Kuwait University **Physics Department**

Physics 101

Summer Semester

Second Midterm Exam

Tuesday, July 18, 2017

6:00 pm – 7:30 pm

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

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

Choose your Instructor's Name:

Prof. Yacoub Makdisi
Dr. Hala Al-Jassar
Dr. Fatema Al Dosari
Dr. Belal Salameh

For Instructors 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

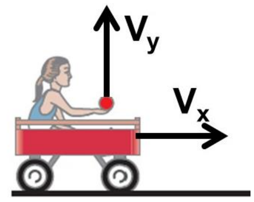
Important:

1. Answer all questions and problems.
2. Full mark = 20 points as arranged in the above table.
   i) 4 **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. **Cheating accidents will be processed according to the university rules.**

GOOD LUCK

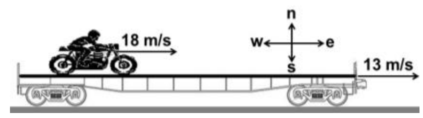
Part I: Questions (Choose the correct answer, one point each)

Q1. A child sits in a wagon which is moving to the right (x-direction) at constant speed V_x. She throws an apple straight up (from her viewpoint) with an initial speed V_y while the wagon continues to travel forward at V_x. Neglect air resistance. **One of the following sentences is correct:**



* the apple will land behind the wagon. * the apple will land in front of the wagon.
* the apple will land in the wagon. * if $V_x < V_y$ then the apple will land in front of the wagon.
* if $V_x < V_y$ then the apple will land behind the wagon.

Q2. A railroad flatcar is traveling in a straight line at a velocity of 13 m/s toward east relative to an observer standing on the ground. A scooter moves on the flatcar in a straight line with a velocity of 18 m/s toward east relative to the same observer. **The direction of the velocity of the scooter relative to the flatcar is:**

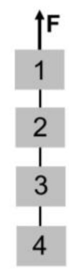


*** west** *** east** *** 36° east of north** *** 36° north of east** *** 36° west of north**

Q3. If you increase the speed of your car by a factor of 4, **then its kinetic energy will be increased by a factor of:**

*** 2** *** 4** *** 8** *** 12** *** 16**

Q4. Four boxes of **equal mass**, m, are connected to one another by strings. Box 1 is pulled by a force (F) and the **system moved upward** as shown in the figure. **Which one of the four boxes has the highest net force?**



*** all the same** *** box 1** *** box 2**
*** box 3** *** box 4**

Part II: Short Problems (2 points each)

SP1. The displacement vector of an object moving in the xy plane is given by $\vec{r}(t) = (-12t + 4t^2)\hat{\imath} + (10 - 3t^2)\hat{\jmath}$, where r is in meters and t is in seconds**. Calculate the magnitude of the acceleration (in m/s²) of the object at t=2 s.**

$$\vec{V} = \frac{d\vec{r}}{dt} = [(-12 + 8t)\,\hat{\imath} - 6t\,\hat{\jmath}]\,\frac{m}{s}$$

$$\vec{a} = \frac{d\vec{V}}{dt} = (8\,\hat{\imath} - 6\,\hat{\jmath})\,\frac{m}{s^2} \;\Rightarrow\; |\vec{a}| = \sqrt{(8)^2 + (-6)^2} = 10\; m/s^2$$

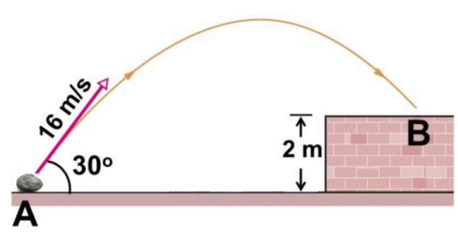
Answer: $|\vec{a}| = 10\; m/s^2$

SP2. A stone is projected from point A with an initial speed of 16 m/s at 30° above the horizontal as shown in the figure. If air resistance is negligible, **how long (in s) does it take for the stone to reach point B?**

$V_{yi} = V_i \sin\theta = 16 \sin 30^o = 8\; m/s$

$\Delta y = V_{yi}t - \frac{1}{2}gt^2$

$+2 = 8t - 5t^2 \;\Rightarrow t = 0.3\; s\; OR\; 1.29\; s$

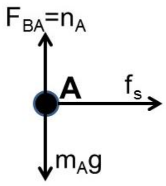


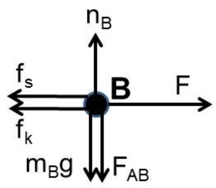
The correct answer is $t = 1.29\; s$

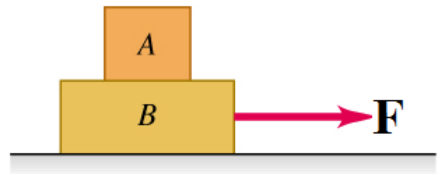
(The first time is when the stone is rising up at a height of 2 m)

Answer: $t = 1.29\; s$

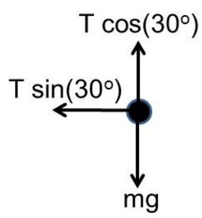
SP3. A person pulls horizontally on block B as shown in the figure, causing both blocks to move together as a unit. If all surfaces are rough, **draw the free body diagram for block A and the free body diagram for block B.**

