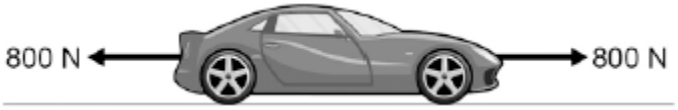
1 The figure below shows the horizontal forces acting on a car.



(a) Which **one** of the statements describes the motion of the car?

Tick **one** box.

It will be slowing down. ☐

It will be stationary. ☐

It will have a constant speed. ☐

It will be speeding up. ☐

(1)

(b) During part of the journey the car is driven at a constant speed for five minutes.

Which one of the equations links distance travelled, speed and time?

Tick **one** box.

distance travelled = speed + time ☐

distance travelled = speed × time ☐

distance travelled = speed − time ☐

distance travelled = speed ÷ time ☐

(1)

(c) During a different part of the journey the car accelerates from 9m / s to 18m / s in 6 s.

Use the following equation to calculate the acceleration of the car.

$$\text{acceleration} = \frac{\text{change in velociy}}{\text{time taken}}$$

.....

.....

acceleration = ... m / s^2

(2)

(d) Which equation links acceleration, mass and resultant force?

Tick **one** box.

resultant force = mass + acceleration ☐

resultant force = mass × acceleration ☐

resultant force = mass − acceleration ☐

resultant force = mass ÷ acceleration ☐

(1)

(e) The mass of the car is 1120 kg. The mass of the driver is 80 kg.

Calculate the resultant force acting on the car and driver while accelerating.

.....

.....

Resultant force = ... N

(2)

(f) Calculate the distance travelled while the car is accelerating.

Use the correct equation from the Physics Equation Sheet.

.....

.....

.....

Distance = ... m

(3)

(g) A car driver sees a fallen tree lying across the road ahead and makes an emergency stop.

The braking distance of the car depends on the speed of the car.

For the same braking force, explain what happens to the braking distance if the speed doubles.

You should refer to kinetic energy in your answer.

.....

.....

.....

.....

.....

.....

.....

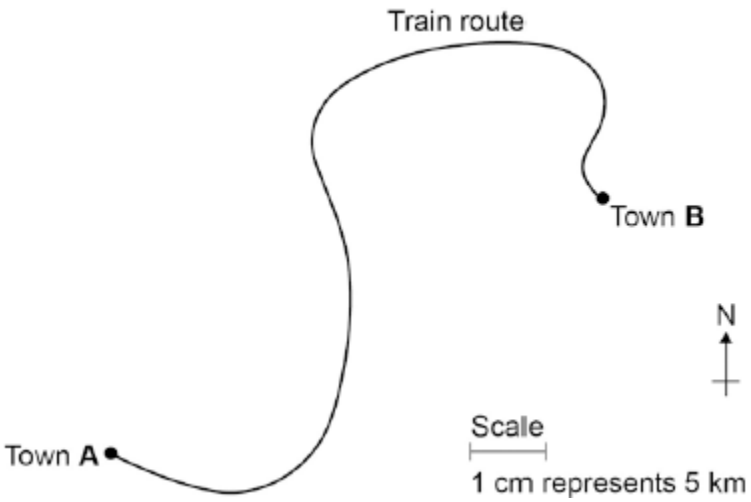
.....

(4)
(Total 14 marks)

2 A train travels from town **A** to town **B**.

Figure 1 shows the route taken by the train.
Figure 1 has been drawn to scale.

Figure 1



(a) The distance the train travels between **A** and **B** is not the same as the displacement of the train.

What is the difference between distance and displacement?

.....

.....

.....

(1)

(b) Use **Figure 1** to determine the displacement of the train in travelling from **A** to **B**.

Show how you obtain your answer.

.....

.....

Displacement = ... km

Direction = ...

(2)

(c) There are places on the journey where the train accelerates without changing speed.

Explain how this can happen.

.....

.....

