MOMENTUM

IB Physics HL

Waves and optics - Set 1

C.1-C.4 | First assessment 2025 | Higher Level

Independent examination-style practice material

10 original problems

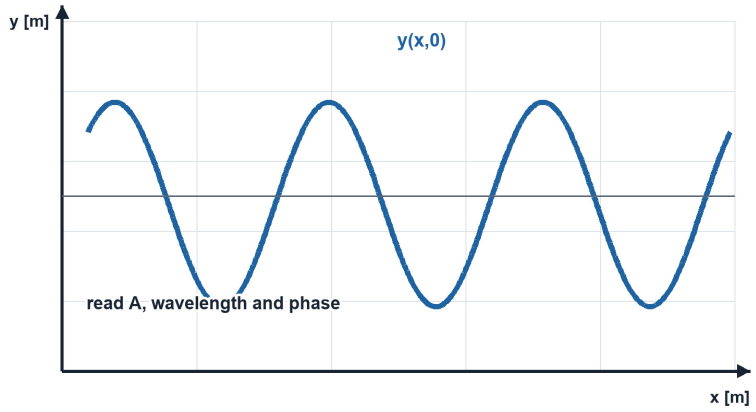
TASK 01

[7]

Reading a travelling wave

Paper 2 style | IB code C.1

A transverse wave is described by y = 0.030 sin(8.0 pi t - 2.0 pi x), where x and y are in metres and t is in seconds.



(a) Determine the amplitude, frequency and wavelength. [3]

(b) Determine the wave speed and direction. [2]

(c) Determine the maximum transverse speed of a particle. [2]

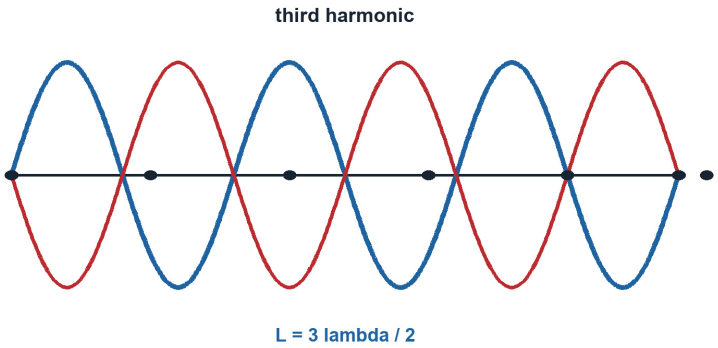
TASK 02

[6]

Standing waves on a string

Paper 2 style | IB code C.2

A string of length 1.20 m is fixed at both ends. Its linear density is 2.50e-3 kg m^{-1} and tension is 90.0 N.



L = 3 lambda / 2

(a) Determine the wave speed. [2]

(b) Determine the first three resonant frequencies. [3]

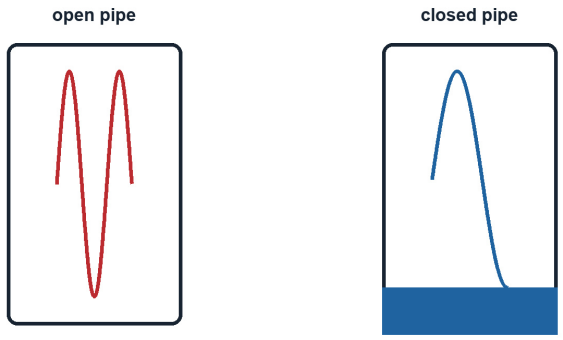
(c) State the number of antinodes in the third harmonic. [1]

TASK 03
[7]

Resonance in air columns

Paper 2 style | IB code C.2

Two pipes have equal length 0.850 m. One is open at both ends and the other is closed at one end. Take sound speed 340 m s^{-1} and neglect end correction.



