Instructor(s): *Field/Rinzler*

PHYSICS DEPARTMENT

PHY 2053 Exam 2 April 3, 2013

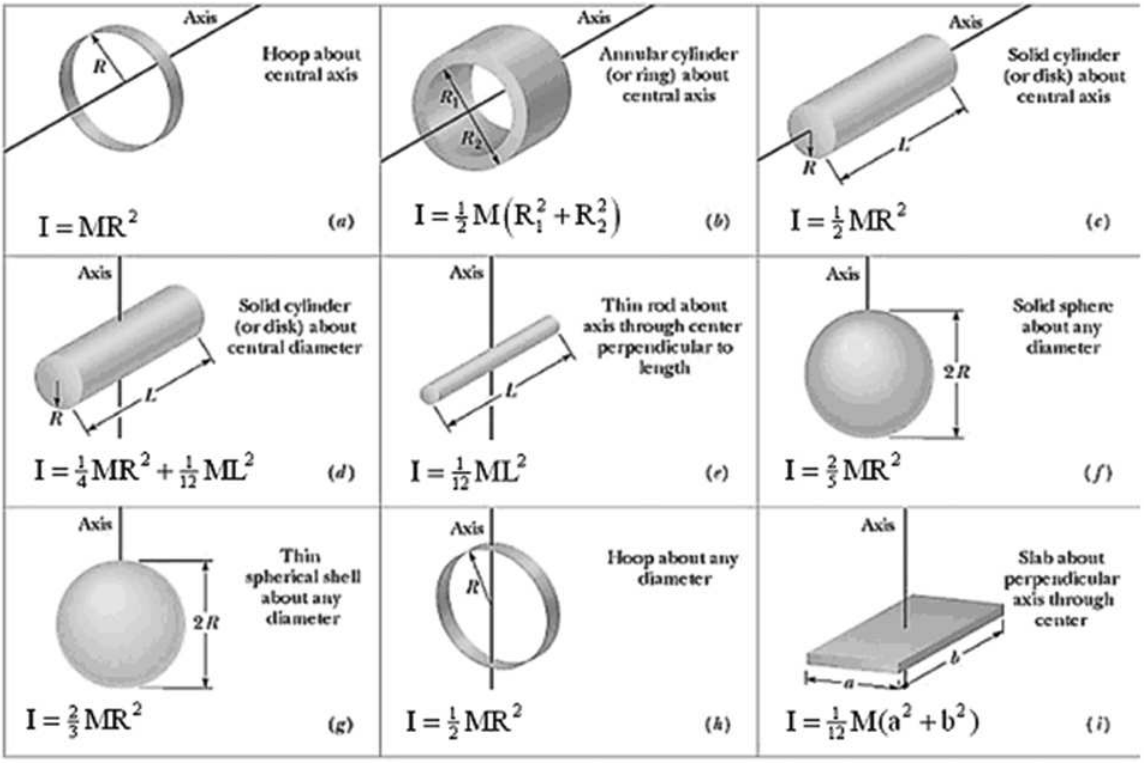
Name (print, last first): _____ Signature: _____

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



77777

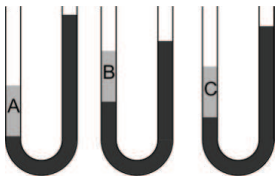
1. Which of the following statements are correct for an ideal spring-and-mass system that is undergoing simple harmonic motion (SHM). The kinetic energy is maximum when:
(A) the speed is maximum.
(B) the momentum is maximum.
(C) moving through the equilibrium position.
(D) the potential energy is minimum.

(1) all (2) only A (3) only A and B (4) all except C (5) all except D

2. A disk spinning about an axis perpendicular to its surface is to be used to store energy in the form of rotational kinetic energy. For a given maximum angular velocity the disk will store the most energy if:

(1) Most of the disk's mass is concentrated near its outermost rim.
(2) Most of the disk's mass is concentrated near its axis of rotation.
(3) Most of the disk's mass is half way between the axis and the rim.
(4) The mass of the disk is uniformly distributed over the entire disk.
(5) It doesn't matter; the rotational kinetic energy is independent of the mass.

3. Three identical U-tubes contain equal volumes of the dark fluid, D. Equal volumes of three different fluids A, B and C are poured into the U-tubes as shown in the figure (the dark fluid does not mix with any of the other fluids). Rank the density of the fluids from low to high.



(1) DBCA (2) ACBD (3) CBDA (4) BDCA (5) CABD

4. What is the mass of a particle (in kg) with a momentum of 2 kg·m/s and a kinetic energy of 4 J?

(1) 0.5 (2) 2.0 (3) 4.5 (4) 1.0 (5) 5.0

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

(1) 2.0 (2) 0.5 (3) 4.5 (4) 1.0 (5) 5.0

6. What is the mass of a particle (in kg) with a momentum of 6 kg·m/s and a kinetic energy of 4 J?

(1) 4.5 (2) 0.5 (3) 2.0 (4) 1.0 (5) 5.0

7. A tennis ball of mass 0.30 kg strikes a brick wall and bounces straight back along the incoming direction. The collision is neither completely elastic nor inelastic. The ball's incident speed is 40 m/s and the ball's return speed is 35 m/s. If the time over which the ball is in contact with the wall is 6 ms, what is the average force on the wall (in N) during the collision?

