Cambridge Assessment International Education

Interactive

Interactive Example Candidate Responses
Paper 2 (May/June 2016), Question 4
Cambridge International AS & A Level
Physics 9702

Version 1.0

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4 (a) By reference to the direction of the propagation of energy, state what is meant by a *longitudinal* wave and by a *transverse* wave.

longitudinal: Waves that travel parralel to direction of proporgation of energy.

transverse: Waves that travel at right angles to direction of proporgation of energy.

[2]

(b) The intensity of a sound wave passing through air is given by

$$I = Kv\rho f^2A^2$$

where I is the intensity (power per unit area),
K is a constant without units,
v is the speed of sound,
ρ is the density of air,
f is the frequency of the wave
and A is the amplitude of the wave.

Show that both sides of the equation have the same SI base units.

$I = \frac{P}{A}$ $\quad P = \frac{F \times d}{t} \rightarrow \frac{\cancel{kg\,m\,s^{-2}}}{\cancel{kg\,m\,s^{-2}}}$ $\quad \frac{kg\,m\,s^{-2} \times m\,s^{-1}}{\frac{kg\,m^2\,s^{-3}}{m^2}}$

$\therefore I = kg\,s^{-3}$

$v\rho f^2A^2 \rightarrow (m s^{-1})(kg m^{-3}) \times (s^{-1})^2 (m)^2$

$\rightarrow kg\,m^{-2}\,s^{-1} \times s^{-1} \times m^2$

$\rightarrow kg\,s^{-3}$

$\therefore$ LHS : RHS

[3]

Your Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

4(d)

Q4	Mark scheme		
(a)	longitudinal: vibrations/oscillations (of the particles/wave) are parallel to the direction or in the same direction (of the propagation of energy)	B1	
	transverse: vibrations/oscillations (of the particles/wave) are perpendicular to the direction (of the propagation of energy)	B1	[2]
(b)	LHS: intensity = power / area units: kg m s^{-2} × m × s–1 × m^{-2} **or** kg m^2 s–3 × m–2	B1	
	RHS: units: m s^{-1} × kg m^{-3} × s^{-2} × m^2	M1	
	LHS and RHS both kg s^{-3}	A13	[3]
(c)(i)	change/difference in the observed/apparent frequency when the source is moving (relative to the observer)	B1	[1]
(c)(ii)	wavelength increases/frequency decreases/red shift	B1	[1]
(d)	observed frequency = $vf_s / (v - v_s)$	C1	
	550 = (340 × 510) / (340 – v_s)	C1	
	v_s = 25 (24.7) m s^{-1}	A1	[3]
			[Total: 10]

(c) (i) Describe the *Doppler effect*.

Where the observed frequency is different from the emitted frequency, when there is motion between the observer & source. [1]

(ii) A distant star is moving away from a stationary observer.

State the effect of the motion on the light observed from the star.

The light becomes less brighter since frequency decreases (observed), ~~and~~

[1]

(d) A car travels at a constant speed towards a stationary observer. The horn of the car sounds at a frequency of 510 Hz and the observer hears a frequency of 550 Hz. The speed of sound in air is 340 m s^{-1}.

Calculate the speed of the car.

$f_o = \frac{f_s \times v}{v - v_s}$

$550 = \frac{510 \times 330}{(330 - x)}$

$181{,}500 - 550x = 168{,}300$

$550x = 13{,}200$

$x = 24 \text{ ms}^{-1}$

speed = 24 ms^{-1} ms^{-1} [3]

[Total: 10]

Select page

HIGH MIDDLE LOW

Your Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

4(d)

Q4	Mark scheme		
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	LHS and RHS both kg s^{-3}	A13	[3]
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	550 = (340 × 510) / (340 – v_S)	C1	
	v_S = 25 (24.7) m s^{-1}	A1	[3]
			[Total: 10]

EXAMINER COMMENTS

MARK SCHEME

Select page

HIGH | MIDDLE | LOW

4 **(a)** By reference to the direction of the propagation of energy, state what is meant by a *longitudinal* wave and by a *transverse* wave.

longitudinal: A wave in which the particle moves parallel to the propagation of energy is known as longitudinal wave.

transverse: A wave in which the particle of the motion moves perpendicular to the direction of motion is known as a transverse wave.