(a) Determine the fundamental frequency of each pipe. [3]

(b) Determine the next resonance of the closed pipe. [2]

(c) Explain why the closed pipe does not support the second harmonic. [2]

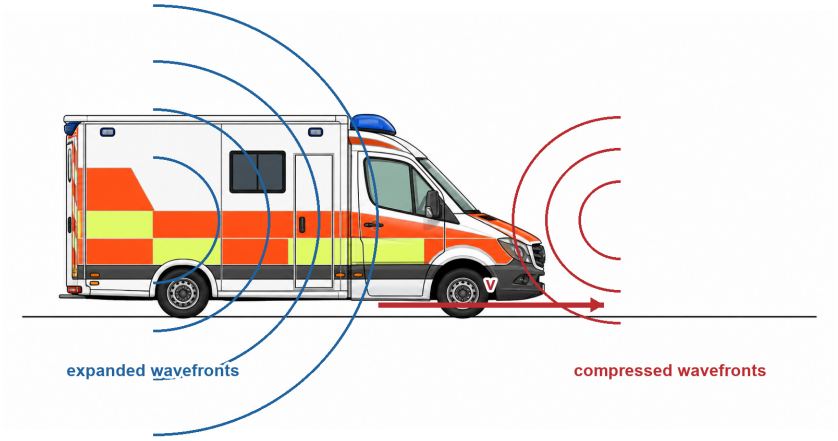
TASK 04

[5]

Doppler shift from an ambulance

Paper 2 style | IB code C.1

An ambulance siren emits 800 Hz and approaches a stationary observer at 25.0 m s^{-1}. Take sound speed 340 m s^{-1}.



(a) Determine the observed frequency while approaching. [2]

(b) Determine the observed frequency after it passes and recedes at the same speed. [2]

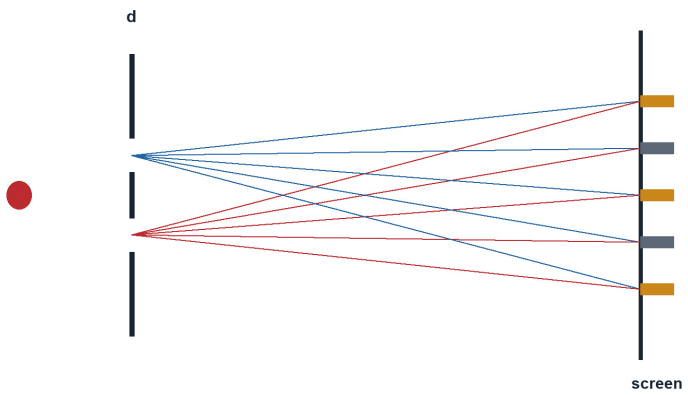
(c) Determine the frequency change heard at the instant of passing. [1]

TASK 05
[5]

Young's double-slit experiment

Paper 2 style | IB code C.3

Monochromatic light of wavelength 600 nm illuminates two slits separated by 0.300 mm. A screen is 2.00 m away.



(a) Determine the fringe spacing. [2]

(b) Determine the distance from the central maximum to the fifth bright fringe. [1]

(c) Explain what happens to the pattern if one slit is covered. [2]

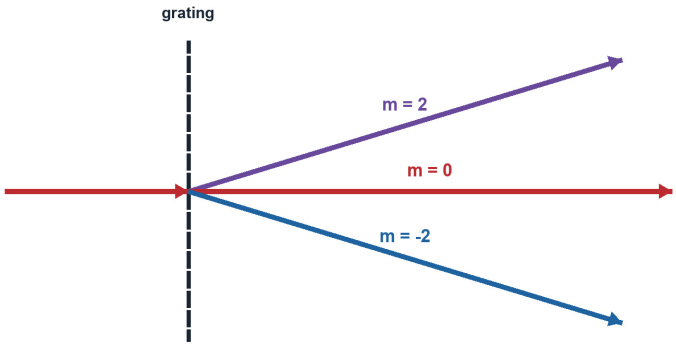
TASK 06

[7]

Resolving wavelengths with a diffraction grating

Paper 2 style | IB code C.3

A grating has 600 lines per millimetre and is illuminated normally by light of wavelength 500 nm.



