Biomedical Admissions Test (BMAT)

Section 2: Physics

Questions by Topic

P6: Waves

P6: Waves - Question by Topic

Mark scheme and explanations at the end

1 A canoe floating on the sea rises and falls 7 times in 49 seconds. The waves pass it at a speed of 5 m/s.

How long are the waves?

A 12m
B 22m
C 25m
D 35m
E 57m

2 Which of the following statements is true with respect to all electromagnetic waves?

1 They can travel through a vacuum
2 They are the same length.
3 They can be reflected.
4 They can be polarised
5 They have the same amount of energy

A 1 and 2 only
B 1 and 3 only
C 1 and 4 only
D 2 and 3 only
E 2 and 4 only
F 1, 2 and 3 only
G 1, 3 and 5 only
H 2, 3 and 4 only
J 1, 3 and 4 only

3 With respect to electromagnetic radiation, which of the following statements is false?

A Radiation can have varying frequencies and wavelengths.
B All electromagnetic waves travel at the speed of light in a vacuum
C Oscillations in electric and magnetic fields is parallel to the direction of energy propagation.
D Ultraviolet radiation is of a higher frequency than infrared radiation.

4 Which of the following statements is/are true with respect to the Doppler Effect?

1 If an object is moving towards the sensor, the wavelength increases and frequency decreases.
2 An object that originally emitted a wave of wavelength of 20mm followed by a second reading of a wavelength of 15mm is moving towards the sensor.
3 The faster the object is moving away from the sensor, the greater the increase in frequency.

A 1 only
B 2 only
C 3 only
D 1 and 2 only
E 1 and 3 only
F 2 and 3 only
G 1, 2 and 3 only
H None of the above

Questions 5-7 refer to the following information:

Most orchestras tune to a standard pitch (frequency= 666Hz). When they are tuning, sound from the orchestra reaches the audience that are 500m away in 1.5 seconds.

5 What is the time period of the sound waves being produced?

A 0.001s
B 0.0015s
C 0.002s
D 0.0025s
E 0.005s
F 0.01s

6 What is the speed of the sound waves being produced?

A 200m/s
B 275m/s
C 315m/s
D 333m/s
E 375m/s
F 422m/s

7 Estimate the wavelength of standard pitch?

A 0.05m
B 0.075
C 0.5m
D 0.75m
E 1m

8 Which of the following statements is correct?

A The speed of light changes when it enters water from air.
B The speed of light changes when it leaves water to air.
C The direction of light changes when it enters water from air.
D The direction of light changes when it leaves water to air.
E All of the above
F None of the above

9 Which of the following statements is true with respect to all electromagnetic spectrum?

A The wavelength of UV waves is shorter than that of X-rays.
B Wavelength of EM waves is directly proportional to frequency.
C Most EM waves can be stopped by a thin layer of aluminium.
D Humans are able to visualise the majority of the EM spectrum.
E None of the above.

10 Which one of the following statements are correct with respect to wave properties?

1 Total internal resistance occurs when the angle of incidence is greater than the critical angle
2 When a wave travels from air to water medium it speeds up.
3 A wave entering a more dense medium will refract towards the normal.

A 1 only
B 2 only
C 1 and 2 only
D 1 and 3 only
E 3 only
F 2 and 3 only
G All of the above

11 A wave of wavelength 2cm completes 24 complete oscillations in 1 minute.

What is the speed of the wave?

A $0.8ms^{-1}$
B $0.05ms^{-1}$
C $0.008ms^{-1}$
D $5ms^{-1}$
E $62.5ms^{-1}$

Solutions

1 D is the answer

This question first requires you to work out the frequency of the waves by using the equation:

$$Frequency = \frac{1}{Time\ period}$$

If seven waves pass in 49 seconds, the time period for 1 wave is 7 seconds:

$$Frequency = \frac{1}{7}$$

To calculate the length of the waves, you then need to use the following equation:

$$Wavelength = \frac{speed}{frequency} = 5m/s \times 7 = 35m$$

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2 J is the answer

Electromagnetic waves form a spectrum varying in frequency, wavelength and energy but what they have in common is that they all travel at the speed of light in a vacuum, they can all be reflected and hey can all be polarised

*Statement **1** is correct as all electromagnetic waves travel at the speed of light through a vacuum.*

Statement **2** is incorrect as electromagnetic waves vary in frequency and wavelength.

