Instructor(s): *Field/Furic*

PHYSICS DEPARTMENT

PHY 2053 Exam 2 November 6, 2013

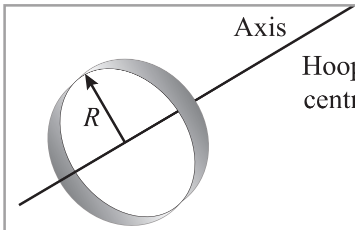
Name (print, last first): ______________________ Signature: ______________________

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.

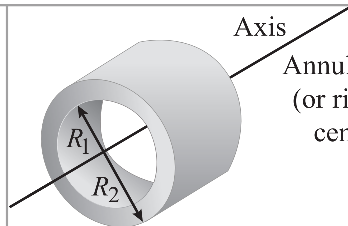
(1) **Code your test number on your answer sheet (use lines 76–80 on the answer sheet for the 5-digit number).** Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. Code your UFID number on your answer sheet.
(2) Print your name on this sheet and sign it also.
(3) Do all scratch work 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.

Use $g = 9.80\ \mathrm{m/s^2}$



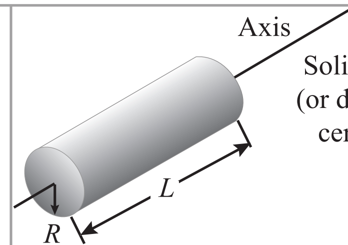
Hoop about central axis

$I = MR^2$



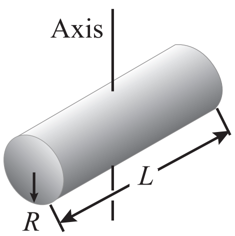
Annular cylinder (or ring) about central axis

$I = \frac{1}{2} M(R_1^2 + R_2^2)$



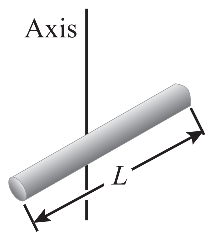
Solid cylinder (or disk) about central axis

$I = \frac{1}{2} MR^2$



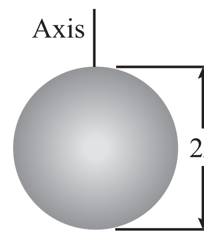
Solid cylinder (or disk) about central diameter

$I = \frac{1}{4} MR^2 + \frac{1}{12} ML^2$



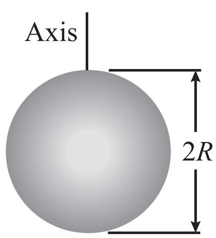
Thin rod about axis through center perpendicular to length

$I = \frac{1}{12} ML^2$



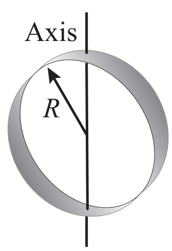
Solid sphere about any diameter

$I = \frac{2}{5} MR^2$



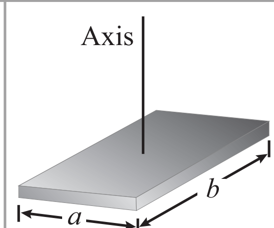
Thin spherical shell about any diameter

$I = \frac{2}{3} MR^2$



Hoop about any diameter

$I = \frac{1}{2} MR^2$



Slab about perpendicular axis through center

$I = \frac{1}{12} M(a^2 + b^2)$

1. A stone of mass m is released from rest a height $h = R_E$ above the surface of the Earth, where R_E is the radius of the Earth. What is the speed of the stone (in km/s) when it hits the Earth? Ignore air resistance and take $R_E = 6.371 \times 10^6$m, $M_E = 5.974 \times 10^{24}$kg, and $G = 6.674 \times 10^{-11}$N·m^2/kg^2, where M_E is the mass of the Earth and G is Newton's constant.

   (1) 7.91 (2) 8.67 (3) 9.13 (4) 11.19 (5) 13.70

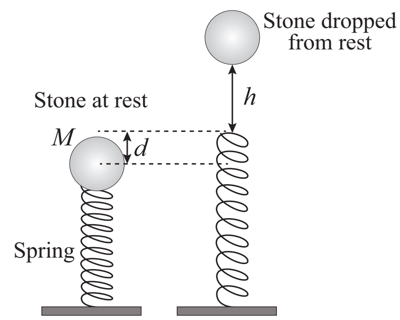
2. A stone of mass m is released from rest a height $h = 1.5R_E$ above the surface of the Earth, where R_E is the radius of the Earth. What is the speed of the stone (in km/s) when it hits the Earth? Ignore air resistance and take $R_E = 6.371 \times 10^6$m, $M_E = 5.974 \times 10^{24}$kg, and $G = 6.674 \times 10^{-11}$N·m^2/kg^2, where M_E is the mass of the Earth and G is Newton's constant.

