Instructor(s): *Field/Rinzler*

PHYSICS DEPARTMENT

PHY 2053 Exam 1 February 21, 2012

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.

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

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1. Suppose $A = BC$, where $A$ has the dimension $L/M$ and $C$ has the dimension $L/T$. Then $B$ has the dimension:

(1) $T/M$ (2) $L^2/(TM)$ (3) $TM/L^2$ (4) $L^2T/M$ (5) $M/(L^2T)$

2. John starts at the origin and walks 2.0 km due east. If he then walks 30° north of east for 8.0 km, what is his distance from the origin (in km)?

(1) 9.8 (2) 10.7 (3) 12.6 (4) 8.0 (5) 6.0

3. John starts at the origin and walks 3.0 km due east. If he then walks 30° north of east for 8.0 km, what is his distance from the origin (in km)?

(1) 10.7 (2) 9.8 (3) 12.6 (4) 11.0 (5) 5.0

4. John starts at the origin and walks 5.0 km due east. If he then walks 30° north of east for 8.0 km, what is his distance from the origin (in km)?

(1) 12.6 (2) 9.8 (3) 10.7 (4) 13.0 (5) 3.0

5. If vector $\vec{A} = 2\hat{x} - 2\hat{y}$ and vector $\vec{B} = 2\hat{x} + 5\hat{y}$, what is the magnitude of the vector $\vec{A} + \vec{B}$? Namely, what is $|\vec{A} + \vec{B}|$?

(1) 5 (2) 10 (3) 13 (4) 8 (5) 3

6. If vector $\vec{A} = 4\hat{x} - 3\hat{y}$ and vector $\vec{B} = 2\hat{x} - 5\hat{y}$, what is the magnitude of the vector $\vec{A} + \vec{B}$? Namely, what is $|\vec{A} + \vec{B}|$?

(1) 10 (2) 5 (3) 13 (4) 8 (5) 3

7. If vector $\vec{A} = 3\hat{x} - 2\hat{y}$ and vector $\vec{B} = 2\hat{x} - 10\hat{y}$, what is the magnitude of the vector $\vec{A} + \vec{B}$? Namely, what is $|\vec{A} + \vec{B}|$?

(1) 13 (2) 5 (3) 10 (4) 8 (5) 3

8. A car travels 50 kilometers at a constant speed of 10 km/h and then travels 100 kilometers at a constant speed of 40 km/h. What is the average speed of the car for this 150-km trip?

(1) 20 km/h (2) 24 km/h (3) 40 km/h (4) 15 km/h (5) 45 km/h

9. A car travels 50 kilometers at a constant speed of 10 km/h and then travels 100 kilometers at a constant speed of 80 km/h. What is the average speed of the car for this 150-km trip?

(1) 24 km/h (2) 20 km/h (3) 40 km/h (4) 15 km/h (5) 45 km/h

10. A car travels 50 kilometers at a constant speed of 20 km/h and then travels 100 kilometers at a constant speed of 80 km/h. What is the average speed of the car for this 150-km trip?

(1) 40 km/h (2) 20 km/h (3) 24 km/h (4) 15 km/h (5) 45 km/h

11. A beanbag is thrown horizontally from a dorm room window a height $h$ above the ground. It hits the ground a horizontal distance $d = 2h$ from the dorm directly below the window from which it was thrown. Ignoring air resistance, find the direction of the beanbag's velocity just before impact.

(1) 45.0° below the horizontal
(2) 76.0° below the horizontal
(3) 33.7° below the horizontal
(4) 63.4° below the horizontal
(5) 26.8° below the horizontal

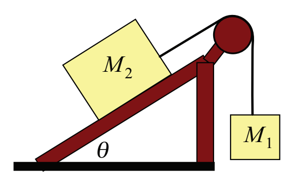
12. A beanbag is thrown horizontally from a dorm room window a height $h$ above the ground. It hits the ground a horizontal distance $d = h/2$ from the dorm directly below the window from which it was thrown. Ignoring air resistance, find the direction of the beanbag's velocity just before impact.

(1) 76.0° below the horizontal
(2) 45.0° below the horizontal
(3) 33.7° below the horizontal
(4) 63.4° below the horizontal
(5) 26.8° below the horizontal

13. A beanbag is thrown horizontally from a dorm room window a height $h$ above the ground. It hits the ground a horizontal distance $d = 3h$ from the dorm directly below the window from which it was thrown. Ignoring air resistance, find the direction of the beanbag's velocity just before impact.

