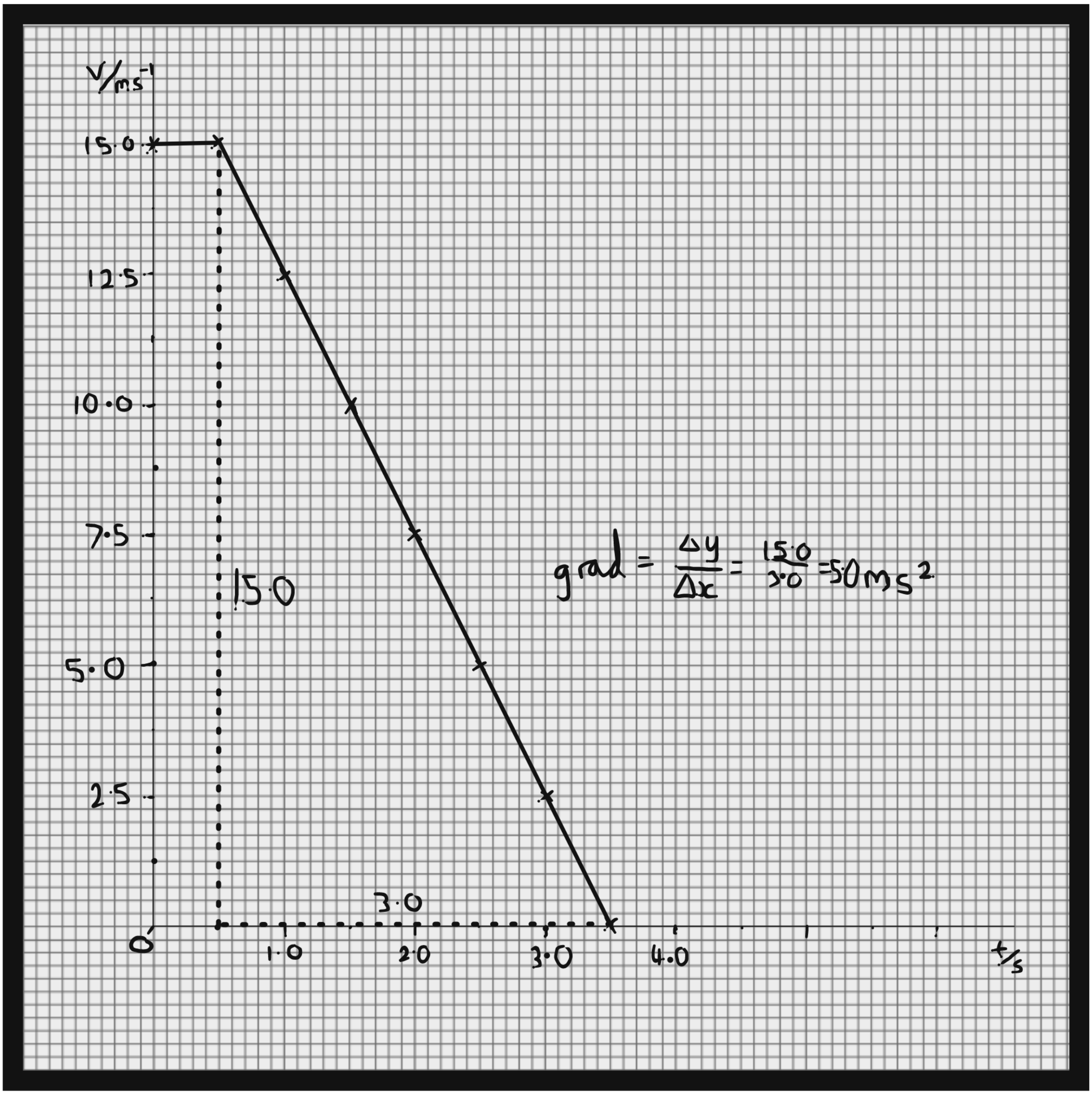
[Paper](#)
[Mark Scheme](#)

1. a.

