Kuwait University Physics Department

Physics 101

Summer Semester
Second Midterm Exam
Wednesday, July 10, 2019
6:30 pm – 8:00 pm

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

Student's Number: ….…… Section: ……

Choose your Instructor's Name:

Prof. Yacoub Makdisi Dr. Tareq Al Refai
Dr. Ahmed Al-Jassar Dr. Belal Salameh
Dr. Hala Al-Jassar

For Instructors use only

Grades:

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

Important:

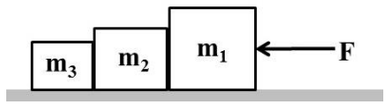
1. Answer all questions and problems.
2. Full mark = 20 points as arranged in the above table.
   i) 4 **Q**uestions
   ii) 5 **S**hort **P**roblems
   iii) 2 **L**ong **P**roblems.
3. No solution = no points.
4. **Use SI units.**
5. Check the correct answer for each question.
6. Assume g = 10 m/s^2.
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 (1 point each)

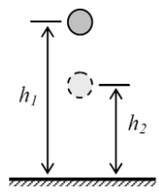
Q1. Three boxes ($m_1 > m_2 > m_3$) are in contact **on a rough horizontal surface** as shown in the figure. A **constant horizontal force** acts on block 1 and the system moves to the left **at a constant speed**. **Which box has the lowest net force?**

* box 1 * box 2 * box 3 ⊙ * All the same

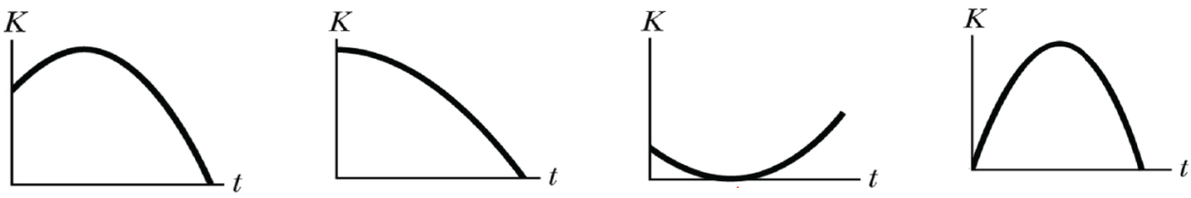


Q2. A ball of mass m is **dropped** from a height h_1. It strikes the floor and rebounds to a maximum height h_2 ($h_2 < h_1$). **The work done on the ball by gravity equals:**

⊙ * $mg(h_1 - h_2)$ * $mg(h_2 - h_1)$ * mgh_1 * zero

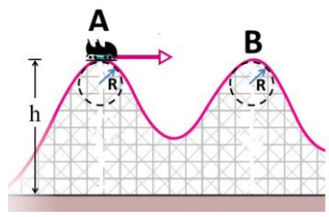


Q3. A stone is thrown **vertically up** from the top of a high building and **return back to the ground**. **Which graph describes the kinetic energy K of the stone during its free fall?**



* * ⊙ * *

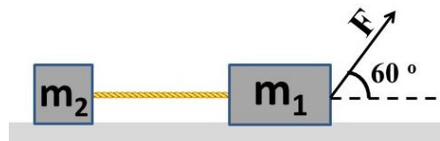
Q4. A car slides on a frictionless track starting from point A with a speed of v_A and reaches point B with a speed of v_B. **Point A and point B have the same height (h)**. The track at points A and B is a part of a circle of **radius R** as shown in the figure. **The normal force on the car at point B equals:**



* $m\left(\frac{v_B^2}{R} - g\right)$ * mg * $m\left(\frac{v_A^2}{R} - g\right)$ ⊙ * $m\left(g - \frac{v_A^2}{R}\right)$

Part II: Short Problems (2 points each)

SP1. Two blocks (m_1 = 15 kg, m_2 = 5 kg) on **a frictionless horizontal** surface are connected by a light rope. A constant force F = 80 N is applied to m_1 as shown in the figure. **Find the acceleration (in m/s^2) of the system.**



$$F\cos(60^o) = (m_1 + m_2)a$$

$$a = \frac{F\cos(60^o)}{(m_1 + m_2)} = \frac{80\cos(60^o)}{20} = 2\ m/s^2$$

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

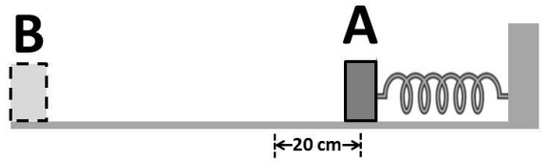
SP2. Find the apparent weight (in N) of a 70 kg man standing in an elevator, if the elevator is **moving upward** and **<u>slowing down</u>** at a rate of 2 m/s^2.

$$mg - n = ma$$

$$n = m\,(g - a) = 70(10 - 2) = 560\ N$$

Answer: $n = 560\ N$

SP3. A 2 kg block on **a rough horizontal surface (μ_k = 0.3)** is attached to a spring of force constant k = 450 N/m. The spring is compressed a distance of 20 cm (at point A) and is released from rest at point A as shown in the figure. The block leaves the spring and stops at point B. **Find the distance (in m) between points A and B.**



$$\sum W = \Delta K$$

$$\frac{1}{2}kx^2 - \mu_k mgd = 0$$

$$\Rightarrow d = \frac{\frac{1}{2}kx^2}{\mu_k mg} = \frac{\frac{1}{2}(450)(0.2)^2}{(0.3)(2)(10)} = 1.5\ m$$

