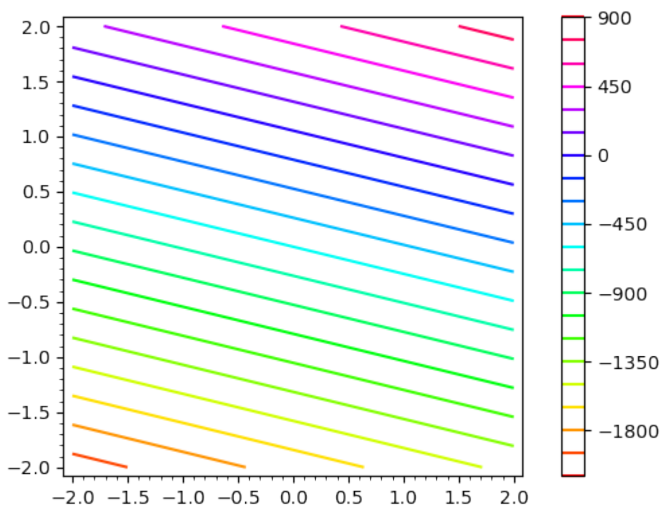
From 9.1:

- Monday: 1, 4, 5, 6, 7
- Wednesday: 2, 3, 8, 14
- Friday: 10, 11, 12, 13, 15, 17

Answers to problems without solutions in the text:

8. (a) The set of points whose distance from the y-axis equals the distance from the xz-plane is a cone opening along the y-axis.
   (b) The equation for the set of points whose distance from the y-axis equals the distance from the xz-plane is $y^2 = x^2 + z^2$.
10. Give a practical interpretation of your answer: $f(2, 3)$ is the concentration of a 2 mg dose in the blood 3 hours after injection.
11. (b) The curves of constant profit in the ab-plane are lines:



14. (a) $z = -12$
    (b) $x = 7$
    (c) Using the equation of a sphere we know $(x-2)^2 + (y-1)^2 + (z-3)^2 = r^2$ for some r. We can then use the fact that $(-1, 0, -1)$ will be on the sphere and thus satisfies our equation to find r:

$$\begin{aligned} (-1-2)^2 + (0-1)^2 + (-1-3)^2 &= r^2 && \text{(plugging in } (-1,0,-1)) \\ 26 &= r^2 && \text{(simplifying LHS)} \end{aligned}$$

    Equivalently, you can think of this as finding the distance between the points $(2, 1, 3)$ and $(-1, 0, -1)$ to get the radius. Our full equation is: $(x-2)^2+(y-1)^2+(z-3)^2 = 26$.
    (d) We know the endpoints of the diameter, so we can find the distance between those

endpoints and divide by 2 to get the radius. The diameter is

$$\sqrt{(-3-7)^2+(1-9)^2+(-5+1)^2} = 6*\sqrt{5}$$

so the radius is $r = 3*\sqrt{5}$ and $r^2 = 9*5 = 45$.

The sphere will be centered halfway between its endpoints, at $(2, 5, -3)$. Our equation is thus $(x-2)^2+(y-5)^2+(z+3)^2 = 45$.

15. (a) The trace of V when $P = 1000$ is $V(1000, T) = \frac{8.314T}{1000} = 8.314*10^{-3}*T$. This equation tells us that for a fixed pressure of 1000 pascals, the trace with respect to temperature is $8.314*10^{-3}*T$. In other words, as temperature increases by 1 degree Kelvin the volume increases by $8.314*10^{-3}$ cubic meters and we have a linear relationship (with a very shallow positive slope) between temperature and volume.
    (b) The trace of V when $T = 5$ is $V(P, 5) = \frac{8.314*5}{P} = \frac{41.57}{P}$. This equation tells us that (when T is fixed) volume and pressure are inversely proportional for ideal gasses.
    (c) The points on the level curve for $V = 0.5$ are pairs (P, T) for which $V(P, T) = 0.5$. For each pair we know that if there are P pascals of pressure and the temperature is T, the gas will take up 0.5 cubic meters.
    (d) Click for WolframAlpha.
    (e) Increasing temperature increases the volume in a linear fashion, where increasing pressure decreases volume in a sharp curve. Near the origin (no pressure and no temperature) the volume tends to infinity! Also interesting is we can see how if pressure increases we need to increase the temperature to stay at the same volume (level curve).
16. (a) If the interest rate is $r = 0.06$ and the duration is $t = 5$, then

$$\begin{aligned} M(0.06, 5) &= \frac{1500*0.06}{1-\frac{1}{\left(1+\frac{0.06}{12}\right)^{12*5}}} \\ &\approx 347.99 \end{aligned}$$

so the monthly payments are around \$348 per month.
    (b) Fixing $r = 0.05$, we get the following table of trace values along t.

t (years)	2	3	4	5	6
M (\$)	789.69	539.48	414.53	339.68	289.89

With a fixed interest rate of 5%, we can see that increasing the number of years one has to pay off the loan decreases the amount paid each month. The decrease is sharp at first, then starts to level off.
    (c) Fixing $t = 3$, we get the following table of trace values along r.

r (%)	3	5	7	9	11
M (\$)	523.46	539.48	555.79	572.40	589.30

With 3 years fixed to pay off the loan, we can see that increasing the rate gently increases the amount to pay each month.

