Name : _____

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SPH4UI Dynamics Unit Test – Apr 2019

Answer the following questions on separate pages and place your final answers in the spaces below. You may use your planetary data sheet and kinematics formula sheet.

Useful formulae and constants:

$$a_c = \frac{v^2}{r} \qquad F_g = \frac{Gm_1m_2}{r^2}$$

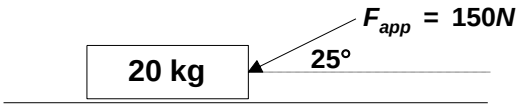
$$circumference = 2\pi r \qquad G=6.67\times10^{-11}\ Nm^2/kg^2$$

*** remember to include proper units in your answers ***

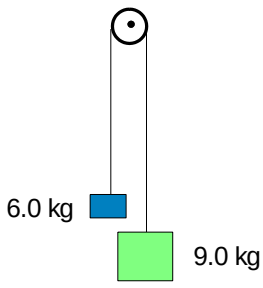
1. _____ /5
2. _____ /4
3. _____ /4
4a. _____ 4b. _____ /5
5a. _____ 5b. _____ /6
6a. _____ /5
7. _____ /3
8a. _____ 8b. _____ /4

/5 1. A toboggan and rider have a combined mass of 75.0kg. The toboggan is sliding down a hill that has an angle of elevation of 37.0° and the coefficient of kinetic friction is 0.270.
   a. Calculate the acceleration of the toboggan down the hill.
   b. Assuming the toboggan starts from rest, how fast will it be going if it slides 11.0m down the hill?

/4 2. A block is being pushed across a flat horizontal surface by an applied force as shown to the right. The coefficient of static friction with the ground is 0.50 and the coefficient of kinetic friction with the ground is 0.35. Will the block move (show your work) and if it does what is the acceleration of the block (assume 2 significant digits in all numbers)?



/4 3. An Atwood machine as shown in the diagram to the right is released and allowed to move. What is the acceleration of the system and the tension in the rope?



/5 4. To train to be fighter pilots, men and women sit in a centrifuge and are spun in a ***horizontal*** circle to simulate 'g' forces. The requirement is to experience 6.0 g's for a minimum of 15 seconds while spinning. The arms of the centrifuge are 9.0m long.

a. At what velocity must the centrifuge spin in order to simulate 6.0 g's?

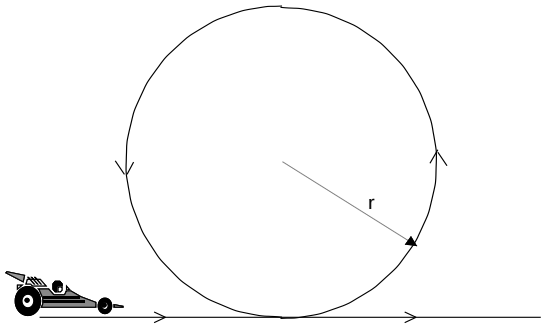
b. What net force would an 85kg pilot feel in this centrifuge?

/6 5. One of Jupiter's moons called Europa, is observed to have a radius of orbit around Jupiter of 6.71×10^8m. Europa takes 3.546 earth days to make one orbit around Jupiter.

a. Calculate the mass of Jupiter (show your calculations).

b. Predict the time it would take another one of its moons, Thebe, to make one orbit around Jupiter if the radius of its orbit is 2.22×10^8m.

/5 6. A roller coaster is travelling at a constant speed of 90km/hr and enters a vertical loop-de-loop as shown to the right. What is the minimum radius of curvature of the loop to ensure the 'g' forces remain below 3.5 in total? (assume 2 significant figures in your answer).



/3 7. A 2500kg car is driving around a circular corner that has a radius of 33m. The coefficients of friction are μ_s=0.80 and μ_k=0.60. What is the maximum speed the car can be travelling to drive around this corner without sliding?

/4 8. The following formula can be used to calculate the maximum speed on a banked corner:

$$Vmax = \sqrt{\frac{rg(sin\theta + \mu_s cos\theta)}{(cos\theta - \mu_s sin\theta)}}$$

a. Calculate the maximum speed of a car on a banked corner, given the following parameters (assume 2 significant figures in your answer).

m=2,500kg, r = 35m, Θ=24°, μ_k=0.70, μ_s=0.90,

a. If you wanted to maintain the same speed as in part a, but now the track was icy and there was zero friction (i.e. μ=0), what is the minimum radius the turn could have (assuming the same angle on the banked corner).