Kuwait University   Physics Department

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

Model Answer

For Instructors use only

Grades:

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

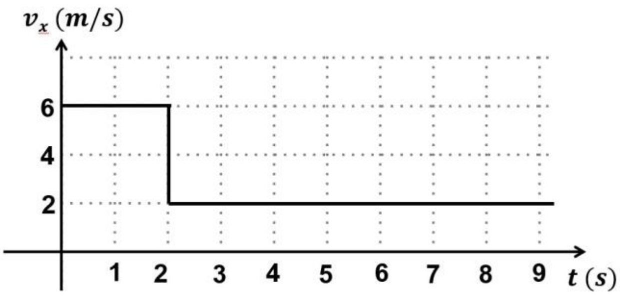
Important:

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 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 $t = 6\ s$.**



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

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

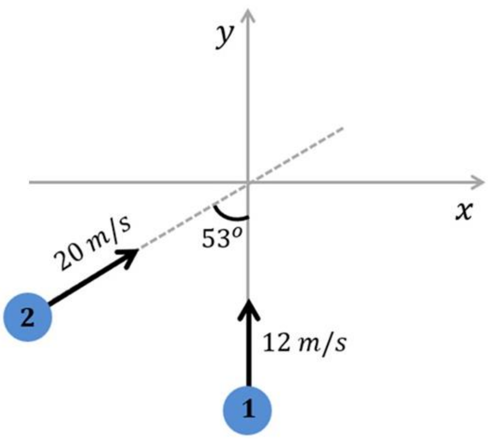
SP2. A disc initially rotates with an angular speed of **20 rad/s**. It slows down with a **constant angular acceleration** and comes to rest after **$40\ s$**. **How many radians does the disc make during this period?**

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

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

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

SP3. Two **identical** point masses ($m_1 = m_2 = 2\ kg$) 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.



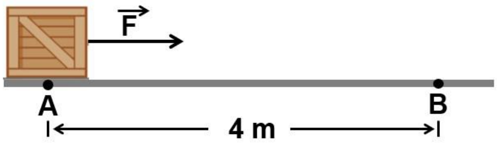
$$\sum \vec{P}_i = \sum \vec{P}_f$$

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

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

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

SP4. A 6 kg box, initially at **rest** at point A, is pulled 4 m along **a rough** horizontal surface by a constant force $F = 21\ N$, 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**.



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

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

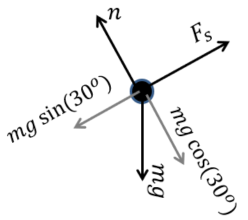
$$\frac{1}{2}mv_B^2 = Fd - \mu_k mgd$$

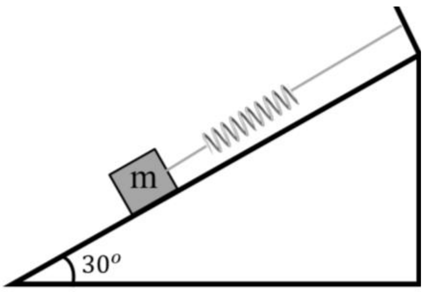
$$\frac{1}{2}(6)v_B^2 = (21)(4) - (0.3)(6)(10)(4) \Rightarrow v_B = 2\ m/s$$

SP5. A block of mass $m = 15\ kg$ **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**.

a) **Draw the free-body diagram of the block**

b) **Determine the force constant of the spring k.**





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

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

$$kx = mg\sin(30^0) \Rightarrow k = \frac{mg\sin(30^0)}{x} = 250\ N/m$$

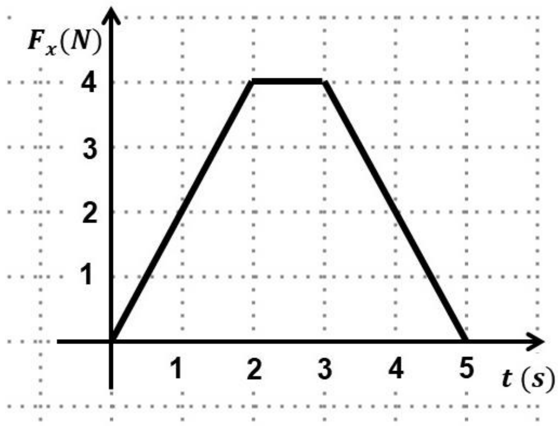
SP6. An elevator carrying passengers has a combined mass of $600\ kg$. **What power must the motor deliver** when the elevator is moving **upward** at a speed of $2\ m/s$ and **speeding up** with an acceleration of magnitude $1\ m/s^2$?