[2]

(b) The intensity of a sound wave passing through air is given by

$$I = Kv\rho f^2 A^2$$

where I is the intensity (power per unit area),
K is a constant without units,
v is the speed of sound,
ρ is the density of air,
f is the frequency of the wave
and A is the amplitude of the wave.

$\frac{\text{mass}}{\text{vol}} = \text{kg m}^{-3}$

Show that both sides of the equation have the same SI base units.

$\frac{\text{kg} \times \cancel{m}\text{s}^{-2} \times \cancel{m}}{s} = K \times \text{ms}^{-1} \times \text{kgm}^{-3} \times$

$\text{kg} \times \text{s}^{-3} = K \times \text{ms}^{-1} \times \text{Kgm}^{-3} \times \text{s}^{-2} \times \text{m}^2$

$\text{kg s}^{-3} = K \times \cancel{m^0} \times \text{Kg} \times \text{s}^{-3}$

$\text{kg s}^{-3} = K \text{ Kg s}^{-3}$

$\text{Hz} = f = \frac{1}{T}$

$= \text{s}^{-1}$

$E = P \times t$

$P = \frac{W}{t}$

$f \times d$ ms^{-2}

$= \frac{\text{kg} \times a \times \text{m}}{s}$

[3]

Your Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

4(d)

Q4	Mark scheme	
(a)	longitudinal: vibrations/oscillations (of the particles/wave) are parallel to the direction or in the same direction (of the propagation of energy)	B1
	transverse: vibrations/oscillations (of the particles/wave) are perpendicular to the direction (of the propagation of energy)	B1 **[2]**
(b)	LHS: intensity = power / area units: kg m s^{-2} × m × s–1 × m^{-2} **or** kg m^2 s–3 × m–2	B1
	RHS: units: m s^{-1} × kg m^{-3} × s^{-2} × m^2	M1
	LHS and RHS both kg s^{-3}	A13 **[3]**
(c)(i)	change/difference in the observed/apparent frequency when the source is moving (relative to the observer)	B1 **[1]**
(c)(ii)	wavelength increases/frequency decreases/red shift	B1 **[1]**
(d)	observed frequency = $vf_S / (v - v_S)$	C1
	550 = (340 × 510) / (340 – v_S)	C1
	v_S = 25 (24.7) m s^{-1}	A1 **[3]**
		[Total: 10]

EXAMINER COMMENTS

MARK SCHEME

Select page

HIGH | MIDDLE | LOW

(c) (i) Describe the *Doppler effect*.

~~It~~ The observed frequency is always different to the frequency emmitted when source and sound are in a relative motion. [1]

(ii) A distant star is moving away from a stationary observer.

State the effect of the motion on the light observed from the star.

The wavelenght and the frequency has now been changed so the motion will also change. [1]

(d) A car travels at a constant speed towards a stationary observer. The horn of the car sounds at a frequency of 510 Hz and the observer hears a frequency of 550 Hz. The speed of sound in air is 340 m s^{-1}.

Calculate the speed of the car.

