Instructor(s): *Field/Qiu*

PHYSICS DEPARTMENT

PHY 2053 Final Exam April 26, 2014

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

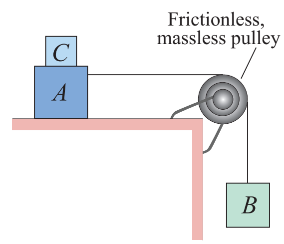
*On my honor, I have neither given nor received unauthorized aid on this examination.*

**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.

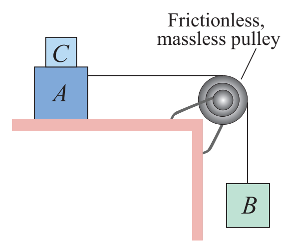
Use $g = 9.80$ m/s$^2$

1. In the figure, blocks A and C have a mass of 30 kg and 6 kg, respectively. If the surface of the table is frictionless and the static coefficient of friction, $\mu_s$, between block A and block C is 0.20, what is the maximum mass of block B (in kg) such that, when the system is released from rest, block C will not slip off block A?



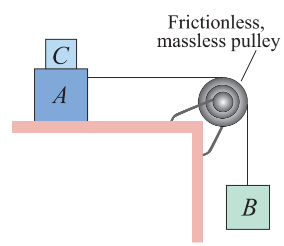

(1) 9 (2) 36 (3) 54 (4) 30 (5) 5

2. In the figure, blocks A and C have a mass of 30 kg and 6 kg, respectively. If the surface of the table is frictionless and the static coefficient of friction, $\mu_s$, between block A and block C is 0.50, what is the maximum mass of block B (in kg) such that, when the system is released from rest, block C will not slip off block A?



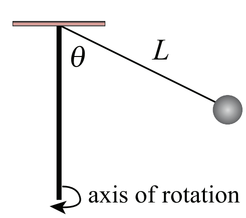

(1) 36 (2) 9 (3) 54 (4) 30 (5) 5

3. In the figure, blocks A and C have a mass of 30 kg and 6 kg, respectively. If the surface of the table is frictionless and the static coefficient of friction, $\mu_s$, between block A and block C is 0.60, what is the maximum mass of block B (in kg) such that, when the system is released from rest, block C will not slip off block A?



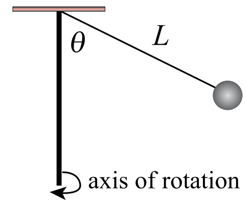

(1) 54 (2) 9 (3) 36 (4) 30 (5) 5

4. Near the surface of the Earth a ball of mass $M$ is attached to a thin rope with negligible mass and length $L = 2.5$ m. The ball and rope are attached to a vertical pole and the entire apparatus, including the pole, rotates with a constant angular velocity about the pole's symmetry axis, as shown in the figure. If the angle $\theta = 60°$, how long (in seconds) does it take the ball to make one complete revolution?



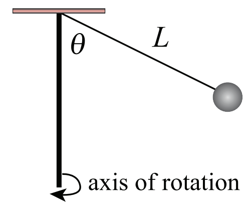

(1) 2.24 (2) 1.86 (3) 1.32 (4) 3.25 (5) 1.05

5. Near the surface of the Earth a ball of mass $M$ is attached to a thin rope with negligible mass and length $L = 2.5$ m. The ball and rope are attached to a vertical pole and the entire apparatus, including the pole, rotates with a constant angular velocity about the pole's symmetry axis, as shown in the figure. If the angle $\theta = 70°$, how long (in seconds) does it take the ball to make one complete revolution?




(1) 1.86 (2) 2.24 (3) 1.32 (4) 3.25 (5) 1.05

6. Near the surface of the Earth a ball of mass $M$ is attached to a thin rope with negligible mass and length $L = 2.5$ m. The ball and rope are attached to a vertical pole and the entire apparatus, including the pole, rotates with a constant angular velocity about the pole's symmetry axis, as shown in the figure. If the angle $\theta = 80°$, how long (in seconds) does it take the ball to make one complete revolution?




