a3*a4^4*b1^5*b2^3*b3^5*b4^2 +
2*a1^5*a2^3*a3^5*a4^2*b1*b2^3*b3*b4^4 + 2*a1*a2^3*a3^5*a4^2*b1^5*b2^3*b3*b4^4 +
2*a1^5*a2^3*a3*a4^2*b1*b2^3*b3^5*b4^4 + 2*a1*a2^3*a3*a4^2*b1^5*b2^3*b3^5*b4^4
2*(a1^4 + b1^4)*(a3^4 + b3^4)*(a4^2 + b4^2)*a1*a2^3*a3*a4^2*b1*b2^3*b3*b4^2
-2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p4^2 + 2*q4)*q1*q2^3*q3*q4^2

2*a1^4*a2^5*a3^3*a4^5*b1^2*b2*b3^3*b4 + 2*a1^2*a2^5*a3^3*a4^5*b1^4*b2*b3^3*b4 +
2*a1^4*a2*a3^3*a4^5*b1^2*b2^5*b3^3*b4 + 2*a1^2*a2*a3^3*a4^5*b1^4*b2^5*b3^3*b4 +
2*a1^4*a2^5*a3^3*a4*b1^2*b2*b3^3*b4^5 + 2*a1^2*a2^5*a3^3*a4*b1^4*b2*b3^3*b4^5 +
2*a1^4*a2*a3^3*a4*b1^2*b2^5*b3^3*b4^5 + 2*a1^2*a2*a3^3*a4*b1^4*b2^5*b3^3*b4^5
2*(a2^4 + b2^4)*(a4^4 + b4^4)*(a1^2 + b1^2)*a1^2*a2*a3^3*a4*b1^2*b2*b3^3*b4
-2*((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*q1^2*q2*q3^3*q4

2*a1^5*a2^4*a3^3*a4^5*b1*b2^2*b3^3*b4 + 2*a1*a2^4*a3^3*a4^5*b1^5*b2^2*b3^3*b4 +
2*a1^5*a2^2*a3^3*a4^5*b1*b2^4*b3^3*b4 + 2*a1*a2^2*a3^3*a4^5*b1^5*b2^4*b3^3*b4 +
2*a1^5*a2^4*a3^3*a4*b1*b2^2*b3^3*b4^5 + 2*a1*a2^4*a3^3*a4*b1^5*b2^2*b3^3*b4^5 +
2*a1^5*a2^2*a3^3*a4*b1*b2^4*b3^3*b4^5 + 2*a1*a2^2*a3^3*a4*b1^5*b2^4*b3^3*b4^5
2*(a1^4 + b1^4)*(a4^4 + b4^4)*(a2^2 + b2^2)*a1*a2^2*a3^3*a4*b1*b2^2*b3^3*b4
-2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*q1*q2^2*q3^3*q4

2*a1^5*a2^5*a3^3*a4^4*b1*b2*b3^3*b4^2 + 2*a1*a2^5*a3^3*a4^4*b1^5*b2*b3^3*b4^2 +
2*a1^5*a2*a3^3*a4^4*b1*b2^5*b3^3*b4^2 + 2*a1*a2*a3^3*a4^4*b1^5*b2^5*b3^3*b4^2 +
2*a1^5*a2^5*a3^3*a4^2*b1*b2*b3^3*b4^4 + 2*a1*a2^5*a3^3*a4^2*b1^5*b2*b3^3*b4^4 +
2*a1^5*a2*a3^3*a4^2*b1*b2^5*b3^3*b4^4 + 2*a1*a2*a3^3*a4^2*b1^5*b2^5*b3^3*b4^4
2*(a1^4 + b1^4)*(a2^4 + b2^4)*(a4^2 + b4^2)*a1*a2*a3^3*a4^2*b1*b2*b3^3*b4^2
-2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*(p4^2 + 2*q4)*q1*q2*q3^3*q4^2

2*a1^4*a2^5*a3^5*a4^3*b1^2*b2*b3*b4^3 + 2*a1^2*a2^5*a3^5*a4^3*b1^4*b2*b3*b4^3 +
2*a1^4*a2*a3^5*a4^3*b1^2*b2^5*b3*b4^3 + 2*a1^2*a2*a3^5*a4^3*b1^4*b2^5*b3*b4^3 +

2*a1^4*a2^5*a3*a4^3*b1^2*b2*b3^5*b4^3 + 2*a1^2*a2^5*a3*a4^3*b1^4*b2*b3^5*b4^3 +
2*a1^4*a2*a3*a4^3*b1^2*b2^5*b3^5*b4^3 + 2*a1^2*a2*a3*a4^3*b1^4*b2^5*b3^5*b4^3
2*(a2^4 + b2^4)*(a3^4 + b3^4)*(a1^2 + b1^2)*a1^2*a2*a3*a4^3*b1^2*b2*b3*b4^3
-2*((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*q1^2*q2*q3*q4^3

```
c0242=sum(c02.find(a4^3*a2^4*w0))+sum(c02.find(a4^3*b2^4*w0))
c0242
c0242.factor()
s0242=-2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 + 2*q2)*q1\
    *q2^2*q3*q4^3
s0242
#This is the sum of the terms with a4^3 and either a2^4 or b2^4, its \
    factorization, and its substitution.
```
2*a1^5*a2^4*a3^5*a4^3*b1*b2^2*b3*b4^3 + 2*a1*a2^4*a3^5*a4^3*b1^5*b2^2*b3*b4^3 +
2*a1^5*a2^2*a3^5*a4^3*b1*b2^4*b3*b4^3 + 2*a1*a2^2*a3^5*a4^3*b1^5*b2^4*b3*b4^3 +
2*a1^5*a2^4*a3*a4^3*b1*b2^2*b3^5*b4^3 + 2*a1*a2^4*a3*a4^3*b1^5*b2^2*b3^5*b4^3 +
2*a1^5*a2^2*a3*a4^3*b1*b2^4*b3^5*b4^3 + 2*a1*a2^2*a3*a4^3*b1^5*b2^4*b3^5*b4^3
2*(a1^4 + b1^4)*(a3^4 + b3^4)*(a2^2 + b2^2)*a1*a2^2*a3*a4^3*b1*b2^2*b3*b4^3
-2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 + 2*q2)*q1*q2^2*q3*q4^3

```
c0243=sum(c02.find(a4^3*a3^4*w0))+sum(c02.find(a4^3*b3^4*w0))
c0243
c0243.factor()
s0243=-2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 + 2*q3)*q1\
    *q2*q3^2*q4^3
s0243
#This is the sum of the terms with a4^3 and either a3^4 or b3^4, its \
    factorization, and its substitution.
```
2*a1^5*a2^5*a3^4*a4^3*b1*b2*b3^2*b4^3 + 2*a1*a2^5*a3^4*a4^3*b1^5*b2*b3^2*b4^3 +
2*a1^5*a2*a3^4*a4^3*b1*b2^5*b3^2*b4^3 + 2*a1*a2*a3^4*a4^3*b1^5*b2^5*b3^2*b4^3 +
2*a1^5*a2^5*a3^2*a4^3*b1*b2*b3^4*b4^3 + 2*a1*a2^5*a3^2*a4^3*b1^5*b2*b3^4*b4^3 +
2*a1^5*a2*a3^2*a4^3*b1*b2^5*b3^4*b4^3 + 2*a1*a2*a3^2*a4^3*b1^5*b2^5*b3^4*b4^3
2*(a1^4 + b1^4)*(a2^4 + b2^4)*(a3^2 + b3^2)*a1*a2*a3^2*a4^3*b1*b2*b3^2*b4^3
-2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 + 2*q3)*q1*q2*q3^2*q4^3

```
bool(c2==c0212+c0213+c0214+c0221+c0223+c0224+c0231+c0232+c0234+c0241+c0242+\
    c0243+-(-c2123-c2124-c2132-c2134-c2142-c2143-c2231-c2234-c2241-c2243-c2341-\
    c2342))
#This is a check to make sure as we seperated the groups we used every term in \
    c2 once and only once.
```
True

```
l2=s0212+s0213+s0214+s0221+s0223+s0224+s0231+s0232+s0234+s0241+s0242+s0243+-(-\
    s2123-s2124-s2132-s2134-s2142-s2143-s2231-s2234-s2241-s2243-s2341-s2342)
l2
l02=l2(p1=a1+b1, p2=a2+b2, p3=a3+b3, p4=a4+b4, q1=-1*a1*b1, q2=-1*a2*b2, q3=-1*\
    a3*b3, q4=-1*a4*b4)
bool(l02==c2)
#This line brings all the group substitutions we created for c2 back into one \
    expression and checks to make sure that when back substitute we end up with \
    c2.
```
2*((p4^2 + 2*q4)^2 - 3*q4^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^3*q3^2 + 2*((p4^2 +
2*q4)^2 - 3*q4^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^3*q2^2*q3^3 + 2*((p4^2 + 2*q4)^2 -
3*q4^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2^3*q3^3 + 2*((p3^2 + 2*q3)^2 - 3*q3^2)*(p3^2 +
2*q3)*(p4^2 + 2*q4)*q1^3*q2^3*q4^2 + 2*((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*(p4^2 +
2*q4)*q1^3*q3^3*q4^2 + 2*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p4^2 +
2*q4)*q2^3*q3^3*q4^2 + 2*((p3^2 + 2*q3)^2 - 3*q3^2)*(p2^2 + 2*q2)*(p3^2 +
2*q3)*q1^3*q2^2*q4^3 + 2*((p3^2 + 2*q3)^2 - 3*q3^2)*(p1^2 + 2*q1)*(p3^2 +
2*q3)*q1^2*q2^3*q4^3 + 2*((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*(p3^2 +
2*q3)*q1^3*q3^2*q4^3 + 2*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p3^2 +
2*q3)*q2^3*q3^2*q4^3 + 2*((p2^2 + 2*q2)^2 - 3*q2^2)*(p1^2 + 2*q1)*(p2^2 +

2*q2)*q1^2*q3^3*q4^3 + 2*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p2^2 +
2*q2)*q2^2*q3^3*q4^3 - 2*((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 +
2*q2)*q1^3*q2^2*q3^3*q4 - 2*((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 +
2*q1)*q1^2*q2^3*q3^3*q4 - 2*((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p3^2 +
2*q3)*q1^3*q2*q3^2*q4 - 2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p3^2 +
2*q3)*q1*q2^3*q3^2*q4 - 2*((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 +
2*q1)*q1^2*q2*q3^3*q4 - 2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 +
2*q2)*q1*q2^2*q3^3*q4 - 2*((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p4^2 +
2*q4)*q1^3*q2*q3*q4^2 - 2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p4^2 +
2*q4)*q1*q2^3*q3*q4^2 - 2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*(p4^2 +
2*q4)*q1*q2*q3^3*q4^2 - 2*((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 +
2*q1)*q1^2*q2*q3*q4^3 - 2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 +
2*q2)*q1*q2^2*q3*q4^3 - 2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 +
2*q3)*q1*q2*q3^2*q4^3
True

```
c4=sum(f10.find(4*w0))
c4
#This finds all our terms in f10 that have a 4 in them and then adds them \
    together. The first set of groups we form will have one of the four a \
    variables or its corresponding b variable to the sixth power.
```
4*a1^3*a2^3*a3^3*a4^6*b1^3*b2^3*b3^3 + 4*a1^3*a2^3*a3^5*a4^5*b1^3*b2^3*b3*b4 +
4*a1^3*a2^5*a3^3*a4^5*b1^3*b2*b3^3*b4 + 4*a1^5*a2^3*a3^3*a4^5*b1*b2^3*b3^3*b4 +
4*a1*a2^3*a3^3*a4^5*b1^5*b2^3*b3^3*b4 + 4*a1^3*a2*a3^3*a4^5*b1^3*b2^5*b3^3*b4 +
4*a1^3*a2^3*a3*a4^5*b1^3*b2^3*b3^5*b4 + 4*a1^3*a2^3*a3^6*a4^3*b1^3*b2^3*b4^3 +
4*a1^3*a2^5*a3^5*a4^3*b1^3*b2*b3*b4^3 + 4*a1^5*a2^3*a3^5*a4^3*b1*b2^3*b3*b4^3 +
4*a1*a2^3*a3^5*a4^3*b1^5*b2^3*b3*b4^3 + 4*a1^3*a2*a3^5*a4^3*b1^3*b2^5*b3*b4^3 +
4*a1^3*a2^6*a3^3*a4^3*b1^3*b3^3*b4^3 + 4*a1^5*a2^5*a3^3*a4^3*b1*b2*b3^3*b4^3 +
4*a1*a2^5*a3^3*a4^3*b1^5*b2*b3^3*b4^3 + 4*a1^6*a2^3*a3^3*a4^3*b2^3*b3^3*b4^3 +
4*a2^3*a3^3*a4^3*b1^6*b2^3*b3^3*b4^3 + 4*a1^5*a2*a3^3*a4^3*b1*b2^5*b3^3*b4^3 +
4*a1*a2*a3^3*a4^3*b1^5*b2^5*b3^3*b4^3 + 4*a1^3*a3^3*a4^3*b1^3*b2^6*b3^3*b4^3 +
4*a1^3*a2^5*a3*a4^3*b1^3*b2*b3^5*b4^3 + 4*a1^5*a2^3*a3*a4^3*b1*b2^3*b3^5*b4^3 +
4*a1*a2^3*a3*a4^3*b1^5*b2^3*b3^5*b4^3 + 4*a1^3*a2*a3*a4^3*b1^3*b2^5*b3^5*b4^3 +
4*a1^3*a2^3*a4^3*b1^3*b2^3*b3^6*b4^3 + 4*a1^3*a2^3*a3^5*a4*b1^3*b2^3*b3*b4^5 +
4*a1^3*a2^5*a3^3*a4*b1^3*b2*b3^3*b4^5 + 4*a1^5*a2^3*a3^3*a4*b1*b2^3*b3^3*b4^5 +
4*a1*a2^3*a3^3*a4*b1^5*b2^3*b3^3*b4^5 + 4*a1^3*a2*a3^3*a4*b1^3*b2^5*b3^3*b4^5 +
4*a1^3*a2^3*a3*a4*b1^3*b2^3*b3^5*b4^5 + 4*a1^3*a2^3*a3^3*b1^3*b2^3*b3^3*b4^6

```
c41=sum(c4.find(a1^6*w0))+sum(c4.find(b1^6*w0))
c41
c41.factor()
s41=-4*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*q2^3*q3^3*q4^3
s41
#This is the sum of the terms with a1^6 or b1^6, its factorization, and its \
    substitution.
```
4*a1^6*a2^3*a3^3*a4^3*b2^3*b3^3*b4^3 + 4*a2^3*a3^3*a4^3*b1^6*b2^3*b3^3*b4^3
4*(a1^4 - a1^2*b1^2 + b1^4)*(a1^2 + b1^2)*a2^3*a3^3*a4^3*b2^3*b3^3*b4^3
-4*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*q2^3*q3^3*q4^3

```
c42=sum(c4.find(a2^6*w0))+sum(c4.find(b2^6*w0))
c42
c42.factor()
s42=-4*((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*q1^3*q3^3*q4^3
s42
#This is the sum of the terms with a2^6 or b2^6, its factorization, and its \
    substitution.
```
4*a1^3*a2^6*a3^3*a4^3*b1^3*b3^3*b4^3 + 4*a1^3*a3^3*a4^3*b1^3*b2^6*b3^3*b4^3
4*(a2^4 - a2^2*b2^2 + b2^4)*(a2^2 + b2^2)*a1^3*a3^3*a4^3*b1^3*b3^3*b4^3
-4*((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*q1^3*q3^3*q4^3

```
c43=sum(c4.find(a3^6*w0))+sum(c4.find(b3^6*w0))
c43
c43.factor()
s43=-4*((p3^2 + 2*q3)^2 - 3*q3^2)*(p3^2 + 2*q3)*q1^3*q2^3*q4^3
s43
#This is the sum of the terms with a3^6 or b3^6, its factorization, and its \
    substitution.
4*a1^3*a2^3*a3^6*a4^3*b1^3*b2^3*b4^3 + 4*a1^3*a2^3*a4^3*b1^3*b2^3*b3^6*b4^3
4*(a3^4 - a3^2*b3^2 + b3^4)*(a3^2 + b3^2)*a1^3*a2^3*a4^3*b1^3*b2^3*b4^3
-4*((p3^2 + 2*q3)^2 - 3*q3^2)*(p3^2 + 2*q3)*q1^3*q2^3*q4^3


c44=sum(c4.find(a4^6*w0))+sum(c4.find(b4^6*w0))
c44
c44.factor()
s44=-4*((p4^2 + 2*q4)^2 - 3*q4^2)*(p4^2 + 2*q4)*q1^3*q2^3*q3^3
s44
#This is the sum of the terms with a4^6 or b4^6, its factorization, and its \
    substitution.
4*a1^3*a2^3*a3^3*a4^6*b1^3*b2^3*b3^3 + 4*a1^3*a2^3*a3^3*b1^3*b2^3*b3^3*b4^6
4*(a4^4 - a4^2*b4^2 + b4^4)*(a4^2 + b4^2)*a1^3*a2^3*a3^3*b1^3*b2^3*b3^3
-4*((p4^2 + 2*q4)^2 - 3*q4^2)*(p4^2 + 2*q4)*q1^3*q2^3*q3^3


c04=c4-c41-c42-c43-c44
c04
#This gets all the terms from c4 that have not been assigned to a group. The \
    groups we form will have two of the four a variables to the third power.
4*a1^3*a2^3*a3^5*a4^5*b1^3*b2^3*b3*b4 + 4*a1^3*a2^5*a3^3*a4^5*b1^3*b2*b3^3*b4 +
4*a1^5*a2^3*a3^3*a4^5*b1*b2^3*b3^3*b4 + 4*a1*a2^3*a3^3*a4^5*b1^5*b2^3*b3^3*b4 +
4*a1^3*a2*a3^3*a4^5*b1^3*b2^5*b3^3*b4 + 4*a1^3*a2^3*a3*a4^5*b1^3*b2^3*b3^5*b4 +
4*a1^3*a2^5*a3^5*a4^3*b1^3*b2*b3*b4^3 + 4*a1^5*a2^3*a3^5*a4^3*b1*b2^3*b3*b4^3 +
4*a1*a2^3*a3^5*a4^3*b1^5*b2^3*b3*b4^3 + 4*a1^3*a2*a3^5*a4^3*b1^3*b2^5*b3*b4^3 +
4*a1^5*a2^5*a3^3*a4^3*b1*b2*b3^3*b4^3 + 4*a1*a2^5*a3^3*a4^3*b1^5*b2^5*b3^3*b4^3 +
4*a1^5*a2*a3^3*a4^3*b1*b2^5*b3^3*b4^3 + 4*a1*a2*a3^3*a4^3*b1^5*b2^5*b3^3*b4^3 +
4*a1^3*a2^5*a3*a4^3*b1^3*b2*b3^5*b4^3 + 4*a1^5*a2^3*a3*a4^3*b1*b2^3*b3^5*b4^3 +
4*a1*a2^3*a3*a4^3*b1^5*b2^3*b3^5*b4^3 + 4*a1^3*a2*a3*a4^3*b1^3*b2^5*b3^5*b4^3 +
4*a1^3*a2^3*a3^5*a4*b1^3*b2^3*b3*b4^5 + 4*a1^3*a2^5*a3^3*a4*b1^3*b2*b3^3*b4^5 +
4*a1^5*a2^3*a3^3*a4*b1*b2^3*b3^3*b4^5 + 4*a1*a2^3*a3^3*a4*b1^5*b2^3*b3^3*b4^5 +
4*a1^3*a2*a3^3*a4*b1^3*b2^5*b3^3*b4^5 + 4*a1^3*a2^3*a3*a4*b1^3*b2^3*b3^5*b4^5


c0412=sum(c04.find(a1^3*a2^3*w0))
c0412
c0412.factor()
s0412=4*((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*q1^3*q2^3*q3*q4
s0412
#This is the sum of the terms with a1^3 and a2^3, its factorization, and its \
    substitution.
4*a1^3*a2^3*a3^5*a4^5*b1^3*b2^3*b3*b4 + 4*a1^3*a2^3*a3*a4^5*b1^3*b2^3*b3^5*b4 +
4*a1^3*a2^3*a3^5*a4*b1^3*b2^3*b3*b4^5 + 4*a1^3*a2^3*a3*a4*b1^3*b2^3*b3^5*b4^5
4*(a3^4 + b3^4)*(a4^4 + b4^4)*a1^3*a2^3*a3*a4*b1^3*b2^3*b3*b4
4*((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*q1^3*q2^3*q3*q4


c0413=sum(c04.find(a1^3*a3^3*w0))
c0413
c0413.factor()
s0413=4*((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*q1^3*q2*q3^3*q4
s0413
#This is the sum of the terms with a1^3 and a2^3, its factorization, and its \
    substitution.
4*a1^3*a2^5*a3^3*a4^5*b1^3*b2*b3^3*b4 + 4*a1^3*a2*a3^3*a4^5*b1^3*b2^5*b3^3*b4 +
4*a1^3*a2^5*a3^3*a4*b1^3*b2*b3^3*b4^5 + 4*a1^3*a2*a3^3*a4*b1^3*b2^5*b3^3*b4^5
4*(a2^4 + b2^4)*(a4^4 + b4^4)*a1^3*a2*a3^3*a4*b1^3*b2*b3^3*b4
```

```
4*((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*q1^3*q2*q3^3*q4

c0414=sum(c04.find(a1^3*a4^3*w0))
c0414
c0414.factor()
s0414=4*((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*q1^3*q2*q3*q4^3
s0414
#This is the sum of the terms with a1^3 and a4^3, its factorization, and its \
    substitution.
4*a1^3*a2^5*a3^5*a4^3*b1^3*b2*b3*b4^3 + 4*a1^3*a2*a3^5*a4^3*b1^3*b2^5*b3*b4^3 +
4*a1^3*a2^5*a3*a4^3*b1^3*b2*b3^5*b4^3 + 4*a1^3*a2*a3*a4^3*b1^3*b2^5*b3^5*b4^3
4*(a2^4 + b2^4)*(a3^4 + b3^4)*a1^3*a2*a3*a4^3*b1^3*b2*b3*b4^3
4*((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*q1^3*q2*q3*q4^3

c0423=sum(c04.find(a2^3*a3^3*w0))
c0423
c0423.factor()
s0423=4*((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*q1*q2^3*q3^3*q4
s0423
#This is the sum of the terms with a2^3 and a3^3, its factorization, and its \
    substitution.
4*a1^5*a2^3*a3^3*a4^5*b1*b2^3*b3^3*b4 + 4*a1*a2^3*a3^3*a4^5*b1^5*b2^3*b3^3*b4 +
4*a1^5*a2^3*a3^3*a4*b1*b2^3*b3^3*b4^5 + 4*a1*a2^3*a3^3*a4*b1^5*b2^3*b3^3*b4^5
4*(a1^4 + b1^4)*(a4^4 + b4^4)*a1*a2^3*a3^3*a4*b1*b2^3*b3^3*b4
4*((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*q1*q2^3*q3^3*q4

c0424=sum(c04.find(a2^3*a4^3*w0))
c0424
c0424.factor()
s0424=4*((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*q1*q2^3*q3*q4^3
s0424
#This is the sum of the terms with a2^3 and a4^3, its factorization, and its \
    substitution.
4*a1^5*a2^3*a3^5*a4^3*b1*b2^3*b3*b4^3 + 4*a1*a2^3*a3^5*a4^3*b1^5*b2^3*b3*b4^3 +
4*a1^5*a2^3*a3*a4^3*b1*b2^3*b3^5*b4^3 + 4*a1*a2^3*a3*a4^3*b1^5*b2^3*b3^5*b4^3
4*(a1^4 + b1^4)*(a3^4 + b3^4)*a1*a2^3*a3*a4^3*b1*b2^3*b3*b4^3
4*((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*q1*q2^3*q3*q4^3

c0434=sum(c04.find(a3^3*a4^3*w0))
c0434
c0434.factor()
s0434=4*((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*q1*q2*q3^3*q4^3
s0434
#This is the sum of the terms with a2^3 and a4^3, its factorization, and its \
    substitution.
4*a1^5*a2^5*a3^3*a4^3*b1*b2*b3^3*b4^3 + 4*a1*a2^5*a3^3*a4^3*b1^5*b2*b3^3*b4^3 +
4*a1^5*a2*a3^3*a4^3*b1*b2^5*b3^3*b4^3 + 4*a1*a2*a3^3*a4^3*b1^5*b2^5*b3^3*b4^3
4*(a1^4 + b1^4)*(a2^4 + b2^4)*a1*a2*a3^3*a4^3*b1*b2*b3^3*b4^3
4*((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*q1*q2*q3^3*q4^3

bool(c0412+c0413+c0414+c0423+c0424+c0434+c41+c42+c43+c44==c4)
#This is a check to make sure as we seperated the groups we used every term in \
    c4 once and only once.
True

l4=s0412+s0413+s0414+s0423+s0424+s0434+s41+s42+s43+s44
l4
l04=l4(p1=a1+b1, p2=a2+b2, p3=a3+b3, p4=a4+b4, q1=-1*a1*b1, q2=-1*a2*b2, q3=-1*\
    a3*b3, q4=-1*a4*b4)
bool(l04==c4)
#This line brings all the group substitutions we created for c4 back into one \
```

-4*((p4^2 + 2*q4)^2 - 3*q4^2)*(p4^2 + 2*q4)*q1^3*q2^3*q3^3 - 4*((p3^2 + 2*q3)^2 - 3*q3^2)*(p3^2 + 2*q3)*q1^3*q2^3*q4^3 - 4*((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*q1^3*q3^3*q4^3 - 4*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*q2^3*q3^3*q4^3 + 4*((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*q1^3*q2^3*q3^3*q4 + 4*((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*q1^3*q2^3*q3^3*q4 + 4*((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*q1*q2^3*q3^3*q4 + 4*((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*q1^3*q2*q3*q4^3 + 4*((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*q1*q2^3*q3*q4^3 + 4*((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*q1*q2*q3^3*q4^3

