YTU Physics Department 2019-2020 Fall Semester		Exam Date: 27.12.2019	Exam Duration: 90 dk.
FIZ1001 PHYSICS-1 FINAL		The 9th article of Student Disciplinary Regulations of YÖK Law No.2547 states ***"Cheating or helping to cheat or attempt to cheat in exams"*** de facto perpetrators take **one or two semesters suspension** penalty. Students are **NOT** permitted to bring **calculators, mobile phones**, **smart watches** and/or any other unauthorized electronic devices into the exam room.	
Question Sheet	**A A A A A**		
Name Surname			
Student No			
Physics Group No			
Department			
Exam Hall		**Student Signature:**	
Instructor's Name Surname			

$\overline{\vec{v}} = \frac{\Delta\vec{r}}{\Delta t}$; $\overline{\vec{a}} = \frac{\Delta\vec{v}}{\Delta t}$; $\vec{v} = \frac{d\vec{r}}{dt}$; $\vec{a} = \frac{d\vec{v}}{dt}$; $\vec{v} = \vec{v}_0 + \vec{a}t$; $\vec{r} = \vec{r}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$; $v^2 = v_0^2 + 2\vec{a}\cdot(\vec{r} - \vec{r}_0)$; $F_r = m\frac{v^2}{r}$; $F_s = -kx$

$f_s \le \mu_s N$; $f_k = \mu_k N$; $P = \vec{F}\cdot\vec{v}$; $W_{total} = \Delta K$; $W = \int \vec{F}\cdot d\vec{r}$; $\bar{P} = \frac{\Delta W}{\Delta t}$; $\vec{F}_{conservative} = -\frac{dU}{dr}\hat{r}$; $W_{conservative} = -\Delta U$

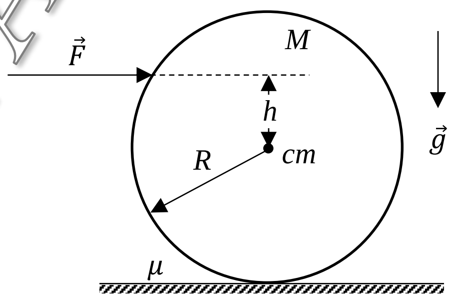
$W = \Delta U + \Delta K$; $U = mgy$; $U = \frac{1}{2}kx^2$; $\vec{F} = \frac{d\vec{p}}{dt}$; $\vec{p} = m\vec{v}$; $\vec{I} = \Delta\vec{p} = \overline{\vec{F}}\Delta t$; $\vec{r}_{cm} = \frac{\sum m_i\vec{r}_i}{\sum m_i}$; $\vec{r}_{cm} = \frac{\int \vec{r}dm}{\int dm}$; $\overline{\vec{\omega}} = \frac{\Delta\vec{\theta}}{\Delta t}$; $\overline{\vec{\alpha}} = \frac{\Delta\vec{\omega}}{\Delta t}$

$\vec{\omega} = \frac{d\vec{\theta}}{dt}$; $\vec{\alpha} = \frac{d\vec{\omega}}{dt}$; $\vec{\omega} = \vec{\omega}_0 + \vec{\alpha}t$; $\vec{\theta} = \vec{\theta}_0 + \vec{\omega}_0 t + \frac{1}{2}\vec{\alpha}t^2$; $\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$; $a_t = r\alpha$; $\vec{\tau} = \vec{r}\times\vec{F}$; $\vec{\tau}_0 = I_0\vec{\alpha}$

$K_{rot} = \frac{1}{2}I\omega^2$; $I = \int r^2 dm$; $I = I_{cm} + MD^2$; $P = \vec{\tau}\cdot\vec{\omega}$; $W = \int \vec{\tau}\cdot d\vec{\theta}$; $\vec{L} = \vec{r}\times\vec{p}$; $\vec{L} = I\vec{\omega}$; $\vec{\tau} = \frac{d\vec{L}}{dt}$; $\overline{\vec{\tau}} = \frac{\Delta\vec{L}}{\Delta t}$