(1) 1.32 (2) 2.24 (3) 1.86 (4) 3.25 (5) 1.05

7. A spacecraft is in a circular orbit around a spherical planet. The radius of the orbit is three times the radius of the planet and the period of the spacecraft's orbit is 14 hours. If the acceleration due to gravity at the surface of the planet is 20 m/s$^2$, what is the radius of the planet (in km)?

(1) 47,661 (2) 54,713 (3) 62,252 (4) 45,202 (5) 77,815

8. A spacecraft is in a circular orbit around a spherical planet. The radius of the orbit is three times the radius of the planet and the period of the spacecraft's orbit is 15 hours. If the acceleration due to gravity at the surface of the planet is 20 m/s$^2$, what is the radius of the planet (in km)?

(1) 54,713 (2) 47,661 (3) 62,252 (4) 45,202 (5) 77,815

9. A spacecraft is in a circular orbit around a spherical planet. The radius of the orbit is three times the radius of the planet and the period of the spacecraft's orbit is 16 hours. If the acceleration due to gravity at the surface of the planet is 20 m/s$^2$, what is the radius of the planet (in km)?

(1) 62,252 (2) 47,661 (3) 54,713 (4) 45,202 (5) 77,815

10. A race car starts from rest at $t = 0$ and travels around a circular track of radius $R$ with a constant angular acceleration. If the magnitude of the tangential acceleration of the car is equal to the magnitude of the radial acceleration (*i.e.,* centripetal acceleration) of the car at $t = 20$ s, how long does it take for the race car to complete its first revolution around the track (in min)?

(1) 1.18 (2) 1.77 (3) 2.36 (4) 1.00 (5) 3.00

11. A race car starts from rest at $t = 0$ and travels around a circular track of radius $R$ with a constant angular acceleration. If the magnitude of the tangential acceleration of the car is equal to the magnitude of the radial acceleration (*i.e.,* centripetal acceleration) of the car at $t = 30$ s, how long does it take for the race car to complete its first revolution around the track (in min)?

(1) 1.77 (2) 1.18 (3) 2.36 (4) 1.00 (5) 3.00

12. A race car starts from rest at $t = 0$ and travels around a circular track of radius $R$ with a constant angular acceleration. If the magnitude of the tangential acceleration of the car is equal to the magnitude of the radial acceleration (*i.e.,* centripetal acceleration) of the car at $t = 40$ s, how long does it take for the race car to complete its first revolution around the track (in min)?

(1) 2.36 (2) 1.18 (3) 1.77 (4) 1.00 (5) 3.00

13. A firecracker is tossed straight upward into the air. It explodes into three pieces (A, B, and C) of equal mass just as it reaches the highest point. If piece A moves off at a speed of 4 m/s and pieces B and C move off with equal speeds of 10 m/s, what is the angle between piece B and C?

(1) 156.9° (2) 132.8° (3) 91.1° (4) 73.7° (5) 62.5°

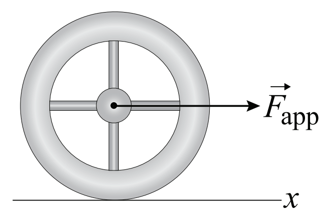
14. A firecracker is tossed straight upward into the air. It explodes into three pieces (A, B, and C) of equal mass just as it reaches the highest point. If piece A moves off at a speed of 8 m/s and pieces B and C move off with equal speeds of 10 m/s, what is the angle between piece B and C?

(1) 132.8° (2) 156.9° (3) 91.1° (4) 73.7° (5) 62.5°

15. A firecracker is tossed straight upward into the air. It explodes into three pieces (A, B, and C) of equal mass just as it reaches the highest point. If piece A moves off at a speed of 14 m/s and pieces B and C move off with equal speeds of 10 m/s, what is the angle between piece B and C?

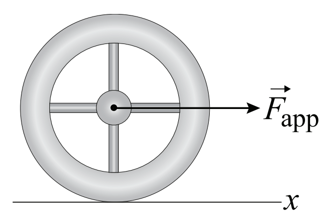
(1) 91.1° (2) 156.9° (3) 132.8° (4) 73.7° (5) 62.5°

16. Near the surface of the Earth a constant horizontal force $\vec{F}_{app}$ is applied to a wheel of radius $R$, mass $M$, and moment of inertia $I = \frac{4}{5}MR^2$ as shown in the figure. If the coefficient of static friction between the wheel and the horizontal floor is $\mu_s = 0.4$ and if the wheel rolls without slipping, what is the minimum time (in s) necessary for the wheel to start from rest and travel a horizontal distance of 10 meters?