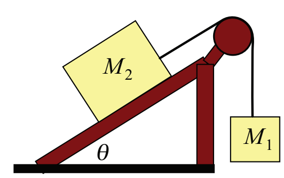
(1) 33.7° below the horizontal
(2) 76.0° below the horizontal
(3) 45.0° below the horizontal
(4) 63.4° below the horizontal
(5) 26.8° below the horizontal

14. A block of mass $M_2 = 3$ kg on a frictionless plane inclined at an angle $\theta$ is connected by a cord over a massless, frictionless pulley to a second block of mass $M_1 = 1$ kg, as shown in the figure. If the blocks remain at rest after they are released, what is the angle $\theta$?



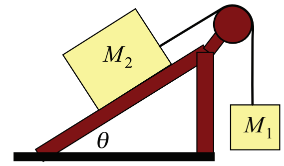

(1) 19.5° (2) 14.5° (3) 11.5° (4) 30.0° (5) 45.0°

15. A block of mass $M_2 = 4$ kg on a frictionless plane inclined at an angle $\theta$ is connected by a cord over a massless, frictionless pulley to a second block of mass $M_1 = 1$ kg, as shown in the figure. If the blocks remain at rest after they are released, what is the angle $\theta$?




(1) 14.5° (2) 19.5° (3) 11.5° (4) 30.0° (5) 45.0°

16. A block of mass $M_2 = 5$ kg on a frictionless plane inclined at an angle $\theta$ is connected by a cord over a massless, frictionless pulley to a second block of mass $M_1 = 1$ kg, as shown in the figure. If the blocks remain at rest after they are released, what is the angle $\theta$?




(1) 11.5° (2) 19.5° (3) 14.5° (4) 30.0° (5) 45.0°

17. An elevator of mass 600 kg starts from rest at $t = 0$ and moves downward. The tension in the supporting cable is constant, and between $t = 0$ and $t = 5$ s the elevator's displacement is 20 m. What is the tension in the supporting cable (in N)?

(1) 4920 (2) 4440 (3) 3960 (4) 5880 (5) 3670

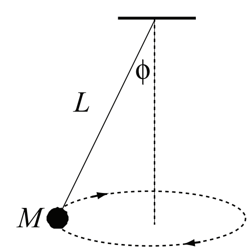
18. An elevator of mass 600 kg starts from rest at $t = 0$ and moves downward. The tension in the supporting cable is constant, and between $t = 0$ and $t = 5$ s the elevator's displacement is 30 m. What is the tension in the supporting cable (in N)?

(1) 4440 (2) 4920 (3) 3960 (4) 5880 (5) 3670

19. An elevator of mass 600 kg starts from rest at $t = 0$ and moves downward. The tension in the supporting cable is constant and between $t = 0$ and $t = 5$ s the elevator's displacement is 40 m. What is the tension in the supporting cable (in N)?

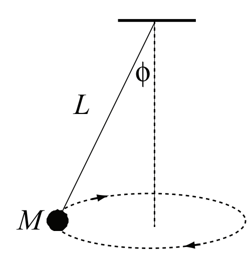
(1) 3960 (2) 4920 (3) 4440 (4) 5880 (5) 3670

20. A conical pendulum is constructed from a stone of mass $M$ connected to a cord with length $L$ and negligible mass. The stone is undergoing uniform circular motion in the horizontal plane as shown in the figure. If the cord makes an angle $\phi = 30°$ with the vertical direction and the period of the circular motion is 3 s, what is the length $L$ of the cord (in meters)?



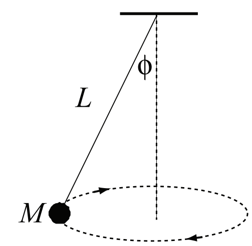

(1) 2.58 (2) 4.59 (3) 7.17 (4) 1.25 (5) 9.46

21. A conical pendulum is constructed from a stone of mass $M$ connected to a cord with length $L$ and negligible mass. The stone is undergoing uniform circular motion in the horizontal plane as shown in the figure. If the cord makes an angle $\phi = 30°$ with the vertical direction and the period of the circular motion is 4 s, what is the length $L$ of the cord (in meters)?



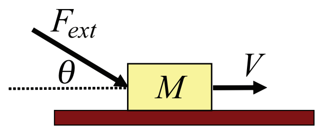

(1) 4.59 (2) 2.58 (3) 7.17 (4) 1.25 (5) 9.46

22. A conical pendulum is constructed from a stone of mass $M$ connected to a cord with length $L$ and negligible mass. The stone is undergoing uniform circular motion in the horizontal plane as shown in the figure. If the cord makes an angle $\phi = 30°$ with the vertical direction and the period of the circular motion is 5 s, what is the length $L$ of the cord (in meters)?



