YTU Physics Department 2024-2025 Fall Semester			
FIZ1001 PHYSICS-1 Midterm 2			
Question Sheet	**AAAAAA**	**27/12/2024 18.30-20.10**	**100 min**

Name	
Surname	
Student No	
Group/Saloon	
Signature	

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.

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	$\pi = 3$

$$\vec{F}_{cons} = -\frac{dU}{dr}\hat{r}\ ;\ W_{cons} = -\Delta U\ ;\ U = mgy;\ U = \frac{1}{2}kx^2;\ \vec{F}_{net} = \frac{d\vec{p}}{dt};\ \vec{p} = m\vec{v};\ \vec{I} = \Delta\vec{p} = \vec{F}\Delta t;\ f_s \le \mu_s n;$$
$$f_k = \mu_k n;\ \vec{\omega} = \frac{\Delta\vec{\theta}}{\Delta t};\ \vec{\alpha} = \frac{\Delta\vec{\omega}}{\Delta t};\ \vec{\omega} = \frac{d\vec{\theta}}{dt};\ \vec{\alpha} = \frac{d\vec{\omega}}{dt};\ \vec{\omega} = \overrightarrow{\omega_0} + \vec{\alpha}t\ ;\ \vec{\theta} = \overrightarrow{\theta_0} + \overrightarrow{\omega_0}t + \frac{1}{2}\vec{\alpha}t^2;\ F = -kx;$$
$$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0);\ v = r\omega\ ;\ a_t = r\alpha;\ \vec{r}_{cm} = \frac{\sum m_i\vec{r}_i}{\sum m_i};\ \vec{r}_{cm} = \frac{\int \vec{r}\,dm}{\int dm};\ \vec{\tau} = \vec{r}\times\vec{F};\ \overrightarrow{\tau_0} = I_0\vec{\alpha};\ I = \int r^2\,dm\ ;$$
$$P = \vec{\tau}\cdot\vec{\omega};\ W = \int \vec{\tau}\cdot\,d\vec{\theta};\ \bar{P} = \frac{\Delta W}{\Delta t};\ W = \Delta U + \Delta K;\ I_{disc} = \frac{1}{2}mr^2;\ I_{sphere} = \frac{2}{5}mr^2;\ I_{rod} = \frac{1}{12}mL^2$$

Sorular 1-3

The potential energy of a particle, given in J, is expressed as: $U(x,y) = (1-x^3)^2 + \frac{1}{2}y^2 + \frac{1}{2}x^2y^2$.

1) What are the components of the force acting on the particle, expressed in N?

A) $F_x = -(6x + 9x^8 - xy^2);\ F_y = y(x^2 - 1)$
B) $F_x = -(6x + 6x^4 + xy^2);\ F_y = y(1 - x^2)$
C) $F_x = (6x^2 - 6x^5 - xy^2);\ F_y = -y(1 + x^2)$
D) $F_x = (3x^2 + 9x^8 - 2xy^2);\ F_y = y(1 - x^2)$
E) $F_x = -(3x^2 + xy^2);\ F_y = -y(1 + x^2)$

2) At which position along the y-axis is the particle in equilibrium?

A) $y = -1$ B) $y = 0$ C) $y = \sqrt{1 - x^2}$ D) $y = 1$ E) $y = -\sqrt{1 - x^2}$

3) If the force vector is $\vec{F}\ (2,3)$ which of the following correctly represents it in N?

A) $-2298\,\hat{\imath} + 9\,\hat{\jmath}$ B) $-126\,\hat{\imath} - 9\,\hat{\jmath}$ C) $-30\,\hat{\imath} - 15\,\hat{\jmath}$ D) $-186\,\hat{\imath} - 15\,\hat{\jmath}$ E) $-2280\,\hat{\imath} - 9\,\hat{\jmath}$

4) In a competition where participants of equal mass demonstrate their performance, the winner is determined by who can lift five cement bags, each weighing 40 kg, to a height of 1 m in the shortest time. Which physical quantity can be used to decide the winner?

A) The total energy transferred to the bags
B) The physical work done
C) The gravitational potential energy
D) The power they generate
E) The ratio of the work done to the energy consumed

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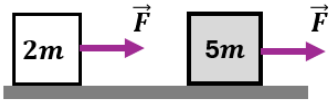
Questions 5-6

F forces are applied to two objects with masses $2m$ and $5m$, which are initially at rest on a frictionless horizontal surface as shown in figure.

