

Wave Parameters and Behaviours

Longitudinal and transverse waves

1. Sound wave – transfers sound energy, water wave – kinetic energy.
2. Wave A is a transverse wave and Wave B is a longitudinal wave.
3. (a) Stretch the spring and move sideways, back and fore at right angles to length of spring.
(b) Stretch the spring and move spring back and fore in direction of spring.
4. Water waves – transverse, Light – transverse, Sound – longitudinal, Radio waves – transverse, X-rays – transverse.

Wave speed, frequency, wavelength and amplitude

5. (a) The distance from the mid line to a wave crest or wave trough.
(b) Wavelength.
(c) Hz
(d) s
(e) The distance travelled by a wave each second.
6. $f = 1/T$
7. 0.1 s
8. 4 s
9. 5 Hz
10. 100 Hz
11. (a) 5 Hz
(b) 3 Hz
(c) 1 Hz
(d) 5 Hz
(e) 0.5 Hz
12. (a) 1 Hz
(b) 2 Hz
(c) 5 Hz
(d) 4 Hz
13. (a) 0.1 m
(b) 0.5 m
(c) 10 cm or 0.1 m
(d) 2 m
14. (a) 256. (b) 15 360
15. 2 Hz

16. (a) 500
(b) 2500
(c) 50

Calculating wave speed using frequency and wavelength

17. $v = f \times \lambda$

18. (a) 20 m s^{-1}
(b) 5 m s^{-1}
(c) 2 m
(d) 5 m
(e) 68 Hz
(f) 0.2 Hz
(g) 1500 m
(h) $3 \times 10^6 \text{ Hz}$
(i) $3 \times 10^8 \text{ m s}^{-1}$

19. 0.02 m

20. 1360 Hz

21. 1 m s^{-1}

22. 6 m s^{-1}

23. (a) 3.2 m
(b) 3.1 m
(c) 2.8 m
(d) 247 m
(e) 1515 m

24. $4.3 \times 10^{14} \text{ Hz}$

Calculating wave speed using distance and time

25. $d = v \times t$

26. (a) 8 m s^{-1}
(b) 20 m s^{-1}
(c) 5 s
(d) 400 s
(e) 2720 m
(f) 20 m

27. 20 s

28. 238 m s^{-1}

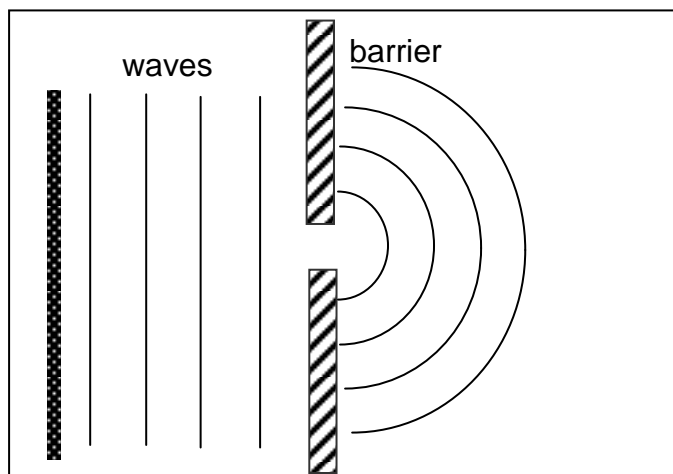
29. 0.3 seconds

30. 4 m s^{-1}

31. (a) 1.27 s
(b) 500 s

32. Diffraction

33.



34. (a) Diffraction

(b) Waves which have a **long** wavelength bend more than waves which have a **short** wavelength.

Extension Questions

35. (a) 0.00003 s
(b) 0.17 m

36. (a) $3 \times 10^8 \text{ m s}^{-1}$
(b) 0.7 m
(c) Waves bend around the person to reach the car.

37. (a) Diffraction
(b) Sound can diffract around the corner of the building.
(c) Low frequency sound is able to diffract over the top of the barrier.
(d) The LW broadcasts can bend around obstacles whilst the high frequency FM cannot.

Light

Refraction of light

38. 90°

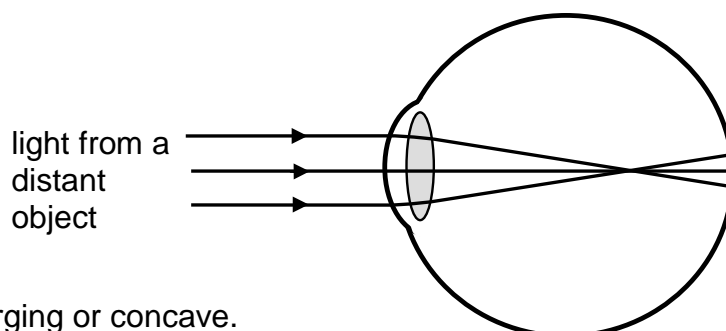
39. (a) Towards.
(b) Away from.
(c) Decreases.
(d) Increases.
(e) Less than.
(f) Greater than.

