107 學年第一學期 普通物理 B 第一次段考試題

[Wolfson Ch. 5-9]　2018/10/30, *8:20am – 09:50am*

(i)答案卷第一張正面為封面。第一張正、反兩面**不要寫任何答案。**

(ii)依空格號碼順序在第二張**正面**寫下所有填充題答案，不要寫計算過程。

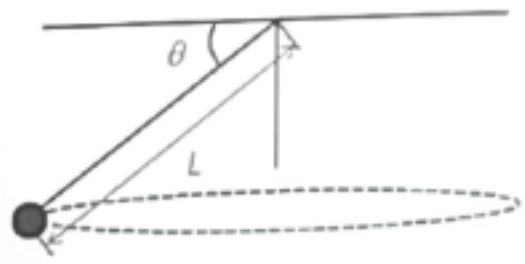
(iii)依計算題之題號順序在第二張**反面**以後寫下演算過程與答案，**每題從新的一頁寫起**。

(iv)根據題目給的參數，**注意答案有效數位。(Please express your answer in significant figures.)**

Universal Constant: Gravitational constant G = $6.67 \times 10^{-11} Nm^2/kg^2$,

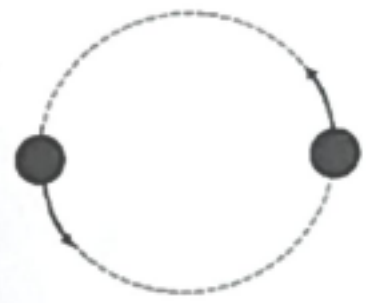
gravitational field on Earth g = 9.81 m/s^2, Mass of Earth: $5.97 \times 10^{24} kg$, Radius of Earth: $6357 km$

Part I. Filling the blank (5 points per blank)



• A ball of mass m whirls around in a horizontal circle at the end of a massless string of length L in right figure. The string makes an angle θ with the horizontal. Find the ball's speed v and the string tension T. v = 【1】; T= 【2】

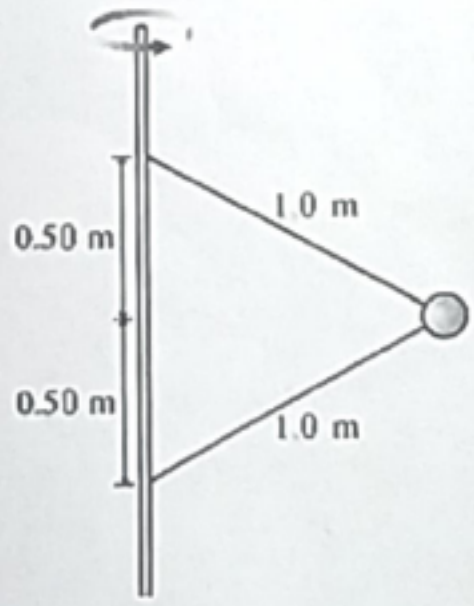
• Workers pushing a 180-kg trunk across a level floor encounter a 10-m-long region where the floor becomes increasingly rough. The coefficient of kinetic friction here is given by $u_k = u_0 + ax^2$, where u_0= *0.17*, a=*0.0062* m^{-2}, and x is the distance from the beginning of the rough region. How much work does it take to push the trunk across the region ? 【3】 kJ.



• Consider two objects with equal mass M orbiting each other, as shown in the right figure. They are separated by a distance d, find out the corresponding orbital period T. T= 【4】.

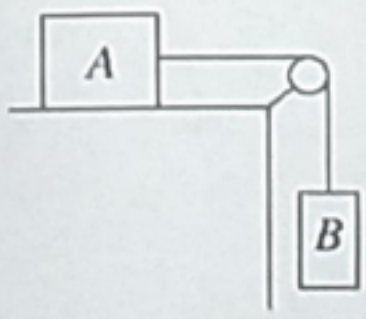
• Ropes used in rock climbing are "springy" so that they cushion a fall. A particular rope exerts a force $F = -kx+bx^2$, where k = 223 N/m, b = 4.10 N/m^2, and x is the stretch. Find the potential energy stored in this rope when it's been stretched 2.62 m, taking $U = 0$ at $x = 0$. 【5】 J

• Consider an elastic head-on collision between a neutron and a deuteron. The neutron has an initial velocity of v and the deuteron is initially at rest. The deuteron is twice more massive than the neutron. Find the fraction of a neutron's kinetic energy that's transferred to an initially stationary deuteron in a head-on elastic collision. 【6】



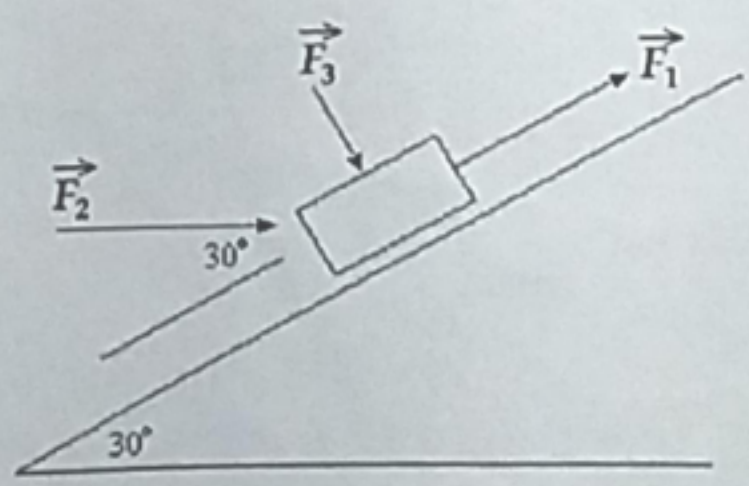
• The figure shows two wires that are tied to a 710 g mass that revolves in a horizontal circle at a constant speed of 7.5 m/s. What is the tension in the upper wire ? 【7】 N

