6 **(a)** **(i)** Define *acceleration*.

.....

.....[1]

(ii) Explain why the acceleration of free fall near the Earth's surface is constant.

.....

.....

.....

.....[3]

(b) The lower face of an electromagnet is fixed at the zero end of a vertical scale, as shown in Fig. 6.1.

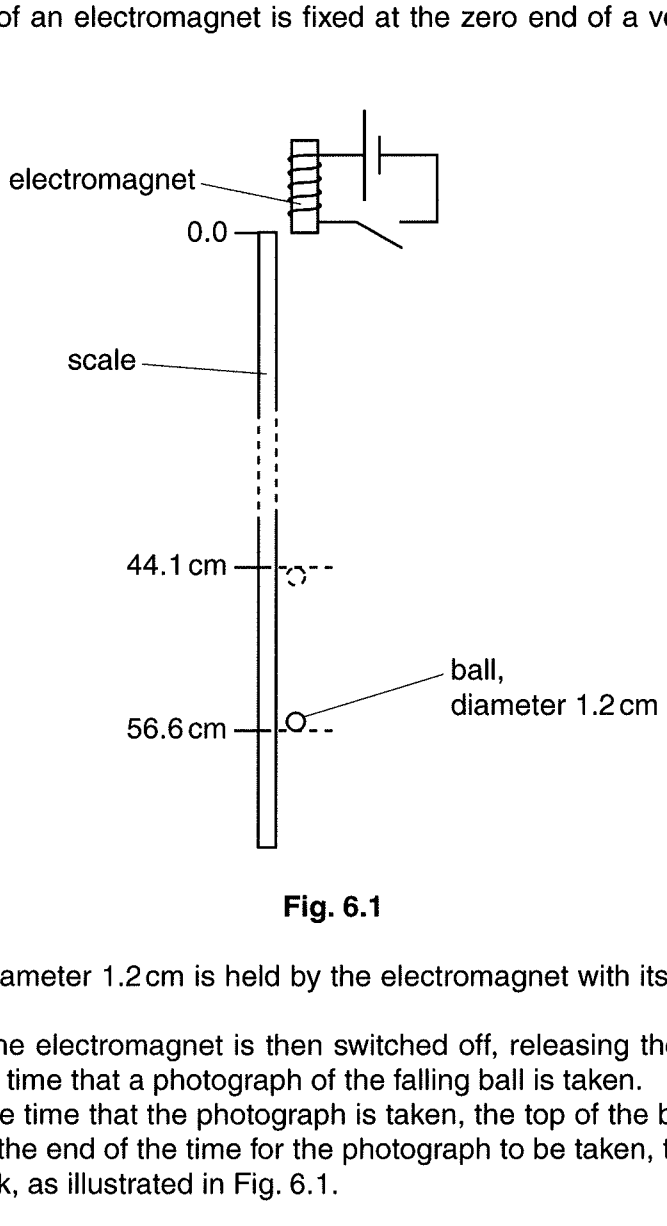

Fig. 6.1

A steel ball of diameter 1.2 cm is held by the electromagnet with its top point at the zero end of the scale.
The current in the electromagnet is then switched off, releasing the ball. The ball is seen to move during the time that a photograph of the falling ball is taken.
At the start of the time that the photograph is taken, the top of the ball is at the 44.1 cm mark on the scale. At the end of the time for the photograph to be taken, the bottom of the ball is at the 56.6 cm mark, as illustrated in Fig. 6.1.

(i) Suggest why, for the falling steel ball, air resistance may be neglected.

.....

.....[1]

(ii) Calculate,

1. the time, to three significant figures, for the ball to fall from rest to the 44.1 cm mark,

time = ... s [2]

2. the time interval T during which the photograph is taken.

T = ... s [3]

(c) The time interval T for the photograph to be taken is stated on the camera as 0.033 s. Use your answer in **(b)(ii)2** to determine a value for the percentage uncertainty in the stated value of T.

uncertainty = ... % [2]

(d) **(i)** The scale has been knocked so that it is no longer vertical. The zero end of the scale remains at the lower face of the electromagnet.
State and explain the difference, if any, between the time for the ball to now fall to the 44.1 cm mark and the time determined in **(b)(ii)1**.

.....

.....

.....[2]

(ii) The scale is returned to its vertical position.
The ball retains some of its magnetic effect so that, for a short distance after release, the ball does not fall freely.
State and explain the effect that this will have on the actual time for the ball to fall to the 44.1 cm mark as compared to the time determined in **(b)(ii)1**.

.....

.....

.....

.....[3]

(e) Air resistance is assumed to be negligible when making the calculations in **(b)**.
State and explain the effect of air resistance on the *acceleration* of a ball falling through a long distance.

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.....

.....[3]