

圆周运动、地心引力练习

1. A model car moves round a circular track of radius 0.3m at 2 revolutions per second. 一模型车在半径 0.3m 在一圆形轨道上每秒可以转上 2 圈。
- a. What is the angular velocity, ω ? 求角速度 ω

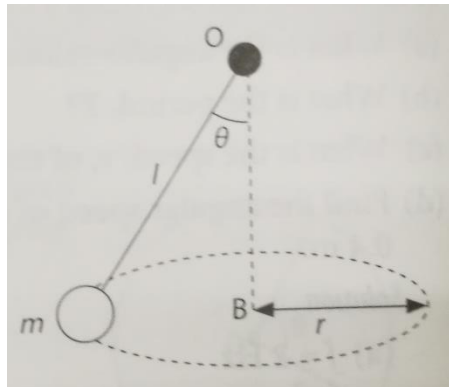
b. What is the period, T? 求周期

c. What is the speed, v , of the car? 汽车的速度 v 是多少

d. Find the angular speed of the car if it moves with a uniform speed of 2ms^{-1} in a circle of radius 0.4m. 如果圆的半径是 0.4m, 一车以均匀速度 2ms^{-1} 移动, 求汽车的角速度

2. When racing cars round an unbanked corner, friction between tyres and the road provides the centripetal force required. In a particular race, Lewis Hamilton is able to navigate round a corner of radius 10m at a maximum speed of 60ms^{-1} . If he next encounters a sharper corner of radius 5m, to what speed he slow down his car in order to turn safely? 一个未筑堤的赛车路弯角, 轮胎与道路之间的摩擦力提供所需的向心力。在特定的比赛中, 刘易斯能够以 60ms^{-1} 的最大速度在半径 10 米的角落安全绕道。如果他接下来遇到半径为 5 米的更锐角, 他可以以什么速度安全绕过?

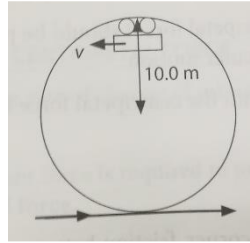
3. A small object of mass m is tied to a string of length l and whirled round in a horizontal circle of radius r , with O fixed directly above the centre B of the circle as shown. 将一个质量为 m 的小物体绑在长度为 l 的弦上，并在半径为 r 的水平圆周上旋转， O 如图所示直接固定在圆的中心 B 的上方。



- a. What determines the angle θ which the string makes with the vertical?
什么决定了弦与垂直线所成的角度 θ ?

- b. If the mass of object is 2.0kg and it spins at a radius of 0.5m and velocity of 2.0ms^{-1} , calculate the tension T in the string. 如果物体的质量是 2.0kg ，并且它以 0.5m 的半径和 2.0ms^{-1} 的速度旋转，则计算弦中的张力 T .

4. Commonly found in roller-coaster rides, passengers “loop-the-loop” in a vertical circle as shown. In one particular loop of radius 10.0m , a passenger of mass 60kg is travelling at 15ms^{-1} at the highest point of the loop. Assume that frictional forces may be neglected. 通常在乘坐过山车的乘客中，乘客在如图所示的垂直圆圈中“回圈”。在一个半径 10.0 米的特定环路中，质量 60kg 的乘客在环路的最高点以 15ms^{-1} 的速度行驶。假设摩擦力可能被忽略。



- a. Calculate the contact force acting on the passenger through the seat at the highest point. 计算在最高点通过座椅作用于乘客的接触力。

- b. Calculate the speed of the passenger after the roller-coaster leaves the loop 计算过山车离开环路后乘客的速度。

- c. Determine the minimum speed required at the top of the loop such that the passenger does not fall off. 求在环路顶部所需的最低速度，以便乘客不会脱落。

