

Model Answers: Hard

1

The correct answer is D because:

- The equation given in the question is
- The equation for the speed of the wave is
- By substituting into the first equation gives
 -
 -
- The equation of a straight line is
- A line going through the origin has a y-intercept of $c = 0$ so
 - Comparing with
- We can see y is equal to f^2 and x is equal to , so, a plot of these two quantities on a graph would give a straight line through the origin

2

The correct answer is A because:

- The amplitude is the maximum displacement of the wave
- The amplitude of P is 8 cm and from the diagram we can see wave Q has an amplitude of half that so 4 cm
- Frequency is the number of waves per second of the wave
- Wave P has a frequency of 100 Hz, for every 1 wave that passes of P there are 3 waves of Q
- The period is the time it takes for a wave to complete one wavelength
 - So, the period of P
- The period of Q is

- The frequency of Q
 - Therefore, wave Q has an amplitude of 4 cm and a frequency of 300 Hz

3

The correct answer is A because:

- Intensity I is proportional to amplitude squared A^2 , i.e.
 -
 - 
- From the graph we can see the amplitude and intensity of wave 1 is equal to
 - $A_1 = 2$
 - $I_1 = 2^2 = 4$
- This corresponds to an intensity of $1.6 \times 10^{-6} \text{ W m}^{-2}$
- From the graph we can see the amplitude and intensity of wave 2 is equal to
 - $A_2 = 3$
 - $I_2 = 3^2 = 9$
- The ratios of I_1 and I_2 can be used to find the corresponding intensity of wave 2
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- Therefore, the intensity of wave 2 is $3.6 \times 10^{-6} \text{ W m}^{-2}$

4

The correct answer is B because:

- The power per unit area intensity
- When the surface area is S and the amplitude is A , the power per unit area $= P$

- The surface area has decreased to , since intensity is inversely proportional to the area, i.e.



- So, when the surface area is decreased by a factor of 3 the intensity is increased by a factor of 3
- The second factor in the question is the amplitude of the wave, which is doubled to $2A$
- Intensity is directly proportional to the square of the amplitude, i.e.
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- Doubling the amplitude increases the intensity to increase by a factor of 2²
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- The new power will therefore be

5

The correct answer is B because:

- The question states that the speed of the electromagnetic (EM) waves in a vacuum is c
 - Speed is given by
 - Therefore, wavelength is equal to
- The speed of EM waves is constant in a vacuum so the speed will stay as c
- The frequency has decreased to so the new wavelength is

- Comparing with , we can see the new wavelength is

6

The correct answer is B because:

- Intensity I is proportional to amplitude squared A^2
 -
- The amplitude of P is 3 units and the amplitude of Q is 1 unit
 - The intensity of P = $3^2 = 9$
 - The intensity of Q = $1^2 = 1$
- Therefore the ratio is

7

The correct answer is A because:

- We are told intensity is inversely proportional to the square of the distance x from the source so
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- When the distance is doubled this causes the intensity to decrease by a quarter
 - 
- Intensity I is also proportional to amplitude squared A^2
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- From the question, we can see the amplitude is $8\text{ }\mu\text{m}$, so intensity is proportional to 8^2
 -
- So, at a distance $2r$, the intensity will be and A^2 is equal to
- Therefore, the amplitude at T is equal to

8

The correct answer is B because:

- The equation for the speed of a wave is
- So, frequency is
- From the graph, the wavelength is 50 m
- The question states that the speed is 8.0 m s^{-1}

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- From the graph, the amplitude is 2 m
- The equation for the maximum speed of the particles is

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- Therefore, the maximum kinetic energy is equal to

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9

The correct answer is D because:

- The equation for the speed of a wave
- So, wavelength is
- One wavelength λ is equivalent to a phase difference of 360 degrees (which is equal to rad)
- The waves are in phase as they are separated by a distance equal to λ
 - The phase difference is therefore 2 rad
- Therefore, a separation of 0.68 m (one wavelength) corresponds to a phase difference of 2 rad

- So, a separation of 0.17m corresponds to

10

The correct answer is A because:

- The Doppler effect is when the observed frequency/wavelength of light is different to the emitted frequency/wavelength of the light due to the motion of either the source, the observer or both
- A shorter wavelength is seen when the source approaches the observer in this case the Sun moving towards the Earth
- A longer wavelength is seen when the source moves away from the observer, in this case the Sun moving away from the Earth
- One side of the Earth will observe the Sun moving away and one side will observe the Sun moving towards the Earth
- This means that from the Earth both long and short wavelengths can be seen at any instant

B is incorrect because a shorter wavelength is observed when the Sun (source) is moving towards the observer (the Earth), the question states that there is a range of wavelengths observed. So, both longer and shorter wavelengths will be seen, not only shorter as in this case

C is incorrect because a longer wavelength is observed when the Sun (source) is moving towards the observer (the Earth) the question states that there is a range of wavelengths observed. So, both longer and shorter wavelengths will be seen, not only longer as in this case

D is incorrect because if the Sun was moving at right angles then both longer and shorter wavelengths would be observed but at only specific instances in time. The shorter wavelengths would be seen as the Sun is moving toward the Earth, once it reaches the line joining the Sun and Earth it will continue to be longer

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