This question is about kinematics.

1a. State the difference between average speed and instantaneous speed. [2 marks]
The graph shows how the acceleration $a$ of a particle varies with time $t$. At time $t = 0$ the instantaneous speed of the particle is zero.

(i) Calculate the instantaneous speed of the particle at $t = 7.5$ s.

(ii) Using the axes below, sketch a graph to show how the instantaneous speed $v$ of the particle varies with $t$. 
Part 2 Projectile motion

A ball is projected horizontally at 5.0 ms\(^{-1}\) from a vertical cliff of height 110 m. Assume that air resistance is negligible and use \(g = 10\) ms\(^{-2}\).

2a. \[3\text{ marks}\]

(i) State the magnitude of the horizontal component of acceleration of the ball after it leaves the cliff.

(ii) On the axes below, sketch graphs to show how the horizontal and vertical components of the velocity of the ball, \(v_x\) and \(v_y\), change with time \(t\) until just before the ball hits the ground. It is not necessary to calculate any values.

![Graphs showing horizontal and vertical components of velocity](image)

2b. \[4\text{ marks}\]

(i) Calculate the time taken for the ball to reach the ground.

(ii) Calculate the horizontal distance travelled by the ball until just before it reaches the ground.
2c. Another projectile is launched at an angle to the ground. In the absence of air resistance it follows the parabolic path shown below. [3 marks]

On the diagram above, sketch the path that the projectile would follow if air resistance were not negligible.

This question is in two parts. Part 1 is about kinematics and gravitation. Part 2 is about radioactivity.

Part 1 Kinematics and gravitation

A ball is released near the surface of the Moon at time \( t = 0 \). The point of release is on a straight line between the centre of Earth and the centre of the Moon. The graph below shows the variation with time \( t \) of the displacement \( s \) of the ball from the point of release.

3a. State the significance of the negative values of \( s \). [1 mark]

3b. Use the graph to [6 marks]

(i) estimate the velocity of the ball at \( t = 0.80 \) s.

(ii) calculate a value for the acceleration of free fall close to the surface of the Moon.
3c. Calculate the speed of an identical ball when it falls 3.0 m from rest close to the surface of Earth. Ignore air resistance. [1 mark]

3d. Sketch, on the graph, the variation with time \( t \) of the displacement \( s \) from the point of release of the ball when the ball is dropped close to the surface of Earth. (For this sketch take the direction towards the Earth as being negative.) [3 marks]