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
         7.5×10^{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)