

Physics 121

First Midterm Exam

Fall Semester (2025-2026)

October 25, 2025
Time: 14:00 – 15:30

Student's Name: Serial Number:

Student's Number: Section:

Instructors: Drs. Al-Refae, Alfailakawi, Alotaibi, Burahmah, Hadipour, Kokkalis, Razee

Important:

1. Answer all questions and problems (No solution = no points).
2. Full mark = 27 points as arranged in the table below.
3. **Give your final answer in the correct units.**
4. Assume $g = 9.8 \text{ m/s}^2$.
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.**

For use by instructors

Grades:

#	P1	P2	P3	P4	P5	P6	P7	Total
Pts	3	4	4	4	4	4	4	27

GOOD LUCK

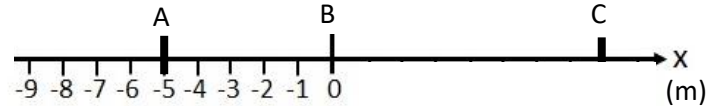
P1. A person begins to move on x-axis from point A to point B with constant acceleration 2.8 m/s^2 . Then, after a short break and with the same initial speed (v_B), he travels further from point B with constant acceleration -2 m/s^2 and come to rest at point C in total time of 0.4 minutes.

a) Find the position of the point C on the x-axis.

(2 points)

b) What is average velocity $\bar{v}$ of the person for whole trip?

(1 point)



$$v_B^2 = v_A^2 + 2a(x_B - x_A) \rightarrow v_B = 5.3 \frac{\text{m}}{\text{s}}$$

$$v_C^2 = v_B^2 + 2a(x_C - x_B) \rightarrow x_C = +7 \text{ m}$$

$$\bar{v} = \frac{\Delta x}{t} = \frac{x_C - x_A}{t} = \frac{7 - (-5)}{0.4 \times 60} = 0.5 \frac{\text{m}}{\text{s}}$$

P2. Ball A is dropped from top of a building that is 120 m high, while ball B is thrown vertically upward from the ground with an initial velocity of 25 m/s . Ignore air resistance.

a) After how long both balls meet at the same height?

(3 points)

b) At that moment, what is their height?

(1 point)

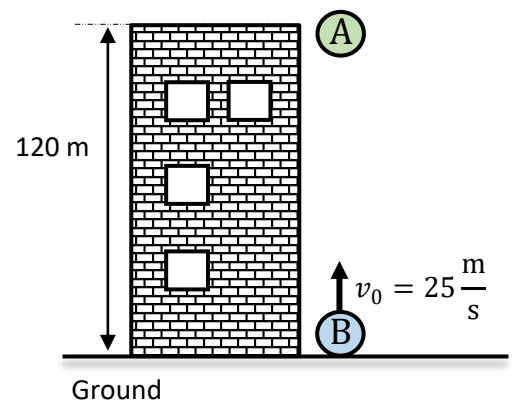
Ball A:

$$y_A = y_0 + v_0 t + \frac{1}{2} g t^2 \rightarrow y_A = 120 + 0 + \frac{1}{2} g t^2$$

Ball B:

$$y_B = y_0 + v_0 t + \frac{1}{2} g t^2 \rightarrow y_B = 0 + 25t + \frac{1}{2} g t^2$$

$$y_A = y_B = h \rightarrow 120 = 25t \rightarrow t = 4.8 \text{ s}$$



$$h = y_B = 25t + \frac{1}{2} g t^2 = 25 \times 4.8 + \frac{1}{2} \times (-9.8) \times (4.8)^2 = 7.1 \text{ m}$$

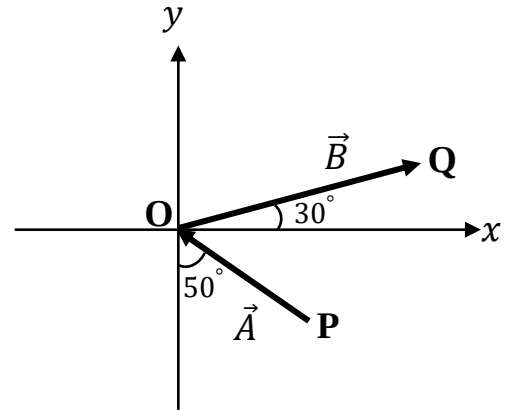
P3. A person walks from point **P** to point **Q** by following paths $A = 200$ m and $B = 350$ m as shown in figure. Find the magnitude and direction of his total displacement. **(4 points)**

$$D_x = A_x + B_x = -A \sin 50^\circ + B \cos 30^\circ = 149.9 \text{ m}$$

$$D_y = A_y + B_y = A \cos 50^\circ + B \sin 30^\circ = 303.5 \text{ m}$$

$$D = \sqrt{D_x^2 + D_y^2} = 338.5 \text{ m}$$

$$\tan \theta = \frac{D_y}{D_x} \rightarrow \theta = \tan^{-1} \left(\frac{303.5}{149.9} \right) = 63.7^\circ$$



