4 **(a)** A ball of mass 430 g is released from a height of 3.40 m above the ground.

The ball deforms when it hits the ground and bounces back to a height of 2.95 m.

(i) Describe how the energy stored in the ball changes between its release and the moment before it first hits the ground.

.....

..... [1]

(ii) Calculate the kinetic energy of the ball the moment before it first hits the ground.

kinetic energy = ... J [2]

(iii) Calculate the kinetic energy of the ball the moment after it first leaves the ground.

kinetic energy = ... J [2]

(iv) The ball continues to bounce and the maximum height of each bounce is recorded in Table 4.1.

bounce	height / m
1	2.95
2	2.36
3	1.75
4	1.21
5	0.78

Table 4.1

Student A suggests that the bounce height decreases exponentially.

If the bounce height decreases exponentially then:

$$\frac{h_1}{h_0} = \frac{h_2}{h_1} = \frac{h_3}{h_2} = \ldots$$

where h_0 is the height of release and h_n is the maximum height reached after the n^{th} bounce.

Use the data in Table 4.1 to determine whether student A is correct.

.....

..... [2]

(b) Student B examines a different ball bouncing. The maximum height of each bounce is recorded in Table 4.2.

Student B forgets to record the initial height from which the ball was released.

Student B uses the data in Table 4.2 to plot the graph in Fig. 4.1 of $\ln(h_n/m)$ against n.

n	h_n/m	$\ln(h_n/m)$
1	3.85	1.35
2	2.67	0.98
3	2.23	
4	1.59	0.47
5	1.10	0.09
6	0.78	
7	0.64	–0.44
8	0.43	–0.85

Table 4.2

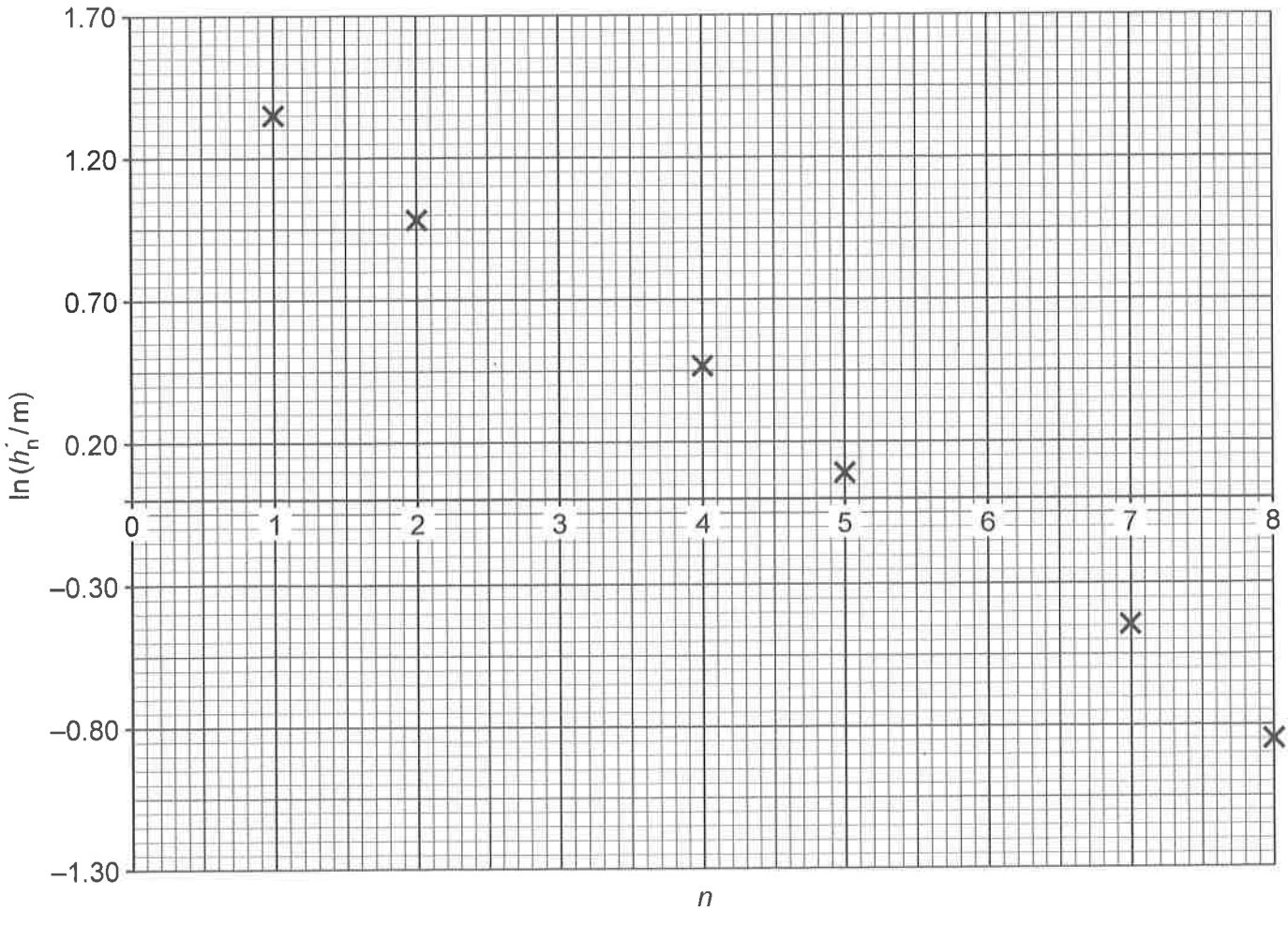

Fig. 4.1

(i) Complete Table 4.2. [1]

(ii) Use Table 4.2 to complete the graph in Fig. 4.1 and add a line of best fit. [3]

(c) Student B suggests the data in Table 4.2 follows the equation

$$h_n = h_0 e^{-kn}$$

where k is a constant.

(i) Explain whether the suggestion of student B is correct.

.....

..... [1]

(ii) Use the graph to find the value of k.

k = ... [3]

(iii) Explain how student B could use the data they have recorded to find the initial height from which they released the ball.

.....

..... [1]

(iv) Find the initial height from which they released the ball.

[1]

[Total: 17]