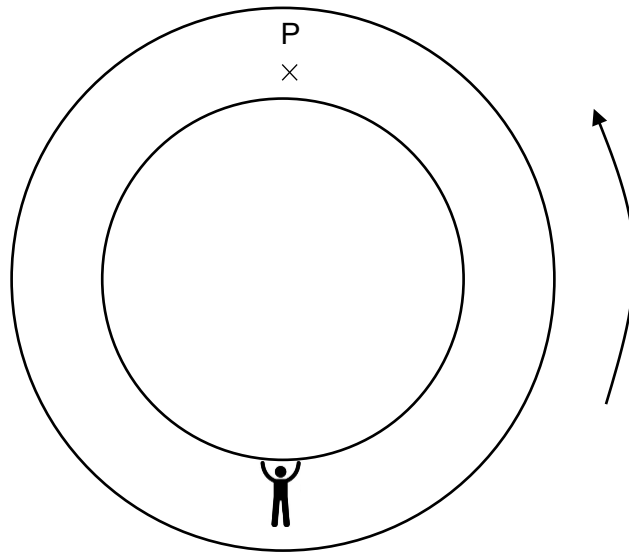


- 2 In the design of space stations, one way to let the astronauts inside stand upright as if they are on Earth would be to spin a ring about an axis through its centre, as shown in **Fig. 2.1**.



**Fig. 2.1**

An astronaut inside the station, who was initially floating weightlessly, grabs hold of the “ceiling” when the space station first starts to spin gradually from rest, as shown in **Fig. 2.1**. Assume that the space station is far away from any massive celestial bodies.

- (a) Draw an arrow in **Fig. 2.1** to show the direction of the force that the astronaut experiences as the space station is *accelerating* to its final rotational speed. [1]

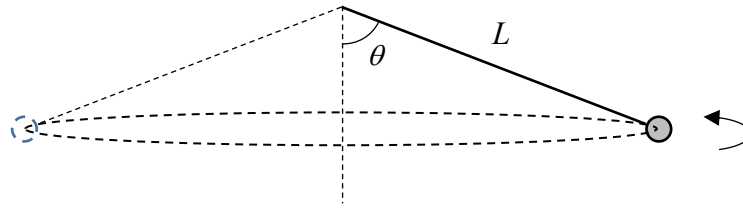
- (b) Explain your answer to (a).

.....  
 .....  
 .....  
 ..... [2]

After the station has reached a constant angular speed, the astronaut, who is at point P in **Fig. 2.1**, releases his hold on the “ceiling”.

- (c) On **Fig. 2.1**, draw the trajectory that the astronaut will follow at the instant he releases his hold at point P. [1]

The astronaut is now able to stand upright like on Earth (see **Fig. 2.3**). However, he feels that his weight is different from that on Earth. He proceeds to perform an experiment in which he swings a bob attached to a light inextensible string so that it performs uniform circular motion in a plane that appears horizontal to him (see **Fig. 2.2**).



**Fig. 2.2**

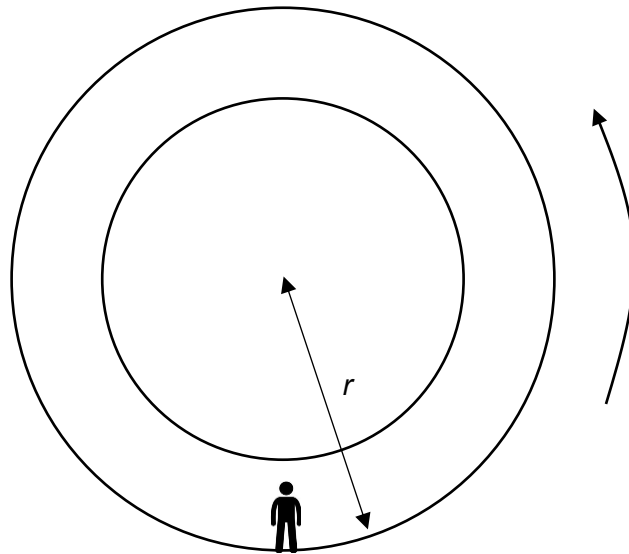
The length  $L$  of the string is 95.8 cm and the period of the circular motion is 1.185 s. The angle  $\theta$  between the string and the vertical is  $65.2^\circ$ .

The rotational motion of the station causes the astronaut to undergo an acceleration  $g$  towards the rotational axis of the station. This acceleration gives him the impression that he is experiencing weight.

**(d)** Determine the acceleration  $g$  experienced by the astronaut due to the station's rotation.

$$g = \dots\dots\dots \text{ m s}^{-2} [4]$$

By looking at the stars outside of the space station as it spins, the astronaut measures the period of rotation of the station to be 14.2 s.



**Fig. 2.3**

- (e) Determine the distance  $r$  between the axis of rotation of the station and the “floor” on which the astronaut stands, as shown in **Fig. 2.3**.

$$r = \dots\dots\dots \text{m} [2]$$

