UNIVERSITY OF GAZIANTEP
DEPARTMENT OF ENGINEERING PHYSICS
EP 105 General Physics I
First Midterm Exam *SUMMER SEMESTER*

Date: 18/7/2019 Time: 13:30 Duration: 100 min.

Ques.	Mark
1	
2	
3	
4	
5	
Total	

DEPARTMENT ☐:CE ☐ MME ☐ IE ☐ ME ☐ TE

Name	Surname	Student No	Signature

- Cheating is a serious offence and may lead to your dismissal from the university.
- Ignore air resistance in all problems unless otherwise stated.
- Write clearly your solutions steps to the space provided and results to the boxes.
- Constants: g = 9.8 m/s^2, π = 3.141593
- Conversions: 1 mm = 10^{-3} m, 1 cm = 10^{-2} m, 1 km = 10^{3} m, 1 h = 3600 s, 1 min = 60 s, 1 rev = 2π rad.

QUESTION 1 (20 %)

Two vectors are given: $\mathbf{A} = 3\mathbf{i} + 4\mathbf{j} + \mathbf{k}$ and $\mathbf{B} = \mathbf{i} + 2\mathbf{j}$

(a) Find the dot (scalar) product of vectors

$$\vec{A} \cdot \vec{B} = (3\hat{i} + 4\hat{j} + \hat{k}) \cdot (\hat{i} + 2\hat{j})$$

$$= 3 + 8 + 0$$

$$= 11$$

11

(b) Find the angle in degrees between vectors

$$\cos\theta = \frac{\vec{A} \cdot \vec{B}}{AB} = \frac{11}{(5.1)(2.2361)}$$

$$= 0.96476$$

$$A = \sqrt{3^2 + 4^2 + 1^2} = 5.10$$

$$B = \sqrt{1^2 + 2^2} = 2.2361$$

$$\theta = \cos^{-1}(0.96476) = 15.25^\circ$$

$\theta = 15.25^\circ$

(c) Find the unit vector in the direction of **A** x **B**

$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 4 & 1 \\ 1 & 2 & 0 \end{vmatrix} = -2\hat{i} + \hat{j} + 2\hat{k}$$

$$\hat{u} = \frac{\vec{A} \times \vec{B}}{|\vec{A} \times \vec{B}|} = \frac{-2\hat{i} + \hat{j} + 2\hat{k}}{3} = -\frac{2}{3}\hat{i} + \frac{1}{3}\hat{j} + \frac{2}{3}\hat{k}$$

$-0.\overline{6}\hat{i} + 0.\overline{3}\hat{j} + 0.\overline{6}\hat{k}$

QUESTION 2 (20 %)

Two objects begin a free fall from rest from the same height, **1.0 s apart**.

(a) How long after the first object begins to fall will the two objects be 10 m apart?

object 1 travels : $y_1 = \frac{1}{2} g t^2$

object 2 travels : $y_2 = \frac{1}{2} g (t-1)^2 = \frac{1}{2} g (t^2 + 1 - 2t)$

distance between them : $y_1 - y_2 = 10 = \frac{1}{2} g (2t - 1)$

Solving for $t = 1.52\ s$

$\boxed{1.52\ s}$

(b) Find velocity of the objects when they are 10 m apart.

using eqn $v = v_0 + at$ $(v_0 = 0)$

$= 0 - gt$

$v_1 = -(9.8)(1.52) = -14.9\ m/s$

$v_2 = -(9.8)(1.52 - 1) = -5.1\ m/s$

$\boxed{14.9\ \frac{m}{s},\ 5.1\ \frac{m}{s}}$

QUESTION 3 (20 %)

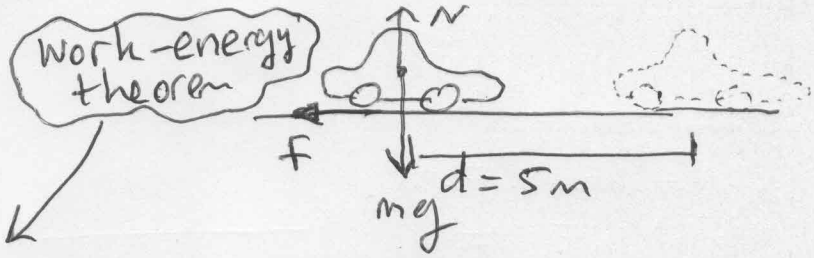
A driver of a 850-kg car moving at 15 m/s on a road in a city had a sudden brake due to a careless child. The wheels are then locked and the car sliding coming to a stop after traveling 5m.

