Two-source interference: finding the rule

Name: _____ Class: _____

Figure 1 on the next page shows two sources, X and Y, sending out waves of the same wavelength in step with each other. The blue arcs are crests. Where crests from X land on crests from Y the water moves up and down strongly; at some other places the surface barely moves at all. Your job is to work out, from measurements alone, what decides which happens where. The straight distances you will measure are not rays.

A The wavelength on the diagram

The heavier arcs on Figure 1 spread out from X, the lighter ones from Y. Pick one set and measure out along a straight line from its own source. Do not measure a single gap — measure across several and divide.

1. Number of gaps counted: _____ Total distance across them: _____ cm
2. Wavelength λ = _____ cm

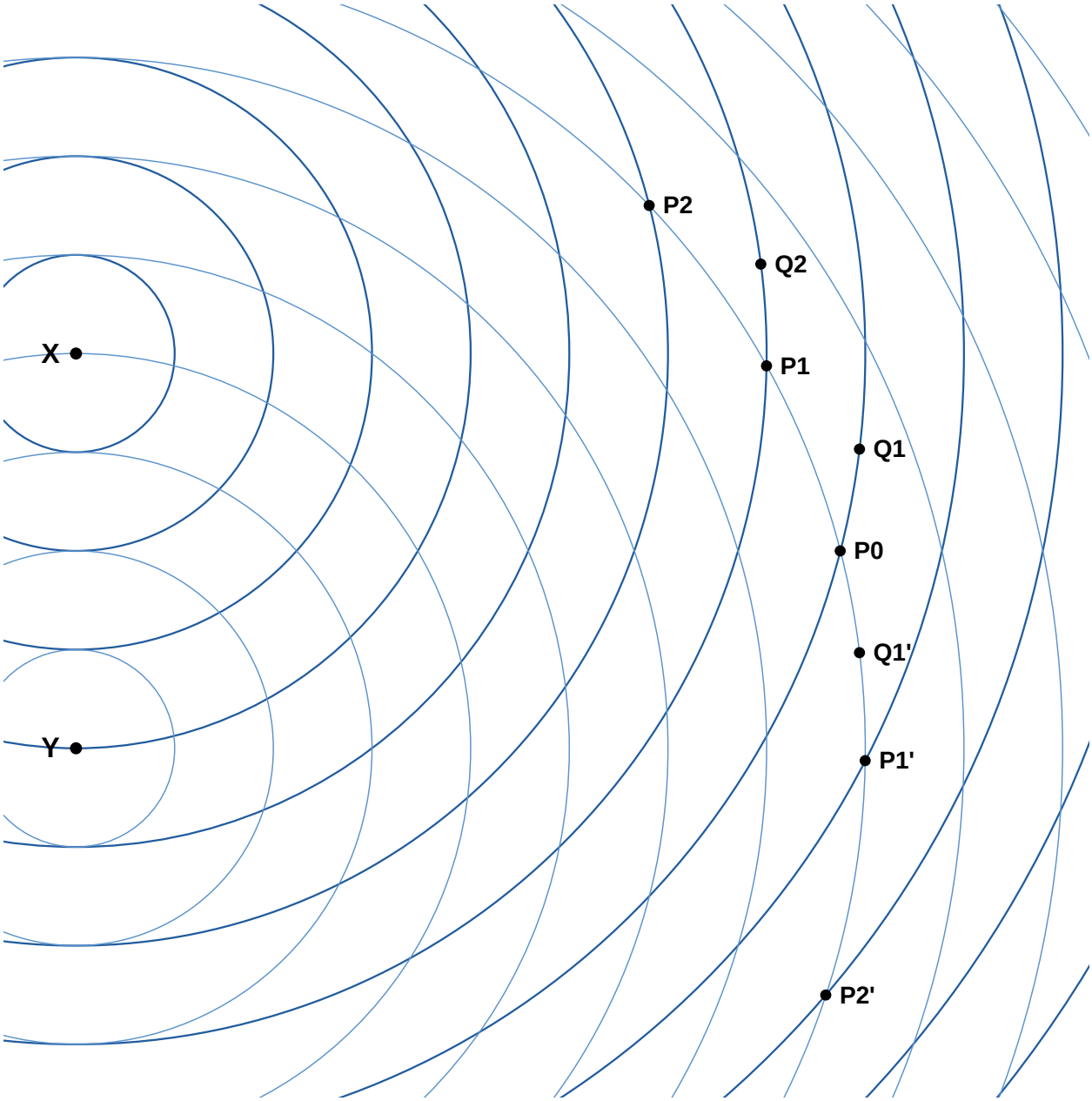
B Measuring the two path lengths

Eight points are marked on Figure 1. For each one, draw a straight pencil line from X to the point and another from Y to the point, then measure both with a ruler to the nearest millimetre. Work out how much further one wave has travelled than the other, then express that extra distance in wavelengths by dividing by your answer to A2.

Point	XP / cm	YP / cm	Difference / cm	In units of λ	Strong or still?
P0					
Q1					
P1					
Q2					
P2					
Q1'					
P1'					
P2'					

Figure 1 Printed to scale — do not enlarge or reduce.

The heavier arcs are crests spreading from X; the lighter arcs are crests from Y.



C The rule

1. List the points where the water moves strongly. Next to each, write its path difference in λ.

2. Do the same for the points where the surface is almost still.

3. Complete both statements, using n for a whole number.

Waves arrive in step and reinforce when the path difference = _____

Waves arrive out of step and cancel when the path difference = _____

4. P0 lies the same distance from both sources. Explain why every point on the line through P0 and the midpoint of XY behaves the same way.

5. Sketch on Figure 1 the line joining all the points whose path difference is λ. What shape is it, and why is it not straight close to the sources?

D Moving the sources closer

Suppose X and Y are moved to 3.0 cm apart instead of 6.0 cm, with the wavelength unchanged.

1. Predict, before doing any working, whether the strong points spread out or bunch up.

2. Test it. Keeping the same distance from the sources as P1, find where the path difference is now λ. A point a long way out at an angle θ from the centre line has a path difference of about d sinθ, where d is the source separation. Use this to compare the two cases.

3. Was your prediction right? Write one sentence linking the spacing of the strong points to d.