   (1) 8.67 (2) 7.91 (3) 9.13 (4) 11.19 (5) 13.70

3. A stone of mass m is released from rest a height $h = 2R_E$ above the surface of the Earth, where R_E is the radius of the Earth. What is the speed of the stone (in km/s) when it hits the Earth? Ignore air resistance and take $R_E = 6.371 \times 10^6$m, $M_E = 5.974 \times 10^{24}$kg, and $G = 6.674 \times 10^{-11}$N·m^2/kg^2, where M_E is the mass of the Earth and G is Newton's constant.

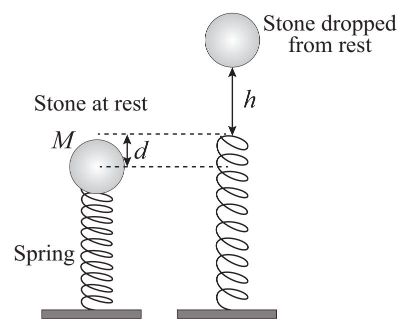
   (1) 9.13 (2) 7.91 (3) 8.67 (4) 11.19 (5) 15.82

4. When a stone of mass M is placed at rest on an elastic spring the spring is compressed a distance d by the weight of the stone as shown in the figure. If the same stone is released from rest a height $h = 3d/2$ above the same spring, what is the compression of the spring when the force of the spring halts the downward velocity of the stone (*i.e.,* when $v_{\text{stone}} = 0$)?



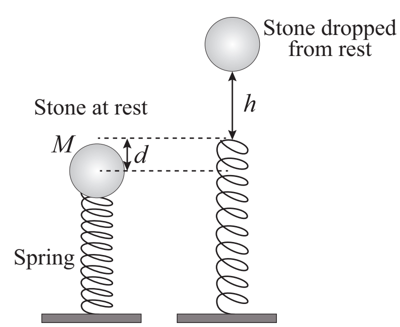
   (1) $3d$ (2) $4d$ (3) $5d$ (4) $2d$ (5) d

5. When a stone of mass M is placed at rest on an elastic spring the spring is compressed a distance d by the weight of the stone as shown in the figure. If the same stone is released from rest a height $h = 4d$ above the same spring, what is the compression of the spring when the force of the spring halts the downward velocity of the stone (*i.e.,* when $v_{\text{stone}} = 0$)?



   (1) $4d$ (2) $3d$ (3) $5d$ (4) $2d$ (5) d

6. When a stone of mass M is placed at rest on an elastic spring the spring is compressed a distance d by the weight of the stone as shown in the figure. If the same stone is released from rest a height $h = 7.5d$ above the same spring, what is the compression of the spring when the force of the spring halts the downward velocity of the stone (*i.e.,* when $v_{\text{stone}} = 0$)?



   (1) $5d$ (2) $3d$ (3) $4d$ (4) $2d$ (5) d

7. What is the momentum (in kg·m/s) of a particle with a mass of 0.5 kg and kinetic energy equal to 4 J?

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

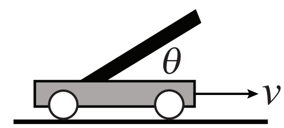
8. What is the momentum (in kg·m/s) of a particle with a mass of 0.5 kg and kinetic energy equal to 9 J?

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

9. What is the momentum (in kg·m/s) of a particle with a mass of 0.5 kg and kinetic energy equal to 16 J?

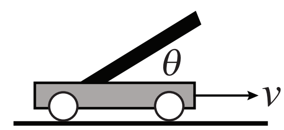
(1) 4 (2) 2 (3) 3 (4) 1 (5) 5

10. A cannon on a railroad car is facing in a direction parallel to the tracks as shown in the figure. The cannon can fire a 100-kg cannonball at a muzzle speed of 180 m/s at an angle of $\theta = 20°$ above the horizontal. The cannon plus railway car have a mass of 2,000 kg. If the cannon and one cannon ball are traveling to the right on the railway car a speed of $v = 10$ m/s, what is the speed of the railway car (in m/s) after the cannon fires the cannonball? Assume that the track is horizontal and there is no friction. The muzzle speed is the velocity of the cannonball relative to the muzzle of the cannon in the rest frame of the cannon.



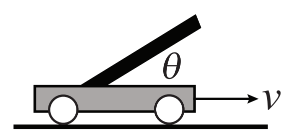
(1) 1.54 (2) 3.54 (3) 5.54 (4) 2.04 (5) 4.14

11. A cannon on a railroad car is facing in a direction parallel to the tracks as shown in the figure. The cannon can fire a 100-kg cannonball at a muzzle speed of 180 m/s at an angle of $\theta = 20°$ above the horizontal. The cannon plus railway car have a mass of 2,000 kg. If the cannon and one cannon ball are traveling to the right on the railway car a speed of $v = 12$ m/s, what is the speed of the railway car (in m/s) after the cannon fires the cannonball? Assume that the track is horizontal and there is no friction. The muzzle speed is the velocity of the cannonball relative to the muzzle of the cannon in the rest frame of the cannon.



