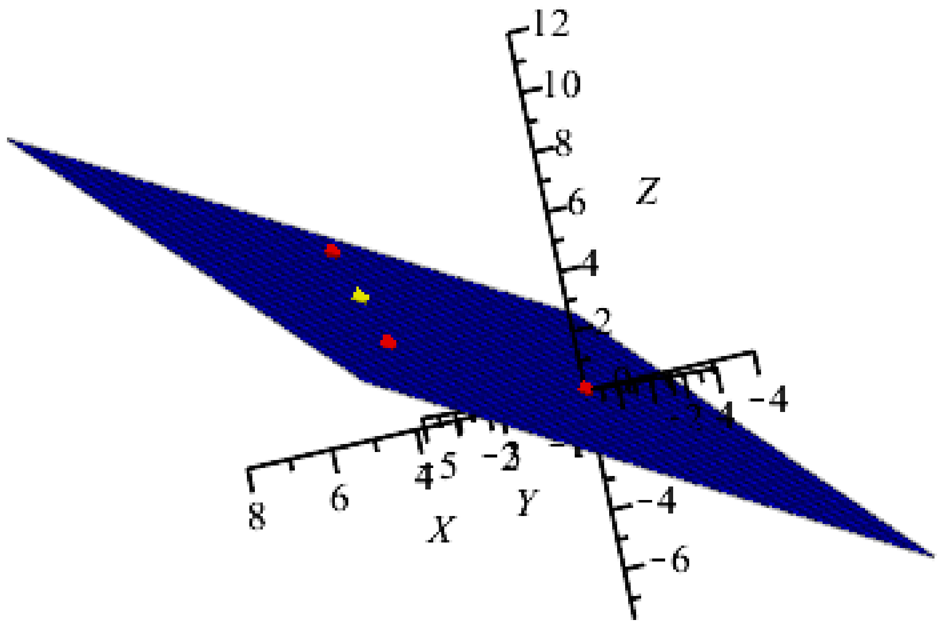
> $with(plots):$

> $pts := pointplot3d([[0, 0, 0], [2, -4, 6], [5, 1, 3]], symbol = soliddiamond, symbolsize = 20, color = red, axes = normal, labels = [X, Y, Z]):$

> $display(pts, P, pt)$



> $P := plot3d\left(\frac{(-18 \cdot x + 24 \cdot y)}{-22}, x = -4 ..8, y = -5 ..4, color = blue\right):$

> $pt := pointplot3d\left(\left[\frac{7}{2}, -\frac{3}{2}, \frac{9}{2}\right], color = yellow, symbol = soliddiamond, symbolsize = 20\right):$

> **#1. The yellow diamond on the plane is the point $\left(\frac{7}{2}, -\frac{3}{2}, \frac{9}{2}\right)$, demonstrating that the point belongs on the plane containing the other 3 points described in the problem.**

