AP PHYSICS
Name: _____
Period: _____ Date: _____

DEVIL PHYSICS

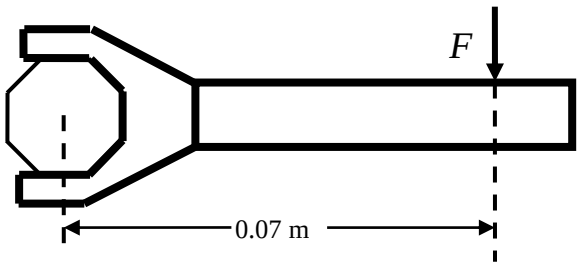
BADDEST CLASS ON CAMPUS

AP EXAM		CHAPTER TEST	
50 Multiple Choice • 45 Single Response • 5 Multi-Response	90 min, 1 point each	25 Multiple Choice • 22 Single Response • 3 Multi-Response	45 min
Free Response • 3 Short Free Response • 2 Long Free Response	90 min • 13 min ea, 7 pts ea • 25 min ea, 12 pts ea	Free Response • 2 Short Free Response • 1 Long Free Response	45 min • 12 min ea, 7 pts ea • 20 min ea, 12 pts ea

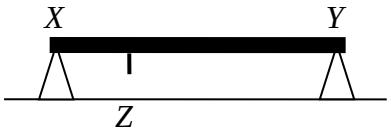
CHAPTER 8 TEST REVIEW MARKSCHEME

MULTIPLE CHOICE

1. Torque
   a. is the vector product of moment arm and force.
   b. is a scalar and has no direction associated with it.
   c. is always equal to force.
   d. is always greater for shorter lever arms.
   e. must always equal zero

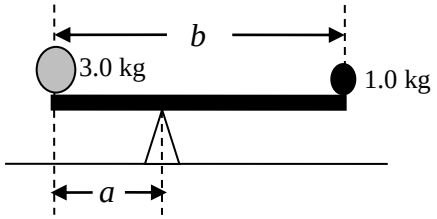


2. A wrench is used to tighten a nut as shown. A 12.0 N force F is applied 0.07 m from the axis of rotation. In units of torque, what is the torque due to the applied force?
   a. 0.58
   b. 0.84
   c. 1.71
   d. 84.0
   e. 171.0

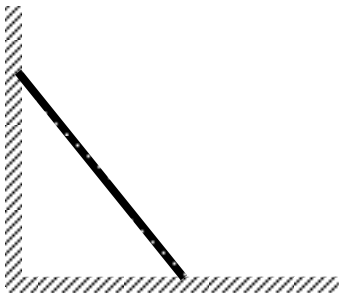


3. A uniform plank of length *XY* is supported by two equal 120 N forces at *X* and *Y* as shown. The support at X is then moved to Z (which is halfway to the plank center). What is the new force at Y after that move is completed?
   a. 40 N
   b. 60 N

c. 80 N
d. 160 N
e. 240 N

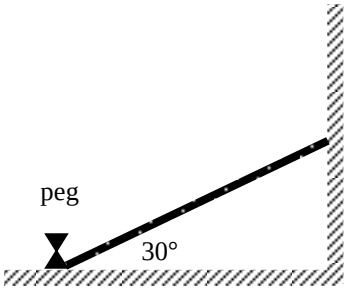


4. A 3.0 kg ball and a 1.0 kg ball are placed at opposite ends of a massless beam so that the system is in equilibrium as shown (not drawn to scale). What is the ratio of length *b* to length *a*?
   a. 2.0
   b. 2.5
   c. 3.0
   d. 4.0
   e. 5.0
5. (__/1) When a net torque is applied to a solid object, it has a tendency to produce what?
   a. static equilibrium
   b. constant velocity
   c. rotational stability
   d. rotation about an axis
   e. linear acceleration
6. What is an equivalent unit for torque?
   a. $kg \cdot m^2/s^2$
   b. $kg^2 \cdot m^3/s$
   c. $kg^2 \cdot m^2/s^3$
   d. m^2/s^2
   e. $kg \cdot m^2/s^3$

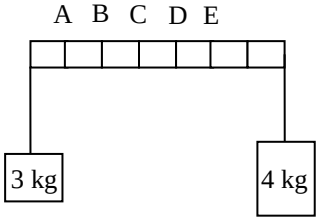


7. A uniform wooden ladder leans against a wall as shown. If the lader is not to slip, which one of the following statements must be true?
   a. Only the coefficient of friction between the ladder and the wall must not be zero.
   b. Only the coefficient of friction between the ladder and the floor must not be zero.
   c. Both the coefficients of friction between the ladder and the wall and the ladder and the floor must not be zero.
   d. The floor's normal force provides the necessary force to keep the ladder from slipping.

