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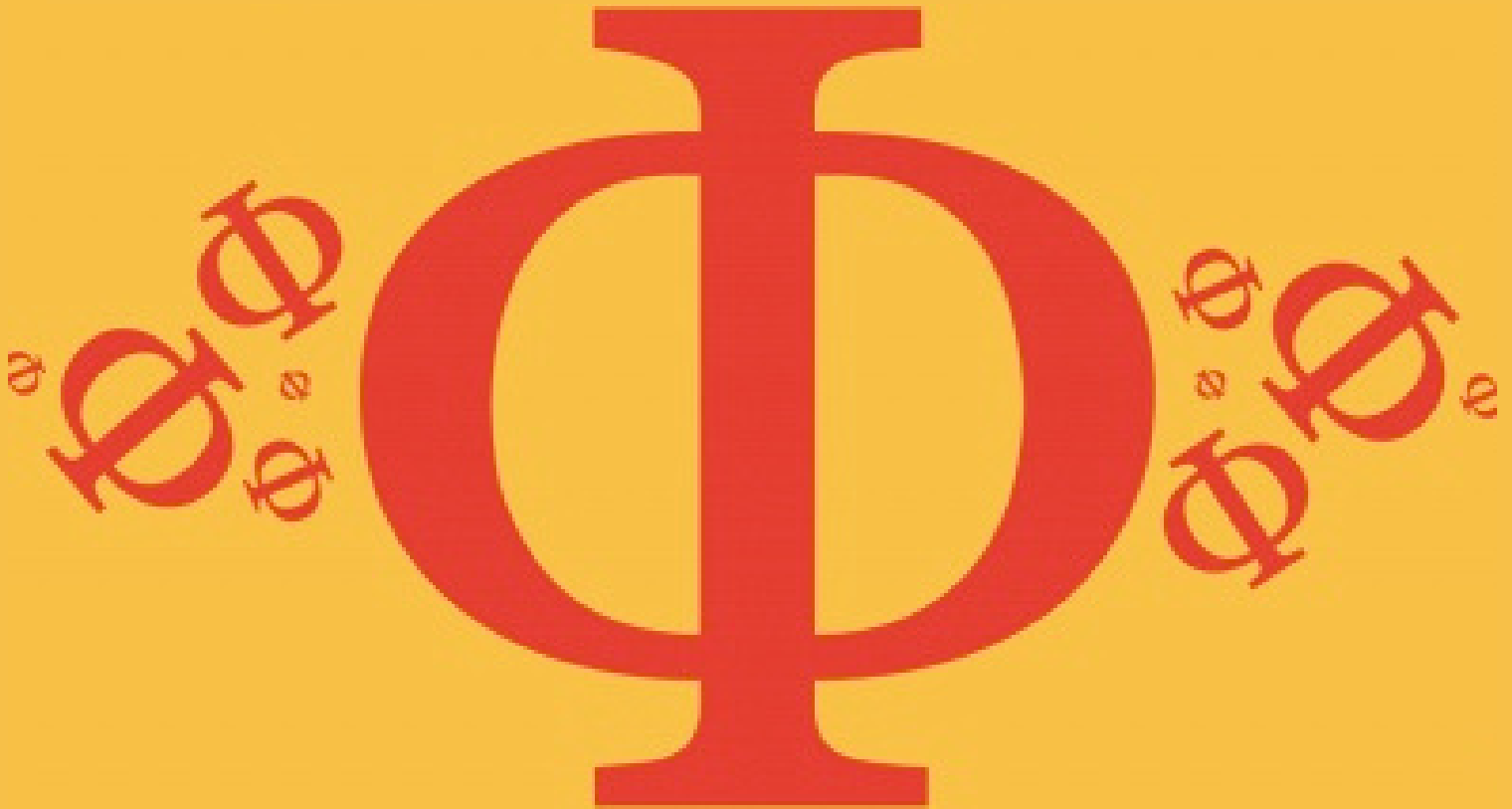
Detailed mark scheme

Suitable for all boards

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9.5 Doppler Effect

Medium



PHYSICS

IB HL

9.5 Doppler Effect

Question Paper

Course	DP IB Physics
Section	9. Wave Phenomena (HL only)
Topic	9.5 Doppler Effect
Difficulty	Medium

EXAM PAPERS PRACTICE

Time allowed: 20
Score: /10
Percentage: /100

Question 1

A car travels in a straight line towards a stationary observer at a speed of $0.2v$, where v is the speed of sound. The car's horn emits a pure sound of frequency f .

What is the frequency of the sound of the horn as heard by the observer?

- A. $0.80f$
- B. $1.25f$
- C. $0.83f$
- D. $1.20f$

[1 mark]

Question 2

An observer approaches a stationary source of sound. The speed of the emitted sound and its wavelength, measured at the source, are v and λ respectively.

Which of the following is the observed wave speed and the observed wavelength, as measured by the moving observer?

	Observed wave speed	Observed wavelength
A.	$> v$	$< \lambda$
B.	$= v$	$> \lambda$
C.	$< v$	$> \lambda$
D.	$= v$	$< \lambda$

[1 mark]

Question 3

A spectral line is observed at 530 nm in the laboratory. The same spectral line is observed in a galaxy which is receding from Earth at a velocity of $3.00 \times 10^6 \text{ m s}^{-1}$.

