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Name-Surname :
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Department :
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FİZ 137 PHYSICS I
MIDTERM II
07.01.2011

1. The duration of the exam is **100** minutes.
2. There are **30** questions with equal weight in this exam.
3. This question booklet is type "**M**" booklet. Check to see that all pages are type "**M**".
4. Use the appropriate box in the answer sheet.
5. Five wrong answers nullify a correct answer.
6. If need be, use the back page of the booklet for calculation.
7. Please fill in identity information both the booklet and answer sheet.
8. It is not allowed to use calculator.

GIVENS

The acceleration of gravity: $g = 10\ m/s^2$

$\sin 45^\circ = \cos 45^\circ = 0.7$
$\sin 37^\circ = \cos 53^\circ = 0.6$
$\sin 53^\circ = \cos 37^\circ = 0.8$
$\tan 37^\circ = 0.75$
$\sin 30^\circ = \cos 60^\circ = -\cos 120^\circ = 0.5$
$\sin 60^\circ = \cos 30^\circ = 0.87$
$\cos 180^\circ = -1$

$\pi = 3$
$\sqrt{2} = 1.4$
$\sqrt{3} = 1.7$

Metric Prefixes

Number	Prefix	Abbr.
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p

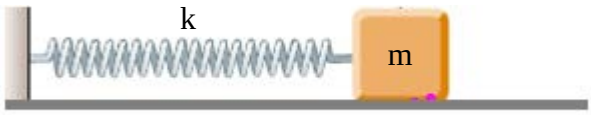
Some Rotational Inertias:

$I_{c.m.} = MR^2/2$ Disk, cylinder (disk or cylinder about central axis)
$I_{c.m.} = MR^2$ Hoop (about central axis which is perpendicular to the hoop plane)
$I_{c.m.} = ML^2/12$ Thin rod (about axis through center perpendicular to length)
$I_{c.m.} = 2MR^2/5$ Sphere (about any diameter of sphere)

1. The radius of the tires of a car of mass 1600 kg is 0.3 m. The frictional coefficients between the tires and the road surface are $\mu_s = 0.8$ and $\mu_k = 0.6$. If the weight of the car is distributed equally on the tires, what is the maximum torque (in N.m) to be transferred by the engine to prevent the rotation of the tires?

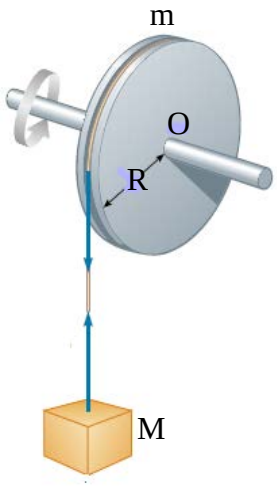
   A) 1240 B) 960 C) 735 D) 546 E) 455

2. A block of mass m attached to an ideal spring with a spring constant k oscillates on a horizontal frictionless surface. The total mechanical energy is E. What is the maximum speed of the block?



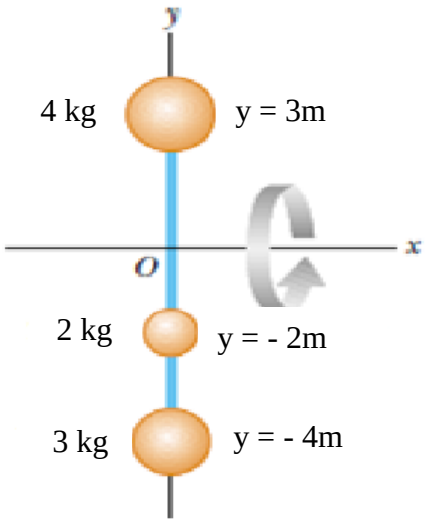
   A) $(2E/m)^{1/2}$ B) $(E/m)^{1/2}$ C) $(2E/k)^{1/2}$ D) $(E/2m)^{1/2}$ E) $(2E/km)^{1/2}$

3. A 6 kg block is attached to one end of a string passing through a frictionless pulley. Considering the pulley is a solid disk of radius 10 cm and mass 3 kg, find the acceleration of the block (in m/s^2).