(1) 3.54 (2) 1.54 (3) 5.54 (4) 2.04 (5) 4.14

12. A cannon on a railroad car is facing in a direction parallel to the tracks as shown in the figure. The cannon can fire a 100-kg cannonball at a muzzle speed of 180 m/s at an angle of $\theta = 20°$ above the horizontal. The cannon plus railway car have a mass of 2,000 kg. If the cannon and one cannon ball are traveling to the right on the railway car a speed of $v = 14$ m/s, what is the speed of the railway car (in m/s) after the cannon fires the cannonball? Assume that the track is horizontal and there is no friction. The muzzle speed is the velocity of the cannonball relative to the muzzle of the cannon in the rest frame of the cannon.



(1) 5.54 (2) 1.54 (3) 3.54 (4) 6.24 (5) 4.14

13. At $t = 0$ a 2.0-kg ball is dropped from rest 50 m above Earth and also at $t = 0$ a second ball, with a mass of 1.0 kg, is thrown straight upward from Earth's surface with an initial speed v_0. If the velocity of the center-of-mass of the two-ball system is zero 0.5 seconds after the balls are released, what is v_0 (in m/s)?

(1) 14.7 (2) 29.4 (3) 44.1 (4) 9.8 (5) 52.5

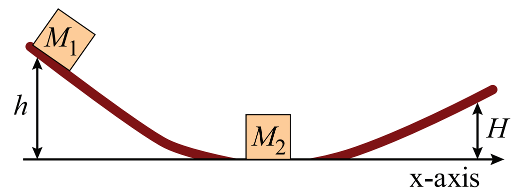
14. At $t = 0$ a 2.0-kg ball is dropped from rest 50 m above Earth and also at $t = 0$ a second ball, with a mass of 1.0 kg, is thrown straight upward from Earth's surface with an initial speed v_0. If the velocity of the center-of-mass of the two-ball system is zero 1.0 seconds after the balls are released, what is v_0 (in m/s)?

(1) 29.4 (2) 14.7 (3) 44.1 (4) 9.8 (5) 52.5

15. At $t = 0$ a 2.0-kg ball is dropped from rest 50 m above Earth and also at $t = 0$ a second ball, with a mass of 1.0 kg, is thrown straight upward from Earth's surface with an initial speed v_0. If the velocity of the center-of-mass of the two-ball system is zero 1.5 seconds after the balls are released, what is v_0 (in m/s)?

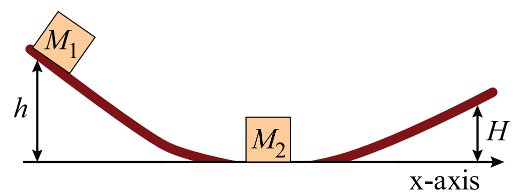
(1) 44.1 (2) 14.7 (3) 29.4 (4) 9.8 (5) 52.5

16. A block of mass M_1 starts from rest at a height h above the level surface and slides down a smooth ramp as shown in the figure. The block slides down the ramp, across the level surface, and collides with a block of mass M_2 which is at rest. The two blocks stick together and travel up a smooth ramp. If all the surfaces are smooth and frictionless, and if $M_2 = M_1$, what is the maximum height H that the combined 2-block system will reach?



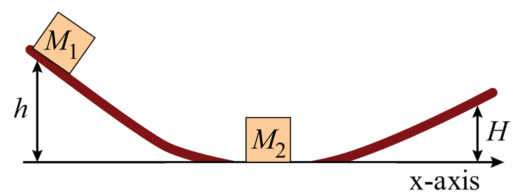
(1) $h/4$ (2) $h/9$ (3) $h/16$ (4) $h/2$ (5) h

17. A block of mass M_1 starts from rest at a height h above the level surface and slides down a smooth ramp as shown in the figure. The block slides down the ramp, across the level surface, and collides with a block of mass M_2 which is at rest. The two blocks stick together and travel up a smooth ramp. If all the surfaces are smooth and frictionless, and if $M_2 = 2M_1$, what is the maximum height H that the combined 2-block system will reach?



(1) $h/9$ (2) $h/4$ (3) $h/16$ (4) $h/2$ (5) h

18. A block of mass M_1 starts from rest at a height h above the level surface and slides down a smooth ramp as shown in the figure. The block slides down the ramp, across the level surface, and collides with a block of mass M_2 which is at rest. The two blocks stick together and travel up a smooth ramp. If all the surfaces are smooth and frictionless, and if $M_2 = 3M_1$, what is the maximum height H that the combined 2-block system will reach?



(1) $h/16$ (2) $h/4$ (3) $h/9$ (4) $h/2$ (5) h

19. A 0.5-kg rubber ball is dropped from rest a height $H = 19.6$ m above the surface of the Earth. It strikes the sidewalk below and rebounds up to a maximum height of 4.9 m. If the magnitude of the average force the sidewalk exerts on the ball during the collision is 73.5 N, how long (in s) was the ball in contact with the sidewalk?

(1) 0.20 (2) 0.25 (3) 0.30 (4) 0.15 (5) 0.35

20. A 0.5-kg rubber ball is dropped from rest a height $H = 19.6$ m above the surface of the Earth. It strikes the sidewalk below and rebounds up to a maximum height of 4.9 m. If the magnitude of the average force the sidewalk exerts on the ball during the collision is 58.8 N, how long (in s) was the ball in contact with the sidewalk?

