

- 1 (a) The speed  $v$  of sound in a gas is given by the expression

$$v = \sqrt{\frac{\gamma P}{\rho}}$$

where  $P$  is the pressure of the gas of density  $\rho$  and  $\gamma$  is a constant.

- (i) State the S.I. base units of pressure.

base units: ..... [1]

- (ii) Show that  $\gamma$  has no unit.

[2]

- (b) A student conducted an experiment to determine the speed of sound  $v$  in air which he found to be  $328.85 \text{ m s}^{-1}$ .

- (i) He used a pressure gauge with a precision of 5 kPa to measure the pressure  $P$  of air which he found to be 105 kPa.

Calculate the fractional error of  $P$ .

fractional error = ..... [1]

(ii) The density  $\rho$  of air is measured to be  $(1.2 \pm 0.1) \text{ kg m}^{-3}$ .

1. Calculate the absolute uncertainty in  $v$ .

absolute uncertainty in  $v = \dots\dots\dots \text{ m s}^{-1}$  [2]

2. State the value of  $v$  and its absolute uncertainty to the appropriate number of significant figures.

$v = \dots\dots\dots \pm \dots\dots\dots \text{ m s}^{-1}$  [1]

(c) The student repeated the experiment in (b) and obtained several values for the speed of sound  $v$

$330 \text{ m s}^{-1}$ ,  $326 \text{ m s}^{-1}$ ,  $334 \text{ m s}^{-1}$ ,  $328 \text{ m s}^{-1}$ ,  $332 \text{ m s}^{-1}$

The theoretical value of  $v$  is  $340 \text{ m s}^{-1}$ .

Explain whether there was a systematic error in the experiment.

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..... [1]

[Total: 8]