$f = 510$

$510 = 550 \times \left(\frac{340}{340 - V_{car}}\right)$

$0.927\,(340 - V_{car}) = 340$

$340 - V_{car} = 366.67$

$V_{car} = 26.67$

speed = ~~26~~ 26.67 m s^{-1} [3]

[Total: 10]

Your Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

4(d)

Q4	Mark scheme		
(a)	longitudinal: vibrations/oscillations (of the particles/wave) are parallel to the direction or in the same direction (of the propagation of energy)	B1	
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(b)	LHS: intensity = power / area units: kg m s^{-2} × m × s–1 × m^{-2} **or** kg m^2 s–3 × m–2	B1	
	RHS: units: m s^{-1} × kg m^{-3} × s^{-2} × m^2	M1	
	LHS and RHS both kg s^{-3}	A13	[3]
(c)(i)	change/difference in the observed/apparent frequency when the source is moving (relative to the observer)	B1	[1]
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(d)	observed frequency = $vf_S / (v - v_S)$	C1	
	550 = (340 × 510) / (340 – v_S)	C1	
	v_S = 25 (24.7) m s^{-1}	A1	[3]
			[Total: 10]

EXAMINER COMMENTS

MARK SCHEME

Select page

HIGH | MIDDLE | LOW

4 (a) By reference to the direction of the propagation of energy, state what is meant by a *longitudinal* wave and by a *transverse* wave.

longitudinal: The energy is ~~...~~ parallel to the direction of the propagation, such as a sound wave.

transverse: The energy is perpendicular to the direction of the propagation, such as in a guitar string.

[2]

(b) The intensity of a sound wave passing through air is given by

$$I = Kv\rho f^2A^2$$

where I is the intensity (power per unit area),
K is a constant without units,
v is the speed of sound,
ρ is the density of air,
f is the frequency of the wave
and A is the amplitude of the wave.

...w that both sides of the equation have the same SI base units.

$I = \cancel{K}v\rho f^2 A^2$

$\frac{m^2s^{-4}}{m^2} = ms^{-1}kgm^{-3}s^{-3}m^2$

$kgs^{-4} = kgs^{-4}$

Thus proved

power $= \frac{f \times d}{t}$

- power $= \frac{mad}{t}$

$= \frac{kgms^{-2}m}{s}$

$= \frac{kgm^2s^{-3}}{t}$

$= kgm^2s^{-4}$

- $v =$ ~~...~~ ms^{-1}
- $\rho = \frac{m}{v} = \frac{kg}{m^3} = kgm^{-3}$
- $f =$ ~~...~~ s^{-3}
- $A = m^2$

[3]

Your Mark

4(a)

4(b)

4(c)(i)

4(c)(ii)

4(d)

Examiner marks and comments

Mark	Comment
0/2	These definitions make no sense and do not describe the waves in the detail required.
0/3	Correct equation for power but mathematical error made in analysis. There is an apparent change in the frequency base units to make units on each side of the equation equal means that no credit can be awarded.
1/1	Clear description given.
1/1	Correct statement made.
2/3	Good presentation of equation and correct substitution of values. Mathematical error made in the third line hence incorrect final answer and loss of one mark.

EXAMINER COMMENTS

MARK SCHEME

Select page

HIGH MIDDLE LOW

(c) (i) Describe the *Doppler effect*.

The change in apparent frequency due to the ~~change in~~ movement of the source or observer [1]

(ii) A distant star is moving away from a stationary observer.

State the effect of the motion on the light observed from the star.

The apparent frequency would decrease

[1]

(d) A car travels at a constant speed towards a stationary observer. The horn of the car sounds at a frequency of 510 Hz and the observer hears a frequency of 550 Hz. The speed of sound in air is 340 m s^{-1}.

Calculate the speed of the car.

$$f_o = \left(\frac{V_w}{V_w - V_s}\right) f_s$$

$$550 = \left(\frac{340}{340 - V_s}\right) 510$$

$$40 = \frac{340}{340 - V_s}$$

$$340 = 13600 - 40V_s$$

$$-13260 = -40V_s$$

$$V_s = 331.5$$

speed = 331.5 m s^{-1} [3]

[Total: 10]

	Your Mark
4(a)	
4(b)	
4(c)(i)	
4(c)(ii)	
4(d)	

Examiner marks and comments

Mark	Comment
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EXAMINER COMMENTS

MARK SCHEME

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