YTU Physics Department 2023 -2024 Fall Semester		Exam Date: 24 .01.2024	Exam Duration: 110 dk.
FIZ1001 PHYSICS-1 Retake Exam		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			

$\vec{\bar{v}} = \frac{\Delta\vec r}{\Delta t}$; $\vec{\bar a} = \frac{\Delta \vec v}{\Delta t}$; $\vec v = \frac{d\vec r}{dt}$; $\vec a = \frac{d\vec v}{dt}$; $\vec v = \vec v_0 + \vec a t$; $\vec r = \vec r_0 + \vec v_0 t + \frac{1}{2} \vec a t^2$; $v^2 = v_0^2 + 2\vec a\cdot(\vec r - \vec r_0)$; $F_r = m\frac{v^2}{r}$; $F_s = -kx$

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

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

$\vec\omega = \frac{d\vec\theta}{dt}$; $\vec\alpha = \frac{d\vec\omega}{dt}$; $\vec\omega = \vec\omega_0 + \vec\alpha t$; $\vec\theta = \vec\theta_0 + \vec\omega_0 t + \frac{1}{2}\vec\alpha t^2$; $\omega^2 = \omega_0^2 + 2\alpha(\theta-\theta_0)$; $a_t = r\alpha$; $\vec\tau = \vec r\times\vec F$; $\vec\tau_0 = I_0\vec\alpha$

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

$v_{cm} = R\omega$; $x(t) = A\cos(\omega t+\varphi)$; $T = \frac{1}{f}$; $\omega = 2\pi f$; $E = \frac{1}{2} kA^2$ $g = 10\ (\mathrm{m/s^2})$

Question 1) The acceleration of an object varies with time as $a = 6t + 6$ (m/s^2). The object starts moving from the origin with a velocity v_0= 4 (m/s) at t = 0. Find the total distance traveled by the object at t =1 second?

A) 6 **B)** 7 **C)** 8 **D)** 24 **E)** 26

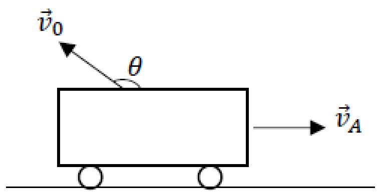
Question 2) An object moves from the origin with a velocity v_0 at t = 0. The displacement of the object varies with time t as $x=-2t^2+12t-5$ (m). How many seconds does it take for the object to come to rest?

A) 2 **B)** 3 **C)** 5 **D)** 12 **E)** 15

Question 3) A ball is thrown horizontally from the top of a tower with velocity of 10 (m/s). During its motion, at a particular point, horizontal and vertical velocities of the ball become equal. Find the time elapsed to reach this point in seconds.

A) 1 **B)** 2 **C)** 3 **D)** 4 **E)** 5

Question 4) While a vehicle is traveling with a velocity of v_A=10 (m/s), a stone is thrown over it with a velocity v_0=20 (m/s). Since a person standing on the ground sees the stone moving vertically upwards, find the speed of the ball relative to the ground at the time of the throw.

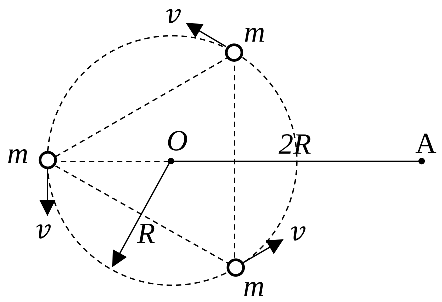


A) $5\sqrt{3}$ (m/s) **B)** $10\sqrt{3}$ (m/s) **C)** $20\sqrt{3}$ (m/s) **D)** $5\sqrt{3}/2$ (m/s) **E)** 20 (m/s)

Question 5) An object performing simple harmonic motion has a position x = - 5 (m) and velocity v=20 (m/s) at t = 0. If the angular frequency of the motion is ω=2 (rad/s), what is the amplitude of the motion in meters?

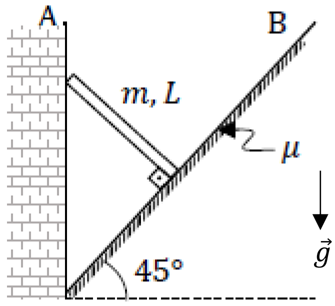
A) $\sqrt{215}$ **B)** $\sqrt{235}$ **C)** $\sqrt{110}$ **D)** $\sqrt{120}$ **E)** $\sqrt{125}$

Question 6) Three identical point masses of $m = 0.1$ (kg) are moving at a constant velocity $v = 10$ (m/s) equidistant from each other on a circular orbit of radius $R = 0.3$ (m). What is the total angular momentum (kg.m2/s) of the three point masses relative to point A at the moment shown in the figure. Point A is 2R away from the center.



