2 A steel bolt of mass 200 g, initially at rest, slides down a hemispherical dome from A to B as shown in Fig 2.1. The surface of the dome is smooth.

The steel bolt loses contact with the surface of the dome at point B, which is 10 m vertically below the top of the dome.

From B to C, the steel bolt continues to fall through the air and hits the ground at point C at a horizontal distance of *x* from B. The radius of the dome is 30 m. Assume air resistance is negligible.

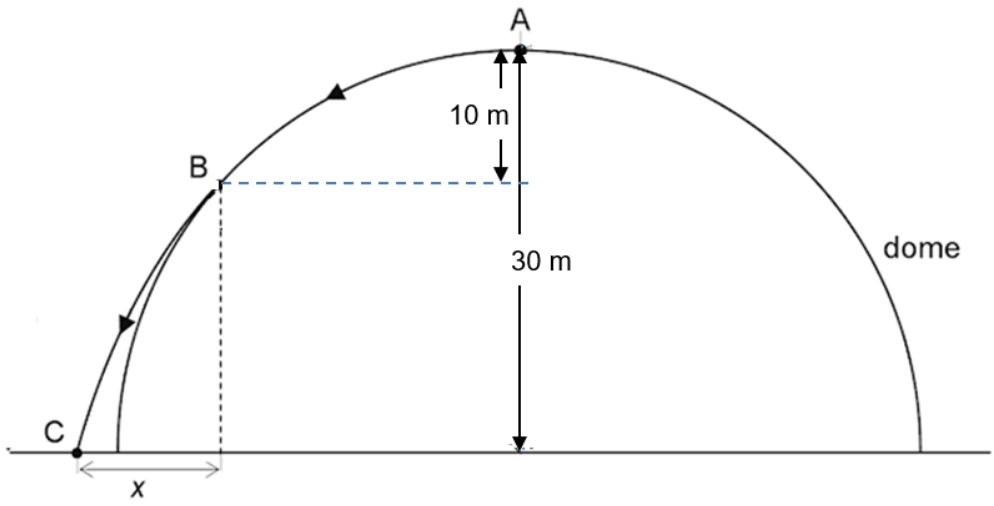

Fig. 2.1

(a) Using energy considerations, show that the velocity of the steel bolt at B is 14 m s^{-1} at an angle of 48.2° below the horizontal.

[2]

(b) **(i)** With reference to the forces acting on the bolt, state and explain the path taken by the steel bolt from B to C.

.....

.....

..... [2]

(ii) Calculate the time taken for the bolt to fall to the ground from B to C,

time taken = ... s [2]

(c) Fig. 2.2 shows the variation with time of the vertical component of acceleration of the bolt a_y from point A to point B. Complete the sketch to show the variation of vertical component acceleration a_y of the bolt with time from point B to C.

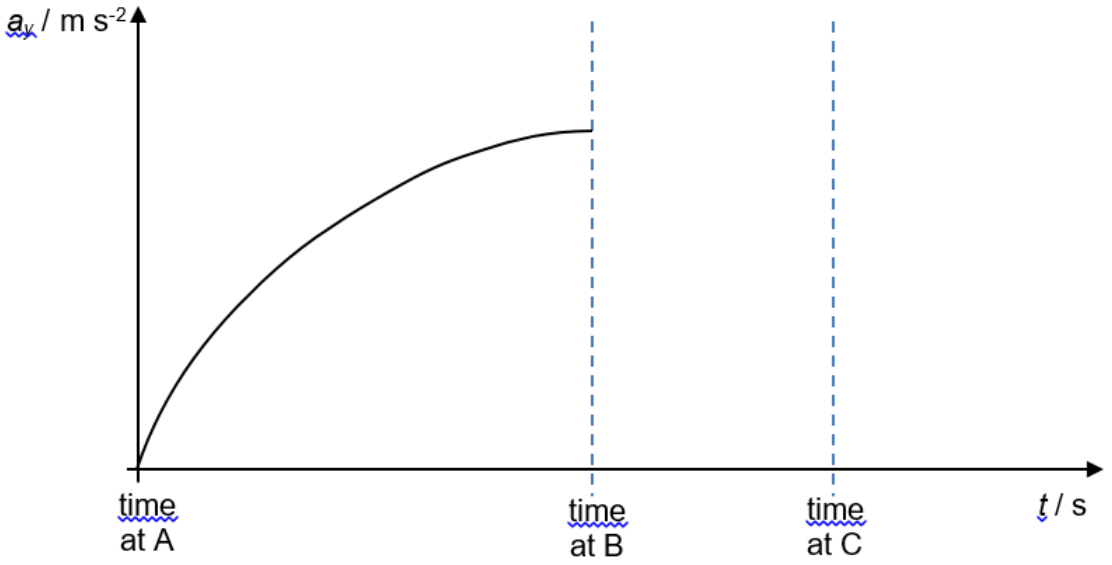

Fig. 2.2

[1]

(d) On Fig.2.3, sketch the variation with time of the vertical component of the velocity v_y of the steel bolt from point A to point C.

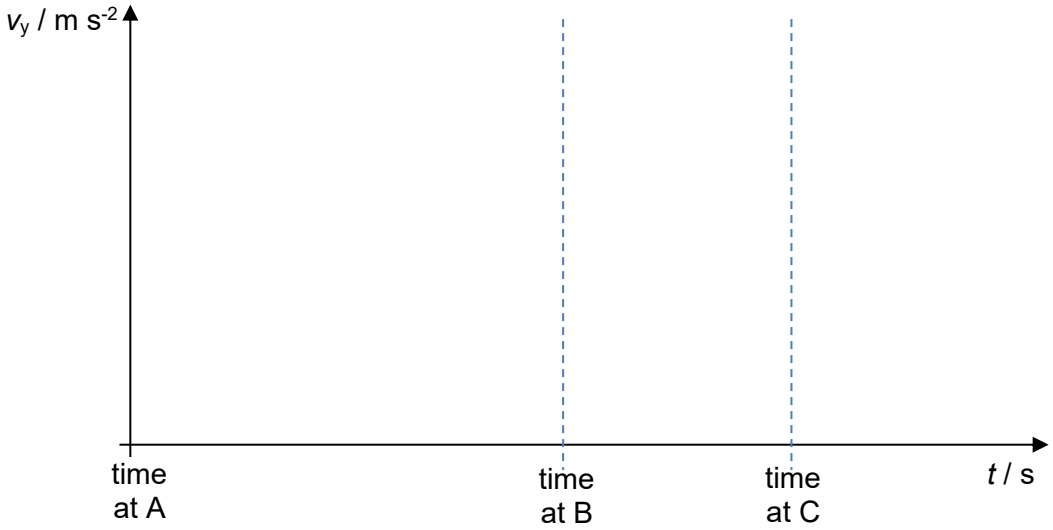

Fig. 2.3

[2]