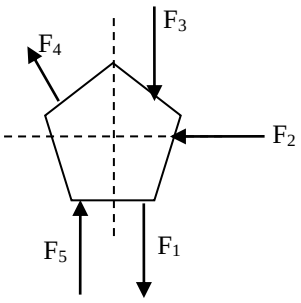
e. Both statements (A) and (B) are correct.



8. A uniform board is 30 m long and weighs 100.0N. It rests with its upper end against a smooth vertical wall, and its lower end rests on the ground as shown. The board is prevented from slipping by a peg drivien in the ground at the lower end of the ladder, and the board makes an angle of 30° with the horizontal. Which one of the following is the approximate force exerted on the board by the wall?
   a. 12.0 N
   b. 18.0 N
   c. 50.0 N
   d. 87.0 N
   e. 150.0 N

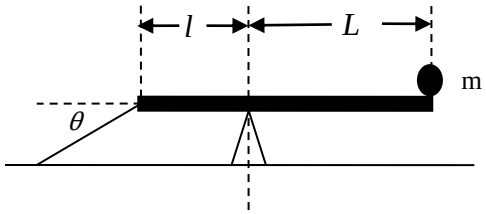


9. Two blocks of mass 3 kg and 4 kg hang from the ends of a rod of negligible mass which is marked in seven equal parts as shown. At which of the points indicated should a string be attached if the rod is to remain horizontal when suspended from the string?
   a. C
   b. E
   c. A
   d. D
   e. B



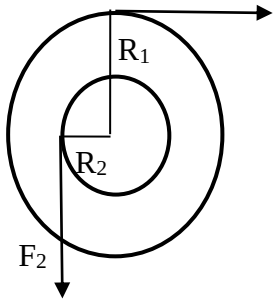
10. The figure above shows a flat object lying on a table of neglibible friction. Five forces are separately applied to the object shown. Which of the five forces will NOT cause the object to rotate about the center of the object?
    a. **F_1**
    b. **F_2**

c. **F_3**
d. **F_4**
e. **F_5**



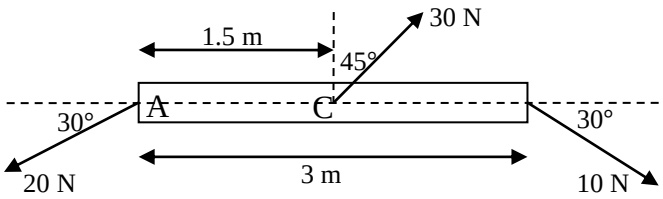
11. The figure above shows a mass *m* sitting on the end of a massless rod which is pivoted on a fulcrum as shown. A string is tied at an angle θ from the horizontal at the right end of the rod to keep the rod from rotating. Which of the following is a correct equation for finding the tension F_T in the string?
    a. $mgL = F_T l$
    b. $mgL = F_T l \cos\theta$
    c. $mgL = F_T l \sin\theta$
    d. $mg = F_T$
    e. $mg = F_T \sin\theta$
12. A point mass *m* is undergoing uniform circular motion with an angular frequency ω in a horizontal circle of radius *r*. Which of the following is a representation of the angular momentum of the mass?
    a. $mr^2\omega$
    b. mr^2/ω
    c. $\omega^2 r/m$
    d. $mr\omega$
    e. $m\omega$
13. A skater extends her arms, holding a 2 kg mass in each hand. She is rotating about a vertical axis at a given rate. She brings her arms inward toward her body in such a way that the distance of each mass from the axis changes from 1 m to 0.50 m. Her rate of rotation (neglecting the mass of the skater) will
    a. remain the same
    b. be quartered
    c. be halved
    d. be doubled
    e. be quadrupled
14. A 1 kg mass swings in a vertical circle after having been released fom a horizontal position with zero velocity. The mass is attached to a massless rigid rod of length 1.5 m. The angular momentum of the mass, in kilogram·square meters per second, when it is in its lowest position is approximately
    a. 4
    b. 5
    c. 8
    d. 10
    e. 12
15. A rock with a mass of 50 g is swung overhead in a horizontal circle of radius 0.3 m at a constant rate of 5 revolutions per seond. The angular momentum of the rock is
    a. $0.14\ kg \cdot m^2/s$

b. $0.0056\ kg \cdot m^2/s$
c. $0.32\ kg \cdot m^2/s$
d. $1.32\ kg \cdot m^2/s$
e. $2.45\ kg \cdot m^2/s$



