Kuwait University Physics Department

Physics 101

Fall Semester

Second Midterm Exam

Saturday, November 25, 2017

12:00 pm – 01:30 pm

Student's Name: ……………….……………………………………. Serial Number: …………….

Student's Number: …………………………………………….. Section: ……………………

Choose your Instructor's Name:

Dr. Ahmed Al-Jassar
Dr. Hala Al-Jassar
Dr. Fatema Al Dosari
Dr. Nasser Demir
Dr. Abdul Mohsen
Dr. Tareq Al Refai
Dr. Abdul Khaleq
Dr. Belal Salameh

For Instructor use only

Grades:

#	Q1	Q2	Q3	Q4	SP1	SP2	SP3	SP4	SP5	LP1	LP2	Total
Pts	1	1	1	1	2	2	2	2	2	3	3	20

Important:

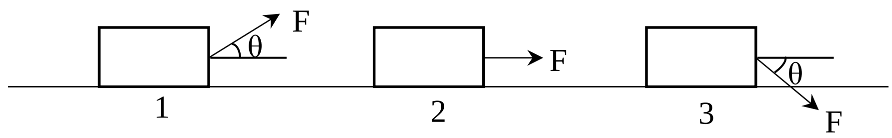
1. Answer all questions and problems.
2. Full mark = 20 points as arranged in the above table.
   i) 4 <u>Q</u>uestions
   ii) 5 <u>S</u>hort <u>P</u>roblems
   iii) 2 <u>L</u>ong <u>P</u>roblems.
3. No solution = no points.
4. **Use SI units.**
5. Check the correct answer for each question.
6. Assume g = 10 m/s^2.
7. Mobiles are **strictly prohibited** during the exam.
8. Programmable calculators, which can store equations, are not allowed.
9. **Cheating incidents will be processed according to the university rules.**

GOOD LUCK

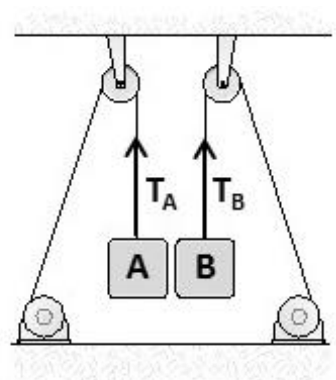
Part I: Questions (Choose the correct answer, one point each)

Q1. A block is pulled by an applied force of magnitude F and moved to the right on a rough horizontal surface as shown in the three cases below. **If the frictional forces acting on the block in the given cases are $\boldsymbol{f_1}$, $\boldsymbol{f_2}$ and $\boldsymbol{f_3}$** respectively, then

* $f_1 = f_2 = f_3$
* $f_1 < f_2 < f_3$
* $f_1 = f_3 \neq f_2$
* $f_1 > f_2 > f_3$



Q2. Two equal masses ($M_A = M_B = M$) are raised at **constant velocities** by light ropes that run over massless pulleys, as shown. Mass A is raised twice as fast as mass B **($V_A = 2V_B$).** The magnitudes of the tensions in the ropes are T_A and T_B, respectively. If the power supplied by the tension to raise M_A and M_B are P_A and P_B respectively, then



* $T_A = T_B$; $P_A = P_B$.
* $T_A = T_B$; $P_A = 2P_B$.
* $T_A = 2T_B$; $P_A = P_B$.
* $T_A = 2T_B$; $P_A = 2P_B$.

Q3. Is it possible for **an elevator** to have an acceleration of **magnitude** $|\vec{a}|$ **greater than g**?

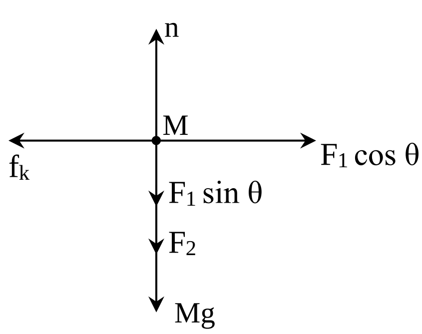
* No, because once $|\vec{a}| = g$ then the elevator is in free fall.
* No, because $|\vec{a}| > g$ is not possible.
* Yes, because $|\vec{a}| > g$ is possible when the cable of the elevator breaks.
* Yes, because $|\vec{a}| > g$ is possible if the tension in the cable is high enough.