>

>

> **#2.**

> $x(t) := 100 \cdot \cos\left(\frac{\text{Pi}}{3}\right) \cdot t$

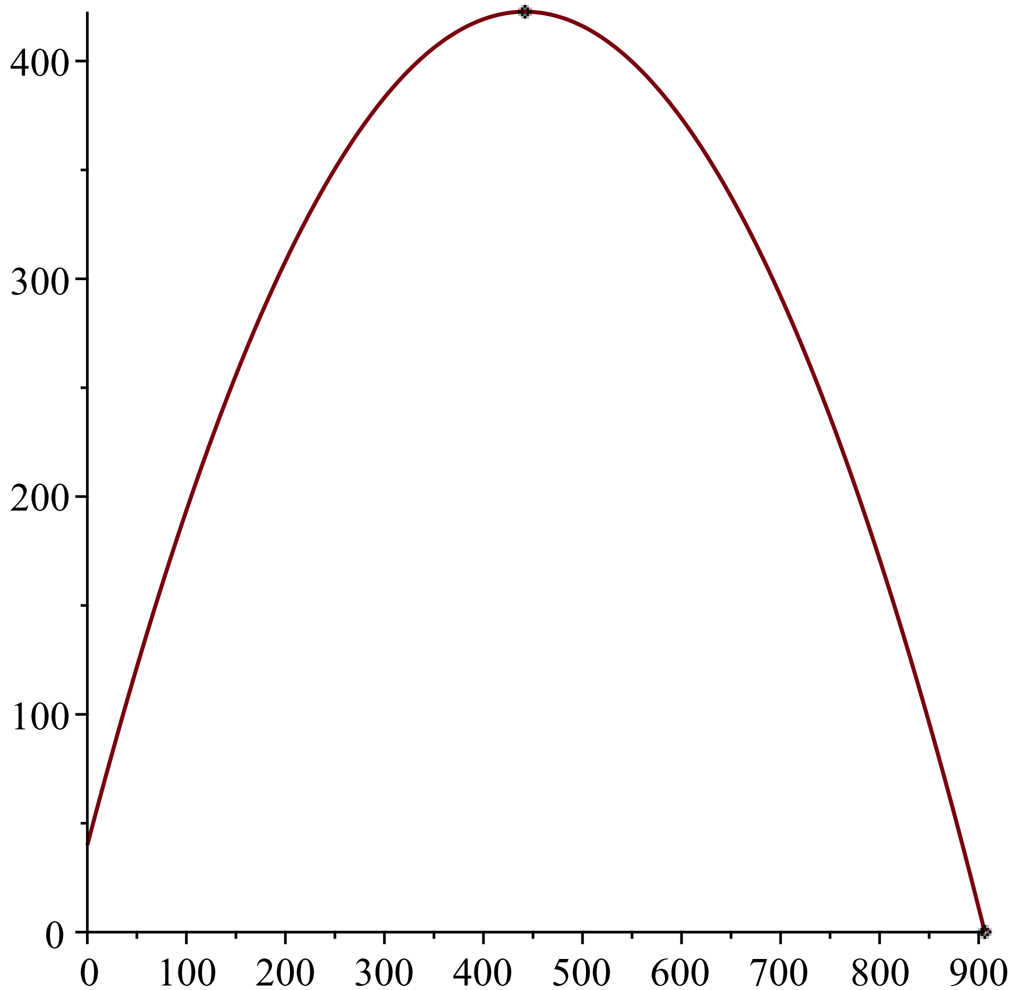
$$x := t \mapsto 100 \cos\left(\frac{\pi}{3}\right) t \quad (1)$$

> $y(t) := 40 + 100\cdot\sin\left(\frac{\text{Pi}}{3}\right)\cdot t - 4.9\cdot t^2$

$$y := t \mapsto 40 + 100\,\sin\left(\frac{\pi}{3}\right)\,t + (-1)\;4.9\,t^2 \tag{2}$$

> $traj := plot([x(t), y(t), t = 0..18.12439004], axes = normal):$

> $display(traj, trajpts)$



> $solve(y(t) = 0, t)$

$$-0.4504022087,\ 18.12439004 \tag{3}$$

> **#2b. The above demonstrates how long the projectile is in the air. The projectile is in the air for 18.12439004 seconds.**

> $evalf(x(18.12439004))$

$$906.2195020 \tag{4}$$

> **#2c. The above demonstrates that the projectile travels 254.1517910 meters in the air before hitting the ground.**

> $solve\left(\frac{d}{dt}(y(t)) = 0, t\right)$

$$8.836993916 \tag{5}$$

> $evalf(x(8.836993916))$

$$441.8496958 \tag{6}$$

```
> #2d. The above demonstrates that the projectile's maximum height
  is 441.8496958 meters.
```

> $evalf\left(\sqrt{subs\left(t=18.12439004, \frac{d}{dt}(x(t))\right)^2 + subs\left(t=18.12439004, \frac{d}{dt}(y(t))\right)^2}\right)$

$$103.8460399 \quad (7)$$

```
> #2e. The above demonstrates finding the magnitude of the vector
  of the projectile trajectory when t = 18.12439004 seconds, which
  is when the projectile hits the ground. This shows that the
  impact velocity of the projectile is 103.8460399 meters per
  second.
```

