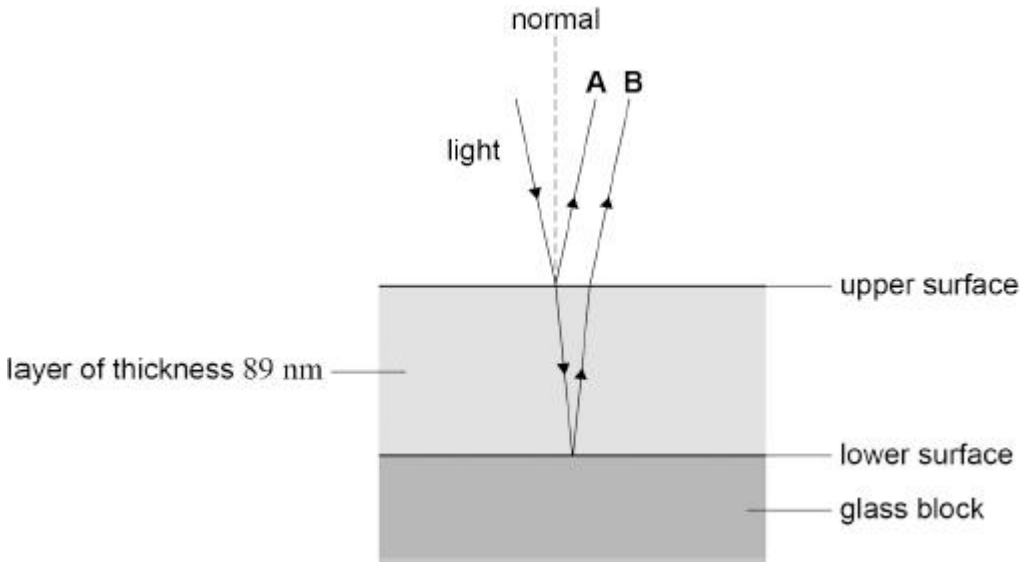
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Exam Preparation and Free Resources

Q1.

A glass block is coated with a layer of transparent material.
Figure 1 shows the incident ray and the reflected rays when monochromatic light is shone onto the upper surface of the transparent layer.

Figure 1



A is light reflecting from the upper surface of the layer.
B is light that leaves the layer after reflection from the lower surface.

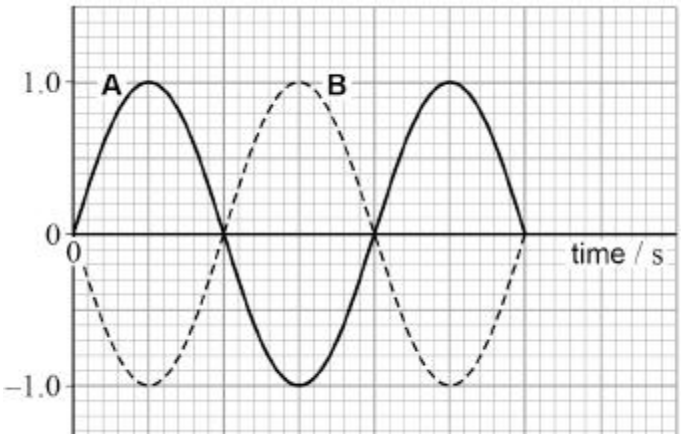
When light reflects at the upper and lower surfaces, there is a change of phase.
In this case, the change of phase is the same at each surface and so can be ignored.

When the monochromatic light is incident **normally** on the upper surface of the layer, **A** and **B** meet and interfere.
Assume that the light is incident **normally** on the upper surface throughout this question.

(a) **Figure 2** shows how **A** and **B** vary with time at the upper surface.

Figure 2

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In the layer, the light has a wavelength of 356 nm.
The thickness of the layer is 89 nm.

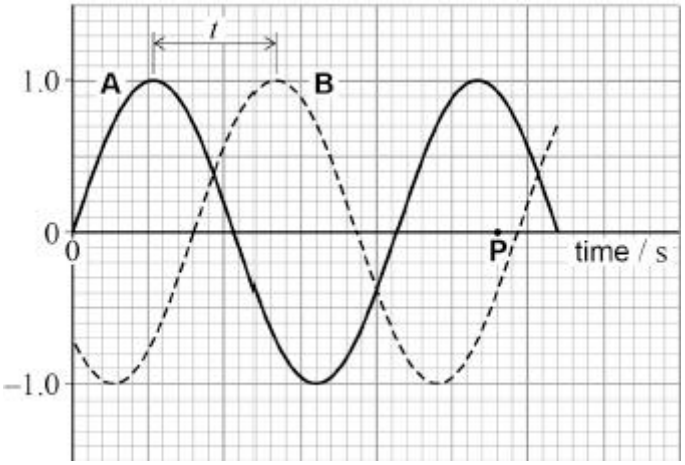
Explain why destructive interference occurs at the upper surface for this thickness.

