Solutions

Multiple choice questions

Example 1 QLD 2016 Question 7

The concept of wave motion is that energy is transferred without the net transfer of matter.

$\therefore$ **B (ANS)**

Example 2 QLD 2017 Question 7

The concept of wave motion (either transverse of longitudinal) is that energy is transferred without the net transfer of matter.

$\therefore$ **B (ANS)**

Example 3 QLD 2018 Question 7

The definition of a longitudinal wave is when the movement of the energy is parallel to the displacement of the mass.

$\therefore$ **B (ANS)**

Example 4 1982 Question 37, 43%

The particles of the coil will vibrate exactly as the source. $\therefore$ A

The wave that is set up, will have a wavelength which depends the speed of the wave (in the medium of coil spring) and the frequency of the vibrations. $\therefore$ D

$\therefore$ **A and D (ANS)**

Example 5 1989 Question 33

With the wave moving to the right, a fraction of a second later the wave will have moved to the right of its current position. This means that the point P has moved upwards.

$\therefore$ **D (ANS)**

Example 6 2009 Question 2, 87%

This is a classic example of a longitudinal wave.

$\therefore$ **B (ANS)**

Example 7 2002 Question 3, 65%

After $\frac{T}{4}$, each point on the wave will have moved ¼ of a cycle to the left. $\therefore$ E

After $\frac{T}{2}$, each point on the wave will have moved ½ of a cycle to the left. $\therefore$ C

$\frac{T}{4}$ **= E** $\frac{T}{2}$ **= C (ANS)**

Example 8

The point X is at n extremity, so it is stationary, and it is about to move up, as the pulse is moving to the right. (A short time later the point X will be where W currently is)

$\therefore$ **C (ANS)**

Example 9

The point Q is moving down, as it will soon be where point P is on the pulse.

$\therefore$ **B (ANS)**

Example 10 1994 Question 1

The spider web is going to vibrate around its mean position. This mean position will remain the same distance from the speaker.
Sound is a longitudinal wave, so the spider web will move (about its mean position) by moving towards and away from the speaker.

$\therefore$ **A (ANS)**

Example 11 1995 Question 2, 52%

Use d = v × t.

$\therefore d = 2.0 \times \frac{1}{4} \times 0.20$

$= 0.10$ m

Diagram A shows a travelling wave that has moved to the right by 0.10 m. (The position zero point of diagram A has moved from a displacement of zero to -1, that is, one quarter of a complete vibration.

$\therefore$ **A (ANS)**

Example 12 1981 Question 43, 55%

(i) The point P is moving up at its maximum speed. (The maximum speed occurs midway between the two extremes)
$\therefore$ **B (ANS)**

(ii) The point P is still moving up, but not at its maximum speed.
$\therefore$ **C (ANS)**

(iii) The point P is now at an extremity of its displacement, so its speed must be zero.
$\therefore$ **A (ANS)**

Example 13 1971 Question 56, 52%

The wave is a transverse wave, so the point P is moving in the direction of either B or E. A fraction of a second later the point P will be on the *x* axis, therefore the point P is moving down.

$\therefore$ **E (ANS)**

Example 14 1971 Question 57, 23%

The point Q is moving at its maximum speed initially. It is moving up, initially. It will move to the top of the crest where its speed will be zero. It will then move downwards, so its velocity will be in the opposite direction so needs an opposite sign. The only graph that shows this is

$\therefore$ **B (ANS)**

Example 15 2010 Question 1, 94%

Use $v = f\lambda$

$\therefore 330 = 512 \times \lambda$

$\therefore \lambda = \frac{330}{512}$

$\therefore \lambda = 0.64$ m

$\therefore$ **B (ANS)**

Example 16 2010 Question 2, 80%

Sound is a longitudinal wave, therefore the air particles will vibrate about their mean position 512 times every second

$\therefore$ **D (ANS)**

Example 17 2009 Question 3, 87%

Use $v = f\lambda$

$\therefore 333 = f \times 2.0$

$\therefore f = \frac{333}{2}$

$\therefore f = 166.5$ Hz

$\therefore$ **C (ANS)**

Example 18 2001 Question 1, 92%

Use $f = \frac{1}{T}$ where T is the period

$\therefore f = \frac{1}{0.005}$

$\therefore f = 200$ Hz

$\therefore$ **D (ANS)**

Example 19 QLD 2009 Question 7

Use v = fλ to find the speed in the water.

