Physics I (FIZ101E) Midterm I October 23, 2011

Questions 1-10		This part will be filled by students.	Surname	:		Booklet Type
Group Number	:		Name	:		**A**
List Number	:		e-mail	:		
Student ID	:		Signature	:		

Your choice for each question from 1 to 25 will be marked in the "ANSWER SHEET". Each right choice is 1 point. Wrong answers do not cause point deductions.

1. The length and width of a rectangular area is measured to be L=12.25 m and W=2.5123 m respectively where the last digits are significant. What is the area, in the unit of m^2, up to the last significant digit?

a) 30.78 b) 30.77567 c) 30.77568 d) 30.775675 e) 30.7757

2. The speed of surface waves on deep water might depend on the gravitational acceleration, g, density of water, ρ, and the wavelength of the wave, λ. Which one of the following could be how this speed depends on these parameters? (Hint: Use dimensional analysis).

a) $v = \sqrt{g\lambda}$ b) $v = \sqrt{\frac{g\lambda}{\rho}}$ c) $v = \rho\sqrt{g\lambda}$ d) $v = \sqrt{\rho g \lambda}$ e) $v = \sqrt{g\rho}$

3. A car travels around a curve of radius r at constant speed v. Its acceleration has a constant magnitude "a". If the car rounds a different curve of radius 2r at a constant speed $\sqrt{2}$v what will its acceleration be?

a) 2a b) 4a c) $a/\sqrt{2}$ d) $a\sqrt{2}$ e) a

4. A car travels from city A to city B. The car takes the first half of the total distance with speed 30 km/h and the next half 45 km/h. What is the average speed of the car for this journey?

a) 37.5 km/h b) 42 km/h c) 36 km/h d) 39 km/h e) The question can not be answered without the total distance is given.

5. An object is <u>speeding up</u> as it goes around a circle. Which statement is necessarily true about the net force acting on the object?

a) None of the statements is true.
b) The force on the object acts directly away the center of the circle.
c) The force on the object acts directly toward the center of the circle.
d) The net force on the object acts in a direction tangent to the circle at the position of the object.
e) An object moving on a circular trajectory cannot speed up.

6. Two blocks made of different materials are placed on a horizontal plane. Gradually the plane is lifted at one end. Block A begins sliding at a smaller slope of the plane than block B. Which of the following is true?

a) Block **B** is heavier than block **A**.
b) None of statements in choices is true.
c) The coefficient of **kinetic** friction of block A is less than that of block B.
d) The coefficient of **static** friction of block A is less than that of block B.
e) Block **A** is heavier than block **B**.

7. As Newton's second law states;------------is that property of an object that causes it to resist any change in its-----------.

a) mass of the body, velocity
b) normal force, weight
c) tension, acceleration
d) gravity, weight
e) mass of the body, acceleration

8. An inertial referans frame is a frame, relative to which ------ for any object with --------?

a) $v = 0,\ a = 0$ b) $a = 0,\ F_{net} = 0$ c) $v = 0,\ F_{net} = 0$ d) $F_{net} \neq 0,\ v = 0$ e) $v \neq 0,\ F_{net} \neq 0$

9. Which of the following is an invalid mathematical statement?

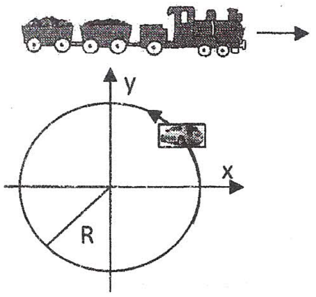
a) $\vec{A}X(\vec{B}X\vec{C})$ b) $\vec{A}X(\vec{B}\bullet\vec{C})$ c) $\vec{A}\bullet(\vec{B}X\vec{C})$ d) $\vec{A}\bullet(\vec{B}-\vec{C})$ e) $(\vec{A}-\vec{B})X\vec{C}$

10. What is the angle between the vector $\vec{A} = 2\hat{i} + 3\hat{j} + \hat{k}$ and x-axis?
(Remember that, Φ=$\cos^{-1}$(cosΦ) = arccos(cosΦ))

a) $\cos^{-1}\left(\sqrt{7/3}\right)$ b) $\cos^{-1}\left(\sqrt{7/2}\right)$ c) $\cos^{-1}\left(\sqrt{2/7}\right)$ d) $\cos^{-1}\left(\sqrt{3/7}\right)$ e) $\cos^{-1}\left(1/\sqrt{7}\right)$