(a) Calculate the work is done on the car by the frictional force exerted by the road surface.

work done by all forces :

$W_N = W_{mg} = 0$

$W_f = f d \cos 180^\circ = -fd$



$W_{net} = W_N + W_{mg} + W_f = \Delta K = \frac{1}{2} m v^2 - \frac{1}{2} m v_0^2$ ($v = 0$)

$\Rightarrow W_f = -\frac{1}{2} m v_0^2 = -95625\ J$

$\boxed{W_f = -95625\ J}$

(b) Find the value of the frictional force assuming it is constant during the skidding.

$W_f = -\frac{1}{2} m v_0^2 = -fd$

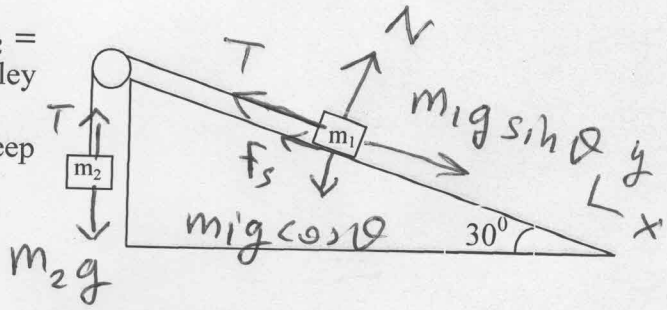
$f = \frac{m v_0^2}{2d} = \frac{(850)(15)^2}{(2)(5)} = 19125\ N$

$\boxed{f = 19125\ N}$

QUESTION 4 (20 %)

Two objects with masses of $m_1 = 2.0$ kg and $m_2 = 0.5$ kg are connected by a massless cord and frictionless pulley as in figure. The inclined plane has an angle of 30^0. Find

(a) the smallest coefficient of static friction that will keep the m_1 from sliding down the incline,



- for mass m_1:

$\Sigma F_y = 0$

$N - m_1 g \cos\theta = 0$

$N = m_1 g \cos\theta$

$\Sigma F_x = 0$

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

$f_s = \mu N$

$m_1 g \sin\theta - T - \mu m_1 g \cos\theta = 0$

$$\mu_s = \frac{m_1 g \sin\theta - T}{m_1 g \cos\theta} \quad (1)$$

- for mass m_2

$\Sigma F_y = 0$

$T - m_2 g = 0$

$T = m_2 g$ (2)

Combining (1) and (2)

$$\mu_s = \frac{m_1 g \sin\theta - m_2 g}{m_1 g \cos\theta}$$

$$= \frac{(2)\sin 30 - 0.5}{(2)\cos 30}$$

$$= 0.29$$

0.29

(b) the frictional force between m_1 and plane.

$$f_s = \mu_s N = \mu_s m_1 g \cos\theta$$

$$= (0.29)(2)(9.8)\cos 30$$

$$= 4.92 \text{ N}$$

4.92 N

QUESTION 5 (20 %)

A ball is thrown from the ground into the air with an initial velocity of $\vec{v} = 6\hat{\imath} + 8\hat{\jmath}\ m/s$.Use equations of motions,

(a) Find the velocity components of the ball at $t = 0.5\ s$.

$\vec{v_0} = 6\hat{i} + 8\hat{j}\ (m/s) \Rightarrow v_{ox} = 6\frac{m}{s} \quad v_{oy} = 8\ m/s$

$t = 0.5\ s$

$v_x = v_{ox} = 6\ m/s$

$v_y = v_{oy} - gt = 8 - (9.8)(0.5) = 3.1\ m/s$

(6 m/s , 3.1 m/s)

(b) Find the position (x and y) of the ball at $t = 0.5\ s$.

$x = v_{ox}t = (6)(0.5) = 3\ m$

$y = v_{oy}t - \frac{1}{2}gt^2 = (8)(0.5) - \frac{1}{2}(9.8)(0.5)^2$

$= 2.77\ m$

(3m , 2.77m)

(c) What maximum height will the ball rise ?

$h_{max} = \frac{v_{oy}^2}{2g} = \frac{8^2}{2(9.8)}$

$= 3.26\ m$

3.26 m