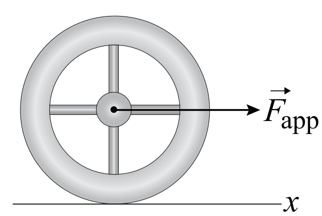

(1) 2.02 (2) 2.86 (3) 3.50 (4) 3.91 (5) 1.57

17. Near the surface of the Earth a constant horizontal force $\vec{F}_{app}$ is applied to a wheel of radius $R$, mass $M$, and moment of inertia $I = \frac{4}{5}MR^2$ as shown in the figure. If the coefficient of static friction between the wheel and the horizontal floor is $\mu_s = 0.4$ and if the wheel rolls without slipping, what is the minimum time (in s) necessary for the wheel to start from rest and travel a horizontal distance of 20 meters?




(1) 2.86 (2) 2.02 (3) 3.50 (4) 3.91 (5) 1.57

18. Near the surface of the Earth a constant horizontal force $\vec{F}_{app}$ is applied to a wheel of radius $R$, mass $M$, and moment of inertia $I = \frac{4}{5}MR^2$ as shown in the figure. If the coefficient of static friction between the wheel and the horizontal floor is $\mu_s = 0.4$ and if the wheel rolls without slipping, what is the minimum time (in s) necessary for the wheel to start from rest and travel a horizontal distance of 30 meters?




(1) 3.50 (2) 2.02 (3) 2.86 (4) 3.91 (5) 1.57

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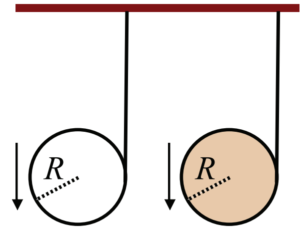
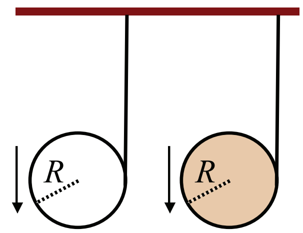
19. Near the surface of the Earth a cloth tape is wound around the outside of a thin uniform hoop with mass $M$, radius $R$, and moment of inertia $I_{\text{hoop}} = MR^2$. A cloth tape is also wound around the outside of a uniform cylinder with the same mass $M$ and the same radius $R$, but with moment of inertia $I_{\text{cylinder}} = MR^2/2$. Both the hoop and the cylinder are fastened to the ceiling as shown in the figure. They are both released from rest at $t = 0$ at the same distance from the ceiling. What is the vertical distance (in m) between the two objects at $t = 2$ s?



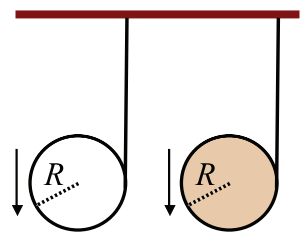

(1) 3.27 (2) 7.35 (3) 13.07 (4) 5.24 (5) 2.25

20. Near the surface of the Earth a cloth tape is wound around the outside of a thin uniform hoop with mass $M$, radius $R$, and moment of inertia $I_{\text{hoop}} = MR^2$. A cloth tape is also wound around the outside of a uniform cylinder with the same mass $M$ and the same radius $R$, but with moment of inertia $I_{\text{cylinder}} = MR^2/2$. Both the hoop and the cylinder are fastened to the ceiling as shown in the figure. They are both released from rest at $t = 0$ at the same distance from the ceiling. What is the vertical distance (in m) between the two objects at $t = 3$ s?