What is the wavelength of the spectral line from the galaxy?

- A. 534.7 nm
- B. 5.3 nm
- C. 535.3 nm
- D. 583 nm

Question 4

A train is moving away from an observer on a platform with a constant speed $\frac{v}{17}$ where v is the speed of sound. The train emits sound of frequency f .

What is the observed speed of sound and the observed frequency as the train recedes?

	Observed speed of sound	Observed frequency
A.	v	$\frac{18f}{17}$
B.	$\frac{v}{17}$	$\frac{18f}{17}$
C.	v	$\frac{17f}{18}$
D.	$17v$	$\frac{17f}{18}$

[1 mark]

Question 5

In the laboratory on Earth, hydrogen emits a spectral line that is measured by an observer to have a wavelength of 400 nm. The same spectral line is emitted by a galactic source that is moving away from Earth at speed of $0.2c$, where c is the speed of light.

What is the wavelength of the same spectral line from the galaxy as measured by the observer on Earth?

- A. 480 nm
- B. 320 nm
- C. 80 nm
- D. 2000 nm

[1 mark]



Question 6

A star emits light of frequency f . This light is observed on Earth to have a frequency f' which is of a lower frequency than f .

Which of the following correctly describes the speed and direction of motion of the star?

	Speed	Direction
A.	$\frac{(f - f')}{f} c$	Towards Earth
B.	$\frac{(f - f')}{f'} c$	Towards Earth
C.	$\frac{(f - f')}{f} c$	Away from Earth
D.	$\frac{(f - f')}{f'} c$	Away from Earth

[1 mark]

Question 7

A siren on a fire engine emits sound of wavelength λ . The speed of sound in still air is v .

What would be the wavelength of the sound recorded by a stationary observer when the ambulance travels towards them at speed of $0.15v$?

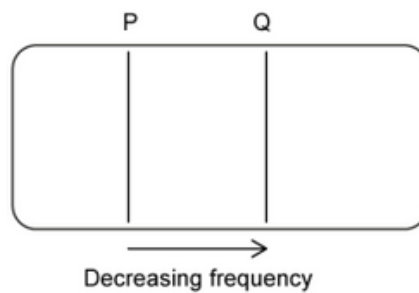
- A. 0.85λ
- B. 1.15λ
- C. 0.15λ
- D. 7.67λ

[1 mark]



Question 8

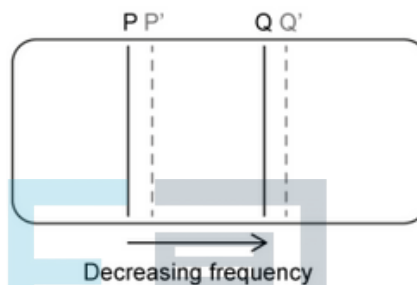
Two lines P and Q in the emission spectrum of a gas are measured on the Earth by a stationary observer.



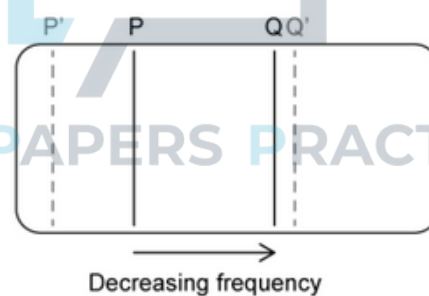
The observer then moves towards the gas sample, and the emission spectrum is recorded as they are moving.

What is the correct pattern for the shifted spectral lines, P' and Q' ?

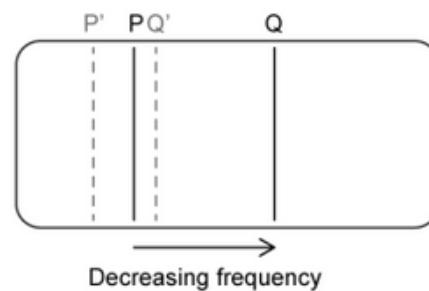
A.



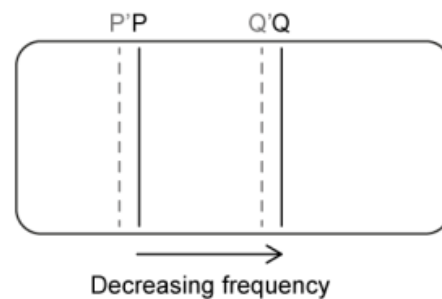
B.



C.



D.



Question 9

Which of the following statements is true about redshift?

- A. Redshift led to the idea that galaxies are expanding
- B. A greater redshift means a faster speed of recession
- C. Redshift shows a few of the galaxies in the universe are moving away from a single point
- D. Redshift causes electromagnetic waves to change frequency and speed.

[1 mark]

Question 10

A car of terrified observers drive away from a stationary, but hungry T. rex, at a speed of 10 m s^{-1} . They hear the roar of the T. rex at a frequency of 170 Hz. The speed of sound in air is 340 m s^{-1} .

What is the frequency of the sound as emitted by the T. rex?

- A. 175 nm
- B. 165 Hz
- C. 120 Hz
- D. 220 Hz

[1 mark]