MANCHESTER 1824

The University of Manchester

Active learning in lectures

Dr Lloyd Cawthorne
Physics & Astronomy

My courses

- PHYS20161, Introduction to Programming for Physicists
  - Year 2, semester 1, 10 credits
  - Core, ~310 enrolled
  - Python from scratch to 2D optimisation, continuously assessed.
  - Started teaching in 18/19
- PHYS30121, Introduction to Nuclear & Particle Physics
  - Year 3, semester 1, 10 credits
  - Core, ~300 enrolled
  - Half nuclear, half particle
  - Started teaching in 19/20
- PHYS10352, Properties of Matter
  - Year 1, semester 2, 10 credits
  - Core, ~370 enrolled
  - Half Classical Thermodynamics; half solids, liquids and gasses.
  - Started teaching in 21/22

PHYS20161, Introduction to Programming for Physicists

Cawthorne, L. *J Mater Sci* 56, 16183–16194 (2021).

Rewrote course in 2019 due to larger cohort.

Blended delivery:

- ~50 mins of 5-10 min videos per week (tapers towards end of term).
- 1h per week interactive session where students answer polls (TurningPoint, Staffnet information on setting up).

Assessment:

- 5 quizzes in weeks 1-3, 7 & 8 worth 7% each. Practice versions of each available.
- 2 assignments due in weeks 4 and 12 worth 15% & 50% respectively.

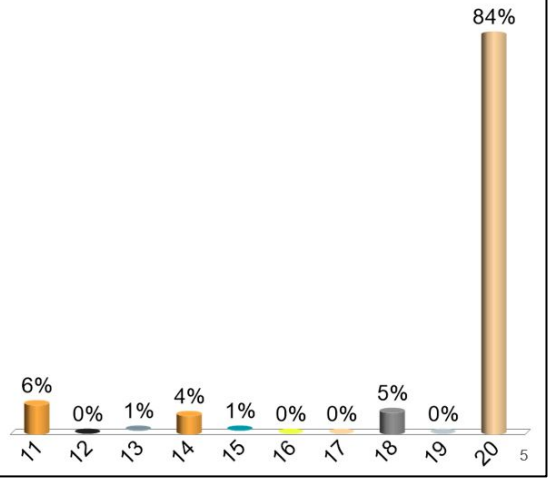
Support:

- 6h per week computing labs facilitated by many GTAs
- Piazza discussion board

- Basic debugging; understanding syntax

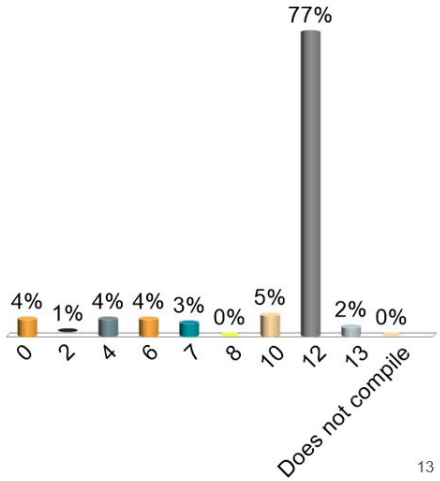
What line is the error on?

```
11 def square_number(number):
12     """
13     Squares input
14     number (float)
15
16     Lloyd Cawthorne 29/08/19
17     """
18     number_squared = number**2
19
20 return number_squared
```



number = 6, what will be printed?

```
11 counter = 0
12 total = 0
13
14 while counter <= number:
15
16     if counter % 2 == 0:
17
18         total = counter + total
19
20     counter +=1
21
22 print(total)
23
```



13

- Logic & iteration; Following code

Feedback / my impression

Pros:

- Vocational courses are well suited to blended learning.
  - Students very much learn by doing, they gain very little from watching me *do* passively.
- Poll results show me where I need to spend time going through content.

Cons:

- Difficult to ask useful poll questions towards the end of the course.
  - Limited on what is reasonable for students to answer in a few minutes.
  - Students fall behind.
  - Will add *purpose-first* programming questions.

PHYS30121, Introduction to Nuclear & Particle Physics

Blended delivery:

- ~60 minutes of videos per week
- Typed notes
- 2h block:
  - 1st hour polls and examples (Pingo: https://trypingo.com/, guidance on setting up)
  - 2nd hour Q&A (Google slides)

Assessment:

- 1h 30 min exam in January

Support:

- 1h examples classes delivered every two weeks
- Piazza discussion board

- Using formula; common misconception

What is the ground state spin & parity of $^{41}_{20}\mathrm{Ca}$?