Questions 11-15

Time dependent position vector of a car that, travels on a circular path of radius R, with a period of T=16 s, is given by $\vec{r}_C = R\left(\hat{i}\cos\frac{2\pi}{T}t + \hat{j}\sin\frac{2\pi}{T}t\right)$. Speed of the train which is traveling in the +x direction with a constant velocity is 30 m/s.
Answer the following questions between 11 and 15:



11. If R=160/π (m) then, what is the velocity of the car at t=8 s in units of (m/s)?

a) $-20\hat{j}$ b) $-10\sqrt{2}\hat{j}$ c) $10\hat{i}-10\hat{j}$ d) $20\hat{j}$ e) $20\hat{i}-20\hat{j}$

12. If R=20 (m) then, what is the average velocity of the car within 12s ≤ t ≤ 20 s interval in units of (m/s)?

a) $\frac{20}{\pi}\hat{j}$ b) $-10\pi\hat{j}$ c) $10\hat{i}+10\hat{j}$ d) $10\hat{j}$ e) $5\hat{j}$

13. If R=160√2/π (m) then, what is the velocity of the car in (m/s) with respect to the train at t=6 s?

a) $-5(2\hat{i}+4\hat{j})$ b) $-10\sqrt{2}(\hat{i}+2\hat{j})$ c) $-10(5\hat{i}+2\hat{j})$ d) $5\sqrt{2}(\hat{i}-2\hat{j})$ e) $-5(\hat{i}+4\hat{j})$

14. If R=160/π (m) then, what is the acceleration of the car in (m/s^2), at t=12 s?

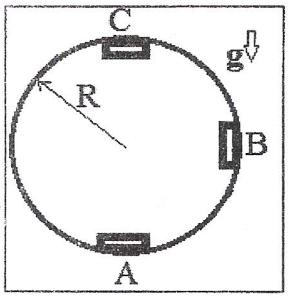
a) $\frac{\pi}{4}\hat{j}$ b) $\frac{10}{4}\hat{j}$ c) $\frac{10\pi}{\sqrt{2}}(\hat{i}+\hat{j})$ d) $\frac{-10\pi}{4}\hat{j}$ e) $\frac{10\pi}{4}\hat{j}$

15. If R=160/π (m) then, what is the average acceleation of the car in (m/s^2), within 4s ≤ t ≤ 8s interval?

a) $-5\hat{j}$ b) $5(\hat{i}-\hat{j})$ c) $5\hat{i}$ d) $5(\hat{i}+\hat{j})$ e) $5\hat{i}-10\hat{j}$

Question 16-20

An object of mass m=1,5 kg is making uniform circular motion with constant speed of 10 m/s inside a metal cylinder of radius R=5 m in vertical plane, as shown in the figure. (Take g=10 m/s^2 and π=22/7) Answer the following questions between 16 and 20.



16. What is the value of the centripetal acceleration?

a) 15 m/s^2 b) 5 m/s^2 c) 20 m/s^2 d) 10 m/s^2 e) 25 m/s^2

17. What is the value of the normal force applied by the cylinder at point A?

a) 45 N b) 30 N c) 60 N d) 35 N e) 15 N

18. What is the value of the normal force applied by the cylinder at point C?

a) 15 N b) 20 N c) 22 N d) 10 N e) 25 N

19. What is the value of the centripetal force at point B?

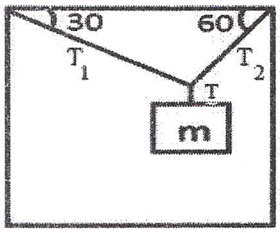
a) 45 N b) 30 N c) 10 N d) 50 N e) 55 N

20. How many turns do the object make in a second?

a) 22/7 turns/second b) 11/7 turns/second c) 5/11 turns/second d) 7/11 turns/second e) 7/22 turns/second

Questions 21-25

A 10kg object is hanged to the ceiling of an elevator by three ropes, where the ropes have negligible masses, and rope 'T_1' makes angle 30° as shown in the figure (Could be used g=10m/s^2, sin30°=0.5, sin60°=0.9, tan30°=0.6 and tan60°=1.7 if needed). Answer the following questions:



21. Determine the tension, T, while the elevator moves <u>downward with a constant velocity</u>.

a) more than 100 N b) insufficient data c) less than 10 kg d) 100 N e) 10 kg

22. Determine the <u>approximate value</u> of T_1 while the elevator moves <u>downward with a constant velocity</u>.

a) 87 N b) 50 N c) 100 N d) -87 N e) None of them

23. Determine the tension, T, while the elevator moves upward with <u>the acceleration</u> a= 2m/s^2.

a) 120 N b) 100 N c) 145 N d) 200 N e) 90 N

24. Determine the tension, T, while the elevator moves downward with <u>the acceleration</u> a= 2m/s^2.

a) 110 N b) 75 N c) -6 N d) 95 N e) 80 N

25. Determine the <u>approximate value</u> of T_1 while the elevator moves <u>downward</u> with <u>the acceleration</u> a= 2m/s^2.

a) 120 N b) 60 N c) 108 N d) 72 N e) 40 N

Physics I (FIZ101E) Midterm II December 3, 2011

Questions 1-10		This part will be filled by students.	Surname	:		Booklet Type
Group Number	:		Name	:		A
List Number	:		e-mail	:		
Student ID	:		Signature	:		

Your choice for each question from 1 to 25 will be marked in the "ANSWER SHEET". Each right choice is 1 point. Wrong answers do not cause point deductions.

1. Which of following is not a unit of energy?

a) W.s b) dyn.cm c) J d) N.m e) $kg.m^3/s^2$

2. A stone of mass 0.5 kg was tightened to a one end of a rope of length 0.8 meters and rotated on a circular path in vertical plane. What is the work done by the gravitational force exerted on the stone during its motion from the bottom to the top? ($g=10m/s^2$)

a) 4J b) 8J c) -15J d) -0.8J e) -8J

3. A force of $\vec{F} = 30\hat{\imath} - 40\hat{\jmath}$ (N) leads to a displacement $\Delta\vec{r} = -9\hat{\imath} - 3\hat{\jmath}$ (m) on a car. What is the work done on the car by the force F?

a) 150J b) 75J c) 50J d) -75J e) -150J

4. A stationary mass is exploded into two pieces with masses m_1 and m_2. If the kinetic energy of the m_1 is two times the kinetic energy of m_2, then what is the ratio of the masses, m_1/m_2?

a) 1/4 b) 1/2 c) 2 d) 1 e) 1/8

5. Which of the following is not correct?

a) If only the conservative forces do work, the mechanic energy is conserved.
b) Kinetic energy of a body can be negative.
c) If a force is perpendicular to a body's velocity then work is not done on the body.
d) In uniform circular motion, kinetic energy is conserved but momentum is not conserved.
e) Total energy of a body is equal to the summation of various energy types.

Question 6-7

When an electric fan is turned off, it slows down with a uniformly decreasing angular velocity from 500 rev/min to 200 rev/min in 4 seconds.

6. Find the angular acceleration in rev/s^2 in the 4 s interval.

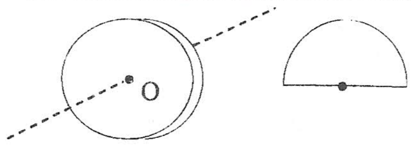
a) -75 b) -7.5 c) -12.5 d) -1.25 e) -5

7. Find the number of revolutions made by the motor in the 4 s interval.

a) 13.3 b) 23.3 c) 43.3 d) 10.0 e) 33.3

Question 8

A thin disk with a radius of R and mass M has moment of inertia I_0, about an axis perpendicular to its plane through its center. What will be the moment of inertia with respect to the same axis when the disk is folded along its diameter as in figure b. Find the result in terms of I_0?

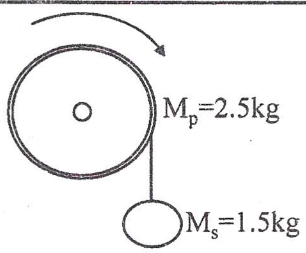


(a) (b)

a) $4 I_0$ b) $I_0/4$ c) $I_0/2$ d) $2 I_0$ e) I_0

Question 9-10

A frictionless pulley has the shape of a uniform solid disk of mass M_P=2.50 kg and radius 20.0 cm. A stone with a mass of M_S=1.5 kg is attached to a very light wire that is wrapped around the rim of the pulley, and the system is released from rest. ($I_{cm}=0.05$ kg.m^2 for disk)



