Kuwait University Physics Department

جامعة الكويت
KUWAIT UNIVERSITY

Physics 101

Fall Semester
Second Midterm Exam
Saturday, November 29, 2025
8:00 – 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, 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

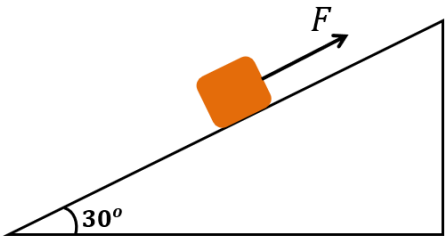
Important:

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. Please box your answers.
8. **Cheating incidents will be processed according to the university rules.**

GOOD LUCK

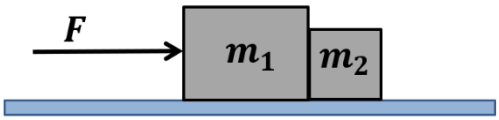
Part I: Short Problems (2 points each)

SP1. A block of mass $m = 22\ kg$ is pulled by a constant force $\vec{F}$ up **a frictionless** incline , as shown. If the block moves up the incline at **constant speed**, **find the magnitude of the force $|\vec{F}|$.**



$$F - mg\sin\theta = 0$$
$$F = mg\sin\theta = 110\ N$$

SP2. Two blocks ($m_1 = 7\ kg$, $m_2 = 3\ kg$) are in contact on a horizontal, **frictionless** surface, as shown. A horizontal force $\vec{F} = 30\ N$ is applied to block 1. **Find the magnitude of the force that block 1 exerts on block 2**.

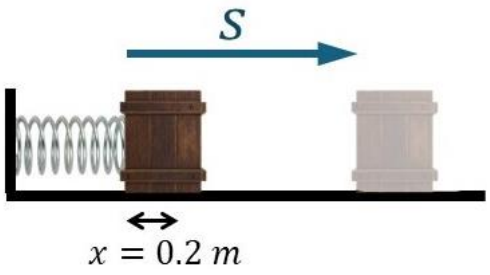


$$F = (m_1 + m_2)a$$
$$a = \frac{F}{(m_1 + m_2)} = \frac{30}{10} = 3\ m/s^2$$
$$F_{12} = m_2 a = 3(3) = 9\ N$$

SP3. A constant net force $\vec{F} = (3\hat{\imath} + 4\hat{\jmath})\ N$ acts on an object that starts moving from **the origin** at $t = 0$ and reaches a position $\vec{r} = (12\hat{\imath} + 16\hat{\jmath})\ m$ at $t = 4s$. **Find the average power delivered by $\vec{F}$.**

$$w = \vec{F}.\vec{S} = 3(12) + 4(16) = 100\ J$$
$$P_{av} = \frac{\Delta W}{\Delta t} = \frac{100}{4} = 25\ W$$

SP4. A box of mass 5 kg, which compresses a spring ($k = 900\ N/m$) by 0.2 m, is released from **rest** such that the spring pushes the box along a **rough** horizontal surface ($\mu_k = 0.45$), as shown. **Find the maximum distance *S* that the box will travel.** (Note: The box is not attached to the spring).



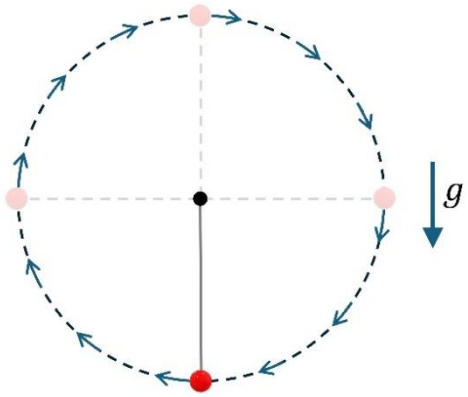
$$W_{tot} = W_g + W_n + W_s + W_{fk} = \Delta K = 0$$

$$0 + 0 + \frac{1}{2}kx^2 - f_k S = 0$$

$$\frac{1}{2}(900)(0.2)^2 - (0.45)(5)(10)S = 0$$

$$S = 0.8 \text{ m}$$

SP5. A 0.5 kg ball is connected to a light string and rotates in **a vertical circle** of radius 3 m, as shown. If the **string breaks** when the tension reaches its maximum value of 33 N, **what is the maximum speed the ball can have while continuing to rotate?**



Maximum speed at the botttom:

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

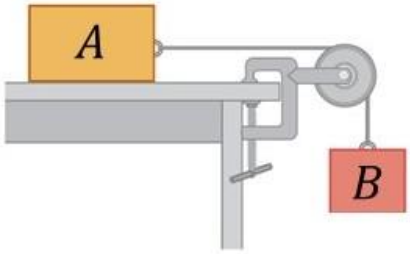
$$33 - 5 = \frac{0.5v_{max}^2}{3}$$

$$v_{max} = 13\ \frac{m}{s}$$

Part II: Long Problems (3 points each)

LP1. Box A of mass 10 kg **rests on a rough** horizontal surface ($\mu_s = 0.4$, $\mu_k = 0.37$) is connected to box B of mass 3 kg by a light string that passes over frictionless light pulley, as shown.

a) Find the static friction force acting on box *A*.



For m_A:

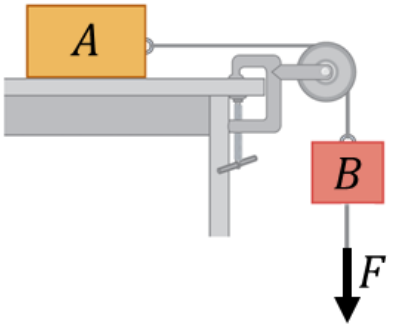
$T - f_s = 0$

For m_B:

$m_B g - T = 0$

So, $f_s = m_B g = 30 = 30\ N$

b) A pulling force $|\vec{F}|$ is applied to box B. Find the magnitude of the <u>minimum pulling force $|\vec{F}|$ required</u> to make the boxes start moving.