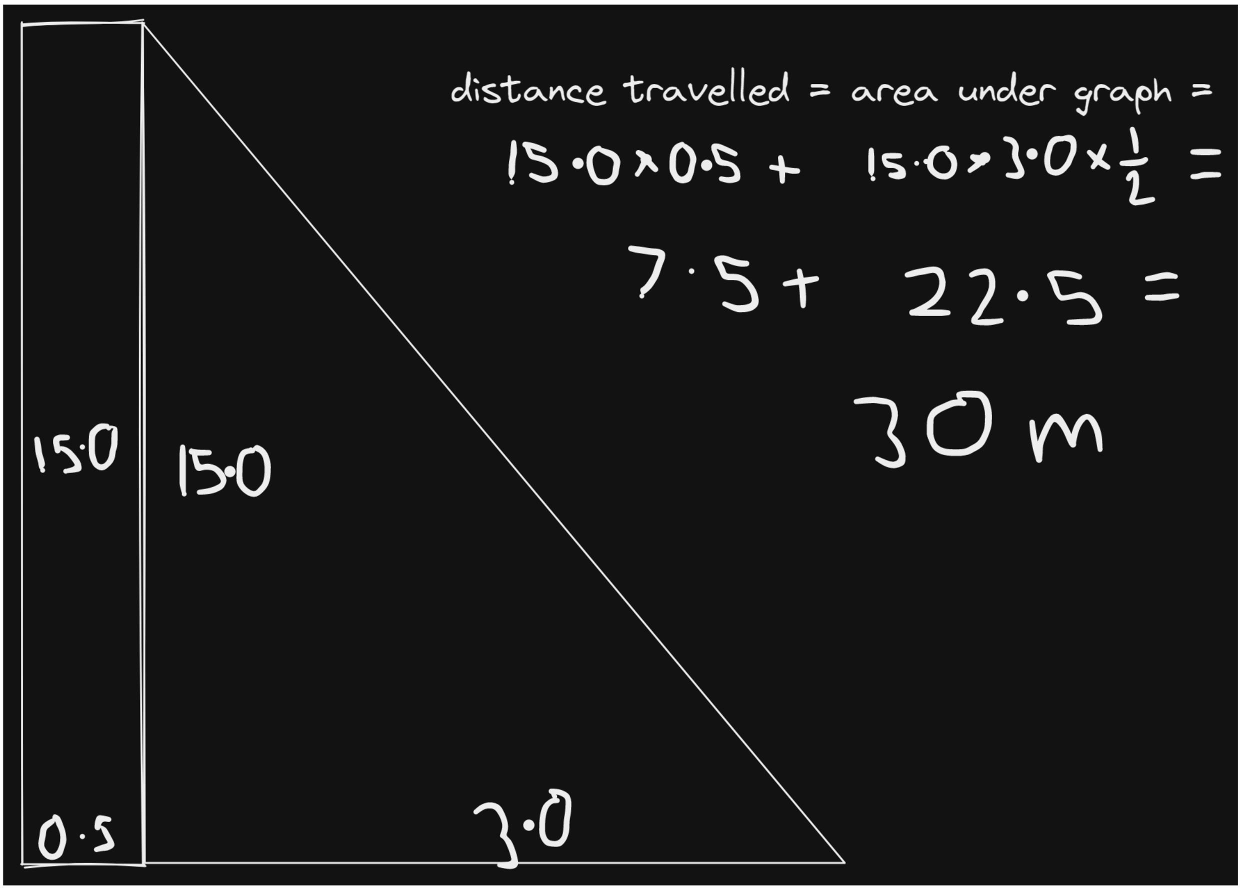


b.

