Instructor(s): *Acosta, Rinzler*

PHYSICS DEPARTMENT

PHY 2048, Spring 2014 — Final Exam — March 24, 2014

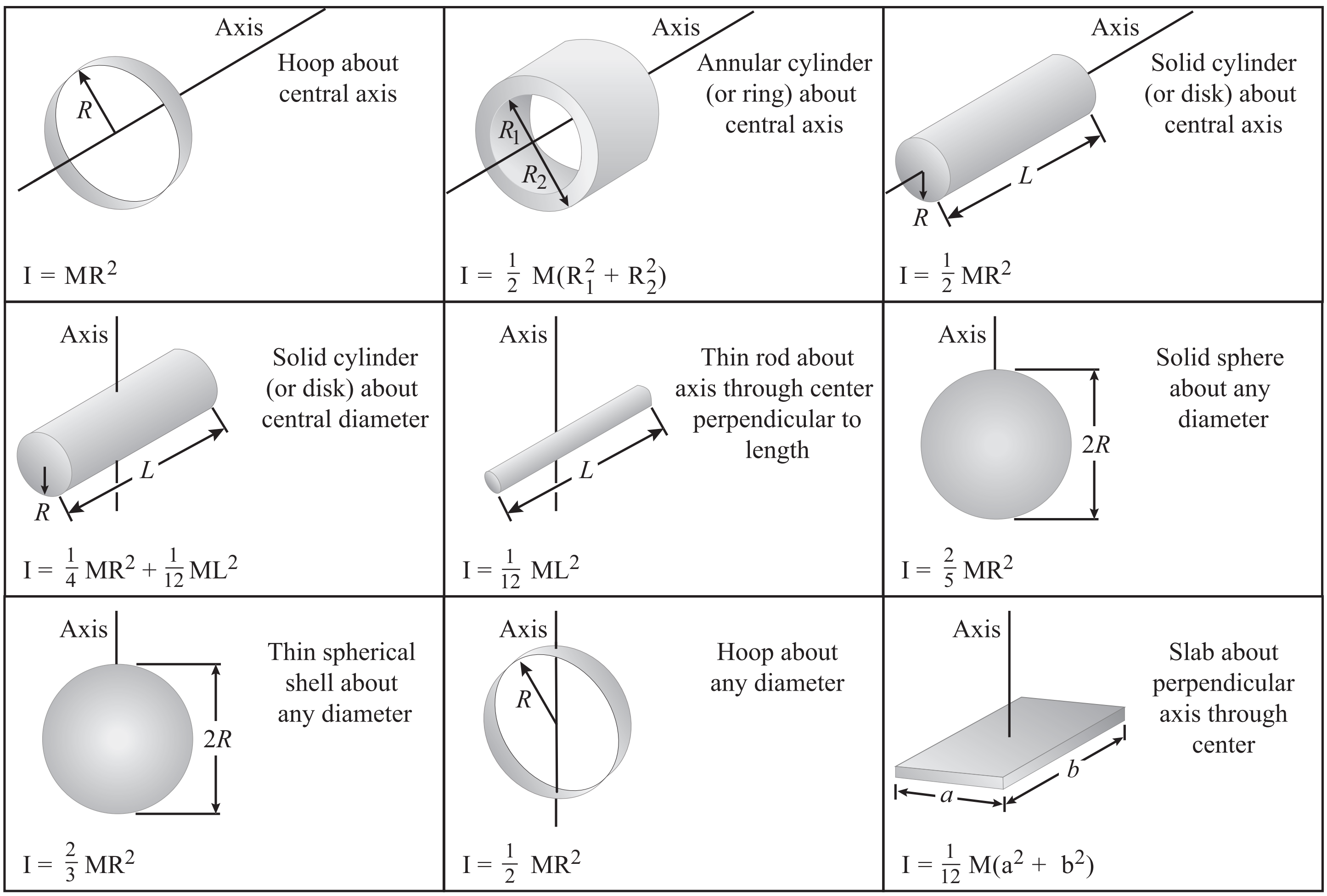
Name (print, last first): ____________________ Signature: ____________________

On my honor, I have neither given nor received unauthorized aid on this examination.

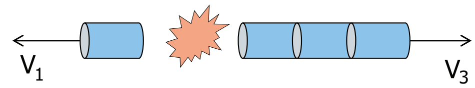
YOUR TEST NUMBER IS THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE.

