GCSE Physics Topic 6 AQA: Waves Mark Scheme

Q1. Reflection [3]

(a) Angle of incidence = angle of reflection (1).
(b) Correctly drawn and labelled:

- incident ray (1)
- reflected ray and normal at right angle to mirror (1).

Q2. Wave equation [3]

(a) $v = f \lambda$ (1).
(b) $v = 50 \times 2$ (1) = 100 m/s (1).

Q3. Water waves [3]

(a) Transverse (1).
(b) Oscillations are perpendicular to direction of energy transfer (1) e.g. ripples move up/down, wave travels outward (1).

Q4. Sound [3]

(a) Longitudinal wave (1).
(b) Vibrations / compressions and rarefactions (1) transfer energy through air particles colliding (1).

Q5. Electromagnetic spectrum [4]

(a) Radio → microwave → infrared → visible → ultraviolet → X-ray → gamma (1 each, max 3).
(b) Gamma rays (1).

Q6. Wavelength of sound [2]

λ = v ÷ f = 340 ÷ 170 (1) = 2.0 m (1).

Q7. Refraction [2]

(a) Speed decreases in glass (1).
(b) Ray bends towards the normal (1).

Q8. Wave on string [4]

(a) v = f λ = 5 × 0.8 (1) = 4.0 m/s (1).
(b) If speed is constant: increasing frequency → decreasing wavelength (1) inverse relationship (1).

Q9. Echoes [5]

(a) Sound reflects from a surface (1) and is heard later than original sound (1).
(b) Total distance = speed × time = 340 × 2 = 680 m (1)
Distance to wall = 680 ÷ 2 (1) = 340 m (1).

Q10. EM radiation uses/risks [2]

(a) Infrared use: heating / TV remote controls / thermal imaging (1).
(b) UV risk: skin cancer / sunburn / eye damage (1).

Q11. Seismic waves [4]

(a) Primary (P) waves (1), Secondary (S) waves (1).
(b) Differences:

- P longitudinal, S transverse (1)
- P travel faster than S (1).

Q12. Frequency [3]

(a) Number of waves passing a point per second (1).
(b) 250 × 2 = 500 waves (1) correct answer with unit “waves” (1).

Q13. EM waves [3]

(a) Travel at speed of light in vacuum / transfer energy / transverse (1).
(b) Microwaves penetrate food (1) and heat water/fat molecules (1).

Q14. Water refraction [3]

(a) Waves speed up in deeper water (1).
(b) Change in speed causes change in direction (1) wavelength increases (1).

Q15. Ultrasound [3]

(a) Use: pre-natal scanning / kidney stone treatment / cleaning equipment (1).
(b) Non-ionising radiation (1) less harmful than X-rays (1).

Q16. Refraction [5]

(a) Refraction = change in direction of a wave (1) when it crosses a boundary and changes speed (1).
(b) Light slows down in glass (1) causing it to bend towards the normal (1). Bending happens because speed depends on optical density (1).

Q17. Ripple tank [5]

(a) Method:

- measure wavelength with ruler (1)
- measure frequency with timer/ strobe (1)
- calculate wave speed using v = f λ (1).
  (b) v = 12 × 0.05 (1) = 0.60 m/s (1).

Q18. Seismic waves [5]

(a) Any two:

- P longitudinal, S transverse (1)
- P travel faster, S slower (1)
- P travel through solids & liquids, S only through solids (1).
  (b) S-waves cannot pass through liquid (1) → large shadow zones observed (1) → shows Earth has a liquid outer core (1).

Q19. Oscilloscope sound [4]

(a) Higher frequency = more waves in same time / closer together (1).
(b) Louder sound = taller waves / greater amplitude (1).
(c) Frequency = number of waves per second (1), amplitude = maximum displacement / loudness (1).

Q20. Microwaves [3]

(a) Use: satellite communication / mobile phones (1).
(b) Microwaves penetrate atmosphere (1) and travel long distances with little absorption (1).

Q21. EM waves [3]

(a) 3×10^8 m/s (1).
(b) UV causes ionisation (1) → damages DNA / cells → skin cancer / eye damage (1).

Q22. Ultrasound underwater [5]

(a) Ultrasound pulse sent out (1), time for echo returning measured (1).
(b) Distance = (speed × time) ÷ 2 (1).
= (1500 × 0.12) ÷ 2 (1) = 90 m (1).

Q23. X-rays & gamma [4]

(a) Medical use: imaging bones / teeth / CT scans (1).
(b) Both are EM waves / ionising / travel at speed of light (1).
(c) Gamma has higher energy / frequency (1), so more ionising and damaging to tissues (1).

Q24. Prism [4]

(a) White light splits into a spectrum (1) colours spread out (1).
(b) Different wavelengths refract by different amounts (1) shorter wavelengths (blue/violet) refract more (1).

Q25. Radio waves [3]

(a) Produced by oscillations of charges in an electrical circuit (1).
(b) Radio waves induce oscillations / alternating current in the aerial (1) → signal is received (1).

Q26. EM spectrum order [3]

(a) X-rays → visible light → microwaves (1).
(b) Higher frequency → shorter wavelength (1), inverse relationship (1).

Q27. Sound [3]

(a) Air particles vibrate backwards and forwards (1).
(b) $f = v \div \lambda = 340 \div 0.68$ (1) = 500 Hz (1).

Q28. Infrared [3]

(a) Use: remote controls / thermal imaging / heating (1).
(b) IR absorbed by detectors (1) and converted into electrical signals / heating effect (1).

Q29. Refraction in water [3]

(a) Waves bend towards the normal in shallow water or away when entering deep (1).
(b) Change in speed causes change in direction (1), wavelength also changes (1).