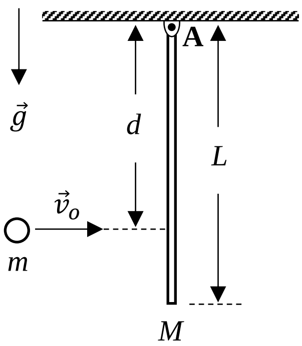
$v_{cm} = R\omega$; $x(t) = A\cos(\omega t + \varphi)$; $T = \frac{1}{f}$; $\omega = 2\pi f$

1) The billiard ball with M and with radius R rests on the rough surface. How high (h) should the momentary horizontal F force (impulse) be applied over the center of mass so that the billiard ball can start rolling without friction force ($f = 0$)? $I_{cm} = \frac{2}{5}MR^2$



A) $\frac{1}{5}R$ **B)** $\frac{2}{3}R$ **C)** $\frac{1}{3}R$ **D)** $\frac{2}{5}R$ **E)** $\frac{3}{5}R$

Questions 2-3 A homogen rod with mass M and length L was hung from the point **A** to the ceiling as shown in the figure. The rod can rotate freely around the point **A** on the vertical plane. A sticky ball of mass m with velocity $\vec{v}_0$ strikes the rod in the distance d away from point **A** and sticks the rod. $I_{cm}^{rod} = \frac{1}{12}ML^2$



2) At what distance d should the sticky ball strike so that no impulse is applied to the rod from point **A** at the moment of collision? (*Note that the linear momentum will be conserved*)

A) $\frac{1}{5}L$ **B)** $\frac{1}{3}L$ **C)** $\frac{2}{3}L$ **D)** $\frac{2}{5}L$ **E)** $\frac{3}{5}L$

3) Find the angular velocity of the rod+ball system immediately after the collision.

A) $\frac{mv_0}{(M+m)L}$ **B)** $\frac{2mv_0}{(M+3m)L}$ **C)** $\frac{2mv_0}{(M+2m)L}$ **D)** $\frac{2mv_0}{\left(M+\frac{1}{3}m\right)L}$ **E)** $\frac{2mv_0}{\left(M+\frac{4}{3}m\right)L}$

Questions 4-5-6 The position vector of an object with mass m=1 (kg) is given by $\vec{r} = (2t + t^2)\hat{\imath} + (1 + t^2)\hat{\jmath}$ (m) depending on time.

4) What is the velocity vector of the object at t = 2 (s)?

A) $6\hat{\imath} + 4\hat{\jmath}$ **B)** $8\hat{\imath} + 5\hat{\jmath}$ **C)** $2\hat{\imath} + 6\hat{\jmath}$ **D)** $8\hat{\imath} + 4\hat{\jmath}$ **E)** $6\hat{\imath} + 8\hat{\jmath}$

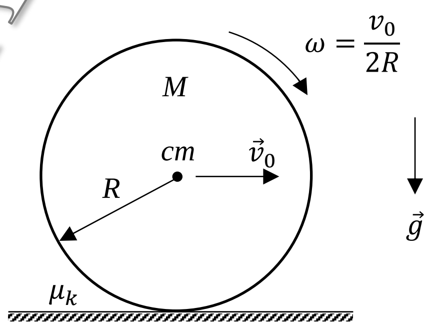
5) Find the angular momentum vector of the object <u>according to the origin</u> at t = 2 (s) in (kg m^2/s).

A) $62\hat{k}$ **B)** $2\hat{k}$ **C)** $48\hat{\imath} + 20\hat{\jmath}$ **D)** $8\hat{\jmath} + 4\hat{k}$ **E)** $2\hat{\imath} + 6\hat{\jmath}$

6) Find the average torque vector acting on the object between t = 1 (s) and t = 2 (s) in (Nm).