True


```
c7=sum(f10.find(7*w0))
c7
```

7*a1^4*a2^4*a3^4*a4^5*b1^2*b2^2*b3^2*b4 + 7*a1^2*a2^4*a3^4*a4^5*b1^4*b2^2*b3^2*b4 + 7*a1^4*a2^2*a3^4*a4^5*b1^2*b2^4*b3^2*b4 + 7*a1^2*a2^2*a3^4*a4^5*b1^4*b2^4*b3^2*b4 + 7*a1^4*a2^4*a3^2*a4^5*b1^2*b2^2*b3^4*b4 + 7*a1^2*a2^4*a3^2*a4^5*b1^4*b2^2*b3^4*b4 + 7*a1^4*a2^2*a3^2*a4^5*b1^2*b2^4*b3^4*b4 + 7*a1^2*a2^2*a3^2*a4^5*b1^4*b2^4*b3^4*b4 + 7*a1^4*a2^4*a3^5*a4^4*b1^2*b2^2*b3*b4^2 + 7*a1^2*a2^4*a3^5*a4^4*b1^4*b2^2*b3*b4^2 + 7*a1^4*a2^2*a3^5*a4^4*b1^2*b2^4*b3*b4^2 + 7*a1^2*a2^2*a3^5*a4^4*b1^4*b2^4*b3*b4^2 + 7*a1^4*a2^5*a3^4*a4^4*b1^2*b2*b3^2*b4^2 + 7*a1^2*a2^5*a3^4*a4^4*b1^4*b2*b3^2*b4^2 + 7*a1^5*a2^4*a3^4*a4^4*b1*b2^2*b3^2*b4^2 + 7*a1*a2^4*a3^4*a4^4*b1^5*b2^2*b3^2*b4^2 + 7*a1^5*a2^2*a3^4*a4^4*b1*b2^4*b3^2*b4^2 + 7*a1*a2^2*a3^4*a4^4*b1^5*b2^4*b3^2*b4^2 + 7*a1^4*a2*a3^4*a4^4*b1^2*b2^5*b3^2*b4^2 + 7*a1^2*a2*a3^4*a4^4*b1^4*b2^5*b3^2*b4^2 + 7*a1^4*a2^5*a3^2*a4^4*b1^2*b2*b3^4*b4^2 + 7*a1^2*a2^5*a3^2*a4^4*b1^4*b2*b3^4*b4^2 + 7*a1^5*a2^4*a3^2*a4^4*b1*b2^2*b3^4*b4^2 + 7*a1*a2^4*a3^2*a4^4*b1^5*b2^2*b3^4*b4^2 + 7*a1^5*a2^2*a3^2*a4^4*b1*b2^4*b3^4*b4^2 + 7*a1*a2^2*a3^2*a4^4*b1^5*b2^4*b3^4*b4^2 + 7*a1^4*a2*a3^2*a4^4*b1^2*b2^5*b3^4*b4^2 + 7*a1^2*a2*a3^2*a4^4*b1^4*b2^5*b3^4*b4^2 + 7*a1^4*a2^4*a3*a4^4*b1^2*b2^2*b3^5*b4^2 + 7*a1^2*a2^4*a3*a4^4*b1^4*b2^2*b3^5*b4^2 + 7*a1^4*a2^2*a3*a4^4*b1^2*b2^4*b3^5*b4^2 + 7*a1^2*a2^2*a3*a4^4*b1^4*b2^4*b3^5*b4^2 + 7*a1^4*a2^4*a3^5*a4^2*b1^2*b2^2*b3*b4^4 + 7*a1^2*a2^4*a3^5*a4^2*b1^4*b2^2*b3*b4^4 + 7*a1^4*a2^2*a3^5*a4^2*b1^2*b2^4*b3*b4^4 + 7*a1^2*a2^2*a3^5*a4^2*b1^4*b2^4*b3*b4^4 + 7*a1^4*a2^5*a3^4*a4^2*b1^2*b2*b3^2*b4^4 + 7*a1^2*a2^5*a3^4*a4^2*b1^4*b2*b3^2*b4^4 + 7*a1^5*a2^4*a3^4*a4^2*b1*b2^2*b3^2*b4^4 + 7*a1*a2^4*a3^4*a4^2*b1^5*b2^2*b3^2*b4^4 + 7*a1^5*a2^2*a3^4*a4^2*b1*b2^4*b3^2*b4^4 + 7*a1*a2^2*a3^4*a4^2*b1^5*b2^4*b3^2*b4^4 + 7*a1^4*a2*a3^4*a4^2*b1^2*b2^5*b3^2*b4^4 + 7*a1^2*a2*a3^4*a4^2*b1^4*b2^5*b3^2*b4^4 + 7*a1^4*a2^5*a3^2*a4^2*b1^2*b2*b3^4*b4^4 + 7*a1^2*a2^5*a3^2*a4^2*b1^4*b2*b3^4*b4^4 + 7*a1^5*a2^4*a3^2*a4^2*b1*b2^2*b3^4*b4^4 + 7*a1*a2^4*a3^2*a4^2*b1^5*b2^2*b3^4*b4^4 + 7*a1^5*a2^2*a3^2*a4^2*b1*b2^4*b3^4*b4^4 + 7*a1*a2^2*a3^2*a4^2*b1^5*b2^4*b3^4*b4^4 + 7*a1^4*a2*a3^2*a4^2*b1^2*b2^5*b3^4*b4^4 + 7*a1^2*a2*a3^2*a4^2*b1^4*b2^5*b3^4*b4^4 + 7*a1^4*a2^4*a3*a4^2*b1^2*b2^2*b3^5*b4^4 + 7*a1^2*a2^4*a3*a4^2*b1^4*b2^2*b3^5*b4^4 + 7*a1^4*a2^2*a3*a4^2*b1^2*b2^4*b3^5*b4^4 + 7*a1^2*a2^2*a3*a4^2*b1^4*b2^4*b3^5*b4^4 + 7*a1^4*a2^4*a3^4*a4*b1^2*b2^2*b3^2*b4^5 + 7*a1^2*a2^4*a3^4*a4*b1^4*b2^2*b3^2*b4^5 + 7*a1^4*a2^2*a3^4*a4*b1^2*b2^4*b3^2*b4^5 + 7*a1^2*a2^2*a3^4*a4*b1^4*b2^4*b3^2*b4^5 + 7*a1^4*a2^4*a3^2*a4*b1^2*b2^2*b3^4*b4^5 + 7*a1^2*a2^4*a3^2*a4*b1^4*b2^2*b3^4*b4^5 + 7*a1^4*a2^2*a3^2*a4*b1^2*b2^4*b3^4*b4^5 + 7*a1^2*a2^2*a3^2*a4*b1^4*b2^4*b3^4*b4^5


```
c71=sum(c7.find(a1^5*w0))+sum(c7.find(b1^5*w0))
c71
c71.factor()
s71=-7*((p1^2 + 2*q1)^2 - 2*q1^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1*\
    q2^2*q3^2*q4^2
s71
```

7*a1^5*a2^4*a3^4*a4^4*b1*b2^2*b3^2*b4^2 + 7*a1*a2^4*a3^4*a4^4*b1^5*b2^2*b3^2*b4^2 +

7*a1^5*a2^2*a3^4*a4^4*b1*b2^4*b3^2*b4^2 + 7*a1*a2^2*a3^4*a4^4*b1^5*b2^4*b3^2*b4^2 +
7*a1^5*a2^4*a3^2*a4^4*b1*b2^2*b3^4*b4^2 + 7*a1*a2^4*a3^2*a4^4*b1^5*b2^2*b3^4*b4^2 +
7*a1^5*a2^2*a3^2*a4^4*b1*b2^4*b3^4*b4^2 + 7*a1*a2^2*a3^2*a4^4*b1^5*b2^4*b3^4*b4^2 +
7*a1^5*a2^4*a3^4*a4^2*b1*b2^2*b3^2*b4^4 + 7*a1*a2^4*a3^4*a4^2*b1^5*b2^2*b3^2*b4^4 +
7*a1^5*a2^2*a3^4*a4^2*b1*b2^4*b3^2*b4^4 + 7*a1*a2^2*a3^4*a4^2*b1^5*b2^4*b3^2*b4^4 +
7*a1^5*a2^4*a3^2*a4^2*b1*b2^2*b3^4*b4^4 + 7*a1*a2^4*a3^2*a4^2*b1^5*b2^2*b3^4*b4^4 +
7*a1^5*a2^2*a3^2*a4^2*b1*b2^4*b3^4*b4^4 + 7*a1*a2^2*a3^2*a4^2*b1^5*b2^4*b3^4*b4^4
7*(a1^4 + b1^4)*(a2^2 + b2^2)*(a3^2 + b3^2)*(a4^2 +
b4^2)*a1*a2^2*a3^2*a4^2*b1*b2^2*b3^2*b4^2
-7*((p1^2 + 2*q1)^2 - 2*q1^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1*q2^2*q3^2*q4^2

7*a1^4*a2^5*a3^4*a4^4*b1^2*b2*b3^2*b4^2 + 7*a1^2*a2^5*a3^4*a4^4*b1^4*b2*b3^2*b4^2 +
7*a1^4*a2*a3^4*a4^4*b1^2*b2^5*b3^2*b4^2 + 7*a1^2*a2*a3^4*a4^4*b1^4*b2^5*b3^2*b4^2 +
7*a1^4*a2^5*a3^2*a4^4*b1^2*b2*b3^4*b4^2 + 7*a1^2*a2^5*a3^2*a4^4*b1^4*b2*b3^4*b4^2 +
7*a1^4*a2*a3^2*a4^4*b1^2*b2^5*b3^4*b4^2 + 7*a1^2*a2*a3^2*a4^4*b1^4*b2^5*b3^4*b4^2 +
7*a1^4*a2^5*a3^4*a4^2*b1^2*b2*b3^2*b4^4 + 7*a1^2*a2^5*a3^4*a4^2*b1^4*b2*b3^2*b4^4 +
7*a1^4*a2*a3^4*a4^2*b1^2*b2^5*b3^2*b4^4 + 7*a1^2*a2*a3^4*a4^2*b1^4*b2^5*b3^2*b4^4 +
7*a1^4*a2^5*a3^2*a4^2*b1^2*b2*b3^4*b4^4 + 7*a1^2*a2^5*a3^2*a4^2*b1^4*b2*b3^4*b4^4 +
7*a1^4*a2*a3^2*a4^2*b1^2*b2^5*b3^4*b4^4 + 7*a1^2*a2*a3^2*a4^2*b1^4*b2^5*b3^4*b4^4
7*(a2^4 + b2^4)*(a1^2 + b1^2)*(a3^2 + b3^2)*(a4^2 +
b4^2)*a1^2*a2*a3^2*a4^2*b1^2*b2*b3^2*b4^2
-7*((p2^2 + 2*q2)^2 - 2*q2^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2*q3^2*q4^2

7*a1^4*a2^4*a3^5*a4^4*b1^2*b2^2*b3*b4^2 + 7*a1^2*a2^4*a3^5*a4^4*b1^4*b2^2*b3*b4^2 +
7*a1^4*a2^2*a3^5*a4^4*b1^2*b2^4*b3*b4^2 + 7*a1^2*a2^2*a3^5*a4^4*b1^4*b2^4*b3*b4^2 +
7*a1^4*a2^4*a3*a4^4*b1^2*b2^2*b3^5*b4^2 + 7*a1^2*a2^4*a3*a4^4*b1^4*b2^2*b3^5*b4^2 +
7*a1^4*a2^2*a3*a4^4*b1^2*b2^4*b3^5*b4^2 + 7*a1^2*a2^2*a3*a4^4*b1^4*b2^4*b3^5*b4^2 +
7*a1^4*a2^4*a3^5*a4^2*b1^2*b2^2*b3*b4^4 + 7*a1^2*a2^4*a3^5*a4^2*b1^4*b2^2*b3*b4^4 +
7*a1^4*a2^2*a3^5*a4^2*b1^2*b2^4*b3*b4^4 + 7*a1^2*a2^2*a3^5*a4^2*b1^4*b2^4*b3*b4^4 +
7*a1^4*a2^4*a3*a4^2*b1^2*b2^2*b3^5*b4^4 + 7*a1^2*a2^4*a3*a4^2*b1^4*b2^2*b3^5*b4^4 +
7*a1^4*a2^2*a3*a4^2*b1^2*b2^4*b3^5*b4^4 + 7*a1^2*a2^2*a3*a4^2*b1^4*b2^4*b3^5*b4^4
7*(a3^4 + b3^4)*(a1^2 + b1^2)*(a2^2 + b2^2)*(a4^2 +
b4^2)*a1^2*a2^2*a3*a4^2*b1^2*b2^2*b3*b4^2
-7*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^2*q2^2*q3*q4^2

7*a1^4*a2^4*a3^4*a4^5*b1^2*b2^2*b3^2*b4 + 7*a1^2*a2^4*a3^4*a4^5*b1^4*b2^2*b3^2*b4 +
7*a1^4*a2^2*a3^4*a4^5*b1^2*b2^4*b3^2*b4 + 7*a1^2*a2^2*a3^4*a4^5*b1^4*b2^4*b3^2*b4 +

7*a1^4*a2^4*a3^2*a4^5*b1^2*b2^2*b3^4*b4 + 7*a1^2*a2^4*a3^2*a4^5*b1^4*b2^2*b3^4*b4 +
7*a1^4*a2^2*a3^2*a4^5*b1^2*b2^4*b3^4*b4 + 7*a1^2*a2^2*a3^2*a4^5*b1^4*b2^4*b3^4*b4 +
7*a1^4*a2^4*a3^4*a4*b1^2*b2^2*b3^2*b4^5 + 7*a1^2*a2^4*a3^4*a4*b1^4*b2^2*b3^2*b4^5 +
7*a1^4*a2^2*a3^4*a4*b1^2*b2^4*b3^2*b4^5 + 7*a1^2*a2^2*a3^4*a4*b1^4*b2^4*b3^2*b4^5 +
7*a1^4*a2^4*a3^2*a4*b1^2*b2^2*b3^4*b4^5 + 7*a1^2*a2^4*a3^2*a4*b1^4*b2^2*b3^4*b4^5 +
7*a1^4*a2^2*a3^2*a4*b1^2*b2^4*b3^4*b4^5 + 7*a1^2*a2^2*a3^2*a4*b1^4*b2^4*b3^4*b4^5
7*(a4^4 + b4^4)*(a1^2 + b1^2)*(a2^2 + b2^2)*(a3^2 +
b3^2)*a1^2*a2^2*a3^2*a4*b1^2*b2^2*b3^2*b4
-7*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^2*q2^2*q3^2*q4

```
bool(c7==c71+c72+c73+c74)
#This is a check to make sure as we seperated the groups we used every term in \
    c4 once and only once.
```
True

```
l7=s71+s72+s73+s74
l7
l07=l7(p1=a1+b1, p2=a2+b2, p3=a3+b3, p4=a4+b4, q1=-1*a1*b1, q2=-1*a2*b2, q3=-1*\
    a3*b3, q4=-1*a4*b4)
bool(l07==c7)
#This line brings all the group substitutions we created for c7 back into one \
    expression and checks to make sure that when back substitute we end up with \
    c7.
```
-7*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^2*q2^2*q3^2*q4
- 7*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^2*q2^2*q3*q4^2
- 7*((p2^2 + 2*q2)^2 - 2*q2^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2*q3^2*q4^2
- 7*((p1^2 + 2*q1)^2 - 2*q1^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1*q2^2*q3^2*q4^2
True

```
c12=sum(f10.find(12*w0))
c12
#This finds all our terms in f10 that have a 12 in them and then adds them \
    together. The groups we form will have one of the four a variables to the \
    third power and either a second a variable or its corresponding b variable \
    to the fifth power.
```
12*a1^3*a2^4*a3^4*a4^5*b1^3*b2^2*b3^2*b4 + 12*a1^4*a2^3*a3^4*a4^5*b1^2*b2^3*b3^2*b4 +
12*a1^2*a2^3*a3^4*a4^5*b1^4*b2^3*b3^2*b4 + 12*a1^3*a2^2*a3^4*a4^5*b1^3*b2^4*b3^2*b4 +
12*a1^4*a2^4*a3^3*a4^5*b1^2*b2^2*b3^3*b4 + 12*a1^2*a2^4*a3^3*a4^5*b1^4*b2^2*b3^3*b4 +
12*a1^4*a2^2*a3^3*a4^5*b1^2*b2^4*b3^3*b4 + 12*a1^2*a2^2*a3^3*a4^5*b1^4*b2^4*b3^3*b4 +
12*a1^3*a2^4*a3^2*a4^5*b1^3*b2^2*b3^4*b4 + 12*a1^4*a2^3*a3^2*a4^5*b1^2*b2^3*b3^4*b4 +
12*a1^2*a2^3*a3^2*a4^5*b1^4*b2^3*b3^4*b4 + 12*a1^3*a2^2*a3^2*a4^5*b1^3*b2^4*b3^4*b4 +
12*a1^3*a2^4*a3^5*a4^4*b1^3*b2^2*b3*b4^2 + 12*a1^4*a2^3*a3^5*a4^4*b1^2*b2^3*b3*b4^2 +
12*a1^2*a2^3*a3^5*a4^4*b1^4*b2^3*b3*b4^2 + 12*a1^3*a2^2*a3^5*a4^4*b1^3*b2^4*b3*b4^2 +
12*a1^3*a2^5*a3^4*a4^4*b1^3*b2*b3^2*b4^2 + 12*a1^5*a2^3*a3^4*a4^4*b1*b2^3*b3^2*b4^2 +
12*a1*a2^3*a3^4*a4^4*b1^5*b2^3*b3^2*b4^2 + 12*a1^3*a2*a3^4*a4^4*b1^3*b2^5*b3^2*b4^2 +
12*a1^4*a2^5*a3^3*a4^4*b1^2*b2*b3^3*b4^2 + 12*a1^2*a2^5*a3^3*a4^4*b1^4*b2*b3^3*b4^2 +
12*a1^5*a2^4*a3^3*a4^4*b1*b2^2*b3^3*b4^2 + 12*a1*a2^4*a3^3*a4^4*b1^5*b2^2*b3^3*b4^2 +
12*a1^5*a2^2*a3^3*a4^4*b1*b2^4*b3^3*b4^2 + 12*a1*a2^2*a3^3*a4^4*b1^5*b2^4*b3^3*b4^2 +
12*a1^4*a2*a3^3*a4^4*b1^2*b2^5*b3^3*b4^2 + 12*a1^2*a2*a3^3*a4^4*b1^4*b2^5*b3^3*b4^2 +
12*a1^3*a2^5*a3^2*a4^4*b1^3*b2*b3^4*b4^2 + 12*a1^5*a2^3*a3^2*a4^4*b1*b2^3*b3^4*b4^2 +
12*a1*a2^3*a3^2*a4^4*b1^5*b2^3*b3^4*b4^2 + 12*a1^3*a2*a3^2*a4^4*b1^3*b2^5*b3^4*b4^2 +
12*a1^3*a2^4*a3*a4^4*b1^3*b2^2*b3^5*b4^2 + 12*a1^4*a2^3*a3*a4^4*b1^2*b2^3*b3^5*b4^2 +
12*a1^2*a2^3*a3*a4^4*b1^4*b2^3*b3^5*b4^2 + 12*a1^3*a2^2*a3*a4^4*b1^3*b2^4*b3^5*b4^2 +
12*a1^4*a2^4*a3^5*a4^3*b1^2*b2^2*b3*b4^3 + 12*a1^2*a2^4*a3^5*a4^3*b1^4*b2^2*b3*b4^3 +
12*a1^4*a2^2*a3^5*a4^3*b1^2*b2^4*b3*b4^3 + 12*a1^2*a2^2*a3^5*a4^3*b1^4*b2^4*b3*b4^3 +
12*a1^4*a2^5*a3^4*a4^3*b1^2*b2*b3^2*b4^3 + 12*a1^2*a2^5*a3^4*a4^3*b1^4*b2*b3^2*b4^3 +
12*a1^5*a2^4*a3^4*a4^3*b1*b2^2*b3^2*b4^3 + 12*a1*a2^4*a3^4*a4^3*b1^5*b2^2*b3^2*b4^3 +
12*a1^5*a2^2*a3^4*a4^3*b1*b2^4*b3^2*b4^3 + 12*a1*a2^2*a3^4*a4^3*b1^5*b2^4*b3^2*b4^3 +
12*a1^4*a2*a3^4*a4^3*b1^2*b2^5*b3^2*b4^3 + 12*a1^2*a2*a3^4*a4^3*b1^4*b2^5*b3^2*b4^3 +
12*a1^4*a2^5*a3^2*a4^3*b1^2*b2*b3^4*b4^3 + 12*a1^2*a2^5*a3^2*a4^3*b1^4*b2*b3^4*b4^3 +

12*a1^5*a2^4*a3^2*a4^3*b1*b2^2*b3^4*b4^3 + 12*a1*a2^4*a3^2*a4^3*b1^5*b2^2*b3^4*b4^3 +
12*a1^5*a2^2*a3^2*a4^3*b1*b2^4*b3^4*b4^3 + 12*a1*a2^2*a3^2*a4^3*b1^5*b2^4*b3^4*b4^3 +
12*a1^4*a2*a3^2*a4^3*b1^2*b2^5*b3^4*b4^3 + 12*a1^2*a2*a3^2*a4^3*b1^4*b2^5*b3^4*b4^3 +
12*a1^4*a2^4*a3*a4^3*b1^2*b2^2*b3^5*b4^3 + 12*a1^2*a2^4*a3*a4^3*b1^4*b2^2*b3^5*b4^3 +
12*a1^4*a2^2*a3*a4^3*b1^2*b2^4*b3^5*b4^3 + 12*a1^2*a2^2*a3*a4^3*b1^4*b2^4*b3^5*b4^3 +
12*a1^3*a2^4*a3^5*a4^2*b1^3*b2^2*b3*b4^4 + 12*a1^4*a2^3*a3^5*a4^2*b1^2*b2^3*b3*b4^4 +
12*a1^2*a2^3*a3^5*a4^2*b1^4*b2^3*b3*b4^4 + 12*a1^3*a2^2*a3^5*a4^2*b1^3*b2^4*b3*b4^4 +
12*a1^3*a2^5*a3^4*a4^2*b1^3*b2*b3^2*b4^4 + 12*a1^5*a2^3*a3^4*a4^2*b1*b2^3*b3^2*b4^4 +
12*a1*a2^3*a3^4*a4^2*b1^5*b2^3*b3^2*b4^4 + 12*a1^3*a2*a3^4*a4^2*b1^3*b2^5*b3^2*b4^4 +
12*a1^4*a2^5*a3^3*a4^2*b1^2*b2*b3^3*b4^4 + 12*a1^2*a2^5*a3^3*a4^2*b1^4*b2*b3^3*b4^4 +
12*a1^5*a2^4*a3^3*a4^2*b1*b2^2*b3^3*b4^4 + 12*a1*a2^4*a3^3*a4^2*b1^5*b2^2*b3^3*b4^4 +
12*a1^5*a2^2*a3^3*a4^2*b1*b2^4*b3^3*b4^4 + 12*a1*a2^2*a3^3*a4^2*b1^5*b2^4*b3^3*b4^4 +
12*a1^4*a2*a3^3*a4^2*b1^2*b2^5*b3^3*b4^4 + 12*a1^2*a2*a3^3*a4^2*b1^4*b2^5*b3^3*b4^4 +
12*a1^3*a2^5*a3^2*a4^2*b1^3*b2*b3^4*b4^4 + 12*a1^5*a2^3*a3^2*a4^2*b1*b2^3*b3^4*b4^4 +
12*a1*a2^3*a3^2*a4^2*b1^5*b2^3*b3^4*b4^4 + 12*a1^3*a2*a3^2*a4^2*b1^3*b2^5*b3^4*b4^4 +
12*a1^3*a2^4*a3*a4^2*b1^3*b2^2*b3^5*b4^4 + 12*a1^4*a2^3*a3*a4^2*b1^2*b2^3*b3^5*b4^4 +
12*a1^2*a2^3*a3*a4^2*b1^4*b2^3*b3^5*b4^4 + 12*a1^3*a2^2*a3*a4^2*b1^3*b2^4*b3^5*b4^4 +
12*a1^3*a2^4*a3^4*a4*b1^3*b2^2*b3^2*b4^5 + 12*a1^4*a2^3*a3^4*a4*b1^2*b2^3*b3^2*b4^5 +
12*a1^2*a2^3*a3^4*a4*b1^4*b2^3*b3^2*b4^5 + 12*a1^3*a2^2*a3^4*a4*b1^3*b2^4*b3^2*b4^5 +
12*a1^4*a2^4*a3^3*a4*b1^2*b2^2*b3^3*b4^5 + 12*a1^2*a2^4*a3^3*a4*b1^4*b2^2*b3^3*b4^5 +
12*a1^4*a2^2*a3^3*a4*b1^2*b2^4*b3^3*b4^5 + 12*a1^2*a2^2*a3^3*a4*b1^4*b2^4*b3^3*b4^5 +
12*a1^3*a2^4*a3^2*a4*b1^3*b2^2*b3^4*b4^5 + 12*a1^4*a2^3*a3^2*a4*b1^2*b2^3*b3^4*b4^5 +
12*a1^2*a2^3*a3^2*a4*b1^4*b2^3*b3^4*b4^5 + 12*a1^3*a2^2*a3^2*a4*b1^3*b2^4*b3^4*b4^5

```
c12012=sum(c12.find(a1^3*a2^5*w0))+sum(c12.find(a1^3*b2^5*w0))
c12012
c12012.factor()
s12012=12*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2*q3^2*\
    q4^2
s12012
#This is the sum of the terms with a1^3 and either a2^5 or b2^5, its \
    factorization, and its substitution.
```
12*a1^3*a2^5*a3^4*a4^4*b1^3*b2*b3^2*b4^2 + 12*a1^3*a2*a3^4*a4^4*b1^3*b2^5*b3^2*b4^2 +
12*a1^3*a2^5*a3^2*a4^4*b1^3*b2*b3^4*b4^2 + 12*a1^3*a2*a3^2*a4^4*b1^3*b2^5*b3^4*b4^2 +
12*a1^3*a2^5*a3^4*a4^2*b1^3*b2*b3^2*b4^4 + 12*a1^3*a2*a3^4*a4^2*b1^3*b2^5*b3^2*b4^4 +
12*a1^3*a2^5*a3^2*a4^2*b1^3*b2*b3^4*b4^4 + 12*a1^3*a2*a3^2*a4^2*b1^3*b2^5*b3^4*b4^4
12*(a2^4 + b2^4)*(a3^2 + b3^2)*(a4^2 + b4^2)*a1^3*a2*a3^2*a4^2*b1^3*b2*b3^2*b4^2
12*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2*q3^2*q4^2

```
c12013=sum(c12.find(a1^3*a3^5*w0))+sum(c12.find(a1^3*b3^5*w0))
c12013
c12013.factor()
s12013=12*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^3*q2^2*q3*\
    q4^2
s12013
#This is the sum of the terms with a1^3 and either a3^5 or b3^5, its \
    factorization, and its substitution.
```
12*a1^3*a2^4*a3^5*a4^4*b1^3*b2^2*b3*b4^2 + 12*a1^3*a2^2*a3^5*a4^4*b1^3*b2^4*b3*b4^2 +
12*a1^3*a2^4*a3*a4^4*b1^3*b2^2*b3^5*b4^2 + 12*a1^3*a2^2*a3*a4^4*b1^3*b2^4*b3^5*b4^2 +
12*a1^3*a2^4*a3^5*a4^2*b1^3*b2^2*b3*b4^4 + 12*a1^3*a2^2*a3^5*a4^2*b1^3*b2^4*b3*b4^4 +
12*a1^3*a2^4*a3*a4^2*b1^3*b2^2*b3^5*b4^4 + 12*a1^3*a2^2*a3*a4^2*b1^3*b2^4*b3^5*b4^4
12*(a3^4 + b3^4)*(a2^2 + b2^2)*(a4^2 + b4^2)*a1^3*a2^2*a3*a4^2*b1^3*b2^2*b3*b4^2
12*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^3*q2^2*q3*q4^2

```
c12014=sum(c12.find(a1^3*a4^5*w0))+sum(c12.find(a1^3*b4^5*w0))
c12014
c12014.factor()
s12014=12*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^3*q2^2*q3\
    ^2*q4
s12014
```