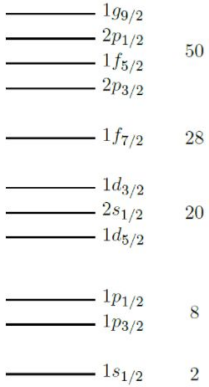
$\frac{3}{2}^+$

$\frac{1}{2}^+$

$\frac{3}{2}^-$

0^+

$\frac{7}{2}^-$



Cannot be determined.

https://pingo.coactum.de/051970

- Highlighting important aspect

Is the reaction $^{190}_{73}\mathrm{Ta} \rightarrow ^{190}_{74}\mathrm{W} + e^- + \bar{\nu}_e$ likely?

- Yes
- No
- Need more information
- Not sure

$M_{\mathrm{at.}}(^{190}_{73}\mathrm{Ta}) = 189.96923\ \mathrm{u}$

$M_{\mathrm{at.}}(^{190}_{74}\mathrm{W}) = 189.96318\ \mathrm{u}$

$m_e = 5.4858 \times 10^{-4}\ \mathrm{u}$

$m_\nu < 4 \times 10^{-9}\ \mathrm{u}$

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- Applying method; underlying principles

Which cluster decay will be the most likely?

$^{238}_{94}\mathrm{Pu} \rightarrow ^{234}_{92}\mathrm{U} + ^{4}_{2}\mathrm{He},\ Q = 5.59\ \mathrm{MeV}$

$^{238}_{94}\mathrm{Pu} \rightarrow ^{210}_{82}\mathrm{Pb} + ^{28}_{12}\mathrm{Mg},\ Q = 75.91\ \mathrm{MeV}$

$^{238}_{94}\mathrm{Pu} \rightarrow ^{206}_{80}\mathrm{Hg} + ^{32}_{14}\mathrm{Si},\ Q = 91.19\ \mathrm{MeV}$

$T = \exp\left(-\sqrt{\frac{E_G}{Q_\alpha}}\right)$ $\qquad E_G = 2(\pi Z_1 Z_2 \alpha)^2 M_r c^2$

Feedback / my impression

Pros:

- More time for examples.
- Polls allow me to highlight common misconceptions and subtleties.

Cons:

- This year students did not like the blended approach.
  - Remotely this was popular, UEQ>4. This year UEQ~3.6.
  - This year it *reminded them of lockdown.*
- They do not like unstructured Q&As.
  - Difficult to conduct a seminar with 300 students.
  - This can be done more inclusively on discussion boards (Piazza).
- Students do not like the polls if they have not watched the videos beforehand.
  - Students do not like compulsory videos.
- In future, will remove Q&A in favour of time spent reviewing the material before polls.

PHYS10352, Properties of Matter

Hybrid delivery:

- ~50 minutes of videos per week
- Typed notes
- 1h review/introduction, Tuesdays.
- 1h interactive polls, Fridays (Pingo).

Assessment:

- 1h 30 min exam (90%) and tutorial participation (10%)

Support:

- Weekly tutorials: example sheet and ~30 minutes with GTA.
- Piazza discussion board.

- Use of machinery; Drilling question

Why does it rotate slower on the cold heat bath?

A. Because it is rotating in the opposite direction
B. Because $T_{\mathrm{H,cup}} > T_{\mathrm{C,plate}}$
C. Because $T_{\mathrm{H,cup}} - T_{\mathrm{air}} > T_{\mathrm{air}} - T_{\mathrm{C,plate}}$
D. Because $V_B > V_A$
E. Because of friction

- Practice underlying principles; prepare for upcoming content

Given the Helmholtz free energy is defined as $F = E - TS$ and $dE = TdS - PdV$, which relationships are correct?

$$S = -\left(\frac{\partial F}{\partial T}\right)_V$$
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$$T = -\left(\frac{\partial F}{\partial V}\right)_S$$
$$P = -\left(\frac{\partial F}{\partial V}\right)_T$$
$$V = \left(\frac{\partial F}{\partial S}\right)_T$$
$$F = \left(\frac{\partial S}{\partial E}\right)_V$$

https://pingo.coactum.de/215009 10

- Use demonstration to support question; cement idea

Consider the system displayed in the diagram. Select all statements that are true.

