Mark schemes

Q1.

(a)   B scan because it is an image (rather than a graph) ✓

           Allow 'brightness scan' for B scan

1

(b)   Determines accurate time for a whole number of heartbeats

OR $\dfrac{their\ number\ of\ beats}{their\ time}$ OR $\dfrac{their\ time}{their\ number\ of\ beats}$ OR converts their bps to bpm ✓

Evidence of T taken from 3, 4 or 5 heartbeats OR repeat and mean for at least three measurements ✓

Leading to answers that round to 56 or 57 bpm ✓

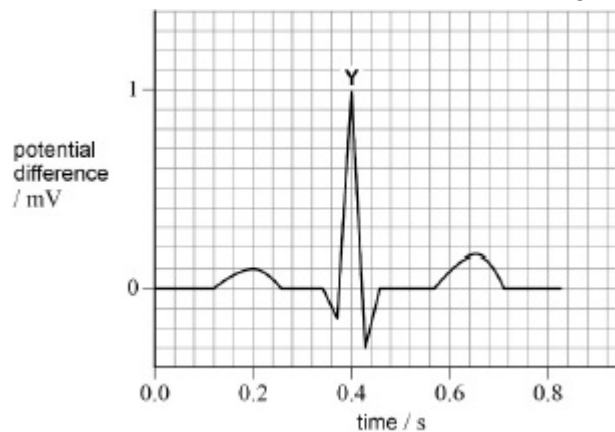   *Accept correct use of frequency for MP2*

3

(c)   mV on *y*-axis and s on *x*-axis ✓

values of *y*-axis with at least 2 values labelled, consistent with 0 at start of line and 1 at peak✓

values on *x*-axis with end point between 0.55 and 1.0 s. At least three evenly spaced values seen including 0✓

position of **Y** indicated to be within one square of the highest peak ✓

Allow for alternative correct units and values eg 0.001 V, time of 400-750 ms

For MP3 ticks on x-axis required; do not accept awkward scales

4

(d) **Why backing is needed**:

Idea that gels improves electrical contact ✔

Property of backing:

gel should have low (electrical) resistance or

non-irritating to skin or

shouldn't react to chemicals produced by skin ✔

How skin is prepared:

skin is shaved / rubbed with abrasive paper/ hair removed ✔
>*For MP2 do not allow reference to or implication of acoustic resistance / impedance*
>
>*MP3 - allow skin is dried or cleaned*

3

[11]

Q2.

(a)   Name coherent and non-coherent bundle ✓₁

> ✓₁ *Accept 'incoherent'*

Coherent bundle transmits images OR
non-coherent bundle transmits light for illumination/ into the body ✓₂

> ✓₂ *'transmits light' insufficient for function of non-coherent bundle*

Bundle that transmits light for illumination requires no cladding ✓₃

> ✓₃ *and* ✓₄ *are for linking the function to the requirement for cladding and can be awarded if names are missing, incorrect or mixed up so long as function clear.*

Cladding is required in bundle that transmits images so that light does not pass from one fibre to another (which would destroy the image) ✓4

> ✓₃₄ *1 mark for stating coherent need cladding and non-coherent do not*

4

(b)   **The mark scheme gives some guidance as to what statements are expected to be seen in a 1- or 2-mark (L1), 3- or 4-mark (L2) and 5- or 6-mark (L3) answer.**
Guidance provided in section 3.10 of the 'Mark Scheme Instructions' document should be used to assist in marking this question.

Mark	Criteria
6	All three areas covered in some detail. 6 marks can be awarded even if there is an error and/or parts of one aspect missing.
5	All three areas covered, at least two in detail. Whilst there will be gaps, there should only be an occasional error.
4	Two areas successfully discussed, or one discussed and two others covered partially. Whilst there will be several gaps, there should only be an occasional error.
3	One area discussed and one discussed partially, or all three covered partially. There are likely to be several errors and omissions in the discussion.
2	Only one area discussed, or makes a partial attempt at two areas.
1	Only one area covered and that partially.
0	No relevant comments.

In each area, a partial response covers one bullet point, a detailed response requires two.

