YTU Physics Department 2025-2026 Fall Semester			
FIZ1001 PHYSICS-1 Midterm 2			
Question Sheet	**AAAAAA**	**24/12/2025 18.30-20.10**	**100 m**

Name		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.
Surname		
Student No		
Group/Saloon		
Signature		

θ	0^0	30^0	37^0	45^0	53^0	60^0	90^0	
sin	0	1/2	3/5	$\sqrt{2}/2$	4/5	$\sqrt{3}/2$	1	$g = 10\, m/s^2$
cos	1	$\sqrt{3}/2$	4/5	$\sqrt{2}/2$	3/5	1/2	0	$\pi = 3$

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

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

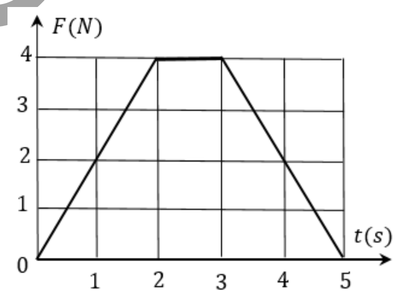
$U = mgy$; $U = \frac{1}{2}kx^2$; $\vec{F} = \frac{d\vec{p}}{dt}$; $\vec{p} = m\vec{v}$; $\vec{I} = \Delta\vec{p} = \overline{\vec{F}}\Delta t$; $\vec{r}_{cm} = \frac{\sum m_i\vec{r}_i}{\sum m_i}$; $\vec{r}_{cm} = \frac{\int \vec{r}dm}{\int dm}$; $\overline{\vec{\omega}} = \frac{\Delta\vec{\theta}}{\Delta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

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

$I = I_{cm} + MD^2$; $I_{disc=cylinder} = \frac{1}{2}mr^2$; $I_{sphere} = \frac{2}{5}mr^2$; $P = \vec{\tau}\cdot\vec{\omega}$; $W = \int \vec{\tau}\cdot d\vec{\theta}$; $\vec{L} = \vec{r}\times\vec{p}$; $\vec{L} = I\vec{\omega}$; $\vec{\tau} = \frac{d\vec{L}}{dt}$; $\overline{\vec{\tau}} = \frac{\Delta\vec{L}}{\Delta t}$

$v_{cm} = R\omega$; $x(t) = A\cos(\omega t + \varphi)$; $T = \frac{1}{f}$; $\omega = 2\pi f$; $E = \frac{1}{2}kA^2$; $T = 2\pi\sqrt{l/g}$; $T = 2\pi\sqrt{m/k}$; $T = 2\pi\sqrt{I/mgh}$

1-2) A $m = 2.0\, kg$ object is acted on by a net force along the x-axis. The force varies with time as shown in the figure.



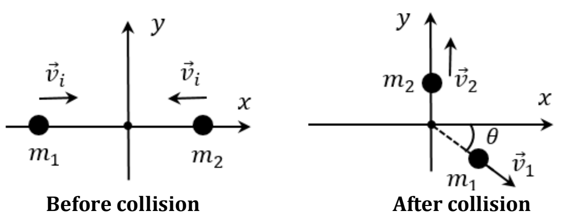
1) What is the average force applied to the object over the interval $0 \le t \le 5$ s, in newtons (N)?

A) 2.0 B) 2.1 C) 2.2 D) 2.3 E) 2.4

2) If the object's speed at $t = 3\ s$, is $v = 10\ m/s$, what is its speed at $t = 0$, in m/s?

A) 0 B) 2 C) 4 D) 6 E) 8

3-4) Two steel balls with masses $m_1 = 3m$ and $m_2 = m$ move toward each other along the x-axis with the same initial speed v_i, as shown in the figure, and undergo an off-center collision. After the collision, the ball of mass m_2 moves in the $+y$ direction with velocity $\vec{v}_2$, while the ball of mass m_1 moves with velocity $\vec{v}_1$, making an angle θ below the $+x$-axis (i.e., an angle $-\theta$ with the $+x$-axis).



3) What is the correct expression for the velocity vector $\vec{v}_1$ in terms of v_i?

A) $\vec{v}_1 = \frac{2v_i}{3}\hat{\imath} - \frac{\sqrt{2}v_i}{3}\hat{\jmath}$

B) $\vec{v}_1 = \frac{\sqrt{2}v_i}{3}\hat{\imath} - \frac{\sqrt{2}v_i}{3}\hat{\jmath}$

C) $\vec{v}_1 = \frac{\sqrt{2}v_i}{3}\hat{\imath} - \frac{4v_i}{3}\hat{\jmath}$

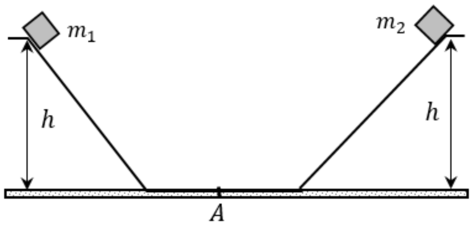
D) $\vec{v}_1 = \frac{v_i}{3}\hat{\imath} - \frac{2v_i}{3}\hat{\jmath}$

E) $\vec{v}_1 = \frac{4v_i}{3}\hat{\imath} - \frac{2v_i}{3}\hat{\jmath}$

4) What is $\tan(\theta)$?

