1. Electromagnetic waves pass through a gap of approximately 3 cm.

Which of the following will undergo a significant amount of diffraction?

A   microwaves
B   ultraviolet waves
C   visible light waves
D   X-rays

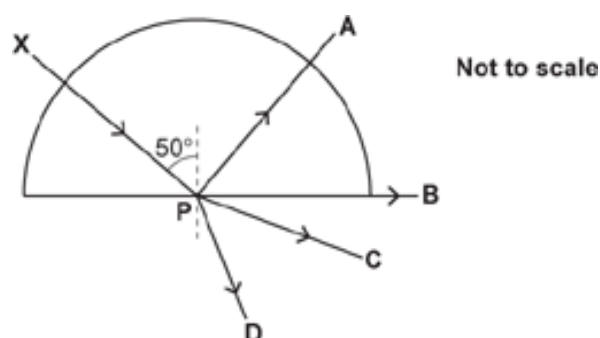Your answer [ ]   **[1]**

2. The diagram shows a semi-circular glass block with a refractive index of 1.5.

The glass block is surrounded by air.

A ray of light follows the path shown from **X** to **P**.

Which path will the ray follow after it arrives at **P**?

Your answer [ ]   **[1]**

3(a). The table shows the speed and wavelength of yellow light in air.

Quantity	Air	Glass
Speed of light / m s^{-1}	3.00×10^8	....
Wavelength / nm	588	....
Frequency / THz	....	....

The refractive index at the air glass boundary is 1.52.

i.   Calculate the frequency, in THz, of yellow light in air.
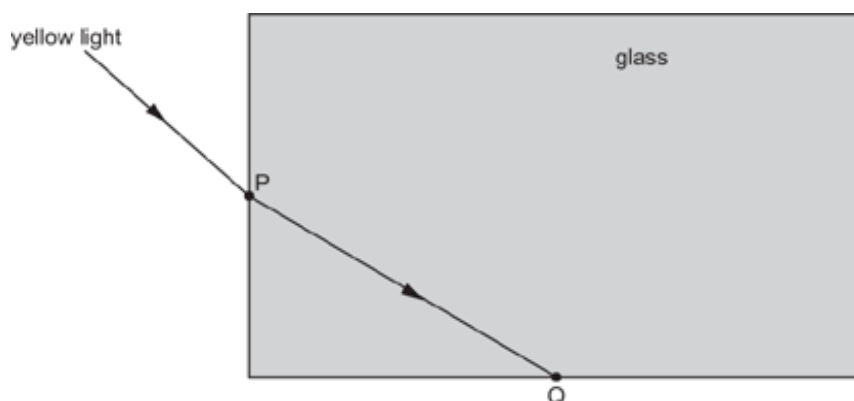   Record your answer in the table.

                                                                                                   [1]

ii.   Complete the table for yellow light in glass.

[2]

(b). A student uses a ray box to investigate the refraction of yellow light in a rectangular glass block.

Fig. 5.1 shows the path the yellow light travels as it enters the block at point P and travels to point Q.

Fig. 5.1

i.   **Draw on Fig. 5.1** the angle of incidence *i* and the angle of refraction *r* at point P.
Label the angles *i* and *r*.

[1]

ii.   Describe how the student produces **Fig. 5.1** experimentally using a ray box.

_____

_____

_____

_____

_____

_____

[4]

iii.   The angle of incidence *i* is 49.9°.

Show that the angle of refraction *r* is approximately 30°.

[1]

iv.   Show that total internal reflection occurs at point Q.

[3]

v.   **Draw on Fig. 5.1** the path of the light as it travels from point Q back into the air.

[1]

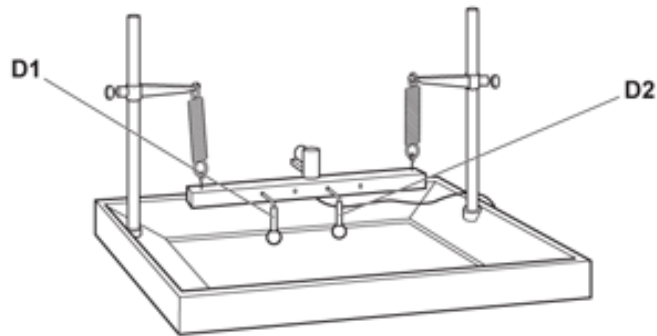4. Two spherical dippers, **D1** and **D2** oscillate on a ripple tank as shown in **Fig. 5.1**.