12*a1^3*a2^4*a3^4*a4^5*b1^3*b2^2*b3^2*b4 + 12*a1^3*a2^2*a3^4*a4^5*b1^3*b2^4*b3^2*b4 +
12*a1^3*a2^4*a3^2*a4^5*b1^3*b2^2*b3^4*b4 + 12*a1^3*a2^2*a3^2*a4^5*b1^3*b2^4*b3^4*b4 +
12*a1^3*a2^4*a3^4*a4*b1^3*b2^2*b3^2*b4^5 + 12*a1^3*a2^2*a3^4*a4*b1^3*b2^4*b3^2*b4^5 +
12*a1^3*a2^4*a3^2*a4*b1^3*b2^2*b3^4*b4^5 + 12*a1^3*a2^2*a3^2*a4*b1^3*b2^4*b3^4*b4^5
12*(a4^4 + b4^4)*(a2^2 + b2^2)*(a3^2 + b3^2)*a1^3*a2^2*a3^2*a4*b1^3*b2^2*b3^2*b4
12*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^3*q2^2*q3^2*q4

c12021=sum(c12.find(a2^3*a1^5*w0))+sum(c12.find(a2^3*b1^5*w0))
c12021
c12021.factor()
s12021=12*((p1^2 + 2*q1)^2 - 2*q1^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1*q2^3*q3^2*\
    q4^2
s12021

12*a1^5*a2^3*a3^4*a4^4*b1*b2^3*b3^2*b4^2 + 12*a1*a2^3*a3^4*a4^4*b1^5*b2^3*b3^2*b4^2 +
12*a1^5*a2^3*a3^2*a4^4*b1*b2^3*b3^4*b4^2 + 12*a1*a2^3*a3^2*a4^4*b1^5*b2^3*b3^4*b4^2 +
12*a1^5*a2^3*a3^4*a4^2*b1*b2^3*b3^2*b4^4 + 12*a1*a2^3*a3^4*a4^2*b1^5*b2^3*b3^2*b4^4 +
12*a1^5*a2^3*a3^2*a4^2*b1*b2^3*b3^4*b4^4 + 12*a1*a2^3*a3^2*a4^2*b1^5*b2^3*b3^4*b4^4
12*(a1^4 + b1^4)*(a3^2 + b3^2)*(a4^2 + b4^2)*a1*a2^3*a3^2*a4^2*b1*b2^3*b3^2*b4^2
12*((p1^2 + 2*q1)^2 - 2*q1^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1*q2^3*q3^2*q4^2

c12023=sum(c12.find(a2^3*a3^5*w0))+sum(c12.find(a2^3*b3^5*w0))
c12023
c12023.factor()
s12023=12*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2^3*q3*\
    q4^2
s12023

12*a1^4*a2^3*a3^5*a4^4*b1^2*b2^3*b3*b4^2 + 12*a1^2*a2^3*a3^5*a4^4*b1^4*b2^3*b3*b4^2 +
12*a1^4*a2^3*a3*a4^4*b1^2*b2^3*b3^5*b4^2 + 12*a1^2*a2^3*a3*a4^4*b1^4*b2^3*b3^5*b4^2 +
12*a1^4*a2^3*a3^5*a4^2*b1^2*b2^3*b3*b4^4 + 12*a1^2*a2^3*a3^5*a4^2*b1^4*b2^3*b3*b4^4 +
12*a1^4*a2^3*a3*a4^2*b1^2*b2^3*b3^5*b4^4 + 12*a1^2*a2^3*a3*a4^2*b1^4*b2^3*b3^5*b4^4
12*(a3^4 + b3^4)*(a1^2 + b1^2)*(a4^2 + b4^2)*a1^2*a2^3*a3*a4^2*b1^2*b2^3*b3*b4^2
12*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2^3*q3*q4^2

c12024=sum(c12.find(a2^3*a4^5*w0))+sum(c12.find(a2^3*b4^5*w0))
c12024
c12024.factor()
s12024=12*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2^3*q3\
    ^2*q4
s12024

12*a1^4*a2^3*a3^4*a4^5*b1^2*b2^3*b3^2*b4 + 12*a1^2*a2^3*a3^4*a4^5*b1^4*b2^3*b3^2*b4 +
12*a1^4*a2^3*a3^2*a4^5*b1^2*b2^3*b3^4*b4 + 12*a1^2*a2^3*a3^2*a4^5*b1^4*b2^3*b3^4*b4 +
12*a1^4*a2^3*a3^4*a4*b1^2*b2^3*b3^2*b4^5 + 12*a1^2*a2^3*a3^4*a4*b1^4*b2^3*b3^2*b4^5 +
12*a1^4*a2^3*a3^2*a4*b1^2*b2^3*b3^4*b4^5 + 12*a1^2*a2^3*a3^2*a4*b1^4*b2^3*b3^4*b4^5
12*(a4^4 + b4^4)*(a1^2 + b1^2)*(a3^2 + b3^2)*a1^2*a2^3*a3^2*a4*b1^2*b2^3*b3^2*b4
12*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2^3*q3^2*q4

c12031=sum(c12.find(a3^3*a1^5*w0))+sum(c12.find(a3^3*b1^5*w0))
c12031
c12031.factor()
s12031=12*((p1^2 + 2*q1)^2 - 2*q1^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1*q2^2*q3^3*\
    q4^2
s12031

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```
12*a1^5*a2^4*a3^3*a4^4*b1*b2^2*b3^3*b4^2 + 12*a1*a2^4*a3^3*a4^4*b1^5*b2^2*b3^3*b4^2 +
12*a1^5*a2^2*a3^3*a4^4*b1*b2^4*b3^3*b4^2 + 12*a1*a2^2*a3^3*a4^4*b1^5*b2^4*b3^3*b4^2 +
12*a1^5*a2^4*a3^3*a4^2*b1*b2^2*b3^3*b4^4 + 12*a1*a2^4*a3^3*a4^2*b1^5*b2^2*b3^3*b4^4 +
12*a1^5*a2^2*a3^3*a4^2*b1*b2^4*b3^3*b4^4 + 12*a1*a2^2*a3^3*a4^2*b1^5*b2^4*b3^3*b4^4
12*(a1^4 + b1^4)*(a2^2 + b2^2)*(a4^2 + b4^2)*a1*a2^2*a3^3*a4^2*b1*b2^2*b3^3*b4^2
12*((p1^2 + 2*q1)^2 - 2*q1^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1*q2^2*q3^3*q4^2
```

```
c12032=sum(c12.find(a3^3*a2^5*w0))+sum(c12.find(a3^3*b2^5*w0))
c12032
c12032.factor()
s12032=12*((p2^2 + 2*q2)^2 - 2*q2^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2*q3^3*\
    q4^2
s12032
```
```
12*a1^4*a2^5*a3^3*a4^4*b1^2*b2*b3^3*b4^2 + 12*a1^2*a2^5*a3^3*a4^4*b1^4*b2*b3^3*b4^2 +
12*a1^4*a2*a3^3*a4^4*b1^2*b2^5*b3^3*b4^2 + 12*a1^2*a2*a3^3*a4^4*b1^4*b2^5*b3^3*b4^2 +
12*a1^4*a2^5*a3^3*a4^2*b1^2*b2*b3^3*b4^4 + 12*a1^2*a2^5*a3^3*a4^2*b1^4*b2*b3^3*b4^4 +
12*a1^4*a2*a3^3*a4^2*b1^2*b2^5*b3^3*b4^4 + 12*a1^2*a2*a3^3*a4^2*b1^4*b2^5*b3^3*b4^4
12*(a2^4 + b2^4)*(a1^2 + b1^2)*(a4^2 + b4^2)*a1^2*a2*a3^3*a4^2*b1^2*b2*b3^3*b4^2
12*((p2^2 + 2*q2)^2 - 2*q2^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2*q3^3*q4^2
```

```
c12034=sum(c12.find(a3^3*a4^5*w0))+sum(c12.find(a3^3*b4^5*w0))
c12034
c12034.factor()
s12034=12*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q2^2*q3\
    ^3*q4
s12034
```
```
12*a1^4*a2^4*a3^3*a4^5*b1^2*b2^2*b3^3*b4 + 12*a1^2*a2^4*a3^3*a4^5*b1^4*b2^2*b3^3*b4 +
12*a1^4*a2^2*a3^3*a4^5*b1^2*b2^4*b3^3*b4 + 12*a1^2*a2^2*a3^3*a4^5*b1^4*b2^4*b3^3*b4 +
12*a1^4*a2^4*a3^3*a4*b1^2*b2^2*b3^3*b4^5 + 12*a1^2*a2^4*a3^3*a4*b1^4*b2^2*b3^3*b4^5 +
12*a1^4*a2^2*a3^3*a4*b1^2*b2^4*b3^3*b4^5 + 12*a1^2*a2^2*a3^3*a4*b1^4*b2^4*b3^3*b4^5
12*(a4^4 + b4^4)*(a1^2 + b1^2)*(a2^2 + b2^2)*a1^2*a2^2*a3^3*a4*b1^2*b2^2*b3^3*b4
12*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q2^2*q3^3*q4
```

```
c12041=sum(c12.find(a4^3*a1^5*w0))+sum(c12.find(a4^3*b1^5*w0))
c12041
c12041.factor()
s12041=12*((p1^2 + 2*q1)^2 - 2*q1^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1*q2^2*q3^2*\
    q4^3
s12041
```
```
12*a1^5*a2^4*a3^4*a4^3*b1*b2^2*b3^2*b4^3 + 12*a1*a2^4*a3^4*a4^3*b1^5*b2^2*b3^2*b4^3 +
12*a1^5*a2^2*a3^4*a4^3*b1*b2^4*b3^2*b4^3 + 12*a1*a2^2*a3^4*a4^3*b1^5*b2^4*b3^2*b4^3 +
12*a1^5*a2^4*a3^2*a4^3*b1*b2^2*b3^4*b4^3 + 12*a1*a2^4*a3^2*a4^3*b1^5*b2^2*b3^4*b4^3 +
12*a1^5*a2^2*a3^2*a4^3*b1*b2^4*b3^4*b4^3 + 12*a1*a2^2*a3^2*a4^3*b1^5*b2^4*b3^4*b4^3
12*(a1^4 + b1^4)*(a2^2 + b2^2)*(a3^2 + b3^2)*a1*a2^2*a3^2*a4^3*b1*b2^2*b3^2*b4^3
12*((p1^2 + 2*q1)^2 - 2*q1^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1*q2^2*q3^2*q4^3
```

```
c12042=sum(c12.find(a4^3*a2^5*w0))+sum(c12.find(a4^3*b2^5*w0))
c12042
c12042.factor()
s12042=12*((p2^2 + 2*q2)^2 - 2*q2^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2*q3^2*\
    q4^3
s12042
```

#This is the sum of the terms with a4^3 and either a2^5 or b2^5, its \
    factorization, and its substitution.

12*a1^4*a2^5*a3^4*a4^3*b1^2*b2*b3^2*b4^3 + 12*a1^2*a2^5*a3^4*a4^3*b1^4*b2*b3^2*b4^3 +
12*a1^4*a2*a3^4*a4^3*b1^2*b2^5*b3^2*b4^3 + 12*a1^2*a2*a3^4*a4^3*b1^4*b2^5*b3^2*b4^3 +
12*a1^4*a2^5*a3^2*a4^3*b1^2*b2*b3^4*b4^3 + 12*a1^2*a2^5*a3^2*a4^3*b1^4*b2*b3^4*b4^3 +
12*a1^4*a2*a3^2*a4^3*b1^2*b2^5*b3^4*b4^3 + 12*a1^2*a2*a3^2*a4^3*b1^4*b2^5*b3^4*b4^3

12*(a2^4 + b2^4)*(a1^2 + b1^2)*(a3^2 + b3^2)*a1^2*a2*a3^2*a4^3*b1^2*b2*b3^2*b4^3

12*((p2^2 + 2*q2)^2 - 2*q2^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2*q3^2*q4^3

c12043=sum(c12.find(a4^3*a3^5*w0))+sum(c12.find(a4^3*b3^5*w0))
c12043
c12043.factor()
s12043=12*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q2^2*q3*\
    q4^3
s12043

#This is the sum of the terms with a4^3 and either a2^5 or b2^5, its \
    factorization, and its substitution.

12*a1^4*a2^4*a3^5*a4^3*b1^2*b2^2*b3*b4^3 + 12*a1^2*a2^4*a3^5*a4^3*b1^4*b2^2*b3*b4^3 +
12*a1^4*a2^2*a3^5*a4^3*b1^2*b2^4*b3*b4^3 + 12*a1^2*a2^2*a3^5*a4^3*b1^4*b2^4*b3*b4^3 +
12*a1^4*a2^4*a3*a4^3*b1^2*b2^2*b3^5*b4^3 + 12*a1^2*a2^4*a3*a4^3*b1^4*b2^2*b3^5*b4^3 +
12*a1^4*a2^2*a3*a4^3*b1^2*b2^4*b3^5*b4^3 + 12*a1^2*a2^2*a3*a4^3*b1^4*b2^4*b3^5*b4^3

12*(a3^4 + b3^4)*(a1^2 + b1^2)*(a2^2 + b2^2)*a1^2*a2^2*a3*a4^3*b1^2*b2^2*b3*b4^3

12*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q2^2*q3*q4^3

bool(c12==c12012+c12013+c12014+c12021+c12023+c12024+c12031+c12032+c12034+c12041\
    +c12042+c12043)
#This is a check to make sure as we seperated the groups we used every term in \
    c12 once and only once.
True

l12=s12012+s12013+s12014+s12021+s12023+s12024+s12031+s12032+s12034+s12041+\
    s12042+s12043
l12
l012=l12(p1=a1+b1, p2=a2+b2, p3=a3+b3, p4=a4+b4, q1=-1*a1*b1, q2=-1*a2*b2, q3\
    =-1*a3*b3, q4=-1*a4*b4)
bool(l012==c12)
#This line brings all the group substitutions we created for c12 back into one \
    expression and checks to make sure that when back substitute we end up with \
    c12.

12*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^3*q2^2*q3^2*q4 + 12*((p4^2 +
2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2^3*q3^2*q4 + 12*((p4^2 + 2*q4)^2 -
2*q4^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q2^2*q3^3*q4 + 12*((p3^2 + 2*q3)^2 -
2*q3^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^3*q2^2*q3^2*q4^2 + 12*((p3^2 + 2*q3)^2 -
2*q3^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2^3*q3^2*q4^2 + 12*((p2^2 + 2*q2)^2 -
2*q2^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^2*q3^2*q4^2 + 12*((p1^2 + 2*q1)^2 -
2*q1^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1*q2^3*q3^2*q4^2 + 12*((p2^2 + 2*q2)^2 -
2*q2^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2*q3^3*q4^2 + 12*((p1^2 + 2*q1)^2 -
2*q1^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1*q2^2*q3^3*q4^2 + 12*((p3^2 + 2*q3)^2 -
2*q3^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q2^2*q3*q4^3 + 12*((p2^2 + 2*q2)^2 -
2*q2^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2*q3^2*q4^3 + 12*((p1^2 + 2*q1)^2 -
2*q1^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1*q2^2*q3^2*q4^3
True

c20=sum(f10.find(20*w0))
c20
#This finds all our terms in f10 that have a 20 in them and then adds them \
    together. The groups we form will have two of the four a variables to the \
    third power and either a second a variable or its corresponding b variable \
    to the forth power.

20*a1^3*a2^3*a3^4*a4^5*b1^3*b2^3*b3^2*b4 + 20*a1^3*a2^4*a3^3*a4^5*b1^3*b2^2*b3^3*b4 +

20*a1^4*a2^3*a3^3*a4^5*b1^2*b2^3*b3^3*b4 + 20*a1^2*a2^3*a3^3*a4^5*b1^4*b2^3*b3^3*b4 +
20*a1^3*a2^2*a3^3*a4^5*b1^3*b2^4*b3^3*b4 + 20*a1^3*a2^3*a3^2*a4^5*b1^3*b2^3*b3^4*b4 +
20*a1^3*a2^3*a3^5*a4^4*b1^3*b2^3*b3*b4^2 + 20*a1^3*a2^5*a3^3*a4^4*b1^3*b2*b3^3*b4^2 +
20*a1^5*a2^3*a3^3*a4^4*b1*b2^3*b3^3*b4^2 + 20*a1*a2^3*a3^3*a4^4*b1^5*b2^3*b3^3*b4^2 +
20*a1^3*a2*a3^3*a4^4*b1^3*b2^5*b3^3*b4^2 + 20*a1^3*a2^3*a3*a4^4*b1^3*b2^3*b3^5*b4^2 +
20*a1^3*a2^4*a3^5*a4^3*b1^3*b2^2*b3*b4^3 + 20*a1^4*a2^3*a3^5*a4^3*b1^2*b2^3*b3*b4^3 +
20*a1^2*a2^3*a3^5*a4^3*b1^4*b2^3*b3*b4^3 + 20*a1^3*a2^2*a3^5*a4^3*b1^3*b2^4*b3*b4^3 +
20*a1^3*a2^5*a3^4*a4^3*b1^3*b2*b3^2*b4^3 + 20*a1^5*a2^3*a3^4*a4^3*b1*b2^3*b3^2*b4^3 +
20*a1*a2^3*a3^4*a4^3*b1^5*b2^3*b3^2*b4^3 + 20*a1^3*a2*a3^4*a4^3*b1^3*b2^5*b3^2*b4^3 +
20*a1^4*a2^5*a3^3*a4^3*b1^2*b2*b3^3*b4^3 + 20*a1^2*a2^5*a3^3*a4^3*b1^4*b2*b3^3*b4^3 +
20*a1^5*a2^4*a3^3*a4^3*b1*b2^2*b3^3*b4^3 + 20*a1*a2^4*a3^3*a4^3*b1^5*b2^2*b3^3*b4^3 +
20*a1^5*a2^2*a3^3*a4^3*b1*b2^4*b3^3*b4^3 + 20*a1*a2^2*a3^3*a4^3*b1^5*b2^4*b3^3*b4^3 +
20*a1^4*a2*a3^3*a4^3*b1^2*b2^5*b3^3*b4^3 + 20*a1^2*a2*a3^3*a4^3*b1^4*b2^5*b3^3*b4^3 +
20*a1^3*a2^5*a3^2*a4^3*b1^3*b2*b3^4*b4^3 + 20*a1^5*a2^3*a3^2*a4^3*b1*b2^3*b3^4*b4^3 +
20*a1*a2^3*a3^2*a4^3*b1^5*b2^3*b3^4*b4^3 + 20*a1^3*a2*a3^2*a4^3*b1^3*b2^5*b3^4*b4^3 +
20*a1^3*a2^4*a3*a4^3*b1^3*b2^2*b3^5*b4^3 + 20*a1^4*a2^3*a3*a4^3*b1^2*b2^3*b3^5*b4^3 +
20*a1^2*a2^3*a3*a4^3*b1^4*b2^3*b3^5*b4^3 + 20*a1^3*a2^2*a3*a4^3*b1^3*b2^4*b3^5*b4^3 +
20*a1^3*a2^3*a3^5*a4^2*b1^3*b2^3*b3*b4^4 + 20*a1^3*a2^5*a3^3*a4^2*b1^3*b2*b3^3*b4^4 +
20*a1^5*a2^3*a3^3*a4^2*b1*b2^3*b3^3*b4^4 + 20*a1*a2^3*a3^3*a4^2*b1^5*b2^3*b3^3*b4^4 +
20*a1^3*a2*a3^3*a4^2*b1^3*b2^5*b3^3*b4^4 + 20*a1^3*a2^3*a3*a4^2*b1^3*b2^3*b3^5*b4^4 +
20*a1^3*a2^3*a3^4*a4*b1^3*b2^3*b3^2*b4^5 + 20*a1^3*a2^4*a3^3*a4*b1^3*b2^2*b3^3*b4^5 +
20*a1^4*a2^3*a3^3*a4*b1^2*b2^3*b3^3*b4^5 + 20*a1^2*a2^3*a3^3*a4*b1^4*b2^3*b3^3*b4^5 +
20*a1^3*a2^2*a3^3*a4*b1^3*b2^4*b3^3*b4^5 + 20*a1^3*a2^3*a3^2*a4*b1^3*b2^3*b3^4*b4^5

```
c20123=sum(c20.find(a1^3*a2^3*a3^4*w0))+sum(c20.find(a1^3*a2^3*b3^4*w0))
c20123
c20123.factor()
s20123=-20*((p4^2 + 2*q4)^2 - 2*q4^2)*(p3^2 + 2*q3)*q1^3*q2^3*q3^2*q4
s20123
#This is the sum of the terms with a1^3, a2^3 and either a3^4 or b3^4, its \
    factorization, and its substitution.
```
20*a1^3*a2^3*a3^4*a4^5*b1^3*b2^3*b3^2*b4 + 20*a1^3*a2^3*a3^2*a4^5*b1^3*b2^3*b3^4*b4 +
20*a1^3*a2^3*a3^4*a4*b1^3*b2^3*b3^2*b4^5 + 20*a1^3*a2^3*a3^2*a4*b1^3*b2^3*b3^4*b4^5
20*(a4^4 + b4^4)*(a3^2 + b3^2)*a1^3*a2^3*a3^2*a4*b1^3*b2^3*b3^2*b4
-20*((p4^2 + 2*q4)^2 - 2*q4^2)*(p3^2 + 2*q3)*q1^3*q2^3*q3^2*q4

```
c20124=sum(c20.find(a1^3*a2^3*a4^4*w0))+sum(c20.find(a1^3*a2^3*b4^4*w0))
c20124
c20124.factor()
s20124=-20*((p3^2 + 2*q3)^2 - 2*q3^2)*(p4^2 + 2*q4)*q1^3*q2^3*q3*q4^2
s20124
#This is the sum of the terms with a1^3, a2^3 and either a3^4 or b3^4, its \
    factorization, and its substitution.
```
20*a1^3*a2^3*a3^5*a4^4*b1^3*b2^3*b3*b4^2 + 20*a1^3*a2^3*a3*a4^4*b1^3*b2^3*b3^5*b4^2 +
20*a1^3*a2^3*a3^5*a4^2*b1^3*b2^3*b3*b4^4 + 20*a1^3*a2^3*a3*a4^2*b1^3*b2^3*b3^5*b4^4
20*(a3^4 + b3^4)*(a4^2 + b4^2)*a1^3*a2^3*a3*a4^2*b1^3*b2^3*b3*b4^2
-20*((p3^2 + 2*q3)^2 - 2*q3^2)*(p4^2 + 2*q4)*q1^3*q2^3*q3*q4^2

