UNIVERSITY OF GAZIANTEP
DEPARTMENT OF ENGINEERING PHYSICS
EP 105 General Physics I
Second Final Exam *FALL 2019*

Date: 07/01/2020 Time: 10:30 Duration: 90 min.

Ques.	Mark
1	
2	
3	
4	
5	
Total	

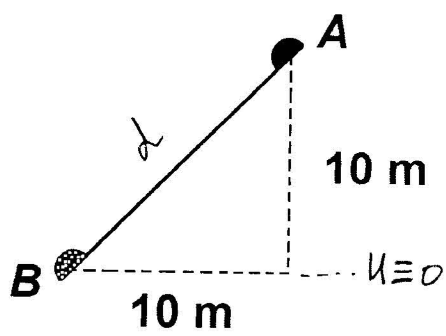
DEPARTMENT :CE ☐ MME ☐ IE ☐ ME ☐ TE ☐ ☐

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: $g = 9.8\ m/s^2$, $\pi = 3.141593$
- Conversions: $1\ g = 10^{-3}$ kg, $1\ cm = 10^{-2}$ m, $1\ km = 10^3$ m, 1 h = 3600 s, 1 min = 60 s, 1 rev = 2π rad.

QUESTION - 1 (20 %)

A 10 kg mass slides from position ***A*** to ***B*** on an incline as shown in the figure. If the body is initially at rest, what is the **speed at point *B*** of the body, if;



a) the incline is frictionless?

Conservation of M-E.

$E_i = E_f$

$\frac{1}{2} m v^2 = mgh$

$v = \sqrt{2gh}$

$= \sqrt{2(9.8)(10)} = 14.0\ m/s$

$V = 14\ m/s$

b) the incline exerts a frictional force of 34 N on the body?

Work done by friction = change in M-E

$W_f = \Delta E = E_f - E_i$

$-fd = \frac{1}{2} m v^2 - mgh$

$v = \sqrt{\frac{2}{m}(mgh - fd)}$

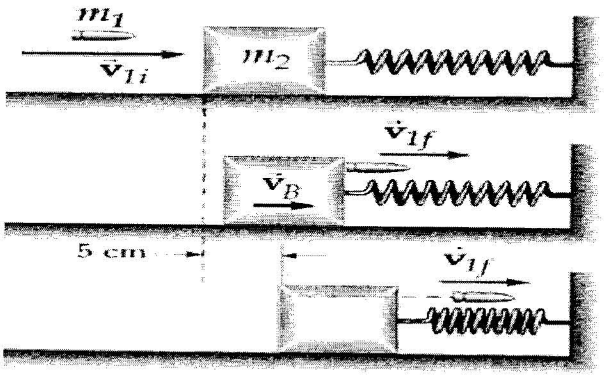
$= \left[\frac{2}{10}\left(10 \times 9.8 \times 10 - 34 \times 10\sqrt{2}\right)\right]^{1/2}$

$= 10\ m/s$

$V = 10\ m/s$

QUESTION - 2 (20 %)

A bullet of mass m_1=5.00 g fired horizontally at a speed of v_{1i} =400 m/s and it hits a m_2=1.00 kg block initially at rest on a frictionless, horizontal surface. The block is also connected to a spring with force constant k=900 N/m. The bullet hits and passes through the block and the block moves d = 5.00 cm to the right, after the collision, before being brought to rest by the spring as shown in symbolic Figures. Assume that the collision occurs on a line through the center of masses.



a) Find the speed of the block, V_B, after the collision.

Conservation of Energy:

$$(K+U)_{before} = (K+U)_{after}$$

$$\frac{1}{2} m v_B^2 = \frac{1}{2} k x^2$$

Or

$$v_B = \sqrt{\frac{k}{m_2}}\, x = \sqrt{\frac{900}{1}}\, 0.05 = 1.5 \text{ m/s}$$

$$\boxed{V_B = 1.5 \text{ m/s}}$$

b) Find the speed, v_{1f}, at which the bullet emerges from the block after the collision.

Conservation of momentum:

$$m_1 v_{1i} + \underbrace{m_2 v_{2i}}_{0} = m_1 v_{1f} + m_2 v_{2f} \quad \leftarrow v_{2f} = v_B$$

Solving for v_{1f}:

$$v_{1f} = \frac{m_1 v_{1i} - m_2 v_B}{m_1}$$

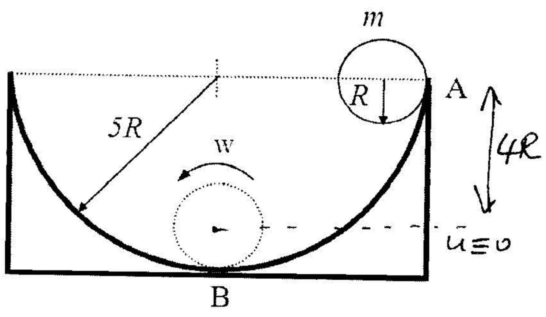
$$= \frac{(5\times10^{-3})(400) - (1)(1.5)}{5\times10^{-3}}$$

$$= 100 \text{ m/s}$$

$$\boxed{v_{1f} = 100 \text{ m/s}}$$

QUESTION - 3 (20 %)

