Question number			Answer	Notes	Marks
1	(a)	(i)	B radio waves		1
		(ii)	C Microwaves and radio waves travel at the same speed in a vacuum.		1
		(iii)	any one sensible property; e. travels (very) fast travel at speed of light can be coded can travel in vacuum	Allow can penetrate the ionosphere, can carry more information (than radio) higher frequency /shorter wavelength (than radio) minimal diffraction	1
	(b)		Quantities substituted in the correct equation; Rearrangement; Calculation; Conversion from hours/days to s at any point (implicit if correct ans in km); e. $3.1 = \frac{2 \times \pi \times r}{(24 \times 3600)}$ $r = \frac{3.1 \times 24 \times 3600}{2\pi}$ r = 42 600 km	No credit for quoting the equation as $v = 2\pi r/T$ is given on page 2. sub and rearrange in either order allow 3600 or 86 400 seen Allow 42630, 42628 Allow 42622 (from π = 3.142)	4

1	(c)		any suitable point; e. Satellite always appears in same part of sky satellite always about the same point on the Earth no need (for satellite dish) to track because it orbits in the same time the earth rotates	Allow idea of geostationary orbit	1

Total 8 marks

Question number	Answer	Notes	Marks
2 (a)	(Current / Electron/particle movement) in a single direction;		1
(b) (i)	ANY SUITABLE, e.g. Travel quickly / at the speed of light; Can code information; Can travel long distances / through buildings / walls / objects; Not harmful/dangerous; can diffract / reflect;		1
(ii)	(microwaves) use - communication / cooking ; harmful effect - heating ; (ultraviolet) use - fluorescent lamps / kill bacteria / harden fillings ; harmful effect - <u>skin</u> cancer / eye damage / sunburn;	ALLOW correct alternatives	4
(c)	ANY FIVE RELEVANT POINTS, e.g. current in coil; changing current/alternating current; produces magnetic field; (constantly) changing (field); which interacts with field of permanent magnet / reference to Fleming's LHR; force on coil /coil moves; vibration in (coil / cone / air); making longitudinal wave;	DO NOT ALLOW 'coil spins'	5
		Total	**11**

Question number	Answer	Notes	Marks
3 (a)	gravity		1
(b) (i)	6960 (km)		1
(ii)	equation quoted (NO MARK) conversion of km OR min; $v = (2 \times \pi \times 6\,960\,000) / (96 \times 60)$; 7600;	 ECF on (i) Allow for rounding errors	3
(c)	EITHER grav pe reduces when closer; (so) ke increases; because total energy conserved; OR gravitational attraction / field strength increases when closer; mass remains constant; so accelerates;	 Grav force increases so ke increases = 1 (mixing arguments) REJECT 'gravity higher' 'gravity stronger' ACCEPT 'pull of gravity' 'force of gravity'	3
(d) (i)	electromagnetic (spectrum)	Accept transverse (waves)	1
(ii)	Any **two** from X-rays have shorter wavelength; ORA X-rays have higher frequency; ORA X-rays have higher energy; ORA X-rays have greater penetration range; ORA X-rays have greater effects on living tissue; ORA	Idea of comparison must be there REJECT 'visible light can be seen' / eq	2

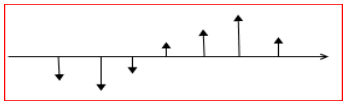
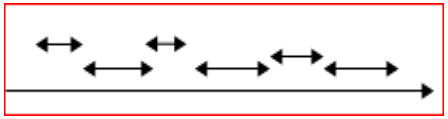
Question number	Answer	Notes	Marks
4 (a) (i)	B;		1
(ii)	A;		1
(iii)	Similarity:- any wave property e.g. transfer energy, reflection, refraction, vibration;	Allow diffraction carry energy	1
	Difference:- any one of • longitudinal particles oscillate in {same direction/ parallel to} the direction of travel; • transverse {particles oscillates/vibration} at right angles to the direction of travel;	Allow • 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

(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