P4. Block $m_1 = 12$ kg is fixed on top of block $m_2 = 18$ kg that is resting on rough horizontal ground. A horizontal force with magnitude $F = 260$ N is applied on block 2, as shown in figure. The kinetic coefficient of friction between block 2 and the ground is $\mu_k = 0.3$.

a) Find the acceleration of each block.

(3 points)

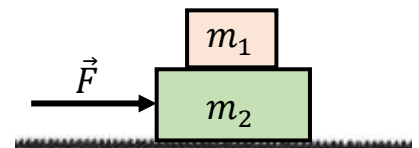
b) What is the contact force between two blocks?

(1 point)

$$F - F_{fr} = (m_1 + m_2)a \rightarrow F - \mu_k F_N = (m_1 + m_2)a$$

$$F_N = (m_1 + m_2)g$$

$$a = \frac{F - \mu_k (m_1 + m_2)g}{m_1 + m_2} = 5.72 \frac{\text{m}}{\text{s}^2}$$



$$|F_{21}| = |F_{12}| = m_1 g = 12 \times 9.8 = 117.6 \text{ N}$$

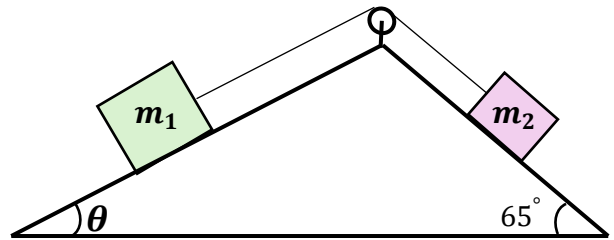
P5. Two boxes of mass $m_1 = 10$ kg and $m_2 = 7$ kg are connected by a massless cord over a frictionless pulley as shown. Find the angle θ so that boxes remain at rest. Ignore frictions. (4 points)

$$T - m_1 g \sin \theta = 0 \rightarrow T = m_1 g \sin \theta$$

$$m_2 g \sin 65^\circ - T = 0 \rightarrow T = m_2 g \sin 65^\circ$$

$$m_1 g \sin \theta = m_2 g \sin 65^\circ \rightarrow \sin \theta = \frac{m_2 \sin 65^\circ}{m_1}$$

$$\sin \theta = \frac{7 \times 0.9}{10} = 0.63 \rightarrow \theta = 39^\circ$$

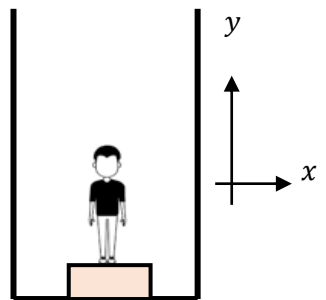


P6. An 85 kg person stands on a scale in an elevator. Shortly, before the elevator stops, the scale reading is 78 kg.

- a) Calculate the magnitude and direction of the acceleration of the elevator. (3 points)
 b) Is the elevator moving upward or downward before it stops? (1 point)

$$F_N - mg = ma$$

$$a = \frac{F_N - mg}{m} = \frac{g \times (78 - 85)}{85} = -0.81 \text{ m/s}^2$$



Upward, the elevators moving from the ground to the top floor.

($v_0 > v = 0$ & $a = \text{downward} \rightarrow v = \text{upward}$)

P7. A coin is placed 5 cm from the axis of a rotating turntable of variable speed. The coefficient of static friction between the coin and the table is $\mu_s = 0.4$. Find the maximum frequency of the turntable to keep the coin from sliding off the table. **(4 points)**

$$\sum F_R = \frac{mv^2}{r} = F_{fr}$$

$$F_{fr} = \mu_s mg \rightarrow \mu_s mg = \frac{mv^2}{r}$$

$$v = \sqrt{r\mu_s g} \rightarrow v = 0.44 \text{ m/s}$$

$$f = \frac{v}{2\pi r} = 1.4 \text{ 1/s}$$