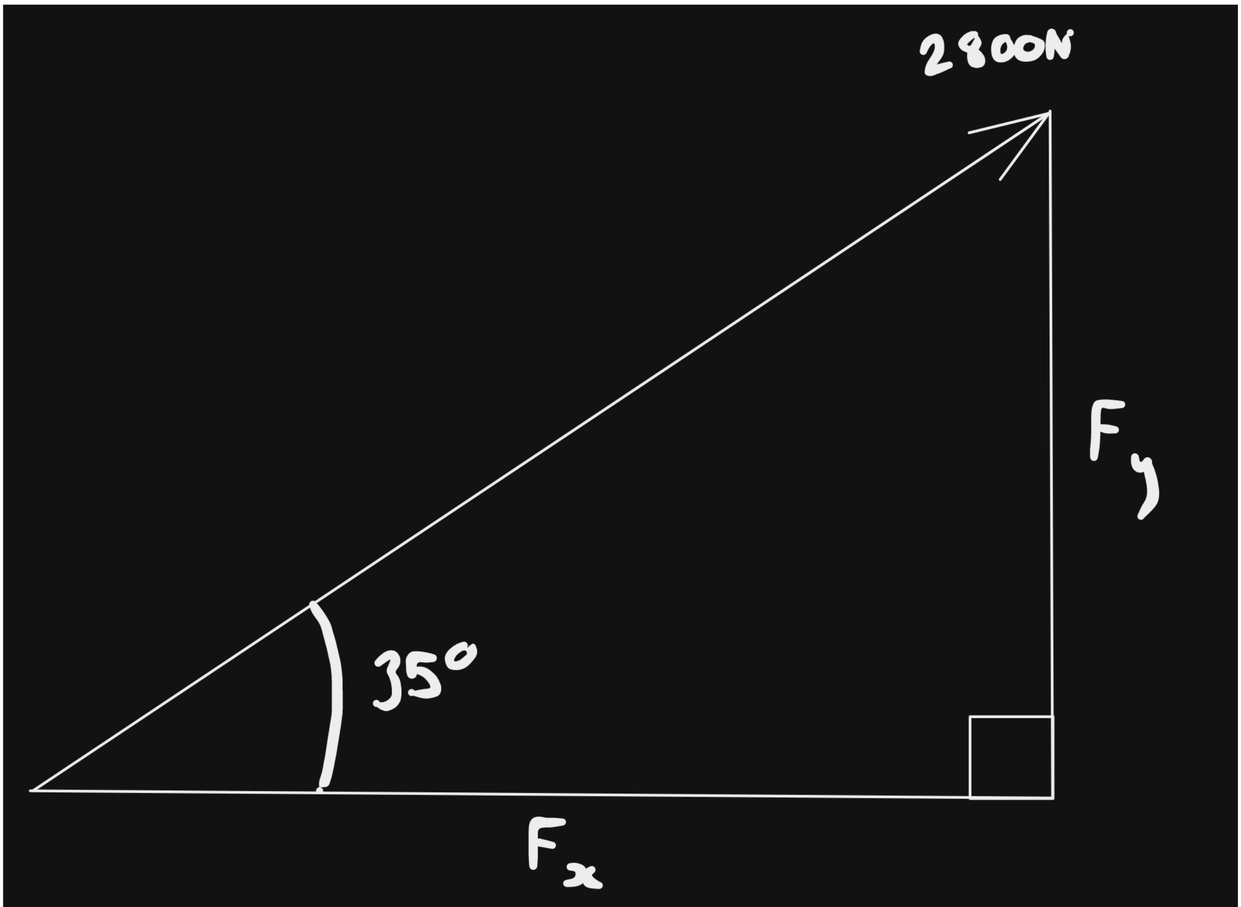
i.

The gradient of a velocity-time graph is the acceleration, as the gradient of the line when t>0.5 is constant, we know the deceleration is uniform.

ii.



2. a.
   i.
   A vector has a direction and magnitude, a scalar only has magnitude
   ii.
   Scalar - Distance, Speed
   Vector - Velocity, Acceleration
   b.
   i.



$$F_x = 2800 \cos 35 = 2293.63 = 2.3\,\text{kN}$$

$$F_y = 2800 \sin 35 = 1606.01 = 1.6\,\text{kN}$$

ii.

$$P = F \times v$$

$$P = 2.3\,kN \times 8.3\,ms^{-1}$$

$$P = 19037$$

$$P = 19\,kW$$

c.

$$Area = \pi r^2 = \pi \times (7 \times 10^{-3})^2 = 4.9 \times 10^{-5}\,\pi\ m^2$$

$$\sigma = \frac{F}{A} = \frac{2800}{4.9 \times 10^{-5}\pi} = 1.82 \times 10^{7}\ Nm^{-2}$$

3. a.

Hooke's law is that the extension of a spring is directly proportional to the force applied, provided the limit of proportionality is not reached.

b.

i.