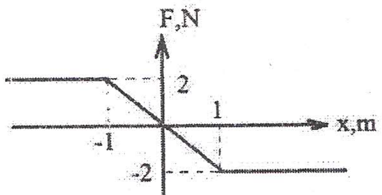
9. How far must the stone fall so that the pulley gains kinetic energy of 10 J?

a) 22/15 b) 23/15 c) 25/14 d) 21/14 e) 27/14

10. When the pulley gains 10J energy what percent of the total kinetic energy does the pulley have?

a) 0% b) 60.60% c) 45.45% d) 55.55% e) 30.30%

Questions 11-15



A force acting on the mass moving on the x-axis is shown in the figure. The value of the potential energy at x=0 is zero.

11. Calculate the work done by this force for the displacement from point -0.5 m to +0.5 m in terms of J.

a) 0.5 b) 1 c) 0.25 d) 0.625 e) 0

12. Which of the following is the potential energy function in the interval -1m < x < 1m ?

a) x^2 b) $-2x^2$ c) $2x^2$ d) $x^2/2$ e) $-x^2$

13. Which of the following is the potential energy function in the interval -2m < x < -1m ?

a) -2x b) -2x-1 c) 2x+1 d) x e) -x

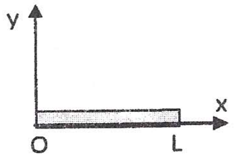
14. Which of the following is the potential energy function in the interval 1m < x < 3m ?

a) 2x-1 b) -x c) x-3 d) 2x+3 e) -2x+1

15. Which of the following can be the interval of motion if the maximum potential energy is 4 J?

a) (-1m, 1m) b) (-2.5m, 2.5m) c) (-25m, 25m) d) (-4m, 4m) e) (-2m, 2m)

Question 16-20



A thin rod of linear mass density $\lambda = \beta x$ (kg/m) and length L is located on the x-axis as shown in the figure (β is a positive constant).

16. What is the total mass of the rod?

a) $\frac{1}{2}\beta L^2$ b) $\frac{1}{3}\beta L^2$ c) $\frac{3}{4}\beta L^2$ d) $\frac{2}{3}\beta L^2$ e) $\frac{1}{4}\beta L^2$

17. What is the x coordinate of the center of mass of this rod?

a) $\frac{1}{2}L$ b) $\frac{3}{4}L$ c) $\frac{1}{4}L$ d) $\frac{2}{3}L$ e) $\frac{3}{5}L$

18. What is the moment of inertia of this rod about point O?

a) $\frac{1}{2}ML^2$ b) $\frac{3}{4}ML^2$ c) $\frac{1}{12}ML^2$ d) $\frac{1}{3}ML^2$ e) $\frac{1}{4}ML^2$

19. If this rod starts rotation from rest about the point O with angular accelartion $\alpha = 2t^2$ (rad/s^2) where t is in unit of second, what is the angular velocity after 3 seconds?

a) 18 rad/sec b) 11 rad/sec c) 12 rad/sec d) 10 rad/sec e) 9 rad/sec

20. Using the information given in question 19, how many revaluations has this rod made in 3 seconds in terms of π?

a) $\frac{8}{\pi}$ b) $\frac{29}{2\pi}$ c) $\frac{27}{2\pi}$ d) $\frac{29}{4\pi}$ e) $\frac{27}{4\pi}$

Questions 21-25

A steel ball of mass m_1=2 kg is moving with a speed $\vec{V}_{01} = 5\hat{\imath}$ (m/s) on a frictionless surface. It collides with another steel ball of mass m_2= 3 kg which is initially at rest. After the collision, the velocity of the ball with a mass m_1 is $\vec{V}_1 = V_x\hat{\imath} + V_y\hat{\jmath}$ (m/s) and the velocity of the ball with mass m_2 is $\vec{V}_2 = 2\hat{\imath} - 2\hat{\jmath}$ (m/s)

21. Find the magnitude of velocity V_1 in units of m/s.

a) $\sqrt{35}$ b) $\sqrt{13}$ c) $\sqrt{75}$ d) $\sqrt{37}$ e) $\sqrt{55}$

22. Find the angle between the x-axis and the velocity V_1.

a) $\tan^{-1}(-7/3)$ b) $\tan^{-1}(4/3)$ c) $\tan^{-1}(-1/3)$ d) $\tan^{-1}(3/2)$ e) $\tan^{-1}(-7/2)$