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

5-6-7) Two blocks with masses $m_1 = 1.5\,kg$ and $m_2 = 1.0\,kg$ are released from rest from the same height $h = 7.2\,m$, as shown in the figure. As they accelerate, they undergo a completely inelastic collision at point A and stick together.



5) What is the common speed of the two blocks immediately after the collision, in m/s ?

A) 0 B) 2.2 C) 2.4 D) 2.6 E) 2.8

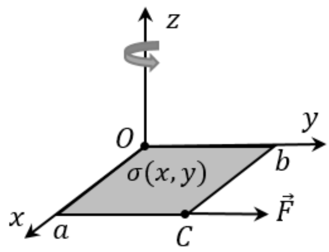
6) How much kinetic energy is lost in the collision, ΔK, in joules (J)?

A) 0 B) -43.2 C) -57.6 D) -86.4 E) -172.8

7) Before coming momentarily to rest, how high above the ground do the blocks rise, in meters (m)?

A) 0.144 B) 0.288 C) 0.432 D) 0.576 E) 0.720

8-9) A thin rectangular plate with side lengths $a = 0.3\,m$ and $b = 0.4\,m$ lies in the xy-plane with one corner at the origin, as shown in the figure. The plate is non-uniform; its surface mass density is $\sigma(x,y) = 8xy\ \ kg/m^2$ where x and y are in meters.



8) What is the moment of inertia of the plate about the z-axis, in $kg\ m^2$?

A) 0.0009 B) 0.0016 C) 0.0025 D) 0.0036 E) 0.0041

9) Initially the plate is at rest. At $t = 0\ s$, a constant force of magnitude $F = 0.12\ N$ is applied at point C, always perpendicular to the side of length a, as shown in the figure. The plate is free to rotate about the z-axis. What is the rotational kinetic energy of the plate at $t = 10\ s$, in joules (J)?

A) 6 B) 9 C) 12 D) 15 E) 18

10-11) A system consists of two particles of masses $m_1 = 0.1\,kg$ and $m_2 = 0.2\,kg$ moving in the horizontal, frictionless xy-plane. The position vector of the center of mass is given as a function of time by $\vec{r}_{CM}(t) = (2t^2 - t + 1)\hat{\imath} + (3t + 2)\hat{\jmath}$ where t is in seconds and $\vec{r}_{CM}$ is in meters.

10) If the position vector of the m_1 particle is $\vec{r}_1(t) = (2t^2 - t + 3)\hat{\imath} + 3t\hat{\jmath}$ what is the position vector $\vec{r}_2(t)$ of the particle m_2, expressed in unit-vector form?

A) $\vec{r}_2(t) = (t^2 + t)\hat{\imath} + (3t + 3)\hat{\jmath}$
B) $\vec{r}_2(t) = (t^2 - t)\hat{\imath} + (3t - 3)\hat{\jmath}$
C) $\vec{r}_2(t) = (2t^2 + t)\hat{\imath} + (3t + 3)\hat{\jmath}$
D) $\vec{r}_2(t) = (2t^2 - t)\hat{\imath} + (3t + 3)\hat{\jmath}$
E) $\vec{r}_2(t) = (t^2 - 2t)\hat{\imath} + (3t + 3)\hat{\jmath}$

11) What is the velocity of the center of mass $\vec{v}_{CM}$ at $t = 1\,s$, expressed in unit-vector form?

A) $\vec{v}_{CM} = 3\hat{\imath} + 3\hat{\jmath}$
B) $v_{CM} = 3\hat{\imath} + 2\hat{\jmath}$
C) $\vec{v}_{CM} = 2\hat{\imath} + 2\hat{\jmath}$
D) $\vec{v}_{CM} = \hat{\imath} + 2\hat{\jmath}$
E) $\vec{v}_{CM} = 2\hat{\imath} + 3\hat{\jmath}$

12-13) A disk is free to rotate about a fixed axis perpendicular to the disk and passing through its center. The angular velocity of a point P on the disk is given by $\omega(t) = 9t^2 - 12t + 9\ (rad/s)$, and the disk has moment of inertia $I = \frac{1}{3}\ kg\ m^2$.

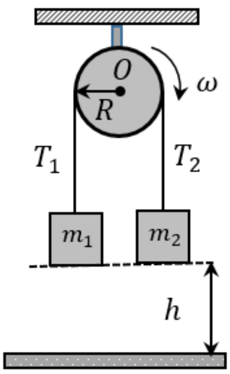
12) How many revolutions does the disk complete by $t = 3\,s$?

A) 9 B) 8 C) 6 D) 4 E) 2

13) Which of the following statements about the torque τ acting on the disk is false?

A) At $t = 0, \tau = -4\ \mathrm{N \cdot m}$.
B) At the instant $t = \frac{2}{3}$ s, τ is zero.
C) The torque at $t = 2$ s is four times the torque at $t = 1$ s.
D) The torque at $t = 1$ s is one-tenth of the torque at $t = 4$ s.
E) The torque decreases linearly with time.

