Kuwait University **Physics Department**

Physics 121

First Midterm Exam

Spring Semester 2016/2017

March 25, 2017

Time: 3:00 – 4:30 pm

Name: ……………………………………………………Serial No : ……………..

Student No. : ……………………………………………Section :………………..

Instructors: Drs. A. Rakhshani, J. Kokaj, P. Lajko

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 student runs along a straight road with constant speed v_0 and covers a distance 65 m in 13 seconds then the students starts to slowdown with constant acceleration and stops after 8 seconds.

a. What is the initial speed v_0.

b. Calculate the average velocity of the student along its motion.

$$v_0 = \frac{65}{13} m/s = 5m/s.$$

$$\bar{v}_{8s} = \frac{5}{2} m/s \qquad and \qquad a_{8s} = v_0 / t = (5m/s)/8s = 0.65m/s^2$$

$$\Delta x_1 = 65m;$$

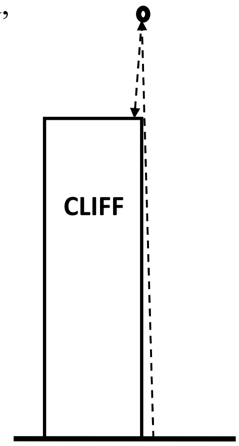
$$\Delta x_2 = \bar{v}_{8s} t = (5/2)m/s \cdot 8s = 20m \qquad or \qquad \Delta x_2 = v_0 t + a_{8s} t^2 / 2 = 20m$$

$$\bar{v} = \frac{65m + ((5/2)\cdot 8)m}{21s} = \frac{85}{21} m/s = 4.05m/s$$

2. A ball is thrown up from the bottom to the top of a cliff, as shown in the figure. If the initial velocity of the ball is 35 m/s upward and the final velocity of the ball when it hits the cliff is 5 m/s downward,

a) find the time of the flight.

b) Find the height of the cliff.



$$v = v_0 + at \Rightarrow t = \frac{v - v_0}{a} = \frac{-5m/s - 35m/s}{-9.8m/s^2} = 4.1s$$

$$\Delta y = \bar{v} t = \frac{35 - 5}{2} 4s = 61.2m$$

or

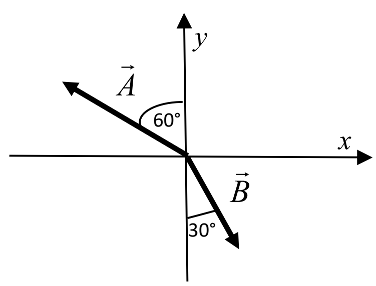
$$\Delta y = v_0 t + at^2 / 2 = 35m/s \cdot 8s - 9.8t^2 / 2 = 61.2m$$

3. A car completes a round trip, first it moves with 120 km/h speed to the east direction for 3 hours then the driver takes a rest for time t_2 after which the car returns to the original position with a constant speed in 4 hours. If the average speed of the car during the round trip is 25 m/s, determine the time t_2.

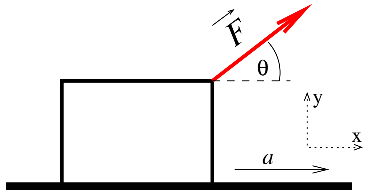
$$v = \frac{\text{distance}}{time} =$$
$$= \frac{2d}{t_1 + t_2 + t_3} = \frac{720km}{t_1 + t_2 + t_3} = 3.6 \cdot 25 \ m/s = 90km/h$$
$$\Rightarrow t_1 + t_2 + t_3 = 8h$$
$$\Rightarrow t_2 = 1 \ h$$

4. The magnitude of vector $\vec{A}$ is 6.0 and the magnitude of vector $\vec{B}$ is 4.0 as shown. If $\vec{A} + \vec{B} + 2\vec{C} = 0$, find the magnitude of $\vec{C}$ and its direction relative to the positive x-axis.

$$A_x = A\cos(150^o) = -5.2; \qquad A_y = A\sin 150^o = 3$$
$$B_x = B\cos(-60^o) = 2; \qquad B_y = B\sin(-60^o) = -3.4666$$
$$\vec{C} = -0.5 \cdot (\vec{A} + \vec{B}) = 1.6i + 0.2333j$$
$$C = \sqrt{C_x^2 + C_y^2} = 1.62$$
$$\theta = \tan^{-1}\left(\frac{C_y}{C_x}\right) = 8.29^o$$



5. A 14-kg block is pulled by force $\vec{F}$ with a magnitude of 100 N. If the magnitude of the normal force between the desk and the block is 74 N,
   a) determine the direction of $\vec{F}$ relative to the positive x axis.
   b) If there is no friction between the box and the desk, calculate the acceleration a of the box.



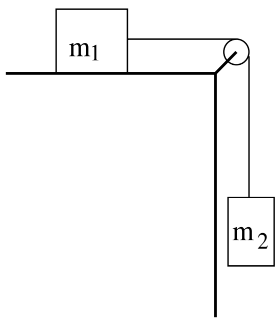
Newton's second law along the y axis:

$$F_N + F\sin\theta - F_G = 0$$
$$F\sin\theta = F_G - F_N = 63.2N$$
$$\theta = \sin^{-1}\left(\frac{63.2}{100}\right) = 39^o$$

Newton's second law along the x axis:

$$F_p\cos(37) = ma$$
$$\Rightarrow a = 80N/14kg = 5.5m/s^2$$

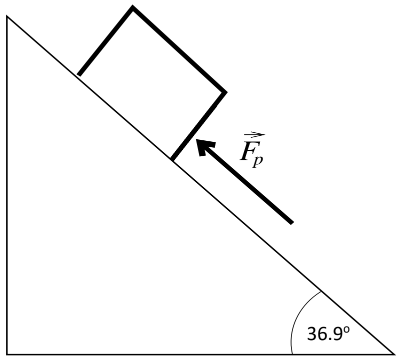
6. Two boxes with masses $\mathbf{m_1}$ = 18 kg and $\mathbf{m_2}$ = 9 kg are connected via a massless wire and pulley as shown in the figure. Box 1 moves on a table where the coefficient of kinetic friction is μ_k = 0.22**.** Calculate the acceleration of box 2.



$$For\ m_1:\ T - \mu_k m_1 g = m_1 a \qquad (1)$$
$$For\ m_2:\ m_2 g - T = m_2 a \qquad (2)$$
$$(1)-(2) \Rightarrow m_2 g - \mu_k m_1 g = (m_1 + m_2)a$$
$$\Rightarrow a = \frac{(m_2 - \mu_k m_1 g)g}{m_1 + m_2} = 1.8m/s^2$$

7. A block of mass m = 10 kg is on a surface inclined at angle θ = 36.9°. If the coefficient of static friction is μ_s = 0.5 between the block and the surface, what is the magnitude of the minimum pushing force $\vec{F}_p$ along the incline to cause upward sliding.

$$F_p - F_{Gx} - F_{fr} = 0 \Rightarrow F_p = F_{Gx} + F_{fr} =$$
$$F_{Gx} = mg\sin 36.9^o;$$
$$F_{fr} = \mu_k mg\cos 36.9^o$$
$$\Rightarrow mg\sin\alpha + \mu_k mg\cos\theta = 98N$$



8. A car moves along a road at the bottom of a valley which has a radius of curvature of 60 m. At the very bottom the normal force on the driver is three times of his weight. Find the speed of the car (in km/h) at the bottom of the valley.

$$F_N - mg = mv^2/r$$
$$3mg - mg = mv^2/r$$
$$\Rightarrow v = (2rg)^{1/2} = 34.3m/s = 123.4km/h$$