3 The volume of air in the cylinder of a car engine is 540 cm^3 at a pressure of 1.1 x 10^5 Pa and a temperature of 27 ^oC. The air is suddenly compressed to a volume of 30 cm^3. No heat energy enters or leaves the gas during the compression. The pressure then rises to 6.5 x 10^6 Pa. Assume that air behaves as an ideal gas.

(a) Determine the temperature of the gas after the compression.

temperature = …… K [2]

(b)(i) State the *first law of thermodynamics*.

……..……...

……..…….. [2]

(ii) Use the law to explain why the temperature of the air changes during compression.

……..……...

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…… [3]

(c) The temperature of a gas depends on the root-mean-square (r.m.s.) speed of its molecules. Calculate the ratio:

$$\frac{\text{r.m.s. speed of gas molecules at 350 K}}{\text{r.m.s. speed of gas molecules at 300 K}}$$

ratio = …… [2]