3 A bow works by storing potential energy in its bent limbs when the bowstring is pulled back, and then converting that potential energy into kinetic energy when the string is released, propelling the arrow forward. Two types of bows, the recurve bow and compound bow are shown in Fig. 3.1.

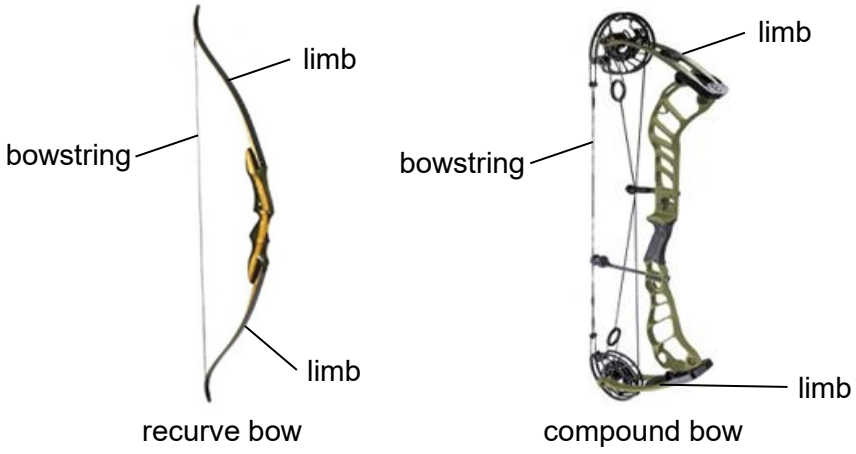

Fig. 3.1

The draw *d* refers to the distance a bowstring is pulled back. Fig. 3.2 shows the variation with *d* of the force *F* required to pull the bowstring of a recurve bow and a compound bow. The maximum draw of both bows is 0.60 m.

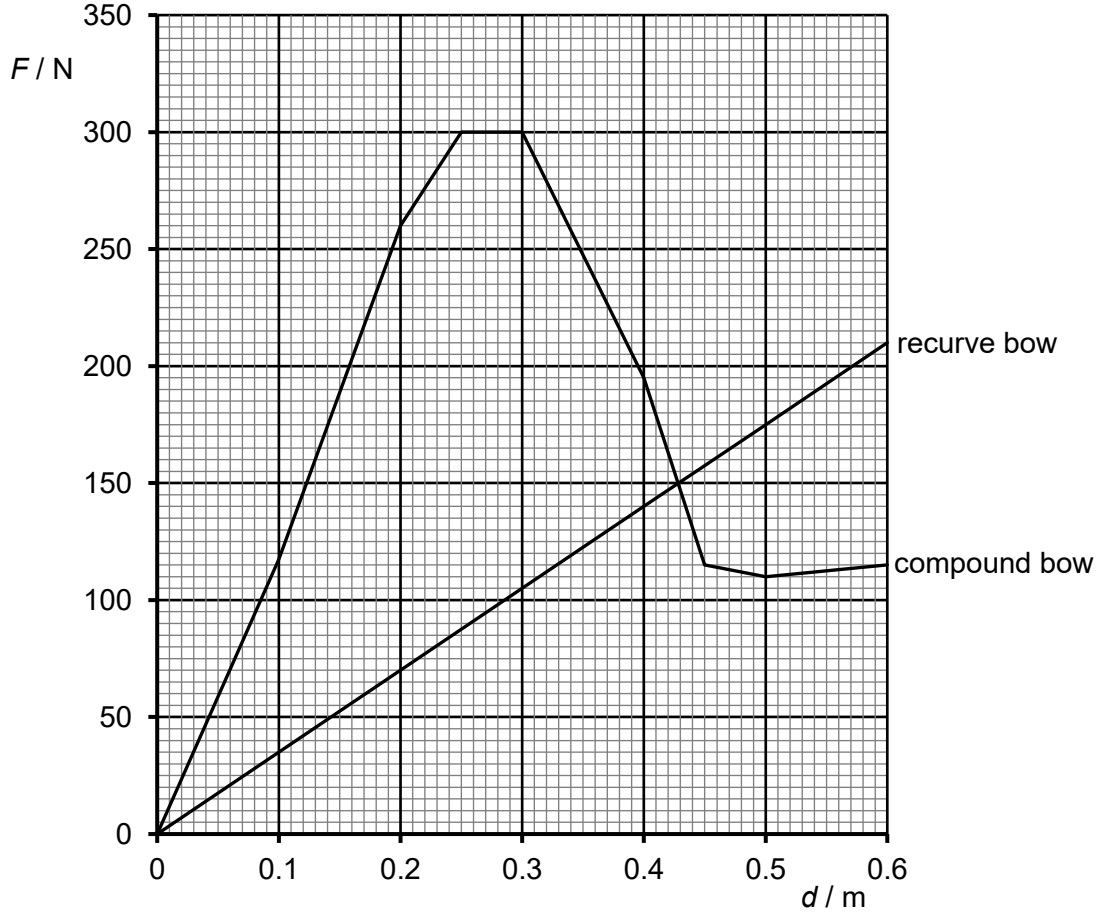

Fig. 3.2

(a) An arrow of mass 32 g is shot from the recurve bow when bow is at maximum draw of d = 0.60 m.

(i) Use Fig. 3.2 to determine the speed of the arrow as it leaves the recurve bow.

State any assumption made.

speed = ... m s^{-1} [3]

(ii) Use Fig. 3.2 to explain an advantage of the compound bow over the recurve bow at maximum draw.

.....

..... [1]

(b) Explain why the bowstring of any fully drawn bow should not be released without an arrow.

.....

..... [1]

(c) An archer is at a distance of less than 50 m away from a tree as shown in Fig. 3.3.

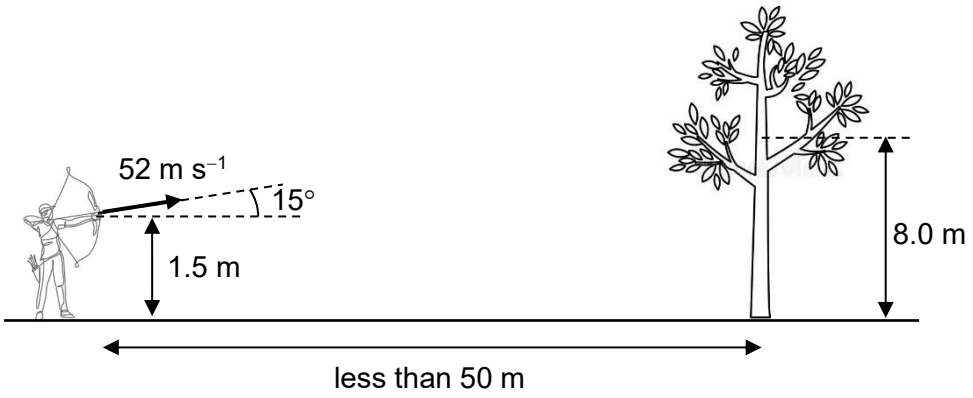

Fig. 3.3

The archer fires an arrow with a speed of 52 m s^{-1} at an angle of 15° above the horizontal from a height of 1.5 m above the ground. The arrow hits the tree at a height of 8.0 m above the ground. The mass of the arrow is 32 g.

The length of the arrow and air resistance are negligible.

(i) Determine the kinetic energy of the arrow just before it hits the tree.

kinetic energy = ... J [2]

(ii) Calculate the distance of the tree from the archer.

distance = ... m [3]

[Total: 10]