

Physics 101

Spring Semester

Final Exam

Monday, May 11, 2026

12:00 PM - 2:00 PM

Student's Name: Serial Number:

Student's Number:Section:

Choose your Instructor's Name:

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

For Instructors use only

Grades:

#	SP1	SP2	SP3	SP4	SP5	SP6	SP7	LP1	LP2	LP3	Q1	Q2	Q3	Q4	Total
	3	3	3	3	3	3	3	5	5	5	1	1	1	1	40
Pts															

Important:

1. Answer all questions and problems (No solution = no points).
2. Full mark = 40 points as arranged in the above table.
3. **Give your final answer in the correct units.**
4. Assume $g = 10 \text{ m/s}^2$.
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.**

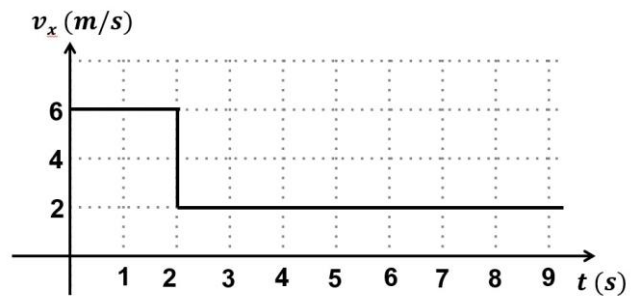
GOOD LUCK

Part I: Short Problems (3 points each)

SP1. The velocity of an object moving along the x-axis varies with time as shown. Find the **average acceleration** during the time interval from $t = 0$ s to $t = 6$ s.

$$a_{av} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

$$a_{av} = \frac{2-6}{6-0} = -0.67 \text{ m/s}^2$$



SP2. A disc initially rotates with an angular speed of **20 rad/s**. It slows down with a **constant angular acceleration** and comes to rest after **40 s**. How many **radians** does the disc make during this period?

$$\omega_f = \omega_i + \alpha t$$

$$0 = 20 + \alpha(40) \Rightarrow \alpha = -0.5 \text{ rad/s}^2$$

$$\Delta\theta = \omega_i t + \frac{1}{2} \alpha t^2 = 20(40) + \frac{1}{2}(-0.5)(40^2) = 400 \text{ rad}$$

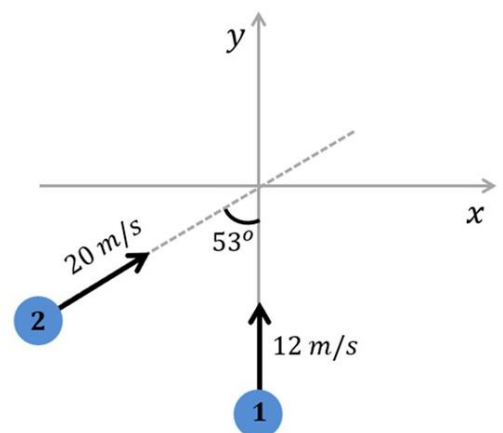
SP3. Two **identical** point masses ($m_1 = m_2 = 2 \text{ kg}$) move in the xy -plane with initial velocities, as shown. The masses collide at the origin and **stick together** after the collision. Find their final common velocity in **unit vector notation** immediately after the collision.

$$\Sigma \vec{P}_i = \Sigma \vec{P}_f$$

$$m\vec{v}_{1i} + m\vec{v}_{2i} = 2m\vec{v}_f$$

$$(12\hat{j}) + (20 \sin(53^\circ) \hat{i} + 20 \cos(53^\circ) \hat{j}) = 2\vec{v}_f$$

$$\vec{v}_f = (8\hat{i} + 12\hat{j}) \text{ m/s}$$



SP4. A 6 kg box, initially at **rest** at point A, is pulled 4 m along a **rough** horizontal surface by a constant force $F = 21\text{ N}$, as shown. The coefficient of kinetic friction between the box and the surface is $\mu_k = 0.3$.