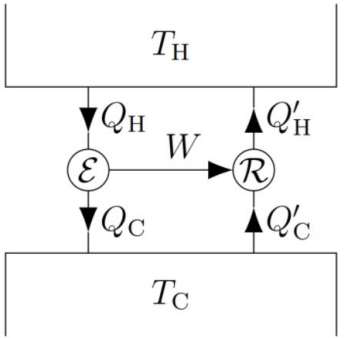
$Q'_{\mathrm{H}} - Q_{\mathrm{H}} > 0$

$Q_{\mathrm{C}} - Q'_{\mathrm{C}} > 0$

$\eta_{\mathcal{R}} = \frac{Q'_{\mathrm{C}}}{Q_{\mathrm{H}} - Q_{\mathrm{C}}}$

$Q_{\mathrm{C}} < Q_{\mathrm{H}}$

$W < 0$



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Feedback / my impression

- This is perhaps the most challenging core course that semester.
  - Other courses build on concepts seen in S1 or A-level.
  - Thermodynamics can easily be a course in itself.

Pros:

- Over a cycle students review content 4 times.
- I can tailor the interactive session in response to questions raised earlier in the week.
- Have time to include demonstrations.

Cons:

- Hybrid approach is hard to deliver.
  - Can say everything quickly, or skip parts.
  - Students do not like being taught at pace.
  - Current feedback suggests I will need to revert back to something more traditional next year.
- Other courses are taught differently.

Summary

- Active learning for large cohorts is fun!
  - I like seeing how well students have understood the content.
  - Students enjoy answering the questions.
- There are a number of technologies and question types that can support active learning. [Questioning technique pocketbook; Pope, G.]
- There are still challenges:
  - A significant number of students still fall behind.
  - Traditional delivery is *easier*.
- Interactive sessions take a long time to prepare (5-6h) and require time for reflection.
- What is expected from students for each course is inconsistent and hence unclear.

Thank you for listening! Any questions?

- I am a TF lecturer on my 4th fixed term contract.
  - I am expected to try new things.
  - UEQ scores affect my job security.
    - Why are these so important?
      Feder, T. Physics Today 73, 1, 24 (2020)

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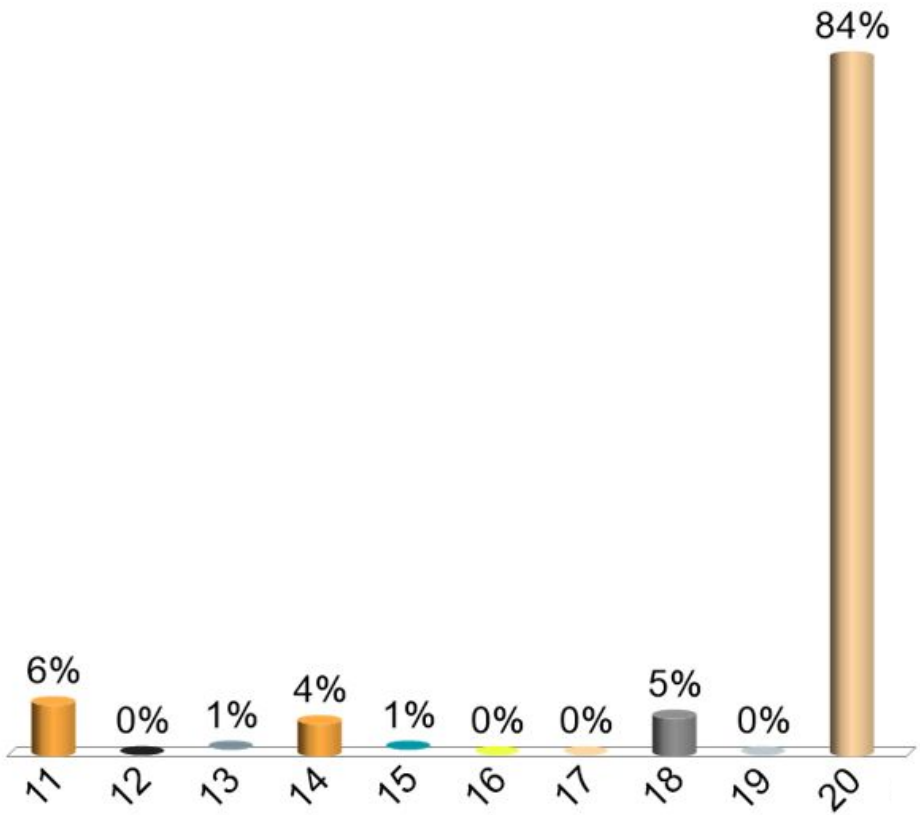

