2 At Luna Amusement Park in Sydney, Australia, the Rotor and Big Dipper Rollercoaster are the most exciting rides.

(a) The popular Rotor ride consists of a large vertical cylinder of radius *R*, which spins about its axis so quickly that any person standing inside is held against the wall when the floor drops away. The passengers maintain horizontal circular motion at constant speed within the cylinder. The normal contact force *N* acting on each passenger is related to the frictional force *f* on the passenger by a constant μ as given by the expression $f = \mu N$.

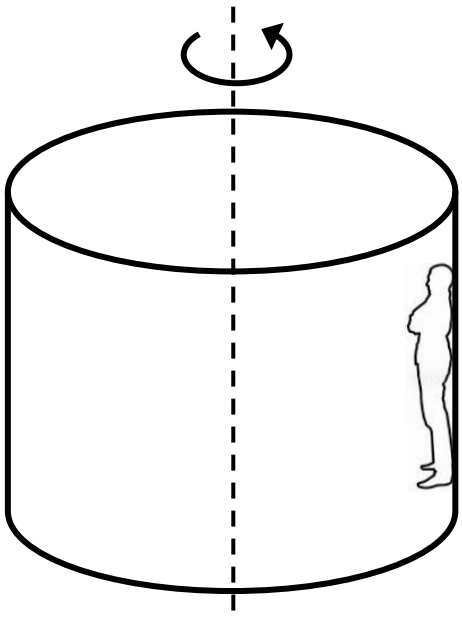

Fig. 2.1

(i) Draw and label, on Fig. 2.1, the forces acting on the passenger. [1]

(ii) Show that the linear velocity *v* at which the passenger must rotate is independent of his mass, *m*.

[3]

(b) The cart on the exhilarating Big Dipper Rollercoaster moves with negligible friction along the track as shown in Fig 2.2. The cart travels with an initial speed v_o of 25 m s^{-1} at the top of one hill, of height h, before reaching the top of a second hill, which forms a circular arc of radius 95 m.

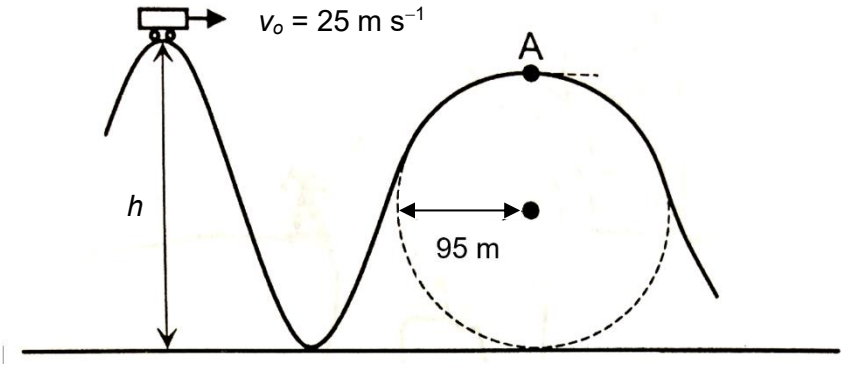

Fig. 2.2

(i) Calculate the maximum speed at which the cart can travel without leaving the track at the top of the second hill at point A.

maximum speed = …….m s^{-1} [2]

(ii) Hence, determine the maximum *h* for the condition in **(b)(i)** to hold.

maximum h = …….m [2]

(iii) The engineers want to modify the ride to allow the cart to move at a speed that is larger than that in **(b)(i)** without leaving the track at point A, for the same track radius. This can be done by designing the wheels to grip the track as shown in Fig. 2.3.

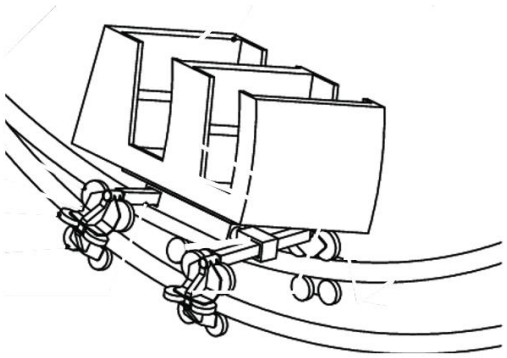

Fig. 2.3

By making reference to the centripetal force, explain how this design would allow the maximum speed in **(b)(i)** to be increased.

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……[2]

[Total: 10]