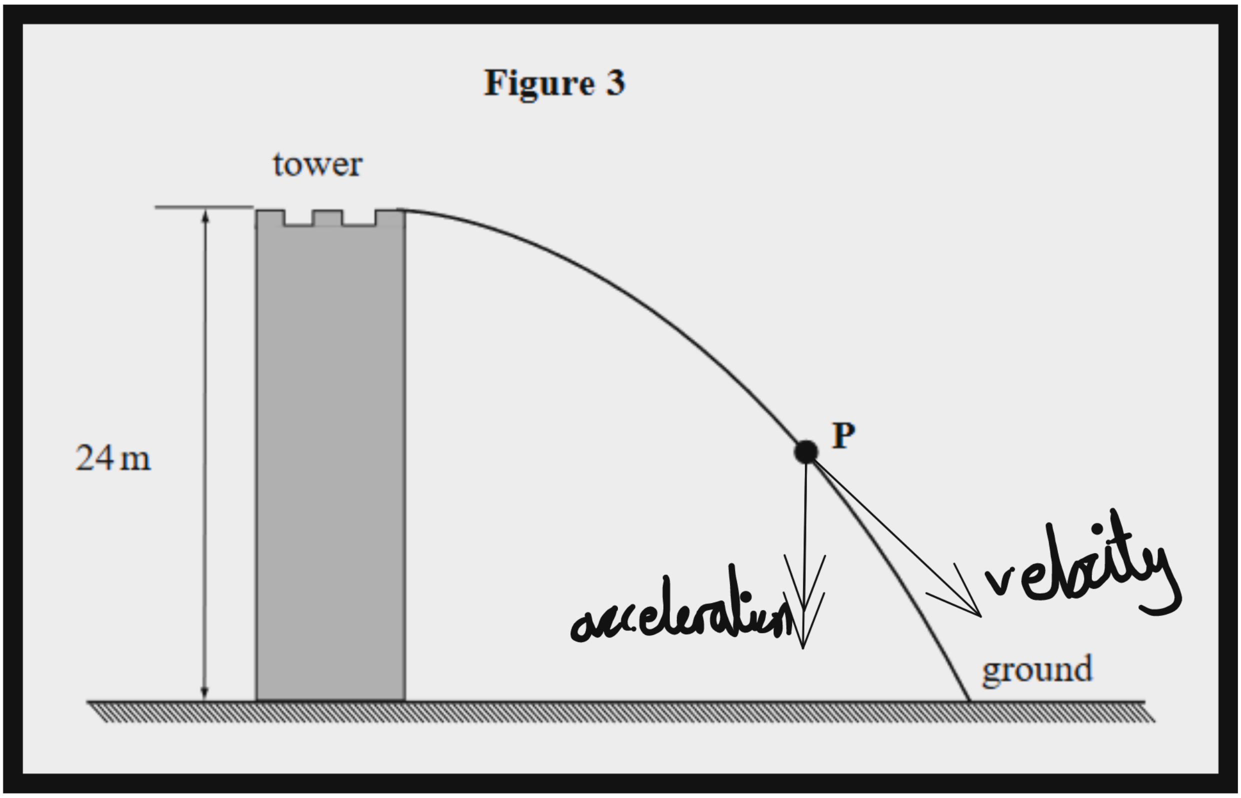
1. Start with the smallest mass. Measure the new length.
2. Record the mass and new length-initial length.
3. Repeat for all masses.
4. Graph the mass against extension.
5. Draw a line of best fit.

6. Find the extension due to the rock sample.
7. Use the line of best fit to find the mass corresponding to the extension of the rock sample.

ii.

Use a clamp to secure the stand to the table, this provides an opposite moment to the weights on the stand.

4. a.



b.

i.

only acceleration in vertical direction

s 24 m
u 0 ms^{-1}
v
a 9.81 ms^{-2}
$\boxed{t}$

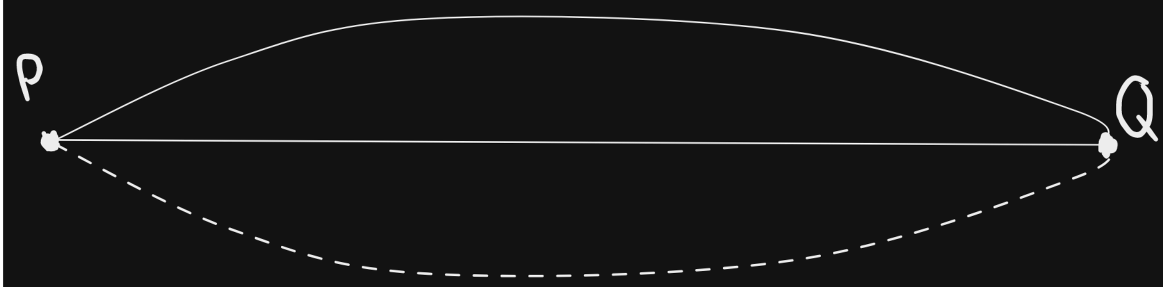
$$s = ut + \frac{1}{2}at^2$$
$$24 = \frac{1}{2}(9.81)t^2$$
$$\frac{48}{9.81} = t^2$$
$$t = 2.21\,s$$

ii.

