7 **(a)** Define gravitational potential energy (*g.p.e.*) and elastic potential energy (*e.p.e.*).

g.p.e. ....

....

....

e.p.e. ....

....

.... [2]

(b) An extension spring of spring constant 10 N cm^{-1} hangs on a retort stand. A mass of 2.0 kg is placed on the other end of the spring and is lowered until the mass reaches equilibrium position.

(i) Calculate the change in gravitational potential energy of the mass.

change in *g.p.e.* = ... J [2]

(ii) Calculate the change in elastic potential energy of the spring.

change in *e.p.e.* = ... J [1]

45°

(iii) Explain the difference in the values calculated in **(b)(i)** and **(b)(ii)**.

....

.... [1]

(c) A compression spring of spring constant 1.0 N cm^{-1} is used to launch a 10 g ball at an angle of 45° as shown in Fig. 7.1.

The ball leaves the spring when the spring is fully extended and the spring is adjusted such that ball always leaves the spring at 8.0 cm above the table.

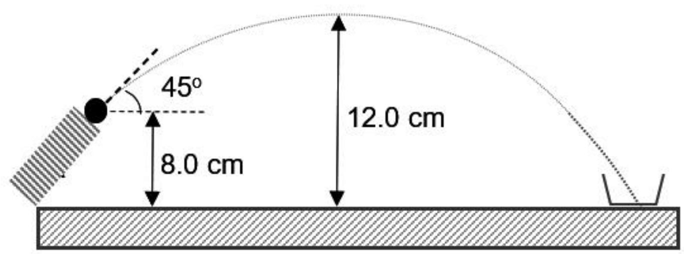

Fig. 7.1

Show that the initial compression of the spring is 1.25 cm if the maximum height reached by the ball is 12.0 cm above the table.

[4]

(d) In a nuclear reactor, a fast moving neutron with initial speed u_1 makes a *head-on elastic* collision with a stationary nucleus of carbon-12. The speeds of the neutron and the carbon nucleus after the collision are v_1 and v_2 respectively as shown in Fig. 7.2.

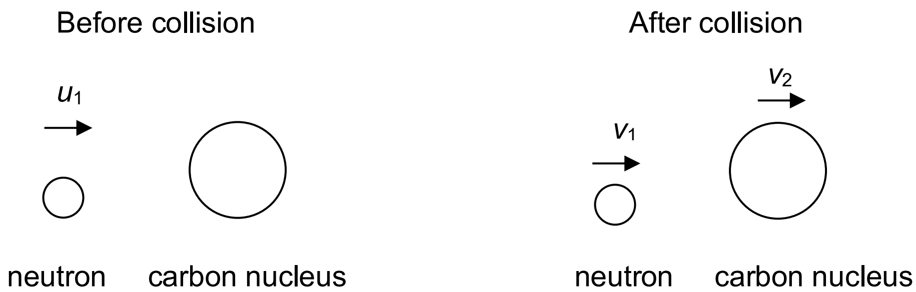

Fig 7.2

(i) Explain what is meant by *head-on* and *elastic*.

head-on ....

....

elastic ....

.... [2]

(ii) In an elastic collision, the relative speed of separation is equal to the relative speed of approach.

Write an equation relating the velocities u_1, v_1 and v_2 to illustrate this fact.

.... [1]

(iii) For this collision, determine the ratio of the speeds $\dfrac{v_1}{u_1}$ of the neutron.

$$\frac{v_1}{u_1} = \text{..................................} \quad [3]$$

(iv) Hence determine the fraction of the kinetic energy of the neutron that is transferred to the carbon nucleus.

fraction = ... [2]

(v) If the *head-on elastic* collision is with a stationary neutron instead of carbon-12, how would the answers in part **(d)(iii)** and **(d)(iv)** be different? In your explanation, state the new ratio of the speeds and the new fraction of the kinetic energy transferred.

....

....

....

....

....

....

.... [2]

[Total: 20]