Kuwait University **Physics Department**

جامعة الكويت
KUWAIT UNIVERSITY

Physics 101

Summer Semester

Second Midterm Exam

Saturday, July 17, 2025

10:00 PM – 11:30 PM

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

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

Choose your Instructor's Name:

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

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	1	1	1	20

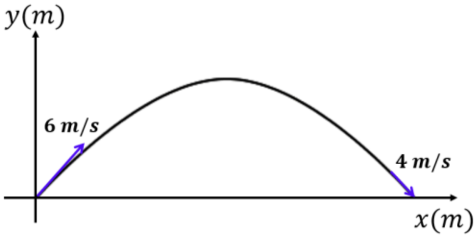
Important:

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 **strictly prohibited** 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 0.4 kg stone is projected from ground level with an initial speed of 6 m/s and strikes the ground with a speed of 4 m/s. **Calculate the work done by air resistance on the stone**.

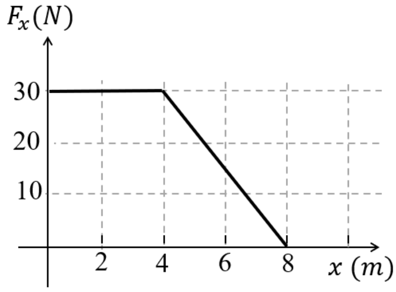


$$\sum W = \Delta K$$

$$W_{air\ resistance} = \Delta K = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$= \frac{1}{2}0.4\,(4^2 - 6^2) = -4\,J$$

SP2. A 6 kg box moves along the x-axis from the origin under the influence of a variable net force, the net force as a function of position is plotted in the graph. **If the box has a speed of 2 m/s at $x = 0$, find its speed at $x = 8\,m$.**



$$\sum W = W_{F_{net}} = \text{Area under the curve}$$

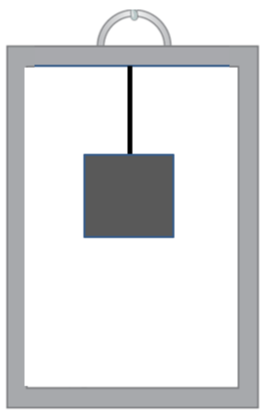
$$= (30)(4) + \frac{1}{2}(4)(30) = 180\,J$$

$$\sum W = \Delta K$$

$$180 = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$180 = 3(v_f^2 - 2^2) \Rightarrow v_f = 8\,m/s$$

SP3. A 50 kg block is suspended from the lower end of a rope of negligible mass, with the upper end attached to the ceiling of an elevator. The elevator is **moving downward and <u>slowing down</u>** at a rate of 3 m/s^2. **Find the tension in the rope**.

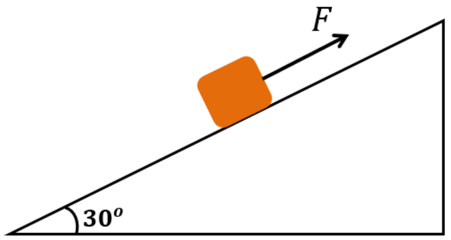


$$a = 3\,m/s^2\ (upward)$$

$$T - mg = ma$$

$$T = m(g + a) = 50(10 + 3) = 650\,N$$

SP4. A block of mass $m = 8\ kg$ is pulled by a constant force $F = 60\ N$ on **a rough** incline , as shown. If the block **moves up** the incline at **constant speed**, **find the coefficient of kinetic friction (μ_k) between the block and the surface**.



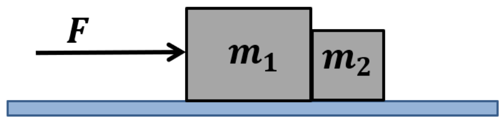
$n = mg\cos\theta$

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

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

$\mu_k = \frac{F - mg\sin\theta}{mg\cos\theta} = 0.29$

SP5. Two blocks ($m_1 = 15\ kg, m_2 = 5\ kg$) are in contact on a horizontal, **frictionless** surface, as shown. A horizontal force of $F = 40\ N$ is applied to block 1. **Find the magnitude of the force that block 1 exerts on block 2**.



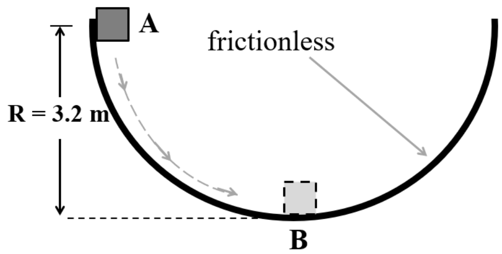
$F = (m_1 + m_2)a$

$a = \frac{F}{(m_1 + m_2)} = \frac{40}{20} = 2\ m/s^2$

$F_{12} = m_2 a = 5(2) = 10\ N$

Part II: Long Problems (3 points each)

LP1. A block of mass $m = 2\ kg$ is released from **rest at point A** and slides inside a **frictionless** circular path of radius R, as shown.



a) Find the speed of the block at point B.

$$\sum W = \Delta K$$

$$W_{mg} = \frac{1}{2}mv_B^2 - \frac{1}{2}mv_A^2$$

$$mgR = \frac{1}{2}mv_B^2 - 0$$

$$v_B = \sqrt{2gR} = \sqrt{2(10)(3.2)} = 8\ m/s$$

b) Find the magnitude of the normal force on the block at point B.

