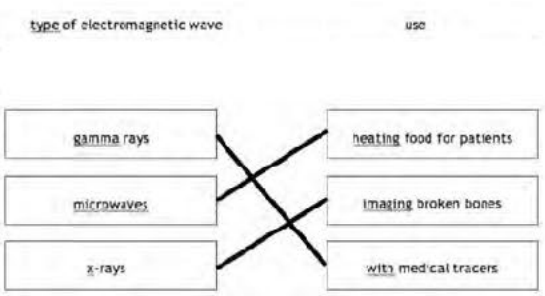
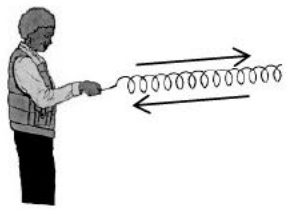
Question number	Answer	Notes	Marks
1 (a) (i)	C – speed in free space;		1
(ii)	All lines correct = 2 marks Any correct line = 1 mark  		2
(iii)	(direction of vibration) perpendicular to (direction in which the wave travels);	allow at right angles to or 90° to	1
(b) (i)	D – 45 000 Hz;		1
(ii)	Any two of - wave travels there and back; depth is half total distance travelled; time (to target) is half total (travel) time;	ignore phrase about reflection received as in stem	2
(iii)	wavelength is longer in patient or wavelength shorter in air; and **one** of:- (because) $v = f \times \lambda$; OR (because) frequency does not change;	allow wavelength is longer in more dense medium ignore • speed related to medium • as speed increases wavelength increases Total 9 marks	2

Question number	Answer	Notes	Marks
2 (a) (i)	arrows in opposite directions and (roughly) parallel with the length of the spring; 	allow • a line with a double head • arrows to R & L ignore arrow length arrows need not be adjacent to the spring judge by eye	1
(ii)	any suitable example; e.g. sound ultrasound 'p' wave	ignore waves in a slinky	1
(b) (i)	suitable horizontal line (labelled W); e.g. from peak to peak from trough to trough from midpoint to corresponding midpoint between any adjacent points in phase	judge by eye but should start and finish at suitable points	1
(ii)	2.5 (cm)	do not allow 5/2 allow 2 ½	1
(iii)	substitution into f=1/T; evaluation; unit; e.g. f=1/15 0.067 Hz	no mark for equation as it is given on page 2 -1 for POT error ignore answers given as fractions allow 0.07, 0.0667 s^{-1} condone incorrect truncation e.g. 0.06, 0.066, 0.0666	3

(iv)	(ring oscillates) perpendicular / at right angles} ; to the direction the wave travels/eq;	allow direction of energy transfer reject 2nd mark if reference to longitudinal wave e.g. 'ring moves parallel to the direction of the wave'	2
(v)	any suitable example; e.g. a named EM wave EM wave 's' wave	allow wave on a rope total marks = 10	1

Question number	Answer	Notes	Marks
3 (a) (i)	(cm)		1
(ii)	Sketched wave (at least 1 cycle) with a larger amplitude; Sketched wave (at least 1 cycle) with a longer wavelength;	Shape of wave and position of axis unimportant (i.e. ignore conditions of wind and tide)	2
(b)	Any five of - MP1. A method to make a loud enough sound; MP2. Speed = $\frac{\text{distance}}{\text{time}}$; MP3. Need for still air; MP4. Repeat AND average; MP5. Need to check/reset stopwatch zero reading; MP6. Idea of clear visual signal; MP7. measurement of time **interval** (between visual signal and sound); MP8. Idea of reaction time(s) (could be a problem);	ignore measurement of distance bald 'clap' • wooden blocks • noise has to heard over 100m RA allow repeat AND sort out anomalies e. • when the sound is seen to be made • smoke from starting pistol (because) light travels faster than sound	5