(1) **Code your test number on your answer sheet (use lines 76–80 on the answer sheet for the 5-digit number)**. Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. Code your UFID number on your answer sheet.
(2) Print your name on this sheet and sign it also.
(3) Do all scratch work anywhere on this exam that you like. **Circle your answers on the test form.** At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout.
(4) **Blacken the circle of your intended answer completely, using a #2 pencil or blue or black ink**. Do not make any stray marks or some answers may be counted as incorrect.
(5) **The answers are rounded off. Choose the closest to exact. There is no penalty for guessing. If you believe that no listed answer is correct, leave the form blank.**
(6) Hand in the answer sheet separately.

Where needed use $g = 9.80$ m/s^2



1. Four identical soda cans initially at rest have a firecracker explode between them such that one can recoils against the other three which are still stuck together. With V_1 and V_3 the velocities of the single and 3 cans, respectively, what is the ratio of the magnitude of the speed of the single can to the magnitude of the speed of the other three (V_1/V_3)?



(1) 3 (2) 2 (3) 4 (4) 1/3 (5) 1/2

2. A cylindrical bar aligned along the x-axis has a mass density that increases linearly along its length: $\lambda(x) = (4 \text{ kg/m}^2)x$. If the bar extends from $x = 0$ to $x = 1.5$ m, at what position along the x-axis (in m) is the center-of-mass of the bar?

(1) 1 (2) 1/2 (3) 1/3 (4) 4/3 (5) 3/2

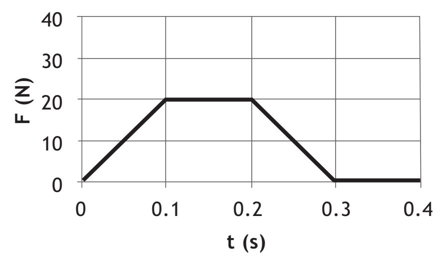
3. A cylindrical bar aligned along the x-axis has a mass density that increases linearly along its length: $\lambda(x) = (4 \text{ kg/m}^2)x$. If the bar extends from $x = 0$ to $x = 0.5$ m, at what position along the x-axis (in m) is the center-of-mass of the bar?

(1) 1/3 (2) 1/2 (3) 1 (4) 4/3 (5) 3/2

4. A cylindrical bar aligned along the x-axis has a mass density that increases linearly along its length: $\lambda(x) = (4 \text{ kg/m}^2)x$. If the bar extends from $x = 0$ to $x = 2$ m, at what position along the x-axis (in m) is the center-of-mass of the bar?

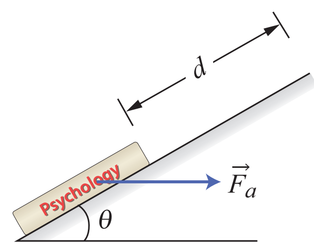
(1) 4/3 (2) 1/2 (3) 1/3 (4) 1 (5) 3/2

5. Consider a ball of mass 0.5 kg that travels only in one dimension along the x axis. Its initial velocity at time $t = 0$ is $v = -5.0$ m/s. A force is then applied to the ball in the x direction as a function of time as shown by the graph. What is the velocity of the ball along the x-axis, including sign, at a time of 0.4 s?



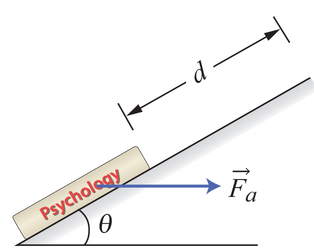
(1) 3 m/s (2) 8 m/s (3) −13 m/s (4) −1 m/s (5) 0 m/s

6. In the figure, a horizontal force $\vec{F}_a$ of magnitude 20 N is applied to a 2.5 kg book as the book slides a distance $d = 1.0$ m up a frictionless ramp at angle $\theta = 30°$. What is the speed of the book at the end of the displacement if it starts initially at rest?



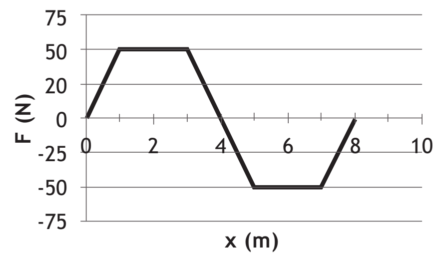
(1) 2.0 m/s (2) 4.0 m/s (3) 7.5 m/s (4) 16.0 m/s (5) 1.0 m/s

7. In the figure, a horizontal force $\vec{F}_a$ of magnitude 20 N is applied to a 2.5 kg book as the book slides a distance $d = 4.0$ m up a frictionless ramp at angle $\theta = 30°$. What is the speed of the book at the end of the displacement if it starts initially at rest?



