Kuwait University **Physics Department**

Physics 121

First Midterm Exam

Fall Semester 2017/2018

October 21, 2017

Time: 2:00 – 3:30 pm

Name: ……Serial No : ……..

Student No. : ……Section :……..

Instructors: Drs. Ali, Kokaj, Lajko, Pichler, Sharma

Instructions to the Students:

1. Take $g = 9.8\ m/s^2$.
2. Answer all the questions.
3. The solution should be given explicitly for each problem.

For use by Instructor only

Prob.	1	2	3	4	5	6	7	8	Total
Marks									

NOTE: IT IS STRICTLY FORBIDDEN TO BRING ANY MOBILE COMMUNICATION DEVICES (MOBILE PHONES, PAGERS, ETC.) INTO THE EXAMINATION HALL.

1. A man walks 12 km east in 2 hours and then he turns back and walks with speed 4.5 km/h west for 2 hours.
   a. What is the man's average speed for the whole journey? **[2 points]**
   b. What is the man's average velocity for the whole journey? **[2 points]**

$$\text{average speed} = \frac{s}{t} = \frac{s_1 + s_2}{t_1 + t_2} =$$
$$= \frac{12\text{km} + 4.5 * 2\text{km}}{(2+2)h} = 5.25 \text{ km/h}$$
$$\bar{v} = \frac{\Delta x}{t} = \frac{\Delta x_1 + \Delta x_2}{t_1 + t_2} =$$
$$= \frac{12\text{km} - 4.5 * 2\text{km}}{(2+2)h} = 0.75 \text{ km/h}$$

2. An airplane has a takeoff speed of 120 km/h.
   a. Starting from rest, what constant acceleration does the airplane require to reach the take-off speed if the length of the runway is 240 m? **[2 points]**
   b. If the airplane has this constant acceleration, how long does it take the airplane to take off? **[2 points]**

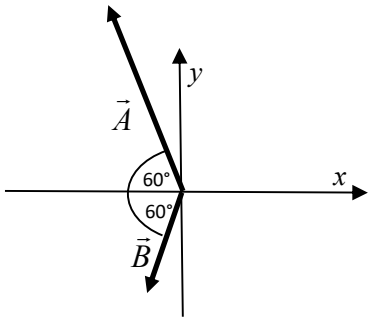
$$v = 120 \text{ km/h} = 33 \text{ m/s}$$
$$v^2 = v_0^2 + 2a\Delta x \qquad \text{if } v_0 = 0$$
$$\Rightarrow a = \frac{v^2}{2a} = 2.3 \text{ m/s}^2.$$
$$t = v/a = 14.35 \text{ s}$$

3. A car is at 24 m distance from a wall and travels towards the wall with 72 km/h when the driver starts to brake with a constant acceleration. The car hits the wall 2 s later.
   a. Calculate the constant acceleration of the car before hitting the wall. **[2 points]**
   b. Determine the speed of the car when it hits the wall. **[2 points]**

$$\Delta x = v_0 t + at^2/2 \Rightarrow$$
$$a = \frac{\Delta x - v_0 t}{t^2/2} = -8 \text{ m/s}^2$$
$$v = v_0 + at$$
$$\Rightarrow v = 4 \text{ m/s}$$

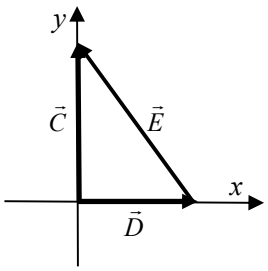
4. The magnitude of vector $\vec{A}$ is 7.0 and the magnitude of vector $\vec{B}$ is 3.0, as shown. Determine the magnitude of the sum vector $\vec{M} = \vec{A} + \vec{B}$. **[5 points]**

$$A_x = 7\cos(120^o) = -3.5;$$
$$A_y = 7\sin(120^o) = 6.07;$$
$$B_x = 3\cos(240^o) = -1.5;$$
$$B_y = 3\sin(240^o) = -2.6;$$
$$M = \sqrt{(A_x + B_x)^2 + (A_y + B_y)^2} = 6.09;$$



5. Vectors $\vec{C}$, $\vec{D}$, and $\vec{E}$ are shown in the figure. Vector $\vec{C}$ has magnitude 7.0 and vector $\vec{D}$ has magnitude 5.0. Determine the direction of vector $\vec{E}$ relative to the positive x-axis. **[3 points]**

$$\vec{E} = \vec{C} - \vec{D} = -5\hat{i} + 7\hat{j}$$
$$\theta = \tan^{-1}\left[\frac{E_y}{E_x}\right] + \pi = 125.5^o$$



6. Two boxes with masses m_1 = 10 kg and m_2 (unknown) are connected via a massless wire and pulley as shown in the figure. Box 1 moves on a table where the coefficient of kinetic friction is zero**.** The acceleration of box 2 is 3.0 m/s^2. Calculate the mass m_2. **[4 points]**

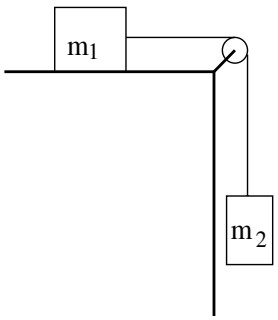
Equation of motion

for m_1 : $T = m_1 a$ (1)

for m_2 : $m_2 g - T = m_2 a$ (2)

$(1)+(2) \Rightarrow m_2 g = (m_1 + m_2)a$

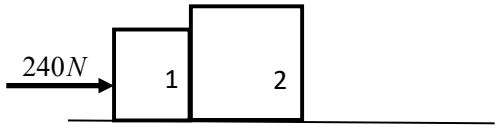
$$\Rightarrow m_2(g-a) = m_1 a \Rightarrow m_2 = m_1 \frac{a}{g-a} = 4.4kg$$



F = 80 N

7. Two boxes of mass m_1= 10 kg, m_2 = 12 kg are in contact and pushed by a force of magnitude 240 N. The coefficient of kinetic friction between the boxes and tables is μ_k = 0.3. Calculate the magnitude of force exerted by box 1 on box 2. **[3 points]**

$$F - F_{fr} = (m_1 + m_2)a \Rightarrow a = (F - F_{fr})/(m_1 + m_2) = 8 \text{ m/s}^2$$
$$F_{12} - F_{fr2} = m_2 a \Rightarrow$$
$$F_{12} = m_2 a + F_{fr2} = 96\text{N} + 35.3N = 131.3 \text{ N}$$



8. The coefficient of kinetic friction between the box A and the incline is μ_k = 0.15. The boxes have identical masses m_A = m_B = 5 kg. Calculate the acceleration of box B when it moves downward. **[5 points]**

$$A: F_p - F_{GA}\sin\theta - F_{fr} = m_A a$$
$$B: F_{GB} - F_p = m_B a;$$
$$(A) + (B) \Rightarrow F_{GB} - F_{GA}\sin\theta - F_{fr} = (m_A + m_B)a$$
$$a = \frac{m_B g - m_A g \sin\theta - \mu_k m_A g \cos\theta}{m_A + m_B} =$$
$$= 2.4 \text{ m/s}^2$$