S5 Physics Practice Paper 3 | Refraction, lenses, standing waves, sound intensity, photoelectric effect and atomic energy levels

Senior Secondary Physics

S5 Physics practice paper 3: refraction, lenses, standing waves, sound intensity, Doppler effect, photoelectric effect and atomic energy levels, with full solutions.

1. Refraction and total internal reflection (18 marks)

Give answers to 3 significant figures and state the formula used.

#	Question
1	(a) Light travels from water (n = 1.33) into air. Find the critical angle.
2	(b) Light in air strikes the water surface at an angle of incidence of 40.0 degrees. Find the angle of refraction.
3	(c) Explain why a diver under water sees everything above the surface within a cone of about 97 degrees.
4	(d) An optical fibre has a core of refractive index 1.50 and a cladding of 1.48. Find the critical angle at the core-cladding boundary.

2. Lens images and magnification (16 marks)

Use 1/f = 1/u + 1/v and m = -v/u; virtual images have negative v.

#	Question
5	(a) A convex lens of focal length 10.0 cm has an object 30.0 cm away. Find the image distance and magnification, and describe the image.
6	(b) The same convex lens now has the object 5.0 cm away. Find the image distance and magnification, and describe the image.
7	(c) A concave lens has focal length 15.0 cm (f = -15.0 cm) and the object is 30.0 cm away. Find the image distance and magnification.
8	(d) A convex lens of focal length 5.0 cm is used as a magnifying glass with a near point of 25 cm. Find the maximum angular magnification.

3. Standing waves and resonance (16 marks)

The string is fixed at both ends; the closed pipe is open at one end. Take the speed of sound in air as 340 m/s.

#	Question
9	(a) A string 0.80 m long is fixed at both ends. The wave speed is 320 m/s. Find the fundamental frequency and wavelength.
10	(b) Find the frequency of the third harmonic of this string and the number of nodes.
11	(c) A closed pipe 0.50 m long (closed at one end) sounds its fundamental. Find the frequency.

#	Question
12	(d) Two tuning forks of 440 Hz and 444 Hz sound together. Find the beat frequency.

4. Sound intensity, decibels and the Doppler effect (18 marks)

Sound intensity level L = 10 log(I / I0) with I0 = 1.0 x 10^-12 W m^-2; take the speed of sound as 340 m/s.

#	Question
13	(a) The sound intensity at a point is 1.0 x 10^-4 W m^-2. Find the sound intensity level.
14	(b) If the distance from a point source is doubled (no absorption), find the new sound intensity level.
15	(c) An ambulance travelling at 34 m/s towards a stationary observer sounds a 500 Hz siren. Find the observed frequency (v = 340 m/s).
16	(d) After passing, the ambulance moves away at the same speed. Find the observed frequency and explain what the observer hears.

5. The photoelectric effect (16 marks)

Use E = hc/λ with hc = 1240 eV nm; the work function is W = 2.30 eV.

#	Question
17	(a) Light of wavelength 400 nm falls on the metal. Find the photon energy and the maximum kinetic energy of the emitted electrons.
18	(b) The wavelength is reduced to 300 nm. Find the maximum kinetic energy and the stopping voltage.
19	(c) If the intensity is increased at the same wavelength, does the stopping voltage change? Explain.
20	(d) Find the threshold wavelength of the metal.

6. Hydrogen energy levels and spectra (16 marks)

Hydrogen levels are En = -13.6/n^2 eV; hc = 1240 eV nm.

#	Question
21	(a) Find the energy and wavelength of the photon emitted when an electron falls from n = 2 to n = 1.
22	(b) What is the ionisation energy of a hydrogen atom? Give a reason.
23	(c) Explain why the hydrogen emission spectrum consists of discrete lines rather than a continuum.
24	(d) Find the wavelength of the line from n = 3 to n = 2 and name its series.