Kuwait University **Physics Department**

Physics 101

Summer Semester

Second Midterm Exam

Saturday, July 20, 2024

8:00 AM – 9:30 AM

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

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

Choose your Instructor's Name:

Instructors: Drs. Al Dosari, Al Jassar, Al Qattan, Salameh

For Instructors use only

Grades:

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

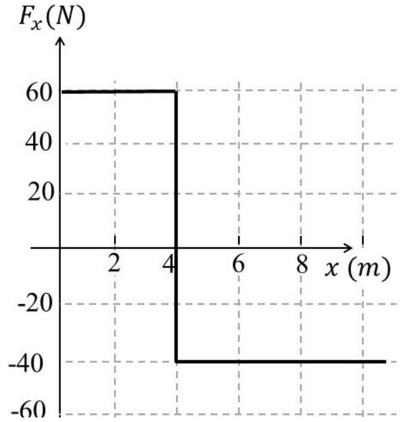
Important:

1. Answer all questions and problems (No solution = no points).
2. Full mark = 20 points as arranged in the above table.
3. **Give your final answer in the correct units.**
4. Assume g = 10 m/s^2.
5. Mobiles are **<u>strictly prohibited</u>** during the exam.
6. Programmable calculators, which can store equations, are not allowed.
7. **Cheating incidents will be processed according to the university rules.**

GOOD LUCK

Part I: Short Problems (2 points each)

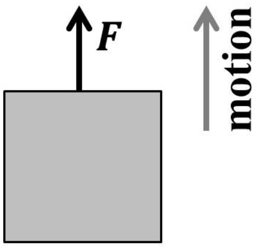
SP1. A block is moving along the $x-axis$ under the influence of **a varying net force. The net force as a function of position is shown in the figure. Find the change in the kinetic energy of the block as it moves from $x = 0\ m$ to $x = 8\ m$.**



$$\Delta K = W_{F_{net}} = Area$$

$$= (4)60) - (4)(40) = +80\ J$$

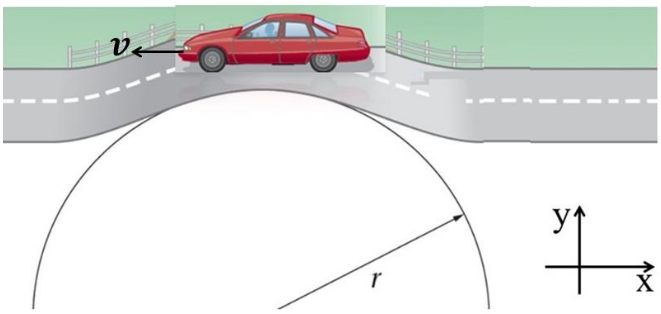
SP2. A constant force F is exerted on a $60\ kg$ block, as shown. The block moves vertically upward at <u>constant speed</u>. **Find the average power output of the force (F) if the block moves $6\ m$ in $12\ s$.**



$$w_F = mgh = 60(10)(6) = 3600\ J$$

$$P_{av} = \frac{w_F}{t} = \frac{3600}{12} = 300\ W$$

SP3. A $1000\ kg$ car is moving with **constant speed**, the car encounters a bump in the road that has a circular cross section, as shown. If the apparent weight of the car as it passes over the top is $7000\ N$, **find its <u>acceleration</u> at the top in unit vector notation.**



$$mg - n = ma_c$$

$$\Rightarrow a_c = \frac{mg - n}{m} = \frac{10000 - 7000}{1000} = 3\ m/s^2$$

$$\vec{a} = -3\hat{\jmath}\ m/s^2$$

SP4. A box of mass $m = 2\ kg$ is attached to a vertical spring ($k = 100\ N/m$). The box is released **from rest** at point A, **where the spring is relaxed**. The box then **moves down** from point A to point B, covering a distance of $s = 0.2\ m$. **Find the speed of the box at point B.**