Continued

Question number	Answer	Notes	Marks
3 (c) (i) cont	wave speed = frequency × wavelength	Allow abbreviations and rearrangements, e.g. $v=f\lambda$	1
(ii)	Conversion to Hz; Substitution into correct equation and rearrangement; Evaluation; e.g. 31 MHz = 31 000 000 Hz wavelength = 300 000 000 ÷ 31 000 000 9.7 m	Allow 10^6 seen at any stage allow answers which round to 9.7 (9.6774)	3
(d)	Any one of the following ideas - MP1. the two waves travel at different speeds; MP2. the two waves travel the same distance (or 1 wavelength) in different times;	ignore references to • transverse and longitudinal • em spectrum	1

Total 13 marks

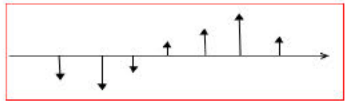
Question number	Answer	Notes	Marks
4 (a) (i)	B;		1
(ii)	A;		1
(iii)	Similarity:- any wave property e.g. transfer energy, reflection, refraction, vibration; Difference:- any one of • longitudinal particles oscillate in {same direction/ parallel to} the direction of travel; • transverse {particles oscillates/vibration} at right angles to the direction of travel;	Allow diffraction carry energy Allow • direction of energy transfer for direction of travel • only transverse waves can be polarised • transverse waves cannot travel through a liquid Ignore mention of vacuum/ medium	1 1

(b)		5

circle the mistake in this sentence	the correct word(s) is
They all travel at 3×10^2 m/s in a vacuum.	10^8 GIVEN
Sound waves are electromagnetic.	any of radio, micro(wave), infrared (IR), visible, ultraviolet (UV), X-ray or gamma
Infra-red waves are the most harmful to people.	gamma
Gamma waves are used for heating up food.	micro(waves)/ Infrared (IR)
Radio waves have the highest frequency.	Gamma (γ)
Gamma waves have a very long wavelength.	radio (waves)

each line for 1 mark;;;;;

(Total for Question 4 = 9 marks)

Question number		Answer	Notes	Marks
5 (a) (i)		B- 2		1
(ii)		C- 8		1
(b)		Idea that in a transverse wave the direction of vibration is perpendicular to the direction of the wave; (May be shown with labels on the diagram) Idea that longitudinal wave the direction of vibration is parallel to the direction of the wave; (May be shown with labels on the diagram) A named freehand sketch of either wave indicating the two directions; e.  transverse  Longitudinal	Allow (for vibration) oscillation / displacement / disturbance (for direction of wave) direction of travel / energy / transfer (for perpendicular) at right angles, is ⊥ to (for parallel) the same as, // the minimum labeliing is to name of the type of wave they have drawn. Allow sine waves with appropriate arrows Allow diagrams indicating compression and rarefaction e.g. in a spring Allow for 1 mark (but only if other mark is scored) a comparison of the directions of vibration of both waves without relating them to the direction of the wave e.g. transverse vibrates up and down but longitudinal vibrates back and forward	3
(c)		any two of		2

			MP1 can travel through vacuum OR needs no medium; MP2 speed (in a vacuum) OR speed = 3 X10^8 (m/s); MP3 obeys laws of reflection / refraction; MP4 obeys wave equation OR speed = frequency × wavelength; MP5 carries energy/ information; MP6 they are transverse	"speed in a vacuum" where seen, scores 2 marks (MP1 and MP2) Accept reflect, refract, diffract	
(d)	i		D - X-rays		1
	ii		A – absorbed by the bone		1
	iii		X-rays OR gamma rays idea of causing damage to cancer cells e.g. cells killed/mutated/ionised/destroys;	allow symbol γ do not allow UV Independent mark	2

Question number	Answer	Notes	Marks
6 (a)	C (sound waves are longitudinal waves);		1
(b) (i)	C (the same as the amplitude of sound P);		1
(ii)	0.004 (s);	Allow answer by calculation or by reading from graph Allow equivalent value with matching unit, e.g. 4 ms	1
(iii)	500 (Hz)	Treat ii and iii as independent, but allow an ecf from ii to iii if seen Accept "double" P	1

Total 4 marks