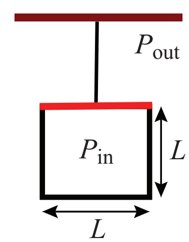

(1) 7.35 (2) 3.27 (3) 13.07 (4) 5.24 (5) 2.25

21. Near the surface of the Earth a cloth tape is wound around the outside of a thin uniform hoop with mass $M$, radius $R$, and moment of inertia $I_{\text{hoop}} = MR^2$. A cloth tape is also wound around the outside of a uniform cylinder with the same mass $M$ and the same radius $R$, but with moment of inertia $I_{\text{cylinder}} = MR^2/2$. Both the hoop and the cylinder are fastened to the ceiling as shown in the figure. They are both released from rest at $t = 0$ at the same distance from the ceiling. What is the vertical distance (in m) between the two objects at $t = 4$ s?



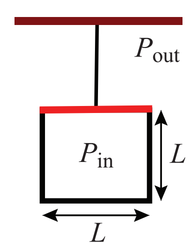

(1) 13.07 (2) 3.27 (3) 7.35 (4) 5.24 (5) 2.25

22. A cubical metal box with sides of mass $M$ and length $L$ has a square lid also with mass $M$ and length $L$. The lid is not attached to the box, however, the lid and the box form an airtight seal. Near the surface of the Earth, the lid is held at rest by a steel cable, as shown in the figure. The pressure outside the box is the atmospheric pressure, $P_{\text{out}} = P_{\text{atm}} = 101$ kPa. The box is partially evacuated to an inside pressure $P_{\text{in}} = 95$ kPa. If $L = 0.2$ m, what is the maximum mass $M$ (in kg) of the sides of the cubical metal box such that the box remains at rest and does not fall?



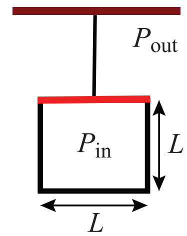

(1) 4.90 (2) 8.98 (3) 13.06 (4) 2.65 (5) 18.89

23. A cubical metal box with sides of mass $M$ and length $L$ has a square lid also with mass $M$ and length $L$. The lid is not attached to the box, however, the lid and the box form an airtight seal. Near the surface of the Earth, the lid is held at rest by a steel cable, as shown in the figure. The pressure outside the box is the atmospheric pressure, $P_{\text{out}} = P_{\text{atm}} = 101$ kPa. The box is partially evacuated to an inside pressure $P_{\text{in}} = 90$ kPa. If $L = 0.2$ m, what is the maximum mass $M$ (in kg) of the sides of the cubical metal box such that the box remains at rest and does not fall?




(1) 8.98 (2) 4.90 (3) 13.06 (4) 2.65 (5) 18.89

24. A cubical metal box with sides of mass $M$ and length $L$ has a square lid also with mass $M$ and length $L$. The lid is not attached to the box, however, the lid and the box form an airtight seal. Near the surface of the Earth, the lid is held at rest by a steel cable, as shown in the figure. The pressure outside the box is the atmospheric pressure, $P_{\text{out}} = P_{\text{atm}} = 101$ kPa. The box is partially evacuated to an inside pressure $P_{\text{in}} = 85$ kPa. If $L = 0.2$ m, what is the maximum mass $M$ (in kg) of the sides of the cubical metal box such that the box remains at rest and does not fall?




(1) 13.06 (2) 4.90 (3) 8.98 (4) 2.65 (5) 18.89

25. Stan and Ollie are standing next to a train track. Stan puts his ear to the steel track to hear the train coming. When the train is 750 m away, he hears the sound of the train whistle through the track 2.1 s before Ollie hears it through the air. If the speed of sound in steel is 5790 m/s, what is the temperature of the air (in °C)?

(1) 9.0 (2) 23.3 (3) 37.9 (4) 18.2 (5) 15.5

26. Stan and Ollie are standing next to a train track. Stan puts his ear to the steel track to hear the train coming. When the train is 770 m away, he hears the sound of the train whistle through the track 2.1 s before Ollie hears it through the air. If the speed of sound in steel is 5790 m/s, what is the temperature of the air (in °C)?

(1) 23.3 (2) 9.0 (3) 37.9 (4) 18.2 (5) 15.5

27. Stan and Ollie are standing next to a train track. Stan puts his ear to the steel track to hear the train coming. When the train is 790 m away, he hears the sound of the train whistle through the track 2.1 s before Ollie hears it through the air. If the speed of sound in steel is 5790 m/s, what is the temperature of the air (in °C)?

