Kuwait University Physics Department

جامعة الكويت
KUWAIT UNIVERSITY

Physics 101

Spring Semester
Second Midterm Exam
Monday, April 21, 2025
6:30 PM – 08:00 PM

Student's Name: …… Serial Number: ……

Student's Number: ……Section: ……

Choose your Instructor's Name:

Instructors: Drs. Al Dosari, Alkurtass, Al Qattan, Al Refai, Al Smadi, Askar, Demir, 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

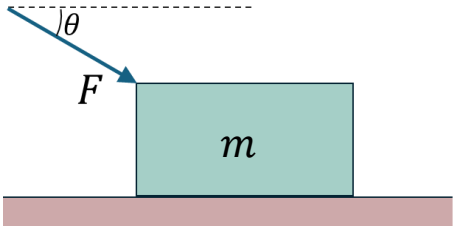
Important:

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 block ($m = 8\ kg$) is pushed along a horizontal **frictionless** floor by a force $|\vec{F}| = 24\ N$ at an angle $\theta = 30°$ with the horizontal, as shown**. Find the magnitude of the block's acceleration**.

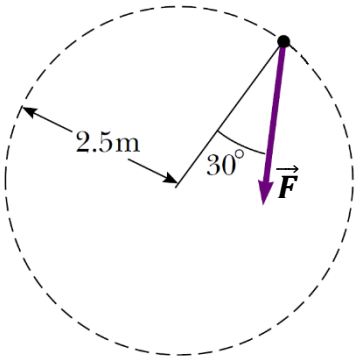


$$F\cos\theta = ma$$
$$24\cos 30 = 8a$$
$$a = 2.6\ m/s^2$$

SP2. The figure shows the **net force** $\vec{F}$ at a given instant on an object ($m = 0.6\ kg$) moving in a **vertical circle** of radius ($R = 2.5\ m$). If $|\vec{F}| = 12\ N$, **find the speed of the particle at that instant.**

$$F_{rad} = \mathrm{F}\cos 30^{\mathrm{o}} = \frac{mv^2}{\mathrm{R}}$$

$$\mathrm{v} = \sqrt{\mathrm{R\,F}\cos 30^{\mathrm{o}}/m} = 6.6\ \mathrm{m/s}$$



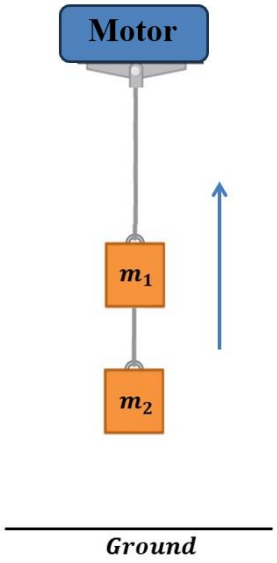
SP3. The only force acting on an object ($m = 5\ kg$) moving along the x-axis is given by:

$$F(x) = (18 - 0.5x)\ N,$$

where x is given in $meters$. If the object is initially **at rest at $x = 0$, what is its speed at $x = 11m$?**

$$W = \int_0^{11} (18 - 0.5x)dx = (18x - 0.25x^2)|_0^{11} = 167.8\ J$$
$$W = 167.8 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = 2.5v_f^2$$
$$v_f = 8.2\ m/s$$

SP4. Two masses ($m_1 = 160\ kg$ and $m_2 = 190\ kg$) are connected by a light rope, as shown. A motor is used to lift these masses **upward** from the ground**. What power delivered by the motor is required to lift these masses at <u>a constant speed</u> of 4 m/s?**

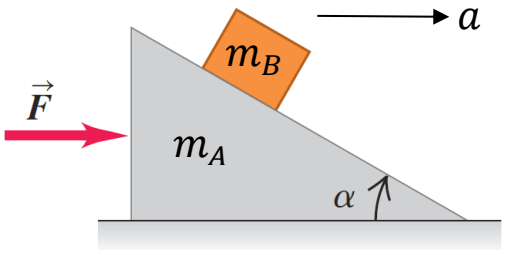


$$\Sigma F_y = T - m_1 g - m_2 g = 0$$

$$T = m_1 g + m_2 g = (1600 + 1900) = 3500\ N$$

$$P = Tv = (3500)(4) = 14000\ W$$

SP5. A body ($m_A = 9\ kg$) rests on a horizontal table, as shown. Another body ($m_B = 5\ kg$) is placed on body A and a horizontal force ($F = 100\ N$) is applied to body A. If all surfaces are **frictionless, find the angle α that allows both bodies to move with the <u>same acceleration</u>**.



For $(m_A + m_B)$:

$$F = (m_A + m_B)\, a$$

$$a = 7.14\ m/s^2$$

For m_B:

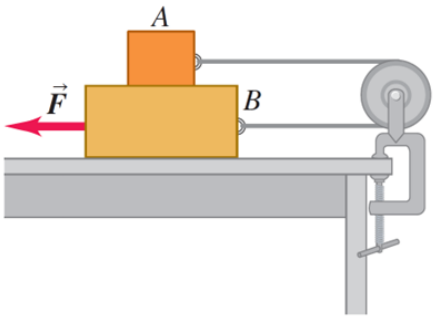
$$n \sin\alpha = m_B a \quad \text{and} \quad n \cos\alpha = m_B g$$

$$\tan\alpha = \frac{a}{g}$$

$$\alpha \approx 35.5°$$

Part II: Long Problems (3 points each)

LP1. Two blocks are placed on top of each other on a **frictionless** table, as shown. The surface between block A and block B is **rough**. They are connected by a light string that passes around a fixed frictionless, and massless pulley. A horizontal force $|\vec{F}| = 10\ N$ is applied to **block B**, causing it to **move to the left at a constant speed**.



a) Find the magnitude of the friction force acting on block A.

