13 The photograph shows a jumping toy.

The head is pushed down onto the base, compressing a spring. When released the spring expands and the toy jumps into the air.

A student investigated the toy.

The student placed the toy on a balance to measure the force required to compress the spring. The force was 14 N when the spring was fully compressed by 1.7 cm.

When the toy was launched it jumped to a height of 1.5 m.

(a) Show that the maximum energy stored in the compressed spring was about 0.1 J.

(2)

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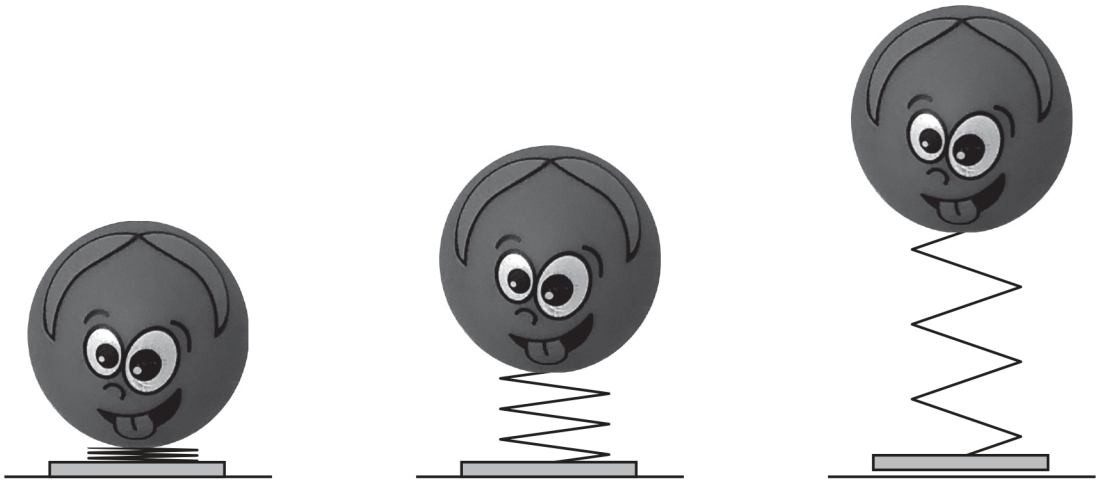
(b) Initially the spring was fully compressed. As the toy was released, the head accelerated upwards on its own until the spring was uncompressed. The head then pulled the base upwards and they moved together at the same speed.



spring fully compressed

head accelerates upwards

head pulls base

The student used the elastic potential energy stored in the spring to determine the maximum speed of the head.

The student used the gravitational potential energy gained by the whole toy to determine its initial upwards speed.

Determine whether the toy obeys the law of conservation of momentum using values of speed calculated in this way.

mass of head = 6.4 g

mass of whole toy = 7.2 g

maximum height of jump = 1.5 m

(5)

(c) Determine whether kinetic energy was conserved as the head began to pull the base upwards.

(2)

(Total for Question 13 = 9 marks)