(1) 37.9 (2) 9.0 (3) 23.3 (4) 18.2 (5) 15.5

28. As a race car passes the spectators at rest on the side of the track, the frequency of the sound of the engine after passing is 0.5 times what it was before. How fast is the race car moving (in m/s)? (Take the speed of sound in the air to be 343 m/s.)

(1) 114.3 (2) 85.8 (3) 49.0 (4) 94.6 (5) 29.6

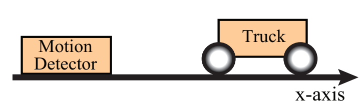
29. As a race car passes the spectators at rest on the side of the track, the frequency of the sound of the engine after passing is 0.6 times what it was before. How fast is the race car moving (in m/s)? (Take the speed of sound in the air to be 343 m/s.)

(1) 85.8 (2) 114.3 (3) 49.0 (4) 94.6 (5) 29.6

30. As a race car passes the spectators at rest on the side of the track, the frequency of the sound of the engine after passing is 0.75 times what it was before. How fast is the race car moving (in m/s)? (Take the speed of sound in the air to be 343 m/s.)

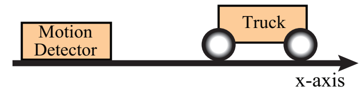
(1) 49.0 (2) 114.3 (3) 85.8 (4) 94.6 (5) 29.6

31. A stationary motion detector on the x-axis sends sound waves of frequency of 500 Hz, as shown in the figure. The waves sent out by the detector are reflected off a truck traveling along the x-axis and then are received back at the detector. If the frequency of the waves received back at the detector is 750 Hz, what is the x-component of the velocity of the truck (in m/s)? (Take the speed of sound to be 343 m/s.)



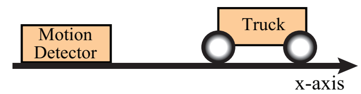

(1) −68.6 (2) 38.1 (3) 60.5 (4) 90.3 (5) 68.6

32. A stationary motion detector on the x-axis sends sound waves of frequency of 500 Hz, as shown in the figure. The waves sent out by the detector are reflected off a truck traveling along the x-axis and then are received back at the detector. If the frequency of the waves received back at the detector is 400 Hz, what is the x-component of the velocity of the truck (in m/s)? (Take the speed of sound to be 343 m/s.)




(1) 38.1 (2) −68.6 (3) 60.5 (4) 90.3 (5) −38.1

33. A stationary motion detector on the x-axis sends sound waves of frequency of 500 Hz, as shown in the figure. The waves sent out by the detector are reflected off a truck traveling along the x-axis and then are received back at the detector. If the frequency of the waves received back at the detector is 350 Hz, what is the x-component of the velocity of the truck (in m/s)? (Take the speed of sound to be 343 m/s.)




(1) 60.5 (2) −68.6 (3) 38.1 (4) 90.3 (5) −60.5

34. A string in a grand piano is 2.5 m long and has a mass density of 1.0 g/m. If the fundamental frequency of oscillations of the string is 440 Hz, what is the tension in the string (in N)?

(1) 4840 (2) 5808 (3) 6776 (4) 3098 (5) 2420

35. A string in a grand piano is 2.5 m long and has a mass density of 1.2 g/m. If the fundamental frequency of oscillations of the string is 440 Hz, what is the tension in the string (in N)?

(1) 5808 (2) 4840 (3) 6776 (4) 3098 (5) 2420

36. A string in a grand piano is 2.5 m long and has a mass density of 1.4 g/m. If the fundamental frequency of oscillations of the string is 440 Hz, what is the tension in the string (in N)?

(1) 6776 (2) 4840 (3) 5808 (4) 3098 (5) 2420

37. Near the surface of the Earth a man whose weight at rest is 180 N stands on a scale in an elevator that starts from rest and accelerates upward with a constant acceleration. If after the elevator has travelled a distance of 10 m its speed is 4 m/s, what is his weight (in N) on the scale in the elevator during his ride?

