M1. (a) (i) 3

1

(ii) 30 000 **or** 10 000 × their (a)(i) correctly calculated

1

(iii) any **two** from:

- frequency is above 20 000 (Hz)
  accept the frequency is 30 000
- frequency is above the upper limit of audible range
- upper limit of audible range equals 20 000 (Hz)
  ignore reference to lower limit
- it is ultrasound/ultrasonic

2

(b) (i) wave (partially) reflected

1

at crack to produce **A** and end of bolt to produce **B**
accept at both ends of the crack

1

(ii) 0.075 (m) allow **2** marks for time = 0.0000125
*allow **1** mark for time = 0.000025*
*answers 0.15 **or** 0.015 **or** 0.09 gain **2** marks*
*answers 0.18 **or** 0.03 gain **1** mark*
the unit is not required but if given must be consistent with numerical answer for the available marks

3

[9]

M2. (a) changes the sound wave(s)

to a varying **or** changing (electric) potential difference **or** p.d. **or** voltage **or** current **or** to an irregular alternating current or a.c. **or** transfers sound energy to electrical energy (1) mark is vibrations **or** pulses **or** of sound **or** in air become electrical waves

*do not credit just 'to electricity' **or** 'to a.c'*

2

(b) (i) decrease **or** reduce the amplitude

accept less amplitude nothing else added

1

(ii) increase the frequency **or** decrease wavelength

accept higher frequency nothing else added

1

[4]

M3. (i) (partly) reflected when they hit a (boundary between two) different media or substance or tissue

accept named substances

*do **not** accept bounce back*

1

time taken for reflected wave (to return) is used to produce the image

1

(ii) any **one** from:

cleaning a delicate mechanism / jewellery

*do **not** accept cleaning*

welding plastics

cutting textiles

mixing emulsion paints

sonar

motion sensors (in burglar alarms)

*do **not** accept burglar alarms*

removing dental plaque

industrial quality control

breaking up kidney stones

treating injuries

1

[3]

M4. (a) (ultrasound) waves reflected

accept 'bounce off'

1

at boundary / from muscle

1

(b) (i) time

1

(ii) speed of (ultrasound) waves

1

[4]

M5. (a) any **two** points:

*do **not** credit features which are true of sound in general eg longitudinal waves*

- humans cannot hear ultrasound
- it has a very high frequency / pitch

  *do **not** credit just 'has a high frequency / pitch'*
- above the (upper) limit for humans / above 20 000 Hz

2

(b) (i) ultrasound / waves are reflected

...are bounced is insufficient, but
...echo is acceptable

1

Pulse **A** indicates / is the crack

Pulse **B** indicates / is the back (of the block or crack)

need to mention both A and B to get this mark

1

(ii) 90 (mm)

accept any answer in the range 88 – 92 (mm)

1

[5]

M6. (a) (i) same frequency / period / pitch / wavelength

ignore references to amplitude

1

(ii) differences in waveform / shape / quality

accept the diagrams are not identical

1

(b) (i) 20 000 Hz / hertz

or 20 kHz / kilohertz

*in both cases, if the **symbol** rather than the name is used, it must be correct in every detail*

1

(ii) material(s) / substance(s) (through which sound travels)

1

(iii) is absorbed

accept (some) sound (energy) is transformed / transferred <u>as</u> heat / thermal energy

1

is transmitted

accept is refracted
accept changes speed
accept changes velocity

*do **not** accept is diffracted*
*do **not** accept is diffused*
*do **not** accept is dissipated*

1

[6]