M1.D

[1]

M2.C

[1]

M3.(a) Suitable experiment eg diffraction through a door / out of a pipe ✓

1

(b) Using $c = d / t$

t = 2 500 / 480 = 5.2 s ✓

1

(c) (Measured time is difference between time taken by light and time taken by sound)

Calculation assumes that light takes no time to reach observer, ie speed is infinite ✓

Do not allow "could not know speed of light"

1

(d) Sound from gun is a mixture of frequencies. ✓

Alternative for 1st mark '(so speed is independent of frequency) the sound of the gun is similar when close and far away'

1

All the sound reaches observer at the same time, ✓

1

(e) More accurate, as it is closer to the accepted value. ✓

1

(f) When $\theta = 0\ ^{\circ}C$ $c = 331.29\ m\ s^{-1}$

1

Therefore

$331.29 = k\sqrt{273.15}$ ✓

$k = 20.045$ ✓

1

(g) The method and value are published ✓

1

other scientists repeat the experiment using the same method ✓

1

[10]

M4.C

[1]

M5.(a) number of (complete) waves (passing a point) in 1 second
OR
number of waves / time (for the waves to pass a point)
OR
(complete number of) oscillations \ vibrations per second
OR
1 / T with T defined as time for 1 (complete) oscillation ✓

Allow: cycles

Allow: unit time

1

(b) For two marks:
oscillation of particles \ medium \ material etc, but not oscillation of wave is parallel to \ in same direction as
the direction wave (travels) ✓ ✓

For one mark:
particles \ material \ medium move(s) \ disturbance \ displacement

parallel to \ in same direction as
the direction wave travels
OR
(oscillations) parallel to direction of wave travel ✓

the one mark answer with:
mention of compressions and rarefactions
OR
(longitudinal waves) cannot be polarised

gets **two** marks
✓

Allow
Vibration
Allow direction of energy transfer \ wave propagation

2

(c) ($f = 1540 / 0.50 \times 10^{-3}$)
= 3 100 000 (Hz) ✓ (3 080 000)
2sf ✓

2

(d) no more than two points from either list (max 3):
Description
- mention of nodes and antinodes
- particles not moving at a node
- maximum displacement at antinode
- particles either side of node in antiphase / between two nodes in phase
- variation of amplitude between nodes

Explanation
- a stationary wave (forms)
- two waves are of equal frequency or wavelength (and amplitude in the same medium)
- reflected and transmitted waves \ waves travelling in opposite directions, pass through each other
- superpose / interference occurs
- constructive interference at antinodes
- destructive interference at nodes

✓ ✓ ✓

Allow 'standing wave'

3

[8]

M6.(a) (i) π / 2 (radians) or 90 (degrees) ✓

No path differences
Penalise contradictions
No fractions of a cycle

1

(ii) 3π / 2 (rad) or 270 (degrees) ✓

No path differences
Penalise contradictions
No fractions of a cycle

1

(b) (oscillation or motion) perpendicular to direction of wave (travel / velocity / energy transfer) ✓
(oscillates from equilibrium to maximum positive displacement, back to equilibrium, then to max negative displacement) and back to equilibrium / starting position / rest position ✓

do not allow 'up and down' for first mark
allow 'up and down', or 'down then up', 'side to side', 'rise and fall' in place of oscillates
Allow 'rest position', 'starting position' , middle', 'centre line'
ref to nodes / antinodes not allowed for 2nd mark

2

(c) (the wave is) transverse **OR** not longitudinal ✓

accept it is an S wave or secondary wave

only transverse can be polarised **OR** longitudinal waves cannot be polarised **OR** oscillations are in one plane ✓

2

(d) (i) number of waves / complete cycles / wavelengths (passing a point / produced) per second ✓

or 'unit time'
allow: (number of) oscillations / vibrations / cycles per second
allow f=1 / T only if T is correctly defined
do not allow references to f=c / λ

1

(ii) ($v = f / \lambda$ $\lambda = v / f$ =) $4.5 \times 10^3 / 6.0$ ✓
= 750 (m) ✓

correct answer only gets 2 marks

2

[9]

M7. (a) (i) oscillates / vibrates ✓

(allow goes up and down / side to side / etc, repeatedly, continuously, etc)

about equilibrium position / perpendicularly to central line ✓

2

(ii) X and Y: antiphase / 180 (degrees out of phase) / π (radians out of phase) ✓

X and Z: in phase / zero (degrees) / 2π (radians) ✓

2

(b) (i) $v = f\lambda$

= 780 x 0.32 / 2 or **780 x 0.16 OR 780 x 320 / 2** or **780 x 160** ✓

THIS IS AN INDEPENDENT MARK

= 124.8 ✓ ($m\ s^{-1}$) correct 4 sig fig answer must be seen

2

(ii) ¼ cycle ✓

$T = 1 / 780$ OR $= 1.28 \times 10^{-3}$ ✓

$0.25 \times 1.28 \times 10^{-3}$

$= 3.2 \times 10^{-4}$ (s) ✓

Allow correct alternative approach using distance of 0.04m ✓

travelled by progressive wave in ¼ cycle divided by speed.

0.04 /125 ✓ $= 3.2 \times 10^{-4}$ (s) ✓

3

(c) (i) antinode ✓

1

(ii) 2 x 0.240 ✓

= 0.48 m ✓ '480m' gets 1 mark out of 2

2

(iii) ($f = v/\lambda$ = 124.8 or 125 / 0.48) = **260** (Hz) ecf from cii ✓

1

[13]

M8. (a) (wave) **B** ✓

(the parts of the) spring oscillate / move back and forth **in direction of / parallel to** wave travel
OR
mention of compressions and rarefactions ✓

Second mark can only be scored if first mark is scored

2

(b) (i) (double ended arrow / line / brackets) from between two points in phase ✓

1

(ii) wave A: arrow vertically upwards ✓

wave B: arrow horizontally to the left ✓

2

(c) (transmitted radio waves are often) polarised ✓

aerial (rods) must be aligned in the same plane (of polarisation / electric field) of the wave ✓

2

[7]