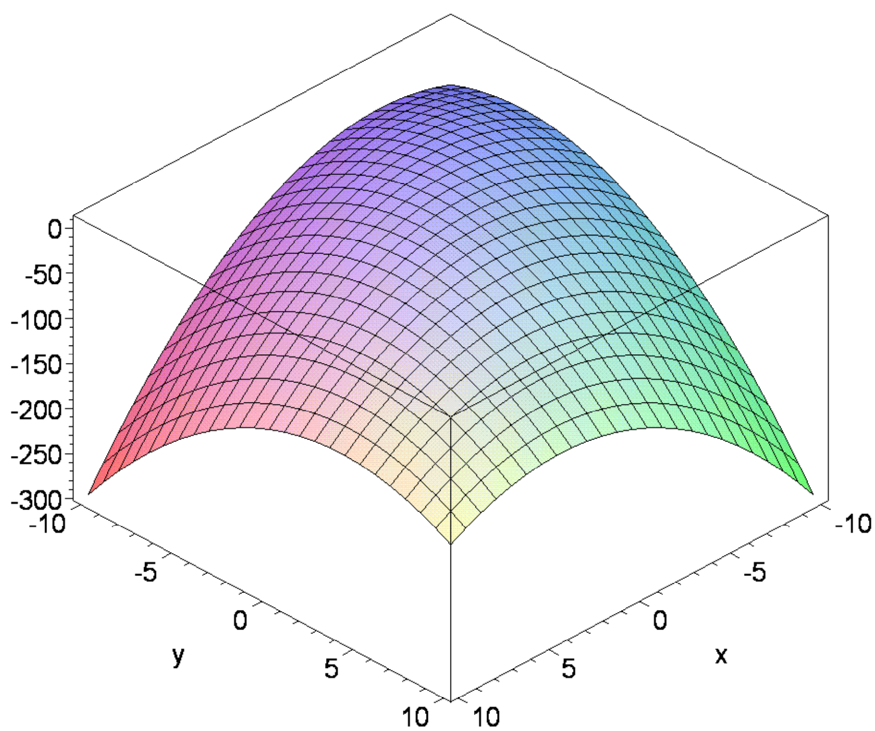
```
> restart;with(plots):with(student):with(Student[VectorCalculus]):
Warning, the name changecoords has been redefined

Warning, the assigned names <,> and <|> now have a global binding

Warning, these protected names have been redefined and unprotected: *, +, -, ., D, Vector, diff, int, limit, series
```

```
> f:=(x,y)-> -x^2+x*y-2*y-2*x-y^2+4;
```

$f := (x, y) \to VectorCalculus{:-}`+`(VectorCalculus{:-}`+`(VectorCalculus{:-}`+`(VectorCalculus{:-}`+`(VectorCalculus{:-}`+`(VectorCalculus{:-}`-`(x^2), VectorCalculus{:-}`*`(x, y)), VectorCalculus{:-}`-`(VectorCalculus{:-}`*`(2, y))), VectorCalculus{:-}`-`(VectorCalculus{:-}`*`(2, x))), VectorCalculus{:-}`-`(y^2)), 4)$

```
>
```

```
> plot3d( f(x,y),x=-10 .. 10,y=-10 .. 10,axes = boxed);
```

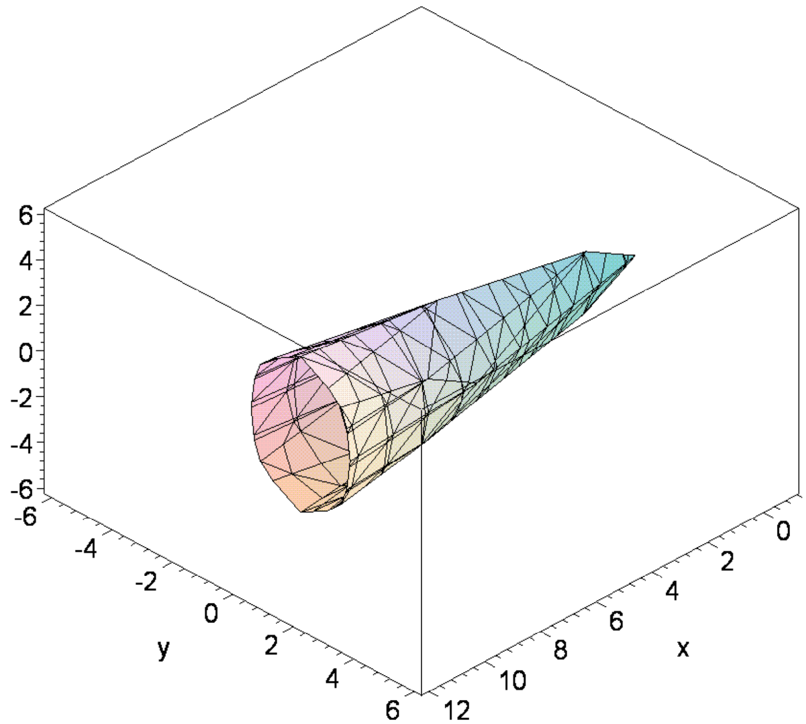



```
> fx:=diff(f(x,y),x)=0;fy:=diff(f(x,y),y)=0;
```

$$fx := -2\,x + y - 2 = 0$$

$$fy := x - 2 - 2\,y = 0$$

```
> # two simultaneous equation
```




```
> fsolve(-2*(2+2*y)+y-2=0);# so the solution is (-2,-2) or another
  way
```

$$-2.$$

```
> poly:={fx,fy}:
  fsolve( poly);
```

$$\{y = -2., x = -2.\}$$

```
> h:=diff(f(x,y),x,x)*diff(f(x,y),y,y)-diff(f(x,y),x,y)*diff(f(x,y),
  x,y);
```