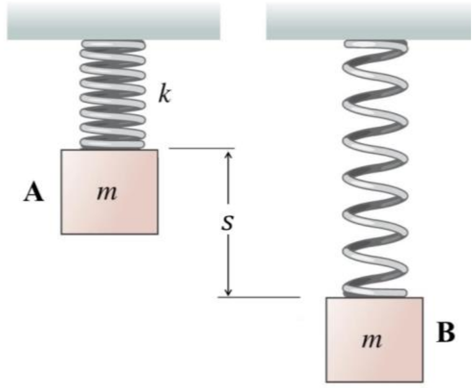
$$\sum W = \Delta K$$

$$W_{mg} + W_{F_s} = \Delta K$$

$$mg(s) + \frac{1}{2}k(x_i^2 - x_f^2) = (\frac{1}{2}mv_f^2 - 0)$$

$$2(10)(0.2) + \frac{1}{2}100(0^2 - 0.2^2) = (\frac{1}{2}(2)v_f^2 - 0)$$

$$v_f = 1.4\ m/s$$



Or

$$E_i = E_f$$

$$mg(s) = \left(\frac{1}{2}mv_f^2 + \frac{1}{2}kx_f^2\right)$$

$$2(10)(0.2) = \frac{1}{2}(2)v_f^2 + \frac{1}{2}100(0.2^2)$$

$$v_f = 1.4\ m/s$$

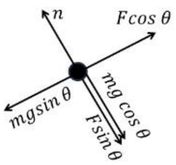
SP5. A block of mas m is sliding down **a frictionless** incline while **<u>a horizontal</u> force** of magnitude (F) is exerted on it, as shown. If $F = mg$, **draw the free body diagram of the block and find the angle (θ) of the incline that allows the block to slide <u>down with constant speed</u>.**

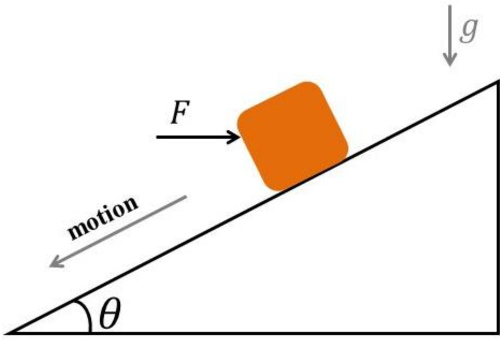
$$mg\ sin\theta - F\ cos\theta = 0$$

$$mg\ sin\theta = mg\ cos\theta$$

$$sin\theta = cos\theta \ \Rightarrow tan\theta = 1$$

$$\Rightarrow \theta = 45^o$$

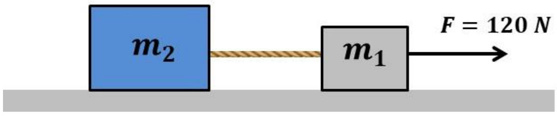




Part II: Long Problems (3 points each)

LP1. Two blocks of wood ($m_1 = 5\ kg, m_2 = 15\ kg$), are connected by a light rope and pulled to the right along a horizontal **rough surface** ($\mu_k = 0.4$), as shown.

a) Find the acceleration of the system.



$$F - \mu_k m_1 g - \mu_k m_2 g = (m_1 + m_2)a$$

$$a = \frac{F - \mu_k m_1 g - \mu_k m_2 g}{m_1 + m_2} = \frac{120 - \big(0.4(50)\big) - (0.4(150))}{20} = 2\ m/s^2$$

b) Find the tension in the rope.

For m_2

$$T - \mu_k m_2 g = m_2 a$$

$$T = \mu_k m_2 g + m_2 a = (0.4)(150) + 15(2) = 90\ N$$

c) Find the magnitude of the **net force** on block 2.

