



**Subject:** Grade 10 Physical Sciences

**Topic:** Physical Sciences: Term 2 - Exam 1

**Total:** 60 Marks

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1. false

2 marks

**Explanation:**

A longitudinal wave is defined as:

"A wave where the particle in the medium moves **parallel** to the direction of propagation of the wave".

Transverse waves occur when the particle moves perpendicular to the direction of propagation of the wave.

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2. B: Frequency

4 marks

**Explanation:**

The energy of an electromagnetic wave is directly proportional to its frequency. This relationship is described by the equation:

$$E = hf$$

The equation can also be written as:

$$E = h \frac{c}{\lambda}$$

Where  $E$  is the energy,  $h$  is Planck's constant,  $f$  is frequency,  $c$  is the speed of light and  $\lambda$  is the wavelength.

- **Higher frequency = higher energy:** For example, gamma rays (which have very high frequencies) carry much more energy than radio waves (which have very low frequencies).

- **Wavelength and energy are inversely proportional:** Since frequency and wavelength are inversely proportional, shorter wavelengths correspond to higher energy and vice versa.

Amplitude and speed does not affect the energy of an electromagnetic wave.



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3. A: The nylon cloth becomes more positively charged as it gave electrons to the aluminium rod. 4 marks

**Explanation:**

When objects are rubbed together, friction occurs. This friction can create a temporary electrostatic charge in objects.

The charge is created by either the loss or gain of **electrons** between the two objects. It is impossible to transfer protons from one object to another through friction.

Which object gains or loses the electrons can be seen on the triboelectric series. If the object is more towards the positive side (or the top in the diagram provided), it will tend to **lose electrons and become positive**. The opposite is true for the more negative side (or the bottom of the diagram provided).

Nylon is higher in the triboelectric series than aluminium. Therefore, the nylon cloth will **lose electrons** and become more **positive**. The electrons are passed on to the aluminium rod which becomes more negative since it gained the electrons.

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4. B: Microwaves

4 marks

**Explanation:**

Wavelengths of electromagnetic radiation are measured in nanometers (nm).

- Gamma rays have the shortest wavelength - roughly less than 1 nm.
- X-rays have a wavelength range of 1 – 10 nm.
- Visible light has a wavelength range of 400 – 700 nm.

**Microwaves** will have the longest wavelengths (from this list) - ranging from  $10^5$  –  $10^8$  nm.

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5. C: Bulbs  $B$  and  $C$  will have the same brightness, but bulb  $A$  will be brighter than both of them. 4 marks

**Explanation:**

When looking at the circuit, we can see that bulb  $A$  is connected in series, while bulbs  $B$  and  $C$  are connected in parallel.

Brightness is a measure of the power provided by a bulb. Since the resistance of all the bulbs is the same, the only difference is the potential difference and current passing through.

$$P = V \times I$$

Bulb  $A$  will receive the **total current**, while the current for  $B$  and  $C$  will be **half** that of  $A$ . This is because current is divided between parallel resistors.  $B$  and  $C$  will receive equal current since they have the same resistance.

Bulb  $A$  will receive a greater potential difference. The potential difference across  $B$  and  $C$  for the parallel section would be:

$$V_{BC} = V_T - V_A$$

Bulbs  $B$  and  $C$  receive the same potential difference as they are in parallel. Potential difference is not divided in parallel.

Taking all of this into account,  $B$  and  $C$  will have the same brightness, since they have the same potential difference and current.

$A$  will be brighter than  $B$  and  $C$ , since it has a **greater current** and **greater potential difference**.

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6. true 2 marks

**Explanation:**

The energy of a wavelength is **inversely proportional** to the wavelength of electromagnetic radiation.

In the diagram,  $G$  has the **smallest wavelength**. Therefore, it has the **highest energy** of all the radiations.

**Gamma rays** have the highest radiation of the electromagnetic spectrum.

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7. false 2 marks

**Explanation:**

Magnetic field lines always run **from north to south**.

In this diagram the arrows are facing in the incorrect direction.

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8. D: There will be constructive interference and the amplitude will be  $2a$ .

4 marks

**Explanation:**

Since the movement of the particles for both pulses is in the same direction from the equilibrium position (both moving upward), when they meet, they will show **constructive interference**.

When constructive interference occurs, the different amplitudes will be **added together**. Since they are both the same sign (constructive), the magnitude of the amplitude will be larger than the individual pulses.

The pulses are identical, so if one pulse has an amplitude of  $a$ , then the other will also have an amplitude of  $a$ . When added together, the new amplitude would be  $2a$ .

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9. false

2 marks

**Explanation:**

First find the new charge on each sphere after contact. Although both charges are in  $\mu\text{C}$ , calculate in Coulombs.

$$Q = \frac{Q_A + Q_B}{2}$$

$$Q = \frac{(+6 \times 10^{-6}) + (-2 \times 10^{-6})}{2}$$

$$Q = 2 \times 10^{-6} \text{ C}$$

Now find the change in charge from contact (either use sphere  $A$  or  $B$  and it will come to the same answer, just remember to keep the signs of each charge). This example will use sphere  $A$  :

$$Q_{\text{new}} = Q_{\text{final}} - Q_{\text{initial}}$$

$$Q_{\text{new}} = (2 \times 10^{-6}) - (+6 \times 10^{-6})$$

$$Q_{\text{new}} = -4 \times 10^{-6} \text{ C}$$

Use the quantisation of charge calculation to find the number of electrons (remember to choose the correct version of either positive or negative charge of the electron depending on whether you are dividing into a positive or negative number of charge):

$$n = \frac{Q}{q^e}$$

$$n = \frac{(-4 \times 10^{-6})}{(-1,6 \times 10^{-19})}$$

$$n = 2,5 \times 10^{13} \text{ electrons transferred.}$$

This makes the statement **false**.

