

Name of the Student: _____

Max. Marks : 19 Marks

Time : 19 Minutes

Q1.

A student buys a portable loudspeaker that is powered by its own internal battery. The battery in the loudspeaker is initially uncharged.

- (a) The battery is connected to a charger that maintains a constant potential difference of 5.0 V across the battery. It takes 2.6 hours for the battery to become fully charged. The average current in the battery during this time is 2.0 A.

The battery is disconnected from the charger.

The fully-charged battery operates the loudspeaker for 12 hours before it is completely discharged.

Calculate the average output power of the battery during these 12 hours.

average output power = _____ W

(2)

- (b) A mobile phone transmits data to the loudspeaker using microwaves. The data are processed at the loudspeaker to produce sound waves.

Microwaves and sound waves travel at different speeds.

Describe **two** other differences between microwaves and sound waves.

1 _____

2 _____

(2)

- (c) A second loudspeaker receives the same data from the mobile phone. The two loudspeakers act as coherent sources of sound waves.

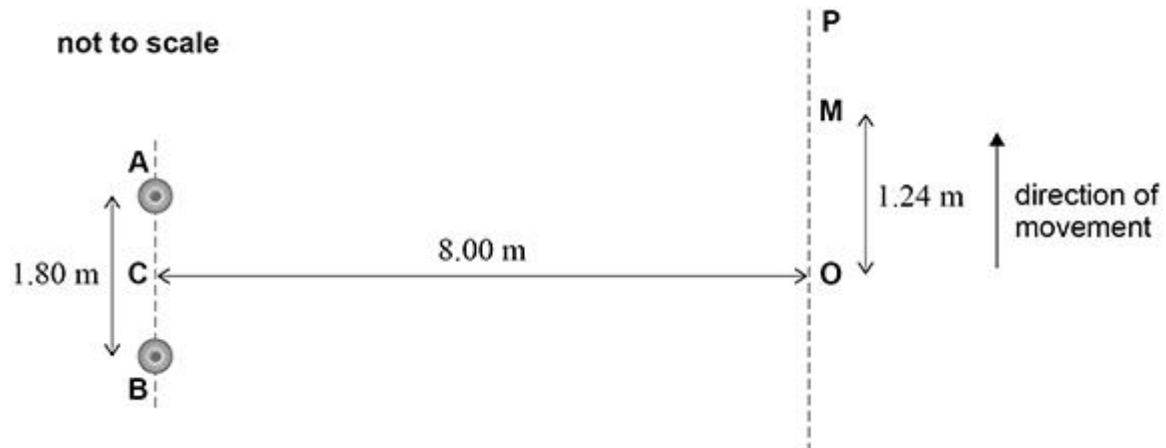
State the **two** conditions required for the sources to be coherent.

1 _____

2 _____

(2)

The figure below shows two loudspeakers **A** and **B** that act as coherent point sources of sound of a single frequency.



C is the midpoint between **A** and **B**.

Distances **OA** and **OB** are equal.

OP is perpendicular to **CO**.

The student uses a sound-level meter to measure the intensity of the sound. The meter detects a maximum intensity at **O**.

The student moves the meter along **OP**. The intensity decreases and reaches a first minimum at **M**.

The intensity then increases as the meter moves towards **P**.

The student records the following distances:

$$AB = 1.80 \text{ m}$$

$$CO = 8.00 \text{ m}$$

$$OM = 1.24 \text{ m.}$$

(d) Show that the difference between the path lengths **AM** and **BM** is approximately 0.3 m.

(2)

- (e) The speed of sound is 340 m s^{-1} .

Determine the frequency of the sound waves.

frequency = _____ Hz

(2)

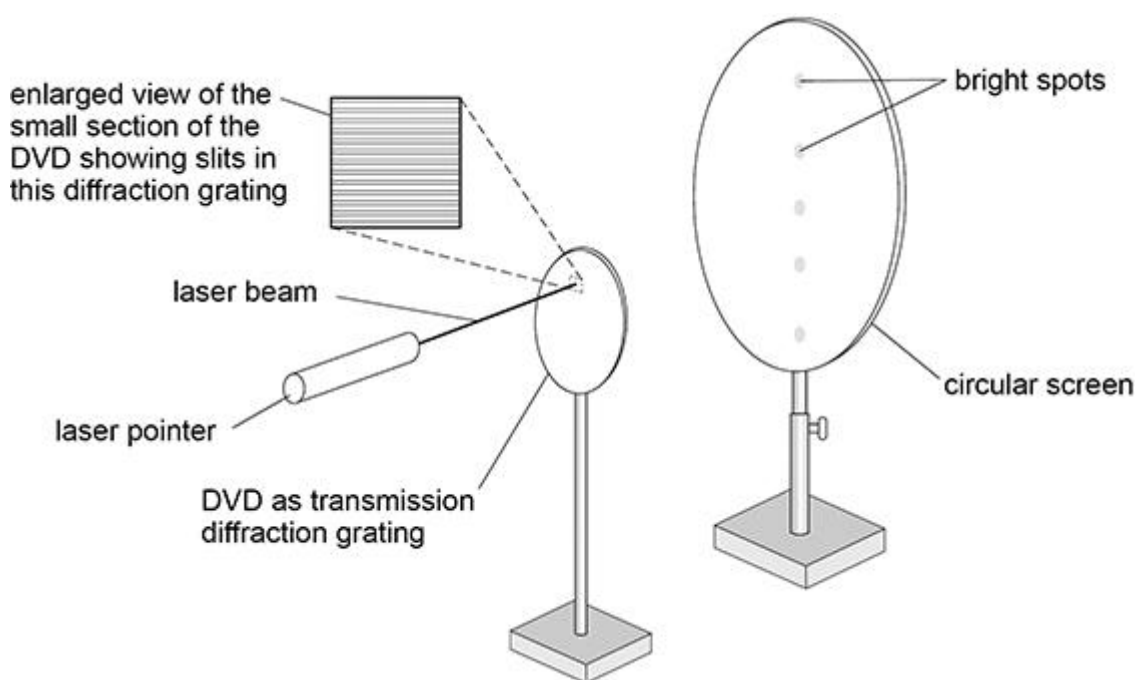
(Total 10 marks)