∴ v = 10 × 3.0

∴ v = 30.0 cm s^{-1}

The speed will remain constant as the water is the same depth.

∴ 30.0 = 2 × λ

∴ λ = 15 cm

∴ **D (ANS)**

Example 20 1966 Question 26, 49%

The waves in front of the source will be closer together and the ones behind the moving source will be further apart.

∴ **D (ANS)**

Example 21 1966 Question 27, 62%

The speed of the waves depends on the medium that they are travelling through, in this case the medium doesn't change, but the wavelength depends on whether it is in front or behind the source.

Using v = f × λ, if the wavelength changes so must the frequency.

∴ **C (ANS)**

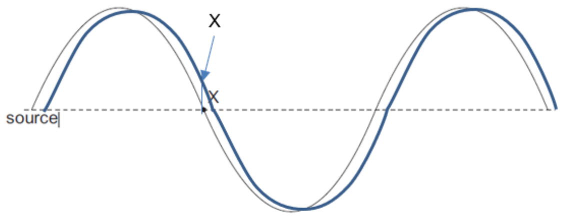
Example 22 QLD 2018 Question 7

Definition of longitudinal waves.

∴ **B (ANS)**

Example 23 QLD 2010 Question 5

With the wave moving to the right, a fraction of a second later the wave will have moved to the blue position. This means that the point X has moved upwards.



∴ **A (ANS)**

Example 24 QLD 2010 Question 6

Use v = fλ

$$\therefore \frac{2000}{5} = 500 \times \lambda$$

∴ 400 = 500 × λ

∴ λ = 0.8 m

∴ **B (ANS)**

Example 25 QLD 2011 Question 7

The frequency of the wave will not change in the shallow water.

Use $f = \frac{1}{T}$

$\therefore f = \frac{1}{0.800}$

$\therefore f = 1.25$ Hz

∴ **D (ANS)**

Example 26 QLD 2011 Question 8

Since V = 322 + 0.6 T, when T is below zero, the speed must be less than 322 m s^{-1}.

∴ **B (ANS)**

Example 27 QLD 2014 Question 9

When water waves enter a shallower medium, they will slow down, so the wavelength will decrease as the frequency remains constant. (This should be obvious from watching waves at the beach. When they come to the shore, they slow down in the shallower water, and the waves behind tend to catch them up. The number of waves entering the shallow region every time interval does not depend on the depth of the water.)

∴ **D (ANS)**

Example 28 NSW 1998 Question 15, 74%

The speed, and hence the wavelength of the sound will vary according to the material that it is in, but, the frequency, (the number of wavefronts going past any point) will remain the same.

∴ **A (ANS)**

Example 29 1987 Question 45, 83%

The frequency of the waves will remain constant, but they will slow down ion the shallow water, so the wavelength will also decrease.

∴ **B (ANS)**

Example 30 1977 Question 74, 72%

As the two axes of polarisation are perpendicular to each other, then the second polariser will not allow any light to pass through.

∴ **B (ANS)**

Example 31 2019 NSW Question 10

Use $I_B = I_0 \cos^2 \theta$

$$\therefore \frac{I_B}{I_0} = \cos^2 30$$

$$\therefore \frac{I_B}{I_0} = 0.866^2$$

$$\therefore \frac{I_B}{I_0} = 0.75$$

Polarisation is a wave property.

$\therefore$ **A (ANS)**

Extended response solutions

Example 32 2019 TAS Question 16a

Use $c = f\lambda$

$\therefore 3.0 \times 10^8 = 2.45 \times 10^9 \times \lambda$

$$\therefore \lambda = \frac{3.0 \times 10^8}{2.45 \times 10^9}$$

$\therefore$ **λ = 0.122 m (ANS)**

Example 33 1977 Question 38, 58%

All points of the pulse are only moving in the vertical direction Therefore the velocity, v, in the horizontal direction is 0

$\therefore$ **0 (ANS)**

Example 34 2003 Question 1, 67%

Sound is a longitudinal wave. The speaker created pressure variations which travelled away from the speaker as a longitudinal wave. These compressions and rarefactions caused the flame to oscillate at the same frequency of the speaker (10 Hz).