$$v = \frac{\Delta s}{\Delta t} = \frac{27}{2.21} = 12.21$$
$$v = 12.2\,ms^{-1}$$

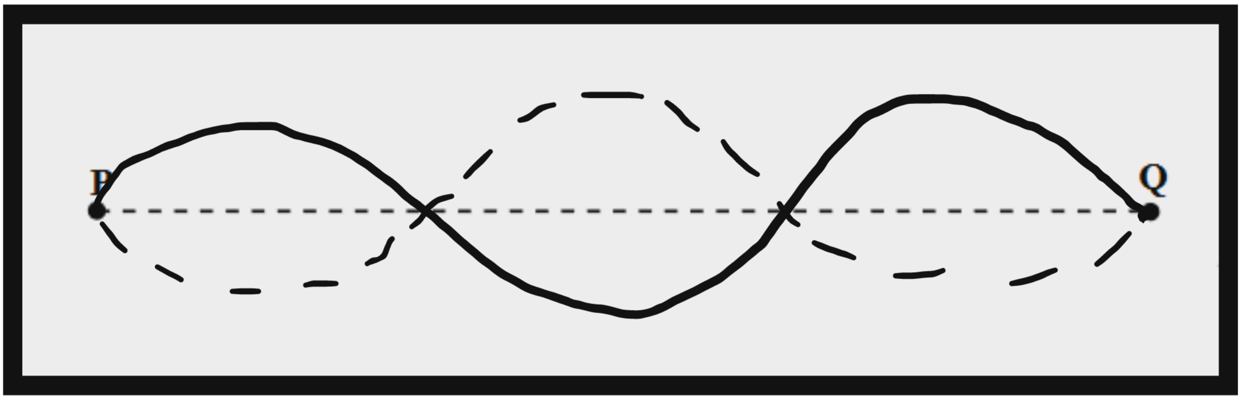
5. a.
The string is fixed on both ends, meaning that the wave will reflect off of the nodes (stationary points). The progressive waves caused by the pluck will therefore interfere with each other, and will undergo constructive interference as they have the same frequency.
b.
i.

$$\text{One loop} = \frac{\lambda}{2} \qquad \lambda = 2.4\,m$$



$$c = f\lambda = 150 \times 2.4 = 360\ ms^{-1}$$

ii.



6. a.

i.

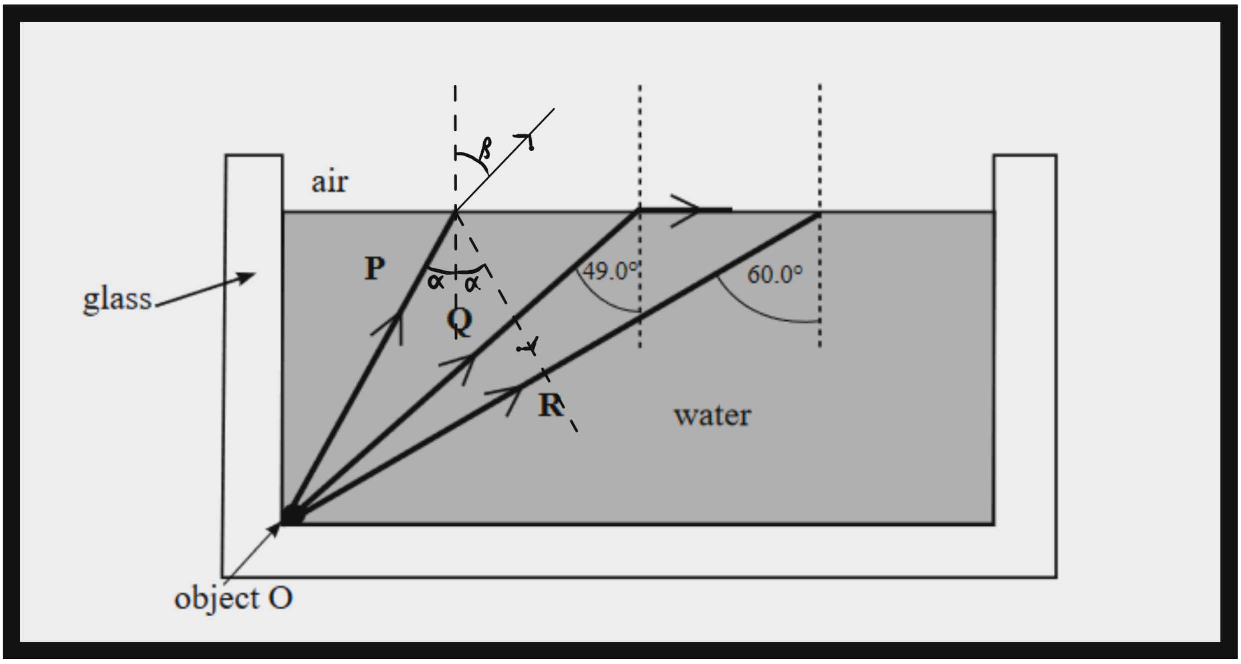
$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$n_1 \sin 49 = 1 \times \sin 90$$