Fig. 5.1

Waves on the surface of the water are produced from each dipper. These waves are in phase with each other.

The water waves have a speed of 8.0 cm s^{-1} and a wavelength of 3.2 cm.

i.   State and explain whether these waves are transverse or longitudinal waves.

[1]

ii.   State and explain whether these waves are plane polarised.

[1]

5. Unpolarised light is observed through a single polarising filter.

The intensity of the light transmitted by the filter is half the intensity of the incident light.

What happens to the intensity of the transmitted light when the filter is rotated through 90°?

A   decreases
B   decreases and then increases
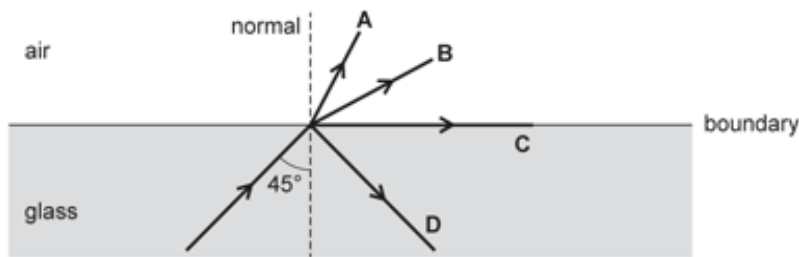**C**   increases
D   does not change

Your answer ☐ **[1]**

6. A ray of monochromatic light is travelling through glass.

The refractive index of the glass is 1.5.

The ray is incident on a glass-air boundary with angle of incidence of 45°.

Which is the correct path of the ray after it reaches the boundary?

Your answer ☐ **[1]**

7. What is a typical value, in cm, for the wavelength of microwave radiation?

A   0.0003
B   0.03
C   3
D   300

Your answer ☐ **[1]**

8. A column of air in a tube of length L, closed at one end, is forced to vibrate at its fundamental frequency. A standing wave is set up inside the tube.

Which row in the table is correct for this standing wave?

	Number of nodes inside the tube	Wavelength / m
A	1	L
B	1	2L
C	1	4L
D	2	2L

Your answer ☐ **[1]**

9. A student is experimenting with sound waves of wavelength 3.0 cm and electromagnetic waves also of wavelength 3.0 cm.

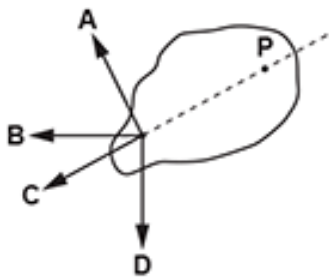Which statement is correct about **both** of these waves?

A They can be polarised.
B They can form stationary waves.
C They have the same frequency.
D They have the same speed.

Your answer ☐ **[1]**

10. A thin metal plate is free to rotate in the vertical plane about the point **P**.
Four forces **A**, **B**, **C** and **D** act at the same point on the plate, as shown below.

The diagram above is drawn to scale.
All the forces are in the vertical plane.
The forces have the same magnitude but act in different directions.
Which force will produce the **greatest** moment about point **P**?
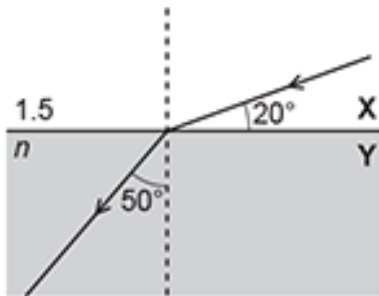
Your answer ☐ **[1]**

11. Plane polarised light is incident perpendicular to a vertical polarising filter.
The polarising filter is rotated about the horizontal axis.
Which property of the transmitted light changes as the filter is rotated?