Example 35 2002 Question 2, 66%

Morgan is more correct.
This is because sound is a wave, and there is no net displacement of the medium. The dust particle will only move back and forwards about its mean position.

Example 36 1998 Question 1

The definition of wavelength is the distance that it takes for the waveform to repeat itself.
I.e. it is the distance between identical points on the wave train.
It is probably easier to deal with the crests in the top diagram, less confusion as to where the point actually is. So the distance between adjacent crests is 3 divisions on the horizontal scale.

$\therefore \lambda = 3 \times 20$ cm
= 60 cm ($\pm$ 4 cm, because you are asked to estimate)

You don't need to do this, **but** for the second wave, which is a longitudinal representation, it is best to try and find the distance between adjacent compressions.
It looks like there were 4 compressions in a distance of about 7.5 divisions
This corresponds to 3 wavelengths (count them to see how this works)

So λ = (7.5 × 20)/3
= 150/3
= 50 cm. (ANS)

Example 37 2002 Question 1, 74%

As Ashley is beating the drum at 2 beats per second, the time between beats is 0.5 secs. If Pat hears the drum at the same instant that the drum is being hit, then he must be the distance away that the sound travels in 0.5 secs.

$\therefore$ Speed of sound $v = \frac{\text{distance}}{\text{time}}$

$= \frac{167}{0.5}$

= 334 m/s (ANS)

Example 38 2000 Question 4, 66%

The higher the frequency, the lower the period.

This is summarised by: $f = \frac{1}{T}$.

$\therefore f = \frac{1}{5 \times 10^{-3}}$

= 200 Hz (ANS)

Example 39 1997 Question 1, 68%

Use $f = \frac{1}{T}$

$\therefore f = \frac{1}{0.010}$

= 100 Hz (ANS)

Be careful to use the period for a complete cycle, the most common error was to use T = 0.005

Example 40 1997 Question 2, 68%

Don't look at the answers provided in the question, work your own out first and then see which one agrees with you.

B (ANS)

Example 41 1997 Question 3, 55%

The dust particles are going to vibrate about their mean position. They are going to vibrate in a horizontal plane, because sound is a longitudinal wave. The actual molecules are not going to move in the direction of the wave, they will only vibrate about their mean position.

$\therefore$ B is the best answer.

Example 42 1996 Question 1

Use $f = \frac{1}{T}$

$\therefore f = \frac{1}{0.002}$ (from graph, period)

= 500 Hz (ANS)

Example 43 1996 Question 2

Use v = f × λ
= 500 × 0.70
= 350 ms^{-1} (ANS)

Example 44 1995 Question 1, 60%

Use $f = \frac{1}{T}$, to get $T = \frac{1}{f}$

$\therefore T = \frac{1}{5.0}$

= 0.2 sec (ANS)

Example 45 1995 Question 2, 66%

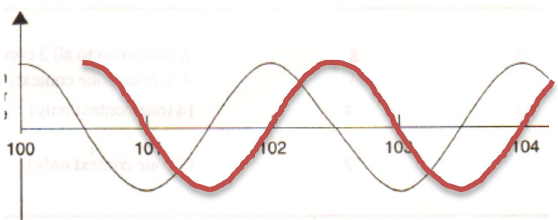
Use v = f × λ
= 5.0 × 0.4
= 2.0 ms^{-1} (ANS)

Example 46 1993 Question 1

Use v = f λ
∴ 340 = f × 2
∴ f = 170 Hz (ANS)

Example 47 1993 Question 3

The shape of the graph remains the same, and it is translated $\frac{1}{4}$ of a cycle to the right.



Example 48 1981 Question 40, 89%

The wavelength is defined as the distance between adjacent points on the wave form. The crests are at 0 and 40 cm.

∴ λ = 40 cm(ANS)

Example 49 1981 Question 41, 59%

In 0.025 sec the first crest has moved from 0 to 10 cm.

Use $v = \frac{x}{t}$,

$\therefore v = \frac{10 - 0}{0.025}$,

∴ v = 400 cm s^{-1}

Use v = f × λ
∴ 400 = f × 40
∴ f = 10 Hz (ANS)

Example 50 1981 Question 42, 75%

(i) Use $v = \frac{x}{t}$,

$\therefore v = \frac{10 - 0}{0.025}$,

$\therefore$ **v = 400 cm s^{-1} (ANS)**

(ii) **Right (ANS)**

Example 51 1971 Question 53, 80%

The first crest moves from 3 cm to 5 cm in 0.10 s.