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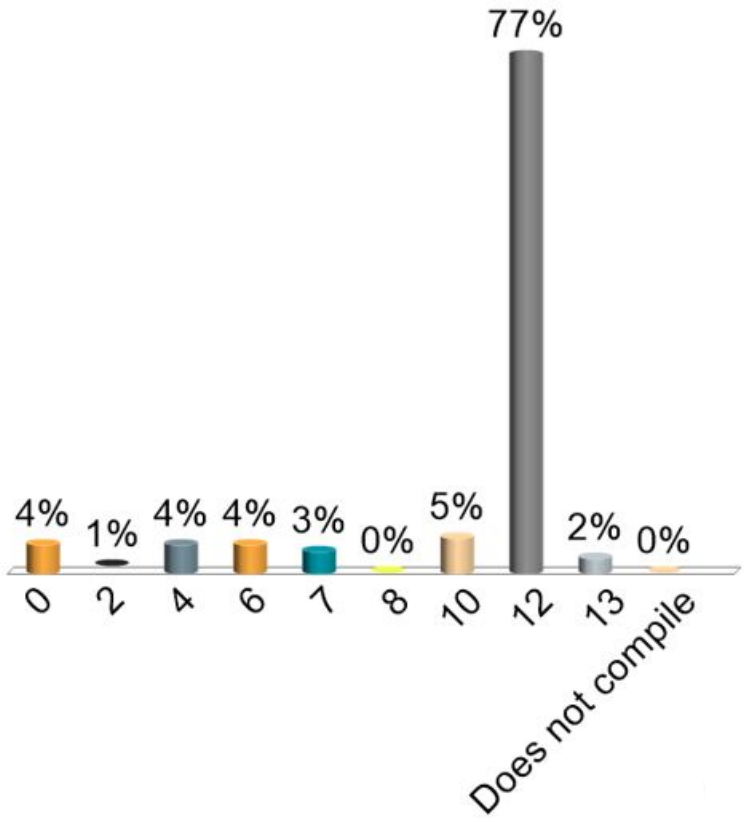

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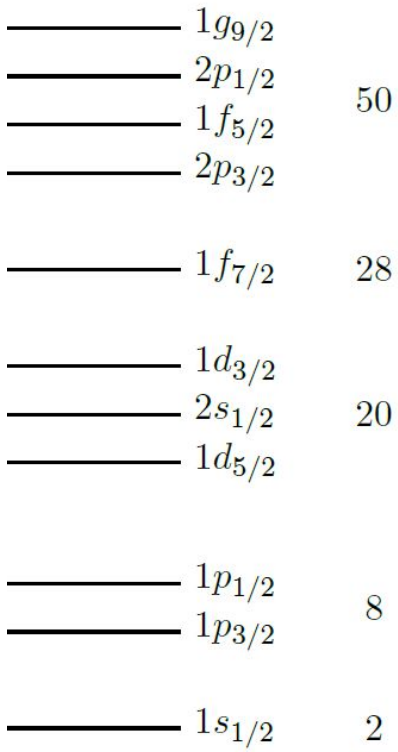

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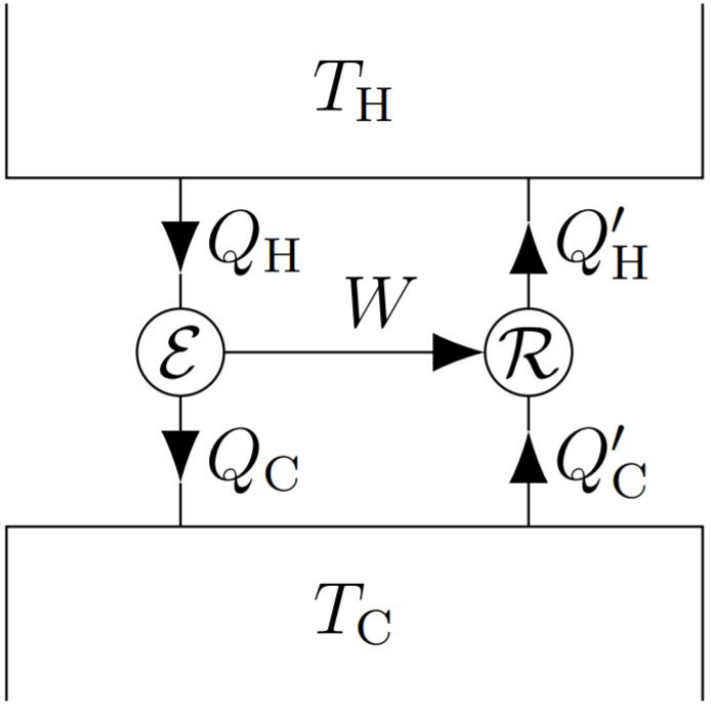

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PHYS10352 student poll on course format (370 enrolled)