A   frequency

B   intensity

C   speed

D   Wavelength

Your answer ☐   **[1]**

12. The diagram below shows the refraction of light at the boundary between two transparent materials **X** and **Y**.

The refractive index of material **X** is 1.5 and the refractive index of material **Y** is *n*.

Which of the following expressions is correct?

A $n \times \sin 70° = 1.5 \times \sin 50°$

B $n \times \sin 20° = 1.5 \times \sin 40°$

C $1.5 \times \sin 70° = n \times \sin 50°$

D $1.5 \times \sin 20° = n \times \sin 40°$

Your answer ☐   **[1]**

13. Which of the following could be the wavelength of ultraviolet radiation?

A 3×10^{-5} m

B 1×10^{-10} m

C 4×10^{2} m

D 2×10^{-7} m

Your answer ☐   **[1]**

14(a). The table shows the refractive index of air, glass and oil for red light. It also shows the speed v of red light in air.

	air	glass	oil
refractive index n	1.00	1.52	1.46
speed of light v / ms^{-1}	3.00×10^8		

Complete the table by determining the missing values for v for glass and oil. Write your answers to 3 significant figures.

[1]

(b). Show that the critical angle for a ray of red light at the boundary between glass and air is less than 45°.

[2]

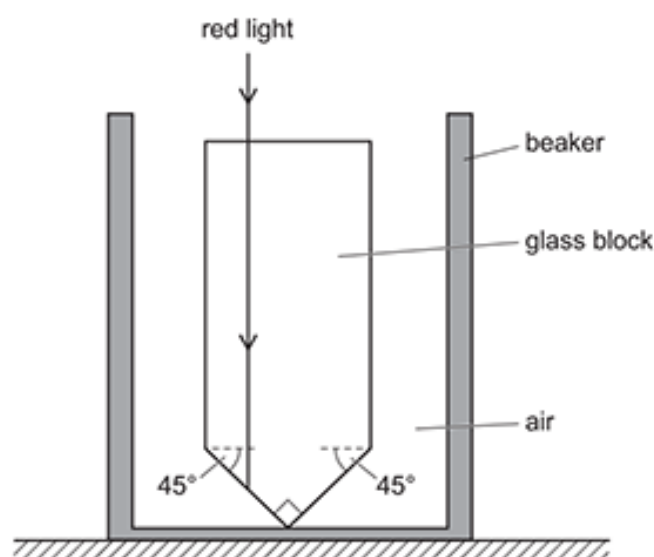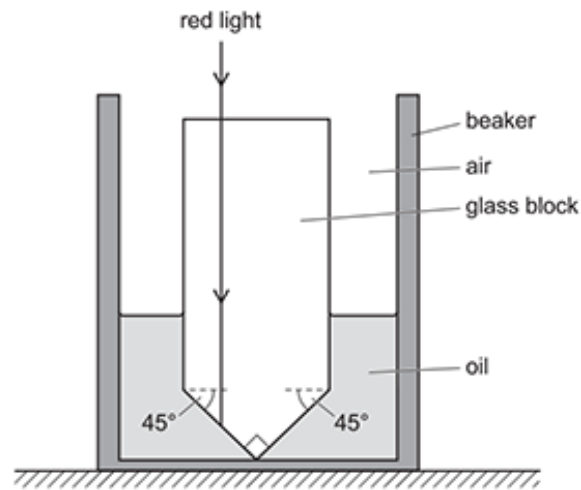**(c).** **Fig. 5.1** shows a glass block inside a beaker.

Fig. 5.1

The path of a ray of red light is shown entering the glass block.

Complete **Fig. 5.1** to show the path of the ray through the block until it leaves the block.   **[2]**

(d). Oil is now added to the beaker as shown in **Fig. 5.2**.

Fig. 5.2

The path of a ray of red light is shown entering the glass block.

i.   Calculate the critical angle *C* for a ray of red light at the boundary between glass and oil.

C = ...° **[2]**

ii.   Complete **Fig. 5.2** to show the path of the ray through the block until it leaves the block.

[1]

END OF QUESTION PAPER