• Two boxes are connected by a weightless cord running over a very light frictionless pulley as shown in the figure. Box A, of mass 8.0 kg, is initially at rest on the top of the table. The coefficient of kinetic friction between box A and the table is 0.10. Box B has a mass of 15.0 kg, and the system begins to move just after it is released. What is the acceleration of box B ? 【8】 m/s^2

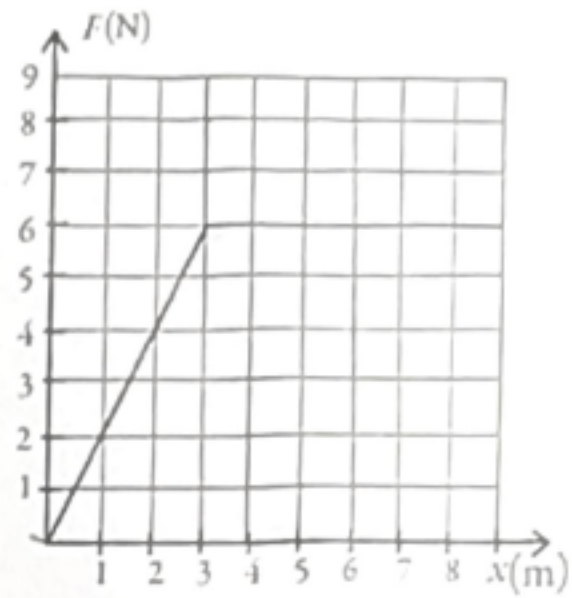


• Jess (mass 53 kg) and Nick (mass 72 kg) sit in a 26-kg kayak at rest on frictionless water. Jess tosses Nick a 17-kg pack, giving it horizontal speed 3.1 m/s relative to the water. What's the kayak's speed v_k while the pack is in the air ? v_k = − 【9】 m/s

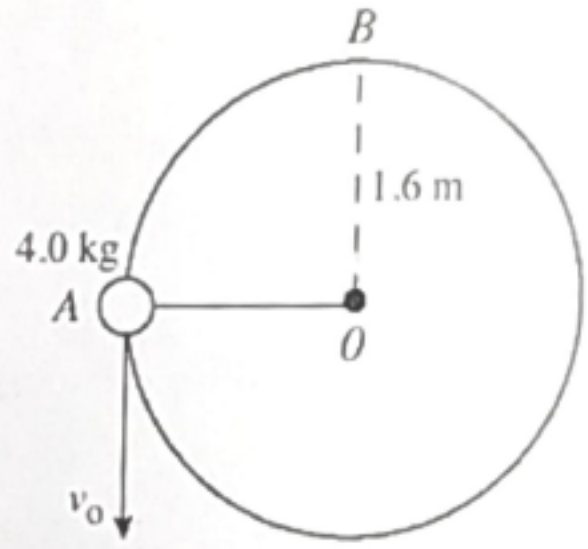
• Three forces, F_1 = 20.0 N, F_2 = 40.0 N, and F_3 = 10.0 N act on an object with a mass of 2.00 kg which can move along a frictionless inclined plane as shown in the figure. The questions refer to the instant when the object has moved through a distance of 0.600 m along the surface of the inclined plane in the upward direction. Calculate the



amount of work W_1, W_2, W_3 = 【10】J, 【11】J, 【12】J , done by F_1, F_2, F_3, respectively.



• A graph of the force on an object as a function of its position is shown in the figure. Determine the amount of work done by this force on an object that moves from x = 1.0 m to x = 6.0 m. (Assume an accuracy of 2 significant figures for the numbers on the graph.) 【13】J



• In the figure, a 4.0-kg ball is on the end of a 1.6-m rope that is fixed at *0*. The ball is held at point *A*, with the rope horizontal, and is given an initial downward velocity. The ball moves through three quarters of a circle with no friction and arrives at *B*, with the rope barely under tension. The initial velocity of the ball, at point *A*, is 【14】m/s

• A 910-kg object is released from rest at an altitude of 1200 km above the north pole of the earth. If we ignore atmospheric friction, with what speed does the object strike the surface of the earth ? 【15】km/s

Part II Problems (10 points per problem)

【1】A lithium-5 nucleus (^{5}Li) is moving at 1.6 Mm/s when it decays into a proton (^{1}H, or p) and an alpha particle (^{4}He, or α). [Superscripts are the total numbers of nucleons and give the approximate masses in unified atomic mass units (u).] The alpha particle is detected moving at 1.4 Mm/s, at 33° to the original velocity of the ^{5}Li nucleus. What are the magnitude and direction of the proton's velocity ?

【2】Materials to construct an 11,000-kg lunar observatory are boosted from Earth to geostationary orbit. There they are assembled and then launched to the Moon, 384,400 km from Earth. Find out the work that must be done against Earth's gravity for the two legs of the trip.

【3】A small hockey puck slides without friction over the icy hill shown in the figure and lands 6.20 m from the foot of the cliff with no air resistance. What was its speed v_0 at the bottom of the hill ?