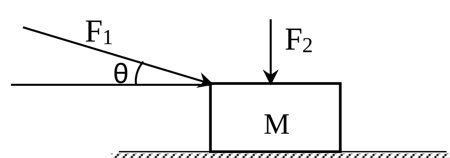
Q4. If a block is lifted vertically upward **with a constant speed** by a force F, then the work done by the gravitational force is:

* negative and the potential energy increases.
* negative and the potential energy decreases.
* zero and the potential energy increases.
* zero and the potential energy does not change.

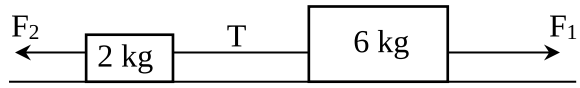
Part II: Short Problems (2 points each)

SP1. A block of mass M is pushed across a **rough** horizontal surface by two applied forces (F_1 and F_2) and moves with constant speed to the right as shown. **Draw the free-body diagram for the block**.





SP2. The horizontal surface on which the objects slide is **frictionless**. If $F_1 = 36$ N and $F_2 = 24$ N, **what is the tension (T) (in N) in the string?**



$F_1 - F_2 = M_{tot}a$

$a = \frac{12}{8} = 1.5\ m/s^2$

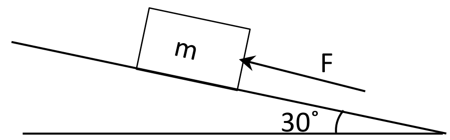
$F_1 - T = 6a$

$T = 36 - 6(1.5)$

$T = 27\ N$

Answer: 27 N

SP3. A block (m = 6 kg) is pushed up **a rough** 30° incline by a constant force (F=56 N) as shown. **If the block moves up with constant speed**, **calculate the coefficient of kinetic friction (μ_k) between the block and the incline.**



$F - f_k - mg\sin\theta = 0$

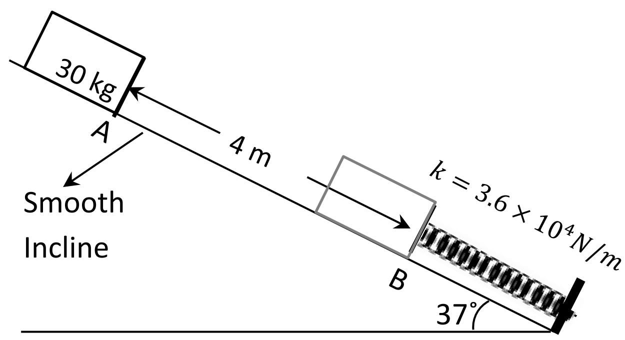
$n = mg\cos\theta$

$F - \mu_k mg\cos\theta - mg\sin\theta = 0$

$\mu_k = \frac{F - mg\sin\theta}{mg\cos\theta} = 0.5$

Answer: 0.5

SP4. The block shown is released from **rest** from point A (when the spring is relaxed) and stops momentarily at point B. The distance between A and B is 4 m. **Using work kinetic energy theorem, find the maximum compression (in m) of the spring.**



$E_A = E_B$

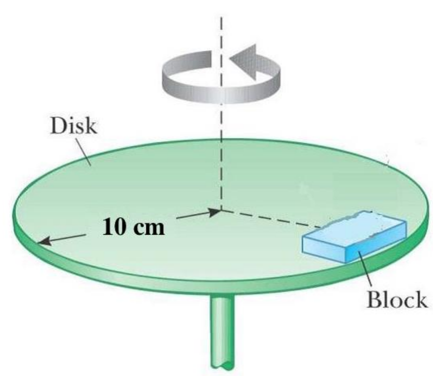
$mg\,(4\sin 37) = \frac{1}{2}\,kx^2$

$x = \sqrt{\frac{8\,mg\sin 37}{k}}$

$= 0.2\ m$

Answer: 0.2 m

SP5. A 20 g block rests on a spinning disk as shown in the figure. If the coefficients of friction between the block and the disk are ($\mu_s = 0.75$, $\mu_k = 0.64$). **What is the maximum speed (in m/s) the disk's rim can have before the block will start sliding?**