Q30. Sound intensity [3]

(a) Amplitude increases when louder (1).
(b) Greater amplitude = more energy per wave (1) → more energy transferred to surroundings (1).

Q31. Radio communication [3]

(a) Radio waves can be reflected by ionosphere (1).
(b) Ionosphere reflects long wavelength radio waves (1) so they can travel long distances beyond horizon (1).

Q32. Total internal reflection [4]

(a) Conditions:

- wave travelling from more dense to less dense medium (1)
- angle of incidence greater than critical angle (1).
  (b) In fibres: light reflects repeatedly (1) stays trapped inside fibre with very little energy loss (1).

Q33. Waves on string [4]

(a) $v = f \lambda = 20 \times 0.25$ (1) = 5.0 m/s (1).
(b) Measure distance over several wavelengths with ruler (1) then divide by number of waves (1).

Q34. Radiation [3]

(a) Harm: cancer / cell mutation / tissue damage (1).
(b) Gamma less ionising per particle but more penetrating (1) → passes through body where alpha cannot (1).

Q35. Echoes [5]

(a) Longer distance means sound takes longer to travel to wall and back (1) so echo is delayed (1).
(b) Total distance = 340 × 0.6 = 204 m (1)
Distance to wall = 204 ÷ 2 (1) = 102 m (1).

Q36. Infrasound [2]

(a) Sound waves below 20 Hz (1).
(b) Use: animal communication / detecting volcanic eruptions / earthquakes (1).

Q37. Seismic waves [3]

(a) S-waves can't travel through liquids (1) → outer core is liquid (1).
(b) Evidence = Earth has a liquid outer core (1).

Q38. Doppler effect [4]

(a) Frequency increases (1).
(b) Light from galaxies is red-shifted (1) shows they are moving away (1) supports expanding universe → Big Bang (1).

Q39. Frequency [2]

Number of waves = 5 in 0.01 s → f = 5 ÷ 0.01 (1) = 500 Hz (1).

Q40. Visible light vs microwaves [2]

(a) Both are electromagnetic / travel at speed of light / transverse waves (1).
(b) Different wavelengths / frequencies / energies (1).

Q41. Seismic waves [4]

- P-waves travel through solids and liquids (1)
- S-waves only travel through solids (1)
- S-wave shadow zone shows they cannot pass through outer core (1)
- Therefore outer core is liquid, inner core must be solid (1)

Q42. Doppler shifts [4]

(a) Light from galaxies is stretched (1), wavelength shifts towards red end of spectrum (1).
(b) Shows galaxies moving away (1), supporting idea Universe is expanding from a single point (Big Bang) (1).

Q43. Superposition [4]

(a) Constructive interference = waves meet in phase (1) → amplitudes add to produce larger wave (1).
(b) Destructive interference = waves meet out of phase (1) → amplitudes cancel / reduce (1).

Q44. Microwaves experiment [3]

- Place receiver on track at different positions (1)
- Move receiver until signal strength alternates between maxima/minima (1)
- Distance between adjacent maxima = half a wavelength (so wavelength can be calculated) (1)

Q45. X-rays [4]

(a) Produced when high-speed electrons are decelerated at metal target / anode (1) → energy released as X-rays (1).
(b) Medical use difference:

- X-rays mainly for imaging bones/CT scans (1)
- Gamma rays used for cancer treatment / sterilisation (1).

Q46. Diffraction [4]

(a) Narrower gap = more spreading/diffraction (1).
(b) Diffraction effects noticeable when wavelength is similar to gap size (1).
Radio waves have long wavelengths comparable to everyday gaps (1), visible light wavelength is too small so little diffraction occurs (1).

Q47. Medical imaging [4]

- Ultrasound: used for scanning soft tissues / babies (1), non-ionising so safer (1).
- X-rays: used for imaging bones / CT scans (1), ionising and can damage cells/tissue (1).

Q48. Seismic waves and Earth's core [4]

- S-waves cannot pass through outer core (1)
- Produces large S-wave shadow zone (1)
- P-waves refract at core boundary (1)
- Shows outer core is liquid, inner core is solid (1).

Q49. Gamma radiation [4]

(a) Gamma has enough energy to remove electrons from atoms (1) → forming ions (1).
(b) Used for sterilisation because: penetrates materials (1) and kills bacteria/microorganisms (1).

Q50. Fibre optics [3]

- Light undergoes total internal reflection at boundary (1)
- Prevents light escaping fibre (1)
- Allows signal to travel long distances with little loss (1).

Q51. Infrasound & Ultrasound [4]

(a) Infrasound: frequency below 20 Hz (1).
(b) Ultrasound: frequency above 20,000 Hz (1).
(c) Infrasound uses: detecting volcanoes/earthquakes/animal communication (1).
Ultrasound uses: scanning in medicine / cleaning / industrial testing (1).

Q52. Gamma vs Microwaves [3]

- Gamma has much higher frequency / energy than microwaves (1)
- Gamma is ionising → damages DNA / cells (1)
- Microwaves only cause heating effects, not ionisation (1).

Q53. Red-shift [4]

(a) Wavelength of light from galaxies increases (1) → shifts towards red end of spectrum (1).
(b) Shows galaxies are moving away (1) → Universe is expanding (1).

Q54. Resonance [3]

- Resonance = when driving frequency matches natural frequency of system (1)
- Causes large amplitude oscillations (1)
- Example: bridge collapse, wine glass breaking, swing pushed at correct frequency (1).

Q55. Wave speed [4]

(a) $v = f \lambda = 4 \times 0.75$ (1) = 3.0 m/s (1).
(b) In shallow water, waves slow down (1) because depth reduces speed → wavelength decreases (1).