1. B

[1]

2. D

[1]

3. B

[1]

4. A

[1]

5. C

[1]

6. C

[1]

7. (a) light from a tungsten filament lamp is not coherent;
this means that the phase difference between the light from the slits will be continuously changing / some other relevant detail; 2

*The action verb is "explain" so more than just a statement is required to award **[2]**.*

(b) "fringes" of equal thickness and spacing and equal height; *(judge by eye)*
with a maximum at X; 2

*Award **[1]** only if not touching the x-axis.*

(c) $d = \frac{\lambda D}{s}$;

$= \frac{\lambda}{\vartheta}$

$= \frac{6.33 \times 10^{-7}}{4.00 \times 10^{-4}} = 1.58$ mm;

or

accept use of $d\sin\theta = n\lambda$ with $n = 1$;
$\sin\theta = \theta$;

$d = \frac{6.33 \times 10^{-7}}{4.00 \times 10^{-4}} = 1.58$ mm; 3

(d) $Ve = \frac{p^2}{2m}$;

$= \frac{h^2}{2\lambda^2 m_e}$;

so $\lambda^2 = \frac{h^2}{2Vem_e}$ to give $\lambda = \frac{h}{\sqrt{2m_eVe}}$;

or

$v = \sqrt{\frac{2V_e}{m}}$;

$p = mv = \sqrt{2V_e m}$;

$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m_eVe}}$; 3

(e) $\lambda = \frac{6.6\times10^{-34}}{(2\times9.1\times10^{-31}\times400\times1.6\times10^{-19})^{1/2}} = 6.1 \times 10^{-11}$ m;

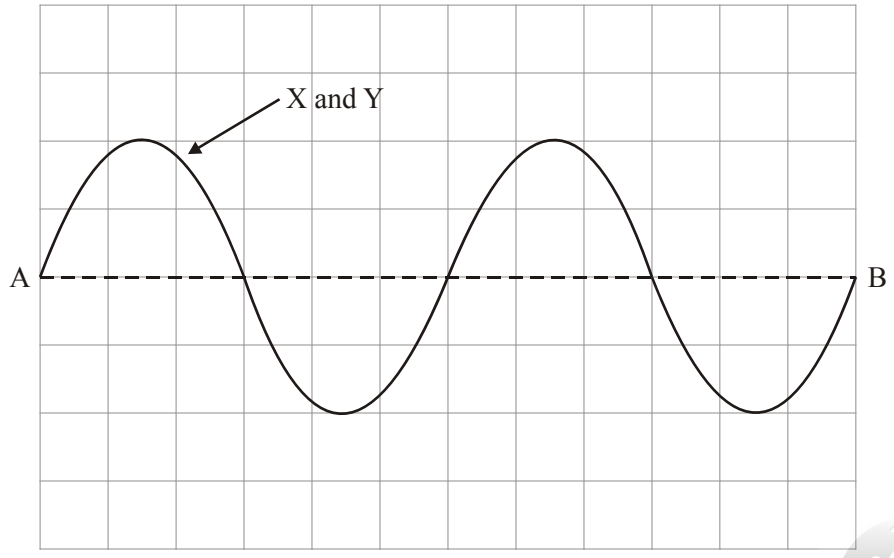
$d = \frac{\lambda}{\theta} = \frac{6.1\times10^{-11}}{4.00\times10^{-4}} = 1.50 \times 10^{-7}$ m; 2

[12]

8. (a) the net **displacement** of the medium/particles (through which waves travel);
is equal to the sum of individual **displacements** (produced by each wave); 2 max

*Award a good understanding **[2 max]** and a reasonable one **[1 max]**.*

(b) *Wave X and wave Y should be identical.*



correct phase for wave X;
correct phase for wave Y;
amplitudes the same for each wave;
amplitude for each wave is two divisions; 4 max

(c) (i) the phase difference between light leaving S_1 and S_2 is constant; 1

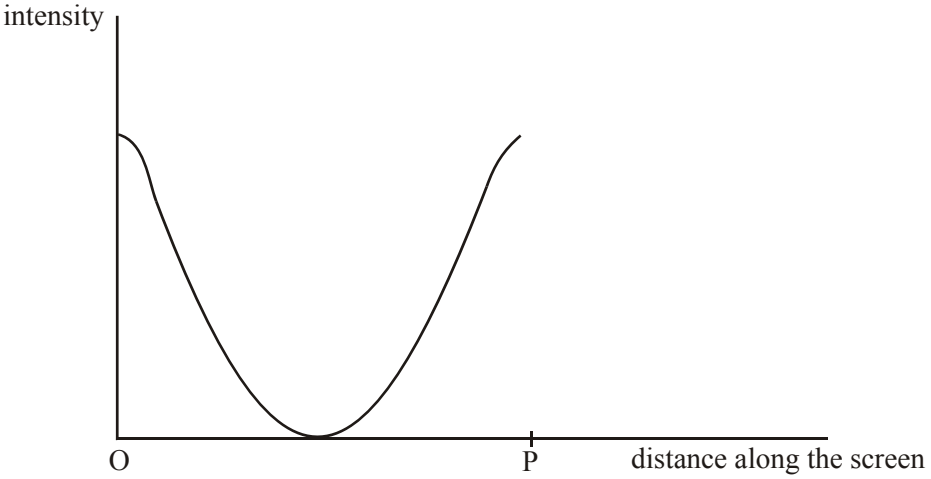
Do not penalize the candidate if they state "has the same phase".