```
c20132=sum(c20.find(a1^3*a3^3*a2^4*w0))+sum(c20.find(a1^3*a3^3*b2^4*w0))
c20132
c20132.factor()
s20132=-20*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*q1^3*q2^2*q3^3*q4
s20132
#This is the sum of the terms with a1^3, a3^3 and either a2^4 or b2^4, its \
    factorization, and its substitution.
```
20*a1^3*a2^4*a3^3*a4^5*b1^3*b2^2*b3^3*b4 + 20*a1^3*a2^2*a3^3*a4^5*b1^3*b2^4*b3^3*b4 +
20*a1^3*a2^4*a3^3*a4*b1^3*b2^2*b3^3*b4^5 + 20*a1^3*a2^2*a3^3*a4*b1^3*b2^4*b3^3*b4^5
20*(a4^4 + b4^4)*(a2^2 + b2^2)*a1^3*a2^2*a3^3*a4*b1^3*b2^2*b3^3*b4
-20*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*q1^3*q2^2*q3^3*q4

```
c20134=sum(c20.find(a1^3*a3^3*a4^4*w0))+sum(c20.find(a1^3*a3^3*b4^4*w0))
```

```
c20134
c20134.factor()
s20134=-20*((p2^2 + 2*q2)^2 - 2*q2^2)*(p4^2 + 2*q4)*q1^3*q2*q3^3*q4^2
s20134
```
#This is the sum of the terms with a1^3, a3^3 and either a4^4 or b4^4, its \
    factorization, and its substitution.
```
20*a1^3*a2^5*a3^3*a4^4*b1^3*b2*b3^3*b4^2 + 20*a1^3*a2*a3^3*a4^4*b1^3*b2^5*b3^3*b4^2 +
20*a1^3*a2^5*a3^3*a4^2*b1^3*b2*b3^3*b4^4 + 20*a1^3*a2*a3^3*a4^2*b1^3*b2^5*b3^3*b4^4
20*(a2^4 + b2^4)*(a4^2 + b4^2)*a1^3*a2*a3^3*a4^2*b1^3*b2*b3^3*b4^2
-20*((p2^2 + 2*q2)^2 - 2*q2^2)*(p4^2 + 2*q4)*q1^3*q2*q3^3*q4^2
```

```
c20142=sum(c20.find(a1^3*a4^3*a2^4*w0))+sum(c20.find(a1^3*a4^3*b2^4*w0))
c20142
c20142.factor()
s20142=-20*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 + 2*q2)*q1^3*q2^2*q3*q4^3
s20142
```
#This is the sum of the terms with a1^3, a4^3 and either a3^4 or b3^4, its \
    factorization, and its substitution.
```
20*a1^3*a2^4*a3^5*a4^3*b1^3*b2^2*b3*b4^3 + 20*a1^3*a2^2*a3^5*a4^3*b1^3*b2^4*b3*b4^3 +
20*a1^3*a2^4*a3*a4^3*b1^3*b2^2*b3^5*b4^3 + 20*a1^3*a2^2*a3*a4^3*b1^3*b2^4*b3^5*b4^3
20*(a3^4 + b3^4)*(a2^2 + b2^2)*a1^3*a2^2*a3*a4^3*b1^3*b2^2*b3*b4^3
-20*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 + 2*q2)*q1^3*q2^2*q3*q4^3
```

```
c20143=sum(c20.find(a1^3*a4^3*a3^4*w0))+sum(c20.find(a1^3*a4^3*b3^4*w0))
c20143
c20143.factor()
s20143=-20*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 + 2*q3)*q1^3*q2*q3^2*q4^3
s20143
```
#This is the sum of the terms with a1^3, a4^3 and either a3^4 or b3^4, its \
    factorization, and its substitution.
```
20*a1^3*a2^5*a3^4*a4^3*b1^3*b2*b3^2*b4^3 + 20*a1^3*a2*a3^4*a4^3*b1^3*b2^5*b3^2*b4^3 +
20*a1^3*a2^5*a3^2*a4^3*b1^3*b2*b3^4*b4^3 + 20*a1^3*a2*a3^2*a4^3*b1^3*b2^5*b3^4*b4^3
20*(a2^4 + b2^4)*(a3^2 + b3^2)*a1^3*a2*a3^2*a4^3*b1^3*b2*b3^2*b4^3
-20*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 + 2*q3)*q1^3*q2*q3^2*q4^3
```

```
c20231=sum(c20.find(a2^3*a3^3*a1^4*w0))+sum(c20.find(a2^3*a3^3*b1^4*w0))
c20231
c20231.factor()
s20231=-20*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*q1^2*q2^3*q3^3*q4
s20231
```
#This is the sum of the terms with a2^3, a3^3 and either a1^4 or b1^4, its \
    factorization, and its substitution.
```
20*a1^4*a2^3*a3^3*a4^5*b1^2*b2^3*b3^3*b4 + 20*a1^2*a2^3*a3^3*a4^5*b1^4*b2^3*b3^3*b4 +
20*a1^4*a2^3*a3^3*a4*b1^2*b2^3*b3^3*b4^5 + 20*a1^2*a2^3*a3^3*a4*b1^4*b2^3*b3^3*b4^5
20*(a4^4 + b4^4)*(a1^2 + b1^2)*a1^2*a2^3*a3^3*a4*b1^2*b2^3*b3^3*b4
-20*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*q1^2*q2^3*q3^3*q4
```

```
c20234=sum(c20.find(a2^3*a3^3*a4^4*w0))+sum(c20.find(a2^3*a3^3*b4^4*w0))
c20234
c20234.factor()
s20234=-20*((p1^2 + 2*q1)^2 - 2*q1^2)*(p4^2 + 2*q4)*q1*q2^3*q3^3*q4^2
s20234
```
#This is the sum of the terms with a2^3, a3^3 and either a4^4 or b4^4, its \
    factorization, and its substitution.
```
20*a1^5*a2^3*a3^3*a4^4*b1*b2^3*b3^3*b4^2 + 20*a1*a2^3*a3^3*a4^4*b1^5*b2^3*b3^3*b4^2 +
20*a1^5*a2^3*a3^3*a4^2*b1*b2^3*b3^3*b4^4 + 20*a1*a2^3*a3^3*a4^2*b1^5*b2^3*b3^3*b4^4
20*(a1^4 + b1^4)*(a4^2 + b4^2)*a1*a2^3*a3^3*a4^2*b1*b2^3*b3^3*b4^2
-20*((p1^2 + 2*q1)^2 - 2*q1^2)*(p4^2 + 2*q4)*q1*q2^3*q3^3*q4^2
```

```
c20241=sum(c20.find(a2^3*a4^3*a1^4*w0))+sum(c20.find(a2^3*a4^3*b1^4*w0))
c20241
```

```
c20241.factor()
s20241=-20*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*q1^2*q2^3*q3*q4^3
s20241
```
```
20*a1^4*a2^3*a3^5*a4^3*b1^2*b2^3*b3*b4^3 + 20*a1^2*a2^3*a3^5*a4^3*b1^4*b2^3*b3*b4^3 +
20*a1^4*a2^3*a3*a4^3*b1^2*b2^3*b3^5*b4^3 + 20*a1^2*a2^3*a3*a4^3*b1^4*b2^3*b3^5*b4^3
20*(a3^4 + b3^4)*(a1^2 + b1^2)*a1^2*a2^3*a3*a4^3*b1^2*b2^3*b3*b4^3
-20*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*q1^2*q2^3*q3*q4^3
```

```
c20243=sum(c20.find(a2^3*a4^3*a3^4*w0))+sum(c20.find(a2^3*a4^3*b3^4*w0))
c20243
c20243.factor()
s20243=-20*((p1^2 + 2*q1)^2 - 2*q1^2)*(p3^2 + 2*q3)*q1*q2^3*q3^2*q4^3
s20243
```
```
20*a1^5*a2^3*a3^4*a4^3*b1*b2^3*b3^2*b4^3 + 20*a1*a2^3*a3^4*a4^3*b1^5*b2^3*b3^2*b4^3 +
20*a1^5*a2^3*a3^2*a4^3*b1*b2^3*b3^4*b4^3 + 20*a1*a2^3*a3^2*a4^3*b1^5*b2^3*b3^4*b4^3
20*(a1^4 + b1^4)*(a3^2 + b3^2)*a1*a2^3*a3^2*a4^3*b1*b2^3*b3^2*b4^3
-20*((p1^2 + 2*q1)^2 - 2*q1^2)*(p3^2 + 2*q3)*q1*q2^3*q3^2*q4^3
```

```
c20341=sum(c20.find(a3^3*a4^3*a1^4*w0))+sum(c20.find(a3^3*a4^3*b1^4*w0))
c20341
c20341.factor()
s20341=-20*((p2^2 + 2*q2)^2 - 2*q2^2)*(p1^2 + 2*q1)*q1^2*q2*q3^3*q4^3
s20341
```
```
20*a1^4*a2^5*a3^3*a4^3*b1^2*b2*b3^3*b4^3 + 20*a1^2*a2^5*a3^3*a4^3*b1^4*b2*b3^3*b4^3 +
20*a1^4*a2*a3^3*a4^3*b1^2*b2^5*b3^3*b4^3 + 20*a1^2*a2*a3^3*a4^3*b1^4*b2^5*b3^3*b4^3
20*(a2^4 + b2^4)*(a1^2 + b1^2)*a1^2*a2*a3^3*a4^3*b1^2*b2*b3^3*b4^3
-20*((p2^2 + 2*q2)^2 - 2*q2^2)*(p1^2 + 2*q1)*q1^2*q2*q3^3*q4^3
```

```
c20342=sum(c20.find(a3^3*a4^3*a2^4*w0))+sum(c20.find(a3^3*a4^3*b2^4*w0))
c20342
c20342.factor()
s20342=-20*((p1^2 + 2*q1)^2 - 2*q1^2)*(p2^2 + 2*q2)*q1*q2^2*q3^3*q4^3
s20342
```
```
20*a1^5*a2^4*a3^3*a4^3*b1*b2^2*b3^3*b4^3 + 20*a1*a2^4*a3^3*a4^3*b1^5*b2^2*b3^3*b4^3 +
20*a1^5*a2^2*a3^3*a4^3*b1*b2^4*b3^3*b4^3 + 20*a1*a2^2*a3^3*a4^3*b1^5*b2^4*b3^3*b4^3
20*(a1^4 + b1^4)*(a2^2 + b2^2)*a1*a2^2*a3^3*a4^3*b1*b2^2*b3^3*b4^3
-20*((p1^2 + 2*q1)^2 - 2*q1^2)*(p2^2 + 2*q2)*q1*q2^2*q3^3*q4^3
```

```
bool(c20==c20123+c20124+c20132+c20134+c20142+c20143+c20231+c20234+c20241+c20243\
    +c20341+c20342)
```
```
True
```

```
l20=s20123+s20124+s20132+s20134+s20142+s20143+s20231+s20234+s20241+s20243+\
    s20341+s20342
l20
l020=l20(p1=a1+b1, p2=a2+b2, p3=a3+b3, p4=a4+b4, q1=-1*a1*b1, q2=-1*a2*b2, q3\
    =-1*a3*b3, q4=-1*a4*b4)
bool(l020==c20)
```

-20*((p4^2 + 2*q4)^2 - 2*q4^2)*(p3^2 + 2*q3)*q1^3*q2^3*q3^2*q4 - 20*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*q1^3*q2^2*q3^3*q4 - 20*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*q1^2*q2^3*q3^3*q4 - 20*((p3^2 + 2*q3)^2 - 2*q3^2)*(p4^2 + 2*q4)*q1^3*q2^3*q3*q4^2 - 20*((p2^2 + 2*q2)^2 - 2*q2^2)*(p4^2 + 2*q4)*q1^3*q2*q3^3*q4^2 - 20*((p1^2 + 2*q1)^2 - 2*q1^2)*(p4^2 + 2*q4)*q1*q2^3*q3^3*q4^2 - 20*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 + 2*q2)*q1^3*q2^2*q3*q4^3 - 20*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*q1^2*q2^3*q3*q4^3 - 20*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 + 2*q3)*q1^3*q2*q3^2*q4^3 - 20*((p1^2 + 2*q1)^2 - 2*q1^2)*(p3^2 + 2*q3)*q1*q2^3*q3^2*q4^3 - 20*((p2^2 + 2*q2)^2 - 2*q2^2)*(p1^2 + 2*q1)*q1^2*q2*q3^3*q4^3 - 20*((p1^2 + 2*q1)^2 - 2*q1^2)*(p2^2 + 2*q2)*q1*q2^2*q3^3*q4^3
True


```
c28=sum(f10.find(28*w0))
c28
c28.factor()
s28=28*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2^2*q3^2*\
    q4^2
s28
#This finds all our terms in f10 that have a 20 in them and then adds them \
    together, its factorization, and its substitution.
```
28*a1^4*a2^4*a3^4*a4^4*b1^2*b2^2*b3^2*b4^2 + 28*a1^2*a2^4*a3^4*a4^4*b1^4*b2^2*b3^2*b4^2 + 28*a1^4*a2^2*a3^4*a4^4*b1^2*b2^4*b3^2*b4^2 + 28*a1^2*a2^2*a3^4*a4^4*b1^4*b2^4*b3^2*b4^2 + 28*a1^4*a2^4*a3^2*a4^4*b1^2*b2^2*b3^4*b4^2 + 28*a1^2*a2^4*a3^2*a4^4*b1^4*b2^2*b3^4*b4^2 + 28*a1^4*a2^2*a3^2*a4^4*b1^2*b2^4*b3^4*b4^2 + 28*a1^2*a2^2*a3^2*a4^4*b1^4*b2^4*b3^4*b4^2 + 28*a1^4*a2^4*a3^4*a4^2*b1^2*b2^2*b3^2*b4^4 + 28*a1^2*a2^4*a3^4*a4^2*b1^4*b2^2*b3^2*b4^4 + 28*a1^4*a2^2*a3^4*a4^2*b1^2*b2^4*b3^2*b4^4 + 28*a1^2*a2^2*a3^4*a4^2*b1^4*b2^4*b3^2*b4^4 + 28*a1^4*a2^4*a3^2*a4^2*b1^2*b2^2*b3^4*b4^4 + 28*a1^2*a2^4*a3^2*a4^2*b1^4*b2^2*b3^4*b4^4 + 28*a1^4*a2^2*a3^2*a4^2*b1^2*b2^4*b3^4*b4^4 + 28*a1^2*a2^2*a3^2*a4^2*b1^4*b2^4*b3^4*b4^4
28*(a1^2 + b1^2)*(a2^2 + b2^2)*(a3^2 + b3^2)*(a4^2 + b4^2)*a1^2*a2^2*a3^2*a4^2*b1^2*b2^2*b3^2*b4^2
28*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2^2*q3^2*q4^2


```
l28=s28
l28
l028=l28(p1=a1+b1, p2=a2+b2, p3=a3+b3, p4=a4+b4, q1=-1*a1*b1, q2=-1*a2*b2, q3\
    =-1*a3*b3, q4=-1*a4*b4)
bool(l028==c28)
#This line brings all the group substitutions we created for c28 back into one \
    expression and checks to make sure that when back substitute we end up with \
    c28.
```
28*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2^2*q3^2*q4^2
True


```
c32=sum(f10.find(32*w0))
c32
#This finds all our terms in f10 that have a 32 in them and then adds them \
    together. The groups we form will have one of the four a variables or its \
    corresponding b variable to the fifth power.
```
32*a1^3*a2^3*a3^3*a4^5*b1^3*b2^3*b3^3*b4 + 32*a1^3*a2^3*a3^5*a4^3*b1^3*b2^3*b3*b4^3 + 32*a1^3*a2^5*a3^3*a4^3*b1^3*b2*b3^3*b4^3 + 32*a1^5*a2^3*a3^3*a4^3*b1*b2^3*b3^3*b4^3 + 32*a1*a2^3*a3^3*a4^3*b1^5*b2^3*b3^3*b4^3 + 32*a1^3*a2*a3^3*a4^3*b1^3*b2^5*b3^3*b4^3 + 32*a1^3*a2^3*a3*a4^3*b1^3*b2^3*b3^5*b4^3 + 32*a1^3*a2^3*a3^3*a4*b1^3*b2^3*b3^3*b4^5


```
c321=sum(c32.find(a1^5*w0))+sum(c32.find(b1^5*w0))
c321
c321.factor()
s321=32*((p1^2 + 2*q1)^2 - 2*q1^2)*q1*q2^3*q3^3*q4^3
s321
#This is the sum of the terms with either a1^4 or b1^4, its factorization, and \
    its substitution.
```

32*a1^5*a2^3*a3^3*a4^3*b1*b2^3*b3^3*b4^3 + 32*a1*a2^3*a3^3*a4^3*b1^5*b2^3*b3^3*b4^3
32*(a1^4 + b1^4)*a1*a2^3*a3^3*a4^3*b1*b2^3*b3^3*b4^3
32*((p1^2 + 2*q1)^2 - 2*q1^2)*q1*q2^3*q3^3*q4^3

```
c322=sum(c32.find(a2^5*w0))+sum(c32.find(b2^5*w0))
c322
c322.factor()
s322=32*((p2^2 + 2*q2)^2 - 2*q2^2)*q1^3*q2*q3^3*q4^3
s322
#This is the sum of the terms with either a2^4 or b2^4, its factorization, and \
    its substitution.
```
32*a1^3*a2^5*a3^3*a4^3*b1^3*b2*b3^3*b4^3 + 32*a1^3*a2*a3^3*a4^3*b1^3*b2^5*b3^3*b4^3
32*(a2^4 + b2^4)*a1^3*a2*a3^3*a4^3*b1^3*b2*b3^3*b4^3
32*((p2^2 + 2*q2)^2 - 2*q2^2)*q1^3*q2*q3^3*q4^3

```
c323=sum(c32.find(a3^5*w0))+sum(c32.find(b3^5*w0))
c323
c323.factor()
s323=32*((p3^2 + 2*q3)^2 - 2*q3^2)*q1^3*q2^3*q3*q4^3
s323
#This is the sum of the terms with either a3^4 or b3^4, its factorization, and \
    its substitution.
```
32*a1^3*a2^3*a3^5*a4^3*b1^3*b2^3*b3*b4^3 + 32*a1^3*a2^3*a3*a4^3*b1^3*b2^3*b3^5*b4^3
32*(a3^4 + b3^4)*a1^3*a2^3*a3*a4^3*b1^3*b2^3*b3*b4^3
32*((p3^2 + 2*q3)^2 - 2*q3^2)*q1^3*q2^3*q3*q4^3

```
c324=sum(c32.find(a4^5*w0))+sum(c32.find(b4^5*w0))
c324
c324.factor()
s324=32*((p4^2 + 2*q4)^2 - 2*q4^2)*q1^3*q2^3*q3^3*q4
s324
#This is the sum of the terms with either a4^4 or b4^4, its factorization, and \
    its substitution.
```
32*a1^3*a2^3*a3^3*a4^5*b1^3*b2^3*b3^3*b4 + 32*a1^3*a2^3*a3^3*a4*b1^3*b2^3*b3^3*b4^5
32*(a4^4 + b4^4)*a1^3*a2^3*a3^3*a4*b1^3*b2^3*b3^3*b4
32*((p4^2 + 2*q4)^2 - 2*q4^2)*q1^3*q2^3*q3^3*q4

```
bool(c32==c321+c322+c323+c324)
#This is a check to make sure as we seperated the groups we used every term in \
    c32 once and only once.
```
True

```
l32=s321+s322+s323+s324
l32
l032=l32(p1=a1+b1, p2=a2+b2, p3=a3+b3, p4=a4+b4, q1=-1*a1*b1, q2=-1*a2*b2, q3\
    =-1*a3*b3, q4=-1*a4*b4)
bool(l032==c32)
#This line brings all the group substitutions we created for c32 back into one \
    expression and checks to make sure that when back substitute we end up with \
    c32.
```
32*((p4^2 + 2*q4)^2 - 2*q4^2)*q1^3*q2^3*q3^3*q4 + 32*((p3^2 + 2*q3)^2 -
2*q3^2)*q1^3*q2^3*q3*q4^3 + 32*((p2^2 + 2*q2)^2 - 2*q2^2)*q1^3*q2*q3^3*q4^3 + 32*((p1^2 +
2*q1)^2 - 2*q1^2)*q1*q2^3*q3^3*q4^3
True


```
c46=sum(f10.find(46*w0))
c46
#This finds all our terms in f10 that have a 46 in them and then adds them \
    together. The groups we form will have one of the four a variables to the \
    third power.
```

46*a1^3*a2^4*a3^4*a4^4*b1^3*b2^2*b3^2*b4^2 + 46*a1^4*a2^3*a3^4*a4^4*b1^2*b2^3*b3^2*b4^2 +
46*a1^2*a2^3*a3^4*a4^4*b1^4*b2^3*b3^2*b4^2 + 46*a1^3*a2^2*a3^4*a4^4*b1^3*b2^4*b3^2*b4^2 +
46*a1^4*a2^4*a3^3*a4^4*b1^2*b2^2*b3^3*b4^2 + 46*a1^2*a2^4*a3^3*a4^4*b1^4*b2^2*b3^3*b4^2 +
46*a1^4*a2^2*a3^3*a4^4*b1^2*b2^4*b3^3*b4^2 + 46*a1^2*a2^2*a3^3*a4^4*b1^4*b2^4*b3^3*b4^2 +
46*a1^3*a2^4*a3^2*a4^4*b1^3*b2^2*b3^4*b4^2 + 46*a1^4*a2^3*a3^2*a4^4*b1^2*b2^3*b3^4*b4^2 +
46*a1^2*a2^3*a3^2*a4^4*b1^4*b2^3*b3^4*b4^2 + 46*a1^3*a2^2*a3^2*a4^4*b1^3*b2^4*b3^4*b4^2 +
46*a1^4*a2^4*a3^4*a4^3*b1^2*b2^2*b3^2*b4^3 + 46*a1^2*a2^4*a3^4*a4^3*b1^4*b2^2*b3^2*b4^3 +
46*a1^4*a2^2*a3^4*a4^3*b1^2*b2^4*b3^2*b4^3 + 46*a1^2*a2^2*a3^4*a4^3*b1^4*b2^4*b3^2*b4^3 +
46*a1^4*a2^4*a3^2*a4^3*b1^2*b2^2*b3^4*b4^3 + 46*a1^2*a2^4*a3^2*a4^3*b1^4*b2^2*b3^4*b4^3 +
46*a1^4*a2^2*a3^2*a4^3*b1^2*b2^4*b3^4*b4^3 + 46*a1^2*a2^2*a3^2*a4^3*b1^4*b2^4*b3^4*b4^3 +
46*a1^3*a2^4*a3^4*a4^2*b1^3*b2^2*b3^2*b4^4 + 46*a1^4*a2^3*a3^4*a4^2*b1^2*b2^3*b3^2*b4^4 +
46*a1^2*a2^3*a3^4*a4^2*b1^4*b2^3*b3^2*b4^4 + 46*a1^3*a2^2*a3^4*a4^2*b1^3*b2^4*b3^2*b4^4 +
46*a1^4*a2^4*a3^3*a4^2*b1^2*b2^2*b3^3*b4^4 + 46*a1^2*a2^4*a3^3*a4^2*b1^4*b2^2*b3^3*b4^4 +
46*a1^4*a2^2*a3^3*a4^2*b1^2*b2^4*b3^3*b4^4 + 46*a1^2*a2^2*a3^3*a4^2*b1^4*b2^4*b3^3*b4^4 +
46*a1^3*a2^4*a3^2*a4^2*b1^3*b2^2*b3^4*b4^4 + 46*a1^4*a2^3*a3^2*a4^2*b1^2*b2^3*b3^4*b4^4 +
46*a1^2*a2^3*a3^2*a4^2*b1^4*b2^3*b3^4*b4^4 + 46*a1^3*a2^2*a3^2*a4^2*b1^3*b2^4*b3^4*b4^4

```
c461=sum(c46.find(a1^3*w0))
c461
c461.factor()
s461=-46*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^2*q3^2*q4^2
s461
#This is the sum of the terms with a1^3, its factorization, and its \
    substitution.
```

46*a1^3*a2^4*a3^4*a4^4*b1^3*b2^2*b3^2*b4^2 + 46*a1^3*a2^2*a3^4*a4^4*b1^3*b2^4*b3^2*b4^2 +
46*a1^3*a2^4*a3^2*a4^4*b1^3*b2^2*b3^4*b4^2 + 46*a1^3*a2^2*a3^2*a4^4*b1^3*b2^4*b3^4*b4^2 +
46*a1^3*a2^4*a3^4*a4^2*b1^3*b2^2*b3^2*b4^4 + 46*a1^3*a2^2*a3^4*a4^2*b1^3*b2^4*b3^2*b4^4 +
46*a1^3*a2^4*a3^2*a4^2*b1^3*b2^2*b3^4*b4^4 + 46*a1^3*a2^2*a3^2*a4^2*b1^3*b2^4*b3^4*b4^4
46*(a2^2 + b2^2)*(a3^2 + b3^2)*(a4^2 + b4^2)*a1^3*a2^2*a3^2*a4^2*b1^3*b2^2*b3^2*b4^2
-46*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^2*q3^2*q4^2

```
c462=sum(c46.find(a2^3*w0))
c462
c462.factor()
s462=-46*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2^3*q3^2*q4^2
s462
#This is the sum of the terms with a2^3, its factorization, and its \
    substitution.
```

46*a1^4*a2^3*a3^4*a4^4*b1^2*b2^3*b3^2*b4^2 + 46*a1^2*a2^3*a3^4*a4^4*b1^4*b2^3*b3^2*b4^2 +
46*a1^4*a2^3*a3^2*a4^4*b1^2*b2^3*b3^4*b4^2 + 46*a1^2*a2^3*a3^2*a4^4*b1^4*b2^3*b3^4*b4^2 +
46*a1^4*a2^3*a3^4*a4^2*b1^2*b2^3*b3^2*b4^4 + 46*a1^2*a2^3*a3^4*a4^2*b1^4*b2^3*b3^2*b4^4 +
46*a1^4*a2^3*a3^2*a4^2*b1^2*b2^3*b3^4*b4^4 + 46*a1^2*a2^3*a3^2*a4^2*b1^4*b2^3*b3^4*b4^4
46*(a1^2 + b1^2)*(a3^2 + b3^2)*(a4^2 + b4^2)*a1^2*a2^3*a3^2*a4^2*b1^2*b2^3*b3^2*b4^2
-46*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2^3*q3^2*q4^2