Use $v = \frac{x}{t}$,

$\therefore v = \frac{5-3}{0.10}$,

$\therefore$ **v = 20 cm s^{-1} (ANS)**

Example 52 1971 Question 54, 71%

The wavelength is the distance between adjacent crests. $\therefore \lambda = 11 - 3$

$\therefore \lambda = 8$ cm

Use $v = f \times \lambda$

$\therefore 20 = f \times 8$

$\therefore$ **f = 2.5 Hz (ANS)**

Example 53 1971 Question 55, 43%

The next highest velocity consistent with the information is if the initial crest (at 3 cm) had moved to 13 cm, instead of just to 5 cm.
This is a movement of 10 cm in 0.10 sec,

$\therefore$ **v = 100 cm s^{-1} (ANS)**

Example 54 1967 Question 44, 83%

Use $V = \frac{x}{t}$ where t, the time between successive pulses, is 0.5 s.

$\therefore V = \frac{x}{0.5}$

$\therefore$ **x = 0.5 V (ANS)**

Example 55 1967 Question 45, 75%

Use $S = \frac{d}{t}$ where t, the time between successive pulses, is 0.5 s.

$\therefore S = \frac{d}{0.5}$

$\therefore$ **d = 0.5 S (ANS)**

Example 56 1967 Question 46, 66%

As the man is walking forwards the pulses ahead (in front) of the man are closer together.

$\therefore$ **x – d (ANS)**

Example 57 1967 Question 47, 56%

As the man is walking forwards the pulses behind the man are further apart.

$\therefore$ **x + d (ANS)**

Example 58 1967 Question 48, 35%

If the separation needs to be $\frac{1}{3}x$,

then $x - d = \frac{1}{3}x$.

$\therefore x - \frac{1}{3}x = d$

$\therefore d = \frac{2}{3}x$

Therefore S must be $\frac{2}{3}$V

$\therefore$ $\frac{2}{3}$**V (ANS)**

Example 59 1966 Question 22, 28%

The waves will continue to travel at the speed V, as the speed of the waves depends on the medium that they are traveling in, and this has not changed.

$\therefore$ **u = V cm s^{-1} (ANS)**

Example 60 1966 Question 23, 67%

The source moves between successive wave fronts (dips in the water). The source dips in *n* times per second.

Use d = v × t, where t is $\frac{1}{n}$.

$\therefore l = S \times \frac{1}{n}$

$\therefore$ $\boldsymbol{l = \frac{S}{n}}$ **cm (ANS)**

Example 61 1966 Question 24, 68%

The wavefronts are moving at speed V,

Use d = V × t, where t is $\frac{1}{n}$.

$\therefore m = V \times \frac{1}{n}$

$\therefore$ $\boldsymbol{m = \frac{V}{n}}$ **cm (ANS)**

Example 62 1966 Question 25, 33%

The wavelength of the waves is given by *m*.
The source moves a distance *l* between wavefronts, so the distance between adjacent wavefronts in front of the moving source is the difference between these two.

$\therefore$ **λ = (*m* – *l*) cm (ANS)**

Extension (not on course)

Example 63   1975 Question 48, 76%

Use v = f × λ, where f = 2.0 and λ = 5.0

∴ v = 2.0 × 5.0

∴ **v = 10.0 cm s^{-1} (ANS)**

Example 64   1975 Question 49, 63%

If the dropper is moving at 10 cm s^{-1} and it had dropped six drops in 3 seconds, then it has moved 30 cm from the start to the last drop. Therefore the start is 30 cm to the left of the point F.

∴ **A (ANS)**

Example 65   1975 Question 50, 64%

The wavelength of the wave with a stationary source is the average wavelength of the wo waves created by a moving source. Therefore the average of 5 and 15 = 10 cm

∴ **10 cm (ANS)**

Example 66   1975 Question 51, 42%

Use v = f × λ, where f = 2.0 and λ = 10.0

∴ v = 2.0 × 10.0

∴ **v = 20.0 cm s^{-1} (ANS)**