(3)

The frequency of the monochromatic light incident on the layer is changed.

Figure 3 shows how **A** and **B** vary with time at the upper surface for this light.

Figure 3



(b) Calculate the resultant of the waves at time **P** in **Figure 3**.

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resultant = _____

(2)

The frequency of the light in **Figure 3** is 4.72×10^{14} Hz.

(c) The phase difference between **A** and **B** shown in **Figure 3** is 137°.

Show that the time interval labelled *t* in **Figure 3** is approximately 8×10^{-16} s.

(3)

(d) 89 nm is the minimum thickness that will produce a phase difference of 137° between **A** and **B**.

Calculate the refractive index of the material of the layer.

refractive index = _____

(4)

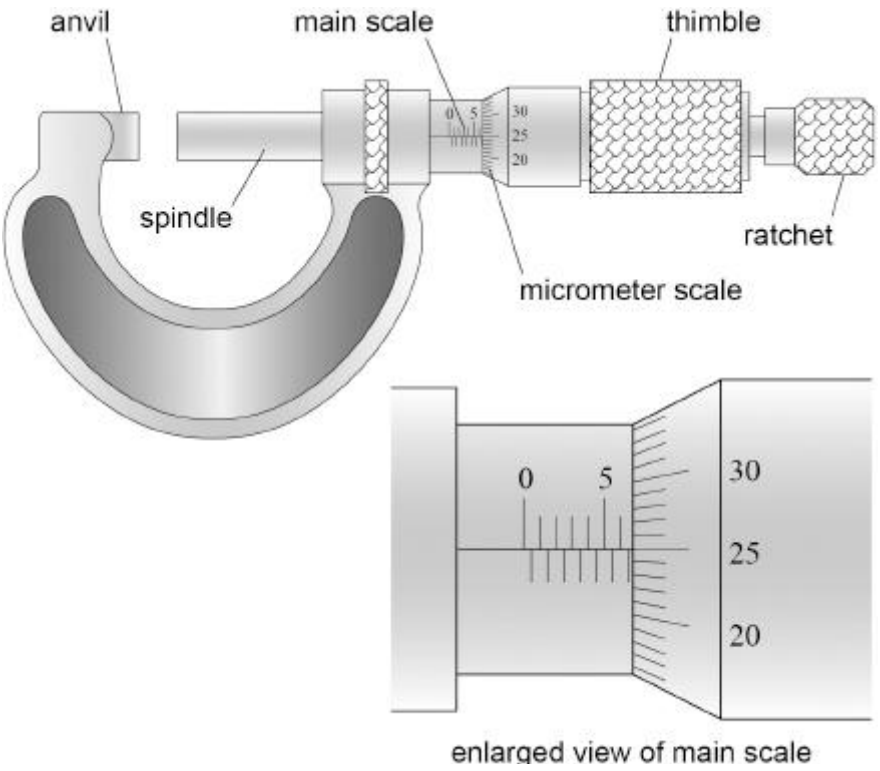
(Total 12 marks)

Q2.

(a) **Figure 1** shows a micrometer screw gauge.

Figure 1

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What is the reading on the micrometer?

Tick ✓ **one** box.

6.25 ☐

6.75 ☐

7.25 ☐

8.25 ☐

(1)

(b) A metal wire of diameter d is held in the gap between the anvil and the spindle.
Just before the reading of d is taken, the gap is closed using the ratchet and not the thimble.

Explain why the gap is closed in this way.

_____

_____

_____

(1)

(c) The mass per unit length μ of the metal wire is given by

$$\mu = \frac{\pi \rho d^2}{4}$$

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where ρ is the density of the metal.

Values of d and μ are used to calculate ρ.

The percentage uncertainty in d is 1.2%.
The percentage uncertainty in μ is 2.0%.