*Statement **3** is correct electromagnetic waves can be reflected.*

*Statement **4** is correct as electromagnetic waves can be polarised.*

Statement **5** is incorrect as waves of the electromagnetic spectrum have varying energies.

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3 C is the answer

Statement **A** is correct as electromagnetic radiation forms a spectrum comprising different frequencies and wavelengths.

Statement **B** is correct as all electromagnetic waves travel at the speed of light in a vacuum.

*Statement **C** is incorrect as electromagnetic waves are examples of transverse waves where the particles oscillate perpendicularly to the direction of energy propagation.*

Statement **D** is correct as Ultraviolet radiation is higher frequency and shorter wavelength than infrared radiation.

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4 **B is the answer**

Statement **1** is incorrect as If an object is moving towards the sensor, the wavelength decreases and frequency increases.

*Statement **2** is correct as when an object moves towards the sensor, wavelength decreases.*

Statement **3** is incorrect as the faster the object is moving away from the sensor, the greater the decrease in frequency.

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5 **D is the answer**

This multi-step question starts off relatively simply but requires you to know the relationship between time period and frequency:

$$Time\ period = \frac{1}{frequency} = \frac{1}{666} = 0.0015s$$

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6 **D is the answer**

This multi-step question continues by requiring the following equation for speed:

$$Speed = distance \div time = 500 \div 1.5 = 333m/s$$

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7 **C is the answer**

The final part of this question requires you to use the equation relating speed, frequency and wavelength:

$$Wavelength = \frac{speed}{frequency} = \frac{333}{666} = 0.5m$$

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8 **E is the answer**

When light enters a more dense medium from a less dense medium, it slows down, wavelength decreases and it causes the light to bend towards the normal. The opposite is true when light exits a more dense medium into a less dense medium

*Statement **A** is correct as the speed of light decreases when it enters water from air.*

*Statement **B** is correct as the speed of light increases when it leaves water to air.*

*Statement **C** is correct as light bends towards the normal when it enters water from air.*

*Statement **D** is correct as light bends away from the normal when it leaves water to air.*

***

9 **E is the answer**

Electromagnetic spectrum is composed of wavelengths of varying frequencies and wavelengths with certain common properties and certain differing properties.

Statement **A** is incorrect as X-rays have a shorter wavelength and higher frequency than UV waves.

Statement **B** is incorrect as the wavelength of EM waves is inversely proportional to frequency.

Statement **C** is incorrect as EM waves have varying degrees of penetrance with high frequency waves such as gamma rays requiring lead or concrete to stop them

Statement **D** is incorrect as humans can only visualise the visible light portion of the EM spectrum

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10 **D is the answer**

When a wave enters a less dense medium at an angle, it will refract. If this occurs at an angle known as the critical angle, the wave will refract along the boundary. If the angle of incidence is greater than the critical angle, the wave will undergo total internal reflection.

*Statement **1** is correct as total internal reflection occurs when the angle of incidence is greater than the critical angle.*

Statement **2** is incorrect as when a wave enters a denser medium (such as water) from air, it slows down.

*Statement **3** is correct as a wave entering a more dense medium will refract towards the normal.*

11 **C is the answer**

The question is asking you to calculate the speed of a wave.

Speed of a wave is calculated using the equation:

$$Speed = frequency \times wavelength$$

Wavelength is given in the question - 0.02m (2cm).

You can calculate the frequency of the wave by first calculating the period:

$60 \div 24 = 2.5\ seconds$

Frequency = 1/period:

$1 \div 2.5 = 0.4$, so the frequency of the wave is 0.4Hz.

Speed of the wave:

$0.02 \times 0.4 = 0.008 ms^{-1}$

A is incorrect - this answer would be obtained by not converting cm to m. Always convert to standard units, and work in standard units for your calculations, to avoid mistakes.

B is incorrect because it calculates speed using period (2.5s) rather than frequency.

D makes both errors explained in A and B – uses period instead of frequency and fails to convert units.

E is incorrect because it calculates the period as 1/24 – always convert into standard units (seconds) before making calculations.