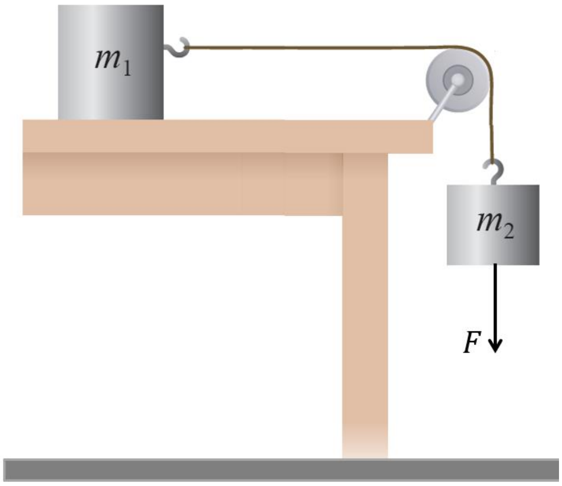
$$n - mg = \frac{mv^2}{R}$$

$$n = m\left(g + \frac{v^2}{R}\right) = 2\left(10 + \frac{8^2}{3.2}\right) = 60\ N$$

c) Find the magnitude of the block's acceleration at point B.

$$a_r = \frac{v^2}{R} = \frac{(8)^2}{3.2} = 20\ m/s^2$$

LP2. Two blocks ($m_1 = 8\ kg$, $m_2 = 2\ kg$) are connected by a light rope that passes over a massless, frictionless pulley. The horizontal surface is **frictionless,** and a constant force $F = 16\ N$ is applied to m_2, as shown.



a) **Find the acceleration of the blocks.**

for $\boldsymbol{m_{tot}}$

$$\sum F = (m_1 + m_2)\ a$$

$$F + m_2 g = (m_1 + m_2) a$$

$$16 + 20 = 10\ a$$

$$a = 3.6\ m/s^2$$

b) **Find the tension in the rope.**

for $\boldsymbol{m_1}$

$$T = m_1 a = (8)(3.6) = 28.8\ N$$

OR for $\boldsymbol{m_2}$

$$F + m_2 g - T = m_2 a$$

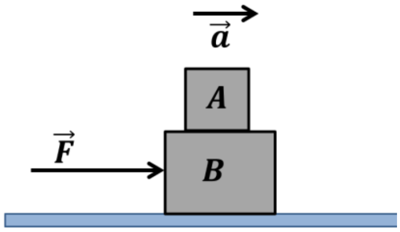
$$T = F + m_2 g - m_2 a = (16) + 20 - (2)(3.6) = 28.8\ N$$

c) **Calculate the power delivered by the tension force on block 2 when it is moving downward at a speed of 2 $\boldsymbol{m/s}$.**

$$P = \vec{T}.\vec{v} = |\vec{T}||\vec{v}|\cos 180^o = (28.8)(2)(-1) = -57.6\ W$$

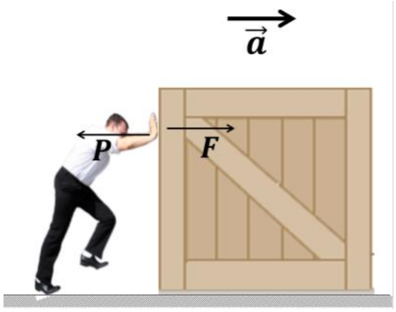
Part III: Questions (Choose the correct answer, one point each)

Q1. Block A is placed on top of block B. A force $\vec{\mathbf{F}}$ is applied to block B, causing both blocks to accelerate to the right, as shown. **Block A does not slip relative to block B**. What is the direction of the **static friction force between the two blocks**?



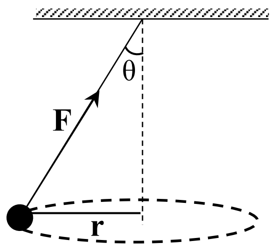
* It acts to the right on both blocks A and B.
* It acts to the left on both blocks A and B.
* It acts to the right on block A and to the left on block B.
* It acts to the left on block A and to the right on block B.

Q2. A man pushes a box of mass M on **a rough** horizontal surface with a force of magnitude F. The box pushes back on the man's hand with a force of magnitude P. **If the man and the box accelerate to the right with a constant acceleration of magnitude** a, then



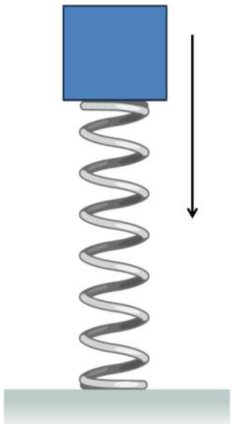
* $F = P$
* $F = P + Ma$
* $F = P + Ma + f_k$
* $F = P + Ma - f_k$

Q3. The ball of a conical pendulum rotates in a horizontal circle at **constant speed,** as shown**.** The work done on the ball by the **tension $\vec{F}$ during one complete revolution equals**



* $F(2\pi r \sin\theta)$
* $F(2\pi r \cos\theta)$
* $F(2\pi r \tan\theta)$
* zero

Q4. A block is placed on the top of a vertical relaxed spring, as shown. As the block moves downward and compresses the spring, **the work done on the block by the spring is:**



* Positive
* Negative
* Zero