```
clear
clc

%
  ----------------------------------------------------------------------
```

2b

```
--------------------------------------------------------------------

syms x y z u a J2 J3

acc = -(3*u*a*a*J2*z*z)/(2*((x^2+y^2+z^2)^(5/2))) +
 (u*a*a*J2)/(2*((x^2+y^2+z^2)^(3/2))) - (5*u*a*a*a*J3*z*z*z)/
(2*((x^2+y^2+z^2)^(7/2))) + (3*u*a*a*a*J3*z)/
(2*((x^2+y^2+z^2)^(5/2)));

dx = diff(acc,x);

dy = diff(acc,y);

dz = diff(acc,z);

a = [dx; dy; dz];

dadx = simplify(diff(a,x));
dady = simplify(diff(a,y));
dadz = simplify(diff(a,z));
dadu = simplify(diff(a,u));
dadJ2 = simplify(diff(a,J2));
dadJ3 = simplify(diff(a,J3));

fprintf('dadx \nx-hat: %s\ny-hat: %s\nz-hat: %s\n
\n',dadx(1),dadx(2),dadx(3))
fprintf('dady \nx-hat: %s\ny-hat: %s\nz-hat: %s\n
\n',dady(1),dady(2),dady(3))
fprintf('dadz \nx-hat: %s\ny-hat: %s\nz-hat: %s\n
\n',dadz(1),dadz(2),dadz(3))
fprintf('dadu \nx-hat: %s\ny-hat: %s\nz-hat: %s\n
\n',dadu(1),dadu(2),dadu(3))
fprintf('dadJ2 \nx-hat: %s\ny-hat: %s\nz-hat: %s\n
\n',dadJ2(1),dadJ2(2),dadJ2(3))
fprintf('dadJ3 \nx-hat: %s\ny-hat: %s\nz-hat: %s\n
\n',dadJ3(1),dadJ3(2),dadJ3(3))
clear x y z u a J2 J3

dadx
x-hat: -(3*J2*a^2*u*(x^2 + y^2 + z^2)^3 - 15*J2*a^2*u*z^2*(x^2 +
 y^2 + z^2)^2 + 315*J3*a^3*u*x^2*z^3 + 15*J3*a^3*u*z*(x^2 + y^2 +
 z^2)^2 - 35*J3*a^3*u*z^3*(x^2 + y^2 + z^2) - 15*J2*a^2*u*x^2*(x^2
 + y^2 + z^2)^2 - 105*J3*a^3*u*x^2*z*(x^2 + y^2 + z^2) +
 105*J2*a^2*u*x^2*z^2*(x^2 + y^2 + z^2))/(2*(x^2 + y^2 + z^2)^(11/2))
```

y-hat: `(15*a^2*u*x*y*(J2*x^4 + J2*y^4 - 6*J2*z^4 + 2*J2*x^2*y^2`
`- 5*J2*x^2*z^2 - 5*J2*y^2*z^2 - 14*J3*a*z^3 + 7*J3*a*x^2*z +`
`7*J3*a*y^2*z))/(2*(x^2 + y^2 + z^2)^(11/2))`
z-hat: `-(315*J3*a^3*u*x*z^4 + 15*J3*a^3*u*x*(x^2 + y^2 + z^2)^2 -`
`45*J2*a^2*u*x*z*(x^2 + y^2 + z^2)^2 + 105*J2*a^2*u*x*z^3*(x^2 +`
`y^2 + z^2) - 210*J3*a^3*u*x*z^2*(x^2 + y^2 +`
`z^2))/(2*(x^2 + y^2 +`
`z^2)^(11/2))`

dady
x-hat: `(15*a^2*u*x*y*(J2*x^4 + J2*y^4 - 6*J2*z^4 + 2*J2*x^2*y^2`
`- 5*J2*x^2*z^2 - 5*J2*y^2*z^2 - 14*J3*a*z^3 + 7*J3*a*x^2*z +`
`7*J3*a*y^2*z))/(2*(x^2 + y^2 + z^2)^(11/2))`
y-hat: `-(3*J2*a^2*u*(x^2 + y^2 + z^2)^3 - 15*J2*a^2*u*z^2*(x^2 +`
`y^2 + z^2)^2 + 315*J3*a^3*u*y^2*z^3 + 15*J3*a^3*u*z*(x^2 + y^2 +`
`z^2)^2 - 35*J3*a^3*u*z^3*(x^2 + y^2 + z^2) - 15*J2*a^2*u*y^2*(x^2`
`+ y^2 + z^2)^2 - 105*J3*a^3*u*y^2*z*(x^2 + y^2 + z^2) +`
`105*J2*a^2*u*y^2*z^2*(x^2 + y^2 + z^2))/(2*(x^2 + y^2 + z^2)^(11/2))`
z-hat: `-(315*J3*a^3*u*y*z^4 + 15*J3*a^3*u*y*(x^2 + y^2 + z^2)^2 -`
`45*J2*a^2*u*y*z*(x^2 + y^2 + z^2)^2 + 105*J2*a^2*u*y*z^3*(x^2 +`
`y^2 + z^2) - 210*J3*a^3*u*y*z^2*(x^2 + y^2 +`
`z^2))/(2*(x^2 + y^2 +`
`z^2)^(11/2))`