   A) 14 B) 12 C) 10
   D) 8 E) 6

4. Three small particles are connected by rigid rods of negligible mass lying along the *y* axis (see figure). If the system rotates about the *x* axis with an angular speed of 2 rad/s, find the total kinetic energy (in J).



   A) 184 B) 92 C) 48
   D) 36 E) 18

5. At an instant, a 1 kg particle-like object has a position vector of $\mathbf{r} = \mathbf{i} - 2\mathbf{k}$ (in m) and a velocity vector $\mathbf{v} = -5\mathbf{i} + 5\mathbf{k}$ (in m/s). What is the angular momentum (in kg.m^2/s) of the object about the origin?

   A) $-5\mathbf{i} - 10\mathbf{k}$ B) $-6\mathbf{i} + 3\mathbf{k}$ C) $5\mathbf{j}$ D) $-15\mathbf{i}$ E) $5\mathbf{i} + 10\mathbf{k}$

6. A 1000 kg compact car is moving with velocity $\mathbf{v}_1 = 30\mathbf{i} + 15\mathbf{j}$ (m/s). It skids on a frictionless surface, and collides with a 500 kg another car moving with velocity $\mathbf{v}_2 = 15\mathbf{i} + 30\mathbf{j}$ (m/s). If they move together after collision, what is their common velocity (in m/s)?

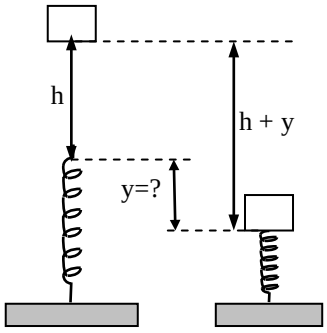
   A) $45\mathbf{i} + 45\mathbf{j}$ B) $-15\mathbf{i} + 15\mathbf{j}$ C) $25\mathbf{i} + 20\mathbf{j}$ D) $15\mathbf{i} - 15\mathbf{j}$ E) $-15\mathbf{i} - 15\mathbf{j}$

7. A body of 4 kg mass makes an elastic collision with another body at rest and continues to move in the original direction but with one-third of its original speed. What is the mass (in kg) of the struck body?

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

8. A block of mass 0.5 kg, initially at rest, is dropped from a height h = 1 m on to a spring whose force constant is 20 N/m. Find the maximum distance y (in m) that the spring will be compressed (see figure).

   A) 0.5 B) 0.2 C) 0.4 D) 2.0 E) 1.0



9. An object of mass M is released from a height 100 m. At the same time, another object with equal mass is thrown vertically upward with an initial velocity 20 m/s. What is the velocity (in m/s) of center of mass of this two particle system at t = 3 s?

   A) $-15\mathbf{j}$ B) $+20\mathbf{j}$ C) $-20\mathbf{j}$ D) $-10\mathbf{j}$ E) $+10\mathbf{j}$

10. A sphere of mass 1 kg and radius 10 cm climbs on a ramp of slope 37^o and height 28 cm. The sphere rolls without slipping on the ramp. What should be the minimum angular velocity (in rad/s) of the sphere at the beginning of ramp to climb the ramp?

A) 35 B) 30 C) 25 D) 20 E) 15

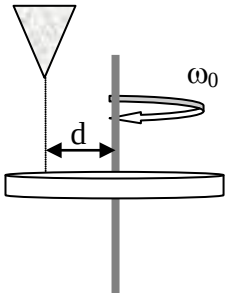
11. An automobile has a total mass of 1700 kg. It accelerates from rest to 72 km/h in 10 s. Assume each wheel is a uniform 32 kg disk. What is the total kinetic energy of each wheel (in J) for the end of the 10 s interval?

