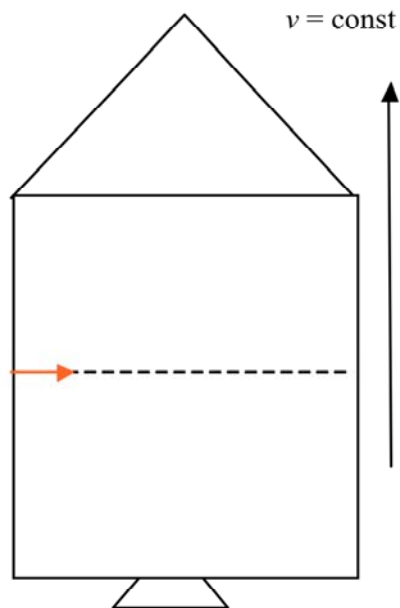


**Support Worksheet – Option H, Worksheet 3**

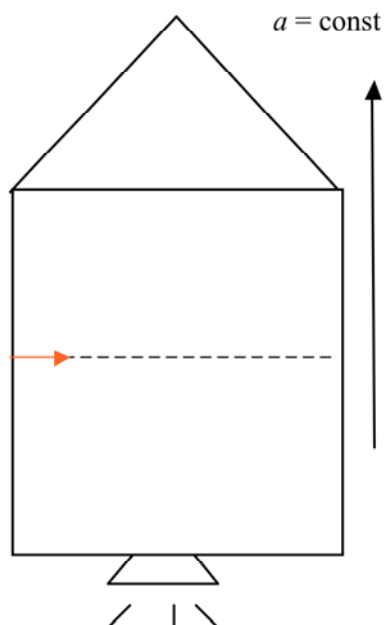
- 1 The diagram shows a rocket moving at constant velocity in outer space.



A ray of light, initially moving parallel to the rocket floor, is emitted from a point on the rocket's left wall. Show the path of the ray according to an observer inside the rocket.

[1]

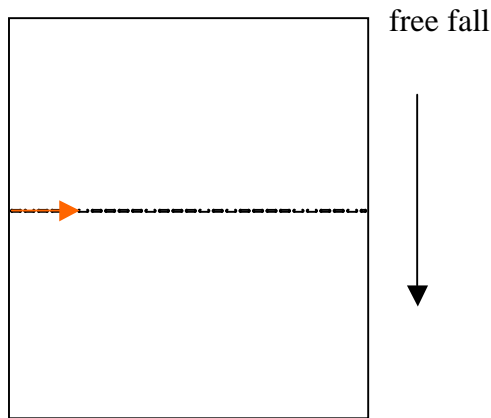
- 2 The diagram shows a rocket moving at constant acceleration in outer space.



A ray of light, initially moving parallel to the rocket floor, is emitted from a point on the rocket's left wall. Show the path of the ray according to an observer inside the rocket.

[1]

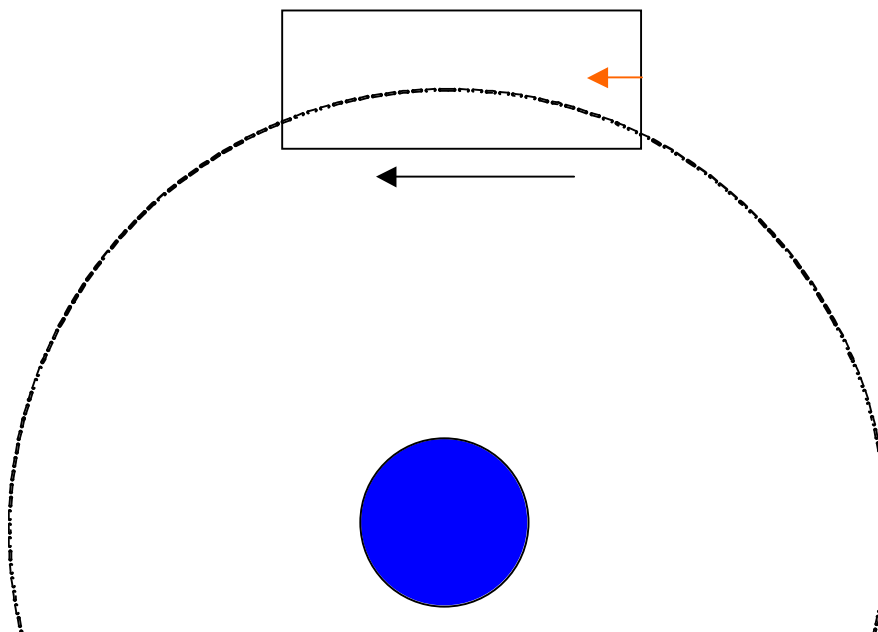
- 3 The diagram shows a box falling freely towards the surface of a planet.



A ray of light, initially moving parallel to the box's floor, is emitted from a point on the box's left wall. Show the path of the ray according to an observer inside the box.

[1]

- 4 The diagram shows a box in a circular orbit around a planet.



A ray of light, initially moving parallel to the box's floor, is emitted from a point on the box's right wall. Show the path of the ray according to an observer inside the box.

[1]

- 5 State what is meant by:

**a** spacetime

[1]

**b** geodesic path.

[1]



- 6** Explain how Einstein would describe the motion of a ray of light passing near the Sun. [3]
- 7** Explain how Einstein would describe the motion of a planet around the Sun. [2]
- 8** Calculate the Schwarzschild radius of a black hole of mass  $4.0 \times 10^{36}$  kg. [1]
- 9** Explain why the Schwarzschild radius of a black hole is likely to increase with time. [2]
- 10** Light of frequency  $4.0 \times 10^{14}$  Hz is emitted from the base of a tower of height 58 m. The frequency of the light is measured at the top of the tower. Calculate the change in the frequency of light at the top of the tower. [2]
- 11** A clock is placed at a distance of  $1.5R_s$  from the centre of a black hole, where  $R_s$  is the Schwarzschild radius of the hole. The time interval between two events according to this clock is 5.0 s. Calculate the time interval between the same two events according to a clock very far from the black hole. [2]