Kuwait University Physics Department

جامعة الكويت
KUWAIT UNIVERSITY

Physics 121

Midterm I Exam
Fall Semester (2024-2025)

October 26, 2024
Time: 14:00 – 15:30

Student's Name: ……..…….…… Serial No: ……

Student's Number: ….…… Section No: ……

Instructors: Drs. Abdulmohsen, Alfailakawi, Alotaibi, Alrefai, Burahmah, Hadipour, Kokkalis, Razee

---

Important Instructions to the Students:

1. Answer all questions and problems.
2. Full mark = 29 points as arranged in the table below.
3. No solution = no points.
4. **Use SI units.**
5. Take g = 9.8 m/s^2.
6. Mobiles are **strictly prohibited** during the exam.
7. Programmable calculators, which can store equations, are not allowed.
8. **Cheating incidents will be processed according to the university rules.**

For use by Instructors only

#	P1	P2	P3	P4	P5	P6	P7	Total
Pts	4	4	4	5	4	4	4	29

GOOD LUCK

P1. A bicycle travels with constant velocity from point P to point Q, by following the paths $A = 60$ m, $B = 85$ m, and $C = 55$ m, as shown. The total time of the trip is 0.5 min.

a) Find the **magnitude of the displacement** of the bicycle. **(3 points)**

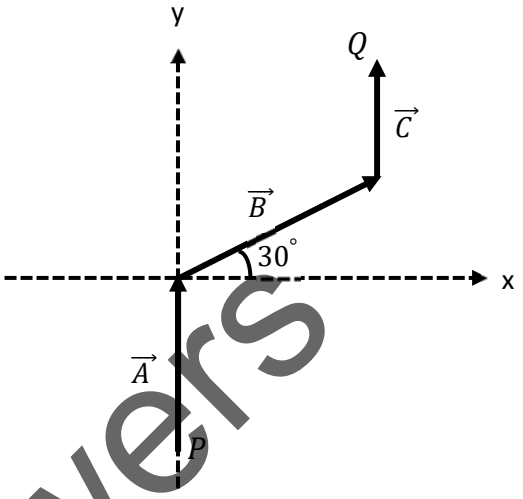
b) Find the **average speed** of the bicycle for the whole trip. **(1 point)**

$$D_x = A_x + B_x + C_x = 0 + B\,cos30^\circ + 0 = 73.6 \text{ m}$$

$$D_y = A_y + B_y + C_y = A + B\,sin30^\circ + C = 157.5 \text{ m}$$

$$D = \sqrt{D_x^2 + D_y^2} = \sqrt{(73.6)^2 + (157.5)^2} = 173.8 \text{ m}$$

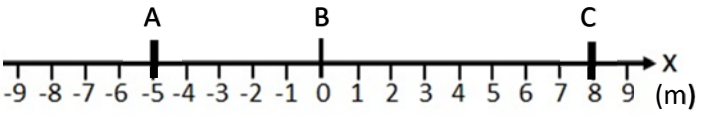
$$\bar{s} = \frac{Distance}{time} = \frac{60 + 85 + 50}{0.5 \times 60} = 6.67 \ {}^{\text{m}}/_{\text{s}}$$



P2. A car travels on x-axis from point A to point B in 2.5 s with **constant velocity**. Then, it travels to point C with **uniform acceleration** $2\ \text{m/s}^2$.

a) **Find the final velocity** of the car at point C. **(2 points)**

b) **Find the average velocity** of the car for the whole trip. **(2 points)**



$$v_B = \frac{\Delta x}{t} = \frac{x_B - x_A}{t} = \frac{0 - (-5)}{2.5} = 2 \ {}^{\text{m}}/_{\text{s}}$$

$$v_C^2 = v_B^2 + 2a(x_C - x_B) \rightarrow v_C = 6 \ {}^{\text{m}}/_{\text{s}}$$

$$v_C = v_B + at \rightarrow t = 2\ s$$

$$\bar{v} = \frac{Displacement}{total\ time} = \frac{\Delta x}{\Delta t} = \frac{8 - (-5)}{2.5 + 2} = 2.9 \ {}^{\text{m}}/_{\text{s}}$$

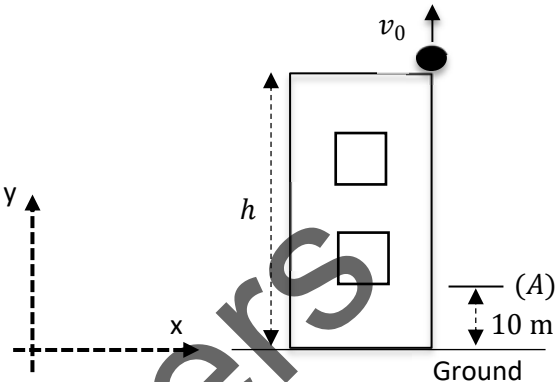
P3. A ball is thrown upward with $v_o = 15$ m/s from the edge of a building, so that later can reach the ground. At 10 m above the ground (point A), the ball's speed is 45 m/s. Ignore air resistance.