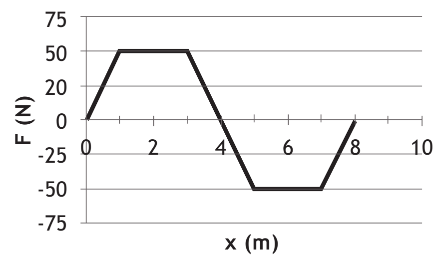
(1) 4.0 m/s (2) 2.0 m/s (3) 7.5 m/s (4) 16.0 m/s (5) 1.0 m/s

8. The figure gives the force acting on a 5.0 kg particle as it moves from rest along an x axis from $x = 0$ to $x = 8.0$ m. What is the particle's speed and direction (give a positive answer if the particle moves along the x axis in the positive direction and negative otherwise) of travel when it reaches $x = 5.0$ m?



(1) +7.1 m/s (2) +5.5 m/s (3) −5.5 m/s (4) −4.5 m/s (5) 0 m/s

9. The figure gives the force acting on a 5.0 kg particle as it moves from rest along an x axis from $x = 0$ to $x = 8.0$ m. What is the particle's speed and direction (give a positive answer if the particle moves along the x axis in the positive direction and negative otherwise) of travel when it reaches $x = 6.0$ m?



(1) +5.5 m/s (2) +7.1 m/s (3) −5.5 m/s (4) −4.5 m/s (5) 0 m/s

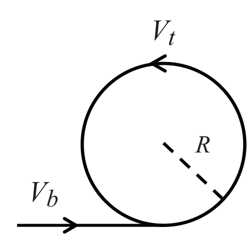
10. A high jumper of mass 70 kg runs toward a high jump bar with a speed of 6.7 m/s. What would be the maximum bar height the center-of-mass of the jumper could clear if he/she were able to convert all of his/her initial kinetic energy into a vertical jump?

(1) 2.3 m (2) 4.6 m (3) 22.4 m (4) 0.4 m (5) 1.5 m

11. A 0.25 kg mass is attached to the end of a relaxed, vertical hanging spring and the mass let go from rest. What is the maximum distance the spring stretches downward after the mass is released if the spring constant is $k = 50$ N/m?

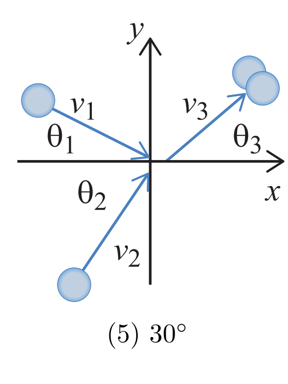
(1) 10 cm (2) 30 cm (3) 5 cm (4) 0 cm (5) 40 cm

12. A roller coaster is to go through a vertical loop as shown. What is the minimum speed at the bottom of the loop (V_b) necessary so that the cars do not fall off of the track at the top of the loop if the radius of the loop is $R = 10$ m? Treat a roller coaster car as a point mass going through the loop.



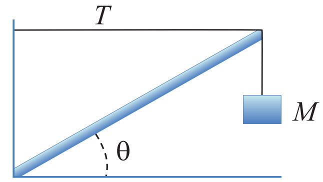
(1) 22 m/s (2) 20 m/s (3) 10 m/s (4) 17 m/s (5) 500 m/s

13. Two sticky equal mass air hockey pucks collide and stick together at the origin of the frictionless x-y plane shown in the figure. The shown angles are $\theta_1 = 30°$ and $\theta_2 = 60°$. The initial speed of both pucks are equal: $v_1 = v_2 = 2$ m/s. Determine the outgoing angle θ_3 for the combined system of two pucks, measured counter-clockwise with respect to the x-axis.



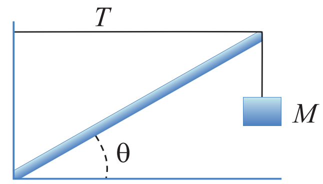
(1) 15° (2) 60° (3) 0° (4) 75° (5) 30°

14. The system depicted in the figure is in equilibrium. A block of mass $M = 300$ kg hangs from the end of a massless strut which is fixed to the ground at the other end and makes an angle $\theta = 30°$ with respect to the horizontal. Find the tension T in the massless, horizontal cable attaching the strut to the wall.



