Question	Answer	Marks
1 (a)	**is a transfer of energy** as a result of oscillations (of the source/medium/particles through which the energy is travelling)	1 1
1 (b)	the displacement/oscillation (of particles) is normal/perpendicular to the direction of energy transfer in a transverse wave the displacement/oscillation (of particles) is parallel to the direction of energy transfer in a longitudinal wave	1 1
1 (c) (i)	wavefronts/paths spread out after passing through a gap or around an obstacle	1
1 (c) (ii)	use of a slit/hole/barrier width of gap/position beyond barrier comparable to wavelength microphone/observer's ear suitably placed sound detected/heard outside of the 'geometrical shadow' region (this shows diffraction)	1 1 1 1
2 (a)	They can all travel through a vacuum. They all have a common speed of 3.0×10^8 m s^{-1} in a vacuum.	1 1
2 (b)	$f = 15 \times 10^9$ Hz $\lambda = \frac{c}{f} = \frac{3.0 \times 10^8}{15 \times 10^9}$ $\lambda = 2.0 \times 10^{-2}$ m The electromagnetic waves are microwaves. (Allow: radio waves)	1 1 1 1
3 (a)	refractive index = $\frac{\text{speed of light in a vaccuum}}{\text{speed of light in material}}$	1
3 (b) (i)	$v = \frac{3.00 \times 10^8}{1.48}$ $v = 2.02 \times 10^8$ m s^{-1}	1 1
3 (b) (ii)	$\sin C = \frac{1}{n} = \frac{1}{1.48}$ $C = 42.5°$	1 1
3 (b) (iii)	The angle of incident at the face AB of the block is 45°. This angle of incidence is greater than the critical angle; hence the ray suffers total internal reflection at AB. The ray of light then travels to the face BC of the block. The angle of incidence is once again greater than the critical angle and total internal reflection takes place at BC. The ray of light then travel parallel to the original ray, but in opposite direction.	1 1 1 1
4 (a) (i)	displacement: any distance moved from equilibrium of a point/particle on a wave amplitude: maximum displacement caused by wave motion	1 1
4 (a) (ii)	frequency: (one of) number of wavelengths passing a point per unit time number of vibrations at a point per unit time number of wavelengths/vibrations produced by the wave source phase difference: found between two points on the same wave (or between two waves of the same frequency); phase difference is how far through the cycle one point is compared to the other.	1 1
4 (b)	pulse starts at 0.5 s ends at 2.0 s pulse shape is reversed from Figure 6.1 pulse has correct amplitudes (0.2 at 0.75 s, –0.12 at 1.25 s, 0.08 at 1.75 s)	1 1 1 1

Question	Answer	Marks
5 (a)	$\frac{5\lambda}{4} = 1.00$ $\lambda = 0.80$ m $v = f\lambda = 2.4 \times 0.80$ $v = 1.92$ m s^{-1}	1 1 1 1
5 (b)	phase difference = $\frac{0.30}{0.80} \times 360°$ phase difference = 135°	1 1
5 (c)	As the wave profile moves to the right, the rope moves in a downward direction. Hence **A** would move vertically down.	1 1
6 (a)	Reference to a transverse wave or to vibrations in plane normal to the direction of energy propagation. Oscillations in one direction are confined to a single plane (containing the direction of propagation).	1 1
6 (b)	Set up apparatus, e.g. tray of water on table with lamp/light from window rotate the filter rotation of filter changes the image intensity/brightness correct orientation for maximum and minimum intensities of image move head up or down to change angle of reflected light observed use of protractor to measure angles image/reflection becomes partially plane polarised/ image changes from bright to dim but does not disappear Max 3 marks from marking points + quality of written communication mark	1 1 1 1 1 1 1
7 (a) (i)	Correct distance shown (e.g. from peak to neighbouring peak or twice distance PQ)	1
7 (a) (ii)	Correct distance shown (e.g. distance from dotted line to either a peak or a trough)	1
7 (b)	Both particles have the same amplitude and frequency. There is a phase difference of 180° between the motions of P and Q.	1 1
7 (c)	wavelength $\lambda = 2.1 \times \frac{4}{3} = 2.8$ cm $v = f\lambda = 20 \times 0.028$ $v = 0.56$ m s^{-1}	1 1 1
7 (d)	$v = f\lambda$; speed $\propto$ wavelength because f is constant. Therefore as the speed is doubled, so is the wavelength of the waves.	1 1
8 (a) (i)	$f = \frac{c}{\lambda} = \frac{3.00 \times 10^8}{620 \times 10^{-9}}$ $f = 4.84 \times 10^{14}$ Hz	1 1
8 (a) (ii)	intensity = $\frac{\text{power}}{\text{area}} = \frac{1.2 \times 10^{-3}}{\pi(0.41 \times 10^{-3})^2}$ intensity = 2.272×10^3 W m^{-2}	1 1
8 (b)	total length = $\frac{2 \times 1.2 \times 10^{-2}}{\sin 40} = 3.734 \times 10^{-2}$ m speed = $\frac{3.00 \times 10^8}{1.50} = 2.00 \times 10^8$ m s^{-1} time = $\frac{\text{distance}}{\text{speed}} = \frac{3.734 \times 10^{-2}}{2.00 \times 10^8} = 1.87 \times 10^{-10}$ s time = 0.19 ns	1 1 1 1