23. Find the change in kinetic energy ($K-K_0$) in the collision.

a) 100 J b) 75 J c) 0 J d) -55 J e) 10 J

24. Find the velocity of center of mass of the objects before the collision in units of m/s.

a) $7\hat{\imath}$ b) $10\hat{\imath}$ c) $2\hat{\imath}$ d) $5\hat{\imath}$ e) $3\hat{\imath}$

25. Find the velocity of center of mass of the objects after the collision in units of m/s.

a) $3\hat{\imath}$ b) $8\hat{\imath}$ c) $2\hat{\imath}$ d) $5\hat{\imath}$ e) $11\hat{\imath}$

Physics I (FIZ101E) Final Exam January 11, 2012

		Surname		Type
Group Number		Name		M
List Number		e-mail		
Student ID		Signature		

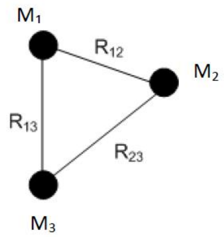
1. A certain physical quantity, R, is calculated using the formula: $R = 4a^2(b - c)$ where a is a speed, b and c are distances. What is the SI unit of R?
(a) $\mathbf{m^3/s^2}$ (b) $\mathrm{cm^2/s}$ (c) $\mathrm{m^2/h}$ (d) $\mathrm{m^2/s}$ (e) cm/h

2. A cannon directed straight upward launches a ball with an initial speed v. The ball reaches a maximum height h in a time t. Then, the same cannon is used to launch a second ball straight upward at a speed $2v$. In terms of h and t, what is the maximum height the second ball reaches and how long does it take to reach that height?
(a) $4h$, $2t$ (b) $2h$, t (c) $2h$, $4t$ (d) $2h$, $2t$ (e) h, t

3. A cylinder, a solid sphere, a hollow sphere, and a ring with the same mass and the same radius roll down without slipping from the top of an inclined plane that has a height of h. Which one of the objects reaches the bottom first?
I_{CM}(cylinder)=(1/2)MR^2, I_{CM}(solid sphere)=(2/5)MR^2, I_{CM}(ring)=MR^2, I_{CM}(hollow sphere)=(2/3)MR^2.
(a) The solid sphere (b) The cylinder (c) The ring (d) They arrive at the bottom at the same time (e) The hollow sphere

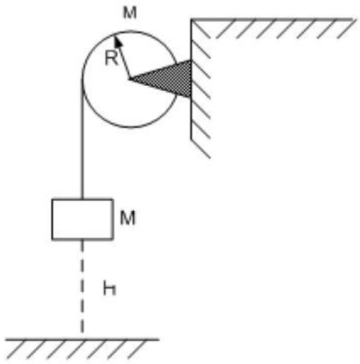
4. A particle moves along the x-axis under the force of $\vec{F}(x) = -k/x^3\ \hat{\imath}$ (k is a constant). If $U(x = 2C) = 0$, which of the following is $U(x)$?
(a) $U(x) = -k/2x^2 + k/8C^2$ (b) $U(x) = k/2x^2 + k/8C^2$ (c) $U(x) = -k/2x^2 - k/8C^2$ (d) $U(x) = -k/2x^2 + k/4C^2$ (e) $U(x) = -k/2x^2 + k/16C^2$

5. Given M_1 and M_2 with a distance R_{12} between them, find the work done by an external force to bring a third mass M_3 slowly with a constant velocity from infinity to a point close to the other masses as shown in the figure.



(a) $W = -G[(M_3M_2/R_{32}) + (M_1M_3/R_{13})]$
(b) $W = -G[(M_1M_2/R_{12}) - (M_3M_2/R_{32})]$
(c) $W = -G[(M_1M_2/R_{12}) - (M_3M_2/R_{32}) - (M_1M_3/R_{13})]$
(d) $W = -G[(M_1M_2/R_{12}) + (M_3M_2/R_{32}) + (M_1M_3/R_{13})]$
(e) $W = +G[(M_1M_2/R_{12}) + (M_3M_2/R_{32}) + (M_1M_3/R_{13})]$

6. A cylinder of mass M and radius R rotates about a stationary horizontal axis. We tie the free end of the massless cable to a block of mass M and release the object without initial velocity at a distance h above the floor. As the block falls, the cable unwinds without stretching or slipping but turning the cylinder. Which of the following statements will be true at the moment the block reaches the floor? I_{CM}=(1/2)MR^2.



