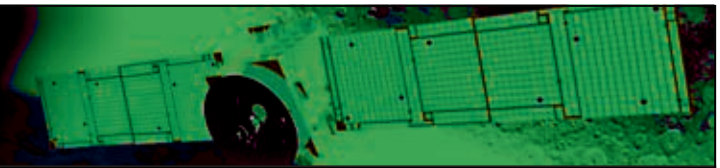
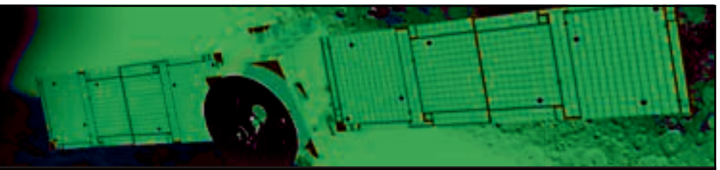


Motion and Forces in a Gravitational Field: Set 3

Set	Problem	Solution
3	1	When he is facing due south. The velocity of the hammer is the tangent to the circle at any point on the circle. When he is facing due south the tangent is a horizontal line westerly (assuming that the hammer thrower is rotating clockwise N to S).
	2	It allows him to run the curve at high speed, by leaning he uses the frictional force to provide the centripetal force.
	3	The friction between the wheels and the surface
	4	
	5	$a = \frac{v^2}{r} = \frac{(3.5m\,s^{-1})^2}{15m}$ 0.82 m s^{-2} toward the centre of the circle
	6	$F = \frac{mv^2}{r} = \frac{0.585\,kg \times {11.5m\,s^{-1}}^2}{1.25m}$ F = 61.9 N
	7a	$v = \frac{2\pi r}{t} = \frac{2\pi \times 3.80m}{15.5s}$ v =1.54 m s^{-2}
	7b	$F = \frac{mv^2}{r} = \frac{28\ kg \times {1.54\ m\,s^{-1}}^2}{3.8\ m}$ 17.5 N
	8	110 km h^{-1} = 30.6 m s^{-1} For banked tracks $\tan\varphi = \frac{v^2}{rg}$ $\tan\varphi = \frac{{30.6\ ms^{-1}}^2}{300m \times 9{,}8\ ms^{-2}}$ φ= 17.6°
	9a	sin θ = 2.5/4 θ = 38.7° $T = \frac{mg}{cos\theta} = \frac{55kg \times 9.8ms^{-1}}{\cos 38.7^o}$ 691 N
	9b	Centripetal force = T sin θ = 691×sin 38.7° = 432N Combine $F = \frac{mv^2}{r}$ and $v = \frac{2\pi r}{t}$ Leads to $t = \sqrt[2]{\frac{4\pi^2 mr}{F}} = \sqrt[2]{\frac{4\pi^2 \times 55\,kg \times 2.5m}{432\ N}}$ t =3.55 s
	10a	Yes, acceleration is defined as changing velocity – in circular motion although speed may be constant the velocity is changing because the direction is constantly changing so the car is accelerating.
	10b	24.0 km h^{-1} = 6.67 m s^{-1} $F = \frac{mv^2}{r} = \frac{1250\ kg \times {6.67ms^{-1}}^2}{18.0m}$ F =3.09 kN
	10c	$tan\varphi = \frac{v^2}{rg} = \frac{{6.67ms^{-1}}^2}{18m \times 9.8ms^{-1}}$ φ=15.3°
	11	$v = \sqrt{rgtan\varphi} = \sqrt{70.0\ m\ \times 9.8\ ms^{-1} xtan\ 20^o}$=15.8 m s^{-1}
	12a	3800 rpm =63.3rps so time for 1 revolution =0.0158 s Lowest speed at smallest r $v = \frac{2\pi r}{t} = \frac{2\pi \times 0.095\,m}{0.0158\ s}$ v =37.8 m s^{-1}
	12b	Maximum acceleration at biggest v which occurs at biggest r $v = \frac{2\pi r}{t} = \frac{2\pi \times 0.12m}{0.0158\ s}$ v= 47.7 m s^{-1}



Motion and Forces in a Gravitational Field: Set **3**

Set	Problem	Solution
		$a = \frac{v^2}{r} = \frac{47.7ms^{-1^2}}{0.12m}$ a = 1.90 × 10^4 m s^{-2}
	12c	a=F/m =8.2 × 10^{-3}N/98×10^{-12}kg = 8.37×10^7 m s^{-2} $v = \sqrt{ar} = \sqrt{8.37 \times 10^7 m\,s^{-1} \times 0.12m} = 3169\ m\,s^{-1}$ $f = \frac{v}{2\pi r} = \frac{3169\,ms^{-1}}{2\pi \times 0.12}$ f=42kHz (17.7 kHz)
	13a	Arrow towards the centre
	13b	$F = \frac{mv^2}{r} = \frac{1.7 \times 10^{-27} kg \times 7.8 \times 10^6 ms^{-1^2}}{200\ m}$ = 2.59 × 10^{-16} N
	13c	Graph should show that F increases with v^2, so when v changes from 5 to 10, F increases by a factor of 4.
	13d	Distance travelled = number laps × πd = 440,000 × π × 400 m =5.53 × 10^8 m
	13e	In 2.5s vertical displacement s= ½ at^2 = ½ ×-9.8 m s^{-2} ×$2.5s^2$ =-30.6m it would drop 30.6 m
	13f	Magnets to repel protons upwards