dadz
x-hat: `-(315*J3*a^3*u*x*z^4 + 15*J3*a^3*u*x*(x^2 + y^2 + z^2)^2 -`
`45*J2*a^2*u*x*z*(x^2 + y^2 + z^2)^2 + 105*J2*a^2*u*x*z^3*(x^2 +`
`y^2 + z^2) - 210*J3*a^3*u*x*z^2*(x^2 + y^2 +`
`z^2))/(2*(x^2 + y^2 +`
`z^2)^(11/2))`
y-hat: `-(315*J3*a^3*u*y*z^4 + 15*J3*a^3*u*y*(x^2 + y^2 + z^2)^2 -`
`45*J2*a^2*u*y*z*(x^2 + y^2 + z^2)^2 + 105*J2*a^2*u*y*z^3*(x^2 +`
`y^2 + z^2) - 210*J3*a^3*u*y*z^2*(x^2 + y^2 +`
`z^2))/(2*(x^2 + y^2 +`
`z^2)^(11/2))`
z-hat: `-(9*J2*a^2*u*(x^2 + y^2 + z^2)^3 + 315*J3*a^3*u*z^5 -`
`90*J2*a^2*u*z^2*(x^2 + y^2 + z^2)^2 + 105*J2*a^2*u*z^4*(x^2 + y^2 +`
`z^2) + 75*J3*a^3*u*z*(x^2 + y^2 + z^2)^2 - 350*J3*a^3*u*z^3*(x^2 +`
`y^2 + z^2))/(2*(x^2 + y^2 + z^2)^(11/2))`

dadu
x-hat: `-(a^2*x*(3*J2*x^4 + 3*J2*y^4 - 12*J2*z^4 + 6*J2*x^2*y^2`
`- 9*J2*x^2*z^2 - 9*J2*y^2*z^2 - 20*J3*a*z^3 + 15*J3*a*x^2*z +`
`15*J3*a*y^2*z))/(2*(x^2 + y^2 + z^2)^(9/2))`
y-hat: `-(a^2*y*(3*J2*x^4 + 3*J2*y^4 - 12*J2*z^4 + 6*J2*x^2*y^2`
`- 9*J2*x^2*z^2 - 9*J2*y^2*z^2 - 20*J3*a*z^3 + 15*J3*a*x^2*z +`
`15*J3*a*y^2*z))/(2*(x^2 + y^2 + z^2)^(9/2))`
z-hat: `(35*J3*a^3*z^4 + 3*J3*a^3*(x^2 + y^2 + z^2)^2 - 9*J2*a^2*z*(x^2`
`+ y^2 + z^2)^2 + 15*J2*a^2*z^3*(x^2 + y^2 + z^2) - 30*J3*a^3*z^2*(x^2`
`+ y^2 + z^2))/(2*(x^2 + y^2 + z^2)^(9/2))`

dadJ2
x-hat: `-(3*a^2*u*x*(x^2 + y^2 - 4*z^2))/(2*(x^2 + y^2 + z^2)^(7/2))`
y-hat: `-(3*a^2*u*y*(x^2 + y^2 - 4*z^2))/(2*(x^2 + y^2 + z^2)^(7/2))`
z-hat: `-(3*a^2*u*z*(3*x^2 + 3*y^2 - 2*z^2))/(2*(x^2 + y^2 +`
`z^2)^(7/2))`

dadJ3

```
x-hat: -(5*a^3*u*x*z*(3*x^2 + 3*y^2 - 4*z^2))/(2*(x^2 + y^2 +
z^2)^(9/2))
y-hat: -(5*a^3*u*y*z*(3*x^2 + 3*y^2 - 4*z^2))/(2*(x^2 + y^2 +
z^2)^(9/2))
z-hat: (a^3*u*(6*x^2*y^2 - 24*x^2*z^2 - 24*y^2*z^2 + 3*x^4 + 3*y^4 +
8*z^4))/(2*(x^2 + y^2 + z^2)^(9/2))
```

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