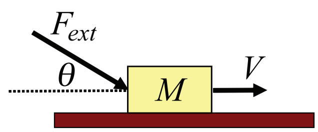

(1) 7.17 (2) 2.58 (3) 4.59 (4) 1.25 (5) 9.46

23. Near the surface of the Earth, a block of mass $M = 10$ kg is pushed along the floor at a constant speed $V$ by an external force $F_{ext} = 100$ N applied at a downward angle $\theta = 25°$ relative to the horizontal as shown in the figure. What is the coefficient of kinetic friction, $\mu_k$, between the block and the floor?



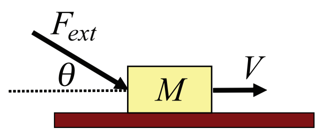

(1) 0.646 (2) 0.585 (3) 0.472 (4) 0.354 (5) 0.732

24. Near the surface of the Earth, a block of mass $M = 10$ kg is pushed along the floor at a constant speed $V$ by an external force $F_{ext} = 100$ N applied at a downward angle $\theta = 30°$ relative to the horizontal as shown in the figure. What is the coefficient of kinetic friction, $\mu_k$, between the block and the floor?




(1) 0.585 (2) 0.646 (3) 0.472 (4) 0.354 (5) 0.732

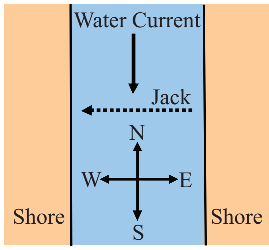
25. Near the surface of the Earth, a block of mass $M = 10$ kg is pushed along the floor at a constant speed $V$ by an external force $F_{ext} = 100$ N applied at a downward angle $\theta = 40°$ relative to the horizontal as shown in the figure. What is the coefficient of kinetic friction, $\mu_k$, between the block and the floor?




(1) 0.472 (2) 0.646 (3) 0.585 (4) 0.354 (5) 0.732

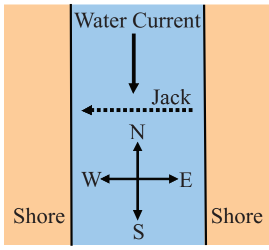
26. Jack wants to row directly across a river from the east shore to a point on the west shore, as shown in the figure. The width of the river is 250 m and the current flows from north to south at 0.5 m/s. The trip takes Jack 4 minutes. At what speed (in m/s) with respect to the still water is Jack able to row?

(1) 1.16
(2) 0.97
(3) 0.86
(4) 1.04
(5) 0.86

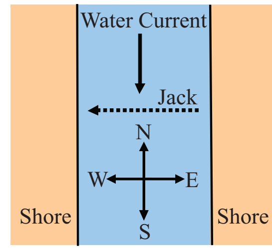



27. Jack wants to row directly across a river from the east shore to a point on the west shore, as shown in the figure. The width of the river is 250 m and the current flows from north to south at 0.5 m/s. The trip takes Jack 5 minutes. At what speed (in m/s) with respect to the still water is Jack able to row?

(1) 0.97
(2) 1.16
(3) 0.86
(4) 1.04
(5) 0.86



28. Jack wants to row directly across a river from the east shore to a point on the west shore, as shown in the figure. The width of the river is 250 m and the current flows from north to south at 0.5 m/s. The trip takes Jack 6 minutes. At what speed (in m/s) with respect to the still water is Jack able to row?




(1) 0.86
(2) 1.16
(3) 0.97
(4) 1.04
(5) 0.86

29. An astronaut is being tested in a centrifuge. The centrifuge has a radius $R$ and, in starting from rest at $t = 0$, rotates with a constant angular acceleration $\alpha = 0.25$ rad/s$^2$. What is the magnitude of the angular velocity, $\omega$, when the magnitude of the tangential acceleration is equal to the magnitude of the radial acceleration (*i.e.,* centripetal acceleration)?

(1) 0.5 rad/s (2) 0.3 rad/s (3) 0.4 rad/s (4) 2.0 rad/s (5) 4.0 rad/s

30. An astronaut is being tested in a centrifuge. The centrifuge has a radius $R$ and, in starting from rest at $t = 0$, rotates with a constant angular acceleration $\alpha = 0.09$ rad/s$^2$. What is the magnitude of the angular velocity, $\omega$, when the magnitude of the tangential acceleration is equal to the magnitude of the radial acceleration (*i.e.,* centripetal acceleration)?