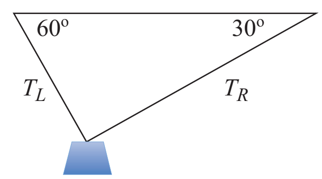
(1) 5100 N (2) 2900 N (3) 1700 N (4) 5900 N (5) 3400 N

15. The system depicted in the figure is in equilibrium. A block of mass $M = 300$ kg hangs from the end of a massless strut which is fixed to the ground at the other end and makes an angle $\theta = 60°$ with respect to the horizontal. Find the tension T in the massless, horizontal cable attaching the strut to the wall.



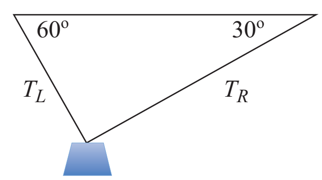
(1) 1700 N (2) 2900 N (3) 5100 N (4) 5900 N (5) 3400 N

16. A mass is attached to, and hangs from, two ropes which are fixed at their other ends in the ceiling, as shown in the figure. The left rope makes an angle of 60° with respect to the horizontal, and the right rope 30°. What is the ratio of the tension in the left rope to that of the right (T_L/T_R)?



(1) $\sqrt{3}$ (2) $1/\sqrt{3}$ (3) 1 (4) $\sqrt{3}/2$ (5) 2

17. A mass is attached to, and hangs from, two ropes which are fixed at their other ends in the ceiling, as shown in the figure. The left rope makes an angle of 60° with respect to the horizontal, and the right rope 30°. What is the ratio of the tension in the right rope to that of the left (T_R/T_L)?

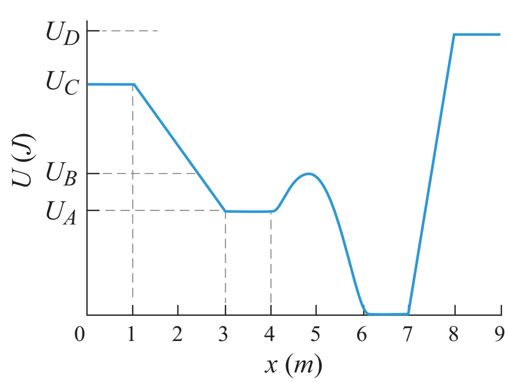


(1) $1/\sqrt{3}$ (2) $\sqrt{3}$ (3) 1 (4) $\sqrt{3}/2$ (5) 2

18. A 5 kg object is suspended from the ceiling by a cylindrical copper wire with a diameter of 1 mm. If the wire initially has a length of 2 m, what is the increase in its length in millimeters (mm) after the object is attached if the Young's modulus of copper is 120×10^9 N/m^2?

(1) 1.0 (2) 5.2×10^{-4} (3) 0.25 (4) 8.2×10^{-7} (5) 1.2×10^{11}

19. The graph shows the potential energy of an object acted upon by a conservative force as a function of its position x. The potential values indicated are: $U_A = 20$ J, $U_B = 25$ J, $U_C = 40$ J, and $U_D = 50$ J. At which of the listed positions in x is the force largest in the $+x$ direction?



(1) 2 m
(2) 7.5 m
(3) 0.5 m
(4) 5 m
(5) 6.5 m

20. The following objects (i) a solid sphere, (ii) a spherical shell and (iii) a cube all have the same mass. The objects all start to move, from rest, from the same elevation on an inclined surface (same incline), at the same time. The spheres each roll without slipping while the cube slides without friction. The order in which they get to the bottom of the incline, fastest first, is:

(1) (iii), (i), (ii) (2) (iii), (ii), (i) (3) (i), (ii), (iii) (4) (ii), (i), (iii) (5) (ii), (iii), (i)

21. A wheel initially has an angular velocity of 30 rad/s but is slowing at a rate of 2 rad/s^2. By the time it stops, the number of revolutions it will have turned through is:

(1) 36 (2) 49 (3) 64 (4) 81 (5) 25

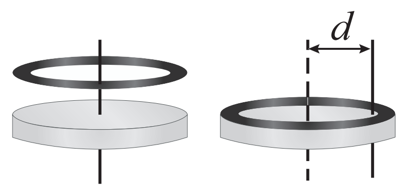
22. A wheel initially has an angular velocity of 35 rad/s but is slowing at a rate of 2 rad/s^2. By the time it stops, the number of revolutions it will have turned through is:

(1) 49 (2) 36 (3) 64 (4) 81 (5) 25

23. A wheel initially has an angular velocity of 40 rad/s but is slowing at a rate of 2 rad/s^2. By the time it stops, the number of revolutions it will have turned through is:

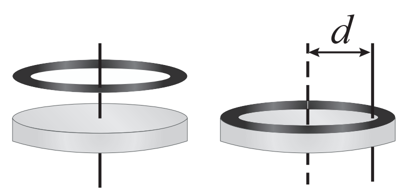
(1) 64 (2) 36 (3) 49 (4) 81 (5) 25

24. A thin hoop of radius R and mass M is welded to a thin uniform disk of the same mass and the same outer radius such that the hoop and disk are coaxial (dotted line). Calculate the rotational inertia for this object about an axis that is $d = (3/4)R$ from the dotted axis, as shown in the sketch. (**Hint:** Make sure to consider the total mass of the system after welding.)



(1) $2.63MR^2$ (2) $3.03MR^2$ (3) $2.06MR^2$ (4) $2.27MR^2$ (5) $1.63MR^2$

25. A thin hoop of radius R and mass M is welded to a thin uniform disk of the same mass and the same outer radius such that the hoop and disk are coaxial (dotted line). Calculate the rotational inertia for this object about an axis that is $d = (7/8)R$ from the dotted axis, as shown in the sketch. (**Hint:** Make sure to consider the total mass of the system after welding.)



(1) $3.03MR^2$ (2) $2.63MR^2$ (3) $2.06MR^2$ (4) $2.27MR^2$ (5) $1.63MR^2$

26. A solid uniform sphere of mass 0.4 kg and diameter 10 cm rolls from rest without slipping down a 30° incline. After rolling 8.0 m, measured along the incline, its rotational kinetic energy is:

(1) 4.48 J (2) 5.60 J (3) 6.72 J (4) 7.84 J (5) 8.96 J

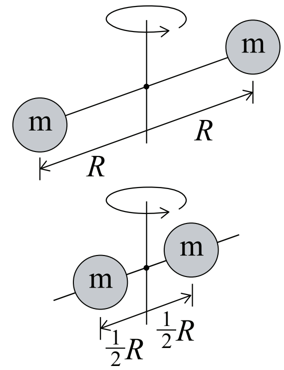
27. A solid uniform sphere of mass 0.4 kg and diameter 10 cm rolls from rest without slipping down a 30° incline. After rolling 10.0 m, measured along the incline, its rotational kinetic energy is:

(1) 5.60 J (2) 4.48 J (3) 6.72 J (4) 7.84 J (5) 8.96 J

28. A solid uniform sphere of mass 0.4 kg and diameter 10 cm rolls from rest without slipping down a 30° incline. After rolling 12.0 m, measured along the incline, its rotational kinetic energy is:

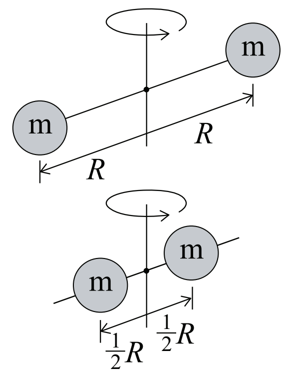
(1) 6.72 J (2) 5.60 J (3) 4.48 J (4) 7.84 J (5) 8.96 J

29. A dumbbell rotor consists of a massless rigid rod free to pivot around a vertical axis through the middle of the rod. Two small, equal masses, are attached to the rod at a distance R from the rotation axis. The rotor rotates with an angular velocity of 1.0 rad/s. An internal mechanism pulls the masses in symmetrically until they are each at $\frac{1}{2}R$ from the axis. The angular velocity of the rotor after this move (in rad/s) is:



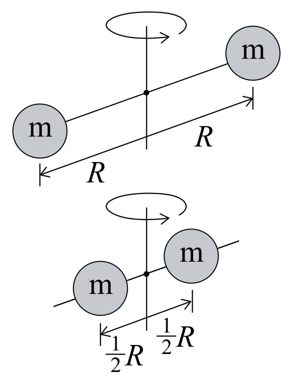
(1) 4
(2) 8
(3) 12
(4) $\frac{1}{4}$
(5) $\frac{1}{8}$

