M1.(a) 6.5×10^{10} Pa ✓

1

(b) $\text{kg m}^{-1}\text{ s}^{-2}$ ✓

1

(c) Direction of movement of particles in transverse wave perpendicular to energy propagation direction ✓

1

Parallel for longitudinal ✓

1

(d) $\rho_1 c_1 = \rho_2 c_2$ ✓

$E = \rho c^2$ or $\rho c = \frac{E}{c}$ seen

1

$\left[\frac{E_1}{c_1} = \frac{E_2}{c_2}\right]$

1

(e) $\left[\frac{\rho_x}{\rho_y} = \frac{c_y}{c_x}\right.$ and $c_x = 2c_y$]

0.5 ✓

1

(f) speed of the wave in seawater is less than speed of the wave in glass ✓

1

argument to show that $_{water}n\ _{glass}$

1

so tir could be observed when wave moves from water to glass ✓

1

[10]

M2.B

[1]

M3.C

[1]

M4.(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]

M5.(a) (i) $\pi / 2$ (radians) or 90 (degrees) ✓

No path differences
Penalise contradictions
No fractions of a cycle

1

(ii) $3\pi / 2$ (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]

M6. (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]

M7. (a) **maximum displacement** from equilibrium/mean position/mid-point/etc **(1)**

1

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

surface of water/water waves/in ripple tank **(1)**

rope **(1)**

slinky clearly qualified as transverse **(1)**

secondary ('s') waves **(1)**

max 1

(ii) transverse wave: oscillation (of medium) is perpendicular to wave travel

or transverse can be polarised

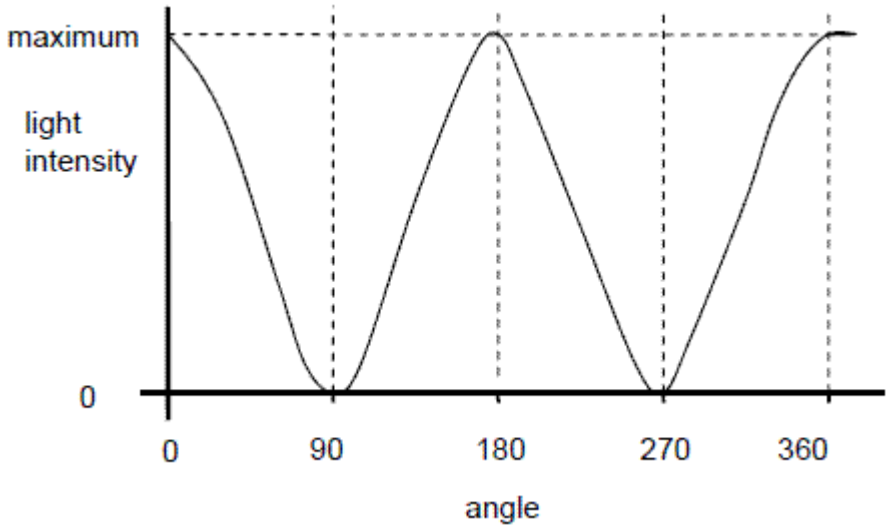
or **all** longitudinal require a medium **(1)**

1

(c) (i) vertical line on B ± 5° **(1)**

1

(ii)



max 0, 180, 360 + min 90, 270 **(1)**

and line reaches same minimum and maximum every time and reasonable shape **(1)**

2

(d) appropriate use **(1)**

reason for Polaroid filter being used **(1)**

eg

Polaroid glasses/**sun**glasses/	to reduce glare windscreens
camera	reduce glare/enhance image
(in a) microscope	to identify minerals/rocks
polarimeter	to analyse chemicals/concentration or type of sugar
stress analysis	reveals areas of high/low stress/ other relevant detail

LCD displays	very low power/other relevant detail	
3D glasses	enhance viewing experience, etc	2

[8]

M8. transverse yes

B1

transverse yes

B1

longitudinal no

B1

[3]

M9.A

[1]

M10.B

[1]

M11.C

[1]

M12.A

[1]

M13. (a) (i) particle vibration (or disturbance or oscillation) **(1)**
same as (or parallel to) direction of propagation
(or energy transfer) **(1)**

(ii) (particle vibration)
perpendicular to direction of propagation (or energy transfer) **(1)**

3

(b) variation in intensity between max and min (or light and dark) **(1)**
two maxima (or two minima) in 360° rotation **(1)**

2

QWC 1

[5]