> $trajpts := pointplot([[x(8.836993916), y(8.836993916)], [x(18.12439004), y(18.12439004)]], color=black) :$

>

```
> #3.
```

> $f(x,y) := x \cdot e^{-2 \cdot x^2 - 2 \cdot y^2}$

$$f := (x,y) \mapsto x\, e^{-2x^2 - 2y^2} \quad (8)$$

> $prob3 := plot3d(f(x,y), x=-4..4, y=-4..4, axes=normal, color=green, labels=[X, Y, Z]) :$

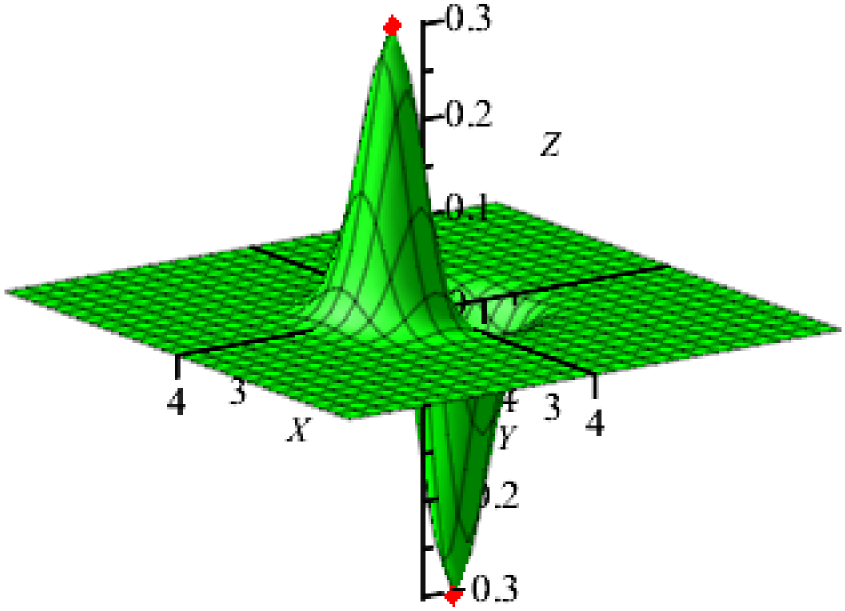
> $solve\left(\frac{\partial}{\partial x}(f(x,y))=0, x\right)$

$$\frac{1}{2}, -\frac{1}{2} \quad (9)$$

> $solve\left(\frac{\partial}{\partial y}(f(x,y))=0, y\right)$

$$0 \quad (10)$$

> $display(prob3, extremes)$



> $extremes := pointplot3d\left(\left[\left[\frac{1}{2}, 0, f\left(\frac{1}{2}, 0\right)\right], \left[-\frac{1}{2}, 0, f\left(-\frac{1}{2}, 0\right)\right]\right], color = red, symbol = soliddiamond, symbolsize = 20\right):$

> **The extrema were identified by taking the partial derivatives with respect to x and y and setting them equal to 0. This resulted in the above local maximum at $\left(\frac{1}{2}, 0, 0.3032653298\right)$ and $\left(-\frac{1}{2}, 0, -0.3032653298\right)$. No need for the R^3 test since the extrema were identified as described above and the graph displays which critical points are the local max and the local min.**

