Kuwait University Physics Department

Physics 101

Fall Semester
Second Midterm Exam
Saturday, November 16, 2019
9:00 am – 10:30 am

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

Student's Number: ….…… Section: ……

Choose your Instructor's Name:

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

For Instructors use only

Grade:

#	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:

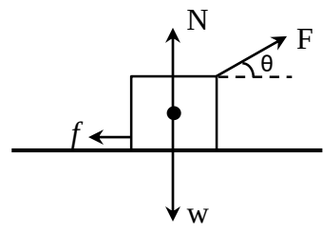
1. Answer all questions and problems.
2. Full mark = 20 points as arranged in the above table.
   i) 4 **Q**uestions
   ii) 5 **S**hort **P**roblems
   iii) 2 **L**ong **P**roblems.
3. No solution = no points.
4. **Use SI units.**
5. Check the correct answer for each question.
6. Assume g = 10 m/s^2.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

GOOD LUCK

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

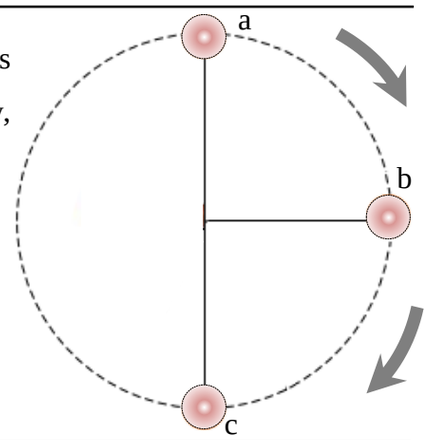
Q1. A person pulls on a block by applying a force (F) and the block remains at **rest**. (w) is the weight, (N) is the normal force, and (*f*) is the frictional force. **Which of the following relations is correct?**

* F = f; N = w.
* F > f; N >w
* F < f; N < w
* (*) F > f; N < w



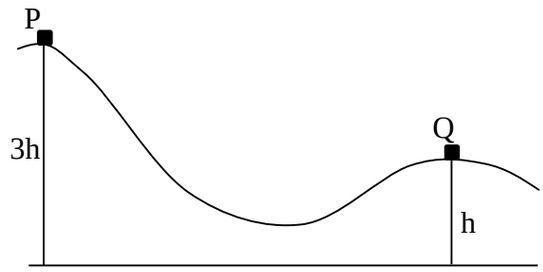
Q2. A small ball of mass (m) is attached to a cord and rotates **vertically** as shown. If the tensions at points a, b, and c are T_a, T_b, and T_c, respectively, then

* $T_a = T_b = T_c$
* (*) $T_a < T_b < T_c$
* $T_a > T_b > T_c$
* $T_a = T_c < T_b$



Q3. A block is released from **rest** at point P and slides along **a frictionless track**, as shown. **When it reaches the point Q, its speed is:**

* $2g\sqrt{2h}$
* (*) $2\sqrt{gh}$
* $2gh$
* $4gh$



Q4. The **net work w** accelerates a car from **rest** to a speed of magnitude v. **How much work is needed to accelerate the car from v to $2v$?**

* **w** * **2w** (*) **3w** * **4w**

Part II: Short Problems (2 points each)

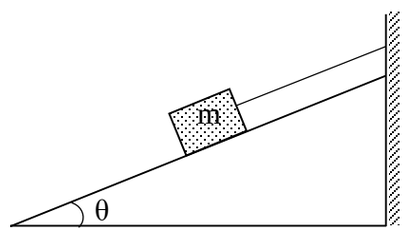
SP1. The block shown in the figure is stationary (**in static equilibrium**). Given: $m = 6\ kg$ and $\theta = 37°$.

What is the tension in the cord?

$\sum F = 0$

$T - m\ g\ \sin(\theta) = 0$

$T = m\ g\ sin(\theta) = 36.1\ N$



Answer: $T = 36.1\ N$

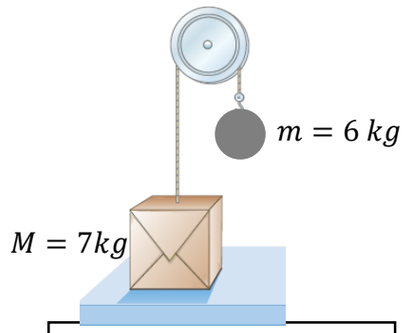
SP2. A box ($M = 7\,Kg$) **rests** on a table. A ball of mass ($m = 6\,kg$) and the box are attached by a rope that passes over a pulley, as shown. **What is the normal force that the table exerts on the box?**

$T + N - Mg = 0$

$N = Mg - T$

$T = mg = 60\,N$

$N = 70 - 60 = 10\,N$



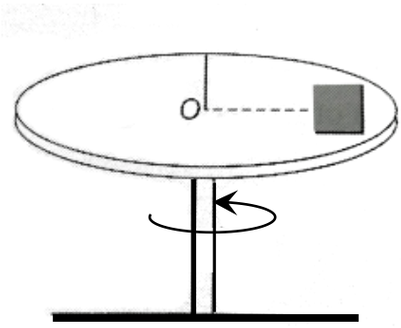
Answer: $N = 10\,N$

SP3. The coefficient of static friction between the block and the surface of a turntable is $\mu_s = 0.3$. The turntable rotates at 20 revolutions per minute. **What is the distance from the center of the turntable at which the block <u>will start to slide</u>?**