(a) Determine the angle of the first-order maximum. [2]

(b) Determine the highest observable order. [2]

(c) A second wavelength is 501 nm. Determine the minimum number of illuminated lines needed to resolve the two wavelengths in second order. [3]

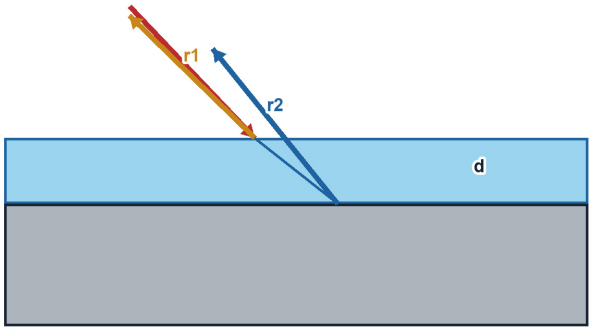
TASK 07

[7]

A thin film in reflected light

Paper 2 style | IB code C.3

A soap film of refractive index 1.33 is surrounded by air and viewed in reflected light at normal incidence. One reflected ray undergoes a phase reversal.



(a) Determine the least non-zero thickness giving constructive reflection for wavelength 600 nm. [3]

(b) Determine the least thickness giving destructive reflection. [2]

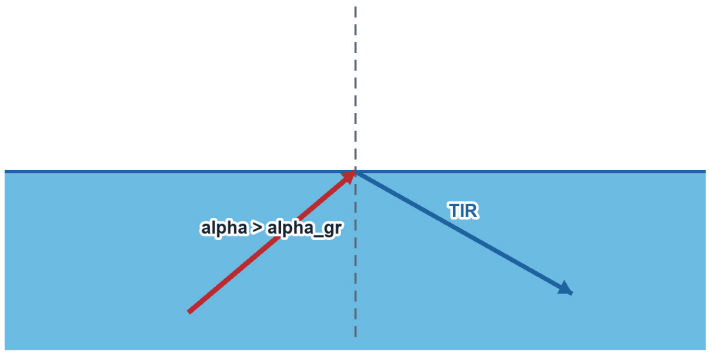
(c) Explain why a white-light film appears coloured. [2]

TASK 08
[5]

Total internal reflection in glass

Paper 2 style | IB code C.3

Light travels from glass of refractive index 1.50 to air.



(a) Determine the critical angle. [2]

(b) A ray strikes at 50.0 degrees. State what happens and determine the reflection angle. [2]

(c) Explain why total internal reflection cannot occur for light travelling from air into glass. [1]

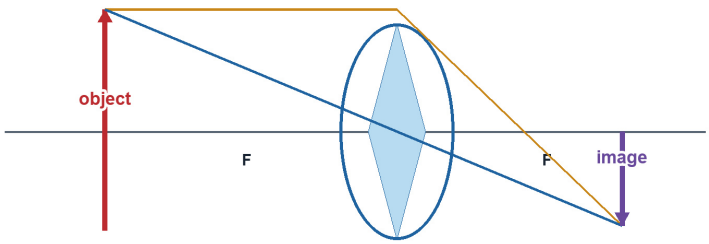
TASK 09

[6]

A converging lens and a real image

Paper 2 style | IB code C.3

An object 2.00 cm high is 30.0 cm from a converging lens of focal length 12.0 cm.



(a) Determine the image distance. [2]

(b) Determine image height and orientation. [2]

(c) Draw the principal rays used to locate the image. [2]

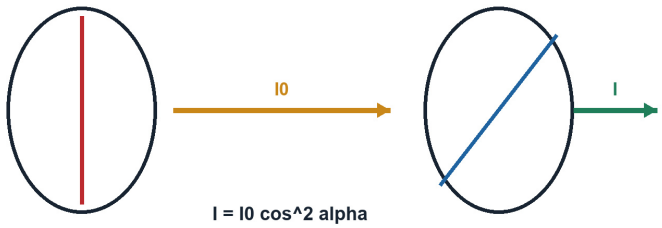
TASK 10

[6]

Polarization and Malus' law

Paper 2 style | IB code C.4

Unpolarized light of intensity I0 passes through an ideal polarizer and then an analyser whose axis is 35.0 degrees to the polarizer axis.



(a) Determine the final intensity as a fraction of I0. [3]

(b) Determine the analyser angle that gives final intensity I0/8. [2]

(c) State what this experiment demonstrates about transverse waves. [1]