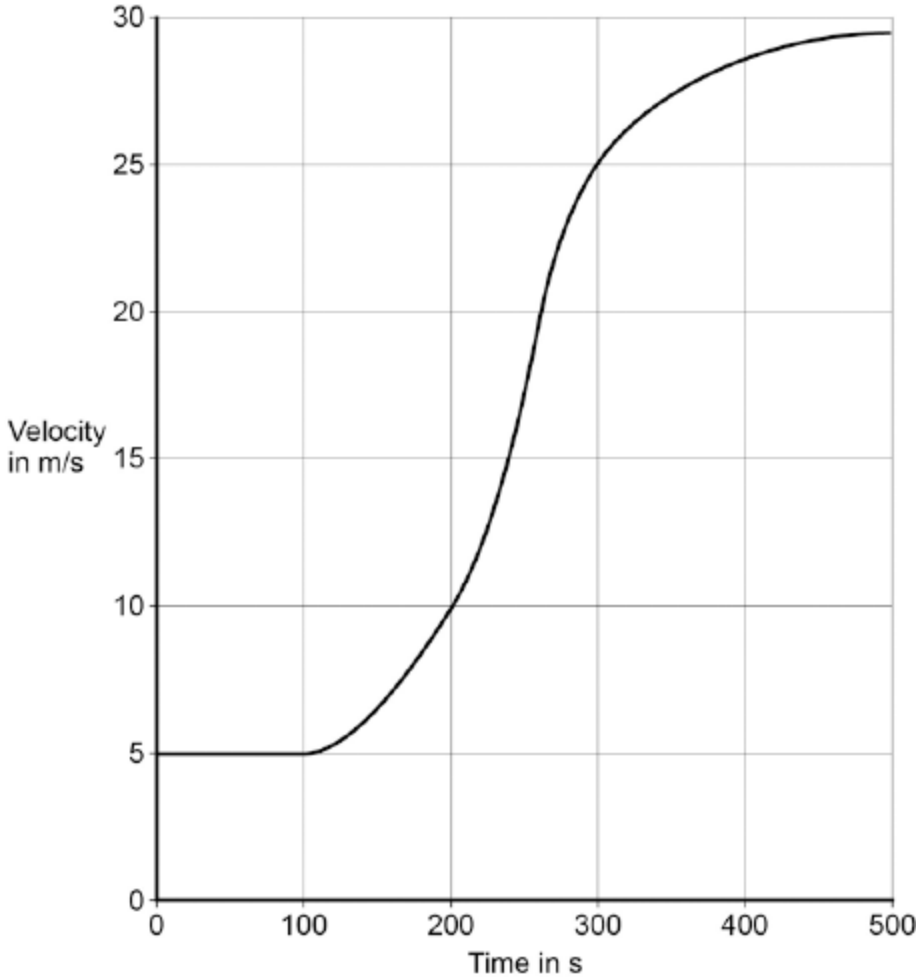
.....

.....

(2)

(d) **Figure 2** shows how the velocity of the train changes with time as the train travels along a straight section of the journey.

Figure 2



Estimate the distance travelled by the train along the section of the journey shown in **Figure 2**.

To gain full marks you must show how you worked out your answer.

.....

.....

.....

.....

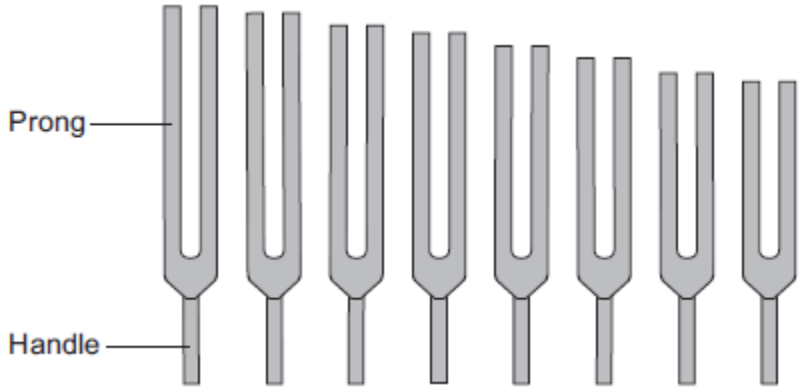
Distance = ... m

(3)

(Total 8 marks)

3 **Figure 1** shows a set of tuning forks.

Figure 1



A tuning fork has a handle and two prongs. It is made from metal.

When the prongs are struck on a hard object, the tuning fork makes a sound wave with a single frequency. The frequency depends on the length of the prongs.

(a) Use the correct answer from the box to complete each sentence.

direction	loudness	pitch	speed

The frequency of a sound wave determines its ..... .

The amplitude of a sound wave determines its ..... .

(2)

(b) Each tuning fork has its frequency engraved on it. A student measured the length of the prongs for each tuning fork.

Some of her data is shown in the table.

Frequency in hertz	Length of prongs in cm
320	9.5
384	8.7
480	7.8
512	7.5

(i) Describe the pattern shown in the table.

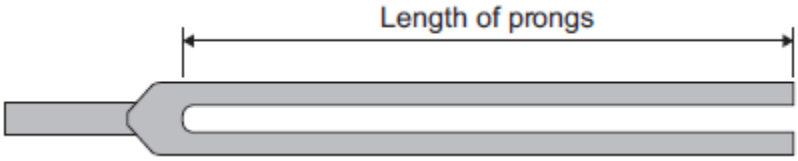
.....