16. A solid cylinder consisting of an outer radius R_1 and an inner radius R_2 is pivoted on a frictionless axle as shown above. A string is wound around the outer radius and is pulled to the right with a force $F_1 = 3$ N. A second string is wound around the inner radius and is pulled down with a force $F_2 = 5$ N. If $R_1 = 0.75$ m and $R_2 = 0.35$ m, what is the net torque acting on the cylinder?
    a. 2.25 N·m
    b. 0.50 N·m
    c. 2.30 N·m
    d. 1.08 N·m
    e. 4.00 N·m

Answer questions 17 and 18 based on the diagram below. The rod is considered massless.



17. What is the net torque about an axis through point A?
    a. 16.5 N
    b. 15.2 N
    c. 5.5 N
    d. 7.8 N
    e. 6.0 N
18. What is the net torque about an axis through point C?
    a. 3.5 N
    b. 7.5 N
    c. 15.2 N
    d. 5.9 N
    e. 7.0 N
19. A 2.00 kg disk is attached to massless rod and is exhibiting uniform circular motion along a horizontal path at a velocity of 4 m/s. A 400 g piece of putty is dropped in the center of the disk. What is the new velocity of the disk-putty system?
    a. 1.50 m/s

b. 2.25 m/s

c. 3.30 m/s

d. 4.00 m/s

e. 5.00 m/s

20. What is the angular velocity of a point on an object in uniform rotational motion that has a frequency of 45 revolutions per minute?

a. 0.75 rad/s

b. 1.5 rad/s

c. $\frac{2}{3}\pi$ rad/s

d. 1.5π rad/s

e. 90π rad/s

21. What is the magnitude of the total linear acceleration of a particle 12 cm from the axis of rotation and rotating with an angular velocity of 44 rad/s and an angular acceleration of 250 rad/s^2?

a. 35 m/s^2

b. 18 m/s^2

c. 223 m/s^2

d. 234 m/s^2

e. 512 m/s^2

22. What is the radial acceleration of an object at a point 25 m from the axis of rotation that has a period of 0.22 seconds?

a. 10,000 m/s^2

b. 20,000 m/s^2

c. 40,000 m/s^2

d. 160,000 m/s^2

e. 980,000 m/s^2

23. What is the ratio of angular velocities on a rotating body at a point half a radius away from its axis of rotation to a point a radius away?

a. 1:4

b. 1:2

c. 1:1

d. 2:1

e. 4:1

24. The units of hertz are equivalent to

I. radians/second

II. revolutions/second

III. second^{-1}

a. I

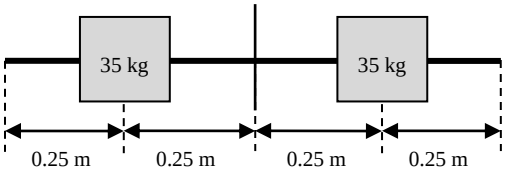
b. II

c. III

d. I and II

e. II and III

25. A point on a rotating disc has a frequency of 120 Hz. What is the angular acceleration of the point for it to be moving at 30 Hz after 1 minute?
    a. -1.5 rad/s^2
    b. $-\frac{2\pi}{3}$rad/s^2
    c. $-\frac{3\pi}{2}$rad/s^2
    d. -3πrad/s^2
    e. -6 rad/s^2
26. A spherical marble of radius 3 cm rolls from rest with an angular acceleration of 4 rad/s^2. How long will it take for it to roll 100 revolutions?
    a. 3 s
    b. 7 s
    c. 9 s
    d. 14 s
    e. 18 s
27. What is the moment of inertia for four masses located in the x-y plane at (2m, 0m), (-2m, 0m), (0m, -2m), (0m, 2m), each with a mass of 15 kg, uniformly rotating around the origin?
    a. 15 kg·m^2
    b. 30 kg·m^2
    c. 60 kg·m^2
    d. 120 kg·m^2
    e. 240 kg·m^2
28. For a pulley of radius 76 cm with a moment of inertia of 46.5 kg·m^2, a rope wrapped around it is pulled with a force of 15 N. What is the magnitude of angular acceleration?
    a. 0.013 rad/s^2
    b. 0.245 rad/s^2
    c. 4.08 rad/s^2
    d. 11.4 rad/s^2
    e. 530 rad/s^2