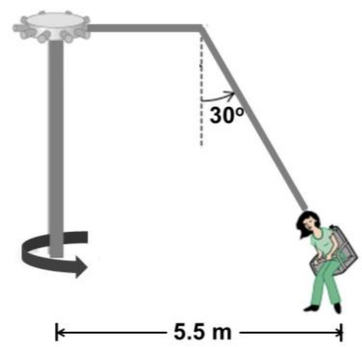






SP4. A swing consists of a vertical central shaft with a horizontal arm attached at its upper end. The arm supports a seat suspended from a cable, the upper end of the cable is fastened to the horizontal arm as shown in the figure. If the swing rotates in **<u>a horizontal circle</u>** around the central shaft **<u>with constant speed</u>**, **find the speed (in m/s) of the swing.**





$T\cos 30^o = mg$

$T\sin\ 30^o = m\dfrac{V^2}{R}$

$\Rightarrow \tan 30^o = \dfrac{V^2}{Rg} \quad \Longrightarrow V = \sqrt{Rg\tan 30^o} \quad = 5.63\ m/s$

Answer: $V = 5.63\ m/s$

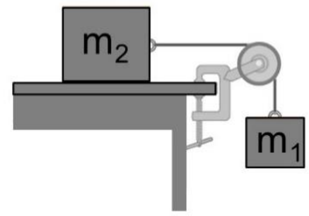
SP5. An object is **initially at the origin**, a force acting on this object is given by $F_x = (-6x + 9x^2)\ N$, where x is measured in meter. **Find the work (in J) done by this force on the object as it moves 3 m to the right.**

$$W = \int_{x_i}^{x_f} F_x\,dx = \int_0^3 (-6x + 9x^2)dx = [-3x^2 + 3x^3]_0^3 = +54\ J$$

Answer: $W = +54\ J$

Part III: Long Problems (3 points each)

LP1. Two blocks (m_1=1.2 kg and m_2=2 kg) are connected by a light string which passes over a massless and frictionless pulley as shown in the figure. **m_1 moves downward** and m_2 which is lying on **a rough surface** moves to the right **at constant speed**.



a) Find the work (in J) done on m_1 by gravity when it moves 80 cm downward.

$W_{m_1 g} = m_1 g h = (1.2)(10)(0.8) = +9.6\ \text{J}$

Answer: $W_{m_1 g} = +9.6\ \text{J}$

b) Find the total work (in J) done on m_1 when it moves 80 cm downward

$W_{total} = \text{Zero}$ (**it is moving with constant velocity**)

Answer: $W_{total} = \text{Zero}$

c) Find the coefficient of kinetic friction between m_2 and the surface.

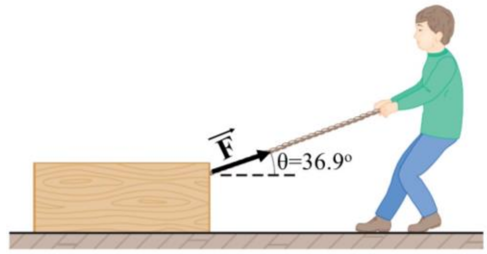
for m_1: $T = m_1 g = 12\ \text{N}$

for m_2: $T = f_k = \mu_k m_2 g \Rightarrow \mu_k = \dfrac{T}{m_2 g} = 0.6$

Answer: $\mu_k = 0.6$

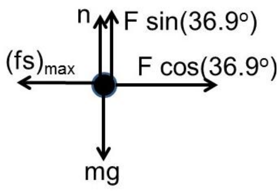
LP2. A 30 kg box rests on **a rough horizontal surface.** A child pulls the rope by a force F as shown in the figure.

a) If the box just starts to move when the child exerts a force of magnitude 130 N, calculate the coefficient of static friction.



$n = mg - F\sin(36.9^o) = 222\ N$

$F\cos(36.9^o) = (f_s)_{max} = \mu_s n \Rightarrow \mu_s = \dfrac{F\cos(36.9^o)}{n} = 0.47$



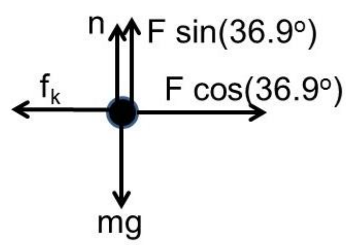
Answer: $\mu_s = 0.47$

b) If the child exerts a force of magnitude 250 N, calculate the magnitude of the acceleration (in m/s²) of the box (assume μ_k=0.3).

$n = mg - F\sin(36.9^o) = 150\ N$

$F\cos(36.9^o) - f_k = ma \Rightarrow a = \dfrac{F\cos(36.9^o) - f_k}{m}$

$= \dfrac{F\cos(36.9^o) - \mu_k n}{m} = 5.16\ m/s^2$



Answer: $a = 5.16\ m/s^2$

c) Calculate the kinetic energy (in J) of the box after it has moved 2 m to the right (assume F=250 N).

$\sum W = \Delta K$

$F\cos(36.9^o)\,(r) - f_k(r) = K_f - 0$

$\Rightarrow K_f = 310\ \text{J}$

Answer: $K_f = 310\ \text{J}$