Find the speed of the box at point B.



$$E_f - E_i = W_{\text{other}}$$

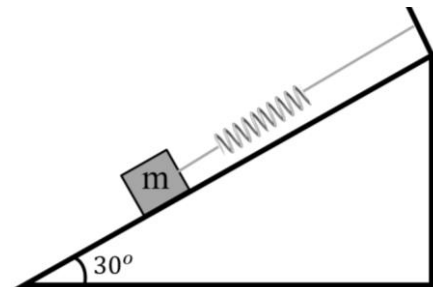
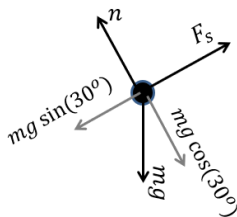
$$\frac{1}{2}mv_B^2 - 0 = W_F + W_{f_k}$$

$$\frac{1}{2}mv_B^2 = Fd - \mu_k mgd$$

$$\frac{1}{2}(6)v_B^2 = (21)(4) - (0.3)(6)(10)(4) \Rightarrow v_B = 2\text{ m/s}$$

SP5. A block of mass $m = 15\text{ kg}$ **rests** on a **frictionless** incline and is attached to a spring, as shown. The spring is stretched by 0.3 m when the **system is in equilibrium**.

- Draw the **free-body diagram** of the block
- Determine the force constant of the spring k .



The system is in equilibrium $\Rightarrow a = 0$

$$F_s - mg \sin(30^\circ) = 0$$

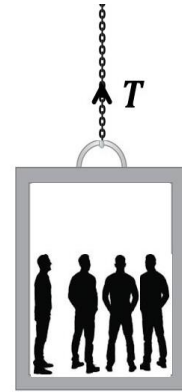
$$kx = mg \sin(30^\circ) \Rightarrow k = \frac{mg \sin(30^\circ)}{x} = 250\text{ N/m}$$

SP6. An elevator carrying passengers has a combined mass of 600 kg . **What power must the motor deliver** when the elevator is moving **upward** at a speed of 2 m/s and **speeding up** with an acceleration of magnitude 1 m/s^2 ?

$$T - mg = ma$$

$$T = m(g + a) = 6600\text{ N}$$

$$P = Tv = (6600)(2) = 13200\text{ W}$$

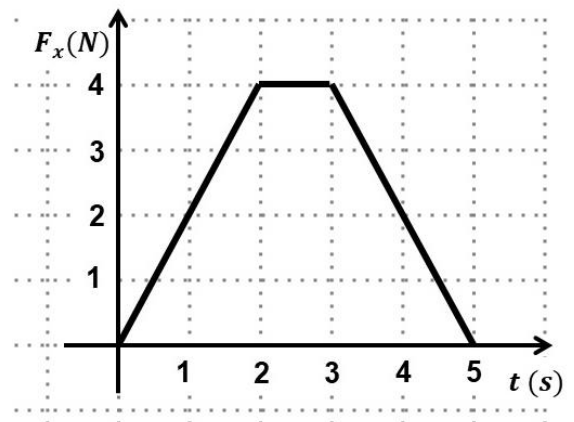


SP7. A 2 kg object starts from **rest** at $t = 0$ and moves along the $x - axis$. The time-dependent net force $F_x(t)$ acting on the object is shown in the figure. **Find the object's speed at $t = 5\text{ s}$.**

