Torque calculations for motor selection:

It is important to check the torque of the servo motors, and estimate whether they are powerful enough to move the lenses, and hold the lenses in position (against their own weight) if the device is at a slight angle. For now, it is expected that the device will be operated with a slant of 10 degrees at most (otherwise the lenses would be unable to focus on the patient's fundus).

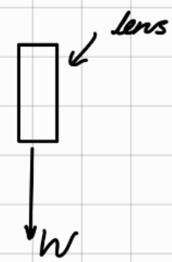
Torque at 5V (from datasheet) for MG955 servo = 10kg-cm ~ 1Nm of torque

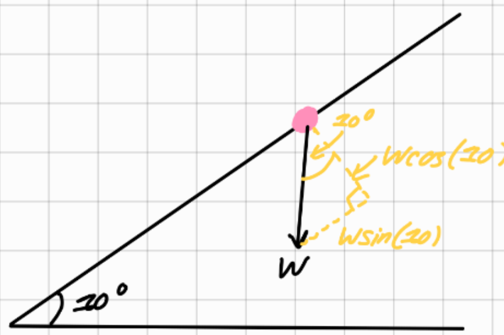
Each lens weighs ~25g, estimated from their 50mm diameter and the density of glass

Weight lens = 25grams × g ~ 0.25N = W

Assume that the lens is a sphere on a frictionless slope, what force is required to stop it from rolling down?

↳ Equivalent to holding the lens in position when the device is at an angle.

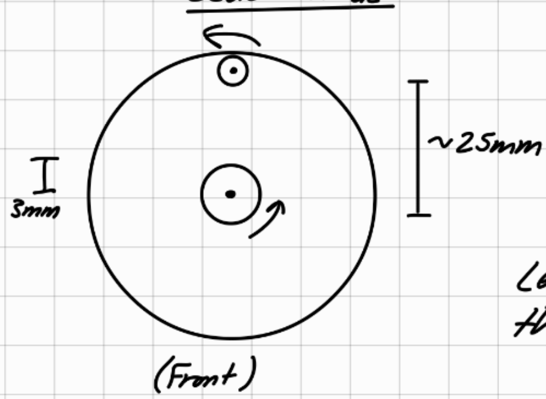




∴ Force needed is $W\sin(10) = 0.043N$

Mechanism Torque:

Scotch disk:



∴ Torque transfer is

$\sim \frac{3}{25} \times 1Nm$

$= 0.12Nm$

Lens pivots at $\frac{50mm}{2}$ from the motors centre of rotation.

∴ Moment needed to hold motor in place $= 0.025 \times 0.043 = 0.001 \, Nm$

∴ We have sufficient torque to hold the lens in place & to move it against gravity.

Mass estimation:

Aluminium tube (12mm OD) ~ 0.26kg/metre

0.8m of tube used, therefore total mass of tubes = 208g

Lens are ~25g each, total mass = 50g

MG955 Servo motor = 70g each = 140g total

3D-printed parts (mass estimated from slicer, PLA used) = ~100g

Part	Mass (g)
Aluminium tube	208
Lenses	50g
MG955 Servo motor	140
3D-printed parts	100
Total mass estimate for mechanism	490 (2 d.p.)

This is a lightweight yet robust assembly, which means that it fits our initial design requirements well. It is also able to withstand mild dust/dirt/vibrations.