

Problem Set 1: Think like a physicist

Issued on 11th June 2026 solutions webinar hosted on 17th June 2026 - written by Dr Justin Palfreyman

1. Warm up [No calculator]

A race has 2026 entrants, all numbered from 1 to 2026 at random.

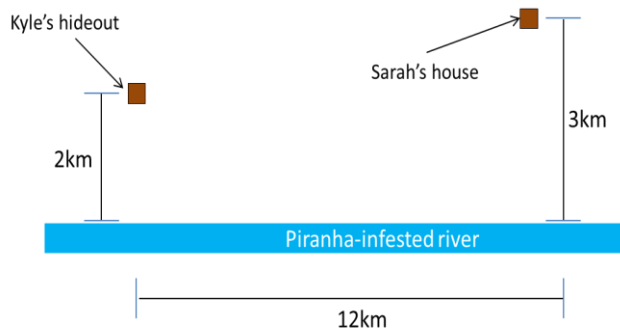
What is the probability that the first three runners to cross the finish line are numbered in ascending order?

*Note – they do **not** need to be consecutive, for example 172, 560, 1843 is ok.*

2. Fetching Water

Sarah Connor is living off the grid and does not have access to fresh water. Following a recent impaling, she is unable to walk. Her survival is vital for the future of humanity. Each day Kyle Rees must travel from his hideout with a bucket, which he fills with water from the piranha-infested river. Needing to conserve his strength (he's also injured), he doesn't want to walk further than is absolutely necessary.

What is the minimum distance Kyle needs to travel to get to Sarah's house via the river?



3. Coach ride

A person travels from Newcastle to Oxford by coach. Traffic is free-flowing and the coach's speed is only limited by whether the road is flat (63 mph), uphill (56 mph) or downhill (72 mph).

The coach ride takes 4 hours from Newcastle to Oxford, but the return journey, which follows the same roads, takes an hour longer.

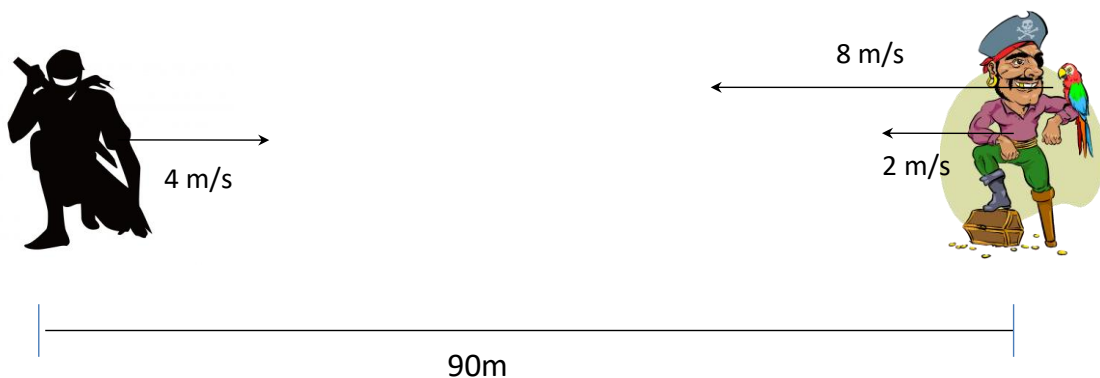
How many miles is the coach ride between Newcastle and Oxford?

4. Pirate v Ninja [No calculator]

It's finally time for a battle to end the long running dispute between pirates and ninjas. They face off at 90 m. The pirate limps towards the ninja at 2 ms^{-1} , while the ninja glides towards the pirate at twice the speed.

It is only a matter of time before they collide and crush the loyal parrot which repeatedly flies back and forth at a constant speed of 8 ms^{-1} , elastically bouncing off the two.

What is the total distance the poor parrot travels before being crushed?



5. Trams in Geneva

On a school trip to visit CERN, I walk down a long street at 1 m/s for an hour. During this time, I count the number of trams that pass me by.

Knowing that they follow a regular timetable in both directions I am initially surprised to note that only 15 trams overtake me, whereas 20 passed me head on.

What is the average speed of the trams?

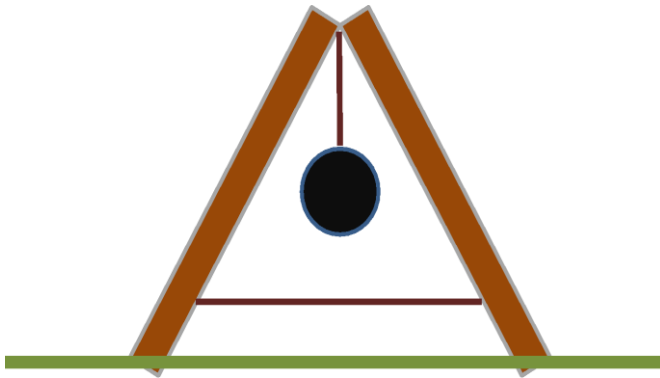
6. Marble in a Fishbowl [No calculator]

A 'fishbowl' of height $\frac{4r}{3}$ is formed by removing the top third of a sphere (radius r). The fishbowl is fixed in sand so that its rim is parallel with the ground. A small marble of mass m rests at the bottom of the fishbowl.

Find the maximum initial velocity that could be given to the marble for it to land back in the fishbowl.

Hint: Assume all surfaces are frictionless and ignore air resistance.

7. **Trusses** [No calculator – use $g \sim 10 \text{ m/s}^2$]



A ball of weight 500 N is suspended from the apex of the structure shown on the left. The structure is made of two trusses, each of length 3.0 m and mass 40 kg.

A 3.0 m horizontal rope connects the trusses, tied a sixth of the way up the trusses.

If the structure were placed on an ice-rink, calculate the resulting tension in the rope.

8. **Race against gravity**

Answer this conceptual question from Paul Hewitt. Be sure to justify your answer¹.

Next-Time Question

CONCEPTUAL Physics

Consider the pair of identical blocks about to be simultaneously released from rest. Block A is completely free, and Block B is attached to one end of a massive chain, the other end held as shown. When dropped, both blocks hit the floor below—a vertical distance equal to the length of the chain.

Which block hits first?

thank to Dove Kagan and Alan Kott

ARBOR SCIENTIFIC
TOOLS THAT TEACH

Hewitt
Drew it!

The graphic contains a diagram showing two hands holding blocks A and B. Block A is a simple cube. Block B is a cube attached to a chain. The chain is held by a hand at the top, and the other end of the chain is attached to block B. The chain is shown hanging vertically. The blocks are positioned above a horizontal line representing the floor.

¹ Derek from Veritasium actually does this experiment: <https://www.youtube.com/watch?v=1erU-Cwcl2c>