```
c463=sum(c46.find(a3^3*w0))
c463
c463.factor()
s463=-46*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^2*q2^2*q3^3*q4^2
s463
#This is the sum of the terms with a3^3, its factorization, and its \
    substitution.
```

46*a1^4*a2^4*a3^3*a4^4*b1^2*b2^2*b3^3*b4^2 + 46*a1^2*a2^4*a3^3*a4^4*b1^4*b2^2*b3^3*b4^2 +
46*a1^4*a2^2*a3^3*a4^4*b1^2*b2^4*b3^3*b4^2 + 46*a1^2*a2^2*a3^3*a4^4*b1^4*b2^4*b3^3*b4^2 +
46*a1^4*a2^4*a3^3*a4^2*b1^2*b2^2*b3^3*b4^4 + 46*a1^2*a2^4*a3^3*a4^2*b1^4*b2^2*b3^3*b4^4 +
46*a1^4*a2^2*a3^3*a4^2*b1^2*b2^4*b3^3*b4^4 + 46*a1^2*a2^2*a3^3*a4^2*b1^4*b2^4*b3^3*b4^4
46*(a1^2 + b1^2)*(a2^2 + b2^2)*(a4^2 + b4^2)*a1^2*a2^2*a3^3*a4^2*b1^2*b2^2*b3^3*b4^2
-46*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^2*q2^2*q3^3*q4^2

```
c464=sum(c46.find(a4^3*w0))
c464
```

```
c464.factor()
s464=-46*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^2*q2^2*q3^2*q4^3
s464
```
#This is the sum of the terms with a4^3, its factorization, and its \
    substitution.
```
46*a1^4*a2^4*a3^4*a4^3*b1^2*b2^2*b3^2*b4^3 + 46*a1^2*a2^4*a3^4*a4^3*b1^4*b2^2*b3^2*b4^3 +
46*a1^4*a2^2*a3^4*a4^3*b1^2*b2^4*b3^2*b4^3 + 46*a1^2*a2^2*a3^4*a4^3*b1^4*b2^4*b3^2*b4^3 +
46*a1^4*a2^4*a3^2*a4^3*b1^2*b2^2*b3^4*b4^3 + 46*a1^2*a2^4*a3^2*a4^3*b1^4*b2^2*b3^4*b4^3 +
46*a1^4*a2^2*a3^2*a4^3*b1^2*b2^4*b3^4*b4^3 + 46*a1^2*a2^2*a3^2*a4^3*b1^4*b2^4*b3^4*b4^3
46*(a1^2 + b1^2)*(a2^2 + b2^2)*(a3^2 + b3^2)*a1^2*a2^2*a3^2*a4^3*b1^2*b2^2*b3^2*b4^3
-46*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^2*q2^2*q3^2*q4^3
```

```
bool(c46==c461+c462+c463+c464)
```
#This is a check to make sure as we seperated the groups we used every term in \
    c46 once and only once.
```
True
```

```
l46=s461+s462+s463+s464
l46
l046=l46(p1=a1+b1, p2=a2+b2, p3=a3+b3, p4=a4+b4, q1=-1*a1*b1, q2=-1*a2*b2, q3\
    =-1*a3*b3, q4=-1*a4*b4)
bool(l046==c46)
```
#This line brings all the group substitutions we created for c46 back into one \
    expression and checks to make sure that when back substitute we end up with \
    c46.
```
-46*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^2*q3^2*q4^2 - 46*(p1^2 + 2*q1)*(p3^2
+ 2*q3)*(p4^2 + 2*q4)*q1^2*q2^3*q3^2*q4^2 - 46*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 +
2*q4)*q1^2*q2^2*q3^3*q4^2 - 46*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 +
2*q3)*q1^2*q2^2*q3^2*q4^3
True
```

```
c70=sum(f10.find(70*w0))
c70
```
#This finds all our terms in f10 that have a 70 in them and then adds them \
    together. The groups we form will have two of the four a variables to the \
    third power.
```
70*a1^3*a2^3*a3^4*a4^4*b1^3*b2^3*b3^2*b4^2 + 70*a1^3*a2^4*a3^3*a4^4*b1^3*b2^2*b3^3*b4^2 +
70*a1^4*a2^3*a3^3*a4^4*b1^2*b2^3*b3^3*b4^2 + 70*a1^2*a2^3*a3^3*a4^4*b1^4*b2^3*b3^3*b4^2 +
70*a1^3*a2^2*a3^3*a4^4*b1^3*b2^4*b3^3*b4^2 + 70*a1^3*a2^3*a3^2*a4^4*b1^3*b2^3*b3^4*b4^2 +
70*a1^3*a2^4*a3^4*a4^3*b1^3*b2^2*b3^2*b4^3 + 70*a1^4*a2^3*a3^4*a4^3*b1^2*b2^3*b3^2*b4^3 +
70*a1^2*a2^3*a3^4*a4^3*b1^4*b2^3*b3^2*b4^3 + 70*a1^3*a2^2*a3^4*a4^3*b1^3*b2^4*b3^2*b4^3 +
70*a1^4*a2^4*a3^3*a4^3*b1^2*b2^2*b3^3*b4^3 + 70*a1^2*a2^4*a3^3*a4^3*b1^4*b2^2*b3^3*b4^3 +
70*a1^4*a2^2*a3^3*a4^3*b1^2*b2^4*b3^3*b4^3 + 70*a1^2*a2^2*a3^3*a4^3*b1^4*b2^4*b3^3*b4^3 +
70*a1^3*a2^4*a3^2*a4^3*b1^3*b2^2*b3^4*b4^3 + 70*a1^4*a2^3*a3^2*a4^3*b1^2*b2^3*b3^4*b4^3 +
70*a1^2*a2^3*a3^2*a4^3*b1^4*b2^3*b3^4*b4^3 + 70*a1^3*a2^2*a3^2*a4^3*b1^3*b2^4*b3^4*b4^3 +
70*a1^3*a2^3*a3^4*a4^2*b1^3*b2^3*b3^2*b4^4 + 70*a1^3*a2^4*a3^3*a4^2*b1^3*b2^2*b3^3*b4^4 +
70*a1^4*a2^3*a3^3*a4^2*b1^2*b2^3*b3^3*b4^4 + 70*a1^2*a2^3*a3^3*a4^2*b1^4*b2^3*b3^3*b4^4 +
70*a1^3*a2^2*a3^3*a4^2*b1^3*b2^4*b3^3*b4^4 + 70*a1^3*a2^3*a3^2*a4^2*b1^3*b2^3*b3^4*b4^4
```

```
c7012=sum(c70.find(a1^3*a2^3*w0))
c7012
c7012.factor()
s7012=70*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^3*q3^2*q4^2
s7012
```
#This is the sum of the terms with a1^3 and a2^3, its factorization, and its \
    substitution.
```
70*a1^3*a2^3*a3^4*a4^4*b1^3*b2^3*b3^2*b4^2 + 70*a1^3*a2^3*a3^2*a4^4*b1^3*b2^3*b3^4*b4^2 +
70*a1^3*a2^3*a3^4*a4^2*b1^3*b2^3*b3^2*b4^4 + 70*a1^3*a2^3*a3^2*a4^2*b1^3*b2^3*b3^4*b4^4
70*(a3^2 + b3^2)*(a4^2 + b4^2)*a1^3*a2^3*a3^2*a4^2*b1^3*b2^3*b3^2*b4^2
70*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^3*q3^2*q4^2
```

```
c7013=sum(c70.find(a1^3*a3^3*w0))
c7013
c7013.factor()
s7013=70*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^3*q2^2*q3^3*q4^2
s7013
#This is the sum of the terms with a1^3 and a3^3, its factorization, and its \
    substitution.
70*a1^3*a2^4*a3^3*a4^4*b1^3*b2^2*b3^3*b4^2 + 70*a1^3*a2^2*a3^3*a4^4*b1^3*b2^4*b3^3*b4^2 +
70*a1^3*a2^4*a3^3*a4^2*b1^3*b2^2*b3^3*b4^4 + 70*a1^3*a2^2*a3^3*a4^2*b1^3*b2^4*b3^3*b4^4
70*(a2^2 + b2^2)*(a4^2 + b4^2)*a1^3*a2^2*a3^3*a4^2*b1^3*b2^2*b3^3*b4^2
70*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^3*q2^2*q3^3*q4^2


c7014=sum(c70.find(a1^3*a4^3*w0))
c7014
c7014.factor()
s7014=70*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^3*q2^2*q3^2*q4^3
s7014
#This is the sum of the terms with a1^3 and a4^3, its factorization, and its \
    substitution.
70*a1^3*a2^4*a3^4*a4^3*b1^3*b2^2*b3^2*b4^3 + 70*a1^3*a2^2*a3^4*a4^3*b1^3*b2^4*b3^2*b4^3 +
70*a1^3*a2^4*a3^2*a4^3*b1^3*b2^2*b3^4*b4^3 + 70*a1^3*a2^2*a3^2*a4^3*b1^3*b2^4*b3^4*b4^3
70*(a2^2 + b2^2)*(a3^2 + b3^2)*a1^3*a2^2*a3^2*a4^3*b1^3*b2^2*b3^2*b4^3
70*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^3*q2^2*q3^2*q4^3


c7023=sum(c70.find(a2^3*a3^3*w0))
c7023
c7023.factor()
s7023=70*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2^3*q3^3*q4^2
s7023
#This is the sum of the terms with a2^3 and a3^3, its factorization, and its \
    substitution.
70*a1^4*a2^3*a3^3*a4^4*b1^2*b2^3*b3^3*b4^2 + 70*a1^2*a2^3*a3^3*a4^4*b1^4*b2^3*b3^3*b4^2 +
70*a1^4*a2^3*a3^3*a4^2*b1^2*b2^3*b3^3*b4^4 + 70*a1^2*a2^3*a3^3*a4^2*b1^4*b2^3*b3^3*b4^4
70*(a1^2 + b1^2)*(a4^2 + b4^2)*a1^2*a2^3*a3^3*a4^2*b1^2*b2^3*b3^3*b4^2
70*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2^3*q3^3*q4^2


c7024=sum(c70.find(a2^3*a4^3*w0))
c7024
c7024.factor()
s7024=70*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2^3*q3^2*q4^3
s7024
#This is the sum of the terms with a2^3 and a4^3, its factorization, and its \
    substitution.
70*a1^4*a2^3*a3^4*a4^3*b1^2*b2^3*b3^2*b4^3 + 70*a1^2*a2^3*a3^4*a4^3*b1^4*b2^3*b3^2*b4^3 +
70*a1^4*a2^3*a3^2*a4^3*b1^2*b2^3*b3^4*b4^3 + 70*a1^2*a2^3*a3^2*a4^3*b1^4*b2^3*b3^4*b4^3
70*(a1^2 + b1^2)*(a3^2 + b3^2)*a1^2*a2^3*a3^2*a4^3*b1^2*b2^3*b3^2*b4^3
70*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2^3*q3^2*q4^3


c7034=sum(c70.find(a3^3*a4^3*w0))
c7034
c7034.factor()
s7034=70*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q2^2*q3^3*q4^3
s7034
#This is the sum of the terms with a3^3 and a4^3, its factorization, and its \
    substitution.
70*a1^4*a2^4*a3^3*a4^3*b1^2*b2^2*b3^3*b4^3 + 70*a1^2*a2^4*a3^3*a4^3*b1^4*b2^2*b3^3*b4^3 +
70*a1^4*a2^2*a3^3*a4^3*b1^2*b2^4*b3^3*b4^3 + 70*a1^2*a2^2*a3^3*a4^3*b1^4*b2^4*b3^3*b4^3
70*(a1^2 + b1^2)*(a2^2 + b2^2)*a1^2*a2^2*a3^3*a4^3*b1^2*b2^2*b3^3*b4^3
70*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q2^2*q3^3*q4^3


bool(c70==c7012+c7013+c7014+c7023+c7024+c7034)
```

True

l70=s7012+s7013+s7014+s7023+s7024+s7034
l70
l070=l70(p1=a1+b1, p2=a2+b2, p3=a3+b3, p4=a4+b4, q1=-1*a1*b1, q2=-1*a2*b2, q3\
    =-1*a3*b3, q4=-1*a4*b4)
bool(l070==c70)
#This line brings all the group substitutions we created for c70 back into one \
    expression and checks to make sure that when back substitute we end up with \
    c70.
70*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^3*q3^2*q4^2 + 70*(p2^2 + 2*q2)*(p4^2 +
2*q4)*q1^3*q2^2*q3^3*q4^2 + 70*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2^3*q3^3*q4^2 + 70*(p2^2
+ 2*q2)*(p3^2 + 2*q3)*q1^3*q2^2*q3^2*q4^3 + 70*(p1^2 + 2*q1)*(p3^2 +
2*q3)*q1^2*q2^3*q3^2*q4^3 + 70*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q2^2*q3^3*q4^3
True


c104=sum(f10.find(104*w0))
c104
#This finds all our terms in f10 that have a 104 in them and then adds them \
    together. The groups we form will have one of the four a variables or its \
    corresponding b variable to the forth power.
104*a1^3*a2^3*a3^3*a4^4*b1^3*b2^3*b3^3*b4^2 + 104*a1^3*a2^3*a3^4*a4^3*b1^3*b2^3*b3^2*b4^3
+ 104*a1^3*a2^4*a3^3*a4^3*b1^3*b2^2*b3^3*b4^3 +
104*a1^4*a2^3*a3^3*a4^3*b1^2*b2^3*b3^3*b4^3 + 104*a1^2*a2^3*a3^3*a4^3*b1^4*b2^3*b3^3*b4^3
+ 104*a1^3*a2^2*a3^3*a4^3*b1^3*b2^4*b3^3*b4^3 +
104*a1^3*a2^3*a3^2*a4^3*b1^3*b2^3*b3^4*b4^3 + 104*a1^3*a2^3*a3^3*a4^2*b1^3*b2^3*b3^3*b4^4

c1041=sum(c104.find(a1^4*w0))+sum(c104.find(b1^4*w0))
c1041
c1041.factor()
s1041=-104*(p1^2 + 2*q1)*q1^2*q2^3*q3^3*q4^3
s1041
#This is the sum of the terms with either a1^4 or b1^4, its factorization, and \
    its substitution.
104*a1^4*a2^3*a3^3*a4^3*b1^2*b2^3*b3^3*b4^3 + 104*a1^2*a2^3*a3^3*a4^3*b1^4*b2^3*b3^3*b4^3
104*(a1^2 + b1^2)*a1^2*a2^3*a3^3*a4^3*b1^2*b2^3*b3^3*b4^3
-104*(p1^2 + 2*q1)*q1^2*q2^3*q3^3*q4^3

c1042=sum(c104.find(a2^4*w0))+sum(c104.find(b2^4*w0))
c1042
c1042.factor()
s1042=-104*(p2^2 + 2*q2)*q1^3*q2^2*q3^3*q4^3
s1042
#This is the sum of the terms with either a2^4 or b2^4, its factorization, and \
    its substitution.
104*a1^3*a2^4*a3^3*a4^3*b1^3*b2^2*b3^3*b4^3 + 104*a1^3*a2^2*a3^3*a4^3*b1^3*b2^4*b3^3*b4^3
104*(a2^2 + b2^2)*a1^3*a2^2*a3^3*a4^3*b1^3*b2^2*b3^3*b4^3
-104*(p2^2 + 2*q2)*q1^3*q2^2*q3^3*q4^3

c1043=sum(c104.find(a3^4*w0))+sum(c104.find(b3^4*w0))
c1043
c1043.factor()
s1043=-104*(p3^2 + 2*q3)*q1^3*q2^3*q3^2*q4^3
s1043
#This is the sum of the terms with either a3^4 or b3^4, its factorization, and \
    its substitution.
104*a1^3*a2^3*a3^4*a4^3*b1^3*b2^3*b3^2*b4^3 + 104*a1^3*a2^3*a3^2*a4^3*b1^3*b2^3*b3^4*b4^3
104*(a3^2 + b3^2)*a1^3*a2^3*a3^2*a4^3*b1^3*b2^3*b3^2*b4^3

-104*(p3^2 + 2*q3)*q1^3*q2^3*q3^2*q4^3

```
c1044=sum(c104.find(a4^4*w0))+sum(c104.find(b4^4*w0))
c1044
c1044.factor()
s1044=-104*(p4^2 + 2*q4)*q1^3*q2^3*q3^3*q4^2
s1044
```
#This is the sum of the terms with either a4^4 or b4^4, its factorization, and \
    its substitution.
104*a1^3*a2^3*a3^3*a4^4*b1^3*b2^3*b3^3*b4^2 + 104*a1^3*a2^3*a3^3*a4^2*b1^3*b2^3*b3^3*b4^4
104*(a4^2 + b4^2)*a1^3*a2^3*a3^3*a4^2*b1^3*b2^3*b3^3*b4^2
-104*(p4^2 + 2*q4)*q1^3*q2^3*q3^3*q4^2

```
bool(c104==c1041+c1042+c1043+c1044)
```
#This is a check to make sure as we seperated the groups we used every term in \
    c104 once and only once.
True

```
l104=s1041+s1042+s1043+s1044
l104
l0104=l104(p1=a1+b1, p2=a2+b2, p3=a3+b3, p4=a4+b4, q1=-1*a1*b1, q2=-1*a2*b2, q3\
    =-1*a3*b3, q4=-1*a4*b4)
bool(l0104==c104)
```
#This line brings all the group substitutions we created for c104 back into one\
     expression and checks to make sure that when back substitute we end up with\
     c104.
-104*(p4^2 + 2*q4)*q1^3*q2^3*q3^3*q4^2 - 104*(p3^2 + 2*q3)*q1^3*q2^3*q3^2*q4^3 - 104*(p2^2
+ 2*q2)*q1^3*q2^2*q3^3*q4^3 - 104*(p1^2 + 2*q1)*q1^2*q2^3*q3^3*q4^3
True

```
c152=sum(f10.find(152*w0))
c152
s152=152*q1^3*q2^3*q3^3*q4^3
s152
```
#This finds all our terms in f10 that have a 152 in them and then adds them \
    together, its factorization, and its substitution.
152*a1^3*a2^3*a3^3*a4^3*b1^3*b2^3*b3^3*b4^3
152*q1^3*q2^3*q3^3*q4^3

```
l152=s152
l152
l0152=l152(p1=a1+b1, p2=a2+b2, p3=a3+b3, p4=a4+b4, q1=-1*a1*b1, q2=-1*a2*b2, q3\
    =-1*a3*b3, q4=-1*a4*b4)
bool(l0152==c152)
```
#This line brings all the group substitutions we created for c152 back into one\
     expression and checks to make sure that when back substitute we end up with\
     c152.
152*q1^3*q2^3*q3^3*q4^3
True