A wheel of tractor have a mass of $m = 30$ kg and radius R=70 cm. It rolls without slipping in a cylindrical trough of radius $5R$ as shown in Figure. The wheel is released from point A and passes through at the bottom of the trough (point B) with speed of 7 m/s.



a) Find the moment of inertia of wheel

Conservation of M.E.

$$E_i = E_f$$

$$4mgR = \frac{1}{2} m v^2 + \frac{1}{2} I w^2$$

$$4mgR = \frac{1}{2} m v^2 + \frac{1}{2} I \frac{v^2}{R^2}$$

Solving for I:

$$I = \frac{R^2}{v^2}\left(8mgR - mv^2\right) = \frac{0.7^2}{7^2}\left(8(30)(9.8)(0.7) - (30)(7)^2\right) = 1.76 \ kg \cdot m^2$$

$I = 1.76 \ kg \cdot m^2$

b) Find the angular momentum of the sphere about its center of mass at point B.

Angular momentum about CM

$$L_{cm} = I_{cm} w = I_{cm} V/R$$

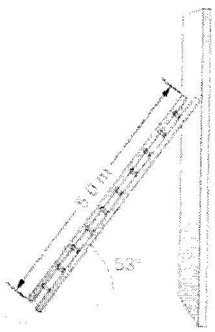
$$= (1.76)(7/0.7)$$

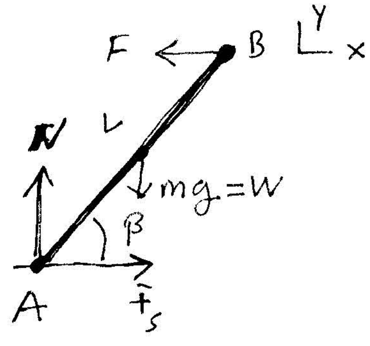
$$= 17.6 \ kg \cdot m^2/s$$

$L = 17.6 \ kg \cdot m^2/s$

QUESTION - 4 (20 %)

A uniform ladder is $L = 5.0$ m long and weighs 400 N. The ladder rests against a slippery vertical wall, as shown in Figure. The inclination angle between the ladder and the rough floor is $\beta = 53°$. Find the coefficient of static friction μ_s at the interface of the ladder with the floor that prevents the ladder from slipping.





Torque about point A

$$-\frac{L}{2} W \cos\beta + LF\sin\beta$$

$$F = \frac{W}{2}\cos\beta = \frac{400}{2}\cos 53° = 150.7 N$$

$N = W$

$F = f_s$

$$\mu_s = \frac{f_s}{N} = \frac{150.7}{400.0} = 0.377$$

$\mu_s = 0.377$

QUESTION - 5 (20 %)

An object attached to a spring of force constant 2 N/m is oscillating about x=0 on the x-axis. Displacement of the object as a function of time is given by $x(t) = (10\ cm) \cos\ (0.2\pi t\ + 1.3\pi)$.

a) What is the displacement of the object from the equilibrium position at $t =\ 1\ s$?

$$x(t) = 10\ \cos(0.2\pi t + 1.3\pi)$$

$$x(1) = 10\ \cos(0.2\pi + 1.3\pi)$$

$$= 10\ \cos(1.5\pi)$$

$$= 0$$

$$\boxed{x(1) = 0}$$

b) What is the speed of the object at $t =\ 1\ s$?

Velocity is the time derivative of x.

$$v = \dot{x} = \frac{d}{dt}\left[10\ \cos(0.2\pi t + 1.3\pi)\right]$$

$$= -0.2 \times 10\pi \sin(0.2\pi t + 1.3\pi)$$

$$v(1) = -2\pi \sin(1.5\pi)$$

$$= 6.28\ cm/s$$

$$= 0.0628\ m/s$$

$$\boxed{v(1) = 0.0628\ \frac{m}{s}}$$

c) What is the total energy of the object at $t =\ 1\ s$?

Total energy is $E = \frac{1}{2} m v^2 + \frac{1}{2} k x^2 = \frac{1}{2} k A^2$

$$\therefore\ E = \frac{1}{2} k A^2 = \frac{1}{2} (2)(0.1)^2 = 0.01\ J$$

$$= 0.01\ kg \cdot \frac{m^2}{s^2}$$

$$\boxed{E = 0.01\ J}$$