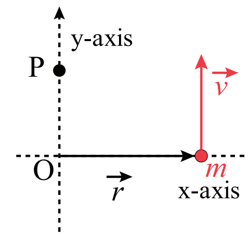
(1) 0.25 (2) 0.20 (3) 0.30 (4) 0.15 (5) 0.35

 77777

21. A 0.5-kg rubber ball is dropped from rest a height $H = 19.6$ m above the surface of the Earth. It strikes the sidewalk below and rebounds up to a maximum height of 4.9 m. If the magnitude of the average force the sidewalk exerts on the ball during the collision is 49.0 N, how long (in s) was the ball in contact with the sidewalk?

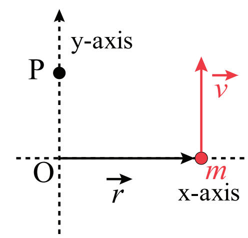
(1) 0.30 (2) 0.20 (3) 0.25 (4) 0.15 (5) 0.35

22. A point particle has velocity $\vec{v} = (2m/s)\hat{y}$ when it it located at $\vec{r} = (3m)\hat{x}$, as shown in the figure. If the magnitude of its angular momentum about the origin $O = (0, 0)$ is 12 kg·m^2/s, what is the magnitude of its angular momentum (in kg·m^2/s) about point P located at $x = 0$ and $y = 4$ m?



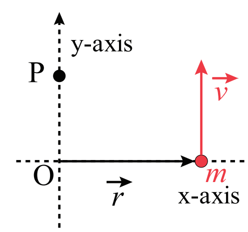
(1) 12 (2) 20 (3) 25 (4) 40 (5) 10

23. A point particle has velocity $\vec{v} = (2m/s)\hat{y}$ when it it located at $\vec{r} = (3m)\hat{x}$, as shown in the figure. If the magnitude of its angular momentum about the origin $O = (0, 0)$ is 15 kg·m^2/s, what is the magnitude of its angular momentum (in kg·m^2/s) about point P located at $x = 0$ and $y = 4$ m?



(1) 15 (2) 20 (3) 25 (4) 40 (5) 10

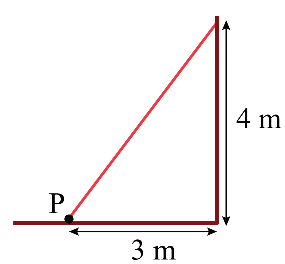
24. A point particle has velocity $\vec{v} = (2m/s)\hat{y}$ when it it located at $\vec{r} = (3m)\hat{x}$, as shown in the figure. If the magnitude of its angular momentum about the origin $O = (0, 0)$ is 24 kg·m^2/s, what is the magnitude of its angular momentum (in kg·m^2/s) about point P located at $x = 0$ and $y = 4$ m?



(1) 24 (2) 20 (3) 15 (4) 40 (5) 10

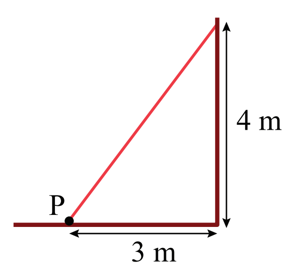
25. A 80-N uniform plank leans at rest against a frictionless wall as shown in the figure. What is the magnitude of the force (in N) applied to the plank by the wall?

(1) 30
(2) 45
(3) 60
(4) 80
(5) 90

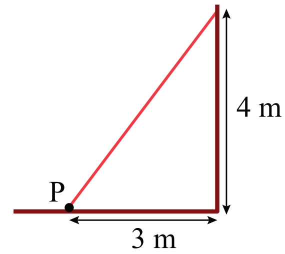


26. A 120-N uniform plank leans at rest against a frictionless wall as shown in the figure. What is the magnitude of the force (in N) applied to the plank by the wall?

(1) 45
(2) 30
(3) 60
(4) 80
(5) 90

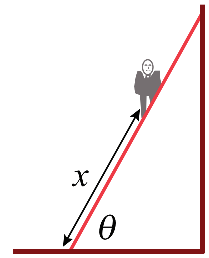


27. A 160-N uniform plank leans at rest against a frictionless wall as shown in the figure. What is the magnitude of the force (in N) applied to the plank by the wall?



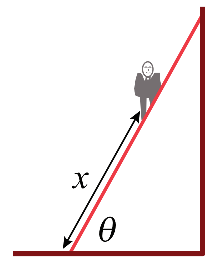
(1) 60
(2) 30
(3) 45
(4) 80
(5) 90

28. A 200-N man climbs up a 100-N uniform ladder of length L that is leaning against a frictionless wall as shown in the figure. If he places the ladder at an angle $\theta = 40°$, and if he can climb up the ladder a distance $x = 2L/3$ before the ladder begins to slip, what is the static coefficient of friction μ_s between the ladder and the floor?