.....

(1)

(ii) **Figure 2** shows a full-size drawing of a tuning fork.

Figure 2



Measure and record the length of the prongs.

Length of prongs = ... cm

(1)

Use the data in the table above to estimate the frequency of the tuning fork in **Figure 2**.

Explain your answer.

.....

.....

.....

.....

.....

Estimated frequency = ... Hz

(3)

(c) Ultrasound waves are used in hospitals.

(i) Use the correct answer from the box to complete the sentence.

electronic	**hydraulic**	**radioactive**

Ultrasound waves can be produced by ..... systems.

(1)

(ii) The frequency of an ultrasound wave used in a hospital is 2×10^6 Hz.

It is **not** possible to produce ultrasound waves of this frequency using a tuning fork.

Explain why.

.....

.....

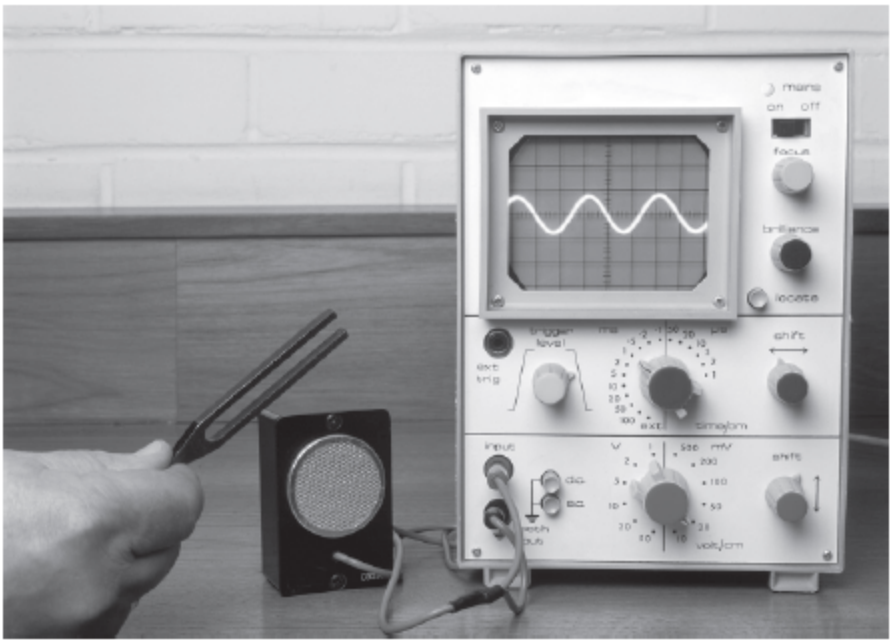
.....

.....

(2)

(d) **Figure 3** shows a tuning fork and a microphone. The microphone is connected to an oscilloscope.

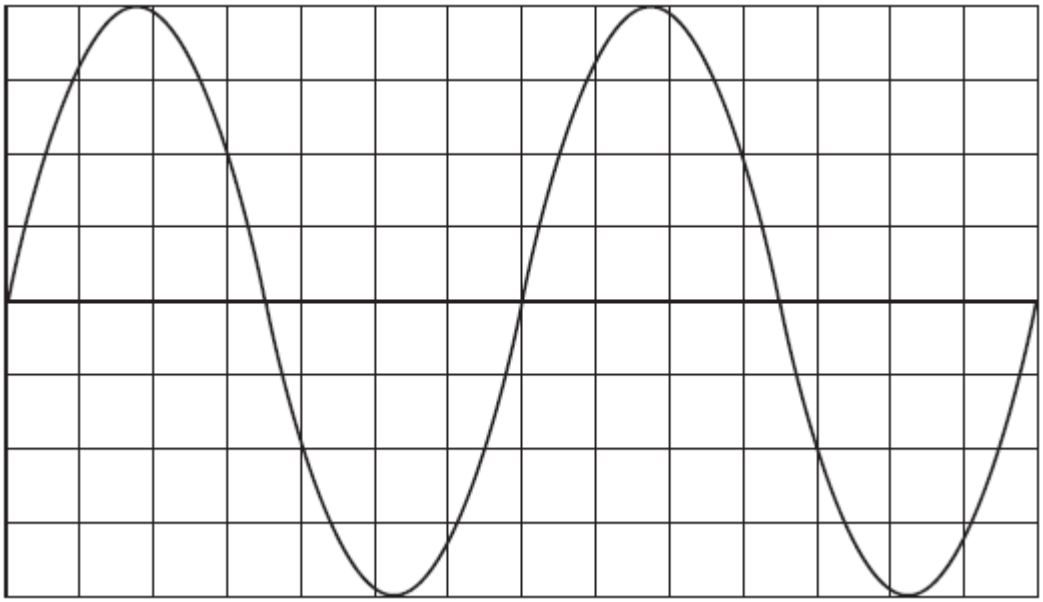
Figure 3



When the tuning fork is struck and then placed in front of the microphone, a trace appears on the oscilloscope screen.