$$h := 3$$

```
> diff(f(x,y),x,x); # conclusion is a local max
```

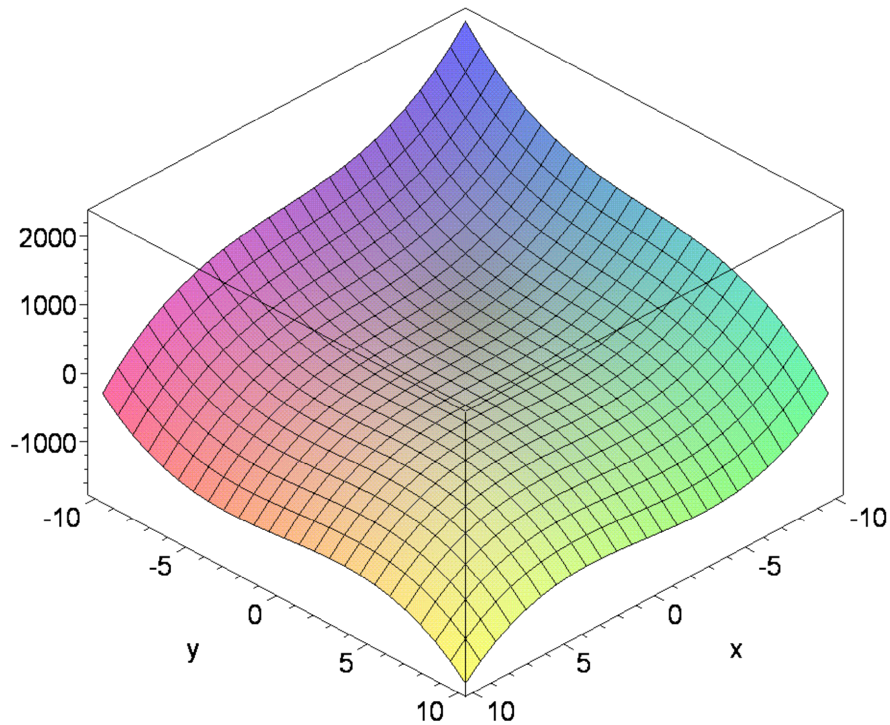
$$-2$$

```
>
>
>
>
> f:=(x,y)-> 3*x*y-y^3-x^3+4;
```

f := (x, y) → VectorCalculus:-`+`(VectorCalculus:-`+`(
VectorCalculus:-`+`(VectorCalculus:-`*`(VectorCalculus:-`*`(3, x), y), VectorCalculus:-`-`($y^3$))
, VectorCalculus:-`-`($x^3$)), 4)

```
>
```

```
> plot3d( f(x,y),x=-10 .. 10,y=-10 .. 10,axes = boxed);
```

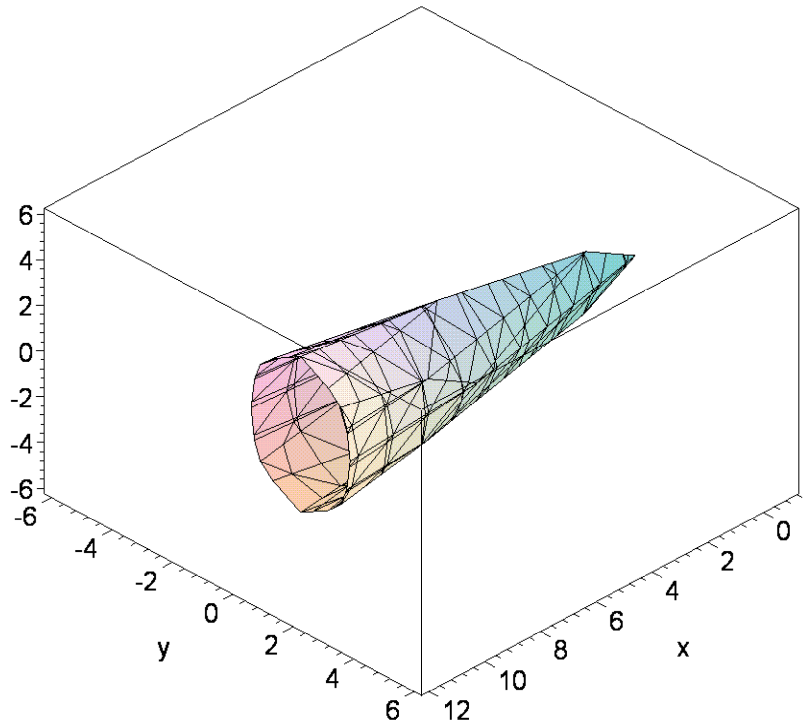



```
> fx:=diff(f(x,y),x)=0;fy:=diff(f(x,y),y)=0;
```

$$fx := 3\,y - 3\,x^2 = 0$$

$$fy := 3\,x - 3\,y^2 = 0$$

```
> # two simultaneous equation but non-linear here caes so sub y =
x^2
```




```
> fsolve(x-(x^2)^2=0); #gives two solutions x=0 and x = 1 so y=0 and
  1 also
```

$$0., 1.$$

```
>
> h:=diff(f(x,y),x,x)*diff(f(x,y),y,y)-diff(f(x,y),x,y)*diff(f(x,y),
  x,y);
```

$$h := 36\, x\, y - 9$$

```
> diff(f(x,y),x,x); # conclusion is a local max
```

$$-6\, x$$

```
> #so at (0,0) hessian is negative so saddle point

> # while at (1,1) hessis + and fxx is negative so a local min
>
```