A) $14\hat{k}$ **B)** $-16\hat{k}$ **C)** $\hat{\imath} - 4\hat{k}$ **D)** $12\hat{k}$ **E)** $4\hat{k}$

Questions 7-8 The billiard ball with the radius R and the M mass on the rough surface is hit with a cue. As shown in the figure, it is observed that the velocity of the center of mass of the ball is $\vec{v}_0$ and the angular velocity is $\frac{v_0}{2R}$ immediately after the ball is hit. If the coefficient of friction is μ_k;



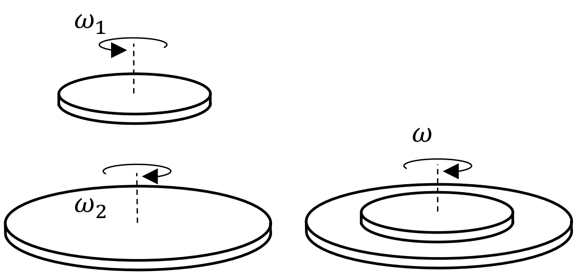
7) How soon does the ball start <u>rolling without sliding</u>? $I_{cm} = \frac{2}{5}MR^2$

A) $\frac{2v_0}{5\mu_k g}$ **B)** $\frac{4v_0}{3\mu_k g}$ **C)** $\frac{v_0}{7\mu_k g}$ **D)** $\frac{2v_0}{3\mu_k g}$ **E)** $\frac{3v_0}{5\mu_k g}$

8) What is the velocity of the center of mass when rolling?

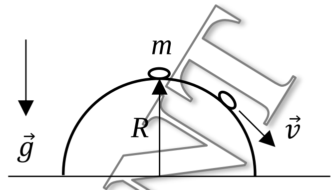
A) $\frac{4v_0}{3}$ **B)** $\frac{2v_0}{5}$ **C)** $\frac{3v_0}{5}$ **D)** $\frac{6v_0}{7}$ **E)** $\frac{v_0}{3}$

9) A disk with moment of inertia I_1=20 (kgm^2) rotates <u>counterclockwise</u> with an angular velocity of $\omega_1 = 80$ (rad/s). Another disk with moment of inertia I_2= 40 (kgm^2) rotates <u>clockwise</u> with an angular velocity of $\omega_2 = 60$ (rad/s). As shown in the figure, find the angular velocity in unit of (rad/s) after the upper disk coaxially adheres to the lower disk.



A) 10 **B)** $\frac{40}{3}$ **C)** $\frac{20}{3}$ **D)** 20 **E)** 40

Questions 10-11 A point object with mass m slips without friction from the top of the hemisphere with radius R.



10) With what velocity does the object leave the hemisphere?

A) $\sqrt{\frac{gR}{3}}$ **B)** $\sqrt{\frac{3gR}{5}}$ **C)** $\sqrt{\frac{2gR}{5}}$ **D)** $\sqrt{\frac{3gR}{4}}$ **E)** $\sqrt{\frac{2gR}{3}}$

11) How high from the ground does the object leave the hemisphere?

A) $\frac{1}{3}R$ **B)** $\frac{3}{5}R$ **C)** $\frac{2}{3}R$ **D)** $\frac{3}{4}R$ **E)** $\frac{2}{5}R$

Questions 12-13-14 The position of an object in simple harmonic motion is given by $x(t) = 0.08\sin(\omega t + \varphi)$ (m). If the period of the motion is 24 (s) and its position is $x(0) = 0.04$ (m) at t = 0;

12) Find the angular frequency ω in (rad/s). (Take $\pi = 3$)

A) $\frac{1}{4}$ **B)** $\frac{1}{2}$ **C)** $\frac{1}{8}$ **D)** $\frac{1}{24}$ **E)** 3

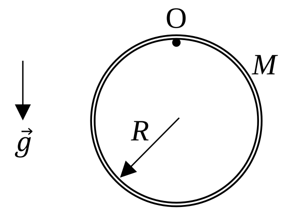
13) Find the phase difference φ in rads.