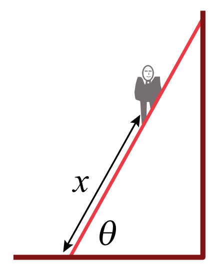
(1) 0.728
(2) 0.513
(3) 0.353
(4) 0.854
(5) 0.285

29. A 200-N man climbs up a 100-N uniform ladder of length L that is leaning against a frictionless wall as shown in the figure. If he places the ladder at an angle $\theta = 50°$, and if he can climb up the ladder a distance $x = 2L/3$ before the ladder begins to slip, what is the static coefficient of friction μ_s between the ladder and the floor?



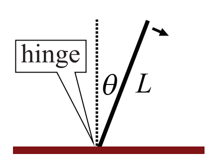
(1) 0.513
(2) 0.728
(3) 0.353
(4) 0.854
(5) 0.285

30. A 200-N man climbs up a 100-N uniform ladder of length L that is leaning against a frictionless wall as shown in the figure. If he places the ladder at an angle $\theta = 60°$, and if he can climb up the ladder a distance $x = 2L/3$ before the ladder begins to slip, what is the static coefficient of friction μ_s between the ladder and the floor?



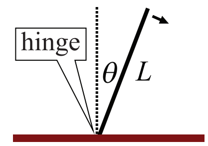
(1) 0.353
(2) 0.728
(3) 0.513
(4) 0.854
(5) 0.285

31. Near the surface of the Earth a thin stick with mass M, length L, and moment of inertia $ML^2/3$ is hinged at its lower end and allowed to fall freely from rest starting at angle θ as shown in the figure. If its length is $L = 2$ m and the speed of the free end of the stick when it hits the table is 4 m/s, what is the starting angle?



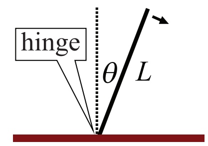
(1) 74.2° (2) 64.8° (3) 52.2° (4) 35.5° (5) 82.3°

32. Near the surface of the Earth a thin stick with mass M, length L, and moment of inertia $ML^2/3$ is hinged at its lower end and allowed to fall freely from rest starting at angle θ as shown in the figure. If its length is $L = 2$ m and the speed of the free end of the stick when it hits the table is 5 m/s, what is the starting angle?



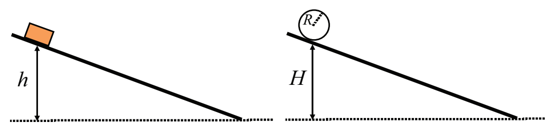
(1) 64.8° (2) 74.2° (3) 52.2° (4) 35.5° (5) 82.3°

33. Near the surface of the Earth a thin stick with mass M, length L, and moment of inertia $ML^2/3$ is hinged at its lower end and allowed to fall freely from rest starting at angle θ as shown in the figure. If its length is $L = 2$ m and the speed of the free end of the stick when it hits the table is 6 m/s, what is the starting angle?



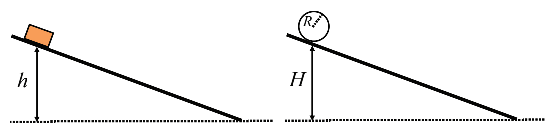
(1) 52.2° (2) 74.2° (3) 64.8° (4) 35.5° (5) 82.3°

34. A small block of mass m starts from rest a height h above the ground and slides down a frictionless incline as shown in the figure. A cylinder with moment of inertia I, mass M and radius R starts from rest at a height H above the ground and rolls without slipping down an incline. If $H = 1.2h$ and the translational speed of the block and the cylinder are the same when they reach the ground, what is the moment of inertia I of the cylinder?



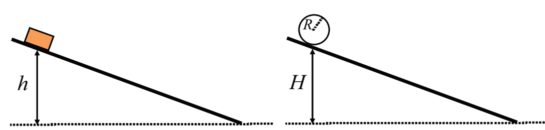
(1) $0.2MR^2$ (2) $0.3MR^2$ (3) $0.4MR^2$ (4) $0.5MR^2$ (5) MR^2

35. A small block of mass m starts from rest a height h above the ground and slides down a frictionless incline as shown in the figure. A cylinder with moment of inertia I, mass M and radius R starts from rest at a height H above the ground and rolls without slipping down an incline. If $H = 1.3h$ and the translational speed of the block and the cylinder are the same when they reach the ground, what is the moment of inertia I of the cylinder?



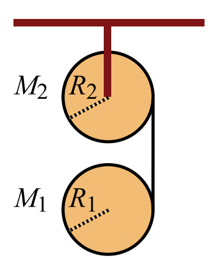
(1) $0.3MR^2$ (2) $0.2MR^2$ (3) $0.4MR^2$ (4) $0.5MR^2$ (5) MR^2

36. A small block of mass m starts from rest a height h above the ground and slides down a frictionless incline as shown in the figure. A cylinder with moment of inertia I, mass M and radius R starts from rest at a height H above the ground and rolls without slipping down an incline. If $H = 1.4h$ and the translational speed of the block and the cylinder are the same when they reach the ground, what is the moment of inertia I of the cylinder?



