

# 9.5 Doppler Effect

## Question Paper

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

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

### Question 1

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 2

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 3

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 4

An observer approaches a stationary source of sound. The speed of the emitted sound and its wavelength, measured at the source, are  $v$  and  $\lambda$  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 5

A spectral line is observed at  $530 \text{ nm}$  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.  $534.7 \text{ nm}$
- B.  $5.3 \text{ nm}$
- C.  $535.3 \text{ nm}$
- D.  $583 \text{ nm}$

[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  $\lambda$ . The speed of sound in still air is  $v$ .

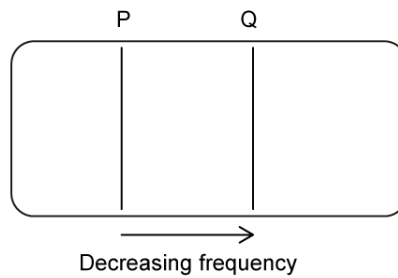
What would be the wavelength of the sound recorded by a stationary observer when the ambulance travels towards them at speed of  $0.15v$ ?

- A.  $0.85\lambda$
- B.  $1.15\lambda$
- C.  $0.15\lambda$
- D.  $7.67\lambda$

[1 mark]

**Question 8**

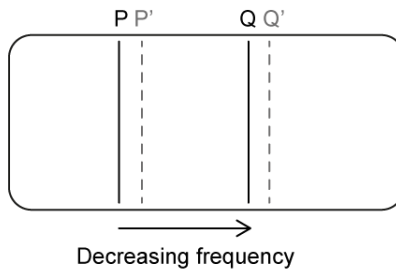
Two lines  $P$  and  $Q$  in the emission spectrum of a gas are measured on the Earth by a stationary observer.



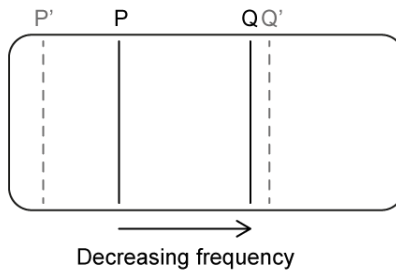
The observer then moves towards the gas sample, and the emission spectrum is recorded as they are moving.

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

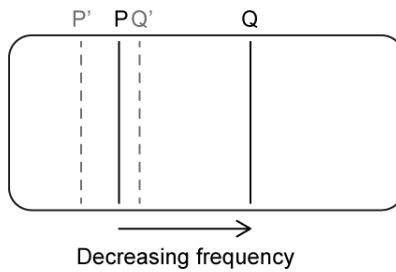
A.



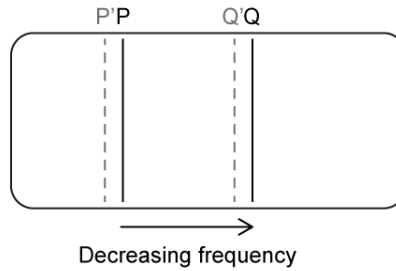
B.



C.



D.



[1 mark]

### 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  $10 \text{ m s}^{-1}$ . They hear the roar of the T. rex at a frequency of  $170 \text{ Hz}$ . The speed of sound in air is  $340 \text{ m s}^{-1}$ .

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

- A.  $175 \text{ nm}$
- B.  $165 \text{ Hz}$
- C.  $120 \text{ Hz}$
- D.  $220 \text{ Hz}$

[1 mark]