A) 2 **B)** 3 **C)** $\frac{1}{3}$ **D)** $\frac{1}{2}$ **E)** $\frac{1}{4}$

14) Find the maximum velocity in (m/s).

A) 0.01 **B)** 0.03 **C)** 0.04 **D)** 0.02 **E)** 1

Questions 15-16 A circle with a mass M and a radius R is suspended from a point O by a nail as shown in the figure.



15) Find the moment of inertia of the circle with respect to the axis perpendicular to the plane of the page and passing through the point O.

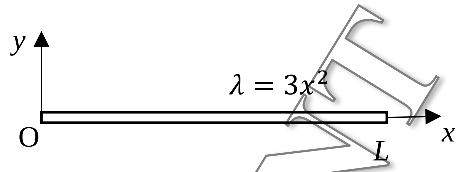
A) $\frac{1}{2}MR^2$ **B)** $\frac{2}{3}MR^2$ **C)** $2MR^2$ **D)** $\frac{3}{2}MR^2$ **E)** MR^2

16) Find the angular frequency of the circle for small oscillations.

A) $\sqrt{\frac{g}{2R}}$ **B)** $\sqrt{\frac{2g}{3R}}$ **C)** $\sqrt{\frac{g}{3R}}$ **D)** $\sqrt{\frac{3g}{2R}}$ **E)** $\sqrt{\frac{g}{R}}$

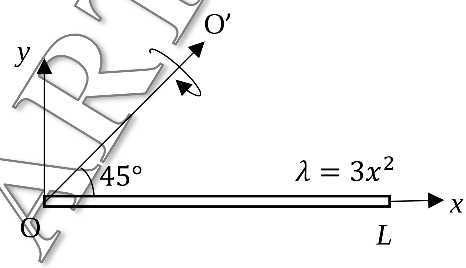
Questions 17-18 The linear mass density of a bar with a length L changes as $\lambda = 3x^2$ (kg/m) depending on x.

17) Find the center of mass of the bar.



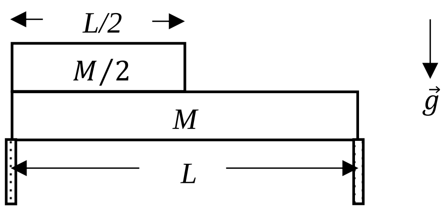
A) $\frac{2L}{3}$ **B)** $\frac{L}{2}$ **C)** $\frac{4L}{5}$ **D)** $\frac{3L}{4}$ **E)** $\frac{L}{3}$

18) Find the moment of inertia of the same bar with respect to the O′ axis as shown in the figure by taking L=1 (m) in unit of (kgm^2).



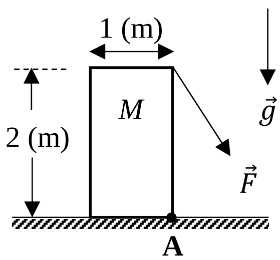
A) $\frac{3}{10}$ **B)** $\frac{1}{20}$ **C)** $\frac{3}{5}$ **D)** $\frac{3}{20}$ **E)** $\frac{1}{30}$

19) Two homogen beams are placed on top of each other as shown in the figure. Find the force applied by the beam to the <u>pillar on the right</u>.



A) $\frac{4Mg}{5}$ **B)** $\frac{5Mg}{8}$ **C)** $\frac{2Mg}{5}$ **D)** $\frac{Mg}{8}$ **E)** $\frac{4Mg}{3}$

20) The force $\vec{F} = F_x\hat{\imath} - 20\hat{\jmath}$ (N) is applied to a homogen block with mass M=3 (kg) resting on the horizontal plane with friction. How many Newtons is the <u>minimum force</u> F_x that will start turning the block around point A? (g=10 m/s^2)



A) 20 **B)** 10 **C)** 12.5 **D)** 15 **E)** 7.5