A) 9600 B) 7200 C) 6400 D) 4800 E) 3200

12. A wheel with a radius of 0.6 m is rotating at an angular speed of 200 rev/min. What is the linear speed (in m/s) of a point on the rim of the wheel?

A) 48 B) 40 C) 24 D) 18 E) 12

13. Sand drops onto a disk rotating freely about an axis. The moment of inertia of the disk about this axis is I, and its original angular speed was ω_0. What is the angular speed after a mass M of sand accumulated on the disk at a distance d from the axis?

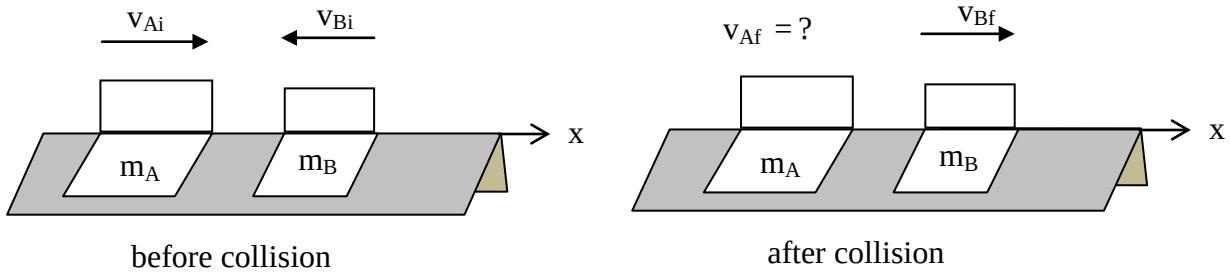


A) $\frac{\omega_0}{(1+Md/I)}$ B) $\frac{\omega_0}{(1+Md^2/I)}$ C) $\frac{I\omega_0}{1+Md^2}$ D) $\omega_0(1+\frac{Md^2}{I})$ E) $\omega_0(1+\frac{Md}{I})$

14. An electric motor runs at 700 rev/min and delivers 1400 W. How much torque (in N.m) does it apply?

A) 10 B) 40 C) 30 D) 20 E) 120

15. As shown in figure, m_A = 0.5 kg and m_B = 0.3 kg masses move toward each other with initial velocities of 2 m/s on a frictionless linear air track. After they collide, m_B moves away with a final velocity of 2 m/s in the positive x direction. What is the final velocity (in m/s) of m_A?



A) 0.4 **i** B) 2 **i** C) -2 **i** D) -0.4 **i** E) zero

16. A 0.25 kg ball is dropped vertically from the window of a building. It strikes to the ground at 25 m/s and rebounds up with 15 m/s. What is the impulse (in N.s), both in magnitude and direction, on the ball during the collision?

A) 5, upward B) 5, downward C) 10, upward D) 10, downward E) 0

17. A 4 kg mass moving at a velocity of 10 m/s is undergoing an inelastic collision with a stationary mass of 6 kg. After collision they move together. What is the energy loss (in J) in this collision?

A) 100 B) 120 C) 180 D) 220 E) 260

18. An object of mass m = 50 g moves in a circle of radius r = 50 cm on a rough surface. Initially the object has angular speed ω_0 = 16 rad/s and after two turns its angular speed is reduced by half. What is the coefficient of kinetic friction μ_K between the block and the rough surface?

A) 0.8 B) 0.7 C) 0.6 D) 0.5 E) 0.4

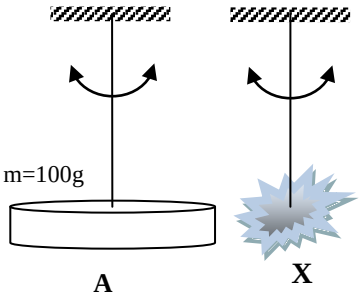
19. A small body of mass 0.2 kg is undergoing simple harmonic motion of amplitude 7 cm and period 0.6 s. What is the maximum value of the force (in N) acting on it?

