Review sections §12.2-12.5 and §13.1 in Hughes-Hallett.
The odd numbered problems in the Exercises (the first chunk of problems) in each section are
worthwhile practice for before the problem set. Answers are in the back for odd numbered problems,
and solutions are in the student solutions manual on reserve in Cabot.

1. Complete the problems posted via WeBWorK.
   These problems are on a mix of topics from §12.2-12.5, 13.1.
   The catalog of surfaces in 12.5 may be a useful reference.
   For the WeBWorK:
   (a) Write up your work for question 6.
   (b) Write up your work for the second half of question 7.
   (c) Explain your reasoning for question 12.
   (d) Write up your work for question 15.
   Submit these writeups as part of your problem set on Gradescope.
   For reference:
   Hughes-Hallett 12.2 3, 23. 12.3 17, 18, 27, 36. 12.4 12. 12.5 1, 6, 23. 13.1 25, 39
   Stewart 12.6 21

2. A wave travels in an irrigation channel, with $x$ its distance along the channel and $t$ the time.
   Let $z$ be the height of the water above a baseline level. The graph of $z$ as a function of $x$ and
   $t$ is given below.
   
   (a) Is the plot given in $txz$-space or in $xtz$-space? Think about the axes labels in analogy to
   $xyz$-space. Is $txz$ a right-handed coordinate system or is $xtz$?
   (b) Draw profiles of the wave using $xz$-axes for times $t = 0, 1, 2$ (these are cross-sections).
   (c) What is the name of the shape of these profiles? (Are they parabolas, hyperbolas, circles,
   lines, sine curves, etc.) The surface is a type of cylinder. What type of cylinder is it?
   (d) Determine whether the wave is traveling in the direction of increasing $x$ or decreasing $x$.
   Explain how you decided.
   (e) Which of the following functions is the best match for this plot?
   
   $f(x, t) = -(x + t)^2 + 2, f(x, t) = -(x - t)^2 + 2, f(x, t) = e^{-(x-t)^2}, f(x, t) = e^{-(x+t)^2}$
   Justify your choice using reasoning about cross-sections.
(f) Use Matlab to make a plot where the wave is moving in the opposite direction as time increases. You can modify the code below if you like - it’s the code I used to make the plot above.

```matlab
1 syms x t
2 f = @(x,t) % Unknown function here.
3 fsurf(x,t,f(x,t),[-3 3 -3 3],'facealpha',0.8,'edgecolor','none')
4 fsurf(t,x,f(t,x),[-3 3 -3 3],'facealpha',0.8,'edgecolor','none')
5 % plot the surface with points (x,t, f(x,t)) or with points (t,x, ...
6   f(t,x)).
7 % Choose one of the fsurf lines to use (the one that matches your ... 
8   answer in (a) and the plot shown above).
9 % facealpha sets the transparency.
10 % edgecolor turns off having parallelogram edges on the surface.
11 axis equal % set the axes to the same scales
12 xlabel('?'); ylabel('?'); zlabel('z') % label the axes — fill in ...
13 % label the axes — fill in ...
14 set(gca,'FontSize',14) % make the fonts bigger.
15 axis([-3 3 -3 3 0 2]) % set axes bounds
16 caxis([-1 10]) % set the range associated with the color of the ...
17 light('position',[3,-3,3], 'style', 'local') % add lighting
```

3. The power, \( P \) (units of \( \text{ML}^2 \text{T}^{-3} \)), produced by a windmill is proportional to the density of the air pushing the blades, \( d \) (units \( \text{ML}^{-3} \)) to the square of the diameter of the windmill, \( r \) (units \( \text{L} \)), and to the cube of the wind speed, \( v \) (units \( \text{LT}^{-1} \)). (\( \text{M} = \text{mass}, \text{L} = \text{length}, \text{T} = \text{time} \)). See [http://faculty.buffalostate.edu/sabatojs/courses/GES497/F08/dimensional_analysis.pdf](http://faculty.buffalostate.edu/sabatojs/courses/GES497/F08/dimensional_analysis.pdf) for more information. Following the instructions in the WeBWorK problem, sketch a contour diagram for \( P \).

*It is fine to make the diagram in Matlab - I don’t know how to do the contour labeling via Matlab at the moment, so if you figure it out please let us know via Piazza. Or you can use Matlab to help you figure out the contours that you sketch and label by hand. Note: stay in a physically plausible range for the values of the variables.*

4. The table below gives the number of calories burned per minute, \( B \), by someone roller-blading, as a function of the person’s weight, \( w \) and speed, \( s \).

<table>
<thead>
<tr>
<th>Table 12.10</th>
<th>Calories burned per minute</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weight</td>
</tr>
<tr>
<td>120 lbs</td>
<td>4.2</td>
</tr>
<tr>
<td>140 lbs</td>
<td>5.1</td>
</tr>
<tr>
<td>160 lbs</td>
<td>6.1</td>
</tr>
<tr>
<td>180 lbs</td>
<td>7.0</td>
</tr>
<tr>
<td>200 lbs</td>
<td>7.9</td>
</tr>
</tbody>
</table>

<sup>7</sup>From the August 28, 1994, issue of *Parade Magazine.*
(a) The data in this table is approximately linear. Give a linear formula that approximates $B$ in terms of $w$ and $s$. There are multiple possible solutions, so show how you arrived at your formula as part of your solution.

(b) For what range of weights and speeds do you think this formula seems to be a reasonable model for the calories burned by a roller-blading adult? This is mostly a judgement call by you: you are choosing a domain over which you think it makes sense to apply the linear approximation you developed above. Explain your choices.

5. Use vectors to show that the medians of a triangle intersect at a point $\frac{1}{3}$ of the way along each median from the side it bisects.

One way to do this is to find a way to use vectors to construct a point $1/3$ of the way along each median, and then to show that all of those points are the same point.

A clear diagram for this problem will be posted to Piazza on Monday Sept 17. I’m not including it here so that you have the chance to ponder this, and to try to frame it into a vector addition/multiplication/subtraction problem yourself, if you’d like.