(a) The block has more kinetic energy than the cylinder.
(b) The cylinder' s angular speed is $\omega = \sqrt{3gh/4R}$.
(c) The speed of block is $v = \sqrt{3h/4}$.
(d) The cylinder has more kinetic energy than the block.
(e) The block and the cylinder have same kinetic energy.

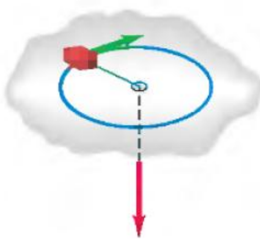
7. A satellite moves in a circular orbit radius R around a star of mass m with period T. If this satellite rotates around another star of mass $3m$, at the same radius of R, then what is the new period in terms of T?
(a) $T/\sqrt{3}$ (b) $T\sqrt{3}$ (c) T (d) $3T$ (e) $T/3$

8. The gravitational acceleration on the surface of a planet is g. What will be the gravitational acceleration on the surface of the planet if the mass of the planet is doubled while keeping the volume constant?
(a) $2g$ (b) Same (c) $4g$ (d) $g/2$ (e) $3g/4$

9. An ice skater is spinning with her arms held tightly to her body about her axis as shown in the figure. When she extends her arms, which of the following statements is not true? (There is no friction.)

(a) Her moment of inertia remains constant. (b) She increases her moment of inertia. (c) She decreases her angular speed. (d) Her total angular momentum remains constant. (e) Total torque acting on her is zero.

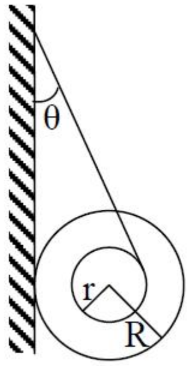
10. A small block on a frictionless, horizontal surface has mass of M(kg). It is attached to a massless cord passing through a hole in the surface. The block is originally revolving at a distance of r_i(m) from the hole with an angular speed of ω_1(rad/s). The cord is then pulled with carefully from below, shortening the radius of the circle in which the block revolves to $r_i/2$(m) at an angular speed of ω_2(rad/s). Taking the block as a point particle what is the ratio of the block's final and initial angular momenta (L_f/L_i)?



(a) 1 (b) 2 (c) 4 (d) 0.5 (e) $\sqrt{2}$

Questions 11-15

A reel of mass m, whose inner and outer radii are r and R, respectively, is tied by means of the string wound on it, to a vertical wall as shown in the figure.
Coefficient of static friction between the wall and the reel is μ_S. (g=10 m/s^2).
If the system is in equilibrium, then:



11. If $R = 10$ cm, $r = 4$ cm, $m = 3$ kg, $\sin\theta = 0.6$, $\cos\theta = 0.8$, $\mu_S = 0.7$, which of the followings is the tension T, on the string?
(a) 25 N (b) 24 N (c) 21 N (d) 18 N (e) 64 N

12. If $R = 10$ cm, $r = 4$ cm, $m = 3$ kg, $\sin\theta = 0.6$, $\cos\theta = 0.8$, $\mu_S = 0.7$, which of the followings is the frictional force between the wall and the reel?
(a) 10 N (b) 22.5 N (c) 16.8 N (d) 18 N (e) 24 N

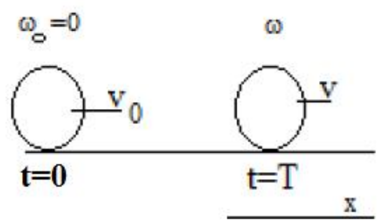
13. If $R = 10$ cm, $r = 4$ cm, $m = 3$ kg, $\sin\theta = 0.6$, $\cos\theta = 0.8$, $\mu_S = 0.7$, which of the followings is the horizontal force that, the wall exerts onto the reel?
(a) 15 N (b) 9.6 N (c) 18 N (d) 24 N (e) 7.2 N

14. If $R = 0.4$ m, $r = 0.1$ m, $\mu_S = 0.5$, $m = 3$ kg, the static frictional force between the wall and the reel is f, the tension on the string is T then, which of the expressions is/are correct?
I) $\sin\theta \geq 1/2$, II) $f = 6$ N, III) $T < 24$ N
(a) I (b) II (c) III (d) I, II, III (e) I and II