$$\vec{j} = \int_0^5 F dt = \text{area under the curve} = \Delta\vec{P}$$

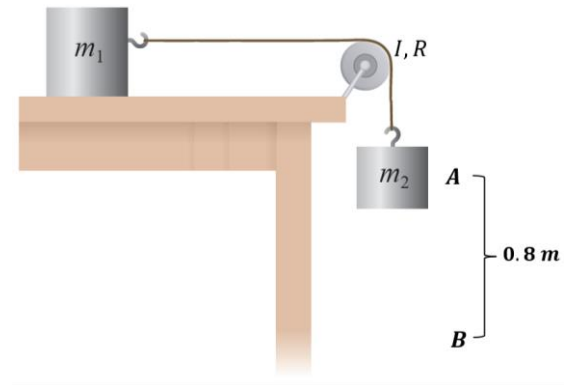
$$\frac{1}{2} \times 2 \times 4 + 1 \times 4 + \frac{1}{2} \times 2 \times 4 = m\vec{v}_f - m\vec{v}_i$$

$$\Rightarrow \vec{v}_f = 6\hat{i}\text{ m/s} \quad \Rightarrow |\vec{v}_f| = 6\text{ m/s}$$



Part II: Long Problems (5 points each)

LP1. Block 1, of mass $m_1 = 4 \text{ kg}$, rests on a **frictionless** horizontal table and is connected by a light rope passing over a pulley to block 2, of mass $m_2 = 6 \text{ kg}$, as shown. The pulley has radius $R = 0.2 \text{ m}$ and a moment of inertia I . The system is **released from rest** when block 2 is at point A, and its speed becomes 3 m/s when it reaches point B.



- a) Find the angular speed of the pulley when block 2 reaches point B.

$$\omega_f = \frac{v_f}{R} = \frac{3}{0.2} = 15 \text{ rad/s}$$

- b) Find the moment of inertia of the pulley.

$$E_i = E_f$$

$$m_2 g y_i = \frac{1}{2} (m_1 + m_2) v_f^2 + \frac{1}{2} I \omega_f^2$$

$$6(10)(0.8) = \frac{1}{2} (10) 3^2 + \frac{1}{2} I (15^2) \Rightarrow I = 0.027 \text{ kg} \cdot \text{m}^2$$

- c) If the pulley was massless, then the speed of block 2 at point B would be:

- more than 3 m/s
- * less than 3 m/s
- * equal to 3 m/s

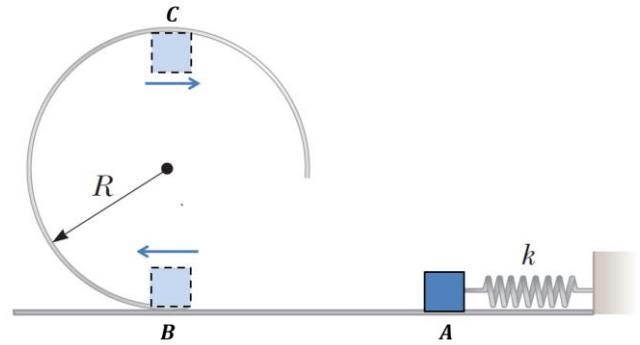
LP2. A block of mass $m = 0.5 \text{ kg}$ is released from **rest** when the spring ($k = 450 \text{ N/m}$) was compressed a distance of $x = 0.3 \text{ m}$ at point A. It moves along a **frictionless** horizontal surface to point B, and then continues up a **vertical frictionless circular track** of radius $R = 1.4 \text{ m}$, as shown.

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

$$E_A = E_B$$

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

$$v_B = \sqrt{\frac{k}{m}x_A} = \sqrt{\frac{450}{0.5}(0.3)} = 9 \text{ m/s}$$



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

$$E_B = E_C$$

$$\frac{1}{2}mv_B^2 = \frac{1}{2}mv_C^2 + mg(2R)$$

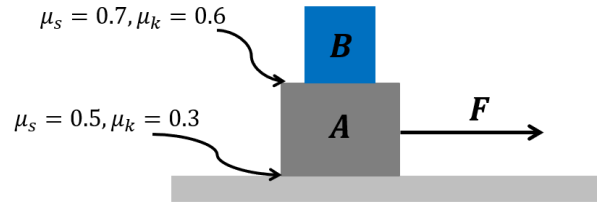
$$v_C = \sqrt{v_B^2 - 4gR} = \sqrt{9^2 - 4(10)(1.4)} = 5 \text{ m/s}$$

c) Find the magnitude of the normal force exerted on the block at point C.