```
c1=f10 - c2 - c4 - c7 - c12 - c20 - c28 - c32 - c46 - c70 - c104 - c152
c1
```
#This finds all our terms in f11 that have a 1 in them and then adds them \
    together. The first groups we form willhave one of the four a variables to \
    the third power and either a second a variable or its corresponding b \
    variable to the sixth power.
a1^3*a2^4*a3^4*a4^6*b1^3*b2^2*b3^2 + a1^4*a2^3*a3^4*a4^6*b1^2*b2^3*b3^2 +
a1^2*a2^3*a3^4*a4^6*b1^4*b2^3*b3^2 + a1^3*a2^2*a3^4*a4^6*b1^3*b2^4*b3^2 +
a1^4*a2^4*a3^3*a4^6*b1^2*b2^2*b3^3 + a1^2*a2^4*a3^3*a4^6*b1^4*b2^2*b3^3 +
a1^4*a2^2*a3^3*a4^6*b1^2*b2^4*b3^3 + a1^2*a2^2*a3^3*a4^6*b1^4*b2^4*b3^3 +

a1^3*a2^4*a3^2*a4^6*b1^3*b2^2*b3^4 + a1^4*a2^3*a3^2*a4^6*b1^2*b2^3*b3^4 +
a1^2*a2^3*a3^2*a4^6*b1^4*b2^3*b3^4 + a1^3*a2^2*a3^2*a4^6*b1^3*b2^4*b3^4 +
a1^4*a2^4*a3^5*a4^5*b1^2*b2^2*b3*b4 + a1^2*a2^4*a3^5*a4^5*b1^4*b2^2*b3*b4 +
a1^4*a2^2*a3^5*a4^5*b1^2*b2^4*b3*b4 + a1^2*a2^2*a3^5*a4^5*b1^4*b2^4*b3*b4 +
a1^4*a2^5*a3^4*a4^5*b1^2*b2*b3^2*b4 + a1^2*a2^5*a3^4*a4^5*b1^4*b2*b3^2*b4 +
a1^5*a2^4*a3^4*a4^5*b1*b2^2*b3^2*b4 + a1*a2^4*a3^4*a4^5*b1^5*b2^2*b3^2*b4 +
a1^5*a2^2*a3^4*a4^5*b1*b2^4*b3^2*b4 + a1*a2^2*a3^4*a4^5*b1^5*b2^4*b3^2*b4 +
a1^4*a2*a3^4*a4^5*b1^2*b2^5*b3^2*b4 + a1^2*a2*a3^4*a4^5*b1^4*b2^5*b3^2*b4 +
a1^4*a2^5*a3^2*a4^5*b1^2*b2*b3^4*b4 + a1^2*a2^5*a3^2*a4^5*b1^4*b2*b3^4*b4 +
a1^5*a2^4*a3^2*a4^5*b1*b2^2*b3^4*b4 + a1*a2^4*a3^2*a4^5*b1^5*b2^2*b3^4*b4 +
a1^5*a2^2*a3^2*a4^5*b1*b2^4*b3^4*b4 + a1*a2^2*a3^2*a4^5*b1^5*b2^4*b3^4*b4 +
a1^4*a2*a3^2*a4^5*b1^2*b2^5*b3^4*b4 + a1^2*a2*a3^2*a4^5*b1^4*b2^5*b3^4*b4 +
a1^4*a2^4*a3*a4^5*b1^2*b2^2*b3^5*b4 + a1^2*a2^4*a3*a4^5*b1^4*b2^2*b3^5*b4 +
a1^4*a2^2*a3*a4^5*b1^2*b2^4*b3^5*b4 + a1^2*a2^2*a3*a4^5*b1^4*b2^4*b3^5*b4 +
a1^3*a2^4*a3^6*a4^4*b1^3*b2^2*b4^2 + a1^4*a2^3*a3^6*a4^4*b1^2*b2^3*b4^2 +
a1^2*a2^3*a3^6*a4^4*b1^4*b2^3*b4^2 + a1^3*a2^2*a3^6*a4^4*b1^3*b2^4*b4^2 +
a1^4*a2^5*a3^5*a4^4*b1^2*b2*b3*b4^2 + a1^2*a2^5*a3^5*a4^4*b1^4*b2*b3*b4^2 +
a1^5*a2^4*a3^5*a4^4*b1*b2^2*b3*b4^2 + a1*a2^4*a3^5*a4^4*b1^5*b2^2*b3*b4^2 +
a1^5*a2^2*a3^5*a4^4*b1*b2^4*b3*b4^2 + a1*a2^2*a3^5*a4^4*b1^5*b2^4*b3*b4^2 +
a1^4*a2*a3^5*a4^4*b1^2*b2^5*b3*b4^2 + a1^2*a2*a3^5*a4^4*b1^4*b2^5*b3*b4^2 +
a1^3*a2^6*a3^4*a4^4*b1^3*b3^2*b4^2 + a1^5*a2^5*a3^4*a4^4*b1*b2*b3^2*b4^2 +
a1*a2^5*a3^4*a4^4*b1^5*b2*b3^2*b4^2 + a1^6*a2^3*a3^4*a4^4*b2^3*b3^2*b4^2 +
a2^3*a3^4*a4^4*b1^6*b2^3*b3^2*b4^2 + a1^5*a2*a3^4*a4^4*b1*b2^5*b3^2*b4^2 +
a1*a2*a3^4*a4^4*b1^5*b2^5*b3^2*b4^2 + a1^3*a3^4*a4^4*b1^3*b2^6*b3^2*b4^2 +
a1^4*a2^6*a3^3*a4^4*b1^2*b3^3*b4^2 + a1^2*a2^6*a3^3*a4^4*b1^4*b3^3*b4^2 +
a1^6*a2^4*a3^3*a4^4*b2^2*b3^3*b4^2 + a2^4*a3^3*a4^4*b1^6*b2^2*b3^3*b4^2 +
a1^6*a2^2*a3^3*a4^4*b2^4*b3^3*b4^2 + a2^2*a3^3*a4^4*b1^6*b2^4*b3^3*b4^2 +
a1^4*a3^3*a4^4*b1^2*b2^6*b3^3*b4^2 + a1^2*a3^3*a4^4*b1^4*b2^6*b3^3*b4^2 +
a1^3*a2^6*a3^2*a4^4*b1^3*b3^4*b4^2 + a1^5*a2^5*a3^2*a4^4*b1*b2*b3^4*b4^2 +
a1*a2^5*a3^2*a4^4*b1^5*b2*b3^4*b4^2 + a1^6*a2^3*a3^2*a4^4*b2^3*b3^4*b4^2 +
a2^3*a3^2*a4^4*b1^6*b2^3*b3^4*b4^2 + a1^5*a2*a3^2*a4^4*b1*b2^5*b3^4*b4^2 +
a1*a2*a3^2*a4^4*b1^5*b2^5*b3^4*b4^2 + a1^3*a3^2*a4^4*b1^3*b2^6*b3^4*b4^2 +
a1^4*a2^5*a3*a4^4*b1^2*b2*b3^5*b4^2 + a1^2*a2^5*a3*a4^4*b1^4*b2*b3^5*b4^2 +
a1^5*a2^4*a3*a4^4*b1*b2^2*b3^5*b4^2 + a1*a2^4*a3*a4^4*b1^5*b2^2*b3^5*b4^2 +
a1^5*a2^2*a3*a4^4*b1*b2^4*b3^5*b4^2 + a1*a2^2*a3*a4^4*b1^5*b2^4*b3^5*b4^2 +
a1^4*a2*a3*a4^4*b1^2*b2^5*b3^5*b4^2 + a1^2*a2*a3*a4^4*b1^4*b2^5*b3^5*b4^2 +
a1^3*a2^4*a4^4*b1^3*b2^2*b3^6*b4^2 + a1^4*a2^3*a4^4*b1^2*b2^3*b3^6*b4^2 +
a1^2*a2^3*a4^4*b1^4*b2^3*b3^6*b4^2 + a1^3*a2^2*a4^4*b1^3*b2^4*b3^6*b4^2 +
a1^4*a2^4*a3^6*a4^3*b1^2*b2^2*b4^3 + a1^2*a2^4*a3^6*a4^3*b1^4*b2^2*b4^3 +
a1^4*a2^2*a3^6*a4^3*b1^2*b2^4*b4^3 + a1^2*a2^2*a3^6*a4^3*b1^4*b2^4*b4^3 +
a1^4*a2^6*a3^4*a4^3*b1^2*b3^2*b4^3 + a1^2*a2^6*a3^4*a4^3*b1^4*b3^2*b4^3 +
a1^6*a2^4*a3^4*a4^3*b2^2*b3^2*b4^3 + a2^4*a3^4*a4^3*b1^6*b2^2*b3^2*b4^3 +
a1^6*a2^2*a3^4*a4^3*b2^4*b3^2*b4^3 + a2^2*a3^4*a4^3*b1^6*b2^4*b3^2*b4^3 +
a1^4*a3^4*a4^3*b1^2*b2^6*b3^2*b4^3 + a1^2*a3^4*a4^3*b1^4*b2^6*b3^2*b4^3 +
a1^4*a2^6*a3^2*a4^3*b1^2*b3^4*b4^3 + a1^2*a2^6*a3^2*a4^3*b1^4*b3^4*b4^3 +
a1^6*a2^4*a3^2*a4^3*b2^2*b3^4*b4^3 + a2^4*a3^2*a4^3*b1^6*b2^2*b3^4*b4^3 +
a1^6*a2^2*a3^2*a4^3*b2^4*b3^4*b4^3 + a2^2*a3^2*a4^3*b1^6*b2^4*b3^4*b4^3 +
a1^4*a3^2*a4^3*b1^2*b2^6*b3^4*b4^3 + a1^2*a3^2*a4^3*b1^4*b2^6*b3^4*b4^3 +
a1^4*a2^4*a4^3*b1^2*b2^2*b3^6*b4^3 + a1^2*a2^4*a4^3*b1^4*b2^2*b3^6*b4^3 +
a1^4*a2^2*a4^3*b1^2*b2^4*b3^6*b4^3 + a1^2*a2^2*a4^3*b1^4*b2^4*b3^6*b4^3 +
a1^3*a2^4*a3^6*a4^2*b1^3*b2^2*b4^4 + a1^4*a2^3*a3^6*a4^2*b1^2*b2^3*b4^4 +
a1^2*a2^3*a3^6*a4^2*b1^4*b2^3*b4^4 + a1^3*a2^2*a3^6*a4^2*b1^3*b2^4*b4^4 +
a1^4*a2^5*a3^5*a4^2*b1^2*b2*b3*b4^4 + a1^2*a2^5*a3^5*a4^2*b1^4*b2*b3*b4^4 +
a1^5*a2^4*a3^5*a4^2*b1*b2^2*b3*b4^4 + a1*a2^4*a3^5*a4^2*b1^5*b2^2*b3*b4^4 +
a1^5*a2^2*a3^5*a4^2*b1*b2^4*b3*b4^4 + a1*a2^2*a3^5*a4^2*b1^5*b2^4*b3*b4^4 +
a1^4*a2*a3^5*a4^2*b1^2*b2^5*b3*b4^4 + a1^2*a2*a3^5*a4^2*b1^4*b2^5*b3*b4^4 +
a1^3*a2^6*a3^4*a4^2*b1^3*b3^2*b4^4 + a1^5*a2^5*a3^4*a4^2*b1*b2*b3^2*b4^4 +
a1*a2^5*a3^4*a4^2*b1^5*b2*b3^2*b4^4 + a1^6*a2^3*a3^4*a4^2*b2^3*b3^2*b4^4 +
a2^3*a3^4*a4^2*b1^6*b2^3*b3^2*b4^4 + a1^5*a2*a3^4*a4^2*b1*b2^5*b3^2*b4^4 +
a1*a2*a3^4*a4^2*b1^5*b2^5*b3^2*b4^4 + a1^3*a3^4*a4^2*b1^3*b2^6*b3^2*b4^4 +
a1^4*a2^6*a3^3*a4^2*b1^2*b3^3*b4^4 + a1^2*a2^6*a3^3*a4^2*b1^4*b3^3*b4^4 +

a1^6*a2^4*a3^3*a4^2*b2^2*b3^3*b4^4 + a2^4*a3^3*a4^2*b1^6*b2^2*b3^3*b4^4 +
a1^6*a2^2*a3^3*a4^2*b2^4*b3^3*b4^4 + a2^2*a3^3*a4^2*b1^6*b2^4*b3^3*b4^4 +
a1^4*a3^3*a4^2*b1^2*b2^6*b3^3*b4^4 + a1^2*a3^3*a4^2*b1^4*b2^6*b3^3*b4^4 +
a1^3*a2^6*a3^2*a4^2*b1^3*b3^4*b4^4 + a1^5*a2^5*a3^2*a4^2*b1*b2*b3^4*b4^4 +
a1*a2^5*a3^2*a4^2*b1^5*b2*b3^4*b4^4 + a1^6*a2^3*a3^2*a4^2*b2^3*b3^4*b4^4 +
a2^3*a3^2*a4^2*b1^6*b2^3*b3^4*b4^4 + a1^5*a2*a3^2*a4^2*b1*b2^5*b3^4*b4^4 +
a1*a2*a3^2*a4^2*b1^5*b2^5*b3^4*b4^4 + a1^3*a3^2*a4^2*b1^3*b2^6*b3^4*b4^4 +
a1^4*a2^5*a3*a4^2*b1^2*b2^2*b3^5*b4^4 + a1^2*a2^5*a3*a4^2*b1^4*b2^2*b3^5*b4^4 +
a1^5*a2^4*a3*a4^2*b1*b2^2*b3^5*b4^4 + a1*a2^4*a3*a4^2*b1^5*b2^2*b3^5*b4^4 +
a1^5*a2^2*a3*a4^2*b1*b2^4*b3^5*b4^4 + a1*a2^2*a3*a4^2*b1^5*b2^4*b3^5*b4^4 +
a1^4*a2*a3*a4^2*b1^2*b2^5*b3^5*b4^4 + a1^2*a2*a3*a4^2*b1^4*b2^5*b3^5*b4^4 +
a1^3*a2^4*a4^2*b1^3*b2^2*b3^6*b4^4 + a1^4*a2^3*a4^2*b1^2*b2^3*b3^6*b4^4 +
a1^2*a2^3*a4^2*b1^4*b2^3*b3^6*b4^4 + a1^3*a2^2*a4^2*b1^3*b2^4*b3^6*b4^4 +
a1^4*a2^4*a3^5*a4*b1^2*b2^2*b3*b4^5 + a1^2*a2^4*a3^5*a4*b1^4*b2^2*b3*b4^5 +
a1^4*a2^2*a3^5*a4*b1^2*b2^4*b3*b4^5 + a1^2*a2^2*a3^5*a4*b1^4*b2^4*b3*b4^5 +
a1^4*a2^5*a3^4*a4*b1^2*b2*b3^2*b4^5 + a1^2*a2^5*a3^4*a4*b1^4*b2*b3^2*b4^5 +
a1^5*a2^4*a3^4*a4*b1*b2^2*b3^2*b4^5 + a1*a2^4*a3^4*a4*b1^5*b2^2*b3^2*b4^5 +
a1^5*a2^2*a3^4*a4*b1*b2^4*b3^2*b4^5 + a1*a2^2*a3^4*a4*b1^5*b2^4*b3^2*b4^5 +
a1^4*a2*a3^4*a4*b1^2*b2^5*b3^2*b4^5 + a1^2*a2*a3^4*a4*b1^4*b2^5*b3^2*b4^5 +
a1^4*a2^5*a3^2*a4*b1^2*b2*b3^4*b4^5 + a1^2*a2^5*a3^2*a4*b1^4*b2*b3^4*b4^5 +
a1^5*a2^4*a3^2*a4*b1*b2^2*b3^4*b4^5 + a1*a2^4*a3^2*a4*b1^5*b2^2*b3^4*b4^5 +
a1^5*a2^2*a3^2*a4*b1*b2^4*b3^4*b4^5 + a1*a2^2*a3^2*a4*b1^5*b2^4*b3^4*b4^5 +
a1^4*a2*a3^2*a4*b1^2*b2^5*b3^4*b4^5 + a1^2*a2*a3^2*a4*b1^4*b2^5*b3^4*b4^5 +
a1^4*a2^4*a3*a4*b1^2*b2^2*b3^5*b4^5 + a1^2*a2^4*a3*a4*b1^4*b2^2*b3^5*b4^5 +
a1^4*a2^2*a3*a4*b1^2*b2^4*b3^5*b4^5 + a1^2*a2^2*a3*a4*b1^4*b2^4*b3^5*b4^5 +
a1^3*a2^4*a3^4*b1^3*b2^2*b3^2*b4^6 + a1^4*a2^3*a3^4*b1^2*b2^3*b3^2*b4^6 +
a1^2*a2^3*a3^4*b1^4*b2^3*b3^2*b4^6 + a1^3*a2^2*a3^4*b1^3*b2^4*b3^2*b4^6 +
a1^4*a2^4*a3^3*b1^2*b2^2*b3^3*b4^6 + a1^2*a2^4*a3^3*b1^4*b2^2*b3^3*b4^6 +
a1^4*a2^2*a3^3*b1^2*b2^4*b3^3*b4^6 + a1^2*a2^2*a3^3*b1^4*b2^4*b3^3*b4^6 +
a1^3*a2^4*a3^2*b1^3*b2^2*b3^4*b4^6 + a1^4*a2^3*a3^2*b1^2*b2^3*b3^4*b4^6 +
a1^2*a2^3*a3^2*b1^4*b2^3*b3^4*b4^6 + a1^3*a2^2*a3^2*b1^3*b2^4*b3^4*b4^6

c112=sum(c1.find(a1^3*a2^6*w0))+sum(c1.find(a1^3*b2^6*w0))
c112
c112.factor()
s112=-((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1\
    ^3*q3^2*q4^2
s112
#This is the sum of the terms with a1^3 and either a2^6 or b2^6, its \
    factorization, and its substitution.

c113=sum(c1.find(a1^3*a3^6*w0))+sum(c1.find(a1^3*b3^6*w0))
c113
c113.factor()
s113=-((p3^2 + 2*q3)^2 - 3*q3^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1\
    ^3*q2^2*q4^2
s113
#This is the sum of the terms with a1^3 and either a3^6 or b3^6, its \
    factorization, and its substitution.
a1^3*a2^4*a3^6*a4^4*b1^3*b2^2*b4^2 + a1^3*a2^2*a3^6*a4^4*b1^3*b2^4*b4^2 +
a1^3*a2^4*a4^4*b1^3*b2^2*b3^6*b4^2 + a1^3*a2^2*a4^4*b1^3*b2^4*b3^6*b4^2 +
a1^3*a2^4*a3^6*a4^2*b1^3*b2^2*b4^4 + a1^3*a2^2*a3^6*a4^2*b1^3*b2^4*b4^4 +
a1^3*a2^4*a4^2*b1^3*b2^2*b3^6*b4^4 + a1^3*a2^2*a4^2*b1^3*b2^4*b3^6*b4^4
(a3^4 - a3^2*b3^2 + b3^4)*(a2^2 + b2^2)*(a3^2 + b3^2)*(a4^2 +
b4^2)*a1^3*a2^2*a4^2*b1^3*b2^2*b4^2
-((p3^2 + 2*q3)^2 - 3*q3^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^2*q4^2

c114=sum(c1.find(a1^3*a4^6*w0))+sum(c1.find(a1^3*b4^6*w0))
c114
c114.factor()

s114=-((p4^2 + 2*q4)^2 - 3*q4^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1\
    ^3*q2^2*q3^2
s114
#This is the sum of the terms with a1^3 and either a4^6 or b4^6, its \
    factorization, and its substitution.
a1^3*a2^4*a3^4*a4^6*b1^3*b2^2*b3^2 + a1^3*a2^2*a3^4*a4^6*b1^3*b2^4*b3^2 +
a1^3*a2^4*a3^2*a4^6*b1^3*b2^2*b3^4 + a1^3*a2^2*a3^2*a4^6*b1^3*b2^4*b3^4 +
a1^3*a2^4*a3^4*b1^3*b2^2*b3^2*b4^6 + a1^3*a2^2*a3^4*b1^3*b2^4*b3^2*b4^6 +
a1^3*a2^4*a3^2*b1^3*b2^2*b3^4*b4^6 + a1^3*a2^2*a3^2*b1^3*b2^4*b3^4*b4^6
(a4^4 - a4^2*b4^2 + b4^4)*(a2^2 + b2^2)*(a3^2 + b3^2)*(a4^2 +
b4^2)*a1^3*a2^2*a3^2*b1^3*b2^2*b3^2
-((p4^2 + 2*q4)^2 - 3*q4^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^2*q3^2

c121=sum(c1.find(a2^3*a1^6*w0))+sum(c1.find(a2^3*b1^6*w0))
c121
c121.factor()
s121=-((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q2\
    ^3*q3^2*q4^2
s121
#This is the sum of the terms with a2^3 and either a1^6 or b1^6, its \
    factorization, and its substitution.
a1^6*a2^3*a3^4*a4^4*b2^3*b3^2*b4^2 + a2^3*a3^4*a4^4*b1^6*b2^3*b3^2*b4^2 +
a1^6*a2^3*a3^2*a4^4*b2^3*b3^4*b4^2 + a2^3*a3^2*a4^4*b1^6*b2^3*b3^4*b4^2 +
a1^6*a2^3*a3^4*a4^2*b2^3*b3^2*b4^4 + a2^3*a3^4*a4^2*b1^6*b2^3*b3^2*b4^4 +
a1^6*a2^3*a3^2*a4^2*b2^3*b3^4*b4^4 + a2^3*a3^2*a4^2*b1^6*b2^3*b3^4*b4^4
(a1^4 - a1^2*b1^2 + b1^4)*(a1^2 + b1^2)*(a3^2 + b3^2)*(a4^2 +
b4^2)*a2^3*a3^2*a4^2*b2^3*b3^2*b4^2
-((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q2^3*q3^2*q4^2

c123=sum(c1.find(a2^3*a3^6*w0))+sum(c1.find(a2^3*b3^6*w0))
c123
c123.factor()
s123=-((p3^2 + 2*q3)^2 - 3*q3^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1\
    ^2*q2^3*q4^2
s123
#This is the sum of the terms with a2^3 and either a3^6 or b3^6, its \
    factorization, and its substitution.
a1^4*a2^3*a3^6*a4^4*b1^2*b2^3*b4^2 + a1^2*a2^3*a3^6*a4^4*b1^4*b2^3*b4^2 +
a1^4*a2^3*a4^4*b1^2*b2^3*b3^6*b4^2 + a1^2*a2^3*a4^4*b1^4*b2^3*b3^6*b4^2 +
a1^4*a2^3*a3^6*a4^2*b1^2*b2^3*b4^4 + a1^2*a2^3*a3^6*a4^2*b1^4*b2^3*b4^4 +
a1^4*a2^3*a4^2*b1^2*b2^3*b3^6*b4^4 + a1^2*a2^3*a4^2*b1^4*b2^3*b3^6*b4^4
(a3^4 - a3^2*b3^2 + b3^4)*(a1^2 + b1^2)*(a3^2 + b3^2)*(a4^2 +
b4^2)*a1^2*a2^3*a4^2*b1^2*b2^3*b4^2
-((p3^2 + 2*q3)^2 - 3*q3^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2^3*q4^2

c124=sum(c1.find(a2^3*a4^6*w0))+sum(c1.find(a2^3*b4^6*w0))
c124
c124.factor()
s124=-((p4^2 + 2*q4)^2 - 3*q4^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1\
    ^2*q2^3*q3^2
s124
#This is the sum of the terms with a2^3 and either a4^6 or b4^6, its \
    factorization, and its substitution.
a1^4*a2^3*a3^4*a4^6*b1^2*b2^3*b3^2 + a1^2*a2^3*a3^4*a4^6*b1^4*b2^3*b3^2 +
a1^4*a2^3*a3^2*a4^6*b1^2*b2^3*b3^4 + a1^2*a2^3*a3^2*a4^6*b1^4*b2^3*b3^4 +
a1^4*a2^3*a3^4*b1^2*b2^3*b3^2*b4^6 + a1^2*a2^3*a3^4*b1^4*b2^3*b3^2*b4^6 +
a1^4*a2^3*a3^2*b1^2*b2^3*b3^4*b4^6 + a1^2*a2^3*a3^2*b1^4*b2^3*b3^4*b4^6
(a4^4 - a4^2*b4^2 + b4^4)*(a1^2 + b1^2)*(a3^2 + b3^2)*(a4^2 +
b4^2)*a1^2*a2^3*a3^2*b1^2*b2^3*b3^2
-((p4^2 + 2*q4)^2 - 3*q4^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2^3*q3^2

```
c131=sum(c1.find(a3^3*a1^6*w0))+sum(c1.find(a3^3*b1^6*w0))
c131
c131.factor()
s131=-((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q2\
    ^2*q3^3*q4^2
s131
```

$a1^6*a2^4*a3^3*a4^4*b2^2*b3^3*b4^2 + a2^4*a3^3*a4^4*b1^6*b2^2*b3^3*b4^2 +$
$a1^6*a2^2*a3^3*a4^4*b2^4*b3^3*b4^2 + a2^2*a3^3*a4^4*b1^6*b2^4*b3^3*b4^2 +$
$a1^6*a2^4*a3^3*a4^2*b2^2*b3^3*b4^4 + a2^4*a3^3*a4^2*b1^6*b2^2*b3^3*b4^4 +$
$a1^6*a2^2*a3^3*a4^2*b2^4*b3^3*b4^4 + a2^2*a3^3*a4^2*b1^6*b2^4*b3^3*b4^4$

$(a1^4 - a1^2*b1^2 + b1^4)*(a1^2 + b1^2)*(a2^2 + b2^2)*(a4^2 +$
$b4^2)*a2^2*a3^3*a4^2*b2^2*b3^3*b4^2$

$-((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q2^2*q3^3*q4^2$

```
c132=sum(c1.find(a3^3*a2^6*w0))+sum(c1.find(a3^3*b2^6*w0))
c132
c132.factor()
s132=-((p2^2 + 2*q2)^2 - 3*q2^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1\
    ^2*q3^3*q4^2
s132
```

$a1^4*a2^6*a3^3*a4^4*b1^2*b3^3*b4^2 + a1^2*a2^6*a3^3*a4^4*b1^4*b3^3*b4^2 +$
$a1^4*a3^3*a4^4*b1^2*b2^6*b3^3*b4^2 + a1^2*a3^3*a4^4*b1^4*b2^6*b3^3*b4^2 +$
$a1^4*a2^6*a3^3*a4^2*b1^2*b3^3*b4^4 + a1^2*a2^6*a3^3*a4^2*b1^4*b3^3*b4^4 +$
$a1^4*a3^3*a4^2*b1^2*b2^6*b3^3*b4^4 + a1^2*a3^3*a4^2*b1^4*b2^6*b3^3*b4^4$

$(a2^4 - a2^2*b2^2 + b2^4)*(a1^2 + b1^2)*(a2^2 + b2^2)*(a4^2 +$
$b4^2)*a1^2*a3^3*a4^2*b1^2*b3^3*b4^2$

$-((p2^2 + 2*q2)^2 - 3*q2^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^2*q3^3*q4^2$

```
c134=sum(c1.find(a3^3*a4^6*w0))+sum(c1.find(a3^3*b4^6*w0))
c134
c134.factor()
s134=-((p4^2 + 2*q4)^2 - 3*q4^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1\
    ^2*q2^2*q3^3
s134
```

$a1^4*a2^4*a3^3*a4^6*b1^2*b2^2*b3^3 + a1^2*a2^4*a3^3*a4^6*b1^4*b2^2*b3^3 +$
$a1^4*a2^2*a3^3*a4^6*b1^2*b2^4*b3^3 + a1^2*a2^2*a3^3*a4^6*b1^4*b2^4*b3^3 +$
$a1^4*a2^4*a3^3*b1^2*b2^2*b3^3*b4^6 + a1^2*a2^4*a3^3*b1^4*b2^2*b3^3*b4^6 +$
$a1^4*a2^2*a3^3*b1^2*b2^4*b3^3*b4^6 + a1^2*a2^2*a3^3*b1^4*b2^4*b3^3*b4^6$

$(a4^4 - a4^2*b4^2 + b4^4)*(a1^2 + b1^2)*(a2^2 + b2^2)*(a4^2 +$
$b4^2)*a1^2*a2^2*a3^3*b1^2*b2^2*b3^3$

$-((p4^2 + 2*q4)^2 - 3*q4^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^2*q2^2*q3^3$