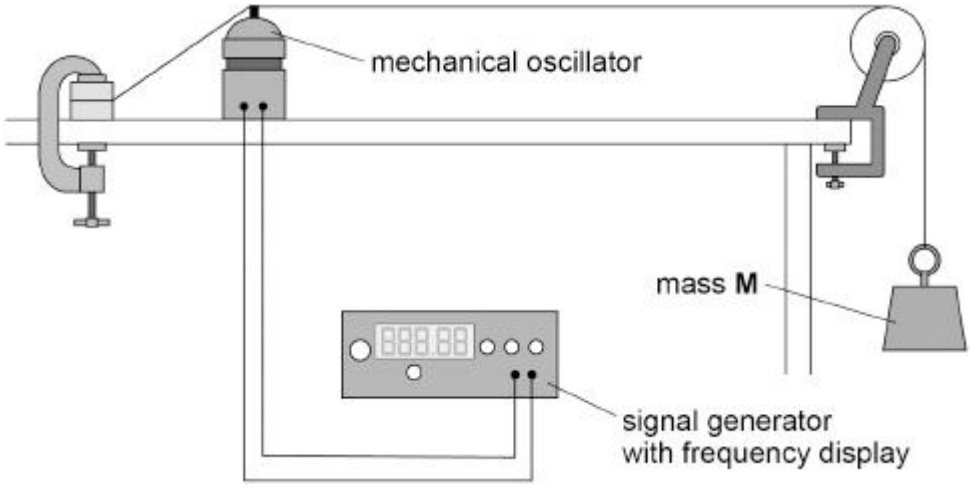
Calculate the percentage uncertainty in the result for ρ.

percentage uncertainty = _____ %

(2)

Figure 2 shows apparatus used to investigate how the frequency of stationary waves on a wire depends on its diameter d.

Figure 2



When the signal generator is switched on, the horizontal part of the wire oscillates.

A student changes the frequency until the first-harmonic stationary wave is produced. The student records the frequency f of the first harmonic and then turns off the signal generator.
She removes the wire and measures d using a micrometer.

She then repeats the experiment for wires of different diameter.

(d) The wires used in the experiment are made of the same metal so that ρ is a control variable.

State **two** other control variables in the experiment.

1 _____

_____

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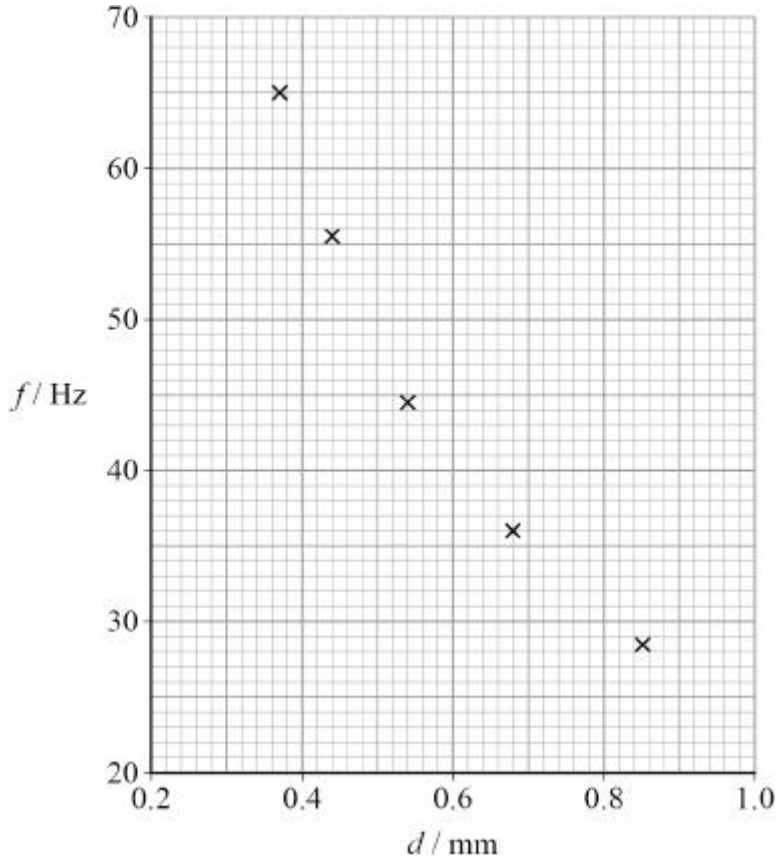
2 _____

_____

(2)

Figure 3 is a plot of the experimental data.

Figure 3



(e) The student suggests that $f \propto \frac{1}{d}$.

Deduce, using data points from **Figure 3**, whether this suggestion is correct.

_____

_____

_____

(2)

(f) Another student repeats the experiment with the mass of **M** doubled.

Explain how this student's plotted data compare with **Figure 3**.

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_____

_____

_____

_____

(2)
(Total 10 marks)

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