15. For $R = r$ and $\sin\theta = 1/2$, which of the followings is the minimum value of μ_S that can hold the reel in equilibrium?
(a) 2 (b) 0.5 (c) 0.25 (d) any positive real number (e) none of them

Questions 16-20

A solid bowling ball with mass M and radius R starts moving at $t = 0$ without any rotation but with an initial linear velocity v_0 along a horizontal surface. The coefficient of kinetic friction between the surface and the ball is μ. It both slips and rolls and finally at $t = T$ rolling without slipping starts. I$_{CM}$(ball)=(2/5)MR^2.



16. What is the acceleration of the center of mass before rolling without slipping starts?
(a) $-\mu g$ (b) $-\mu g v_0$ (c) $+m\mu g$ (d) $-m\mu$ (e) $-m\mu g$

17. What is the linear speed (m/s) of the object at the instant rolling without slipping starts?
(a) $v = v_0 - \mu g T$ (b) $v = -v_0 - \mu g T$ (c) $v = v_0 + \mu g T$ (d) $v = -\mu g T$ (e) $v = v_0 g T$

18. What is the angular acceleration α (rad/s^2) of the object before rolling without slipping starts?
(a) $\alpha = 5\mu g/2R$ (b) $\alpha = 2\mu g/5R$ (c) $\alpha = 5\mu/2$ (d) $\alpha = 5\mu/2R$ (e) $\alpha = 2\mu/5R$

19. What is the angular speed (rad/s) as a function of time before rolling without slipping starts, ($t < T$)?
(a) $\omega = 5\mu g t/2R$ (b) $\omega = 5gt/2R$ (c) $\omega = 5\mu t/2R$ (d) $\omega = 5\mu g/2R$ (e) $\omega = 2\mu g t/5R$

20. Find T, the time (s) at which rolling without slipping starts.
(a) $2v_0/7\mu g$ (b) $7v_0/2\mu g$ (c) $2v_0/7g$ (d) $v_0/7\mu g$ (e) $2v_0/\mu g$

Questions 21-25

Two stars with masses M_1 and M_2 are in circular orbits around their center of mass. The star with mass M_1 has an orbit of radius R_1 and the star with mass M_2 has an orbit of radius R_2. Please consider, the stars and center of mass shall always be kept on the same line.

21. What is the ratio of the orbital radii of the two stars, (R_1/R_2)?
(a) M_2/M_1 (b) $(M_2/M_1)^2$ (c) $(M_2/M_1)^{(1/2)}$ (d) $(M_2/M_1)^3$ (e) $(M_2/M_1)^{(1/3)}$

22. What is the relationship between the accelerations of the stars.
(a) $M_1\vec{a}_1 = -M_2\vec{a}_2$ (b) $M_1\vec{a}_1 = M_2\vec{a}_2$ (c) $M_1\vec{a}_2 = M_2\vec{a}_1$ (d) $M_1\vec{a}_2 = -M_2\vec{a}_1$ (e) None of them

23. If their orbital velocities are such that $\vec{V}_1 = -3\vec{V}_2$, what is the ratio of their orbital radii, (R_1/R_2)?
(a) 3 (b) $\sqrt{3}$ (c) 1/3 (d) 9 (e) $\sqrt{3}/3$

24. If their orbital velocities are such that $\vec{V}_1 = -3\vec{V}_2$, which of the following would give the period of the second star in terms of its distance from the center of mass (R_2) and mass (M_2)?
(a) $T = 8\pi\sqrt{3}R_2^{3/2}/\sqrt{GM_2}$ (b) $T = 16\pi\sqrt{3}R_2^{3/2}/\sqrt{GM_2}$ (c) $T = 8\pi\sqrt{3}R_2^{3/2}/\sqrt{GM_1}$ (d) $T = 4\pi\sqrt{3}R_2^{3/2}/\sqrt{GM_2}$
(e) $T = 8\pi\sqrt{3}R_2^{3/2}/\sqrt{2GM_2}$

25. Assuming the masses are the same $(M_1 = M_2 = M)$, what is the binding energy of the system? $(R_1 = R_2 = R)$
(a) $-GM^2/2R$ (b) $2GM^2/R$ (c) $-2GM^2/R$ (d) $GM^2/2R$ (e) GM^2/R