(1) 0.3 rad/s (2) 0.5 rad/s (3) 0.4 rad/s (4) 2.0 rad/s (5) 4.0 rad/s

31. An astronaut is being tested in a centrifuge. The centrifuge has a radius $R$ and, in starting from rest at $t = 0$, rotates with a constant angular acceleration $\alpha = 0.16$ rad/s$^2$. What is the magnitude of the angular velocity, $\omega$, when the magnitude of the tangential acceleration is equal to the magnitude of the radial acceleration (*i.e.,* centripetal acceleration)?

(1) 0.4 rad/s (2) 0.5 rad/s (3) 0.3 rad/s (4) 2.0 rad/s (5) 4.0 rad/s

32. At what altitude (in km) above the Earth's surface would your weight be three-fourths of what it is at the Earth's surface? (Assume that the radius of the Earth is $R_E = 6,371$ km.)

(1) 985.6 (2) 1,431.8 (3) 2,639.0 (4) 7,356.6 (5) 786.2

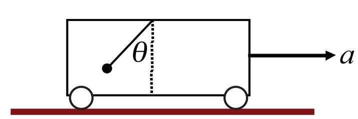
33. At what altitude (in km) above the Earth's surface would your weight be two-thirds of what it is at the Earth's surface? (Assume that the radius of the Earth is $R_E = 6,371$ km.)

(1) 1,431.8 (2) 985.6 (3) 2,639.0 (4) 7,356.6 (5) 786.2

34. At what altitude (in km) above the Earth's surface would your weight be one-half of what it is at the Earth's surface? (Assume that the radius of the Earth is $R_E = 6,371$ km.)

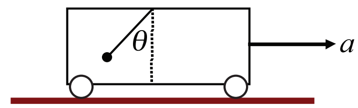
(1) 2,639.0 (2) 985.6 (3) 1,431.8 (4) 7,356.6 (5) 786.2

35. Consider a mass $M = 2$ kg 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 as shown in the figure, causing the mass to hang at an angle $\theta$ with the vertical. If the acceleration of the railway car is $a = 2$ m/s$^2$, what is the tension in the string (in N)?



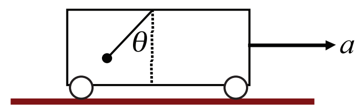

(1) 20.0 (2) 42.3 (3) 68.9 (4) 9.8 (5) 4.9

36. Consider a mass $M = 4$ kg 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 as shown in the figure, causing the mass to hang at an angle $\theta$ with the vertical. If the acceleration of the railway car is $a = 4$ m/s$^2$, what is the tension in the string (in N)?




(1) 42.3 (2) 20.0 (3) 68.9 (4) 9.8 (5) 4.9

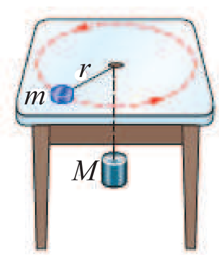
37. Consider a mass $M = 6$ kg suspended by a very light string from the ceiling of a railway car near the surface of the Earth. The car has a constant acceleration as shown in the figure, causing the mass to hang at an angle $\theta$ with the vertical. If the acceleration of the railway car is $a = 6$ m/s$^2$, what is the tension in the string (in N)?




(1) 68.9 (2) 20.0 (3) 42.3 (4) 9.8 (5) 4.9

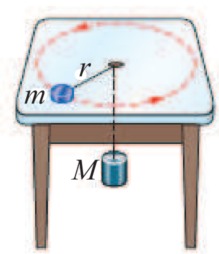
38. A puck of mass $m = 2$ kg slides in a circle of radius $r = 0.5$ m on a frictionless table while attached to a hanging cylinder of mass $M = 3$ kg by a cord through a hole in the table, as shown in the figure. What speed (in m/s) of the mass $m$ keeps the cylinder at rest?

(1) 2.71
(2) 3.13
(3) 3.50
(4) 2.21
(5) 4.32



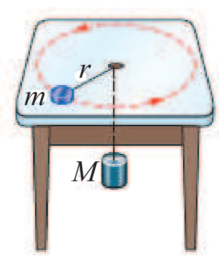

39. A puck of mass $m = 2$ kg slides in a circle of radius $r = 0.5$ m on a frictionless table while attached to a hanging cylinder of mass $M = 4$ kg by a cord through a hole in the table, as shown in the figure. What speed (in m/s) of the mass $m$ keeps the cylinder at rest?