30. A dumbbell rotor consists of a massless rigid rod free to pivot around a vertical axis through the middle of the rod. Two small, equal masses, are attached to the rod at a distance R from the rotation axis. The rotor rotates with an angular velocity of 2.0 rad/s. An internal mechanism pulls the masses in symmetrically until they are each at $\frac{1}{2}R$ from the axis. The angular velocity of the rotor after this move (in rad/s) is:



(1) 8
(2) 4
(3) 12
(4) $\frac{1}{4}$
(5) $\frac{1}{8}$

31. A dumbbell rotor consists of a massless rigid rod free to pivot around a vertical axis through the middle of the rod. Two small, equal masses, are attached to the rod at a distance R from the rotation axis. The rotor rotates with an angular velocity of 3.0 rad/s. An internal mechanism pulls the masses in symmetrically until they are each at $\frac{1}{2}R$ from the axis. The angular velocity of the rotor after this move (in rad/s) is:



(1) 12
(2) 4
(3) 8
(4) $\frac{1}{4}$
(5) $\frac{1}{8}$

32. A spherical shell is free to rotate about its vertical axis having rotational inertia $I = 40$ N·m^2 about that axis. A motor causes a torque that gives the shell a constant angular acceleration of 1.4 rad/s^2. In rotating the shell through 15 revolutions the motor does an amount of work (in J) equal to

(1) 5.3×10^3 (2) 0.84×10^3 (3) 6.0×10^3 (4) 4.5×10^3 (5) 2.1×10^3

33. A spherical shell is free to rotate about its vertical axis having rotational inertia $I = 40$ N·m^2 about that axis. A motor causes a torque that gives the shell a constant angular acceleration of 1.6 rad/s^2. In rotating the shell through 15 revolutions the motor does an amount of work (in J) equal to

(1) 6.0×10^3 (2) 0.84×10^3 (3) 5.3×10^3 (4) 4.5×10^3 (5) 2.1×10^3

34. A spherical shell is free to rotate about its vertical axis having rotational inertia $I = 40$ N·m^2 about that axis. A motor causes a torque that gives the shell a constant angular acceleration of 1.2 rad/s^2. In rotating the shell through 15 revolutions the motor does an amount of work (in J) equal to

(1) 4.5×10^3 (2) 0.84×10^3 (3) 5.3×10^3 (4) 6.0×10^3 (5) 2.1×10^3

35. Tarzan, having a mass of 88.0 kg, swings on a 10.0 m long vine such that just before getting to the bottom of the swing his angular velocity is 1.40 rad/s. At the bottom of the swing he picks up Cheetah (mass of 20.0 kg) who was waiting there at rest. Just after the pick-up their angular velocity in (rad/s) was (hint: treat both Tarzan and Cheetah as point masses):

(1) 1.14 (2) 1.30 (3) 1.47 (4) 0.98 (5) 0.81

36. Tarzan, having a mass of 88.0 kg, swings on a 10.0 m long vine such that just before getting to the bottom of the swing his angular velocity is 1.60 rad/s. At the bottom of the swing he picks up Cheetah (mass of 20.0 kg) who was waiting there at rest. Just after the pick-up their angular velocity in (rad/s) was (hint: treat both Tarzan and Cheetah as point masses):

(1) 1.30 (2) 1.14 (3) 1.47 (4) 0.98 (5) 0.81

37. Tarzan, having a mass of 88.0 kg, swings on a 10.0 m long vine such that just before getting to the bottom of the swing his angular velocity is 1.80 rad/s. At the bottom of the swing he picks up Cheetah (mass of 20.0 kg) who was waiting there at rest. Just after the pick-up their angular velocity in (rad/s) was (hint: treat both Tarzan and Cheetah as point masses):

(1) 1.47 (2) 1.14 (3) 1.30 (4) 0.98 (5) 0.81

FOLLOWING GROUPS OF QUESTIONS WILL BE SELECTED AS ONE GROUP FROM EACH TYPE
TYPE 1
Q# S 2
Q# S 3
Q# S 4
TYPE 2
Q# S 6
Q# S 7
TYPE 3
Q# S 8
Q# S 9
TYPE 4
Q# S 14
Q# S 15
TYPE 5
Q# S 16
Q# S 17
TYPE 6
Q# S 21
Q# S 22
Q# S 23
TYPE 7
Q# S 24
Q# S 25
TYPE 8
Q# S 26

Q# S 27
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TYPE 11
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