Figure 4 shows part of the trace on the screen.

Figure 4



Each horizontal division in **Figure 4** represents a time of 0.0005 s.

What is the frequency of the tuning fork?

.....

.....

.....

Frequency = ... Hz

(3)

(Total 13 marks)

4 (a) Human ears can detect a range of sound frequencies.

(i) Use the correct answers from the box to complete the sentence.

2	**20**	**200**	**2000**	**20 000**

The range of human hearing is from about ..... Hz to ..... Hz.

(2)

(ii) What is ultrasound?

.....

.....

(1)

(iii) Ultrasound can be used to find the speed of blood flow in an artery.

State **one** other medical use of ultrasound.

.....

(1)

(b) The speed of an ultrasound wave in soft tissue in the human body is 1.5×10^3 m / s and the frequency of the wave is 2.0×10^6 Hz.

Calculate the wavelength of the ultrasound wave.

.....

.....

Wavelength = ... m

(2)

(c) When ultrasound is used to find the speed of blood flow in an artery:

- an ultrasound transducer is placed on a person's arm
- ultrasound is emitted by the transducer
- the ultrasound is reflected from blood cells moving **away** from the transducer
- the reflected ultrasound is detected at the transducer.

Describe the differences between the ultrasound waves emitted by the transducer and the reflected waves detected at the transducer.

.....

.....

.....

.....

(2)
(Total 8 marks)

5 A car has an oil leak. Every 5 seconds an oil drop falls from the bottom of the car onto the road.

(a) What force causes the oil drop to fall towards the road?

.....

(1)

(b) The diagram shows the spacing of the oil drops left on the road during part of a journey

Describe the motion of the car as it moves from **A** to **B**.

.....

Explain the reason for your answer.

.....

.....

.....

.....

(3)

(c) When the brakes are applied, a braking force slows down and stops the car.

(i) The size of the braking force affects the braking distance of the car.

State **one** other factor that affects the braking distance of the car.

.....

(1)

(ii) A braking force of 3 kN is used to slow down and stop the car in a distance of 25 m.

Calculate the work done by the brakes to stop the car and give the unit.

.....

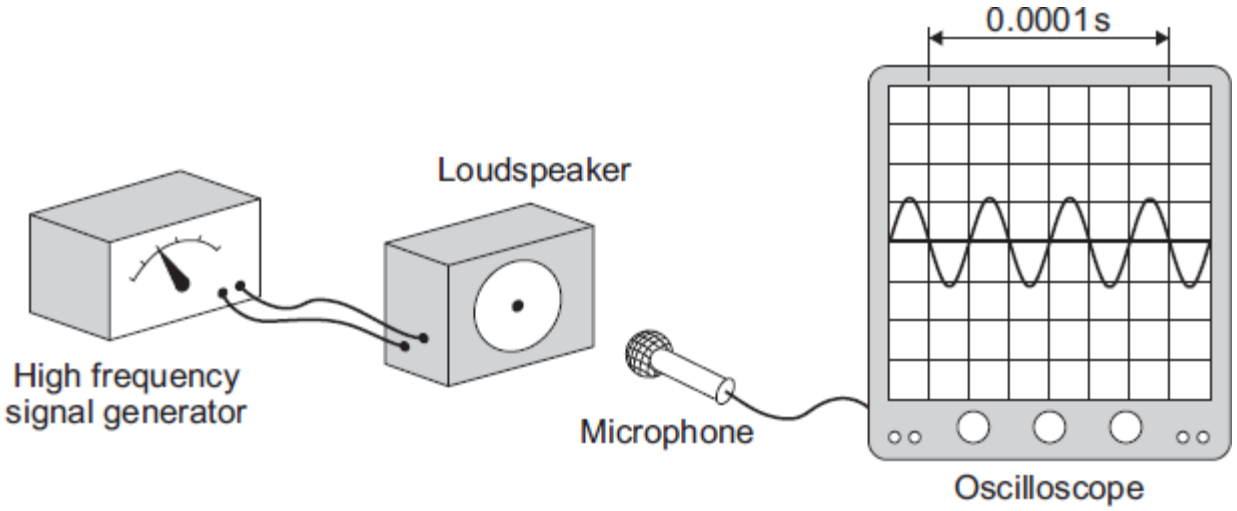
.....