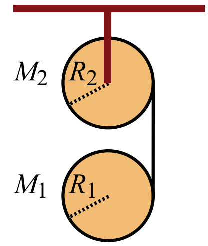
(1) $0.4MR^2$ (2) $0.2MR^2$ (3) $0.3MR^2$ (4) $0.5MR^2$ (5) MR^2

37. Near the surface of the Earth, a cloth tape is wound around the outside of the two uniform solid cylinders shown in the figure. Solid cylinder 1 has mass M_1, radius R_1, and moment of inertia $I_1 = \frac{1}{2}M_1R_1^2$. Solid cylinder 2 has mass M_2, radius R_2, and moment of inertia $I_2 = \frac{1}{2}M_2R_2^2$. Cylinder 2 is attached to the ceiling and rotates without friction, and cylinder 1 hangs vertically. If $M_1 = M_2$, when the cylinders are released from rest and the tape unwinds off both cylinders, what is the acceleration of the center-of-mass of cylinder 1 (in m/s^2)?



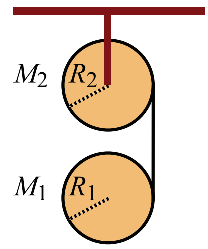
(1) 7.84 (2) 7.35 (3) 8.40 (4) 6.53 (5) 4.25

38. Near the surface of the Earth, a cloth tape is wound around the outside of the two uniform solid cylinders shown in the figure. Solid cylinder 1 has mass M_1, radius R_1, and moment of inertia $I_1 = \frac{1}{2}M_1R_1^2$. Solid cylinder 2 has mass M_2, radius R_2, and moment of inertia $I_2 = \frac{1}{2}M_2R_2^2$. Cylinder 2 is attached to the ceiling and rotates without friction, and cylinder 1 hangs vertically. If $M_1 = 0.5M_2$, when the cylinders are released from rest and the tape unwinds off both cylinders, what is the acceleration of the center-of-mass of cylinder 1 (in m/s^2)?



(1) 7.35 (2) 7.84 (3) 8.40 (4) 6.53 (5) 4.25

39. Near the surface of the Earth, a cloth tape is wound around the outside of the two uniform solid cylinders shown in the figure. Solid cylinder 1 has mass M_1, radius R_1, and moment of inertia $I_1 = \frac{1}{2}M_1R_1^2$. Solid cylinder 2 has mass M_2, radius R_2, and moment of inertia $I_2 = \frac{1}{2}M_2R_2^2$. Cylinder 2 is attached to the ceiling and rotates without friction, and cylinder 1 hangs vertically. If $M_1 = 2M_2$, when the cylinders are released from rest and the tape unwinds off both cylinders, what is the acceleration of the center-of-mass of cylinder 1 (in m/s^2)?



(1) 8.40 (2) 7.84 (3) 7.35 (4) 6.53 (5) 4.25

40. Two small balls are simultaneously released from rest in a deep pool of water (with density ρ_{water}). The first ball is released from rest at the surface of the pool and has a density $\rho_1 = 1.2\rho_{\text{water}}$. A second ball is released from rest at the bottom of the pool and has density $\rho_2 = 0.2\rho_{\text{water}}$. If it takes the first ball 5 seconds to reach the bottom of the pool, how long (in s) does it take the second ball to reach the surface? Neglect hydrodynamic drag forces.

(1) 1.02 (2) 2.18 (3) 3.75 (4) 4.25 (5) 5.00

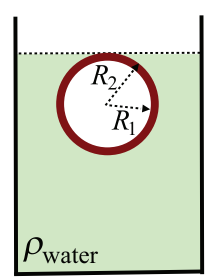
41. Two small balls are simultaneously released from rest in a deep pool of water (with density ρ_{water}). The first ball is released from rest at the surface of the pool and has a density $\rho_1 = 1.4\rho_{\text{water}}$. A second ball is released from rest at the bottom of the pool and has density $\rho_2 = 0.4\rho_{\text{water}}$. If it takes the first ball 5 seconds to reach the bottom of the pool, how long (in s) does it take the second ball to reach the surface? Neglect hydrodynamic drag forces.

(1) 2.18 (2) 1.02 (3) 3.75 (4) 4.25 (5) 5.00

42. Two small balls are simultaneously released from rest in a deep pool of water (with density ρ_{water}). The first ball is released from rest at the surface of the pool and has a density $\rho_1 = 1.6\rho_{\text{water}}$. A second ball is released from rest at the bottom of the pool and has density $\rho_2 = 0.6\rho_{\text{water}}$. If it takes the first ball 5 seconds to reach the bottom of the pool, how long (in s) does it take the second ball to reach the surface? Neglect hydrodynamic drag forces.

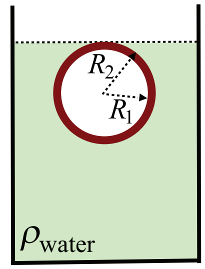
(1) 3.75 (2) 1.02 (3) 2.18 (4) 4.25 (5) 5.00

43. A hollow uniform spherical metal shell floats almost completely submerged in water (*i.e.,* just touching the surface) as shown in the figure. The inner radius of the metal shell is R_1 and the outer radius is R_2, and the center of the sphere is located a distance R_2 below the surface. If $R_1 = 0.8R_2$, what is the specific gravity of the metal (*i.e.,* what is $\rho_{\text{metal}}/\rho_{\text{water}}$)?



