OCES 2003 Assignment 1, Spring 2021

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Set on: Tue 16th Feb; due: Tue 23th Feb

Blurb

- Assignments have a maximum mark out of 20, although you will see that there are 22 marks available to get in total, i.e. if you get 22/20 you still only get credit for 20/20
  - 16-17 is roughly around the A- boundary
  - anything below 8 is probably a fail
  - there may or may not be bonus prizes for those who consistently try to get beyond the maximum mark, or you can use it to satisfy your own ego that you went above and beyond :)
- There will be at least one question that is 'hard' and/or 'open-ended'
- Please show working in calculation
  - no working + wrong answer = no credit whatsoever
  - some working + wrong answer = partial credit
  - generically, give things to 2 decimal place and provide the appropriate units (marks are allocated for these), unless otherwise specified
- No answers except the 'hard' ones should need more than a paragraph / half a page. Excess answers that are not to the point will be penalised.
- Type up the assignment or send a photo of your written up work in (the former is preferred). The only request I have is no Microsoft Word documents (you can type up things with Word but export it as a pdf if you do).
  - write in full sentences where appropriate
  - particularly poor and/or scrappy presentation will have a mark that can be taken off
- There will be a rigid mark scheme, and model solutions will be available in due course
  - the TAs only mark the stuff, you should come to the instructor for arguing marks, and note the re-marking can result in marks going up or down

Problems

1. Name four of the world's Western Boundary Currents and their geographical locations. [1 mark]

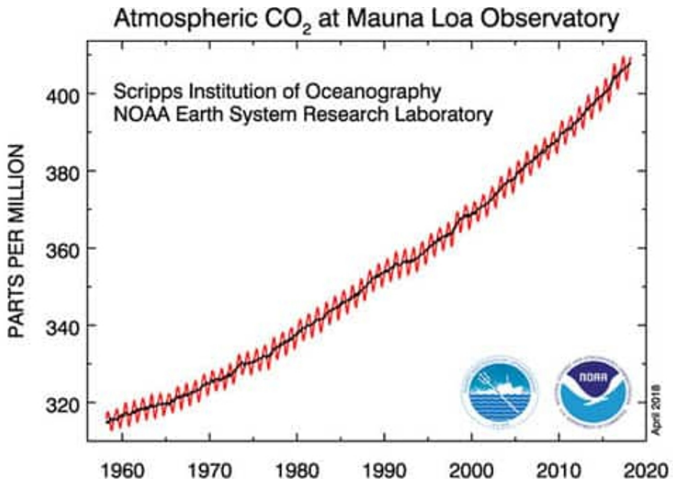
2. This question concerns the *Leeuwin current* (look this up).

   (a) Where is the Leeuwin current located? [1 mark]

   (b) How is this current different to other typical *East*ern boundary currents? [1 mark]

   (c) A typical quoted speed of the current is around 1 knot = 1.852 km per hour. Translate this typical speed into units of meters per second (show your working and give final answer to two decimal places). [2 marks]

3. Consider the following graph showing CO_2 concentration against time:



   Denoting the concentration of CO_2 as $[CO_2]$ and time as t, state whether $\partial[CO_2]/\partial t$ is positive or negative. Justify your answer. [1 mark]

4. As above, but for

$$\frac{\partial^2[CO_2]}{\partial t^2} = \frac{\partial}{\partial t}\frac{\partial[CO_2]}{\partial t}.$$

   Again, justify your answer. What does your answer actually mean? [2 marks]

5. Pictorially or otherwise (but show your working), find the answer to the following:

   (a) $-\boldsymbol{e}_x \times \boldsymbol{e}_z = ?$

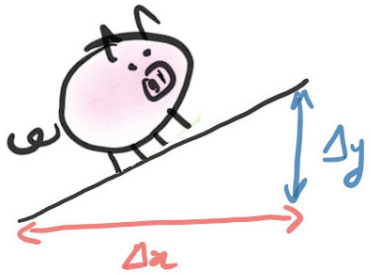
   (b) $\boldsymbol{e}_z \times ? = -\boldsymbol{e}_x$

   (c) $\boldsymbol{e}_x \cdot (\boldsymbol{e}_y \times \boldsymbol{e}_x) = ?$

   (d) $(\boldsymbol{e}_x \times \boldsymbol{e}_y) \times \boldsymbol{e}_z = ?$ [2 marks]

6. Draw or state a 2d non-zero flow that has no curl or div. [1 mark]

7. Consider our neighbourhood friendly pig on an inclined slope:



   (a) Comment on why "*the pig weighs 100 kg*" is technically an incorrect statement. Provide an appropriate correction. [1 mark]

   (b) Draw on the pig's weight and the normal force. Where is the pig going to go just by consideration of these two forces (justify your answer)? [2 marks]

   (c) Draw on the frictional force based on the above answer (justify your answer). [1 mark]

   (d) Is the frictional force a vector or a scalar (justify your answer)? [1 mark]

8. (Harder + open-ended) Given what you have learnt so far, speculate on what might happen to global sea level on long time-scales (say more than 100 years) if for whatever reason the Strait of Gibraltar is blocked off, providing appropriate reasons to back up your claims. What about on even longer time-scales (say 1000 or 10,000 years), and what other effects might there be? Provide appropriate arguments to back up your statements, and if you used sources, cite those as well. Claims that are not backed up accordingly (either by referencing or arguing using plausible logic) gets no credit.

   (Minor hint: each appropriate point mentioned gets about 0.5 marks. 1 mark is allocated for referencing.)

   [6 marks]

!? (No marks bonus question for those more mathematically inclined.) Intuitively we might expect that, if friction is large enough, then our pig friend might just stay put even if it is on an inclined slope (lets assume it hasn't eaten so much that it is round). Suppose the pig is of mass m, the slope makes an angle of ϕ with the horizontal, the normal force is denoted R, and the friction can be represented by $\mu|R|$, where $|R|$ is the magnitude of the normal force and μ is the coefficient of friction (it's just a number). Taking gravitational acceleration to be g pointing downwards, find the condition μ should satisfy for some given ϕ if the pig is to stay put and not move. Give me the associated maximum ϕ if μ is smaller than or equal to 1.

   (Hint: draw some forces and angles in, and you need to do some secondary school trigonometry.)