```
c141=sum(c1.find(a4^3*a1^6*w0))+sum(c1.find(a4^3*b1^6*w0))
c141
c141.factor()
s141=-((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q2\
    ^2*q3^2*q4^3
s141
```

$a1^6*a2^4*a3^4*a4^3*b2^2*b3^2*b4^3 + a2^4*a3^4*a4^3*b1^6*b2^2*b3^2*b4^3 +$
$a1^6*a2^2*a3^4*a4^3*b2^4*b3^2*b4^3 + a2^2*a3^4*a4^3*b1^6*b2^4*b3^2*b4^3 +$
$a1^6*a2^4*a3^2*a4^3*b2^2*b3^4*b4^3 + a2^4*a3^2*a4^3*b1^6*b2^2*b3^4*b4^3 +$
$a1^6*a2^2*a3^2*a4^3*b2^4*b3^4*b4^3 + a2^2*a3^2*a4^3*b1^6*b2^4*b3^4*b4^3$

$(a1^4 - a1^2*b1^2 + b1^4)*(a1^2 + b1^2)*(a2^2 + b2^2)*(a3^2 +$

b3^2)*a2^2*a3^2*a4^3*b2^2*b3^2*b4^3

-((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q2^2*q3^2*q4^3

c142=sum(c1.find(a4^3*a2^6*w0))+sum(c1.find(a4^3*b2^6*w0))
c142
c142.factor()
s142=-((p2^2 + 2*q2)^2 - 3*q2^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1\
    ^2*q3^2*q4^3
s142
#This is the sum of the terms with a4^3 and either a2^6 or b2^6, its \
    factorization, and its substitution.

a1^4*a2^6*a3^4*a4^3*b1^2*b3^2*b4^3 + a1^2*a2^6*a3^4*a4^3*b1^4*b3^2*b4^3 +
a1^4*a3^4*a4^3*b1^2*b2^6*b3^2*b4^3 + a1^2*a3^4*a4^3*b1^4*b2^6*b3^2*b4^3 +
a1^4*a2^6*a3^2*a4^3*b1^2*b3^4*b4^3 + a1^2*a2^6*a3^2*a4^3*b1^4*b3^4*b4^3 +
a1^4*a3^2*a4^3*b1^2*b2^6*b3^4*b4^3 + a1^2*a3^2*a4^3*b1^4*b2^6*b3^4*b4^3

(a2^4 - a2^2*b2^2 + b2^4)*(a1^2 + b1^2)*(a2^2 + b2^2)*(a3^2 +
b3^2)*a1^2*a3^2*a4^3*b1^2*b3^2*b4^3

-((p2^2 + 2*q2)^2 - 3*q2^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^2*q3^2*q4^3

c143=sum(c1.find(a4^3*a3^6*w0))+sum(c1.find(a4^3*b3^6*w0))
c143
c143.factor()
s143=-((p3^2 + 2*q3)^2 - 3*q3^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1\
    ^2*q2^2*q4^3
s143
#This is the sum of the terms with a4^3 and either a3^6 or b3^6, its \
    factorization, and its substitution.

a1^4*a2^4*a3^6*a4^3*b1^2*b2^2*b4^3 + a1^2*a2^4*a3^6*a4^3*b1^4*b2^2*b4^3 +
a1^4*a2^2*a3^6*a4^3*b1^2*b2^4*b4^3 + a1^2*a2^2*a3^6*a4^3*b1^4*b2^4*b4^3 +
a1^4*a2^4*a4^3*b1^2*b2^2*b3^6*b4^3 + a1^2*a2^4*a4^3*b1^4*b2^2*b3^6*b4^3 +
a1^4*a2^2*a4^3*b1^2*b2^4*b3^6*b4^3 + a1^2*a2^2*a4^3*b1^4*b2^4*b3^6*b4^3

(a3^4 - a3^2*b3^2 + b3^4)*(a1^2 + b1^2)*(a2^2 + b2^2)*(a3^2 +
b3^2)*a1^2*a2^2*a4^3*b1^2*b2^2*b4^3

-((p3^2 + 2*q3)^2 - 3*q3^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^2*q2^2*q4^3

c01=c1 - c112 - c113 - c114 - c121 - c123 - c124 - c131 - c132 - c134 - c141 - c142 - c143
c01
#This gets all the terms from c1 that have not been assigned to a group. The \
    groups we form will have one of the four a variables or its corresponding b \
    variable to the forth power and either a second a variable or its \
    corresponding b variable to the forth power.

a1^4*a2^4*a3^5*a4^5*b1^2*b2^2*b3*b4 + a1^2*a2^4*a3^5*a4^5*b1^4*b2^2*b3*b4 +
a1^4*a2^2*a3^5*a4^5*b1^2*b2^4*b3*b4 + a1^2*a2^2*a3^5*a4^5*b1^4*b2^4*b3*b4 +
a1^4*a2^5*a3^4*a4^5*b1^2*b2*b3^2*b4 + a1^2*a2^5*a3^4*a4^5*b1^4*b2*b3^2*b4 +
a1^5*a2^4*a3^4*a4^5*b1*b2^2*b3^2*b4 + a1*a2^4*a3^4*a4^5*b1^5*b2^2*b3^2*b4 +
a1^5*a2^2*a3^4*a4^5*b1*b2^4*b3^2*b4 + a1*a2^2*a3^4*a4^5*b1^5*b2^4*b3^2*b4 +
a1^4*a2*a3^4*a4^5*b1^2*b2^5*b3^2*b4 + a1^2*a2*a3^4*a4^5*b1^4*b2^5*b3^2*b4 +
a1^4*a2^5*a3^2*a4^5*b1^2*b2*b3^4*b4 + a1^2*a2^5*a3^2*a4^5*b1^4*b2*b3^4*b4 +
a1^5*a2^4*a3^2*a4^5*b1*b2^2*b3^4*b4 + a1*a2^4*a3^2*a4^5*b1^5*b2^2*b3^4*b4 +
a1^5*a2^2*a3^2*a4^5*b1*b2^4*b3^4*b4 + a1*a2^2*a3^2*a4^5*b1^5*b2^4*b3^4*b4 +
a1^4*a2*a3^2*a4^5*b1^2*b2^5*b3^4*b4 + a1^2*a2*a3^2*a4^5*b1^4*b2^5*b3^4*b4 +
a1^4*a2^4*a3*a4^5*b1^2*b2^2*b3^5*b4 + a1^2*a2^4*a3*a4^5*b1^4*b2^2*b3^5*b4 +
a1^4*a2^2*a3*a4^5*b1^2*b2^4*b3^5*b4 + a1^2*a2^2*a3*a4^5*b1^4*b2^4*b3^5*b4 +
a1^4*a2^5*a3^5*a4^4*b1^2*b2*b3*b4^2 + a1^2*a2^5*a3^5*a4^4*b1^4*b2*b3*b4^2 +
a1^5*a2^4*a3^5*a4^4*b1*b2^2*b3*b4^2 + a1*a2^4*a3^5*a4^4*b1^5*b2^2*b3*b4^2 +
a1^5*a2^2*a3^5*a4^4*b1*b2^4*b3*b4^2 + a1*a2^2*a3^5*a4^4*b1^5*b2^4*b3*b4^2 +
a1^4*a2*a3^5*a4^4*b1^2*b2^5*b3*b4^2 + a1^2*a2*a3^5*a4^4*b1^4*b2^5*b3*b4^2 +
a1^5*a2^5*a3^4*a4^4*b1*b2*b3^2*b4^2 + a1*a2^5*a3^4*a4^4*b1^5*b2^5*b3^2*b4^2 +
a1^5*a2^5*a3^2*a4^4*b1*b2*b3^4*b4^2 + a1*a2^5*a3^2*a4^4*b1^5*b2*b3^4*b4^2 +
a1^5*a2*a3^2*a4^4*b1*b2^5*b3^4*b4^2 + a1*a2*a3^2*a4^4*b1^5*b2^5*b3^4*b4^2 +

a1^4*a2^5*a3*a4^4*b1^2*b2*b3^5*b4^2 + a1^2*a2^5*a3*a4^4*b1^4*b2*b3^5*b4^2 +
a1^5*a2^4*a3*a4^4*b1*b2^2*b3^5*b4^2 + a1*a2^4*a3*a4^4*b1^5*b2^2*b3^5*b4^2 +
a1^5*a2^2*a3*a4^4*b1*b2^4*b3^5*b4^2 + a1*a2^2*a3*a4^4*b1^5*b2^4*b3^5*b4^2 +
a1^4*a2*a3*a4^4*b1^2*b2^5*b3^5*b4^2 + a1^2*a2*a3*a4^4*b1^4*b2^5*b3^5*b4^2 +
a1^4*a2^5*a3^5*a4^2*b1^2*b2*b3*b4^4 + a1^2*a2^5*a3^5*a4^2*b1^4*b2*b3*b4^4 +
a1^5*a2^4*a3^5*a4^2*b1*b2^2*b3*b4^4 + a1*a2^4*a3^5*a4^2*b1^5*b2^2*b3*b4^4 +
a1^5*a2^2*a3^5*a4^2*b1*b2^4*b3*b4^4 + a1*a2^2*a3^5*a4^2*b1^5*b2^4*b3*b4^4 +
a1^4*a2*a3^5*a4^2*b1^2*b2^5*b3*b4^4 + a1^2*a2*a3^5*a4^2*b1^4*b2^5*b3*b4^4 +
a1^5*a2^5*a3^4*a4^2*b1*b2*b3^2*b4^4 + a1*a2^5*a3^4*a4^2*b1^5*b2*b3^2*b4^4 +
a1^5*a2*a3^4*a4^2*b1*b2^5*b3^2*b4^4 + a1*a2*a3^4*a4^2*b1^5*b2^5*b3^2*b4^4 +
a1^5*a2^5*a3^2*a4^2*b1*b2*b3^4*b4^4 + a1*a2^5*a3^2*a4^2*b1^5*b2*b3^4*b4^4 +
a1^5*a2*a3^2*a4^2*b1*b2^5*b3^4*b4^4 + a1*a2*a3^2*a4^2*b1^5*b2^5*b3^4*b4^4 +
a1^4*a2^5*a3*a4^2*b1^2*b2*b3^5*b4^4 + a1^2*a2^5*a3*a4^2*b1^4*b2*b3^5*b4^4 +
a1^5*a2^4*a3*a4^2*b1*b2^2*b3^5*b4^4 + a1*a2^4*a3*a4^2*b1^5*b2^2*b3^5*b4^4 +
a1^5*a2^2*a3*a4^2*b1*b2^4*b3^5*b4^4 + a1*a2^2*a3*a4^2*b1^5*b2^4*b3^5*b4^4 +
a1^4*a2*a3*a4^2*b1^2*b2^5*b3^5*b4^4 + a1^2*a2*a3*a4^2*b1^4*b2^5*b3^5*b4^4 +
a1^4*a2^4*a3^5*a4*b1^2*b2^2*b3*b4^5 + a1^2*a2^4*a3^5*a4*b1^4*b2^2*b3*b4^5 +
a1^4*a2^2*a3^5*a4*b1^2*b2^4*b3*b4^5 + a1^2*a2^2*a3^5*a4*b1^4*b2^4*b3*b4^5 +
a1^4*a2^5*a3^4*a4*b1^2*b2*b3^2*b4^5 + a1^2*a2^5*a3^4*a4*b1^4*b2*b3^2*b4^5 +
a1^5*a2^4*a3^4*a4*b1*b2^2*b3^2*b4^5 + a1*a2^4*a3^4*a4*b1^5*b2^2*b3^2*b4^5 +
a1^5*a2^2*a3^4*a4*b1*b2^4*b3^2*b4^5 + a1*a2^2*a3^4*a4*b1^5*b2^4*b3^2*b4^5 +
a1^4*a2*a3^4*a4*b1^2*b2^5*b3^2*b4^5 + a1^2*a2*a3^4*a4*b1^4*b2^5*b3^2*b4^5 +
a1^4*a2^5*a3^2*a4*b1^2*b2*b3^4*b4^5 + a1^2*a2^5*a3^2*a4*b1^4*b2*b3^4*b4^5 +
a1^5*a2^4*a3^2*a4*b1*b2^2*b3^4*b4^5 + a1*a2^4*a3^2*a4*b1^5*b2^2*b3^4*b4^5 +
a1^5*a2^2*a3^2*a4*b1*b2^4*b3^4*b4^5 + a1*a2^2*a3^2*a4*b1^5*b2^4*b3^4*b4^5 +
a1^4*a2*a3^2*a4*b1^2*b2^5*b3^4*b4^5 + a1^2*a2*a3^2*a4*b1^4*b2^5*b3^4*b4^5 +
a1^4*a2^4*a3*a4*b1^2*b2^2*b3^5*b4^5 + a1^2*a2^4*a3*a4*b1^4*b2^2*b3^5*b4^5 +
a1^4*a2^2*a3*a4*b1^2*b2^4*b3^5*b4^5 + a1^2*a2^2*a3*a4*b1^4*b2^4*b3^5*b4^5

```
c0112=sum(c01.find(a1^4*a2^4*w0))+sum(c01.find(a1^4*b2^4*w0))+sum(c01.find(b1\
    ^4*b2^4*w0))+sum(c01.find(b1^4*a2^4*w0))
c0112
c0112.factor()
s0112=((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p2^2\
    + 2*q2)*q1^2*q2^2*q3*q4
s0112
#This is the sum of the terms with either a1^4 or b1^4 and either a2^4 or b2^4,\
    its factorization, and its substitution.
```

a1^4*a2^4*a3^5*a4^5*b1^2*b2^2*b3*b4 + a1^2*a2^4*a3^5*a4^5*b1^4*b2^2*b3*b4 +
a1^4*a2^2*a3^5*a4^5*b1^2*b2^4*b3*b4 + a1^2*a2^2*a3^5*a4^5*b1^4*b2^4*b3*b4 +
a1^4*a2^4*a3*a4^5*b1^2*b2^2*b3^5*b4 + a1^2*a2^4*a3*a4^5*b1^4*b2^2*b3^5*b4 +
a1^4*a2^2*a3*a4^5*b1^2*b2^4*b3^5*b4 + a1^2*a2^2*a3*a4^5*b1^4*b2^4*b3^5*b4 +
a1^4*a2^4*a3^5*a4*b1^2*b2^2*b3*b4^5 + a1^2*a2^4*a3^5*a4*b1^4*b2^2*b3*b4^5 +
a1^4*a2^2*a3^5*a4*b1^2*b2^4*b3*b4^5 + a1^2*a2^2*a3^5*a4*b1^4*b2^4*b3*b4^5 +
a1^4*a2^4*a3*a4*b1^2*b2^2*b3^5*b4^5 + a1^2*a2^4*a3*a4*b1^4*b2^2*b3^5*b4^5 +
a1^4*a2^2*a3*a4*b1^2*b2^4*b3^5*b4^5 + a1^2*a2^2*a3*a4*b1^4*b2^4*b3^5*b4^5
(a3^4 + b3^4)*(a4^4 + b4^4)*(a1^2 + b1^2)*(a2^2 + b2^2)*a1^2*a2^2*a3*a4*b1^2*b2^2*b3*b4
((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p2^2 +
2*q2)*q1^2*q2^2*q3*q4

```
c0113=sum(c01.find(a1^4*a3^4*w0))+sum(c01.find(a1^4*b3^4*w0))+sum(c01.find(b1\
    ^4*b3^4*w0))+sum(c01.find(b1^4*a3^4*w0))
c0113
c0113.factor()
s0113=((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p3^2\
    + 2*q3)*q1^2*q2*q3^2*q4
s0113
#This is the sum of the terms with either a1^4 or b1^4 and either a3^4 or b3^4,\
    its factorization, and its substitution.
```

a1^4*a2^5*a3^4*a4^5*b1^2*b2*b3^2*b4 + a1^2*a2^5*a3^4*a4^5*b1^4*b2*b3^2*b4 +
a1^4*a2*a3^4*a4^5*b1^2*b2^5*b3^2*b4 + a1^2*a2*a3^4*a4^5*b1^4*b2^5*b3^2*b4 +

a1^4*a2^5*a3^2*a4^5*b1^2*b2*b3^4*b4 + a1^2*a2^5*a3^2*a4^5*b1^4*b2*b3^4*b4 +
a1^4*a2*a3^2*a4^5*b1^2*b2^5*b3^4*b4 + a1^2*a2*a3^2*a4^5*b1^4*b2^5*b3^4*b4 +
a1^4*a2^5*a3^4*a4*b1^2*b2*b3^2*b4^5 + a1^2*a2^5*a3^4*a4*b1^4*b2*b3^2*b4^5 +
a1^4*a2*a3^4*a4*b1^2*b2^5*b3^2*b4^5 + a1^2*a2*a3^4*a4*b1^4*b2^5*b3^2*b4^5 +
a1^4*a2^5*a3^2*a4*b1^2*b2*b3^4*b4^5 + a1^2*a2^5*a3^2*a4*b1^4*b2*b3^4*b4^5 +
a1^4*a2*a3^2*a4*b1^2*b2^5*b3^4*b4^5 + a1^2*a2*a3^2*a4*b1^4*b2^5*b3^4*b4^5
(a2^4 + b2^4)*(a4^4 + b4^4)*(a1^2 + b1^2)*(a3^2 + b3^2)*a1^2*a2*a3^2*a4*b1^2*b2*b3^2*b4
((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p3^2 +
2*q3)*q1^2*q2*q3^2*q4

c0114=sum(c01.find(a1^4*a4^4*w0))+sum(c01.find(a1^4*b4^4*w0))+sum(c01.find(b1\
    ^4*b4^4*w0))+sum(c01.find(b1^4*a4^4*w0))
c0114
c0114.factor()
s0114=((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*(p4^2\
    + 2*q4)*q1^2*q2*q3*q4^2
s0114
#This is the sum of the terms with either a1^4 or b1^4 and either a4^4 or b4^4,\
     its factorization, and its substitution.
a1^4*a2^5*a3^5*a4^4*b1^2*b2*b3*b4^2 + a1^2*a2^5*a3^5*a4^4*b1^4*b2*b3*b4^2 +
a1^4*a2*a3^5*a4^4*b1^2*b2^5*b3*b4^2 + a1^2*a2*a3^5*a4^4*b1^4*b2^5*b3*b4^2 +
a1^4*a2^5*a3*a4^4*b1^2*b2*b3^5*b4^2 + a1^2*a2^5*a3*a4^4*b1^4*b2*b3^5*b4^2 +
a1^4*a2*a3*a4^4*b1^2*b2^5*b3^5*b4^2 + a1^2*a2*a3*a4^4*b1^4*b2^5*b3^5*b4^2 +
a1^4*a2^5*a3^5*a4^2*b1^2*b2*b3*b4^4 + a1^2*a2^5*a3^5*a4^2*b1^4*b2*b3*b4^4 +
a1^4*a2*a3^5*a4^2*b1^2*b2^5*b3*b4^4 + a1^2*a2*a3^5*a4^2*b1^4*b2^5*b3*b4^4 +
a1^4*a2^5*a3*a4^2*b1^2*b2*b3^5*b4^4 + a1^2*a2^5*a3*a4^2*b1^4*b2*b3^5*b4^4 +
a1^4*a2*a3*a4^2*b1^2*b2^5*b3^5*b4^4 + a1^2*a2*a3*a4^2*b1^4*b2^5*b3^5*b4^4
(a2^4 + b2^4)*(a3^4 + b3^4)*(a1^2 + b1^2)*(a4^2 + b4^2)*a1^2*a2*a3*a4^2*b1^2*b2*b3*b4^2
((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*(p4^2 +
2*q4)*q1^2*q2*q3*q4^2

c0123=sum(c01.find(a2^4*a3^4*w0))+sum(c01.find(a2^4*b3^4*w0))+sum(c01.find(b2\
    ^4*b3^4*w0))+sum(c01.find(b2^4*a3^4*w0))
c0123
c0123.factor()
s0123=((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*(p3^2\
    + 2*q3)*q1*q2^2*q3^2*q4
s0123
#This is the sum of the terms with either a2^4 or b2^4 and either a3^4 or b3^4,\
     its factorization, and its substitution.
a1^5*a2^4*a3^4*a4^5*b1*b2^2*b3^2*b4 + a1*a2^4*a3^4*a4^5*b1^5*b2^2*b3^2*b4 +
a1^5*a2^2*a3^4*a4^5*b1*b2^4*b3^2*b4 + a1*a2^2*a3^4*a4^5*b1^5*b2^4*b3^2*b4 +
a1^5*a2^4*a3^2*a4^5*b1*b2^2*b3^4*b4 + a1*a2^4*a3^2*a4^5*b1^5*b2^2*b3^4*b4 +
a1^5*a2^2*a3^2*a4^5*b1*b2^4*b3^4*b4 + a1*a2^2*a3^2*a4^5*b1^5*b2^4*b3^4*b4 +
a1^5*a2^4*a3^4*a4*b1*b2^2*b3^2*b4^5 + a1*a2^4*a3^4*a4*b1^5*b2^2*b3^2*b4^5 +
a1^5*a2^2*a3^4*a4*b1*b2^4*b3^2*b4^5 + a1*a2^2*a3^4*a4*b1^5*b2^4*b3^2*b4^5 +
a1^5*a2^4*a3^2*a4*b1*b2^2*b3^4*b4^5 + a1*a2^4*a3^2*a4*b1^5*b2^2*b3^4*b4^5 +
a1^5*a2^2*a3^2*a4*b1*b2^4*b3^4*b4^5 + a1*a2^2*a3^2*a4*b1^5*b2^4*b3^4*b4^5
(a1^4 + b1^4)*(a4^4 + b4^4)*(a2^2 + b2^2)*(a3^2 + b3^2)*a1*a2^2*a3^2*a4*b1*b2^2*b3^2*b4
((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*(p3^2 +
2*q3)*q1*q2^2*q3^2*q4

c0124=sum(c01.find(a2^4*a4^4*w0))+sum(c01.find(a2^4*b4^4*w0))+sum(c01.find(b2\
    ^4*b4^4*w0))+sum(c01.find(b2^4*a4^4*w0))
c0124
c0124.factor()
s0124=((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 + 2*q2)*(p4^2\
    + 2*q4)*q1*q2^2*q3*q4^2
s0124
#This is the sum of the terms with either a2^4 or b2^4 and either a4^4 or b4^4,\
     its factorization, and its substitution.

a1^5*a2^4*a3^5*a4^4*b1*b2^2*b3*b4^2 + a1*a2^4*a3^5*a4^4*b1^5*b2^2*b3*b4^2 +
a1^5*a2^2*a3^5*a4^4*b1*b2^4*b3*b4^2 + a1*a2^2*a3^5*a4^4*b1^5*b2^4*b3*b4^2 +
a1^5*a2^4*a3*a4^4*b1*b2^2*b3^5*b4^2 + a1*a2^4*a3*a4^4*b1^5*b2^2*b3^5*b4^2 +
a1^5*a2^2*a3*a4^4*b1*b2^4*b3^5*b4^2 + a1*a2^2*a3*a4^4*b1^5*b2^4*b3^5*b4^2 +
a1^5*a2^4*a3^5*a4^2*b1*b2^2*b3*b4^4 + a1*a2^4*a3^5*a4^2*b1^5*b2^2*b3*b4^4 +
a1^5*a2^2*a3^5*a4^2*b1*b2^4*b3*b4^4 + a1*a2^2*a3^5*a4^2*b1^5*b2^4*b3*b4^4 +
a1^5*a2^4*a3*a4^2*b1*b2^2*b3^5*b4^4 + a1*a2^4*a3*a4^2*b1^5*b2^2*b3^5*b4^4 +
a1^5*a2^2*a3*a4^2*b1*b2^4*b3^5*b4^4 + a1*a2^2*a3*a4^2*b1^5*b2^4*b3^5*b4^4
(a1^4 + b1^4)*(a3^4 + b3^4)*(a2^2 + b2^2)*(a4^2 + b4^2)*a1*a2^2*a3*a4^2*b1*b2^2*b3*b4^2
((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 + 2*q2)*(p4^2 +
2*q4)*q1*q2^2*q3*q4^2

c0134=sum(c01.find(a3^4*a4^4*w0))+sum(c01.find(a3^4*b4^4*w0))+sum(c01.find(b3\
    ^4*b4^4*w0))+sum(c01.find(b3^4*a4^4*w0))
c0134
c0134.factor()
s0134=((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 + 2*q3)*(p4^2\
    + 2*q4)*q1*q2*q3^2*q4^2
s0134
#This is the sum of the terms with either a3^4 or b3^4 and either a4^4 or b4^4,\
    its factorization, and its substitution.
a1^5*a2^5*a3^4*a4^4*b1*b2*b3^2*b4^2 + a1*a2^5*a3^4*a4^4*b1^5*b2*b3^2*b4^2 +
a1^5*a2*a3^4*a4^4*b1*b2^5*b3^2*b4^2 + a1*a2*a3^4*a4^4*b1^5*b2^5*b3^2*b4^2 +
a1^5*a2^5*a3^2*a4^4*b1*b2*b3^4*b4^2 + a1*a2^5*a3^2*a4^4*b1^5*b2*b3^4*b4^2 +
a1^5*a2*a3^2*a4^4*b1*b2^5*b3^4*b4^2 + a1*a2*a3^2*a4^4*b1^5*b2^5*b3^4*b4^2 +
a1^5*a2^5*a3^4*a4^2*b1*b2*b3^2*b4^4 + a1*a2^5*a3^4*a4^2*b1^5*b2*b3^2*b4^4 +
a1^5*a2*a3^4*a4^2*b1*b2^5*b3^2*b4^4 + a1*a2*a3^4*a4^2*b1^5*b2^5*b3^2*b4^4 +
a1^5*a2^5*a3^2*a4^2*b1*b2*b3^4*b4^4 + a1*a2^5*a3^2*a4^2*b1^5*b2*b3^4*b4^4 +
a1^5*a2*a3^2*a4^2*b1*b2^5*b3^4*b4^4 + a1*a2*a3^2*a4^2*b1^5*b2^5*b3^4*b4^4
(a1^4 + b1^4)*(a2^4 + b2^4)*(a3^2 + b3^2)*(a4^2 + b4^2)*a1*a2*a3^2*a4^2*b1*b2*b3^2*b4^2
((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 + 2*q3)*(p4^2 +
2*q4)*q1*q2*q3^2*q4^2

bool(c1==c0112+c0113+c0114+c0123+c0124+c0134-(-c112-c113-c114-c121-c123-c124-\
    c131-c132-c134-c141-c142-c143))
#This is a check to make sure as we seperated the groups we used every term in \
    c1 once and only once.
True

l1=s0112+s0113+s0114+s0123+s0124+s0134+s112+s113+s114+s121+s123+s124+s131+s132+\
    s134+s141+s142+s143
l1
l01=l1(p1=a1+b1, p2=a2+b2, p3=a3+b3, p4=a4+b4, q1=-1*a1*b1, q2=-1*a2*b2, q3=-1*\
    a3*b3, q4=-1*a4*b4)
bool(l01==c1)
#This line brings all the group substitutions we created for c1 back into one \
    expression and checks to make sure that when back substitute we end up with \
    c1.
-((p4^2 + 2*q4)^2 - 3*q4^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^2*q3^2 -
((p4^2 + 2*q4)^2 - 3*q4^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2^3*q3^2 -
((p4^2 + 2*q4)^2 - 3*q4^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^2*q2^2*q3^3 -
((p3^2 + 2*q3)^2 - 3*q3^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^2*q4^2 -
((p3^2 + 2*q3)^2 - 3*q3^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2^3*q4^2 -
((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q3^2*q4^2 -
((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q2^3*q3^2*q4^2 -
((p2^2 + 2*q2)^2 - 3*q2^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^2*q3^3*q4^2 -
((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q2^2*q3^3*q4^2 -
((p3^2 + 2*q3)^2 - 3*q3^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^2*q2^2*q4^3 -
((p2^2 + 2*q2)^2 - 3*q2^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^2*q3^2*q4^3 -
((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q2^2*q3^2*q4^3 +
((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p2^2 +

2*q2)*q1^2*q2^2*q3*q4 + ((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2*q3^2*q4 + ((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1*q2^2*q3^2*q4 + ((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2*q3*q4^2 + ((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1*q2^2*q3*q4^2 + ((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1*q2*q3^2*q4^2
True


l=l1+l2+l4+l7+l12+l20+l28+l32+l46+l70+l104+l152
l
#This line brings all the group substitutions back into one expression.
28*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2^2*q3^2*q4^2 - 46*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^2*q3^2*q4^2 - 46*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2^3*q3^2*q4^2 + 70*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^3*q3^2*q4^2 - 46*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^2*q2^2*q3^3*q4^2 + 70*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^3*q2^2*q3^3*q4^2 + 70*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2^3*q3^3*q4^2 - 104*(p4^2 + 2*q4)*q1^3*q2^3*q3^3*q4^2 - 46*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^2*q2^2*q3^2*q4^3 + 70*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^3*q2^2*q3^2*q4^3 + 70*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2^3*q3^2*q4^3 - 104*(p3^2 + 2*q3)*q1^3*q2^3*q3^2*q4^3 + 70*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q2^2*q3^3*q4^3 - 104*(p2^2 + 2*q2)*q1^3*q2^2*q3^3*q4^3 - 104*(p1^2 + 2*q1)*q1^2*q2^3*q3^3*q4^3 + 152*q1^3*q2^3*q3^3*q4^3 - ((p4^2 + 2*q4)^2 - 3*q4^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^2*q3^2 - ((p4^2 + 2*q4)^2 - 3*q4^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2^3*q3^2 + 2*((p4^2 + 2*q4)^2 - 3*q4^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^3*q3^2 - ((p4^2 + 2*q4)^2 - 3*q4^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^2*q2^2*q3^3 + 2*((p4^2 + 2*q4)^2 - 3*q4^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^3*q2^2*q3^3 + 2*((p4^2 + 2*q4)^2 - 3*q4^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2^3*q3^3 - 4*((p4^2 + 2*q4)^2 - 3*q4^2)*(p4^2 + 2*q4)*q1^3*q2^3*q3^3 - 7*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^2*q2^2*q3^2*q4 + 12*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^3*q2^2*q3^2*q4 + 12*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2^3*q3^2*q4 - 20*((p4^2 + 2*q4)^2 - 2*q4^2)*(p3^2 + 2*q3)*q1^3*q2^3*q3^2*q4 + 12*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q2^2*q3^3*q4 - 20*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*q1^3*q2^2*q3^3*q4 - 20*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*q1^2*q2^3*q3^3*q4 + 32*((p4^2 + 2*q4)^2 - 2*q4^2)*q1^3*q2^3*q3^3*q4 - ((p3^2 + 2*q3)^2 - 3*q3^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^2*q4^2 - ((p3^2 + 2*q3)^2 - 3*q3^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2^3*q4^2 + 2*((p3^2 + 2*q3)^2 - 3*q3^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2^3*q4^2 - 7*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^2*q2^2*q3*q4^2 + 12*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^3*q2^2*q3*q4^2 + 12*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2^3*q3*q4^2 - 20*((p3^2 + 2*q3)^2 - 2*q3^2)*(p4^2 + 2*q4)*q1^3*q2^3*q3*q4^2 - ((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q3^2*q4^2 - 7*((p2^2 + 2*q2)^2 - 2*q2^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^2*q2*q3^2*q4^2 + 12*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1^3*q2*q3^2*q4^2 - 7*((p1^2 + 2*q1)^2 - 2*q1^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1*q2^2*q3^2*q4^2 - ((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q2^3*q3^2*q4^2 + 12*((p1^2 + 2*q1)^2 - 2*q1^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1*q2^3*q3^2*q4^2 - ((p2^2 + 2*q2)^2 - 3*q2^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^2*q3^3*q4^2 + 2*((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1^3*q3^3*q4^2 + 12*((p2^2 + 2*q2)^2 - 2*q2^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2*q3^3*q4^2 - 20*((p2^2 + 2*q2)^2 - 2*q2^2)*(p4^2 + 2*q4)*q1^3*q2*q3^3*q4^2 - ((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q2^2*q3^3*q4^2 + 12*((p1^2 + 2*q1)^2 - 2*q1^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1*q2^2*q3^3*q4^2 + 2*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q2^3*q3^3*q4^2 - 20*((p1^2 + 2*q1)^2 - 2*q1^2)*(p4^2 + 2*q4)*q1*q2^3*q3^3*q4^2 - ((p3^2 + 2*q3)^2 - 3*q3^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^2*q2^2*q4^3 + 2*((p3^2 + 2*q3)^2 - 3*q3^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^3*q2^2*q4^3 + 2*((p3^2 + 2*q3)^2 - 3*q3^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2^3*q4^3 - 4*((p3^2 + 2*q3)^2 - 3*q3^2)*(p3^2 + 2*q3)*q1^3*q2^3*q4^3 + 12*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q2^2*q3*q4^3 - 20*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 + 2*q2)*q1^3*q2^2*q3*q4^3 - 20*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*q1^2*q2^3*q3*q4^3 + 32*((p3^2 + 2*q3)^2 -

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2*q3^2)*q1^3*q2^3*q3*q4^3 - ((p2^2 + 2*q2)^2 - 3*q2^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^2*q3^2*q4^3 + 2*((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1^3*q3^2*q4^3 + 12*((p2^2 + 2*q2)^2 - 2*q2^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2*q3^2*q4^3 - 20*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 + 2*q3)*q1^3*q2*q3^2*q4^3 - ((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q2^2*q3^2*q4^3 + 12*((p1^2 + 2*q1)^2 - 2*q1^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1*q2^2*q3^2*q4^3 + 2*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q2^3*q3^2*q4^3 - 20*((p1^2 + 2*q1)^2 - 2*q1^2)*(p3^2 + 2*q3)*q1*q2^3*q3^2*q4^3 + 2*((p2^2 + 2*q2)^2 - 3*q2^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q3^3*q4^3 - 4*((p2^2 + 2*q2)^2 - 3*q2^2)*(p2^2 + 2*q2)*q1^3*q3^3*q4^3 - 20*((p2^2 + 2*q2)^2 - 2*q2^2)*(p1^2 + 2*q1)*q1^2*q2*q3^3*q4^3 + 32*((p2^2 + 2*q2)^2 - 2*q2^2)*q1^3*q2*q3^3*q4^3 + 2*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q2^2*q3^3*q4^3 - 20*((p1^2 + 2*q1)^2 - 2*q1^2)*(p2^2 + 2*q2)*q1*q2^2*q3^3*q4^3 - 4*((p1^2 + 2*q1)^2 - 3*q1^2)*(p1^2 + 2*q1)*q2^3*q3^3*q4^3 + 32*((p1^2 + 2*q1)^2 - 3*q1^2)*q1*q2^3*q3^3*q4^3 + ((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p2^2 + 2*q2)*q1^2*q2^2*q3*q4 - 2*((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*q1^3*q2^2*q3*q4 - 2*((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*q1^2*q2^3*q3*q4 + 4*((p3^2 + 2*q3)^2 - 2*q3^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*q1^3*q2^3*q3*q4 + ((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*(p3^2 + 2*q3)*q1^2*q2*q3^2*q4 - 2*((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p3^2 + 2*q3)*q1^3*q2*q3^2*q4 + ((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*(p3^2 + 2*q3)*q1*q2^2*q3^2*q4 - 2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p3^2 + 2*q3)*q1*q2^3*q3^2*q4 - 2*((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p1^2 + 2*q1)*q1^2*q2*q3^3*q4 + 4*((p2^2 + 2*q2)^2 - 2*q2^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*q1^3*q2*q3^3*q4 - 2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*(p2^2 + 2*q2)*q1*q2^2*q3^3*q4 + 4*((p1^2 + 2*q1)^2 - 2*q1^2)*((p4^2 + 2*q4)^2 - 2*q4^2)*q1*q2^3*q3^3*q4 + ((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*(p4^2 + 2*q4)*q1^2*q2*q3*q4^2 - 2*((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p4^2 + 2*q4)*q1^3*q2*q3*q4^2 + ((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 + 2*q2)*(p4^2 + 2*q4)*q1*q2^2*q3*q4^2 - 2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p4^2 + 2*q4)*q1*q2^3*q3*q4^2 + ((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 + 2*q3)*(p4^2 + 2*q4)*q1*q2*q3^2*q4^2 - 2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*(p4^2 + 2*q4)*q1*q2*q3^3*q4^2 - 2*((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p1^2 + 2*q1)*q1^2*q2*q3*q4^3 + 4*((p2^2 + 2*q2)^2 - 2*q2^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*q1^3*q2*q3*q4^3 - 2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*(p2^2 + 2*q2)*q1*q2^2*q3*q4^3 + 4*((p1^2 + 2*q1)^2 - 2*q1^2)*((p3^2 + 2*q3)^2 - 2*q3^2)*q1*q2^3*q3*q4^3 - 2*((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*(p3^2 + 2*q3)*q1*q2*q3^2*q4^3 + 4*((p1^2 + 2*q1)^2 - 2*q1^2)*((p2^2 + 2*q2)^2 - 2*q2^2)*q1*q2*q3^3*q4^3