A) 0.9 **B)** 1.2 **C)** 1.8 **D)** 3.0 **E)** 3.6

Question 7) As shown in the figure, a rod of mass $m = 1$ (kg) and length $L = 1$ (m) is standing between the frictionless wall A and the frictional plate B. The rod is perpendicular to plate B. What should the minimum coefficient of friction be for the rod to stay at rest?

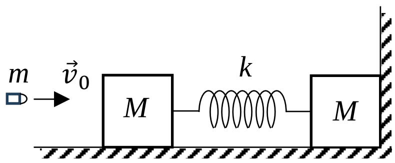


A) $\frac{1}{3}$ **B)** $\frac{2}{3}$ **C)** $\frac{2}{\sqrt{2}}$ **D)** $\frac{2}{\sqrt{3}}$ **E)** $\frac{1}{\sqrt{2}}$

Question 8) A particle of mass $m_1 = 1$ kg is at $(10\ m, 20\ m)$ at time $t = 0$. It is released from rest. Another particle of mass $m_2 = 2$ kg is at $(20\ m, 40\ m)$ at the same instant and it is projected with velocity $(10\,\hat{\imath} + 10\,\hat{\jmath})m/s$. Find the position vector of the center of mass of the particles after $t = 1$ second.

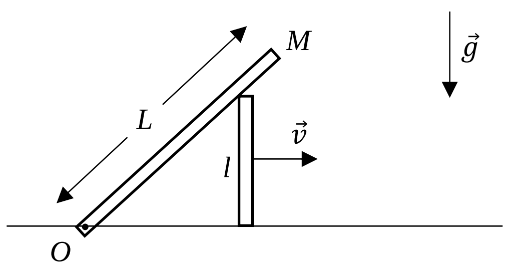
A) $\frac{70}{3}\,\hat{\imath} + 35\,\hat{\jmath}$ **B)** $\frac{50}{3}\,\hat{\imath} + 30\,\hat{\jmath}$ **C)** $\frac{70}{3}\,\hat{\imath} + 45\,\hat{\jmath}$ **D)** $\frac{50}{3}\,\hat{\imath} + \frac{100}{3}\,\hat{\jmath}$ **E)** $\frac{25}{3}\,\hat{\imath} + \frac{45}{3}\,\hat{\jmath}$

Question 9) Two identical blocks each of mass $M = 9\ kg$ are placed on a rough horizontal surface of frictional coefficient $\mu = 0.1$. The two blocks are joined by a light spring and block $B$is in contact with a vertical fixed wall as shown in figure. A bullet of mass m = 1 kg and $v_0 = 10 m/s$ hits block A and gets embedded in it. Find the maximum compression of spring in meters.. (Spring constant $k = 240\ N/m, g = 10\ m/s^2$)



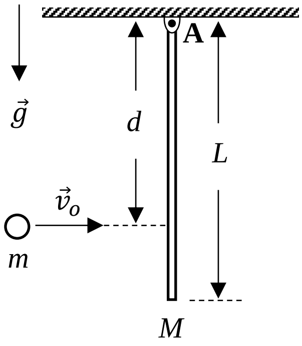
A) $\frac{1}{6}$ **B)** $\frac{1}{3}$ **C)** $\frac{2}{3}$ **D)** $\frac{1}{7}$ **E)** $\frac{3}{4}$

Question 10) A rod of length L and mass M is fixed so that it can rotate around point O. As shown in the figure, if another rod of $l = 4$ (m) perpendicular to the ground is pulled to the right with a constant velocity $v = 3$ (m / s), what is the angular velocity (rad/s) of L rod at $t = 1$ (s)?



A) 0.48 **B)** 0.50 **C)** 0.23 **D)** 0.25 **E)** 0.17

Questions 11-12) A homogeneous 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. $I_{cm}^{rod} = \frac{1}{12}ML^2$



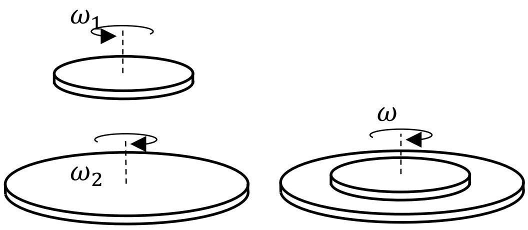
11) At what distance d should the sticky ball strike so that <u>no impulse is applied</u> to the rod from point **A** at the moment of collision? (*Note that the linear momentum will be conserved*)

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

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

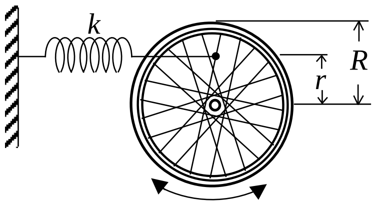
A) $\frac{mv_0}{(M+m)L}$ **B)** $\frac{2mv_0}{(M+3m)L}$ **C)** $\frac{2mv_0}{(M+2m)L}$ **D)** $\frac{2mv_0}{\left(M+\frac{1}{3}m\right)L}$ **E)** $\frac{2mv_0}{\left(M+\frac{4}{3}m\right)L}$

Question 13) 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 14-15) A wheel is free to rotate about its fixed axle. A spring is attached to one of its spokes a distance r from the axle, as shown in figure. The wheel is a hoop of mass M radius R and has a moment of inertia $I = MR^2$.