.....

Work done =.....

(3)
(Total 8 marks)

6 (a) The diagram shows a microphone being used to detect the output from a loudspeaker.
The oscilloscope trace shows the wave pattern produced by the loudspeaker.



(i) How many waves are produced by the loudspeaker in 0.0001 seconds?

.....

(1)

(ii) How many waves are produced by the loudspeaker every second?
Assume the input to the loudspeaker does not change.

.....

.....

(1)

(iii) A person with normal hearing cannot hear the sound produced by the loudspeaker.

Explain why.

.....

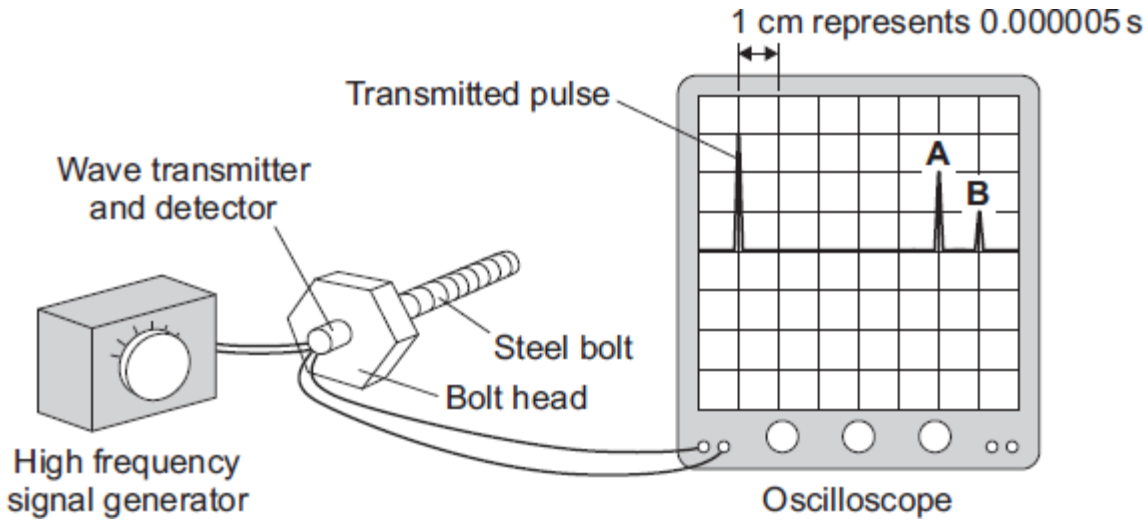
.....

.....

.....

(2)

(b) The diagram shows how a very high frequency sound wave can be used to check for internal cracks in a large steel bolt. The oscilloscope trace shows that the bolt does have an internal crack.



(i) Explain what happens to produce pulse **A** and pulse **B**.

.....

.....

.....

.....

(2)

(ii) Use the information in the diagram and the equation in the box to calculate the distance from the head of the bolt to the internal crack.

distance = speed × time

Speed of sound through steel = 6000 m/s

Show clearly how you work out your answer.

.....

.....

.....

.....

.....

.....

(3)
(Total 9 marks)

7 (a) The diagrams show oscilloscope traces for the same musical note played on two different instruments. The oscilloscope settings are not changed.

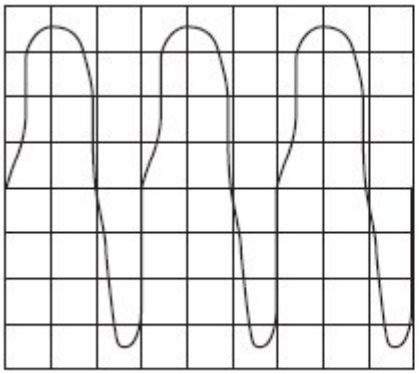


Diagram X

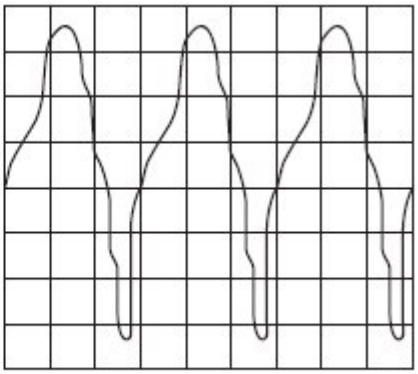


Diagram Y

(i) How can you tell, from the diagrams, that it is the same musical note?

.....

.....

(1)

(ii) How can you tell, from the diagrams, that the musical note has been played on different instruments?