10. true

2 marks

**Explanation:**

In longitudinal waves, the particles of the medium vibrate **parallel** to the direction of wave propagation. For sound waves in air, this means that air molecules compress and expand (forming **compressions** and **rarefactions**) as the wave travel.

In transverse waves, particles of the medium vibrate **perpendicular** to the direction of wave propagation. This motion results in crests and troughs, such as in water waves or electromagnetic waves. This is **not** how sound moves through air.

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11. C: The electrons in the metal sphere move away from the rod and the protons do not move. 4 marks

**Explanation:**

Protons in an object are **not** able to move because of an electrostatic force. The only sub-atomic particle that can move because of an electrostatic force are the **electrons**.

Since the rod is negatively charged, the electrons in the metal sphere will be **repelled** as they are like charges. Therefore, the electrons will move away from the rod, while the protons will not move.

This is what causes temporary poles in the metal sphere (or any neutral object). Once the rod is moved away (assuming it does not touch the sphere), the electrons will redistribute themselves accordingly.

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12. false 2 marks

**Explanation:**

The formula for the speed of a sound wave is:

$$v = f\lambda$$

$$\therefore v = 500 \times 0,5$$

$$v = 250 \text{ m} \cdot \text{s}^{-1}$$

Therefore a speed of  $340 \text{ m} \cdot \text{s}^{-1}$  is **not correct**.

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13. A:  $6,67 \Omega$  4 marks

**Explanation:**

The resistors in this diagram are connected in **parallel**. Use the formula:

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_p} = \frac{1}{10} + \frac{1}{20}$$

$$\frac{1}{R_p} = \frac{3}{20}$$

But this is the inverse of the value of resistance, therefore we need to **flip** the fraction values for the actual resistance in parallel.

$$R_p = \frac{20}{3}$$

$$R_p = 6,67 \Omega$$

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14. false

2 marks

**Explanation:**

The circuit has been set up in **series**.

To find the total resistance, **add all the resistances together**.

Therefore, the total resistance will be  $4R$ .

Only when resistors are in parallel do we calculate using the inverse of each resistor.

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15. B:  $A$  - Wavelength

4 marks

$B$  - Compression

$C$  - Rarefaction

**Explanation:**

The motion of the particle is **parallel** to the motion of the wave.

$B$  represents a **compression**, a point where the medium becomes 'tightened' or closer together.

$C$  represents a **rarefaction**, a point where the medium becomes more spread out.

$A$  represents the **wavelength**. This is similar to the crests and troughs of a transverse wave, but instead you measure from compression to compression (or from rarefaction to rarefaction).

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16. D: Each piece will become a new magnet with two poles each.

4 marks

**Explanation:**

Magnets always have two poles: a north pole and a south pole. These poles are the result of the alignment of magnetic domains (tiny regions within the material that act like miniature magnets). When you cut a magnet in half, the alignment of these domains does not change.

- Each new piece will still have a north and a south pole because the magnetic domains in the pieces remain aligned.
- You cannot isolate a single north or south pole; this is because magnetic monopoles (single magnetic poles) do not exist in nature. Even if you keep dividing the magnet into smaller pieces, each piece will always have two poles.

This behavior is a fundamental property of magnets and is explained by the nature of the magnetic field, which always forms a closed loop from one pole to the other.

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17. false

2 marks

**Explanation:**

No contact is made between the spheres.

The excess electrons of the negatively charged sphere will repel the electrons in the neutral sphere.

This will **temporarily** make one side of the neutral sphere more positively charged, and the other side more negatively charged. The sphere will become **polarised**, but not positively charged.

The metal sphere remains neutral overall because no charge has been added or removed; the charges are only redistributed within the sphere.

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18. C: 68 m

4 marks

**Explanation:**

Use the information provided to find the total distance covered during the 0,4 seconds.

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

$$\text{distance} = 340 \times 0,4$$

$$\text{distance} = 136 \text{ m}$$

This represents the distance the sound travelled to the other side of the cliff **AND returning** back to the hiker.

Therefore, for distance  $D$ , divide the calculated distance by 2.

The final answer is 68 m.

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19. true

2 marks

**Explanation:**

Amplitude is the maximum displacement from the equilibrium position. In this instance, both E and F reach 0,2 m above and below the mean. So they have the same amplitude.

Wavelength is the time it takes for two successive crests (or troughs) to pass through a set point. Both E and F take 1 s to complete one wave. Therefore, they both have the same wavelength.

The only difference is that they are slightly out of time phase with each other.

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20. true

2 marks

**Explanation:**

In a parallel circuit, adding more resistors creates additional pathways for current to flow. This reduces the overall resistance of the circuit because the total resistance in a parallel circuit is calculated using the reciprocal formula:

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} \dots$$

As more resistors are added, the reciprocal sum increases, leading to a decrease in  $R_{total}$ .

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**Total:** 60 Marks