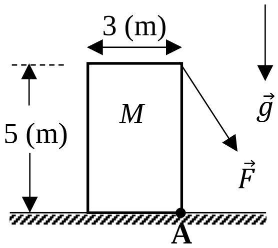
14) Which of the following is the equation of motion for small oscillations?

A) $\frac{d^2\theta}{d\theta^2} + \frac{kr^2}{2MR^2}\theta = 0$ **B)** $\frac{d^2\theta}{d\theta^2} + \frac{kR^2}{Mr^2}\theta = 0$ **C)** $\frac{d^2\theta}{d\theta^2} + \frac{kr^2}{MR^2}\theta = 0$ **D)** $\frac{d^2\theta}{d\theta^2} + \frac{kr}{MR}\theta = 0$ **E)** $\frac{d^2\theta}{d\theta^2} + \frac{kr}{MR^2}\theta = 0$

15) Find the period for small oscillations

A) $2\pi\sqrt{\frac{MR^2}{kr^2}}$ **B)** $2\pi\sqrt{\frac{MR^2}{kr^2}}$ **C)** $2\pi\sqrt{\frac{MR^2}{2kr^2}}$ **D)** $2\pi\sqrt{\frac{MR}{kr}}$ **E)** $2\pi\sqrt{\frac{Mr^2}{kR^2}}$

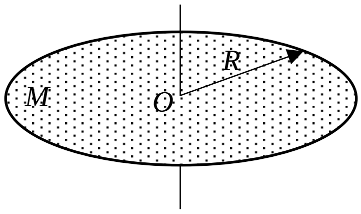
Question 16) The force $\vec{F} = F_x\hat{\imath} - 20\hat{\jmath}$ (N) is applied to a homogen block with mass $M = 4$ (kg) resting on the horizontal plane with friction. How many Newtons is the minimum force F_x that will start turning the block around point A? ($g = 10$ m/s^2)



A) 20 **B)** 10 **C)** 12.5 **D)** 15 **E)** 12

Questions 17-18 A circular lamina of radius R and center O has a mass per unit area of $\sigma = \alpha r^2$, where r is the distance from O and α is a constant. If the mass of the lamina is M,

17) Find constant α in terms of M , R and π.

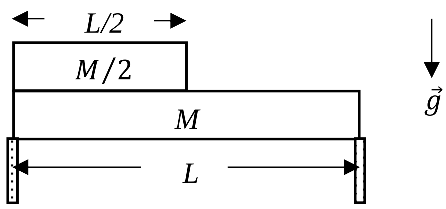


A) $\frac{2M}{\pi R^2}$ **B)** $\frac{M}{\pi R^2}$ **C)** $\frac{2M}{\pi R^4}$ **D)** $\frac{M}{\pi R^4}$ **E)** $\frac{2M}{3\pi R^4}$

18) Find moment of inertia of the lamina about an axis through O and perpendicular to the lamina.

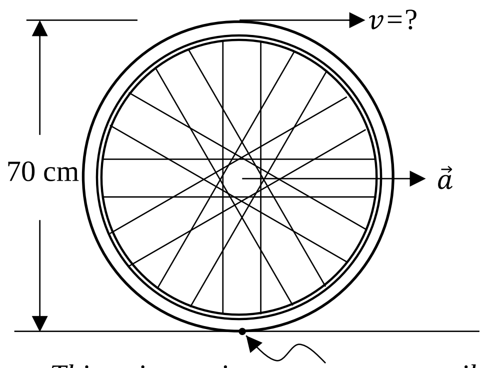
A) $\frac{1}{6}MR^2$ **B)** $\frac{1}{2}MR^2$ **C)** $\frac{5}{3}MR^2$ **D)** $\frac{1}{3}MR^2$ **E)** $\frac{2}{3}MR^2$

Question 19) Two homogeneous beams are placed on top of each other as shown in the figure. Find the force applied by the beam to the pillar on the right.



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

Question 20) A cyclist accelerates from rest at a rate of 1 (m/s^2). How fast will a point the top of the rim of the tire be moving after 2.5 seconds?



A) 7.5 $(\frac{\text{m}}{\text{s}})$ **B)** 5 $(\frac{\text{m}}{\text{s}})$ **C)** 4 $(\frac{\text{m}}{\text{s}})$ **D)** 3.5 $(\frac{\text{m}}{\text{s}})$ **E)** 5.5 $(\frac{\text{m}}{\text{s}})$