.....

.....

(1)

(b) This passage is from an electronics magazine.

> *Electronic systems can be used to produce ultrasound waves. These waves have a higher frequency than the upper limit for hearing in humans.*
> *Ultrasound waves are partially reflected when they meet a boundary between two different media.*

(i) Approximately what is the highest frequency that humans can hear?

State the number and the unit.

.....

(1)

(ii) What does the word *media* mean when it is used in this passage?

.....

.....

(1)

(iii) What happens to the ultrasound which reaches the boundary between two different media and is **not** reflected?

.....

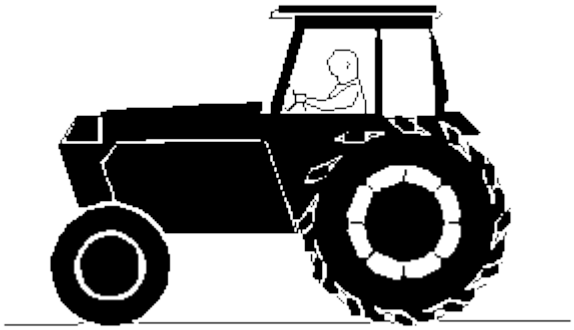
.....

.....

.....

(2)
(Total 6 marks)

8 (a) The diagram below shows a moving tractor. The forward force from the engine exactly balances the resisting forces on the tractor.



(i) Describe the motion of the tractor.

.....

(ii) The tractor comes to a drier part of the field where the resisting forces are less. If the forward force from the engine is unchanged how, if at all, will the motion of the tractor be affected?

.....

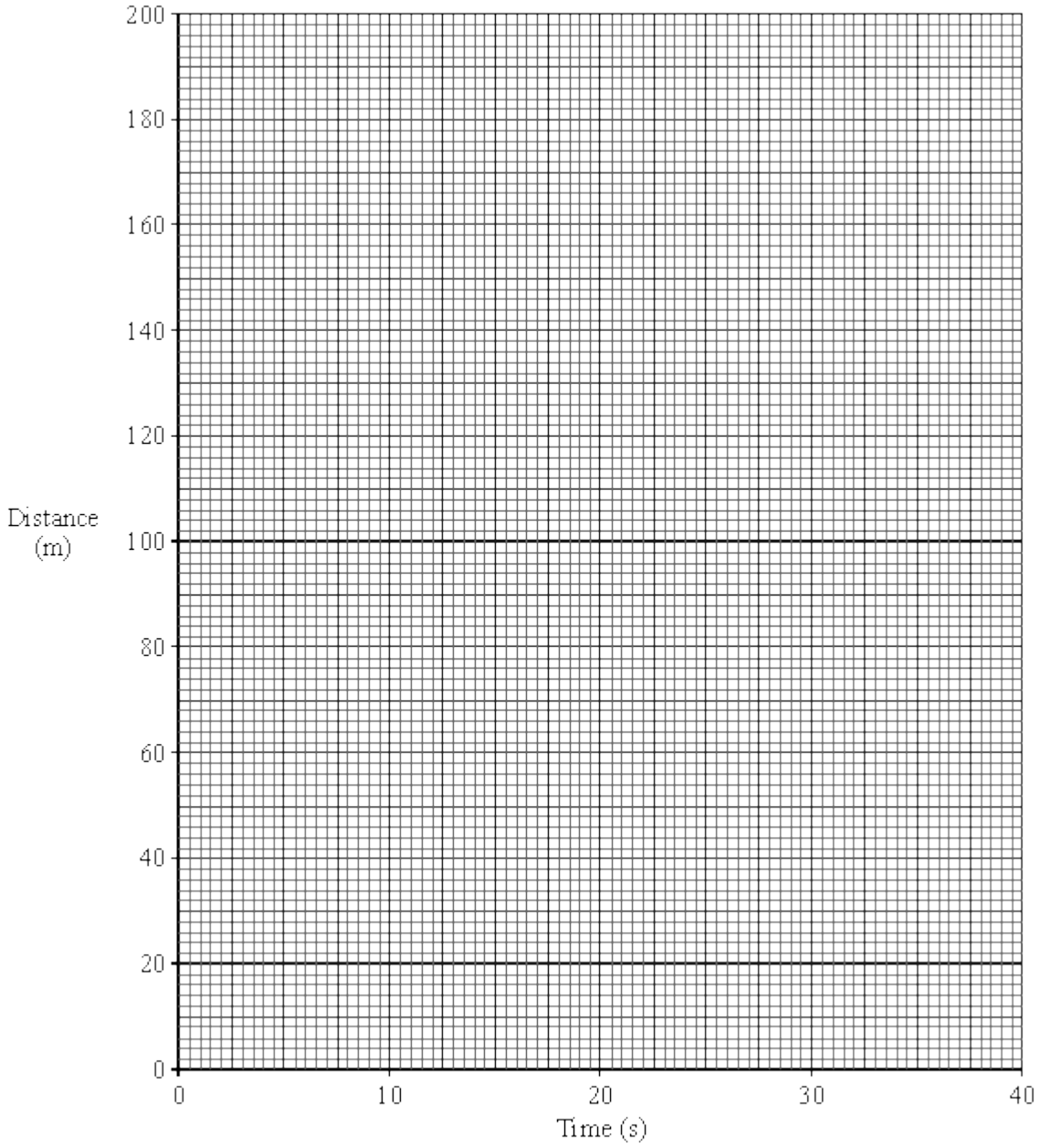
.....