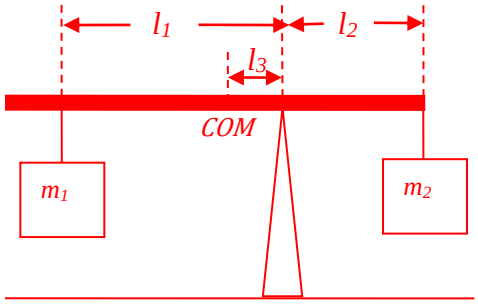
29. Two 35 kg weights are each initially halfway from the center to the endpoints of a massless 1 meter rod as shown, rotating around the rod's center at 12 rad/s. If the weights shift to the endpoints of the rod, what is the new angular velocity?
    a. 3 rad/s
    b. 6 rad/s
    c. 9 rad/s
    d. 12 rad/s
    e. 15 rad/s

FREE RESPONSE

30. In the laboratory, you are asked to determine the mass of a meter stick without using a scale of any kind. In addition to the meter stick, you may use any or all of the following equipment

_☒__ set of known masses	_☒__ four weight hangers	___ tape
_☒__ fulcrum upon which the meterstick can be mounted and pivoted	___ string	___ stopwatch

a. (__/5) Briefly list the steps in your procedure that will lead you to the mass of the meter stick. Include a diagram of the apparatus you will use and definitions of any parameters that you will measure.



Mount the meter stick on the fulcrum so that it is pivoted on a point other than the center of the stick. Hang two unequal weights on either side of the meter stick at such distances that the meter stick remains horizontal. Record the value of each mass and the distance from the fulcrum to each mass. Let m_1 be the mass on the left and l_1 be the distance from the fulcrum to m_1. Likewise, let m_2 be the mass on the right and l_2 be the distance from the fulcrum to m_2. Let COM be the center of mass of the meter stick and l_3 be the distance from the fulcrum. Repeat the procedure using several different masses and distances

b. (__/2) On the equipment list before part (a) place a check mark beside each piece of equipment you will need to do this experiment.

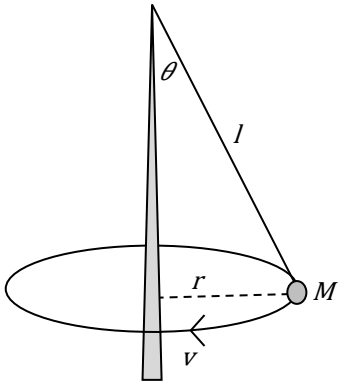
c. (__/3) Show the calculations you would perform to find the mass of the meter stick.

$$m_1 g l_1 + COM g l_3 = m_2 g l_2$$

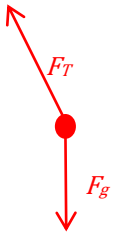
$COM l_3 = m_2 l_2 - m_1 l_1$

$COM = \frac{m_2 l_2 - m_1 l_1}{l_3}$

31. A conical pendulum consists of a point mass suspended from a light string making a vertical angle θ, as shown below. The string has length l, and mass is M. The mass is undergoing uniform circular motion with an instantaneous velocity v.



a. (__/2) Draw a free-body diagram for this situation.



b. (__/5) Derive an expression for the square of the angular momentum L in terms of M, l, g, and θ only. *(This is a very challenging problem -- think lots of trig and lots of Algebra).*

$L = Mvr$ | $r = l \sin\theta$ | $F_{T_x} = F_T \sin\theta$

$L^2 = M^2 v^2 r^2$ | $\frac{F_{T_x} l \sin\theta}{M} = v^2$ | $F_{T_x} =$

$\sum F = Ma$ | $r^2 = l^2 \sin^2\theta$ | $v^2 = \left(\frac{\cancel{M} g \sin\theta}{\cos\theta}\right)\left(\frac{l \sin\theta}{\cancel{M}}\right)$

$F_{T_x} = M\frac{v^2}{r}$ | $F_{T_y} = Mg$ | $v^2 = \frac{gl \sin^2\theta}{\cos\theta}$

$\frac{F_{T_x} r}{M} = v^2$ | $F_T = \frac{Mg}{\cos\theta}$ | $L^2 = M^2\left(\frac{gl \sin^2\theta}{\cos\theta}\right)(l^2 \sin^2\theta)$

$L^2 = \frac{M^2 g l^3 \sin^4\theta}{\cos\theta}$

c. (__/2) If l = 1 m, M = 0.15 kg, and θ = 10°, determine the magnitude of the angular momentum

$L^2 = \frac{M^2 g l^3 \sin^4\theta}{\cos\theta}$

$L = \sqrt{\frac{M^2 g l^3 \sin^4\theta}{\cos\theta}}$

$$L = \sqrt{\frac{(0.15)^2(9.81)(1)^3 \sin^4(10)}{\cos(10)}} = 1.43x10^{-2}$$

32. A 13 kg solid cylinder with a 54 cm diameter rolls without slipping down a 30° incline from a height of 1.25 meters.

a. (__/5) If the solid cylinder has a moment of inertia of $I = 1/2\,(MR^2)$, what will its speed be at the base of the incline?