For m_A:

$T - f_{smax} = 0$

For m_B:

$F_{min} + m_B g - T = 0$

So, $F_{min} = f_{smax} - m_B g$

$F_{min} = \mu_s(m_A g) - m_B g$

$F_{min} = 0.4(100) - 30 = 10\ N$

c) After the boxes start moving, find the magnitude of the pulling force $|\vec{F}|$ required to make the boxes move at <u>constant speed</u>.

For m_A:

$T - f_k = 0$

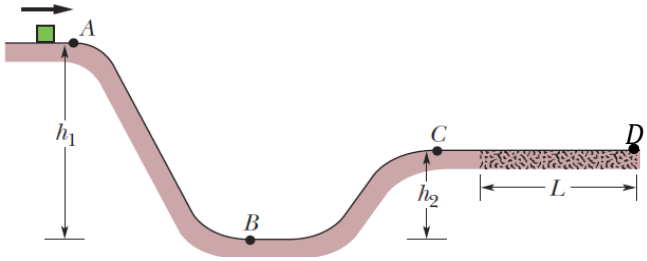
For m_B:

$F + m_B g - T = 0$

So, $F = f_k - m_B g = \mu_k(m_A g) - m_B g$

$F = 0.37(100) - 30 = 7\ N$

LP2. A small block of mass $m = 0.5\ kg$ passes through **point A** with a speed of $5\ m/s$. Its path is frictionless until it reaches the section of length $L = 12\ m$, where the coefficient of kinetic friction is μ_k. The indicated heights are $h_1 = 4\ m$ and $h_2 = 2\ m$.



a) Find the change in the gravitational potential energy as the block moves from A to B.

$$\Delta U_g = -w_{mg} = -mgh_1 = -0.5(10)(4)$$
$$= -20\ J$$

b) Find the speed of the block at point C.

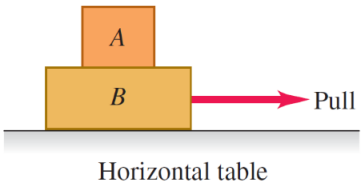
$$E_A = E_C$$
$$mgh_1 + \frac{1}{2}mv_A^2 = mgh_2 + \frac{1}{2}mv_C^2$$
$$20 + \frac{1}{2}(0.5)(5^2) = 10 + \frac{1}{2}(0.5)(v_c^2) \Rightarrow v_C = 8.1\ m/s$$

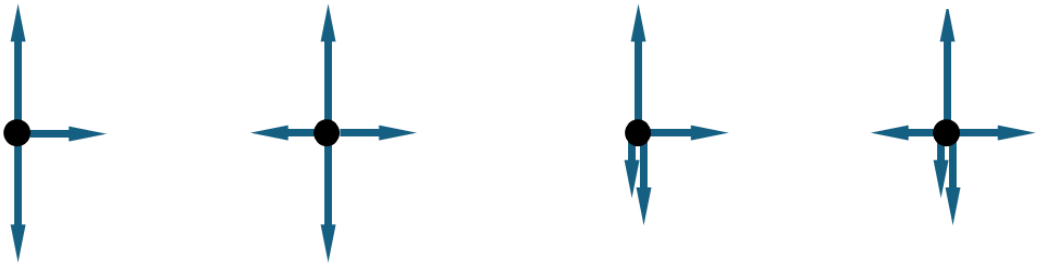
c) If the block completely stops at point D, find μ_k.

$$E_D - E_C = w_{f_k}$$
$$0 - \frac{1}{2}mv_C^2 = -\mu_k mgd$$
$$-\frac{1}{2}(0.5)(8.1)^2 = -\mu_k(0.5)(10)(12)$$
$$\mu_k = 0.27$$

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

Q1. You pull horizontally on block B, as shown, causing **both blocks to accelerate together as a unit**. Which of the following correctly represents **the free-body diagram of block *B*** if **the table is frictionless**?



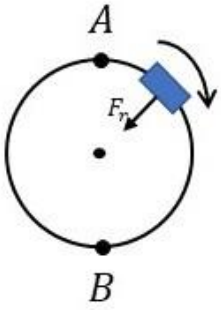


* * * (*)

Q2. A **30 kg** boy stands on a scale while riding in the elevator. **If the scale reads 330 N, then the elevator is moving:**

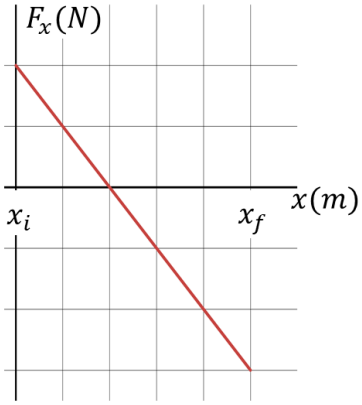
* downward with increasing speed.
(*) downward with decreasing speed.
* upward with decreasing speed.
* upward with constant speed.

Q3. **The work done by a radial force ($\vec{F}_{rad}$)** on an object moving in a circle from point A to point B **with increasing speed** is:



(*) $W = 0$
* $W = \Delta K$
* $W = |\vec{F}_{tan}||\vec{S}|$
* $W = |\vec{F}_{rad}||\vec{S}|$

Q4. A particle is under the influence of **a net force along the *x*-axis** whose graph is shown. **Which of the following statements is true about its initial speed (v_i) at x_i and its final speed (v_f) at x_f?**



(*) $v_i > v_f$
* $v_i < v_f$
* $v_i = v_f \neq 0$
* $v_i = v_f = 0$