(1) 3.13
(2) 2.71
(3) 3.50
(4) 2.21
(5) 4.32




40. A puck of mass $m = 2$ kg slides in a circle of radius $r = 0.5$ m on a frictionless table while attached to a hanging cylinder of mass $M = 5$ kg by a cord through a hole in the table, as shown in the figure. What speed (in m/s) of the mass $m$ keeps the cylinder at rest?

(1) 3.50
(2) 2.71
(3) 3.13
(4) 2.21
(5) 4.32




41. An elevator cable winds on a drum of radius 80.0 cm that is connected to a motor. If the elevator is moving down at 0.50 m/s, what is the angular speed of the drum?

(1) 0.625 rad/s (2) 0.75 rad/s (3) 0.875 rad/s (4) 0.50 rad/s (5) 0.80 rad/s

42. An elevator cable winds on a drum of radius 80.0 cm that is connected to a motor. If the elevator is moving down at 0.60 m/s, what is the angular speed of the drum?

(1) 0.75 rad/s (2) 0.625 rad/s (3) 0.875 rad/s (4) 0.50 rad/s (5) 0.80 rad/s

43. An elevator cable winds on a drum of radius 80.0 cm that is connected to a motor. If the elevator is moving down at 0.70 m/s, what is the angular speed of the drum?

(1) 0.875 rad/s (2) 0.625 rad/s (3) 0.75 rad/s (4) 0.50 rad/s (5) 0.80 rad/s

44. A highway curve has a radius of 150 m. At what angle should the road be banked so that a car traveling at 20 m/s has no tendency to skid sideways on the road? (Hint: No tendency to skid means the frictional force is zero.)

(1) 15.2° (2) 31.5° (3) 47.4° (4) 22.5° (5) 52.4°

45. A highway curve has a radius of 150 m. At what angle should the road be banked so that a car traveling at 30 m/s has no tendency to skid sideways on the road? (Hint: No tendency to skid means the frictional force is zero.)

(1) 31.5° (2) 15.2° (3) 47.4° (4) 22.5° (5) 52.4°

46. A highway curve has a radius of 150 m. At what angle should the road be banked so that a car traveling at 40 m/s has no tendency to skid sideways on the road? (Hint: No tendency to skid means the frictional force is zero.)

(1) 47.4° (2) 15.2° (3) 31.5° (4) 22.5° (5) 52.4°

47. Near the surface of the Earth a block is released from rest 10 m above the ground. If the kinetic energy of the block is 490 J when it hits the ground, what is the mass $M$ of the block (in kg)?

(1) 5.0 (2) 10.0 (3) 20.0 (4) 2.5 (5) 25.0

48. Near the surface of the Earth a block is released from rest 5 m above the ground. If the kinetic energy of the block is 490 J when it hits the ground, what is the mass $M$ of the block (in kg)?

(1) 10.0 (2) 5.0 (3) 20.0 (4) 2.5 (5) 25.0

49. Near the surface of the Earth a block is released from rest 5 m above the ground. If the kinetic energy of the block is 980 J when it hits the ground, what is the mass $M$ of the block (in kg)?

(1) 20.0 (2) 5.0 (3) 10.0 (4) 2.5 (5) 25.0

50. Ice fishing equipment weighing 3,000 N is pulled at a constant speed V = 0.5 m/s across a frozen lake by means of a horizontal rope. If the coefficient of kinetic friction is 0.05, what is the work done (in J) by the fisherman in pulling the equipment a distance of 500 m?

(1) $7.5 \times 10^4$ (2) $6.0 \times 10^4$ (3) $9.0 \times 10^4$ (4) $1.5 \times 10^4$ (5) $7.5 \times 10^5$

51. In the previous problem, what is the power output (in W) of the fisherman as he pulls the equipment across the frozen lake?

(1) 75 (2) 60 (3) 90 (4) 50 (5) 100

52. Ice fishing equipment weighing 3,000 N is pulled at a constant speed V = 0.5 m/s across a frozen lake by means of a horizontal rope. If the coefficient of kinetic friction is 0.04, what is the work done (in J) by the fisherman in pulling the equipment a distance of 500 m?

(1) $6.0 \times 10^4$ (2) $7.5 \times 10^4$ (3) $9.0 \times 10^4$ (4) $1.5 \times 10^4$ (5) $7.5 \times 10^5$

53. In the previous problem, what is the power output (in W) of the fisherman as he pulls the equipment across the frozen lake?