Methods used to reduce dispersion
- Mentions either mono-mode fibre (mod), monochromatic light (mat), small difference in refractive indices of core and cladding (mod) or repeaters (both)
- Mentions two methods with at least one linked to correct type of dispersion (name or description)

Why the methods are not required
- Short distance of the endoscope
- Reason given for why this results in insignificant dispersion
- No pulse broadening due to analogue signal
- Idea that function of non-coherent bundle is unaffected by dispersion
- Comparison of (lower) data transfer rate for endoscope compared to high speed data transfer for communications. Means dispersion is not noticeable

How the methods affect the function
- Refractive index of core close to refractive index of cladding - lots of light escapes. Reduces intensity of image (which makes it harder to see)
- Mono-mode fibre reduces amount of light transmitted. Reduces intensity of image
- Monochromatic light - image is monochrome (which makes diagnosis harder)
- Narrower fibres therefore more fibres can fit in the bundle therefore better resolution
- Discussion of impact of any one of these changes on diagnosis/ treatments
- Repeaters would make the endoscope too wide to go inside patient.

6

[10]

Q3.

(a)   To damp the vibrations (of the piezoelectric crystal) (after the pulse has been transmitted) ✓

To allow the crystal to serve as receiver (as well as transmitter)/ so reflected and transmitted pulses remain separate (at the transducer)/ so pulses can be short ✓

2

(b)   Max 2 from ✓✓

(Muscle $Z = \rho c$ =) 1100 × 1600 OR 1.76×10^6 (kg s^{-1} m^{-2}) ✓$_a$

Use of $\left(\frac{I_r}{I_i} =\right) \left(\frac{Z_2 - \text{their } Z_1}{Z_2 + \text{their } Z_1}\right)^2$ to find reflected ratio OR 0.25 ✓$_b$

Conversion of their ratio to % and subtraction from 100 ✓$_c$

✓$_b$ *Accept Z_1 and Z_2 in either order*

Expect $\left(\frac{5.3 \times 10^6 - 1.76 \times 10^6}{5.3 \times 10^6 + 1.76 \times 10^6}\right)^2$

do not accept use of ρ or c as Z

75 (%) ✓

Calc value 74.85815631

3

[5]

Q4.

The mark scheme gives some guidance as to what statements are expected to be seen in a 1 or 2 mark (L1), 3 or 4 mark (L2) and 5 or 6 mark (L3) answer.
Guidance provided in section 3.10 of the 'Mark Scheme Instructions' document should be used to assist in marking this question.

Mark	Criteria
6	Ultrasound or CT identified and justified, quality comments on all 3, at least 3 other factors. Must refer to resolution / detail for 6 marks.
5	Ultrasound or CT identified and justified, quality comments on all 3, at least 2 other factor. Must differentiate between the quality of CT and ultrasound for kidney stones.
4	Ultrasound or CT scanner identified. Quality comments on all 3 or 2 quality comments and 1 other factor.

3	Ultrasound or CT scanner identified. 2 comments including at least 1 quality comment Or MR scanner identified and stated as highest resolution, with 2 quality comments and 2 others factors.
2	Any choice, with a relevant supporting argument (allow MR scanner as highest resolution provided one other relevant factor is provided). Or At least 3 valid comments with no choice made.
1	Any valid comments (ignore MR scanner as highest resolution).
0	No relevant comments.

Points to consider:

Relevant quality
- MR scanner – low quality image of calcium / kidney stones (allow cannot see)
- CT scanner – high resolution image of kidney stone
- Ultrasound – low resolution image of kidney stone

(Allow CT scanner and Ultrasound produce good images of kidney stone but not for 6 marks)
Allow references to bone instead of kidney stone

Other factors
- (CT scanner / MRI is more expensive than ultrasound)
- Ultrasound / MRI causes no harm
- CT scanner emits ionising radiation
- Ionising radiation damages cells
- Do not have to remain still for ultrasound
- Ultrasound is fastest / real time
- MRI can cause claustrophobia

Ignore references to metal / pace maker in the body for MRI
Ignore references to 3D images

Justified choice
- Ultrasound
- Quality is good enough, (cheaper) and safe

- CT
- Best quality image of kidney stones
- (except for pregnant women and children)

[6]

Q5.

    (a)   Align spins of protons / hydrogen nuclei ✓

                Do NOT allow hydrogen atoms

                Allow causes protons / hydrogen nuclei to precess around magnetic field / in one direction

                Do NOT allow causes protons to spin

                1

    (b)   (radio frequency photons) excite protons ✓

        Flip the spin of protons ✓

        (When pulse stopped) protons emit radio frequency signals when they relax ✓

                MAX 2

                Condone RF

                Condone atoms for protons

                Condone move or make into antialignment with magnetic field for MP2

                2

                [3]