5) What should the ratio $\Delta t_{2m}/\Delta t_{5m}$ of the durations of the forces' application be for the objects to have the same linear velocity?



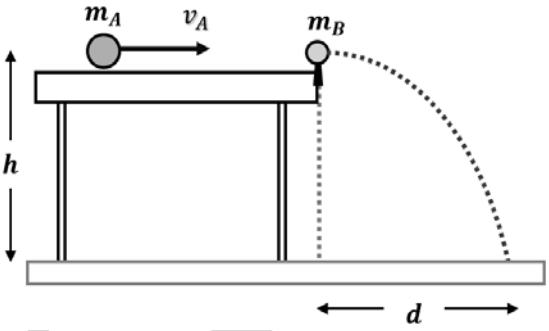
A) 2/5 B) 5/2 C) 3/5 D) 5 E) 1

6) What should the ratio $\Delta t_{2m}/\Delta t_{5m}$ of the durations of the forces' application be for the objects to have the same kinetic energy?

A) $2/\sqrt{5}$ B) $\sqrt{2}/\sqrt{5}$ C) 2/5 D) 5/2 E) $1/\sqrt{5}$

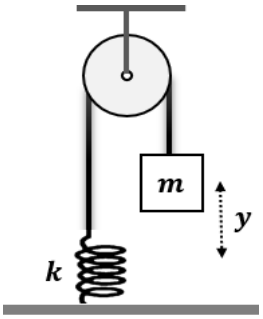
7) LABORATORY QUESTION

In a frictionless environment, a sphere A with a mass of $0.5\ kg$ moves at $2.0\ m/s$ on a horizontal plane and collides head-on with a stationary sphere B of mass $0.2\ kg$. After the collision, sphere A rebounds with a speed of $0.8\ m/s$ in a straight line, while sphere B moves forward along the trajectory shown. If the height of the table from the ground is $5\ cm$, what is the horizontal distance d in cm?



A) 58 B) 28 C) 84 D) 30 E) 70

8) In the system shown, a spring with a force constant k is initially at its equilibrium position and then released. The pulley is frictionless. When the mass m descends vertically by a distance y, what is the velocity of m?

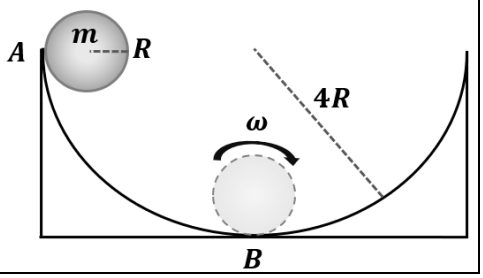


A) $\sqrt{gy-\frac{k}{m}y^2}$ B) $\sqrt{2gy-\frac{k}{m}y^2}$ C) $\sqrt{gy-\left(\frac{k}{m}\right)^2}$ D) $\sqrt{\frac{gy}{2}-\frac{2k}{m}}$ E) $\sqrt{gy-\frac{2k}{m}y^2}$

Questions 9-10

A glass marble with mass m and radius R starts rolling without slipping from point A at the top of a spherical bowl with radius $4R$.

9) What is the linear velocity of the marble as it passes point B at the bottom of the bowl?



A) $\sqrt{30gR/7}$
B) $\sqrt{40gR/7}$
C) $\sqrt{50gR/7}$
D) $\sqrt{60gR/7}$
E) $\sqrt{10gR}$

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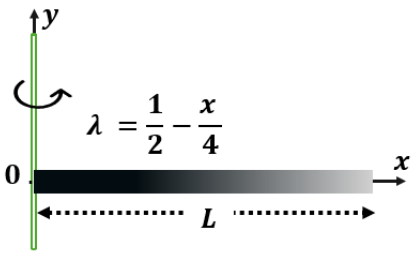
10) What is the kinetic energy of the glass marble at point B?

A) $5/8\ (mgR)$
B) $5/4\ (mgR)$
C) $3\ (mgR)$
D) $7/3\ (mgR)$
E) $15\ (mgR)$

Questions 11-14

A solid rod with a length of 1 m has a non-uniform linear mass density given by $\lambda = \frac{1}{2} - \frac{x}{4}$, where λ and x are expressed in $\frac{kg}{m}$ and m, respectively. Initially, the rod is stationary, and at $t = 0$, it begins to rotate with a constant angular acceleration of $\alpha = 4\ rad/s^2$.