(1) 60 (2) 75 (3) 90 (4) 50 (5) 100

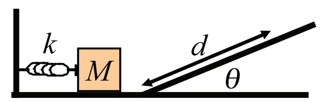
54. Ice fishing equipment weighing 3,000 N is pulled at a constant speed V = 0.5 m/s across a frozen lake by means of a horizontal rope. If the coefficient of kinetic friction is 0.06, what is the work done (in J) by the fisherman in pulling the equipment a distance of 500 m?

(1) $9.0 \times 10^4$ (2) $7.5 \times 10^4$ (3) $6.0 \times 10^4$ (4) $1.5 \times 10^4$ (5) $7.5 \times 10^5$

55. In the previous problem, what is the power output (in W) of the fisherman as he pulls the equipment across the frozen lake?

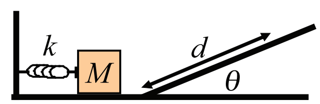
(1) 90 (2) 75 (3) 60 (4) 50 (5) 100

56. Near the surface of the Earth, an ideal spring with spring constant $k = 50$ N/m is on a frictionless horizontal surface at the base of a frictionless inclined plane as shown in the figure. A block with mass $M = 0.5$ kg is pressed against the spring, compressing it 0.5 m from its equilibrium position. The block is then released and is not attached to the spring. If the block slides a distance $d = 1.5$ m up the inclined plane before coming to rest and then sliding back down, what is the angle $\theta$ of the inclined plane relative to the horizontal?



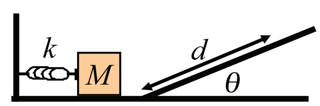

(1) 58.2° (2) 39.6° (3) 25.2° (4) 30.0° (5) 45.0°

57. Near the surface of the Earth, an ideal spring with spring constant $k = 50$ N/m is on a frictionless horizontal surface at the base of a frictionless inclined plane as shown in the figure. A block with mass $M = 0.5$ kg is pressed against the spring, compressing it 0.5 m from its equilibrium position. The block is then released and is not attached to the spring. If the block slides a distance $d = 2.0$ m up the inclined plane before coming to rest and then sliding back down, what is the angle $\theta$ of the inclined plane relative to the horizontal?




(1) 39.6° (2) 58.2° (3) 25.2° (4) 30.0° (5) 45.0°

58. Near the surface of the Earth, an ideal spring with spring constant $k = 50$ N/m is on a frictionless horizontal surface at the base of a frictionless inclined plane as shown in the figure. A block with mass $M = 0.5$ kg is pressed against the spring, compressing it 0.5 m from its equilibrium position. The block is then released and is not attached to the spring. If the block slides a distance $d = 3.0$ m up the inclined plane before coming to rest and then sliding back down, what is the angle $\theta$ of the inclined plane relative to the horizontal?




(1) 25.2° (2) 58.2° (3) 39.6° (4) 30.0° (5) 45.0°

THE FOLLOWING QUESTIONS, NUMBERED IN THE ORDER OF THEIR APPEARANCE ON THE ABOVE LIST, HAVE BEEN FLAGGED AS CONTINUATION QUESTIONS: 51 53 55 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 5
Q# S 6
Q# S 7
TYPE 3
Q# S 8
Q# S 9

Q# S 10
TYPE 4
Q# S 11
Q# S 12
Q# S 13
TYPE 5
Q# S 14
Q# S 15
Q# S 16
TYPE 6
Q# S 17
Q# S 18
Q# S 19
TYPE 7
Q# S 20
Q# S 21
Q# S 22
TYPE 8
Q# S 23
Q# S 24
Q# S 25
TYPE 9
Q# S 26
Q# S 27
Q# S 28
TYPE 10
Q# S 29
Q# S 30
Q# S 31
TYPE 11
Q# S 32
Q# S 33
Q# S 34
TYPE 12
Q# S 35
Q# S 36
Q# S 37
TYPE 13
Q# S 38
Q# S 39
Q# S 40
TYPE 14
Q# S 41
Q# S 42
Q# S 43
TYPE 15
Q# S 44
Q# S 45
Q# S 46
TYPE 16
Q# S 47
Q# S 48
Q# S 49
TYPE 17
Q# S 50 51
Q# S 52 53
Q# S 54 55
TYPE 18
Q# S 56
Q# S 57
Q# S 58