$f_{s_{max}} = \frac{mV^2}{R}$

$\mu_s n = \frac{mV^2}{R}$

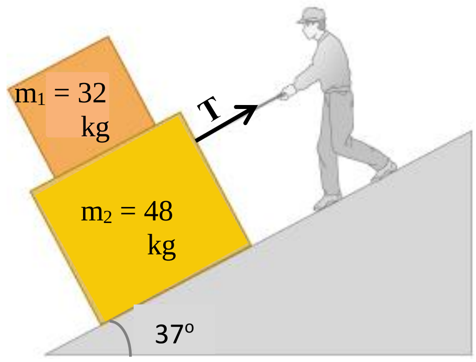
$\mu_s mg = \frac{mV^2}{R}$

$V = \sqrt{Rg\mu_s} = 0.87\ m/s$

Answer: 0.87 m/s

Part III: Long Problems (3 points each)

LP1. You are **lowering** two boxes, one on top of the other, down the ramp by pulling on a rope parallel to the surface of the ramp as shown in the figure. **Both boxes move together at a constant speed**. The coefficient of kinetic friction between the ramp and the lower box is ($\mu_k = 0.4$). The coefficient of static friction between the two boxes is ($\mu_s = 0.8$).



a) What the tension (in N) exerted on the lower box?

$\boldsymbol{M_{tot}}$

$$T + f_k - m_{tot} g \sin\theta = 0$$

$$f_k = \mu_k (m_{tot} g \cos\theta)$$

$$T = m_{tot} g \,(\sin\theta - \mu_k \cos\theta)$$

$$\cong 226\ N$$

Answer: 226 N

b) What is the magnitude (in N) and the direction of the friction force on the upper box?

$\boldsymbol{M_1}$

$$f_s - m_1 g \sin\theta = 0$$

$$f_s = m_1 g \sin\theta = 192.6\ N$$

Up the ramp

Answer: 192.6, up the ramp

c) What power (in W) do you generate to keep the boxes moving down the ramp with constant speed of 1.2 m/s?

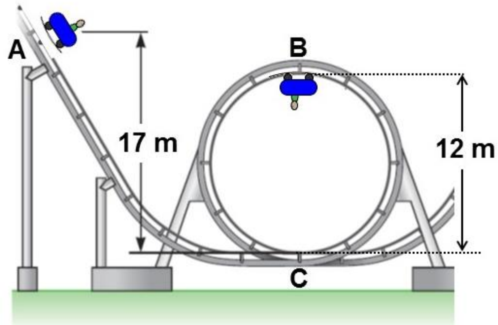
$$P = \vec{F} \cdot \vec{V}$$

$$= -TV \cong -271.2\ W$$

Answer: –271.2 W

LP2. A 150 kg roller coaster car starts from **rest at point A** and slides down the **frictionless** loop-the-loop shown.

a) What is the speed (in m/s) of the car at point B?



$E_A = E_B$

$mg(17) = mg(12) + \frac{1}{2}mv^2$

$v = \sqrt{2(170 - 120)} = 10$ m/s

Answer: 10 m/s

b) What is the normal force (in N) on the car by the track at point B?

$n + mg = \frac{mv^2}{R}$

$n = \frac{mv^2}{R} - mg = 1000\ N$

Answer: 1000 N

c) What is the tangential acceleration (in m/s^2) of the car at point B?

$a_T = 0$

Answer: 0

d) What is the work (in J) done by the normal force as the car moved from point B to point C?

$W_n = 0$

Answer: 0