a) **Find the height (h)** of the building. **(2 points)**

b) **How long** does it take for the ball to reach point A? **(2 points)**

$$v^2 = v_0^2 + 2a(y - y_0) \rightarrow v^2 = v_0^2 + 2a(10 - h)$$

$$(-45)^2 = (15)^2 + 2(-9.8)(10 - h) \rightarrow h = 101.8 \text{ m}$$



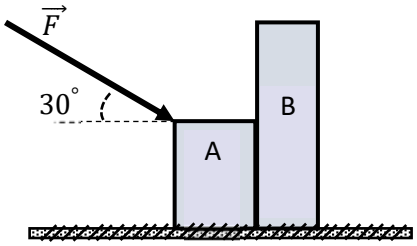
$$v = v_0 + at$$

$$-45 = 15 + (-9.8)t \rightarrow t = 6.1 \text{ s}$$

P4. Two boxes A ($m_A = 8$ kg), and B ($m_B = 5$ kg) are in contact and placed on a rough surface ($\mu_k = 0.2$). When a constant force $\overrightarrow{F}$ is applied to box A, the acceleration of the system is 2 m/s^2.

a) **Find the contact force between box A and B.** **(2 points)**

b) **Find the magnitude of the force $\overrightarrow{F}$.** **(3 points)**



Box B

$$\sum F_x = m_B a_x \rightarrow F_{AB} - \mu_k m_B g = m_B a$$

$$F_{AB} = m_B(a + \mu_k g) \rightarrow F_{AB} = 19.8 \text{ N}$$

Box A:

$$F_{fr} = \mu_k(m_A g + F sin30^\circ)$$

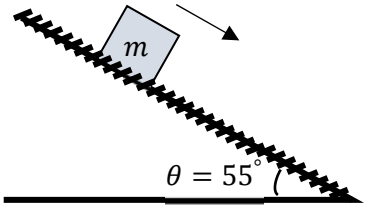
$$\sum F_x = m_A a_x \rightarrow F cos30^\circ - F_{AB} - \mu_k(m_A g + F sin30^\circ) = m_A a$$

$$F = \frac{F_{AB} + m_A(\mu_k g + a)}{cos30^\circ - \mu_k sin30^\circ} \rightarrow F = 67.2 \text{ N}$$

P5. A box ($m = 18$ kg) is sliding down a **rough inclined surface** with uniform acceleration 6.5 $\mathrm{m/s^2}$, as shown in figure.

a) **Draw the free-body diagram** of the mass m. **(1 point)**

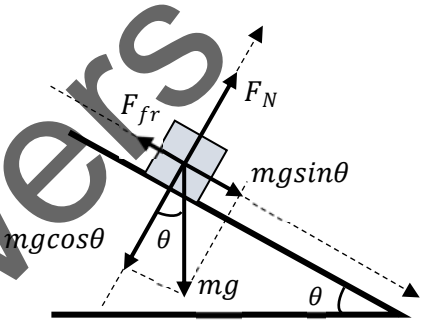
b) **Find the kinetic coefficient of friction (μ_k),** between the box and the surface. **(3 points)**



$$\sum F_x = ma_x \rightarrow mgsin55^\circ - F_{fr} = ma$$

$$F_{fr} = m\left(gsin55^\circ - a\right) \rightarrow F_{fr} = 27.5 \text{ N}$$

$$F_{fr} = \mu_k \times F_N \rightarrow \mu_k = \frac{F_{fr}}{F_N} = \frac{F_{fr}}{mgcos55^\circ} \rightarrow \mu_k = 0.27$$

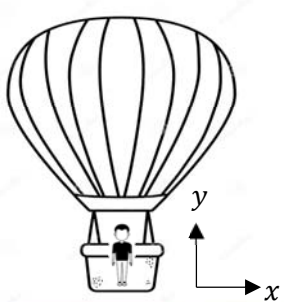


P6. A person of 80 kg mass is standing on a scale inside an air balloon that is moving upwards. The scale shows 62.5 kg. **Find the magnitude and the direction of the acceleration of the balloon.** **(4 points)**

$$F_N = m_{scale} \times g = 62.5 \times 9.8 = 612.5 \text{ N}$$

$$\sum F_y = ma_y \rightarrow F_N - mg = ma$$

$$a = \frac{F_N - mg}{m} = \frac{612.5 - 80 \times 9.8}{80} = -2.14 \ \mathrm{m/s^2}$$



P7. A coin is placed 17.0 cm from the axis of a rotating turntable. The coefficient of static friction between the coin and the table is $\mu_s = 0.3$. Find the maximum frequency of the turntable to keep the coin from sliding off the table. **(4 points)**

$$\sum F_R = \frac{mv^2}{r} = \left(F_{fr}\right)_{max} \rightarrow \mu_s mg = \frac{mv^2}{r}$$

$$v = \sqrt{r\mu_s g} \rightarrow v = 0.7 \ {}^{\mathrm{m}}/_{\mathrm{s}}$$

$$f = \frac{v}{2\pi r} = 0.65 \ {}^{1}/_{\mathrm{s}}$$