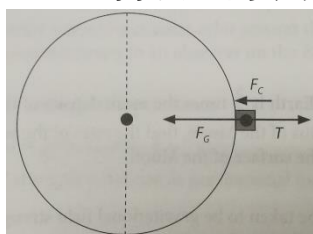
SJUEC.COM

5. Given that the mean density of Earth is $\frac{5}{3}$ times the mean density of the Moon, and that the radius of the Earth is 3.6 times the radius of the Moon, find the ratio of the acceleration of free fall on the surface of the Earth to that on the surface of the Moon. 已知地球的平均密度是月球平均密度的 $\frac{5}{3}$ 倍，并且地球半径是月球半径的 3.6 倍，求地球表面自由落体的加速度和在月球表面的比例。

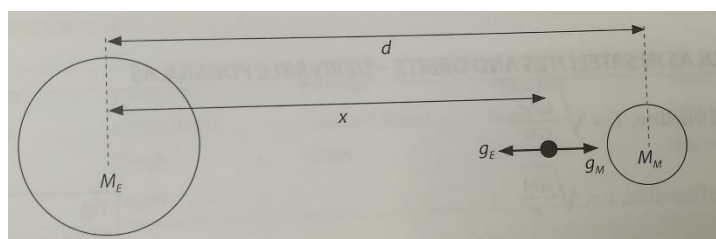
6. The Earth may be considered to be a uniform sphere of radius 6380km, spinning on its axis with a period of 24.0 hours. The gravitational field at the Earth's surface is identical with that of a point mass of 5.98×10^{24} kg at the Earth's centre. For a 1.0kg mass situated at the Equator, 球的半径是 6380 公里的均匀球体，有 24.0

小时的周期旋转。地球表面的引力场相同与地球中心的点质量 $5.98 \times 10^{24} \text{kg}$ 。对于位于赤道的 1.0kg 质量，

- Calculate the gravitational force on the mass 计算质量上的地心引力
- Determine the force required to maintain the circular path of the mass 维持质量进行圆周运动所需的力
- Deduce the reading on a Newton-metre supporting the mass 牛顿计上在支持质量的读数



7. Given that mass of the Earth is $6.0 \times 10^{24} \text{kg}$, the mass of the Moon is $7.4 \times 10^{22} \text{kg}$, and that the distance between their centres of mass is $3.84 \times 10^8 \text{m}$, find 地球的质量是 $6.0 \times 10^{24} \text{kg}$ ，如果月球的质量是 $7.4 \times 10^{22} \text{kg}$ ，质量中心之间的距离是 $3.84 \times 10^8 \text{m}$ ，求



- The distance x from the Earth such that the gravitational field strength due to both bodies is zero 与地球的距离 x 使两个物体引起的引力场强度为零

b. The gravitational potential at this point. 此时的重力势能

8. A meteorite with an initial speed of 2000ms^{-1} falls from Point X, a distance of $1.0 \times 10^7\text{m}$ from the Earth's surface to a Point Y on the Earth's surface before disintegrating. Given that the radius of the Earth is $6.4 \times 10^6\text{m}$ and that the mass of the Earth is $6.0 \times 10^{24}\text{kg}$, find 初始速度为 2000ms^{-1} 的陨石从 X 点落下，在离解之前从地球表面到地球表面的 Y 点 $1.0 \times 10^7\text{m}$ 。地球的半径是 6.4×10^6 米，并且地球的质量是 6.0×10^{24} 公斤，请查找

a. The change in potential between point X and Y 点 X 和 Y 之间的重力势能变化

b. Find the velocity of the meteorite just before it reaches the Earth's surface, assume air resistance is negligible. 陨石在到达地球表面的速度，假设空气阻力可以忽略不计。

SJUEC.COM

9. a. Show all that geostationary satellites orbiting the Earth have the same orbital radius which is independent of the mass of the satellite.

所有围绕地球轨道运行的卫星与卫星质量无关但具有的相同的轨道半径。

b. hence, explain why all geostationary satellites in orbit round the Earth must have the same orbital speed. 解释为什么地球轨道上的所有卫星必须具有相同的轨道速度。

c. For a geostationary satellite, determine 对于地球卫星，求

i. the radius of its orbit 它的轨道半径

ii. its height above the Earth's surface 高于地球表面的高度

iii. its linear speed 其线速度



SJUEC.COM