$$n_C + mg = m\frac{v_C^2}{R}$$

$$n_C = m\left(\frac{v_C^2}{R} - g\right) = 3.9 \text{ N}$$

LP3. Two blocks have masses $m_A = 25 \text{ kg}$ and $m_B = 15 \text{ kg}$. Block B rests on top of block A. A constant force is applied to block A as shown, and the two blocks move to the right. **Block B does not slide on block A.**



- a) Find the magnitude and direction of the frictional force acting on block A, when the system moves with constant velocity.

$$f_k = \mu_k(m_A + m_B)g = 0.3(40)(10) = 120 \text{ N}$$

(to the left, only from the lower surface)

- b) Find the magnitude and direction of the frictional force acting on block B, when the system moves with constant velocity.

$$f_{\text{friction}}(\text{on block B}) = 0, \text{ (because } a = 0\text{)}$$

- c) If the applied force is increased to $F = 220 \text{ N}$, find the magnitude of the acceleration of the system.

$$F - f_k = (m_A + m_B)a$$

$$220 - 120 = 40a \Rightarrow a = 2.5 \text{ m/s}^2$$

- d) If the applied force is $F = 220 \text{ N}$, find the magnitude and direction of the frictional force acting on block B.

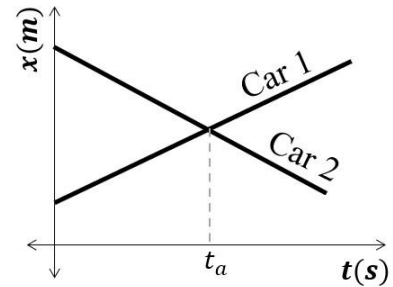
$$f_s = m_B a = 15(2.5) = 37.5 \text{ N to the right}$$

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

Q1. The position-versus-time graph for two cars moving along the x-axis in two parallel lanes is shown.

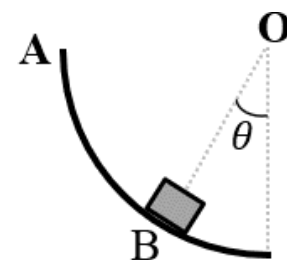
At time t_a , the two cars have:

- different velocities, and the same acceleration.
- * the same velocity, and different accelerations.
- * the same velocity, and the same acceleration.
- * different velocities, and different accelerations.



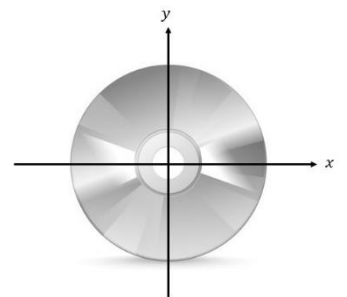
Q2. A block of mass m is released from rest at point A and slides down a frictionless quarter-circular surface, as shown. As the block passes point B, which of the following is correct about the magnitude of the normal force on the block, n ?

- * $n = mg \cos \theta$
- * $n < mg \cos \theta$
- $n > mg \cos \theta$
- * $n = 0$



Q3. A disc rotates about an axis passing through its center. If both its angular velocity and angular acceleration are negative, then which of the following statements is correct?

- * The disc is rotating clockwise and slowing down.
- The disc is rotating clockwise and speeding up.
- * The disc is rotating counterclockwise and slowing down.
- * The disc is rotating counterclockwise and speeding up.



Q4. A particle moves along the x-axis. Its linear momentum varies with time as shown. Rank the numbered regions according to the magnitude of the net force acting on the particle, from smallest to greatest.

- 1-2-3
- * 2-3-1
- * 3-2-1
- * 2-1-3