$PE = KE_{linear} + KE_{rotational}$

$mgh = \left(\frac{m}{2} + \frac{I_{cm}}{2r^2}\right)v^2 \quad I = \frac{1}{2}mr^2$

$mgh = 1/2\,mv^2 + 1/2\,I_{cm}\omega^2$

$\cancel{m}gh = \left(\frac{\cancel{m}}{2} + \frac{\cancel{mr^2}}{\cancel{4}r^2}\right)v^2$

$v = \omega r$

$gh = \left(\frac{3}{4}\right)v^2$

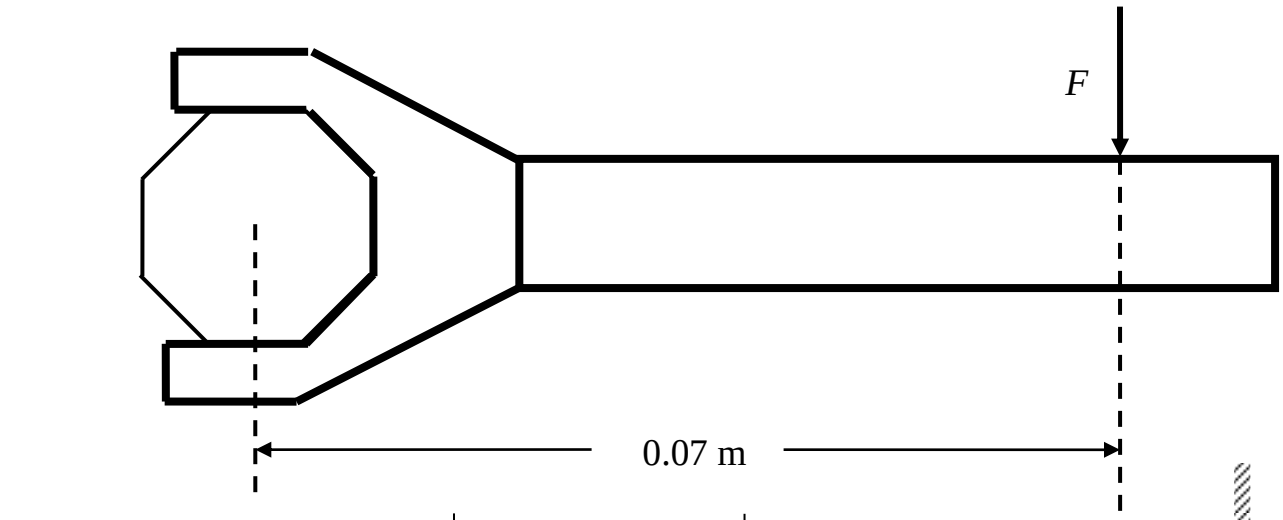
$\frac{v}{r} = \omega$

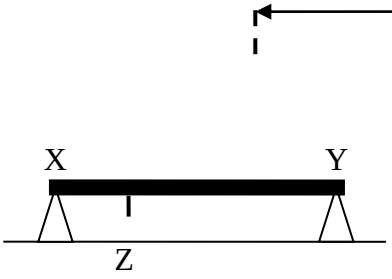
$\sqrt{\frac{4gh}{3}} = v = 4.0\,m/s$

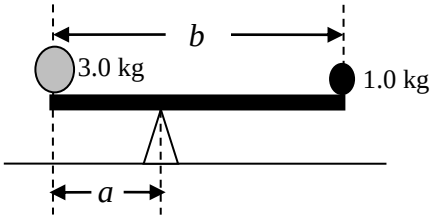
$mgh = 1/2\,mv^2 + 1/2\,I_{cm}\frac{v^2}{r^2}$

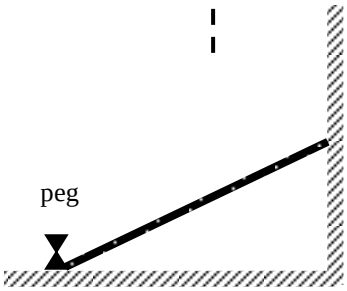
b. (__/X) What will its speed be if it rolls from a height of 1.25 meters down a 60° incline and how do you account for this?