$$n_1 = \frac{1}{\sin 49} = 1.3250\ldots$$

$$n_1 = 1.33$$

ii.

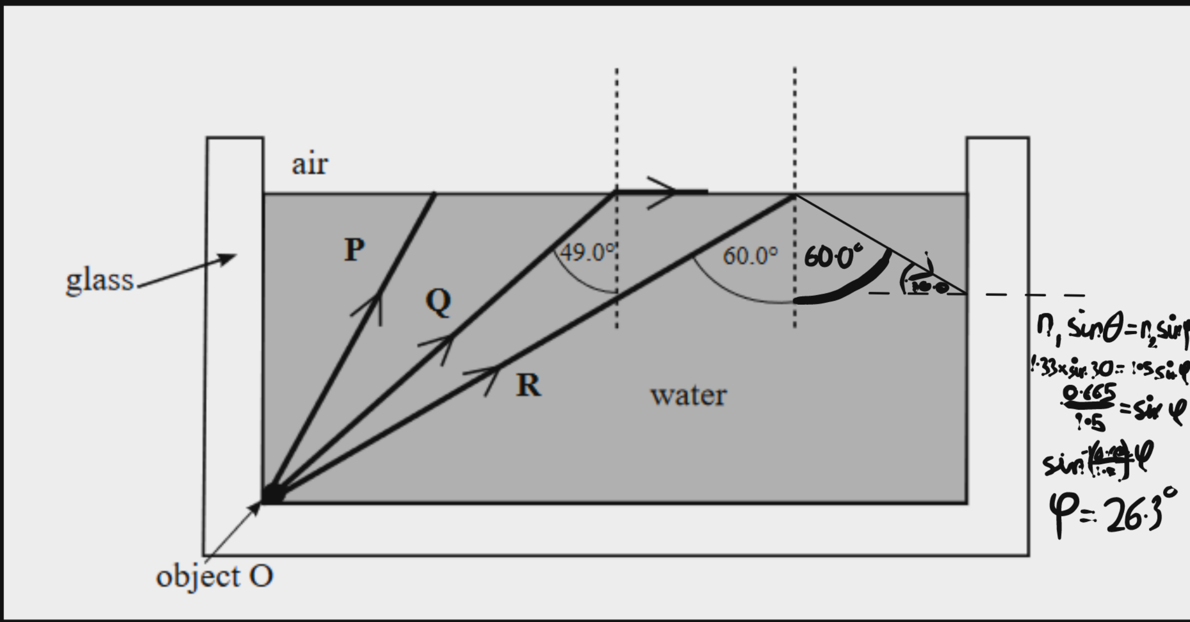


b.

i.

In 6ai, the critical angle is found to be 49°. As the angle of R is 60°, greater than 49°, the ray will be totally internally reflected.

ii.



as $\frac{n_1 \sin\theta}{n_2} < 1$, $\sin\left(\frac{n_1 \sin\theta}{n_2}\right)$ is possible so the ray will enter the glass

7. a
   a.
   i.
   Diffraction
   ii.
   Interference where the light superposes near at the screen causes the fringe pattern. Bright fringes are formed where the light interferes constructively, dark fringes appear where the light interferes destructively.
   iii.

$$W = \frac{\lambda D}{s}$$

$$\frac{Ws}{D} = \lambda$$

$$\frac{3.6\times10^{-3}}{4} = W = 0.9\times10^{-3}\ m$$

$$\frac{0.9\times10^{-3}\times0.56\times10^{-3}}{0.80} = \lambda = 6.3\times10^{-7}\ m$$

$$\lambda = 630\ nm$$

b.

The appearance would change by the fringes becoming a continuous spectra, with the centre fringe being white. The spectra would have red on the outside edge and blue on the inside edge.