7 **(a)** The distance *s* moved by an object in time *t* may be given by the expression

$$s = \frac{1}{2}at^2$$

where *a* is the acceleration of the object.

State two conditions for this expression to apply to the motion of the object.

1. ……

……

2. ……

…… [2]

(b) A student takes a photograph of a steel ball of radius 5.0 cm as it falls from rest. The image of the ball is blurred, as illustrated in Fig. 7.1.

The image is blurred because the ball is moving while the photograph is being taken.

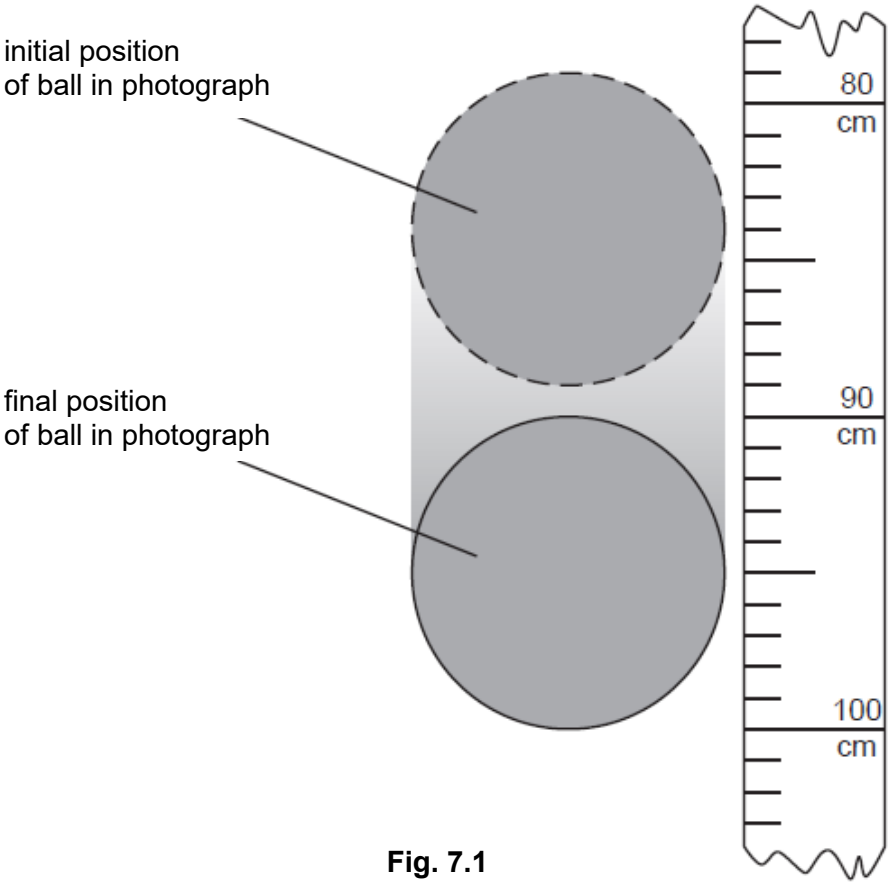

Fig. 7.1

The scale shows the distance fallen from rest by the ball. At time $t = 0$, the top of the ball is level with the zero mark on the scale. Air resistance is negligible.

(i) Calculate the time the ball falls before the photograph is taken,

time = ……s [2]

(ii) Calculate the time interval T during which the photograph is taken.

T = ……s [2]

(iii) The time for which the shutter stays open is marked as $\frac{1}{30}$ s.
Comment on whether your answer in **(ii)** confirms this time.

.....

.....

.....[2]

(iv) The student takes a second photograph starting at the same position on the scale. The ball has the same radius but is less dense, so that air resistance is not negligible.

State and explain the changes that will occur in the photograph.

.....

.....

.....

.....[2]

(c) Fig. 7.2 shows a block of mass 0.30 kg released from rest at a height of 0.10 m above a light spring of force constant 80 N m^{-1}. The block lands on the light board and compresses

a vertical spring before rebounding. The spring obeys Hooke's law. Assume that all the energy the block loses becomes elastic potential energy in the spring.

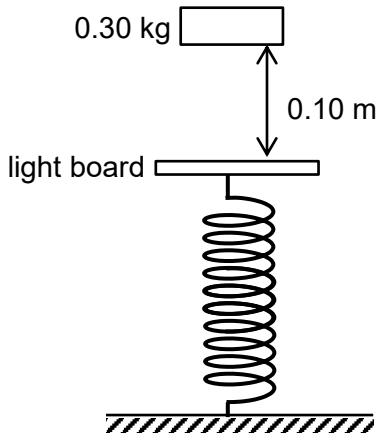

Fig. 7.2

(i) Calculate the maximum compression of the spring.

maximum compression = ……. m [2]

(ii) When the spring is compressed, the block attains a maximum kinetic energy before coming to a momentary stop.

At the position where the block has maximum kinetic energy,

1. show that the compression of the spring is 0.037 m,

[2]

2. determine the maximum kinetic energy attained by the block using energy considerations.

maximum kinetic energy = ……. J [3]

(iii) On Fig. 7.3, sketch the variation with position of the block of the kinetic energy (label this KE), gravitational potential energy (label this GPE) and elastic potential energy (label this EPE) of the block-spring system.

Take the gravitational potential energy to be zero when the spring is at maximum compression.

There is no need to indicate numerical values.

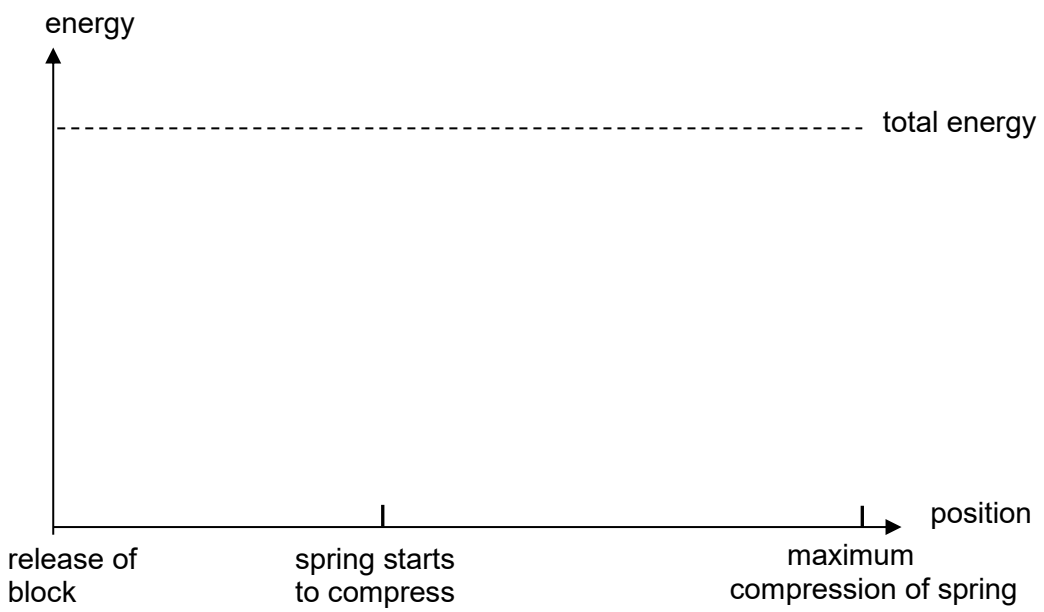

Fig. 7.3

[3]

[Total: 20]