A) 3.0 B) 2.0 C) 1.4 D) 1.0 E) 0.5

20. A disk is turning about its center initially ω_0 = 126 rad/s. If it is slowing down uniformly and stops in 7 minutes, due to an external torque. If the magnitude of the torque is τ_{ext} = 0.9 N.m, find the initial angular momentum (in kg .m^2 /s) of the disk.

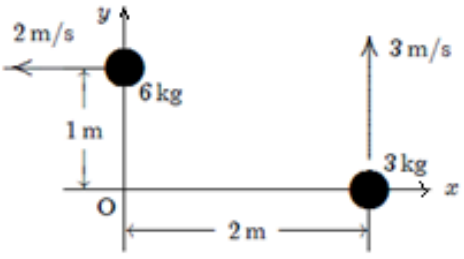
A) 456 B) 378 C) 216 D)148 E) zero

21. A thin disk with a radius of 10 cm and a mass of 100 g is suspended at its center by a long wire and its period T_a of angular simple harmonic motion is measured to be 3 s. An irregularly shaped object X is hung by the same wire and its period T_x is found to be 6 s. What is the rotational inertia of object X about its suspension axis (in kg.m^2)?



A) 2×10^{-3} B) 4×10^{-3} C) 5×10^{-3}
D) 6×10^{-3} E) 1

22. Two objects are moving in the x, y plane as shown. What is the magnitude of their total angular momentum (in kg·m^2/s) about the origin?

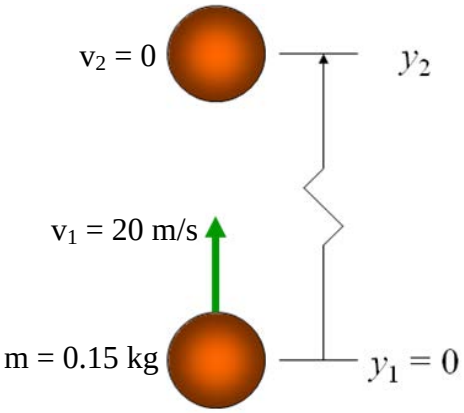


A) 0 B) 6 C) 12
D) 30 E) 78

23. An oscillating object of mass m, oscillating on the end of a spring with spring constant k, has amplitude A. What is its maximum speed?

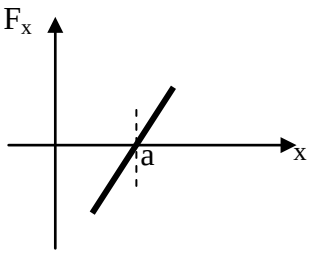
A) $A(k/m)^{1/2}$ B) A^2 k/m C) $A(m/k)^{1/2}$ D) A m/k E) A^2m/k

24. You toss a 0.15 kg baseball straight upward so that it leaves your hand moving at 20 m/s. The ball reaches a maximum height y_2. What is the speed of the ball (in m/s) when it is at a height of $y_2/2$? Ignore air resistance.



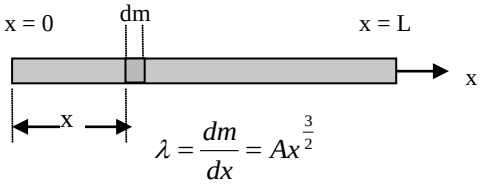
A) 10 B) $10\sqrt{2}$ C) $15/\sqrt{2}$
D) $20/\sqrt{2}$ E) 5

25. The graph shows a conservative force F_x as a function of x in the vicinity of $x = a$. As the graph shows, $F_x = 0$ at $x = a$. Which statement about the associated *potential energy* function U at $x = a$ correct?