```
ll=l(p1=a1+b1, p2=a2+b2, p3=a3+b3, p4=a4+b4, q1=-1*a1*b1, q2=-1*a2*b2, q3=-1*a3\
    *b3, q4=-1*a4*b4)
bool(ll==f10)
#This is a check to make sure that when back substitute we end up with the \
    original coefficient.
True
```

```
m=l.expand()
m
latex(m)
#This is the expansion of our coefficient and a latex output for easy copying \
    to the thesis.
```

p1^2*p2^2*p3^4*p4^4*q1^2*q2^2*q3*q4 + p1^2*p2^4*p3^2*p4^4*q1^2*q2*q3^2*q4 + p1^4*p2^2*p3^2*p4^4*q1*q2^2*q3^2*q4 + p1^2*p2^4*p3^4*p4^2*q1^2*q2*q3*q4^2 + p1^4*p2^2*p3^4*p4^2*q1*q2^2*q3*q4^2 + p1^4*p2^4*p3^2*p4^2*q1*q2*q3^2*q4^2 - p2^2*p3^2*p4^6*q1^3*q2^2*q3^2 - p1^2*p3^2*p4^6*q1^2*q2^3*q3^2 - p1^2*p2^2*p4^6*q1^2*q2^2*q3^3 + 5*p1^2*p2^2*p3^2*p4^4*q1^2*q2^2*q3^2*q4 - p2^2*p3^6*p4^2*q1^3*q2^2*q4^2 - p1^2*p3^6*p4^2*q1^2*q2^3*q4^2 + 5*p1^2*p2^2*p3^4*p4^2*q1^2*q2^2*q3*q4^2 - p2^6*p3^2*p4^2*q1^3*q3^2*q4^2 + 5*p1^2*p2^4*p3^2*p4^2*q1^2*q2*q3^2*q4^2 + 5*p1^4*p2^2*p3^2*p4^2*q1*q2^2*q3^2*q4^2 -

p1^6*p3^2*p4^2*q2^3*q3^2*q4^2 - p1^2*p2^6*p4^2*q1^2*q3^3*q4^2 -
p1^6*p2^2*p4^2*q2^2*q3^3*q4^2 - p1^2*p2^2*p3^6*q1^2*q2^2*q4^3 -
p1^2*p2^6*p3^2*q1^2*q3^2*q4^3 - p1^6*p2^2*p3^2*q2^2*q3^2*q4^3 - 2*p3^2*p4^6*q1^3*q2^3*q3^2
- 2*p2^2*p4^6*q1^3*q2^2*q3^3 - 2*p1^2*p4^6*q1^2*q2^3*q3^3 -
6*p2^2*p3^2*p4^4*q1^3*q2^2*q3^2*q4 - 6*p1^2*p3^2*p4^4*q1^2*q2^3*q3^2*q4 -
6*p1^2*p2^2*p4^4*q1^2*q2^2*q3^3*q4 - 2*p3^6*p4^2*q1^3*q2^3*q4^2 -
6*p2^2*p3^4*p4^2*q1^3*q2^2*q3*q4^2 - 6*p1^2*p3^4*p4^2*q1^2*q2^3*q3*q4^2 -
6*p2^4*p3^2*p4^2*q1^3*q2*q3^2*q4^2 + 12*p1^2*p2^2*p3^2*p4^2*q1^2*q2^2*q3^2*q4^2 -
6*p1^4*p3^2*p4^2*q1*q2^3*q3^2*q4^2 - 2*p2^6*p4^2*q1^3*q3^3*q4^2 -
6*p1^2*p2^4*p4^2*q1^2*q2*q3^3*q4^2 - 6*p1^4*p2^2*p4^2*q1*q2^2*q3^3*q4^2 -
2*p1^6*p4^2*q2^3*q3^3*q4^2 - 2*p2^2*p3^6*q1^3*q2^2*q4^3 - 2*p1^2*p3^6*q1^2*q2^3*q4^3 -
6*p1^2*p2^2*p3^4*q1^2*q2^2*q3*q4^3 - 2*p2^6*p3^2*q1^3*q3^2*q4^3 -
6*p1^2*p2^4*p3^2*q1^2*q2*q3^2*q4^3 - 6*p1^4*p2^2*p3^2*q1*q2^2*q3^2*q4^3 -
2*p1^6*p3^2*q2^3*q3^2*q4^3 - 2*p1^2*p2^6*q1^2*q3^3*q4^3 - 2*p1^6*p2^2*q2^2*q3^3*q4^3 -
4*p4^6*q1^3*q2^3*q3^3 - 12*p3^2*p4^4*q1^3*q2^3*q3^2*q4 - 12*p2^2*p4^4*q1^3*q2^2*q3^3*q4 -
12*p1^2*p4^4*q1^2*q2^3*q3^3*q4 - 12*p3^4*p4^2*q1^3*q2^3*q3*q4^2 -
31*p2^2*p3^2*p4^2*q1^3*q2^2*q3^2*q4^2 - 31*p1^2*p3^2*p4^2*q1^2*q2^3*q3^2*q4^2 -
12*p2^4*p4^2*q1^3*q2*q3^3*q4^2 - 31*p1^2*p2^2*p4^2*q1^2*q2^2*q3^3*q4^2 -
12*p1^4*p4^2*q1*q2^3*q3^3*q4^2 - 4*p3^6*q1^3*q2^3*q4^3 - 12*p2^2*p3^4*q1^3*q2^2*q3*q4^3 -
12*p1^2*p3^4*q1^2*q2^3*q3*q4^3 - 12*p2^4*p3^2*q1^3*q2*q3^2*q4^3 -
31*p1^2*p2^2*p3^2*q1^2*q2^2*q3^2*q4^3 - 12*p1^4*p3^2*q1*q2^3*q3^2*q4^3 -
4*p2^6*q1^3*q3^3*q4^3 - 12*p1^2*p2^4*q1^2*q2*q3^3*q4^3 - 12*p1^4*p2^2*q1*q2^2*q3^3*q4^3 -
4*p1^6*q2^3*q3^3*q4^3 - 24*p4^4*q1^3*q2^3*q3^3*q4 - 46*p3^2*p4^2*q1^3*q2^3*q3^2*q4^2 -
46*p2^2*p4^2*q1^3*q2^2*q3^3*q4^2 - 46*p1^2*p4^2*q1^2*q2^3*q3^3*q4^2 -
24*p3^4*q1^3*q2^3*q3*q4^3 - 46*p2^2*p3^2*q1^3*q2^2*q3^2*q4^3 -
46*p1^2*p3^2*q1^2*q2^3*q3^2*q4^3 - 24*p2^4*q1^3*q2*q3^3*q4^3 -
46*p1^2*p2^2*q1^2*q2^2*q3^3*q4^3 - 24*p1^4*q1*q2^3*q3^3*q4^3 - 60*p4^2*q1^3*q2^3*q3^3*q4^2
- 60*p3^2*q1^3*q2^3*q3^2*q4^3 - 60*p2^2*q1^3*q2^2*q3^3*q4^3 - 60*p1^2*q1^2*q2^3*q3^3*q4^3
- 56*q1^3*q2^3*q3^3*q4^3

$p_{1}^{2} p_{2}^{2} p_{3}^{4} p_{4}^{4} q_{1}^{2} q_{2}^{2} q_{3} q_{4} + p_{1}^{2} p_{2}^{4} p_{3}^{2} p_{4}^{4} q_{1}^{2} q_{2} q_{3}^{2} q_{4} + p_{1}^{4} p_{2}^{2} p_{3}^{2} p_{4}^{4} q_{1} q_{2}^{2} q_{3}^{2} q_{4} + p_{1}^{2} p_{2}^{4} p_{3}^{4} p_{4}^{2} q_{1}^{2} q_{2} q_{3} q_{4}^{2} + p_{1}^{4} p_{2}^{2} p_{3}^{4} p_{4}^{2} q_{1} q_{2}^{2} q_{3} q_{4}^{2} + p_{1}^{4} p_{2}^{4} p_{3}^{2} p_{4}^{2} q_{1} q_{2} q_{3}^{2} q_{4}^{2} - p_{2}^{2} p_{3}^{2} p_{4}^{6} q_{1}^{3} q_{2}^{2} q_{3}^{2} - p_{1}^{2} p_{3}^{2} p_{4}^{6} q_{1}^{2} q_{2}^{3} q_{3}^{2} - p_{1}^{2} p_{2}^{2} p_{4}^{6} q_{1}^{2} q_{2}^{2} q_{3}^{3} + 5 \, p_{1}^{2} p_{2}^{2} p_{3}^{2} p_{4}^{4} q_{1}^{2} q_{2}^{2} q_{3}^{2} q_{4} - p_{2}^{2} p_{3}^{6} p_{4}^{2} q_{1}^{3} q_{2}^{2} q_{4}^{2} - p_{1}^{2} p_{3}^{6} p_{4}^{2} q_{1}^{2} q_{2}^{3} q_{4}^{2} + 5 \, p_{1}^{2} p_{2}^{2} p_{3}^{4} p_{4}^{2} q_{1}^{2} q_{2}^{2} q_{3} q_{4}^{2} - p_{2}^{6} p_{3}^{2} p_{4}^{2} q_{1}^{3} q_{3}^{2} q_{4}^{2} + 5 \, p_{1}^{2} p_{2}^{4} p_{3}^{2} p_{4}^{2} q_{1}^{2} q_{2} q_{3}^{2} q_{4}^{2} + 5 \, p_{1}^{4} p_{2}^{2} p_{3}^{2} p_{4}^{2} q_{1} q_{2}^{2} q_{3}^{2} q_{4}^{2} - p_{1}^{6} p_{3}^{2} p_{4}^{2} q_{2}^{3} q_{3}^{2} q_{4}^{2} - p_{1}^{2} p_{2}^{6} p_{4}^{2} q_{1}^{2} q_{3}^{3} q_{4}^{2} - p_{1}^{6} p_{2}^{2} p_{4}^{2} q_{2}^{2} q_{3}^{3} q_{4}^{2} - p_{1}^{2} p_{2}^{2} p_{3}^{6} q_{1}^{2} q_{2}^{2} q_{4}^{3} - p_{1}^{2} p_{2}^{6} p_{3}^{2} q_{1}^{2} q_{3}^{2} q_{4}^{3} - p_{1}^{6} p_{2}^{2} p_{3}^{2} q_{2}^{2} q_{3}^{2} q_{4}^{3} - 2 \, p_{3}^{2} p_{4}^{6} q_{1}^{3} q_{2}^{3} q_{3}^{2} - 2 \, p_{2}^{2} p_{4}^{6} q_{1}^{3} q_{2}^{2} q_{3}^{3} - 2 \, p_{1}^{2} p_{4}^{6} q_{1}^{2} q_{2}^{3} q_{3}^{3} - 6 \, p_{2}^{2} p_{3}^{2} p_{4}^{4} q_{1}^{3} q_{2}^{2} q_{3}^{2} q_{4} - 6 \, p_{1}^{2} p_{3}^{2} p_{4}^{4} q_{1}^{2} q_{2}^{3} q_{3}^{2} q_{4} - 6 \, p_{1}^{2} p_{2}^{2} p_{4}^{4} q_{1}^{2} q_{2}^{2} q_{3}^{3} q_{4} - 2 \, p_{3}^{6} p_{4}^{2} q_{1}^{3} q_{2}^{3} q_{4}^{2} - 6 \, p_{2}^{2} p_{3}^{4} p_{4}^{2} q_{1}^{3} q_{2}^{2} q_{3} q_{4}^{2} - 6 \, p_{1}^{2} p_{3}^{4} p_{4}^{2} q_{1}^{2} q_{2}^{3} q_{3} q_{4}^{2} - 6 \, p_{2}^{4} p_{3}^{2} p_{4}^{2} q_{1}^{3} q_{2} q_{3}^{2} q_{4}^{2} + 12 \, p_{1}^{2} p_{2}^{2} p_{3}^{2} p_{4}^{2} q_{1}^{2} q_{2}^{2} q_{3}^{2} q_{4}^{2} - 6 \, p_{1}^{4} p_{3}^{2} p_{4}^{2} q_{1} q_{2}^{3} q_{3}^{2} q_{4}^{2} - 2 \, p_{2}^{6} p_{4}^{2} q_{1}^{3} q_{3}^{3} q_{4}^{2} - 6 \, p_{1}^{2} p_{2}^{4} p_{4}^{2} q_{1}^{2} q_{2} q_{3}^{3} q_{4}^{2} - 6 \, p_{1}^{4} p_{2}^{2} p_{4}^{2} q_{1} q_{2}^{2} q_{3}^{3} q_{4}^{2} - 2 \, p_{1}^{6} p_{4}^{2} q_{2}^{3} q_{3}^{3} q_{4}^{2} - 2 \, p_{2}^{2} p_{3}^{6} q_{1}^{3} q_{2}^{2} q_{4}^{3} - 2 \, p_{1}^{2} p_{3}^{6} q_{1}^{2} q_{2}^{3} q_{4}^{3} - 6 \, p_{1}^{2} p_{2}^{2} p_{3}^{4}$

$$q_{1}^{2} q_{2}^{2} q_{3} q_{4}^{3} - 2 \, p_{2}^{6} p_{3}^{2} q_{1}^{3} q_{3}^{2} q_{4}^{3} - 6 \, p_{1}^{2} p_{2}^{4} p_{3}^{2} q_{1}^{2} q_{2} q_{3}^{2} q_{4}^{3} - 6 \, p_{1}^{4} p_{2}^{2} p_{3}^{2} q_{1} q_{2}^{2} q_{3}^{2} q_{4}^{3} - 2 \, p_{1}^{6} p_{3}^{2} q_{2}^{3} q_{3}^{2} q_{4}^{3} - 2 \, p_{1}^{2} p_{2}^{6} q_{1}^{2} q_{3}^{3} q_{4}^{3} - 2 \, p_{1}^{6} p_{2}^{2} q_{2}^{2} q_{3}^{3} q_{4}^{3} - 4 \, p_{4}^{6} q_{1}^{3} q_{2}^{3} q_{3}^{3} - 12 \, p_{3}^{2} p_{4}^{4} q_{1}^{3} q_{2}^{3} q_{3}^{2} q_{4} - 12 \, p_{2}^{2} p_{4}^{4} q_{1}^{3} q_{2}^{2} q_{3}^{3} q_{4} - 12 \, p_{1}^{2} p_{4}^{4} q_{1}^{2} q_{2}^{3} q_{3}^{3} q_{4} - 12 \, p_{3}^{4} p_{4}^{2} q_{1}^{3} q_{2}^{3} q_{3} q_{4}^{2} - 31 \, p_{2}^{2} p_{3}^{2} p_{4}^{2} q_{1}^{3} q_{2}^{2} q_{3}^{2} q_{4}^{2} - 31 \, p_{1}^{2} p_{3}^{2} p_{4}^{2} q_{1}^{2} q_{2}^{3} q_{3}^{2} q_{4}^{2} - 12 \, p_{2}^{4} p_{4}^{2} q_{1}^{3} q_{2} q_{3}^{3} q_{4}^{2} - 31 \, p_{1}^{2} p_{2}^{2} p_{4}^{2} q_{1}^{2} q_{2}^{2} q_{3}^{3} q_{4}^{2} - 12 \, p_{1}^{4} p_{4}^{2} q_{1} q_{2}^{3} q_{3}^{3} q_{4}^{2} - 4 \, p_{3}^{6} q_{1}^{3} q_{2}^{3} q_{4}^{3} - 12 \, p_{2}^{2} p_{3}^{4} q_{1}^{3} q_{2}^{2} q_{3} q_{4}^{3} - 12 \, p_{1}^{2} p_{3}^{4} q_{1}^{2} q_{2}^{3} q_{3} q_{4}^{3} - 12 \, p_{2}^{4} p_{3}^{2} q_{1}^{3} q_{2} q_{3}^{2} q_{4}^{3} - 31 \, p_{1}^{2} p_{2}^{2} p_{3}^{2} q_{1}^{2} q_{2}^{2} q_{3}^{2} q_{4}^{3} - 12 \, p_{1}^{4} p_{3}^{2} q_{1} q_{2}^{3} q_{3}^{2} q_{4}^{3} - 4 \, p_{2}^{6} q_{1}^{3} q_{3}^{3} q_{4}^{3} - 12 \, p_{1}^{2} p_{2}^{4} q_{1}^{2} q_{2} q_{3}^{3} q_{4}^{3} - 12 \, p_{1}^{4} p_{2}^{2} q_{1} q_{2}^{2} q_{3}^{3} q_{4}^{3} - 4 \, p_{1}^{6} q_{2}^{3} q_{3}^{3} q_{4}^{3} - 24 \, p_{4}^{4} q_{1}^{3} q_{2}^{3} q_{3}^{3} q_{4} - 46 \, p_{3}^{2} p_{4}^{2} q_{1}^{3} q_{2}^{3} q_{3}^{2} q_{4}^{2} - 46 \, p_{2}^{2} p_{4}^{2} q_{1}^{3} q_{2}^{2} q_{3}^{3} q_{4}^{2} - 24 \, p_{1}^{2} p_{4}^{2} q_{1}^{2} q_{2}^{3} q_{3}^{3} q_{4}^{2} - 46 \, p_{3}^{4} q_{1}^{3} q_{2}^{3} q_{3} q_{4}^{3} - 46 \, p_{2}^{2} p_{3}^{2} q_{1}^{3} q_{2}^{2} q_{3}^{2} q_{4}^{3} - 24 \, p_{1}^{2} p_{3}^{2} q_{1}^{2} q_{2}^{3} q_{3}^{2} q_{4}^{3} - 46 \, p_{2}^{4} q_{1}^{3} q_{2} q_{3}^{3} q_{4}^{3} - 24 \, p_{1}^{2} p_{2}^{2} q_{1}^{2} q_{2}^{2} q_{3}^{3} q_{4}^{3} - 60 \, p_{1}^{4} q_{1} q_{2}^{3} q_{3}^{3} q_{4}^{3} - 60 \, p_{4}^{2} q_{1}^{3} q_{2}^{3} q_{3}^{3} q_{4}^{2} - 60 \, p_{3}^{2} q_{1}^{3} q_{2}^{3} q_{3}^{2} q_{4}^{3} - 60 \, p_{2}^{2} q_{1}^{3} q_{2}^{2} q_{3}^{3} q_{4}^{3} - 60 \, p_{1}^{2} q_{1}^{2} q_{2}^{3} q_{3}^{3} q_{4}^{3} - 56 \, q_{1}^{3} q_{2}^{3} q_{3}^{3} q_{4}^{3}$$