40. (a) P
(b) R

41. C, F, H, I, J

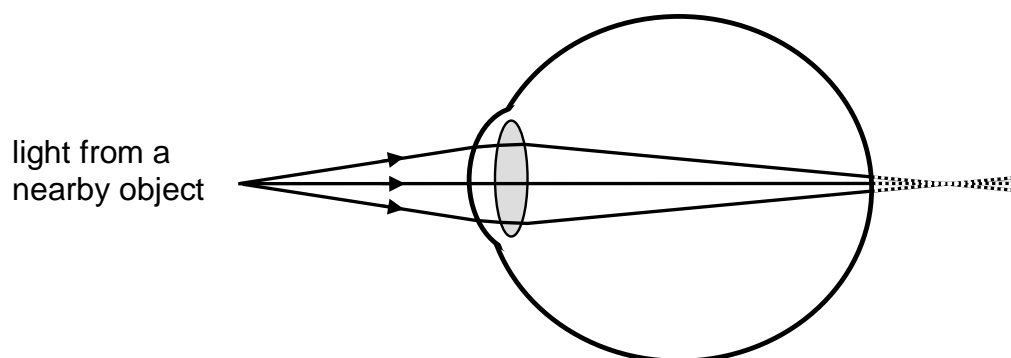
42. (a) angle of incidence = 40° , angle of refraction = 25°
(b) angle of incidence = 50° , angle of refraction = 31°
(c) angle of incidence = 25° , angle of refraction = 16°
(d) angle of incidence = 35° , angle of refraction = 23°

43. (a)



- (b) Diverging or concave.

44. (a)

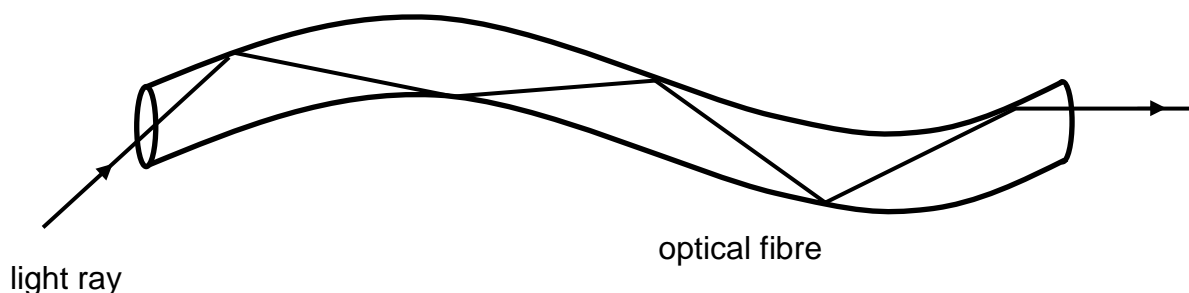


- (b) Convex or converging.

45. Occurs when a ray of light tries to escape from a glass to air and the angle of incidence is greater than the critical angle. The ray is reflected back into the glass.

46. (a) Ray refracts out of block with some reflection.
 (b) Ray refracts at 90° along block face with some reflection.
 (c) Ray totally reflects back into block.

47.



48. (a) 28°
 (b) 28°
 (c) 28°
 (d) 45°
49. (a) Total internal reflection.
 (b) It will decrease as some of the light has been refracted out of the windscreen.
50. (a) Convex or converging.
 (b) Backwards.
 (c) Long sight.

Electromagnetic Spectrum

The electromagnetic spectrum

51. (a) $3 \times 10^8 \text{ m s}^{-1}$
 (b) At the same time.
 (c) (i) Radio and TV waves.
 (ii) Gamma radiation
 (iii) Gamma radiation.
 (iv) Radio and TV waves

52.

	Wave frequency	Wavelength	Type of wave
(a)	$3 \times 10^{19} \text{ Hz}$	$1 \times 10^{-11} \text{ m}$	Gamma radiation
(b)	$4.3 \times 10^{14} \text{ Hz}$	$6.97 \times 10^{-7} \text{ m}$	Red light
(c)	$3 \times 10^{10} \text{ Hz}$	0.01 m	Microwaves
(d)	$7.5 \times 10^{14} \text{ Hz}$	$4 \times 10^{-7} \text{ m}$	Violet light
(e)	$1.0 \times 10^{16} \text{ Hz}$	$3 \times 10^{-8} \text{ m}$	Ultraviolet
(f)	$1.0 \times 10^{18} \text{ Hz}$	$3 \times 10^{-10} \text{ m}$	X-rays
(g)	$1.0 \times 10^8 \text{ Hz}$	3 m	Radio and TV
(h)	$1.0 \times 10^6 \text{ Hz}$	300 m	Long wave
(i)	$3.0 \times 10^{13} \text{ Hz}$	$1 \times 10^{-5} \text{ m}$	Infrared

