1 Experimental measurements of the gravitational constant G in different years are shown in the table.

Year	G / $m^3kg^{-1}s^{-2}$
2000	$(6.674215 \pm 0.00009) \times 10^{-11}$
2007	$(6.67234 \pm 0.00014) \times 10^{-11}$
2009	$(6.67349 \pm 0.00017) \times 10^{-11}$

(a) State the year in which the measurement of G appears to be the most precise. Explain your answer.

……

…… [1]

(b) The value of G was determined in 2010 at the University of Zurich. The value was consistent with the value obtained in the 2007 experiment but was not consistent with the values from 2000 or 2009. The experimenter who obtained the value for G in 2010 thinks that there is probably a systematic error in each of the other two experiments.

(i) Explain what is meant by a *systematic error*.

……..……..

…… [1]

(ii) Explain why the most precise result may not be the most accurate.

……..……..

……..……..

…… [2]

(c) In year 2009, experimental measurements were made of the mass of Earth, mass of Moon, and the gravitational force between Earth and Moon.

mass of Earth, M	$5.972 \times 10^{24} \pm 1\%$ kg
mass of Moon, m	$7.348 \times 10^{22} \pm 2\%$ kg
gravitational force between Earth and Moon, F	$(1.98 \pm 0.02) \times 10^{20}$ N

The distance between the centres of Earth and moon, R, is estimated to be around 3.844×10^8 m.

Express R and its actual uncertainty ΔR. Show your working clearly.

$R \pm \Delta R$ = …… ± …… m [3]