Time

SACE Stage 2 physics

Historically

- Time simply ticks one second at a time

You

- As the observer, your time is always the same, every second seems like every other second no matter what is happening around you

But gravity

- Gravity slows time
- Just think of this – the earth's core is younger than its surface? Wow
- But … you cant feel the difference between every one of your seconds feels like any other second 'to you'

But gravity is a lie – well not really

- Gravity is simply an accelerated reference frame
- Importantly, you cant tell the difference between standing on the earth's surface or being accelerated at $9.8ms^{-2}$ in deep space – because they are the same
- And therefore – a tilted car cannot be discerned from an accelerating car without external references

Black hole event horizon

- Massive gravity – no time
- Yes – since gravity slows time, ‘infinite’ gravity will stop time

By the way – lets use the correct terminology

- The higher the **gravitational potential** (the farther the clock is from the source of gravitation), the faster time passes.

$$t_0 = t_f \sqrt{1 - \frac{2GM}{rc^2}} = t_f \sqrt{1 - \frac{r_2}{r}}$$

- t_0 in this case is the time observed by an outside observer of the thing in the gravitational field (the slower one)
- You don't need to 'memorise the maths' – BUT you need to be able to explain the concept

And … (terminology)

- $r_s = \frac{2GM}{c^2}$ is the Schwarzschild radius of the mass M
- the radius defining the event horizon of a Schwarzschild black hole.

What does this mean as you approach a black hole?

$$t_0 = t_f \sqrt{1 - \frac{2GM}{rc^2}} = t_f \sqrt{1 - \frac{r_2}{r}}$$

Think

- If two people are travelling in space at the same average velocity, would it be possible for them to age at different rates?

How does having artificial gravity on a fast travelling space craft change aging?

- If you have both artificial gravity and fast speed, you ‘slow time twice’