(1) 194.7 (2) 213.1 (3) 238.8 (4) 165.3 (5) 146.9

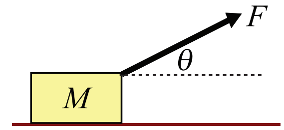
38. Near the surface of the Earth a man whose weight at rest is 180 N stands on a scale in an elevator that starts from rest and accelerates upward with a constant acceleration. If after the elevator has travelled a distance of 10 m its speed is 6 m/s, what is his weight (in N) on the scale in the elevator during his ride?

(1) 213.1 (2) 194.7 (3) 238.8 (4) 165.3 (5) 146.9

39. Near the surface of the Earth a man whose weight at rest is 180 N stands on a scale in an elevator that starts from rest and accelerates upward with a constant acceleration. If after the elevator has travelled a distance of 10 m its speed is 8 m/s, what is his weight (in N) on the scale in the elevator during his ride?

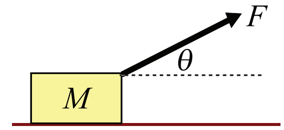
(1) 238.8 (2) 194.7 (3) 213.1 (4) 165.3 (5) 121.2

40. Near the surface of the Earth, a block of mass $M = 2$ kg is pulled along a horizontal surface at a constant speed by a constant force $F$ that is at an angle $\theta = 20°$ with the horizontal as shown in the figure. If the kinetic coefficient of friction between the block and the horizontal surface is $\mu_k = 0.5$, what is the magnitude of the normal force that the surface exerts on the block (in N)?



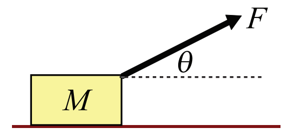

(1) 16.6 (2) 13.8 (3) 10.5 (4) 19.6 (5) 8.3

41. Near the surface of the Earth, a block of mass $M = 2$ kg is pulled along a horizontal surface at a constant speed by a constant force $F$ that is at an angle $\theta = 40°$ with the horizontal as shown in the figure. If the kinetic coefficient of friction between the block and the horizontal surface is $\mu_k = 0.5$, what is the magnitude of the normal force that the surface exerts on the block (in N)?



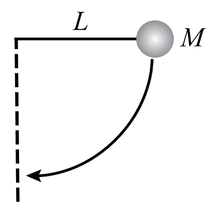

(1) 13.8 (2) 16.6 (3) 10.5 (4) 19.6 (5) 8.3

42. Near the surface of the Earth, a block of mass $M = 2$ kg is pulled along a horizontal surface at a constant speed by a constant force $F$ that is at an angle $\theta = 60°$ with the horizontal as shown in the figure. If the kinetic coefficient of friction between the block and the horizontal surface is $\mu_k = 0.5$, what is the magnitude of the normal force that the surface exerts on the block (in N)?



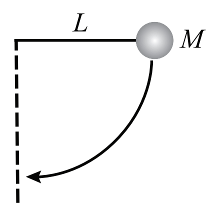

(1) 10.5 (2) 16.6 (3) 13.8 (4) 19.6 (5) 8.3

43. Near the surface of the Earth, a wrecking ball of mass $M$ 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 $2.0 \times 10^{11}$Pa. Ignoring the weight of the cable itself, if when the ball-cable system swings through vertical (*i.e.,* ball at its lowest point), the cable stretches 1.5 cm, what is the mass $M$ of the wrecking ball (in kg)?



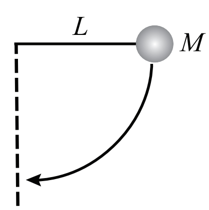

(1) 801.4 (2) 1068.6 (3) 1335.7 (4) 2404.3 (5) 3205.7

44. Near the surface of the Earth, a wrecking ball of mass $M$ 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 $2.0 \times 10^{11}$Pa. Ignoring the weight of the cable itself, if when the ball-cable system swings through vertical (*i.e.,* ball at its lowest point), the cable stretches 2.0 cm, what is the mass $M$ of the wrecking ball (in kg)?



