2 **(a)** State Newton's second law of motion.

.....

..... [1]

(b) A delivery company suggests using a remote-controlled aircraft to drop a parcel into the garden of a customer. When the aircraft is vertically above point P on the ground, it releases the parcel with a velocity that is horizontal and of magnitude $5.4\,m\,s^{-1}$. The path of the parcel is shown in Fig. 2.1.

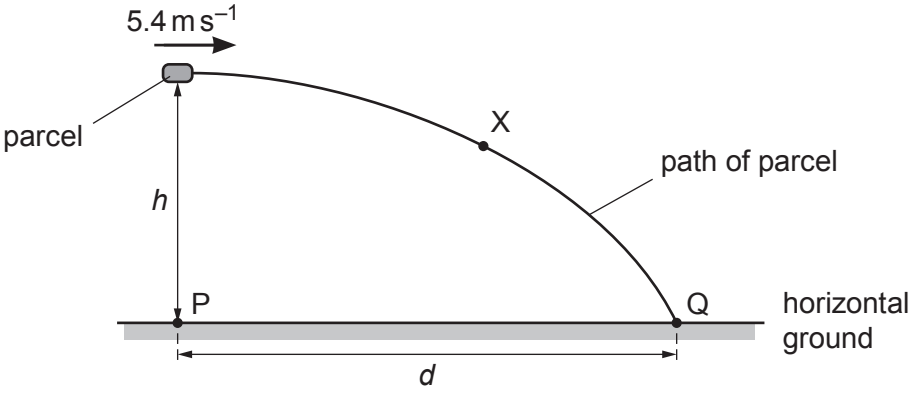

Fig. 2.1 (not to scale)

The parcel takes a time of 0.81 s after its release to reach point Q on the horizontal ground. Assume air resistance is negligible.

(i) On Fig. 2.1, draw an arrow from point X to show the direction of the acceleration of the parcel when it is at that point. [1]

(ii) Determine the height *h* of the parcel above the ground when it is released.

h = ... m [2]

(iii) Calculate the horizontal distance *d* between points P and Q.

d = ... m [1]

(c) Another parcel is accidentally released from rest by a different aircraft when it is hovering at a great height above the ground. Air resistance is now significant.

(i) On Fig. 2.2, draw arrows to show the directions of the forces acting on the parcel as it falls vertically downwards. Label each arrow with the name of the force.

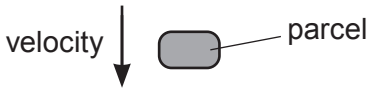

Fig. 2.2

[2]

(ii) By considering the forces acting on the parcel, state and explain the variation, if any, of the acceleration of the parcel as it moves downwards before it reaches constant (terminal) speed.

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..... [3]

(iii) Describe the energy conversion that occurs when the parcel is falling through the air at constant (terminal) speed.

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..... [1]

[Total: 11]