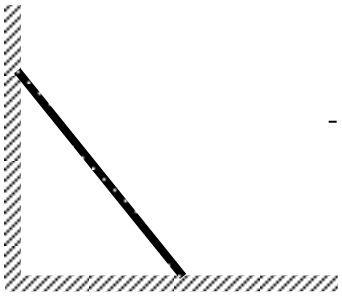
The speed will be the same since energy is dependent only on the starting height

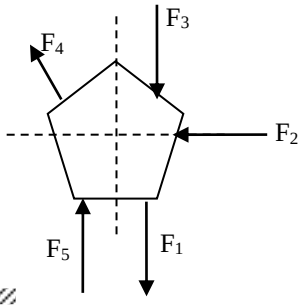

F
0.07 m

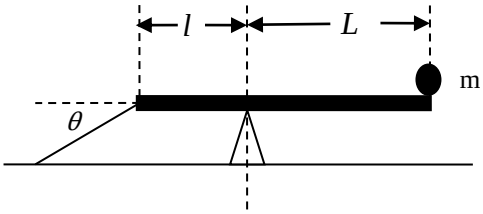

X
Y
Z

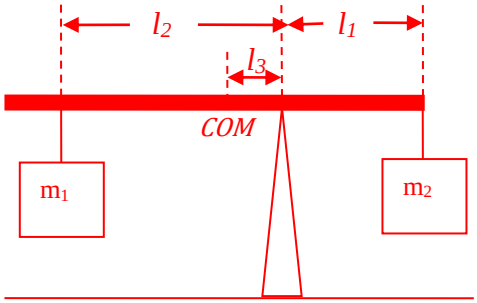

b
3.0 kg
1.0 kg
a

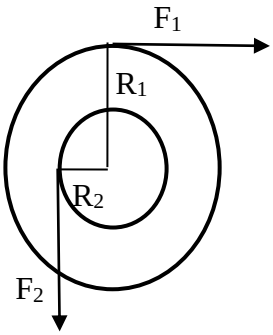

peg

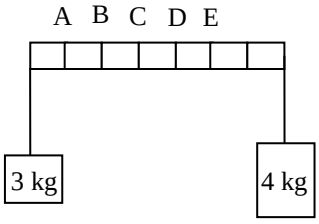


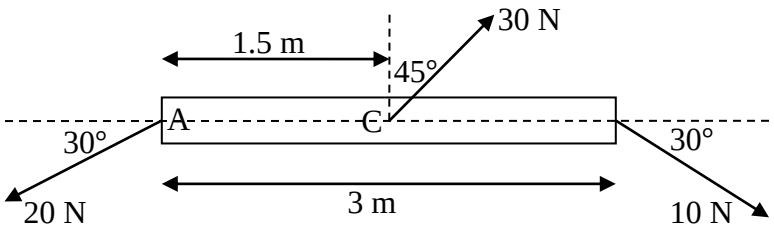

F3
F4
F2
F5
F1

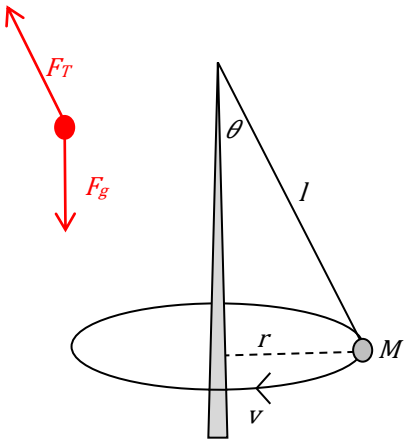

l
L
m
θ

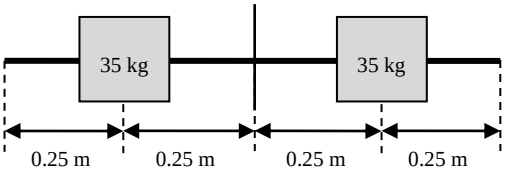

l2
l1
l3
COM
m1
m2


F1
R1
R2
F2


A B C D E
3 kg
4 kg


1.5 m
30 N
45°
A
C
30°
30°
20 N
3 m
10 N


F_T
F_g
θ
l
r
M
v


35 kg
35 kg
0.25 m
0.25 m
0.25 m
0.25 m