$f_{s,max} = \frac{mv^2}{R}$

$\mu_S\, mg = \frac{mv^2}{R} = m\frac{(20\times 2\pi R)^2}{R(60)^2}$

$R = \frac{\mu_S g(60)^2}{(20)^2\times 4\pi^2} = 0.68\,m$



Answer: $R = 0.68\,m$

SP4. A resultant force acting on a 5 kg mass changes its speed from 15 m/s to 25 m/s during a period of 20 s. **Find the average power of the resultant force during the given time period.**

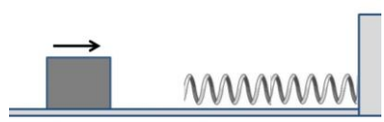
$w = \Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$= \frac{1}{2}(5)(625) - \frac{1}{2}(5)(225) = 1000\,J$

$\mathrm{P} = \frac{W}{t} = \frac{1000}{20} = 50\,W$

Answer: P = 50 W

SP5. A 4 Kg block moving on **a horizontal rough surface** ($\mu_k = 0.6$) slides into a relaxed spring of force constant k = 200 N/m that is attached to a wall. **If the maximum compression of the spring is 20 cm, find the speed of the block just before it touches the spring,**



$w_{total} = \Delta K$

$w_{f_k} + w_{F_s} = \Delta K$

$-\mu_k mg d_{max} + \frac{1}{2}k(0^2 - d_{max}^2) = 0 - \frac{1}{2}mv_i^2$

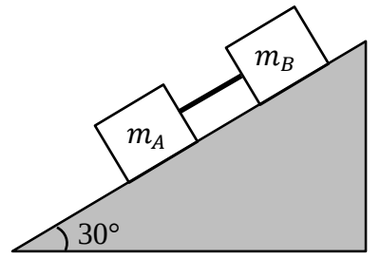
$-(0.6)(4)(10)(0.2) - \frac{1}{2}(200)(0.2)^2 = -\frac{1}{2}(4)(v_i^2) \Rightarrow v_i = 2.1\,m/s$

Answer: v_i =2.1 m/s

Part III: Long Problems (3 points each)

LP1. Two blocks, ($m_A = m_B = 5\,Kg$) are connected by **a massless rod of fixed length,** slide **down** a 30° inclined plane, as shown. The coefficient of kinetic friction between the plane and block A is $\mu_A = 0.2$ and between the plane and block B is $\mu_B = 0.3$.

a) Find the acceleration of the blocks.



$$2m_A\, g\, \sin\theta - \mu_A\, m_A g \cos\theta - \mu_B\, m_B g \cos\theta = 2m_A a$$
$$10 - 0.2(8.66) - 0.3(8.66) = 2a$$
$$a = 2.84\ m/s^2$$

Answer: $a = 2.84\ m/s^2$

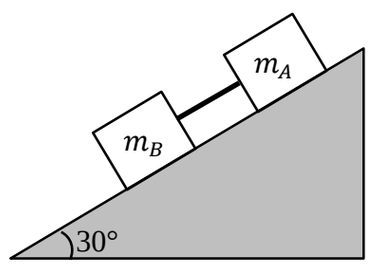
b) Find the tension in the rod.

$$m_A\, g \sin\theta - T - \mu_A\, m_A g\, \cos\theta = m_A\, a$$
$$T = m_A\,(g\, \sin\theta - \mu_A\, g\, \cos\theta - a)$$
$$= 5(10\, \sin 30 - 0.2\,(10)\,(\cos 30) - 2.84) = 2.14$$

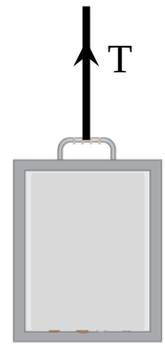
Answer: $T = 2.14\ N$

c) If the initial positions of the blocks are reversed with m_B starting down the slope as shown in the figure, then the blocks acceleration will

i) Increase
ii) Decrease
iii) Not change



LP2. An elevator of mass $m = 500\ kg$ starts from **rest** and moves **downward** with acceleration $a = 2\ m/s^2$. The elevator moves down a distance of 25 m.



a) Calculate the work done by gravity on the elevator.

$w_g = mg\ d$

$= 500 \times 10 \times 25 = 125000\ J$

Answer: $w_g = 125000\ J$

b) Calculate the work done by the tension.

$mg - T = ma$

$T = m(g - a) = 4000\ J$

$w_T = |T||\vec{s}| \cos\theta = -4000(25) = -100000\ J$

Answer: $w_T = -100000\ J$

c) What is the speed of the elevator after it moves 25 m down? (use work-energy theorem)

$w_{tot} = w_{mg} + w_T = 25000J$

$w_{tot} = \Delta K = \frac{1}{2} m v_f^2$

$v_f = 10\ m/s$

Answer: $v_f = 10\ m/s$