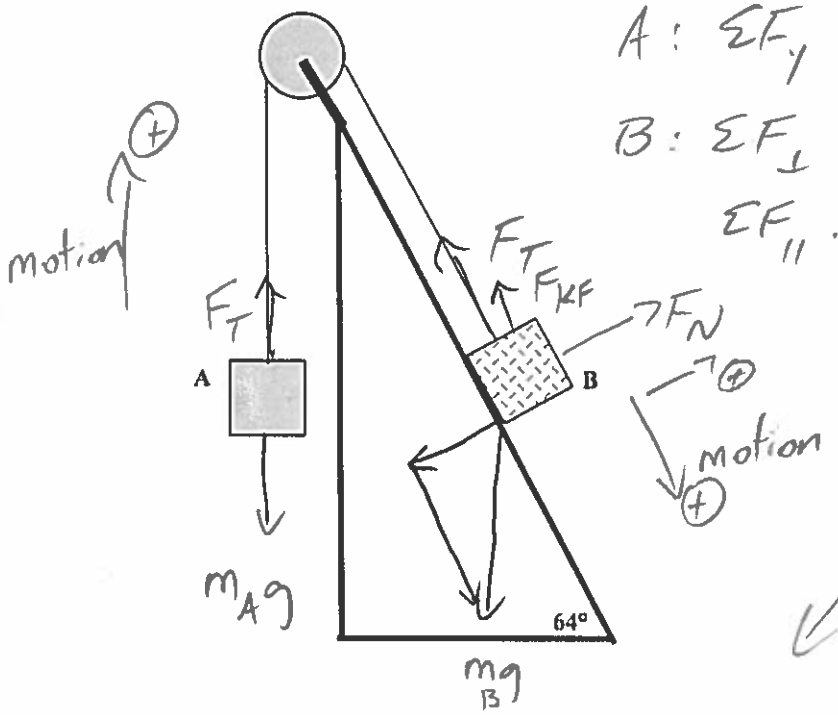
Physics 10154 - Exam #2C

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

$m_B g \sin 64° > m_A g \Rightarrow$ block B slides down

1. (35 pts) Two masses (A = 7.5 kg, B = 12 kg) are connected by a thin string draped over a pulley as shown below. If the coefficient of kinetic friction between block B and the incline is 0.22, what is (a) the tension in the rope and (b) the magnitude and direction of the acceleration of block B?



A: ΣF_y: $F_T - m_A g = m_A a$

B: $\Sigma F_\perp$: $F_N - m_B g \cos 64° = 0$

$\Sigma F_{||}$: $m_B g \sin 64°$

$-F_T - \mu_k F_N = m_B a$

$F_T - m_A g = m_A a$

$m_B g \sin 64° - F_T - \mu_k m_B g \cos 64° = m_B a$

$m_B g \sin 64° - \mu_k m_B g \cos 64° - m_A g = (m_A + m_B) a$

$105.70 - 11.34 - 73.5 = 19.5\, a$

$a = 1.01\ m/s^2$, down ramp

$F_T = m_A g + m_A a = (7.5)(10.87) = 82\ N$

2. (30 pts) The distance between the centers of the Earth and Moon is approximately 240,000 miles (about 61 Earth radii). The mass of the Earth is 81 times larger than the mass of the Moon. At what point, as measured from the center of the Earth, does the gravitational force exerted on a spacecraft by the Earth balance that exerted by the moon? Answer in Earth radii.

$$\frac{G M_E m}{r_E^2} = \frac{G M_m m}{r_m^2}$$

$$r_E + r_m = 3.86 \times 10^8 \text{ m}$$

$$\frac{M_E}{M_m} = \frac{r_E^2}{r_m^2}$$

$$81 = \frac{r_E^2}{(3.86 \times 10^8 - r_E)^2}$$

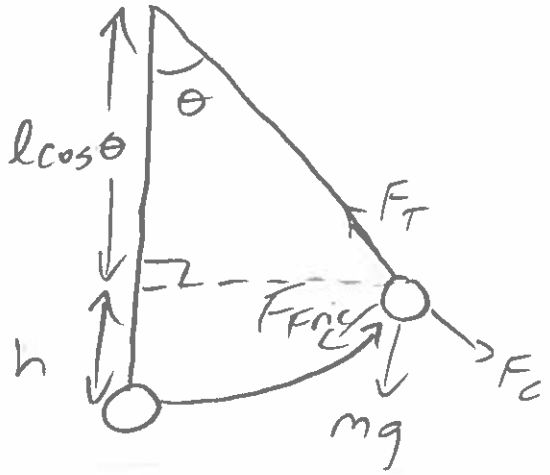
$$9 = \frac{r_E}{3.86 \times 10^8 - r_E}$$

$$3.475 \times 10^9 - 9 r_E = r_E$$

$$r_E = 3.475 \times 10^8 \text{ m} \cdot \frac{1 R_E}{6.38 \times 10^6}$$

$$= \boxed{54 R_E}$$

3. (35 pts) A 550-gram mass hangs vertically from the end of a light string of length 1.2 meters. The mass has an initial velocity of 3.2 m/s parallel to the ground and swings upward in a circular arc like a pendulum. Eventually, the object comes to a momentary halt at a point where the string makes some angle A with its initial vertical orientation before it begins to swing back downward. Assuming frictional forces do -0.45 Joules of work during the motion, find the angle A.



$W_T = 0$

$W_c = 0$

$W_g = -mgh$

$W_{Fric} = -0.45\ J$

$\Delta K = 0 - \frac{1}{2}(.550)(3.2)^2$

$= -2.816\ J$

$-mgh - 0.45 = -2.816$

$-5.39h = -2.366$

$h = 0.439m$

$0.439 = l(1 - \cos\theta)$

$0.366 = 1 - \cos\theta$

$0.634 = \cos\theta$

$\boxed{\theta = 51°}$