

Physics CST (2021-22) Homework 2

Please send the completed file to my mailbox yy.lam@qq.com by October 13rd, with using the filename format:

2020xxxxxx_yourname_cst_hw2

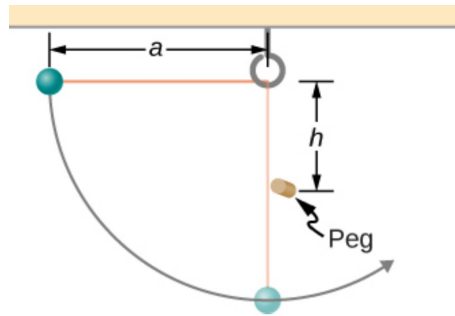
Please answer the questions by filling on these sheets. It would be perfect if you are able to write on the sheets directly (by using a stylus or a pen with the computer software, e.g. Microsoft Edge). If you do not have the appropriate hardware (I mean “pen”), you may handle the questions as usual by using pieces of blank papers, then take the photos and paste onto the blank spaces of these question sheets.

1. Given the distance of the centre to centre distance of Earth and the Moon 3.84×10^5 km, the time interval for a month 27.3 days, (a) find the acceleration due to Earth’s gravity at the distance of the moon. (b) Given the radius of Earth 6370 km, calculate the period of an artificial satellite orbiting at an average altitude of 1800 km above Earth’s surface.

2. A person is located on Earth's surface at a latitude α . Calculate the centripetal acceleration of the person resulting from the rotation of Earth around its polar axis. Express your answer in terms of α , the radius R_E of Earth, and time T for one rotation of Earth. Compare your answer with g for $\alpha = 40^\circ$.
3. A truck is traveling east at 75 kmh^{-1} . At an intersection 32 km ahead, a car is traveling north at 45 kmh^{-1} . (a) How long after this moment will the vehicles be closest to each other? (b) How far apart will they be at that point? (Hint: Write the question in terms of the position vector.)

4. A bird has a mass of 26 g and perches in the middle of a stretched telephone line. (a) Show that the tension in the line can be calculated using the equation $T = \frac{mg}{2 \sin \theta}$. Determine the tension when (b) $\theta = 5^\circ$ and (c) $\theta = 0.5^\circ$. Assume that each half of the line is straight.
5. A hockey puck of mass 0.18 kg is shot across a rough floor with the roughness different at different places, which can be described by a position-dependent coefficient of kinetic friction. For a puck moving along the x -axis the coefficient of kinetic friction is the following function of x , where x is in m: $\mu(x) = 0.1 + 0.06x$. Find the work done by the kinetic friction force on the hockey puck when it has moved (a) from $x = 0$ to $x = 2.2$ m, and (b) from $x = 2.2$ m to $x = 4.5$ m.

6. A small ball of mass m attached to a string of length a . A small peg is located a distance h below the point where the string is supported. If the ball is released when the string is horizontal, show that h must be greater than $3a/5$ if the ball is to swing completely around the peg.



7. If you wish to reduce the stress (which is related to centripetal force) on high-speed tires, would you use large or small diameter tires? Explain with some equations.

8. A body of mass m and negligible size starts from rest and slides down the surface of a frictionless solid sphere of radius R as shown. What is the angle θ while the body leaves the sphere?