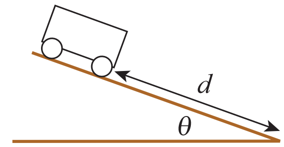

(1) 1068.6 (2) 801.4 (3) 1335.7 (4) 2404.3 (5) 3205.7

45. Near the surface of the Earth, a wrecking ball of mass $M$ 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 $2.0 \times 10^{11}$Pa. Ignoring the weight of the cable itself, if when the ball-cable system swings through vertical (*i.e.,* ball at its lowest point), the cable stretches 2.5 cm, what is the mass $M$ of the wrecking ball (in kg)?



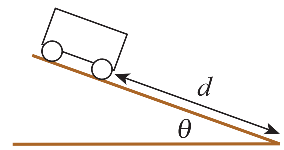

(1) 1335.7 (2) 801.4 (3) 1068.6 (4) 2404.3 (5) 4007.1

46. Near the surface of the Earth, a truck loses its brakes while rolling down a long straight grade making an angle $\theta$ with the horizontal as shown in the figure. If the truck is moving at 10 m/s when it is a distance $d = 400$ m (measured along the road) from the bottom of the hill, and the truck's speed is 50 m/s when it passes the bottom, what is the angle $\theta$? Ignore friction and air resistance.



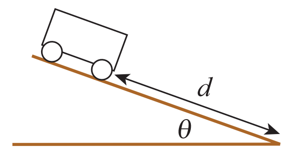

(1) 17.8° (2) 26.5° (3) 37.8° (4) 10.5° (5) 34.6°

47. Near the surface of the Earth, a truck loses its brakes while rolling down a long straight grade making an angle $\theta$ with the horizontal as shown in the figure. If the truck is moving at 10 m/s when it is a distance $d = 400$ m (measured along the road) from the bottom of the hill, and the truck's speed is 60 m/s when it passes the bottom, what is the angle $\theta$? Ignore friction and air resistance.




(1) 26.5° (2) 17.8° (3) 37.8° (4) 10.5° (5) 34.6°

48. Near the surface of the Earth, a truck loses its brakes while rolling down a long straight grade making an angle $\theta$ with the horizontal as shown in the figure. If the truck is moving at 10 m/s when it is a distance $d = 400$ m (measured along the road) from the bottom of the hill, and the truck's speed is 70 m/s when it passes the bottom, what is the angle $\theta$? Ignore friction and air resistance.




(1) 37.8° (2) 17.8° (3) 26.5° (4) 10.5° (5) 34.6°

49. Near the surface of the Earth a 600-kg elevator starts from rest at $t = 0$ and moves downward. The tension in the supporting cable is constant and equal to 5,000 N. What is the elevator's momentum (in kg·m/s) at time $t = 4$ s?

(1) 3,520 (2) 4,400 (3) 5,280 (4) 2,500 (5) 6,920

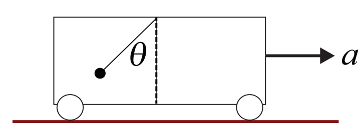
50. Near the surface of the Earth a 600-kg elevator starts from rest at $t = 0$ and moves downward. The tension in the supporting cable is constant and equal to 5,000 N. What is the elevator's momentum (in kg·m/s) at time $t = 5$ s?

(1) 4,400 (2) 3,520 (3) 5,280 (4) 2,500 (5) 6,920

51. Near the surface of the Earth a 600-kg elevator starts from rest at $t = 0$ and moves downward. The tension in the supporting cable is constant and equal to 5,000 N. What is the elevator's momentum (in kg·m/s) at time $t = 6$ s?

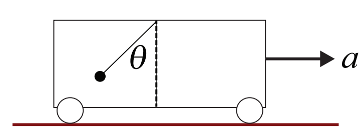
(1) 5,280 (2) 4,400 (3) 3,520 (4) 2,500 (5) 6,920

52. Consider a small metal ball with weight $W$ suspended by a very light string from the ceiling of a railway car near the surface of the Earth. The car has a constant acceleration of $a$ as shown in the figure, causing the mass to hang at an angle $\theta$ with the vertical. If the tension in the string is $2W$ (*i.e.,* twice the weight of the ball), what is the acceleration $a$ (in $m/s^2$) of the railway car?