$T - mg = ma$

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

$P = Tv = (6600)(2) = 13200\ W$

SP7. A $2\ kg$ object moves to the right with an initial speed of $2\ m/s$ at $t = 0$. The time-dependent net force $F_x(t)$ acting on the object along the $x - axis$ is shown in the figure. **Find the object's speed at $t = 5\ s$.**



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

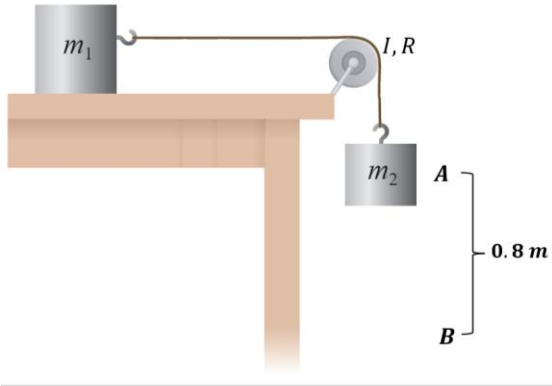
$\frac{1}{2} \times 2 \times 4 + 1 \times 4 + \frac{1}{2} \times 2 \times 4 = 2\vec{v}_f - 2(2\hat{\imath})$

$\Rightarrow \vec{v}_f = 8\hat{\imath}\ m/s \quad \Rightarrow |\vec{v}_f| = 8\ m/s$

Part II: Long Problems (5 points each)

LP1. Block 1, of mass $m_1 = 4\ kg$, rests on **a frictionless** horizontal table and is connected by a light rope passing over a pulley to block 2, of mass $m_2 = 6\ kg$, as shown. The pulley has radius $R = 0.2\ m$ 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.**



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

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

$$E_i = E_f$$

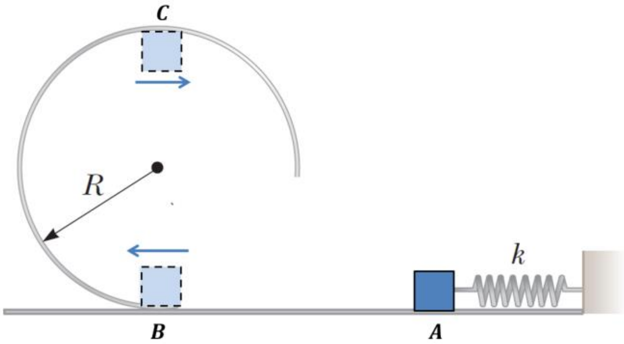
$$m_2 g y_i = \frac{1}{2}(m_1 + m_2)v_f^2 + \frac{1}{2}I\omega_f^2$$

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

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



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

$$E_A = E_B$$

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

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

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

$$E_B = E_C$$

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

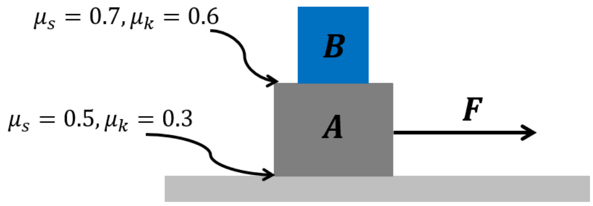
$$v_c = \sqrt{v_B^2 - 4gR} = \sqrt{9^2 - 4(10)(1.4)} = 5\ m/s$$

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

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

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

LP3. Two blocks have masses $m_A = 25\ kg$ and $m_B = 15\ kg$. 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 <u>does not</u> slide on block A.**



a) **Find the magnitude and direction of the frictional force acting on block A, when the system moves with <u>constant velocity</u>.**

$f_k = \mu_k(m_A + m_B)g = 0.3(40)(10) = 120\ N$
(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 <u>constant velocity</u>.**

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

c) **If the applied force is <u>increased</u> to $F = 220\ N$, find the magnitude of the acceleration of the system.**

$F - f_k = (m_A + m_B)a$
$220 - 120 = 40a \ \Rightarrow a = 2.5\ m/s^2$

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

$f_s = m_B a = 15(2.5) = 37.5\ N$ 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.

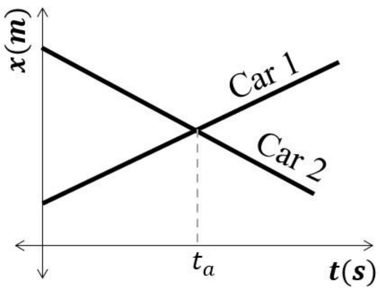
At time t_a, the two cars have:

∗ different velocities, and the same acceleration.

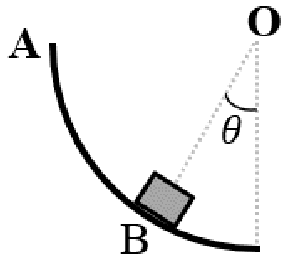
∗ the same velocity, and different accelerations.

∗ 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**?



∗ $n = mg\cos\theta$

∗ $n < mg\cos\theta$

∗ $n > mg\cos\theta$

∗ $n = 0$

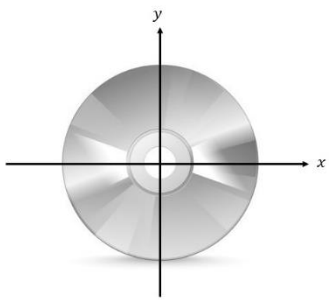
Q3. A disc rotates about an axis passing through its center. **If both its angular velocity and angular acceleration are negative**, then which of the following statements is correct?

∗ 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