For A:
$T - f_k = 0$
$f_k = T$

For B:
$F - T - f_k = 0$
$F - 2f_k = 0$

$\Longrightarrow \quad f_k = \frac{1}{2}F = 5\ N$

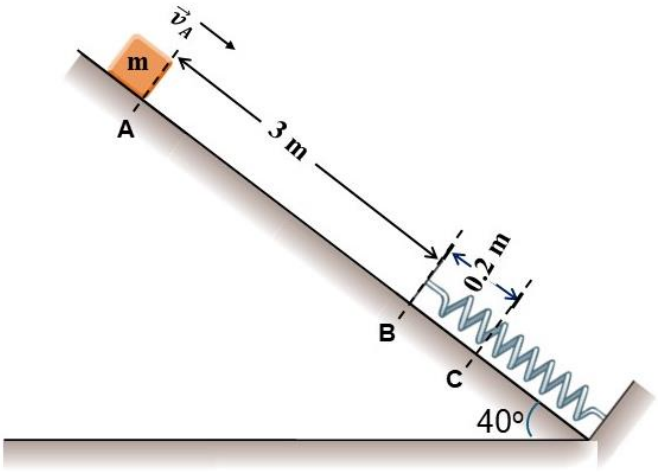
b) After block B has moved a distance $s = 0.2\ m$, **find the work done by the friction force on block A.**

$$W_{fk} = -|f_k||s| = -5 \times 0.2 = -1\ J$$

c) What is the correct relation between the total work done on block A ($W_{\text{tot A}}$) and on block B ($W_{\text{tot B}}$)?

⊙ $W_{\text{tot A}} = W_{\text{tot B}}$ * $W_{\text{tot A}} > W_{\text{tot B}}$ * $W_{\text{tot A}} < W_{\text{tot B}}$

LP2. A block of mass ($m = 1.4\ kg$) is projected with a speed v_A from point **A** on **a frictionless** incline toward a spring, as shown. The spring ($k = 1450\ N/m$) is compressed a maximum distance ($x = 0.2\ m$) before coming to **rest momentarily** at point **C**.



a) Calculate the work done by gravity as the block moves from point A to point C.

$$W_g = mg \times s \times sin\theta$$
$$W_g = 14 \times 3.2 \times sin40 = 28.8\ J$$

b) Use the work-energy theorem to calculate the block's speed at point A.

$$W_g + W_n + W_s = K_f - K_i$$
$$28.8 + 0 + -\frac{1}{2}\ kx^2 = \frac{1}{2}\ mv_C^2 - \frac{1}{2}\ mv_A^2$$

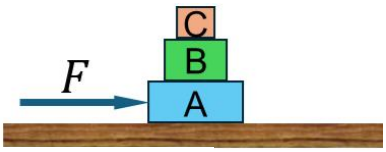
$$28.8 - \frac{1}{2}(1450)(0.2)^2 = -\frac{1}{2}\ (1.4)v_A^2$$
$$v_A = 0.53\ m/s$$

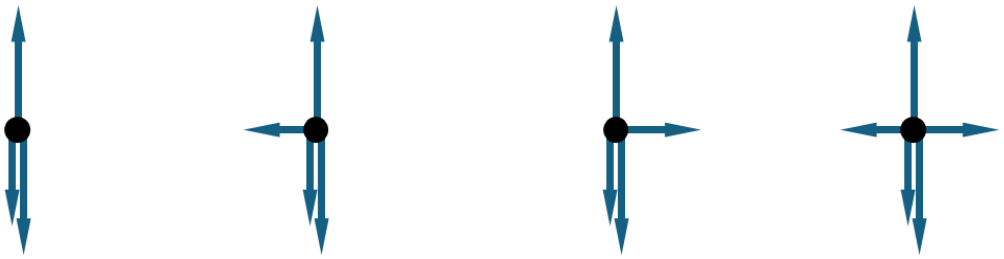
c) What is the direction of the block's acceleration at point C?

* Down the incline (*) Up the incline * Zero

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

Q1. Three boxes are stacked on top of each other on a horizontal table, as shown. A horizontal force ($\vec{F}$) is applied to box A, causing all the boxes to move with the **same acceleration**. Which of the following correctly represents **the free-body diagram of box B?**





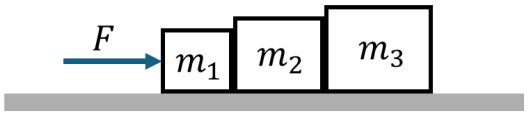
* * * (*)

Q2. A woman with mass (m) stands on a bathroom scale in an elevator. While the elevator is **slowing down as it goes downward, the scale (n) reads**

(*) $n > mg$ * $n = mg$

* $n < mg$ * $n = 0$

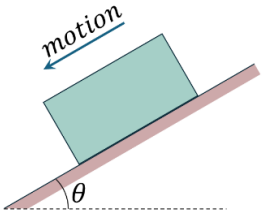
Q3. Three boxes ($m_1 < m_2 < m_3$) are in contact on a **rough** horizontal surface, as shown. A constant horizontal force acts on box 1, and the system moves to the right **at a constant acceleration**. **Which box has the lowest net force?**



(*) box 1 * box 2

* box 3 * all the same

Q4. A block is sliding down a **rough** incline, as shown. If the **total work done on the block is zero**, which of the following is correct about the weight (mg) and the magnitude of friction (f_k)?



* $mg < f_k$ (*) $mg > f_k$ * $mg = f_k = 0$ * $mg = f_k \neq 0$