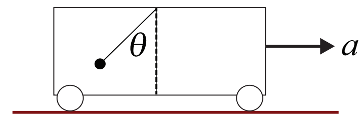

(1) 17.0 (2) 27.7 (3) 38.0 (4) 11.0 (5) 45.0

53. Consider a small metal ball with weight $W$ suspended by a very light string from the ceiling of a railway car near the surface of the Earth. The car has a constant acceleration of $a$ as shown in the figure, causing the mass to hang at an angle $\theta$ with the vertical. If the tension in the string is $3W$ (*i.e.,* three times the weight of the ball), what is the acceleration $a$ (in $m/s^2$) of the railway car?



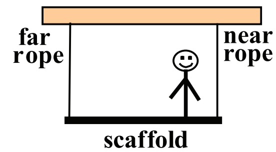

(1) 27.7 (2) 17.0 (3) 38.0 (4) 11.0 (5) 45.0

54. Consider a small metal ball with weight $W$ suspended by a very light string from the ceiling of a railway car near the surface of the Earth. The car has a constant acceleration of $a$ as shown in the figure, causing the mass to hang at an angle $\theta$ with the vertical. If the tension in the string is $4W$ (*i.e.,* four times the weight of the ball), what is the acceleration $a$ (in $m/s^2$) of the railway car?



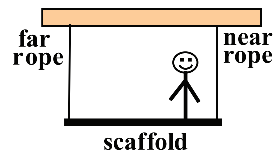

(1) 38.0 (2) 17.0 (3) 27.7 (4) 11.0 (5) 45.0

55. A billboard worker stands on a uniform scaffold with a weight of 500 N and length $L = 5$ m. The scaffold is supported by vertical ropes at each end as shown in the figure. If the worker stands 1.0 m from one end and the tension in the rope farthest from the worker is 390 N, what is the weight of the worker (in N)?



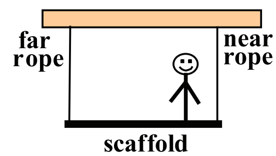

(1) 700 (2) 750 (3) 800 (4) 650 (5) 600

56. A billboard worker stands on a uniform scaffold with a weight of 500 N and length $L = 5$ m. The scaffold is supported by vertical ropes at each end as shown in the figure. If the worker stands 1.0 m from one end and the tension in the rope farthest from the worker is 400 N, what is the weight of the worker (in N)?




(1) 750 (2) 700 (3) 800 (4) 650 (5) 600

57. A billboard worker stands on a uniform scaffold with a weight of 500 N and length $L = 5$ m. The scaffold is supported by vertical ropes at each end as shown in the figure. If the worker stands 1.0 m from one end and the tension in the rope farthest from the worker is 410 N, what is the weight of the worker (in N)?




(1) 800 (2) 700 (3) 750 (4) 650 (5) 600

58. What is the maximum total mass (including the mass of the empty balloon) that a spherical helium balloon with a radius of 1.5 m can lift off the ground? The density of helium and the air are $\rho_{\mathrm{He}} = 0.18\ \mathrm{kg/m^3}$ and $\rho_{\mathrm{air}} = 1.2\ \mathrm{kg/m^3}$, respectively.

(1) 14.42 kg (2) 34.18 kg (3) 66.76 kg (4) 10.45 kg (5) 72.25 kg

59. What is the maximum total mass (including the mass of the empty balloon) that a spherical helium balloon with a radius of 2.0 m can lift off the ground? The density of helium and the air are $\rho_{\mathrm{He}} = 0.18\ \mathrm{kg/m^3}$ and $\rho_{\mathrm{air}} = 1.2\ \mathrm{kg/m^3}$, respectively.

(1) 34.18 kg (2) 14.42 kg (3) 66.76 kg (4) 10.45 kg (5) 72.25 kg

60. What is the maximum total mass (including the mass of the empty balloon) that a spherical helium balloon with a radius of 2.5 m can lift off the ground? The density of helium and the air are $\rho_{\mathrm{He}} = 0.18\ \mathrm{kg/m^3}$ and $\rho_{\mathrm{air}} = 1.2\ \mathrm{kg/m^3}$, respectively.

(1) 66.76 kg (2) 14.42 kg (3) 34.18 kg (4) 10.45 kg (5) 72.25 kg

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

77777

TYPE 20
Q# S 58
Q# S 59
Q# S 60