(d) If $M(r,t) = 200$ then

$$\begin{aligned}
200 &= \frac{1500r}{1 - \frac{1}{\left(1+\frac{r}{12}\right)^{12t}}} \\
1 - \frac{1}{\left(1+\frac{r}{12}\right)^{12t}} &= \frac{1500r}{200} \\
1 - \frac{15r}{2} &= \left(1 + \frac{r}{12}\right)^{-12t} \\
\ln\left(1 - \frac{15r}{2}\right) &= -12t \ln\left(1 + \frac{r}{12}\right) \\
\frac{\ln\left(1 - \frac{15r}{2}\right)}{-12\ln\left(1+\frac{r}{12}\right)} &= t.
\end{aligned}$$

Click here for Wolfram graph. This upward curve represents how if we're only allowed to pay off \$200 per month, an increase in interest rate increases the amount of time needed to pay off the loan.

17. (a) We aren't allowed to plug negative numbers into the square root, so we cant have $4 - x^2 - y^2$ be negative. We can rewrite this as

$$\begin{aligned}
0 &\leq 4 - x^2 - y^2 \\
x^2 + y^2 &\leq 4
\end{aligned}$$

which is satisfied by (x, y) pairs within a circle of radius 4. In other words, the domain is a circle of radius 4.

(b) The range of h is $[6, 8]$.

The range of the square root function is $[0, \infty)$, so the smallest $\sqrt{4 - x^2 - y^2}$ can be is 0. When computing h we then take at least 0 away from 8, so the most h can be is 8. On the other hand, since we're plugging real numbers in for x and y, if either x or y is nonzero it'll decrease $\sqrt{4 - x^2 - y^2}$, so the largest $\sqrt{4 - x^2 - y^2}$ can be is $\sqrt{4 - 0^2 - 0^2} = 2$. Then h takes at most 2 away from 8 and has to be at least 6.

(c) From Figure 1, we see that the shape of a typical level curve is a circle.

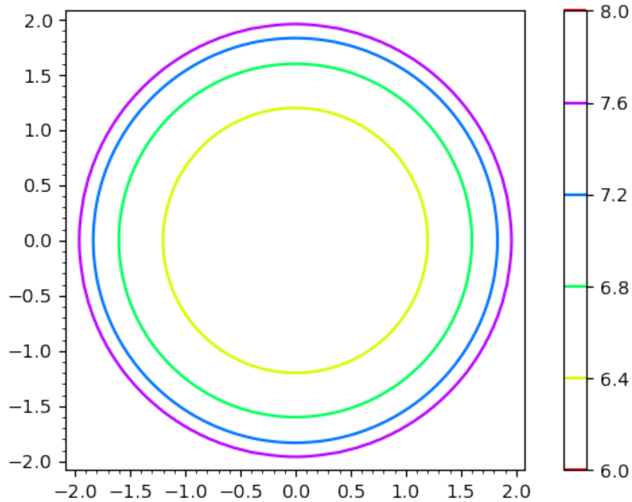


Figure 1: 4 level curves for h at 6.4, 6.8, 7.2 and 7.6.

(d) In Figure 2 the curve for $x = 2/5$ is the same as $x = -2/5$ and is at the top, the curve for $x = 1/5$ is the same as $x = -1/5$ and is in the middle, and the curve for $x = 0$ is at the bottom.

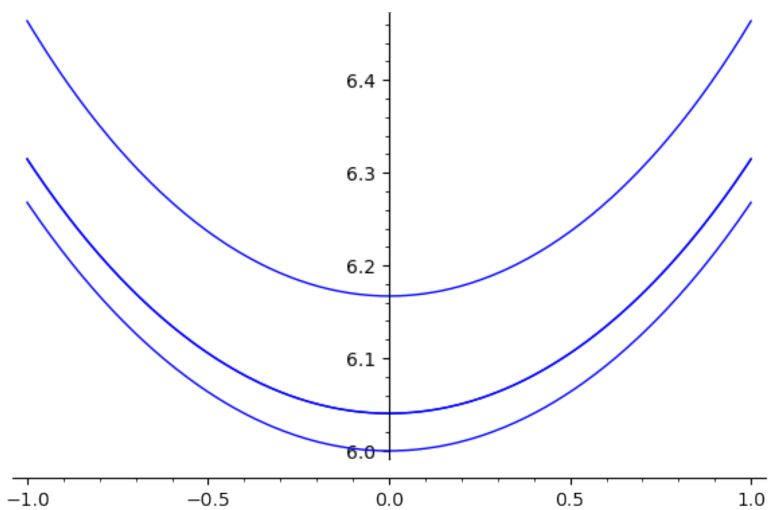


Figure 2: Select curves for the trace of h along y.

(e) Due to the symmetry of h in the x and y directions, part (e) should give you almost exactly the same graph as (d), but with the roles of x and y swapped.

(f) It looks like a bowl! Plot in WolframAlpha.