> $evalf\left(f\left(\frac{1}{2}, 0\right)\right)$

$$0.3032653298 \tag{11}$$

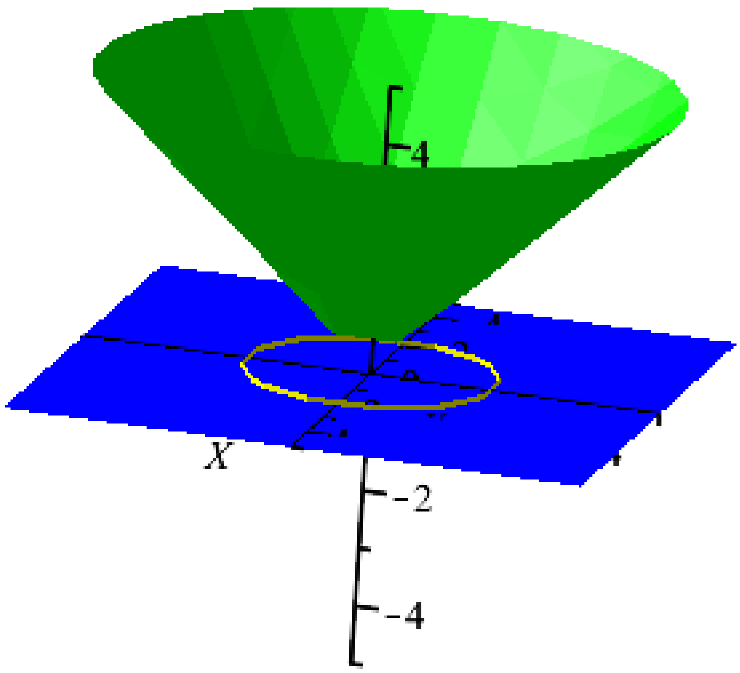
> $evalf\left(f\left(-\frac{1}{2}, 0\right)\right)$

$$-0.3032653298 \tag{12}$$

> **#4.**

> $prob4 := implicitplot3d\left(z = \sqrt{x^2 + y^2}, x = -5 ..5, y = -5 ..5, z = -5 ..5, axes = normal, color = green, labels = [X, Y, Z]\right) :$

> $display(prob4, secondpart, supportingvisual)$



> $secondpart := implicitplot3d\left(x^2 + y^2 \le 5, x = -5 ..5, y = -5 ..5, z = 0 ...1, axes = normal, color = yellow\right) :$

> $supportingvisual := implicitplot3d(z = 0, x = -5 ..5, y = -5 ..5, z = -5 ..5, color = blue) :$

> **Excuse the poor rendering. I attempted to graph using the $\le$ sign, but it wouldn't allow me to do so with the results I wanted. The contents of the yellow circle at the bottom of the graph should be filled out.**

> $\int_{0}^{2 \cdot \mathrm{Pi}} \int_{0}^{\sqrt{5}} r^2 \, \mathrm{d}r \, \mathrm{d}\theta$

$$\frac{10 \sqrt{5} \pi}{3} \quad (13)$$

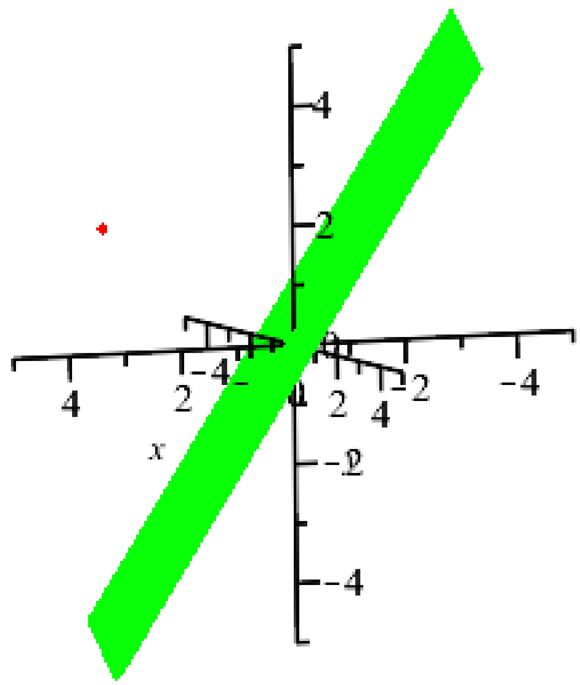
>

> **The above is the volume.** $\frac{10 \sqrt{5} \pi}{3}$

> #5a.

> $P := implicitplot3d(6 \cdot x - 2 \cdot y + 4 \cdot z = 1, x = -5 ..5, y = -5 ..5, z = -5 ..5, axes = normal, color = green)$:

> $display(P, pt)$



> $pt := pointplot3d([3, -1, 2], color = red)$:

> #5a is FALSE. If a line originating from the origin were to be drawn to the point given above, that line would not be parallel to the plane. Because the vector between two points can be found using head - tail, and anything - 0 is itself, the point effectively represents the vector, which is not parallel to the plane.

