Vertical Circles solutions

1. Jet plane

1890 km/hr = 525 m/s (convert) ac = v2/r = 5352/6000 = 45.9 m/s/s

ΣF = mac = mv2/r= FN – mg ; Fn = mv2/r+ mg =

FN = (80)(45.9) + 80)(9.8) = 4456 N

1. Ball on string

ΣFtop = mac = mg + FT; FT = mv2/r– mg = (0.3)(4)2/0.72 – 0.3(9.8)

T = 6.67 – 2.94 = 3.73 N

ΣFbot = mac = FT – mg; FT = mv2/r + mg = 6.67 + 2.94 = 9.61 N

1. String will break. Max tension will be at bottom

ΣFbot = mac = mv2/r = FT – mg; v = [(r/m)( FT – mg)]1/2

v = [(0.75m/0.45m)(75 – 4.4)]1/2 = (117.6)1/2 = 10.9 m/s

1. Ball on string

ΣFtop = mac = mg + FT; = mv2/r– mg =

T =(0.4kg)(3.5 m/s)2/0.45m – 0.4(9.8) = 10.9 – 3.92 = 6.98 N

ΣFbot = mac = FT – mg; FT = mv2/r + mg = 10.9 + 3.92 = 14.8 N

1. Minimum coaster speed

ΣF = mv2/r = FN + mg and set FN = 0 to get

mv2/r = mg so v = (gr)1/2 = 8.5 m/s

1. Tension at top and bottom

ΣFtop = mac = mg + FT; = mv2/r– mg =

T =(0.150kg)(4.5 m/s)2/0.95m – (0.150kg)(9.8) = 3.20 – 1.47 = 1.73 N

ΣFbot = mac = FT – mg; FT = mv2/r + mg = 3.20 + 1.47 = 4.67 N

1. Ferris wheel v = 2πr/T = 6.28 (7.2m)/28 s = 1.61 m/s

ΣFtop = mv2/r = mg – FN; FN = mg – mv2/r

FN = 55kg(9.8) – 55(1.61 m/s)2/7.2 m) = 539 – 19.8 = 519.2 N

ΣFbot = mv2/r = FN – mg ; FN = mv2/r+ mg = 539 + 19.8 = 558.8 N

1. Car over hill

ΣFtop = mv2/r = mg – FN; FN = mg – mv2/r;

FN = (67kg)(9.8 N/kg) – 67(12)2/35m = 656 – 276 = 380 N

1. Jill swings on rope

ΣFbot = mac = FT – mg; FT = mv2/r + mg =

FT = 61kg (2.4m/s)2/6.5 m + 61kg (9.8N/kg) = 54 + 597.8 = 652 N

1. Roller coaster speed to feel weightless

ΣF = mv2/r = FN + mg and set FN = 0 to get

mv2/r = mg so v = (gr)1/2 = [(15 m)(9.8 N/kg)]1/2 = 12.1 m/s

1. Car in a dip

ΣFbot = mv2/r = FN – mg ; FN = m(v2/r+ g) = m(172/65 + 9.8) = 14.2m

1. Motorcycle

ΣFtop = mv2/r = mg – FN set FN = 0 & (gr)1/2 = v max = 21m/s