53. $3 \times 10^{-7} \text{ m}$ 54. (a) 3×10^8

(b) 3.1 m

(c) 0.0003 s

55. $3 \times 10^{12} \text{ Hz}$

56. (a) 500 s

(b) $1 \times 10^{20} \text{ Hz}$

57. (a) 0.17 m

(b) $1.7 \times 10^{-5} \text{ s}$

58. (a) 5

(b) 4

(c) 6

(d) 2

(e) 1

(f) 7

(g) 3

59. (a) Radio and TV waves.

(b) Infrared.

(c) Heating food in a microwave oven.

(d) Visible or Infrared.

60. (a) A hot object.
(b) An infrared camera or infrared sensitive film. It will also cause objects which absorb it to warm up.
(c) Thermographs, treating muscle injuries, remote controls, burglar alarm activators.
61. (a) Using materials which fluoresce (glow) under ultraviolet light.
(b) It can cause skin cancer.
(c) Can be used in the treatment of skin diseases or to security mark objects.
62. (a) Frequent exposure to X-rays would be harmful.
(b) X-rays are more likely to damage cells which are actively dividing, such as in a young child.
(c) It completely blocks more of the X-rays.
63. (a) The bone blocks the X-rays reaching the film.
(b) 3×10^{18} Hz
(c) X-rays could harm the foetus.
(d) Ultrasound.
64. Waves from the electromagnetic spectrum will transfer **energy** from one place to another. The amount of energy the waves carry depends upon the frequency or wavelength of the waves. The **higher** the frequency or **shorter** the wavelength, the more energy they carry. Waves with a **longer** wavelength and a **low** frequency carry less energy.
65. (a) $Uv A = 1 \times 10^{15}$ Hz, $uv B = 7.5 \times 10^{14}$ Hz so uv A has the higher frequency
(b) Uv A as the higher frequency radiation carries more energy.

Extension Questions

66. (a) 0.33 m
(b) (i) Two from: infrared, visible light, ultraviolet, x-rays or gamma radiation.
(ii) TV and radio and long waves
(c) 1.3×10^{-5} s
(d) High frequency waves carry more energy.
(e) 3.6×10^7 m
67. (a) Sound waves are longitudinal waves and cannot travel through a vacuum. Waves from the EM spectrum are transverse and can travel through a vacuum.
(b) Ultraviolet, X-rays and gamma radiation.
(c) They carry more energy.
(d) When electrons move in a conductor.
(e) Static.
(f) To 'see' when there is no light.
(g) The ozone layer in the atmosphere filters it out.
(h) It can be harmful.
(i) Sterilising medical instruments, destroying cancer cells.

Nuclear Radiation

Properties of Radiation

68. (a) Neutron.

(b) Proton

(c) Electron

69. They are equal in number.

70. When alpha or beta particles pass another atom, they tend to pull electrons off it leaving it with a positive charge.

71. There are three different types of nuclear radiation – alpha, beta and gamma. Alpha radiation is a **helium** nucleus and has a **positive** charge. It is a **strongly** ionising radiation so will damage cells if it gets into the body. Fortunately, it is blocked by a thin sheet of **paper** or a few centimetres of **air**. Beta radiation is a fast moving **electron** from the break up of a proton in an atom's **nucleus**. It has a **negative** charge and requires 3 millimetres of aluminium to block it. The last type is gamma radiation which is not a particle but a **wave** and part of the electromagnetic spectrum. Gamma requires 3 centimetres of **lead** to block its path. Beta and gamma are **weakly** ionising radiations and do not ionise as strongly as alpha radiation.

72. (a) Sheet of paper or 3 cm of air.

(b) Strongly ionises.

(c) Fast moving electron.

(d) Weakly ionises.

(e) Gamma.

(f) 3 cm of lead.

73. (a) When alpha or beta particles pass another atom, they tend to pull electrons off it leaving it with a positive charge.

(b) It is good at ionising the air.

74. Becquerel.

75. 2×10^6 Gy

76. 1.8×10^7

77. 6×10^6

78. (a) Background radiation is present all time, either from natural sources or man-made sources.

(b)

<i>Source</i>	<i>Natural</i>	<i>Man-made</i>
Building materials		✓
Nuclear medicine		✓
Nuclear power stations		✓
Cosmic radiation	✓	
Granite rock	✓	
Radon gas		✓
Bananas	✓	
Water	✓	
Tobacco		✓
Smoke detectors		✓
Luminous watches		✓

Absorbed Dose and Equivalent Dose

79. (a) Absorbed dose = energy/mass

(b) Gray (Gy).

