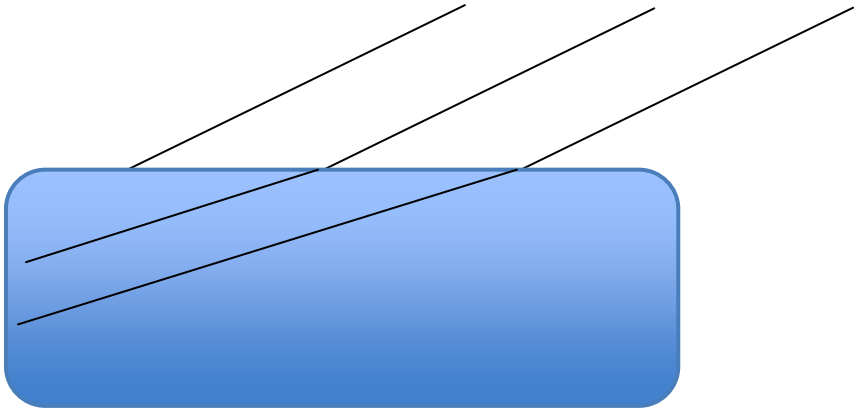
Mark scheme for Extension Worksheet – Topic 4, Worksheet 3

1 **a** The frequency in air and water is the same; hence

$$\frac{c_{\text{air}}}{720} = \frac{c_{\text{water}}}{\lambda_w} \Rightarrow \lambda_w = 720 \times \frac{c_{\text{water}}}{c_{\text{air}}} = \frac{720}{n} = \frac{720}{1.33} = 541 \text{ nm}$$ [2]

b Snell's law works with angles between rays and normal or wavefront and surface. $1.00 \times \sin(90^\circ - 38^\circ) = 1.33 \times \sin\theta \Rightarrow \theta = 36^\circ$; the required angle is $90^\circ - 36^\circ = 54^\circ$ [2]

c



[2]

2 **a** The resulting displacement when two waves arrive at the same point in space; is the sum of the individual displacements. [2]

b The amplitude will be obtained (in this case) for when the waves cross; and so will be approximately 5.6 cm. [2]

3 **a** At M the distances to the two sources are equal; hence when the waves arrive there they will not meet crest to crest (because they were not crest to crest when they were emitted); and so the intensity will not be the maximum possible. [3]

b The wavelength is $\lambda = 6.0 \times 5.0 = 30$ m; there is a phase difference of $\frac{\pi}{2}$ initially which corresponds to a path difference of $\frac{\lambda}{4}$; so to get a maximum the path difference must be $\frac{3\lambda}{4} = 22.5$ m for the point **above** M and $\frac{\lambda}{4} = 7.5$ m for the point **below** M. [3]