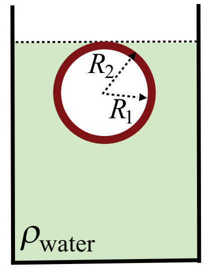
(1) 2.05
(2) 3.69
(3) 7.01
(4) 1.25
(5) 11.3

44. A hollow uniform spherical metal shell floats almost completely submerged in water (*i.e.,* just touching the surface) as shown in the figure. The inner radius of the metal shell is R_1 and the outer radius is R_2, and the center of the sphere is located a distance R_2 below the surface. If $R_1 = 0.9R_2$, what is the specific gravity of the metal (*i.e.,* what is $\rho_{\mathrm{metal}}/\rho_{\mathrm{water}}$)?



(1) 3.69
(2) 2.05
(3) 7.01
(4) 1.25
(5) 11.3

45. A hollow uniform spherical metal shell floats almost completely submerged in water (*i.e.,* just touching the surface) as shown in the figure. The inner radius of the metal shell is R_1 and the outer radius is R_2, and the center of the sphere is located a distance R_2 below the surface. If $R_1 = 0.95R_2$, what is the specific gravity of the metal (*i.e.,* what is $\rho_{\mathrm{metal}}/\rho_{\mathrm{water}}$)?



(1) 7.01
(2) 2.05
(3) 3.69
(4) 1.25
(5) 11.3

46. A spherical helium balloon has a radius $R = 2$ m. What is the maximum total mass M (including the mass of the empty balloon) that the balloon can lift off the surface of the Earth, if density of helium and the air are $\rho_{\mathrm{HE}} = 0.18$ kg/m^3 and $\rho_{\mathrm{air}} = 1.2$ kg/m^3, respectively?

(1) 34.2 kg (2) 115.4 kg (3) 273.4 kg (4) 10.0 kg (5) 377.5 kg

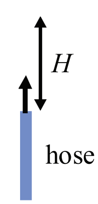
47. A spherical helium balloon has a radius $R = 3$ m. What is the maximum total mass M (including the mass of the empty balloon) that the balloon can lift off the surface of the Earth, if density of helium and the air are $\rho_{\mathrm{HE}} = 0.18$ kg/m^3 and $\rho_{\mathrm{air}} = 1.2$ kg/m^3, respectively?

(1) 115.4 kg (2) 34.2 kg (3) 273.4 kg (4) 10.0 kg (5) 377.5 kg

48. A spherical helium balloon has a radius $R = 4$ m. What is the maximum total mass M (including the mass of the empty balloon) that the balloon can lift off the surface of the Earth, if density of helium and the air are $\rho_{\mathrm{HE}} = 0.18$ kg/m^3 and $\rho_{\mathrm{air}} = 1.2$ kg/m^3, respectively?

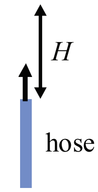
(1) 273.4 kg (2) 34.2 kg (3) 115.4 kg (4) 10.0 kg (5) 377.5 kg

49. Near the surface of the Earth, a garden hose of inner radius 3 cm carries water at 2.0 m/s. The nozzle at the end has a radius of 1.5 cm and is held in a vertical position as shown in the figure. How high (in m) will the water rise above the nozzle, (*i.e.,* what is H)?



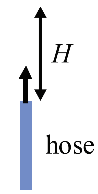
(1) 3.27 (2) 7.35 (3) 13.06 (4) 1.52 (5) 14.68

50. Near the surface of the Earth, a garden hose of inner radius 3 cm carries water at 3.0 m/s. The nozzle at the end has a radius of 1.5 cm and is held in a vertical position as shown in the figure. How high (in m) will the water rise above the nozzle, (*i.e.,* what is H)?



(1) 7.35 (2) 3.27 (3) 13.06 (4) 1.52 (5) 14.68

51. Near the surface of the Earth, a garden hose of inner radius 3 cm carries water at 4.0 m/s. The nozzle at the end has a radius of 1.5 cm and is held in a vertical position as shown in the figure. How high (in m) will the water rise above the nozzle, (*i.e.,* what is H)?



(1) 13.06 (2) 3.27 (3) 7.35 (4) 1.52 (5) 14.68

52. An airtight box, having a lid of area 80 cm^2, is partially evacuated to 80% of the atmospheric pressure. The atmospheric pressure is 1.01×10^5Pa. What is the minimum force required to pull the lid off of the box (in N)?

(1) 161.6 (2) 242.4 (3) 323.2 (4) 98.5 (5) 444.2

53. An airtight box, having a lid of area 80 cm^2, is partially evacuated to 70% of the atmospheric pressure. The atmospheric pressure is 1.01×10^5Pa. What is the minimum force required to pull the lid off of the box (in N)?