Q2.

A student removes the reflective layer from a DVD. She uses the DVD as a transmission diffraction grating.

Figure 1 shows light from a laser pointer incident normally on a small section of this diffraction grating. The grooves on this section act as adjacent slits of the transmission diffraction grating. A vertical pattern of bright spots (maxima) is observed on a circular screen behind the disc.

Figure 1



- (a) Light of wavelength λ travels from each illuminated slit, producing maxima on the screen.

State the path difference between light from adjacent slits when this light produces a first-order maximum on the screen.

(1)

- (b) Explain how light from the diffraction grating forms a maximum on the screen.

(3)

The student has three discs: a Blu-ray disc, a DVD and a CD. She removes the reflective coating from the discs so that they act as transmission diffraction gratings. These diffraction gratings have different slit spacings.

The student also has two laser pointers **A** and **B** that emit different colours of visible light.

Table 1 and **Table 2** show information about the discs and the laser pointers.

Table 1

Disc	Slit spacing / μm
Blu-ray disc	0.32
DVD	0.74
CD	1.60

Table 2

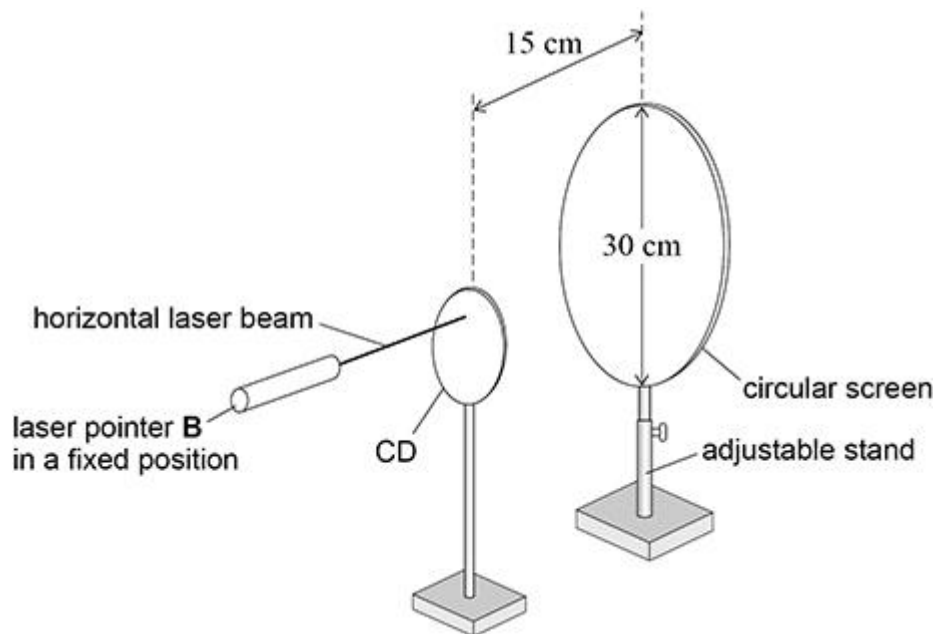
Laser pointer	Wavelength of light emitted / 10^{-7} m
A	4.45
B	6.36

- (c) Deduce the combination of disc and laser pointer that will produce the **greatest** possible number of interference maxima.

(2)

- (d) The student uses the CD and laser pointer **B** as shown in **Figure 2**. A diffraction pattern is produced on the screen. Laser pointer **B** and the CD are in fixed positions. The laser beam is horizontal and incident normally on the CD. The height of the screen can be adjusted.

Figure 2



The screen has a diameter of 30 cm and is positioned behind the CD at a fixed horizontal distance of 15 cm.

The student plans to adjust the height of the screen until she observes the greatest number of spots.

The student predicts that, using this arrangement, the greatest number of spots on the screen will be 3.

Determine whether the student's prediction is correct.

(3)
(Total 9 marks)