11) What is the moment of inertia of the rod about an axis passing through its denser end and perpendicular to its length in $kg\ m^2$?

A) 5/16 B) 5/24 C) 11/48 D) 5/48 E) 5/36

12) What is the rotational kinetic energy of the rod about the same axis at $t = 2\ s$, in joules?

A) 22/3
B) 10/3
C) 20
D) 40
E) 5/3

13) What is the magnitude of the net torque acting on the rod about the same axis at $t = 2\ s$, in Nm?

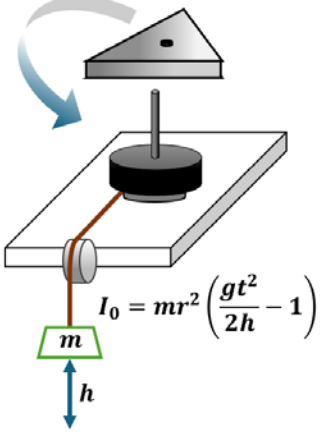
A) 5/4 B) 5/6 C) 5/12 D) 11/12 E) 5/9

14) What is the distance between the center of mass of the rod and its denser end at the initial moment, in meters?

A) 8/9 B) 8/15 C) 4/9 D) 4/15 E) 4/5

15) LABORATORY QUESTION

A setup to determine the moment of inertia using energy conservation includes a pulley with a radius $r = 2\ cm$ attached under a reference table. A string is wound around the pulley, with a mass of 10 g attached to the string's end. The string passes over an massless and frictionless pulley and hangs vertically with mass m. When the system is released, the time it takes for m to fall a vertical distance $h = 100\ cm$ is measured, and the reference table's moment of inertia is determined to be 760 $g\ cm^2$. When a homogeneous equilateral triangular plate is placed on the reference table with its center of mass aligned with the rotation axis, it is found that m takes 5 s to travel the same distance. What is the moment of inertia of the equilateral triangular plate relative to its center of mass in $g\ cm^2$? (All frictional forces are neglected)



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

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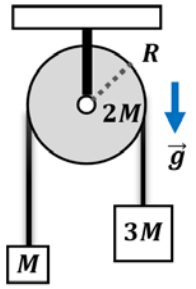
Questions 16-17

Two objects with masses M and 3M are attached to the ends of a massless string passing over a pulley with a mass of 2M, fixed to the ceiling. The string does not slip on the pulley, and the pulley can rotate frictionlessly around its axis.



16) What is the acceleration of the blocks?

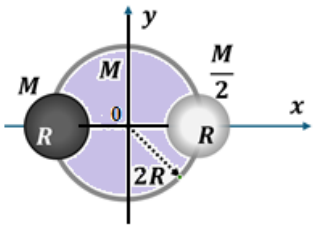
A) $g/5$ B) $2g/3$ C) $3g/5$ D) $g/10$ E) $2g/5$

17) What is the T_1/T_2 ratio?

A) 10/9 B) 7/10 C) 7/9 D) 9/7 E) 1

Questions 18-19

A solid disk with a mass M and radius 2R has two solid spheres attached at its edges, each with a radius R. The spheres, made from different materials, have uniform mass densities, with masses M and M/2, respectively.



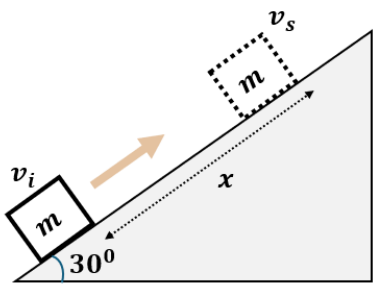
18) What are the coordinates of the center of mass in terms of R?

A) $(-1/5, 0)$ B) $(0, 7/5)$ C) $(-2/5, 0)$ D) $(-3/5, 0)$ E) $(0, 2/5)$

19) What is the moment of inertia of the system about an axis passing through its center of mass, expressed in MR^2?

A) 41/5 B) 4/5 C) 43/5 D) 51/25 E) 11/5

20) On a frictionless inclined plane, an object m with a mass of 235 g, initially moves with a velocity of $v_i = 5\ m/s$. As it travels a displacement x, its speed decreases by 2 m/s. What is the displacement of the object in m?



A) 6/5
B) 5/2
C) 21/10
D) 47/3
E) 8/5

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