(1) 242.4 (2) 161.6 (3) 323.2 (4) 98.5 (5) 444.2

54. An airtight box, having a lid of area 80 cm^2, is partially evacuated to 60% of the atmospheric pressure. The atmospheric pressure is 1.01×10^5Pa. What is the minimum force required to pull the lid off of the box (in N)?

(1) 323.2 (2) 161.6 (3) 242.4 (4) 98.5 (5) 444.2

55. At the surface of a freshwater lake the pressure is 101 kPa. What is the pressure increase (in kPa) in going 25 m below the surface? (Use $\rho_{\text{water}} = 1000$ kg/m^3)

(1) 245 (2) 490 (3) 735 (4) 346 (5) 591

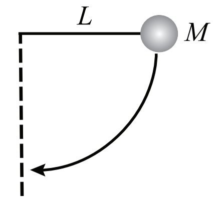
56. At the surface of a freshwater lake the pressure is 101 kPa. What is the pressure increase (in kPa) in going 50 m below the surface? (Use $\rho_{\text{water}} = 1000$ kg/m^3)

(1) 490 (2) 245 (3) 735 (4) 346 (5) 591

57. At the surface of a freshwater lake the pressure is 101 kPa. What is the pressure increase (in kPa) in going 75 m below the surface? (Use $\rho_{\text{water}} = 1000$ kg/m^3)

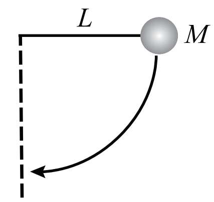
(1) 735 (2) 245 (3) 490 (4) 346 (5) 836

58. Near the surface of the Earth, a 2,000 kg wrecking ball is connected to a steel cable that has a diameter of 2.0 cm and an unstretched length of $L = 40$ m. The other end of the cable is fixed in position and the ball is initially held at rest horizontally, as shown in the figure. When the ball is released from rest it swings down. The Young's modulus of steel is 2.0×10^{11}Pa. Ignoring the weight of the cable itself, when the ball-cable system swings through vertical (*i.e.,* ball at its lowest point) how much does the cable stretch (in cm)?



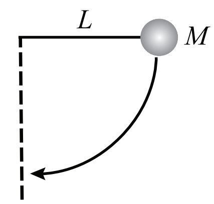
(1) 3.74 (2) 2.40 (3) 1.66 (4) 1.25 (5) 4.25

59. Near the surface of the Earth, a 2,000 kg wrecking ball is connected to a steel cable that has a diameter of 2.5 cm and an unstretched length of $L = 40$ m. The other end of the cable is fixed in position and the ball is initially held at rest horizontally, as shown in the figure. When the ball is released from rest it swings down. The Young's modulus of steel is 2.0×10^{11}Pa. Ignoring the weight of the cable itself, when the ball-cable system swings through vertical (*i.e.,* ball at its lowest point) how much does the cable stretch (in cm)?



(1) 2.40 (2) 3.74 (3) 1.66 (4) 1.25 (5) 0.80

60. Near the surface of the Earth, a 2,000 kg wrecking ball is connected to a steel cable that has a diameter of 3.0 cm and an unstretched length of $L = 40$ m. The other end of the cable is fixed in position and the ball is initially held at rest horizontally, as shown in the figure. When the ball is released from rest it swings down. The Young's modulus of steel is 2.0×10^{11}Pa. Ignoring the weight of the cable itself, when the ball-cable system swings through vertical (*i.e.,* ball at its lowest point) how much does the cable stretch (in cm)?



(1) 1.66 (2) 3.74 (3) 2.40 (4) 1.25 (5) 0.55

FOLLOWING GROUPS OF QUESTIONS WILL BE SELECTED AS ONE GROUP FROM EACH TYPE
TYPE 1
Q# S 1
Q# S 2
Q# S 3
TYPE 2
Q# S 4
Q# S 5
Q# S 6
TYPE 3
Q# S 7
Q# S 8
Q# S 9
TYPE 4
Q# S 10
Q# S 11
Q# S 12
TYPE 5
Q# S 13
Q# S 14
Q# S 15
TYPE 6
Q# S 16
Q# S 17
Q# S 18
TYPE 7
Q# S 19
Q# S 20
Q# S 21
TYPE 8
Q# S 22
Q# S 23
Q# S 24
TYPE 9

Q# S 25
Q# S 26
Q# S 27
TYPE 10
Q# S 28
Q# S 29
Q# S 30
TYPE 11
Q# S 31
Q# S 32
Q# S 33
TYPE 12
Q# S 34
Q# S 35
Q# S 36
TYPE 13
Q# S 37
Q# S 38
Q# S 39
TYPE 14
Q# S 40
Q# S 41
Q# S 42
TYPE 15
Q# S 43
Q# S 44
Q# S 45
TYPE 16
Q# S 46
Q# S 47
Q# S 48
TYPE 17
Q# S 49
Q# S 50
Q# S 51
TYPE 18
Q# S 52
Q# S 53
Q# S 54
TYPE 19
Q# S 55
Q# S 56
Q# S 57
TYPE 20
Q# S 58
Q# S 59
Q# S 60