80. (a) 5×10^{-4} Gy

(b) 0.025 Gy

(c) 2.5×10^{-5} J

(d) 1.5×10^{-7} J

(e) 0.25 kg

(f) 1 kg

81. 1.25×10^{-3} Gy

82. 17 Gy

83. (a) Equivalent dose = absorbed dose \times weighting factor.

(b) Sievert (Sv)

84. (a) Some forms of radiation are more harmful than others to living tissue.

(b) It strongly ionises so will cause greatest disruption and damage to living cells.

85. (a) 2×10^{-4} Sv

(b) 0.015 Sv

(c) 5×10^{-4} Sv

(d) 5×10^{-6} Sv

(e) 2×10^{-6} Sv

(f) 10×10^{-6} Sv

86. 20 μSv

87. 0.05 Sv

88. (a) 3.3 μJ
(b) 66 μJ

89. 100 μSv

Applications of nuclear radiation

90. (a) Alpha will be blocked by the aluminium foil while gamma will pass straight through unaffected.
(b) It has become thicker.
(c) It would be reduced.

91. (a) Gamma radiation can escape from the body, alpha radiation is very harmful within the body.
(b) The right kidney.
(c) Radioactivity decreases with time.
(d) (i) The left side of the thyroid has not absorbed the radioactive iodine (as well).
(ii) The radioactivity of the iodine may decrease to a low level before it is used.

92. (a) So that householders do not receive radiation in their water.
(b) About 40 metres.
(c) Only gamma will be able to travel through the rocks and soil to the surface.

Half-life

93. It is the time taken for the activity of the source to decrease to half its original value.

94. 8 minutes.

95. 500 Bq

96. 8 days.

97. (a) Radiation from natural or man-made sources that is always present.
(b) Deducted.
(c) Approximately 16 minutes

98. 16 g

99. 10 million

100. 625 kBq

- 101.** Nuclear fission takes place when a **neutron** collides with a **large** unstable nucleus of **uranium**. This causes it to **split** into two **smaller** nuclei. At the same time it releases more **neutrons** and a quantity of **heat**.
- 102.** Nuclear fusion takes place when two **small** nuclei collide and join together to create a **larger** nucleus. This also causes **heat** energy to be released. This is the same atomic reaction that provides the energy for the **Sun**.
- 103.** (a) Turbine.
(b) It is used to produce steam.
(c) It converts the kinetic energy of the turbine into electricity.
(d) Nuclear energy into heat.
- 104.** (a) Fission occurs when a large nucleus splits in two, releasing energy. Nuclear fusion occurs when two small nuclei combine together to form a larger nucleus, again releasing energy.
(b) Fission.
- 105.** Neutrons are released by nuclear fission which go on to produce more fission which releases more neutrons and so on.
- 106.** A A neutron strikes a large nucleus which becomes unstable.
B The nucleus splits into two smaller nuclei.
C Heat is released along with more neutrons.
- 107.** 1. **TRUE** – Most radiation comes from cosmic rays from space and from radon gas escaping from underground rocks.
2. **FALSE** – Estimates vary, but there is sufficient nuclear fuel, in the form of uranium, to last for at least a hundred years. Newer types of nuclear reactors could make this last a lot longer.
3. **TRUE** – Radioactive waste from nuclear reactors remains radioactive for a long time so needs to be stored underground till the radiation levels decrease enough.
4. **TRUE** - Nuclear fission is currently used though scientists are working on using nuclear fusion to produce energy.
5. **FALSE** - Nuclear reactors take many years to plan and build so can't be built quickly.
6. **FALSE** - Nuclear reactors do not produce any sulphur dioxide.
7. **FALSE** – Only a tiny fraction of the overall background radiation comes from nuclear power stations though there have been some major disasters such as Chernobyl power station in Russia which blew up as a result of workers switching off safety mechanisms.
8. **FALSE** – Industry can create demands for large quantities of energy but like fossil fuelled power stations, this can be supplied by nuclear power stations.
9. **FALSE** - Nuclear reactors do not produce any greenhouse gases.

10. **FALSE** – None of the nuclear power stations in the west are of the type that exploded in Chernobyl.

Extension Questions

108. (a) D

(b) B

(c) C

(d) A

(e) (i) 4000 Bq

(ii) 250 Bq

109. (a) Cosmic radiation, radon gas, rocks, medical radioactivity etc.

(b) Approximately 8.5 seconds

(c) Any spillages are kept enclosed.

(d) It is buried underground in sealed containers.

110. (a) It is the time taken for the activity of the source to decrease to half its original value.

(b) Approximately 9 minutes

(c) When alpha or beta particles pass another atom, they tend to pull electrons off it leaving it with a positive charge.

(d) 12 000 years.