(3)

(b) Two pupils are given the task of finding out how fast a tractor moves across a field. As the tractor starts a straight run across the field the pupils time how long it takes to pass a series of posts which are forty metres apart. The results obtained are shown in the table below.

Distancetravelled (m)	0	40	80	120	160	200
Timetaken (s)	0	8	16	24	32	40

(i) Draw a graph of distance travelled against time taken using the axes on the graph below. Label your graph line A.



(2)

(ii) Calculate the speed of the tractor.

.....

.....

(3)

(c) In another, wetter field there is more resistance to the movement of the tractor. It now travels at 4 m/s.

(i) Calculate the time needed to travel 200m.

.....

.....

.....

(ii) On the graph in part (b) draw a line to represent the motion of the tractor across the second field. Label this line B.

(4)

(d) On a road the tractor accelerates from rest up to a speed of 6 m/s in 15 seconds.

Calculate the acceleration of the tractor.

.....

.....

.....

.....Acceleration = ...m/s^2

(3)
(Total 15 marks)

9 When a gun is fired, a very large force acts on the bullet for a very short time.

The change in momentum of the bullet is given by the following relationship:

force (N) × time(s) = change in momentum (kg m/s)

(a) An average force of 4000 newton acts for 0.01 seconds on a bullet of mass 50g.

Calculate the speed of the bullet. (*Show your working*.)

.....

.....

.....

Answer ..... m/s

(4)

(b) The bullet is fired horizontally. In the short time it takes for the bullet to reach its target, its horizontal speed has fallen to 80% of its initial speed.

(i) Explain why the speed of the bullet decreases so quickly.

.....

.....

(2)

(ii) Calculate the percentage of its original kinetic energy the bullet still has when it reaches its target.

(Show your working.)

.....

.....

.....

.....

(4)
(Total 10 marks)

Mark schemes

1

(a) It will have a constant speed.

1

(b) distance travelled = speed × time

1

(c) $a = \frac{18 - 9}{6}$

1

$a = 1.5$

*allow 1.5 with no working shown for **2** marks*

1

(d) resultant force = mass × acceleration

1

(e) $F = (1120+80) \times 1.5$

1

$F = 1800$ (N)

*allow 1800 with no working shown for **2** marks*

1

*accept their 10.3 × 1200 correctly calculated for **2** marks*

(f) $18^2 - 9^2 = 2 \times 1.5 \times s$

1

$s = 18^2 - 9^2 / 2 \times 1.5$

1

$s = 81$ (m)

1

*allow 81 (m) with no working shown for **3** marks*

*accept answer using their 10.3 (if not 1.5) correctly calculated for **3** marks*

(g) **Level 2 (3–4 marks):**
A detailed and coherent explanation is provided. The response makes logical links between clearly identified, relevant points that include references to the numerical factor.

Level 1 (1–2 marks):
Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:
No relevant content.

Indicative content

- doubling speed increase the kinetic energy
- kinetic energy increases by a factor of 4
- work done (by brakes) to stop the car increases
- work done increases by a factor of 4
- work done is force × distance and braking force is constant
- so if work done increases by 4 then the braking distance must increase by 4

4

[14]

2 (a) distance is a scalar and displacement is a vector

or

distance has magnitude only, displacement has magnitude and direction

1

(b) 37.5 km

accept any value between 37.0 and 38.0 inclusive

1

062° or N62°E

accept 62° to the right of the vertical

1

accept an angle in the range 60° −64°

accept the angle correctly measured and marked on the diagram

(c) train changes direction so velocity changes

1

acceleration is the rate of change of velocity

1

(d) number of squares below line = 17

accept any number between 16 and 18 inclusive

1

each square represents 500 m

1

distance = number of squares × value of each square correctly calculated − 8500 m