>

> #5b.

> $f(x, y) := \sin(x) + \sin(y)$

$$f := (x, y) \mapsto \sin(x) + \sin(y) \quad \textbf{(14)}$$

> $\frac{\partial}{\partial x}(f(x, y))$

$$\cos(x) \quad \textbf{(15)}$$

> $\frac{\partial}{\partial y}(f(x, y))$

$$\cos(y) \tag{16}$$

> TRUE.

>

> #5c.

> $\int_1^2 \int_3^4 x^2 e^y \, dy \, dx$

$$-\frac{7e^3}{3} + \frac{7e^4}{3} \tag{17}$$

> $\int_1^2 x^2 \, dx \cdot \int_3^4 e^y \, dy$

$$-\frac{7e^3}{3} + \frac{7e^4}{3} \tag{18}$$

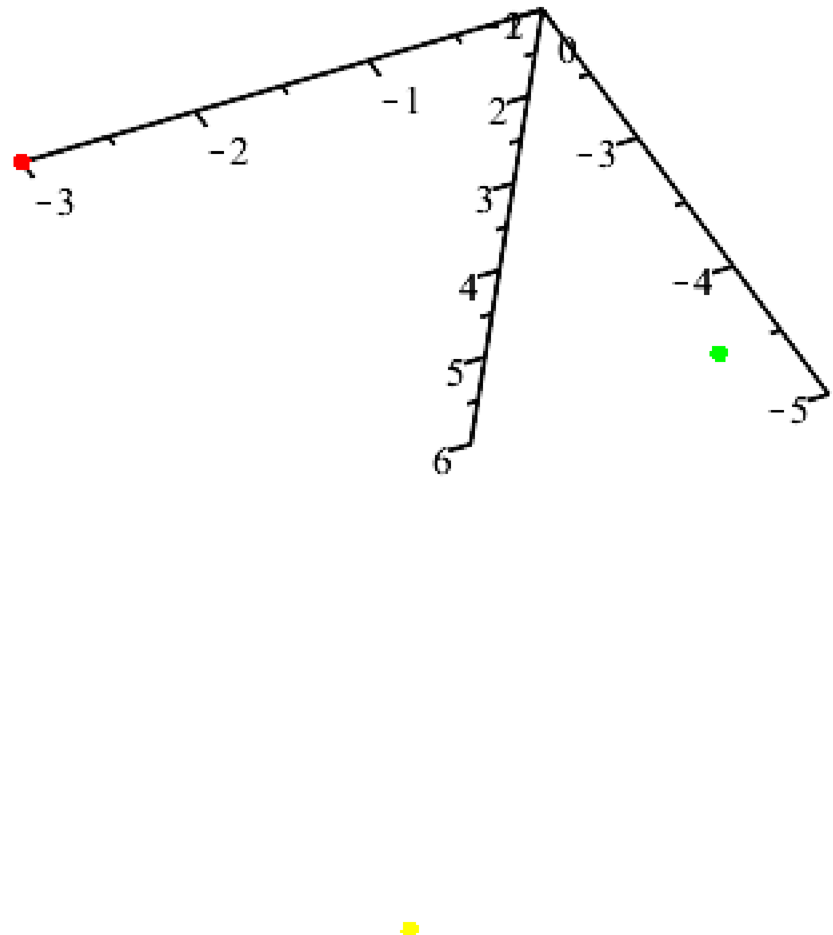
> TRUE.

>

> #5d.

> *pts* := *pointplot3d*([[1,-3,-2], [2, 0,-4], [6,-2,-5]], *axes* = *normal*, *color* = [*red*, *green*, *yellow*], *symbolsize* = 20) :

> *display*(*pts*)



> TRUE. Dot product of vectors from green point to red and yellow points results in 0, which means the vectors are perpendicular to each other, which means the points make up a right triangle.

>

>

> #5e.

> TRUE.

>

> Done by Jacob Hreshchyshyn

>