A) U = a B) dU/dx > 0 C) U is a minimum
D) dU/dx < 0 E) U is a maximum

26. One end of a straight rod of length L is fixed at the origin and the other end is at $x = L$. If the mass per unit length of the rod is given by $Ax^{3/2}$, where is its center of mass (x_{cm}) (A is a constant)?

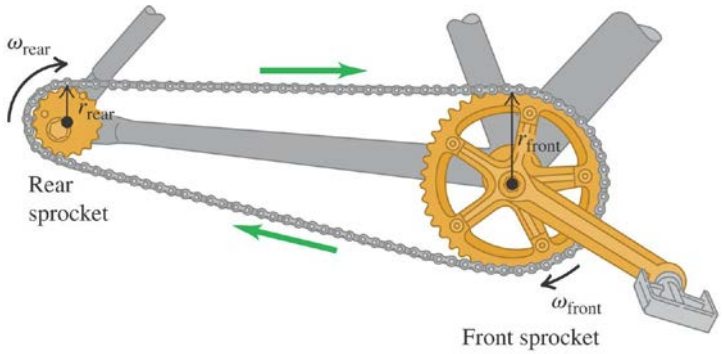


A) $\frac{2}{3}$L B) $\frac{3}{4}L$ C) $\frac{5}{7}L$ D) $\frac{3}{5}L$ E) $\frac{4}{5}L$

27. A 2 kg particle has a velocity of $\mathbf{v}_1 = 4t\mathbf{i} - 10\mathbf{j}$ (m/s) and a 4 kg particle has a velocity of $\mathbf{v}_2 = 5\mathbf{i} + 2t\mathbf{j}$ (m/s). Find the magnitude of the acceleration of the center of mass (in m/s^2) of the system.

A) $\sqrt{2}/3$ B) $4\sqrt{2}/3$ C) $4\sqrt{2}$ D) $2\sqrt{2}$ E) 0

28. Compared to a gear tooth on the rear sprocket (on the left, of small radius) of a bicycle, a gear tooth on the *front* sprocket (on the right, of large radius) has



A) $v_{front} > v_{rear}$ and $\omega_{front} > \omega_{rear}$

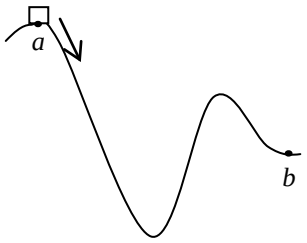
B) $v_{front} = v_{rear}$ and $\omega_{front} > \omega_{rear}$

C) $v_{front} < v_{rear}$ and $\omega_{front} = \omega_{rear}$

D) $v_{front} = v_{rear}$ and $\omega_{front} < \omega_{rear}$

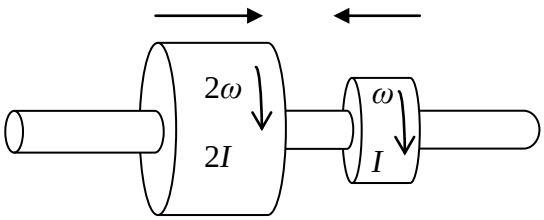
E) $v_{front} = v_{rear}$ and $\omega_{front} = \omega_{rear}$

29. A 3.0 kg block slides along a frictionless track from point a to point b, as shown. It travels through a total distance of 2.0 m along the track, and a net vertical distance of 0.8 m. How much work (in J) is done on the block by the gravitational force during the slide?



A) 80 B) 64 C) 40 D) 32 E) 24

30. Two disks are mounted on a common shaft without friction. The disk on the right has rotational inertia I and is spinning with angular velocity ω. The disk on the left has rotational inertia 2I and is spinning in the same direction as the first disk with angular velocity 2ω as shown. The two disks are slowly forced toward each other along the shaft until they couple. What would be the final common angular velocity of the disks?



A) $5\omega/3$ B) $\omega\sqrt{3}$ C) $\omega\sqrt{7/3}$ D) ω E) 3ω