(ii) to produce **sufficient** diffraction;
for the beams to overlap;
OWTTE; 2 max

(d) (i) path difference between S_1 and S_2 is an integral number of wavelengths; 1

Accept "waves arrive at P in phase".

(ii)



maximum at O and P;
general shape with minimum about half way between O and P; 2 max

(e) fringe spacing = 2.5×10^{-4} m;

$\lambda = \dfrac{(2.5\times10^{-4}\times3.00\times10^{-3})}{1.50} = 5.0 \times 10^{-7}$ m; 2

[14]

9. (a) Q is destructive interference;
since the difference in path lengths from the speakers to Q;
must be a $\frac{1}{2}\lambda$ difference; 3 max

Accept $(n + \frac{1}{2})$ difference / OWTTE.

(b) frequency = 2 Hz ⇒ time between loud points = 0.5 s;
wavelength of sound, $\lambda = 330 / 360 = 0.917$ m;
distance between loud points = $\lambda D / a$;
$= (0.917 \times 10.0 / 4.0)$ m
$= 2.29$ m;
Accept solutions using $n\lambda = d \sin \theta$.

since speed = distance / time;
$= 2.29 / 0.5$ ms^{-1}
$= 4.58$ ms^{-1}
≈ 5 ms 6 max

N.B. *The solution above is, of course, an estimation. If the answer attempts "full" solution (i.e. does not resort to small angle estimations) but still gets confused with maths, full marks can be awarded if appropriate progress is made or understanding shown.*

(c) realization that the set-up is to do with <u>beats</u>;
two signal generators give different frequencies that are 2 Hz apart;
must be 359 Hz and the other 361 Hz; 3 max

[12]

10. Wave properties

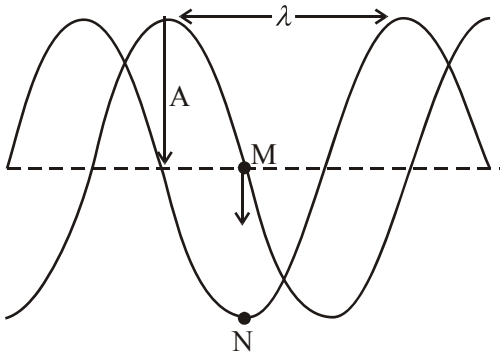
(a) (i)

1

(ii)

1

(b)



(i) downwards; 1

(ii) correct marking of A; 1

(iii) correct marking of λ; 1

(iv) +ve sine curve;
correct position of N; 2
Watch for ecf from (i).

(c) (i) $f = \frac{v}{\lambda}$ = to give 2.0 Hz; 1

(ii) $T = 0.5$ s;

$s = \frac{vT}{4} = 1.25$ (1.3) cm;

or

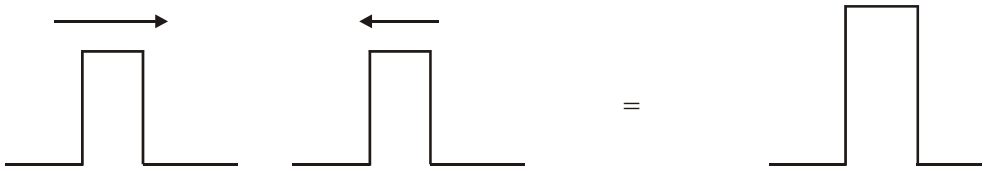
in $\frac{T}{4}$ wave moves forward $\frac{1}{4}\ \lambda$;

$= \frac{5}{4} = 1.25$ (1.3) cm; 2 max

(d) *Principle of superposition*:
when two or more waves overlap, the resultant displacement at any point;
is the sum of the displacements due to each wave separately / *OWTTE*;

*Award **[2 max]** for an answer that shows a clear understanding of the principle, **[1]** for a reasonable understanding and **[0]** for a weak answer.*

Explanation:



suitable diagram;
when two +ve pulses (or two wave crests) overlap, they reinforce / OWTTE; 4

Any situation where resultant displacement looks as though it is the sum of the individual displacements. Mark the description of the principle and the description of constructive interference together.

(e) (i) $S_2X = n\lambda$;
where $n = 0, 1, 2$; *(Accept "n is an integer")* 2

(ii) $\sin\theta \approx \theta$;

therefore $\theta = \frac{S_2X}{d}$; 2

(iii) $\phi = \frac{y_n}{D}$; 1

Award the small angle approximation mark anywhere in (i) or (ii).

(f) (i) $\theta = \frac{S_2X}{d} = \frac{n\lambda}{d}$ *so* $\lambda = \frac{d\theta}{n}$;

substitute to get $\lambda = 4.73 \times 10^{-7}$ m; 2

(ii) θ and ϕ are small;

therefore $\frac{\lambda}{d} = \frac{y}{D}$;

so $y = \frac{D\lambda}{d} = 0.510$ mm; 3