Question	Answer	Mark
1(a)((i)	Sketch of <u>curved</u> optic fibre with light ray undergoing at least one total internal reflection	**B1**
(a)(ii)	Light travels down (optic) fibre<u>s</u> into or out of body	**B1**
	To examine internal organ/part	**B1**
	Light travels both ways into and out of body	**B1**
	OR	
	To destroy (cancerous) cells	**(B1)**
	by heating	**(B1)**
	OR	
	Endoscope/fibre bundle inserted into body	**(B1)**
	To view internal organ body part OR for keyhole surgery	**(B1)**
(b)	Light in air: 3×10^8 m/s	**B1**
	Microwaves in vacuum: 3×10^8 m/s	**B1**
	Sound in steel: 6000 m/s	**B1**
(c)	n = speed in air/speed in glass (or rearranged)	
	OR 1.5 = 3×10^8/speed in glass (or rearranged)	**C1**
	2.0×10^8 m/s	**A1**
		Total: 9

2 **(a** clear attempt at semi circles, at least 3   [1]
        same wavelength as incoming wavefronts, by eye   [1]

   (b) speed ÷ wavelength or 20 ÷ 2.5 or $v = f\lambda$ [1]
         8 Hz or 8 s^{1} or 8 waves/second   [1]

   (c) candidate's **(b)** OR "the same" OR nothing   [1]

   (d) low frequency signals have longer wavelength (than high frequency signals) OR
         high frequency signals have shorter wavelength   [1]

         low frequency signals / long wavelength signals diffract more OR
         low frequency / short wavelength signals diffract less   [1]

3 **(a** **(i)** X-rays   B1

      (ii) Infra-red   B1

 (b) **(i)** $v = f\lambda$ in any form OR $v{\div}f$ OR $3.0 \times 10^8 \div (2.45 \times 10^9)$ C1
         $0.12\,m$ A1

      (ii) $(Q =) ml$ OR 150×330 C1
         $49\,000\,(J)$ OR $49\,000\,(J)$ OR $50\,000\,(J)$

         $P = Q/t$ in any form OR $(t =)\, Q/P$ OR (0.65×1100) OR 715 C1
         $69\,s$ A1

                                                                                                [Total: 8]

4 **(a** **(i)** $2.0 - 4.0 \times 10^8\,m/s$ *Unit penalty applies   B1

      (ii) $(f =)\, v/\lambda$ **or** $3.0 \times 10^8/4.0 \times 10^7$ ecf from **6(a)(i)**   C1
         $7.5 \times 10^{14}\,Hz$ *Unit penalty applies   ecf from **6(a)(i)**   A1

 (b) **(i)** 55° *Unit penalty applies   B1

      (ii) sin i/sin r = n **or** sin 55°/1.5 **or** 0.54610   ecf from **6(b)(i)**   C1
         33° *Unit penalty applies   ecf from **6(b)(i)**   A1   **[6]**

   ***Apply unit penalty once onl

5   **(a (i)**   light of a single wavelength / frequency   ignore 'one colour'   B1

        (ii) $n = \sin i/\sin r$ OR $1.52 = \sin 50/\sin r$ OR $\sin r = \sin 50/1.52$ C1
              $30.26°$ at least 2 s.f.   A1

       (iii) ray closer to normal in block   B1
              ray parallel to incident ray emerging from block   B1

    (b) (i) $n = v_A/v_G$ OR $n = 1.54/v_G$ OR $v_G = 3 \times 10^8/1.54$ C1
             1.948×10^8 m/s

        (ii) ray with smaller angle of refraction than red in block i.e. violet ray under red ray B1
            emerging ray parallel to incident ray   B1   **[9]**

6 **(a (i)** sound   B1

       (ii) particle OR mechanical OR compression OR longitudinal
            OR matter wave   B1

      (iii) ultra violet/uv   B1

    (b) $v = f\lambda$ OR $\lambda = v/f$ B1
        $3.0 \times 10^8/2.5 \times 10^8$ OR $3.0 \times 10^8 = 2.5 \times 10^8\,\lambda$ C1
        1.2 m   A1

                                                          [Total: 6]

7   **(a**   red ray refracted away from normal   B1

                violet ray refracted more than red ray in prism   B1

                violet ray further refracted from red ray to screen   B1   **3**

     (b) $1.52 = \sin 40°/\sin r$ M1

             $\sin r = \sin 40°/ 1.52\ (= 0.423)$ C1

             $r = 25°$ A1   **3**

     (c)   **(i)** 3×10^8 m/s   A1

            (ii)   same as **(i)**   A1   **2**

                                                                   [8]

8	**(a**	**(i)**	x-rays or gamma ra	B1	
		(ii)	infra red or radio	B1	**2**
	(b)		$f = v/\lambda$ or $3 \times 10^8/ 1 \times 10^{12}$	C1	
			$= 3 \times 10^{20}$ Hz	A1	**2**
	(c)		3×10^8 m/s	1	**1**
					[5]

  9 **(a)**   expect two internal reflections at sensible angles   **1**   **1**

    (b)   angle of incidence at Y greater than critical angle   **1**

              total internal reflection occurs   **1**   **2**

    (c) **(i)**   frequency = velocity/wavelength or $1.9 \times 10^8/3.2 \times 10^7$ **1**

                         $= 5.9 \times 10^{14}$ Hz   **1**

         (ii) refractive index $= 3/1.9$ or $1.9/3$ **1**

                            $= 1.58$ (no e.c.f.)   **1**   **4**

                                                          (7)