1

[8]

3 (a) pitch

1

loudness

1

(b) (i) as length (of prongs) decreases frequency / pitch increases

accept converse

accept negative correlation

ignore inversely proportional

1

(ii) 8.3 (cm)

accept 8.3 ± 0.1 cm

1

(iii) (8.3 cm is) between 7.8 (cm) and 8.7 (cm)

*ecf from part **(ii)***

1

(so *f* must be) between 384 (Hz) and 480 (Hz)

1

410 (Hz) ≤ *f* ≤ 450 (Hz)

*if only the estimated frequency given, accept for **1** mark an answer within the range*

1

(c) (i) electronic

1

(ii) frequency is (very) high

accept frequency above

*20 000 (Hz) **or** audible range*

1

so tuning fork ***or*** length of prongs would be very small (1.2 mm)

1

(d) 285.7 (Hz)

accept any correct rounding 286, 290, 300

*allow **2** marks for 285*

*allow **2** marks for correct substitution 0.0035 = 1 / f*

*allow **1** mark for T = 0.0035 s*

*allow **1** mark for an answer of 2000*

3

[13]

4 (a) (i) 20

1

20 000

either order

accept ringed answers in box

1

(ii) (frequency) above human range

accept pitch for frequency

or

(frequency) above 20 000 (Hz)

*do **not** accept outside human range*

*allow ecf from incorrect value in **(a)(i)***

1

(iii) any **one** from:

- pre-natal scanning

  accept any other appropriate scanning use

  *do **not** accept pregnancy testing*
- removal / destruction of kidney / gall stones
- repair of damaged tissue / muscle

  accept examples of repair, eg alleviating bruising, repair scar damage, ligament / tendon damage, joint inflammation

  accept physiotherapy

  accept curing prostate cancer or killing prostate cancer cells
- removing plaque from teeth

  cleaning teeth is insufficient

1

(b) 7.5×10^{-4} (m)

*$1.5 \times 10^3 = 2.0 \times 10^6 \times \lambda$ gains **1** mark*

2

(c) for reflected waves

must be clear whether referring to emitted or detected / reflected waves

if not specified assume it refers to reflected wave

any **two** from:

- frequency decreased
- wavelength increased
- intensity has decreased

  allow amplitude / energy has decreased

  allow the beam is weaker

2

[8]

5 (a) gravitational / gravity / weight

*do **not** accept gravitational potential*

1

(b) accelerating

accept speed / velocity increases

1

the distance between the drops increases

1

but the time between the drops is the same

accept the time between drops is (always) 5 seconds
accept the drops fall at the same rate

1

(c) (i) any **one** from:

- speed / velocity
- (condition of) brakes / road surface / tyres
- weather (conditions)

accept specific examples, eg wet / icy roads

accept mass / weight of car friction is insufficient

reference to any factor affecting thinking distance negates this answer

1

(ii) 75 000

*allow **1** mark for correct substitution, ie 3000 × 25 provided no subsequent step shown*

***or** allow **1** mark for an answer 75*
***or** allow **2** marks for*
75 k(+ incorrect unit), eg 75 kN

2

joules / J

*do **not** accept j*

*an answer 75 kJ gains **3** marks*

for full marks the unit and numerical answer must be consistent

1

[8]

6 (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]

7 (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 as 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]

8 (a) (i) Constant speed

2

(ii) Accelerates to higher constant speed

1

(b) (i) Points correct (allow one major or two minor mistakes)
Line correct (for their points)

2

(ii) 5 m/s
or 5

gets 2 marks

or correct unit

gets 1 mark mark

3

(c) (i) 50 s or 50

gets 2 marks

or t = d/v

gets 1 mark

3

(ii) Line correct (of gradient 4 and spans 30 consecutive seconds)

1

(d) (i) 0.04 or 6/15

gets 2 marks

or a = v/t

gets 1 mark

3

[15]

9 (a) *any evidence of:* momentum = mass × velocity (words, symbols or numbers) appropriate re-arrangement mass as 0.05kg

each gains 1 mark

but 800

gains 4 marks

4

(b) (i) *any reference to* friction with air/air resistance

gains 1 mark

but *idea that* friction with air/air resistance is high (at high speed)

gains 2 marks

2

(ii) *any evidence of:* k.e. $\propto v^2$ **or** k.e. = ½ mv^2

$\frac{\text{final k.e.}}{\text{initial k.e.}}$

either initial or final k.e. correctly calculated (i.e. 16000; 10240)

each gains 1 mark

but $(0.8)^2$

gains 3 marks

but 64%(credit 0.64)

gains 4 marks (also credit e.c.f)

4

[10]