14-15-16) Two blocks of masses $m_1 = 1\,kg$ and $m_2 = 2\,kg$ are connected by a massless rope that passes over a fixed pulley of mass $M = 2\,kg$ and radius $R = 0.1\,m$, as shown in the figure. The pulley can rotate without friction about an axle through its center. At $t = 0$, the blocks are released from rest when the $m_2$block is at a height $h = 1\,m$ above the ground. ($I_{pulley} = \frac{1}{2}MR^2$)



14) What is the linear acceleration of the $m_2$block, in m/s^2?

A) 1.5 B) 2.5 C) 3.5 D) 4.5 E) 5.5

15) What is the difference in the rope tensions, ($T_2 - T_1$), in newtons (N)?

A) 5.5 B) 4.5 C) 3.5 D) 2.5 E) 0

16) What is the angular speed ω of the pulley at the instant the $m_2$block reaches the ground, in rad/s?

A) $2\sqrt{5}$

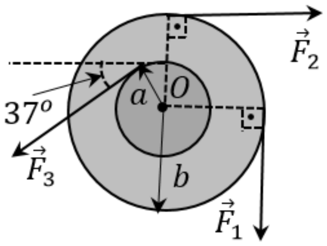
B) $4\sqrt{5}$

C) $6\sqrt{5}$

D) $8\sqrt{5}$

E) $10\sqrt{5}$

17-18) A pulley of radius $a = 10\ cm$ and moment of inertia $I_a = 0.15\ kg\ m^2$ is riveted coaxially to another pulley, of radius $b = 20\ cm$ and moment of inertia $I_b = 0.20\ kg\ m^2$, so that their centers coincide. The resulting composite pulley can rotate freely about an axis through point O, perpendicular to the plane of the pulleys. At $t = 0$, three forces of magnitudes $F_1 = 3\,\mathrm{N}$, $F_2 = 4\,\mathrm{N}$, and $F_3 = 7\,\mathrm{N}$ act on the composite pulley as shown in the figure.



17) At $t = 0$, what is the net torque about point O acting on the composite pulley, in $N.m$?

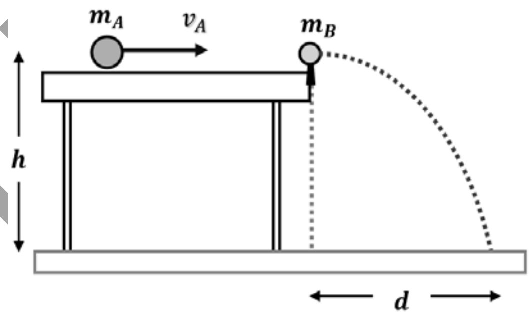
A) 0.70 B) 0.84 C) 0.98 D) 1.40 E) 0

18) At $t = 0\ s$, what is the angular acceleration of the composite pulley, in rad/s^2?

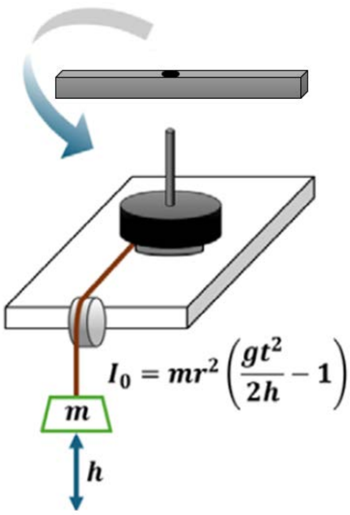
A) 0 B) 1 C) 2 D) 3 E) 4

19) In a frictionless, setup, a sphere A of mass $0.5\ kg$ moves along a horizontal surface with speed $1.0\ m/s$and collides head-on with a sphere B of mass $0.2\ kg$ that is initially at rest. After the collision, sphere A is reflected backwards along the same line with speed $0.4\ m/s$, while sphere B continues forward along the same line and then leaves the edge of the table, following the trajectory shown in the figure. If the horizontal distance is $d = 140\ cm$, what is the height of the table above the floor, in centimeters?

A) 50 B) 60 C) 70 D) 80 E) 90



20) An experimental setup determines an object's moment of inertia using energy conservation. A light string is wrapped around a pulley of radius $r = 2\ cm$ attached beneath a rotating reference platform. A hanging mass $m = 10\ g$ is attached to the free end of the string, which passes over an ideal guide pulley (its moment of inertia neglected) and hangs vertically. When the system is released from rest, the mass m falls a vertical distance $h = 1\ m$ in $2\ s$; from this, the moment of inertia of the reference platform is determined. A uniform rectangular plate is then placed on the platform with its center of mass aligned with the rotation axis. Under the same conditions, the mass m takes $5\ s$ to fall the same distance h. What is the moment of inertia of the rectangular plate about its center of mass, expressed in $g\ cm^2$? (Neglect all friction.)



A) 1200 B) 2200 C) 3200 D) 4200 E) 5200