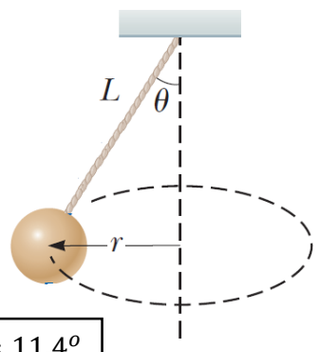
Answer: $d = 1.5\ m$

SP4. The bob of a conical pendulum rotates with a **constant speed** of 1.1 m/s in a horizontal circle of radius r = 0.6 m as shown in the figure. **Find the angle (θ) between the rope and the vertical axis.**

$$\mathrm{T}\sin(\theta) = \mathrm{m}\frac{\mathrm{v}^2}{\mathrm{r}}$$

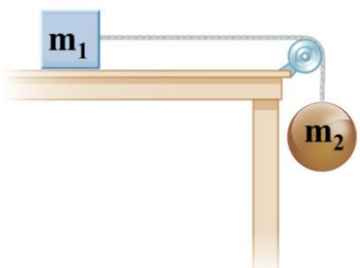
$$\mathrm{T}\cos(\theta) = \mathrm{mg}$$

$$\Rightarrow \tan(\theta) = \frac{\mathrm{v}^2}{\mathrm{rg}} = \frac{(1.1)^2}{6} \Rightarrow \theta = 11.4^o$$



Answer: $\theta = 11.4^o$

SP5. A block (m_1 = 6 kg) rests on **a frictionless** horizontal surface is attached to a ball (m_2 = 4 kg) by a massless rope that passes over a light frictionless pulley as shown in the figure. **If the system is released from rest, find the speed (in m/s) of the ball when it has fallen 0.5 m.**



$$E_f = E_i$$

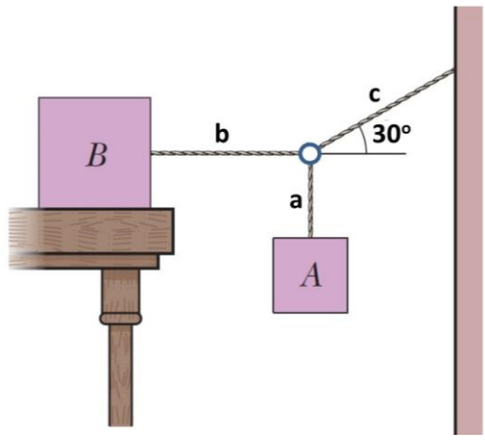
$$\frac{1}{2}(m_1 + m_2)v^2 = m_2 gh$$

$$v = \sqrt{\frac{2m_2 gh}{m_1 + m_2}} = 2\ \mathrm{m/s}$$

Answer: $v = 2\ \mathrm{m/s}$

Part III: Long Problems (3 points each)

LP1. Two blocks (m_A= 20 kg and m_B = 50 kg) are connected by light ropes through a light **O** ring as shown in the figure. **Block B is stationary on the rough table and rope b remains horizontal.**



a) Find the tension (in N) in rope a.

$T_a = m_A g = 200\ N$

Answer: $T_a = 200\ N$

b) Find the tension (in N) in rope b and in rope c.

$T_a = T_c \sin(30^o) \Rightarrow T_c = \dfrac{T_a}{\sin(30^o)} = 400\ N$

$T_b = T_c\, \text{sos}(30^o) = 346.4\ N$

Answer: $T_c = 400\ N$

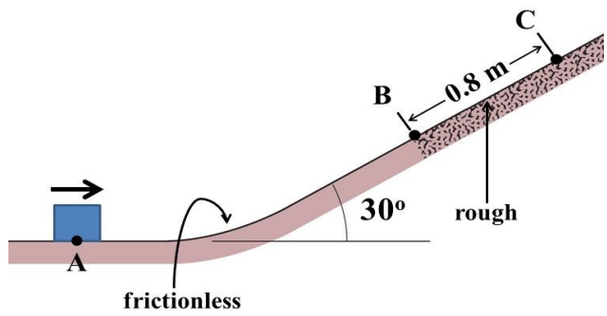
Answer: $T_b = 346.4\ N$

c) Find the minimum coefficient of static friction between block B and the table required to prevent block B from motion.

$$T_b = (f_s)_{max} = \mu_s m_B g \Rightarrow \mu_s = \frac{T_b}{m_B g} = \frac{346.4}{500} = 0.69$$

Answer: $\mu_s = 0.69$

LP2. A 4 kg block starts from point **A** with a speed of 8 m/s and slides along a frictionless track until point **B**. **The region after point B is rough (μ_k = 0.4)**. The block reaches point C and stops there.



a. Find the total work (in J) done on the block between points A and C.

$$\sum W = \Delta K = \frac{1}{2}m(V_C^2 - V_A^2)$$
$$= \frac{1}{2}(4)(0 - 64) = -128\,J$$

Answer: $\sum W = -128\,J$

b. Find the work (in J) done on the block by friction.

$$W_{f_k} = -f_k L = -\mu_k mg\,cos(30^o)\,L = -0.4(4)(10)cos(30^o)(0.8) = -11.1\ J$$

Answer: $W_{f_k} = -11.1\ J$

c. Find the speed (in m/s) of the block at point B.

$$\boldsymbol{E_C - E_B} = W_{f_k}$$
$$\boldsymbol{mgL\,sin(30^o) - \frac{1}{2}mV_B^2 = -11.1}$$
$$\boldsymbol{V_B = \sqrt{\frac{2}{m}(mgL\,sin(30^o) - 11.1)} = 1.57\,m/s}$$

Answer: $\boldsymbol{V_B = 1.57\,m/s}$