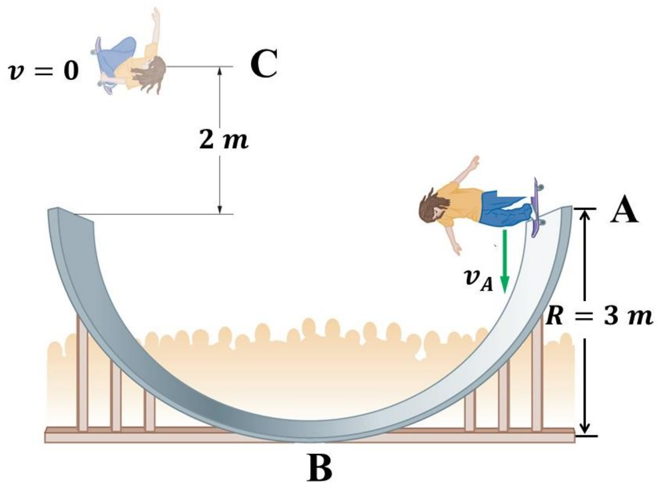
$$F_{net} = m_2 a = 15(2) = 30\ N$$

LP2. A 30 kg boy starts skating at point A with an initial speed of v_A and rises to a maximum height of 2 meters above the top of the circular ramp at point C, as shown.

a) Find the boy's speed **at the bottom of the ramp (point B).**

$$\frac{1}{2}mv_B^2 = mgy_c$$

$$v_B = \sqrt{2gy_c} = \sqrt{2(10)(5)} = 10\ m/s$$



b) Find the force exerted by the ramp on the boy **at the bottom of the ramp (point B).**

$$n_B - mg = m\frac{v^2}{R}$$

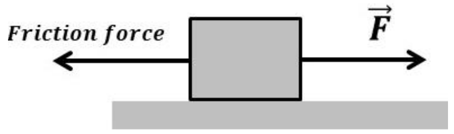
$$n_B = m\left(g + \frac{v^2}{R}\right) = 30\left(10 + \frac{10^2}{3}\right) = 1300\ N$$

c) Find the work done on the boy **by gravity** as he moves **<u>from point A to point C</u>**.

$$W_{mg} = -mgh = -30(10)(2) = -600\ J$$

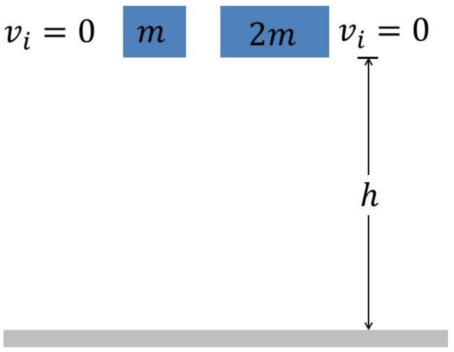
Part III: Questions (Choose the correct answer, one point each)

Q1. A box of mass m **rests** on **a rough horizontal surface** is being pushed by a horizontal force, as shown. The magnitude of the pushing force ($\vec{F}$) is increasing **while the box remains at rest**, which of following statements is true about the magnitude of the friction force:



* the friction force is constant.
* the friction force is increasing.
* the friction force is decreasing.
* Impossible to tell without the values of m, μ_k, and F.

Q2. When a box of mass m is released from rest from a height h, its kinetic energy just before touching the ground is K. If a second box of mass $2m$ is released from rest from **the same height** h, then its kinetic energy just before touching the ground is:

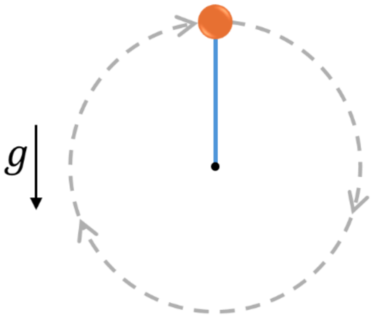


* K
* $2K$
* $4K$
* $8K$

Q3. Accelerating a block from $0\ m/s$ to $5\ m/s$ requires a work of magnitude W_o. Accelerating the same block from $5\ m/s$ to $15\ m/s$ requires the following work:

* $2W_o$
* $3W_o$
* $4W_o$
* $8W_o$

Q4. A ball of mass m attached to a light string of length L rotates in a vertical circle, as shown. During **one complete revolution**, which of the followings is true regarding **the work done on the ball by force of gravity (W_g):**



* $W_g > 0$
* $W_g = 0$
* $W_g < 0$
* Impossible to tell without the values of m and L