(1) 3750 (2) 5625 (3) 7500 (4) 250 (5) 375

8. A tennis ball of mass 0.45 kg strikes a brick wall and bounces straight back along the incoming direction. The collision is neither completely elastic nor inelastic. The ball's incident speed is 40 m/s and the ball's return speed is 35 m/s. If the time over which the ball is in contact with the wall is 6 ms, what is the average force on the wall (in N) during the collision?

(1) 5625 (2) 3750 (3) 7500 (4) 250 (5) 375

9. A tennis ball of mass 0.60 kg strikes a brick wall and bounces straight back along the incoming direction. The collision is neither completely elastic nor inelastic. The ball's incident speed is 40 m/s and the ball's return speed is 35 m/s. If the time over which the ball is in contact with the wall is 6 ms, what is the average force on the wall (in N) during the collision?

(1) 7500 (2) 3750 (3) 5625 (4) 250 (5) 375

10. A block of wood of mass M is initially at rest on a frictionless horizontal surface as shown in the figure. A bullet of mass 50 g traveling at 200 m/s strikes the block and becomes embedded in it. The block-bullet system slides along the surface and up a frictionless incline. If the maximum height above the surface the block-bullet system reaches before sliding back down the incline is $h = 0.5$ m, what is the mass M of the block of wood (in kg)?

(1) 3.14 (2) 2.21 (3) 1.79 (4) 0.76 (5) 5.32

11. A block of wood of mass M is initially at rest on a frictionless horizontal surface as shown in the figure. A bullet of mass 50 g traveling at 200 m/s strikes the block and becomes embedded in it. The block-bullet system slides along the surface and up a frictionless incline. If the maximum height above the surface the block-bullet system reaches before sliding back down the incline is $h = 1.0$ m, what is the mass M of the block of wood (in kg)?

(1) 2.21 (2) 3.14 (3) 1.79 (4) 0.76 (5) 5.32

12. A block of wood of mass M is initially at rest on a frictionless horizontal surface as shown in the figure. A bullet of mass 50 g traveling at 200 m/s strikes the block and becomes embedded in it. The block-bullet system slides along the surface and up a frictionless incline. If the maximum height above the surface the block-bullet system reaches before sliding back down the incline is $h = 1.5$ m, what is the mass M of the block of wood (in kg)?

(1) 1.79 (2) 3.14 (3) 2.21 (4) 0.76 (5) 5.32

13. Hercules (mass 130 kg) and his wife Deianeira (mass 60 kg) stand on (frictionless) ice separated by a distance d, with a light rope stretched between them. They both pull on the rope. If they meet a distance of 3.8 m from Hercules' original position, what is the distance d (in m)?

(1) 12 (2) 15 (3) 20 (4) 25 (5) 8

14. Hercules (mass 130 kg) and his wife Deianeira (mass 60 kg) stand on (frictionless) ice separated by a distance d, with a light rope stretched between them. They both pull on the rope. If they meet a distance of 4.7 m from Hercules' original position, what is the distance d (in m)?

(1) 15 (2) 12 (3) 20 (4) 25 (5) 8

15. Hercules (mass 130 kg) and his wife Deianeira (mass 60 kg) stand on (frictionless) ice separated by a distance d, with a light rope stretched between them. They both pull on the rope. If they meet a distance of 6.3 m from Hercules' original position, what is the distance d (in m)?

(1) 20 (2) 12 (3) 15 (4) 25 (5) 8

16. A cart of mass 0.30 kg is at rest on a frictionless air track. A second cart of mass 0.10 kg collides with the first and the two carts stick together moving off with a common speed of 0.5 m/s. What was the speed of the second cart (in m/s) just before it collided with the cart that was at rest?

(1) 2.0 (2) 2.4 (3) 2.8 (4) 0.5 (5) 0.75

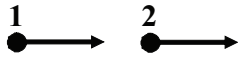
17. A cart of mass 0.30 kg is at rest on a frictionless air track. A second cart of mass 0.10 kg collides with the first and the two carts stick together moving off with a common speed of 0.6 m/s. What was the speed of the second cart (in m/s) just before it collided with the cart that was at rest?

(1) 2.4 (2) 2.0 (3) 2.8 (4) 0.5 (5) 0.75

18. A cart of mass 0.30 kg is at rest on a frictionless air track. A second cart of mass 0.10 kg collides with the first and the two carts stick together moving off with a common speed of 0.7 m/s. What was the speed of the second cart (in m/s) just before it collided with the cart that was at rest?

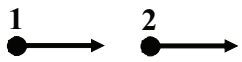
(1) 2.8 (2) 2.0 (3) 2.4 (4) 0.5 (5) 0.75

19. Two point particles move toward the right as shown in the figure. If particle 1 has mass M and speed v, and particle 2 has mass $2M$ and speed 2v, what is the speed of the center-of-mass of this two particle system?



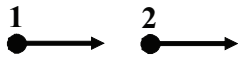
(1) 1.67v (2) 2.5v (3) 1.75v (4) 2v (5) 0.5v

20. Two point particles move toward the right as shown in the figure. If particle 1 has mass M and speed v, and particle 2 has mass $3M$ and speed 3v, what is the speed of the center-of-mass of this two particle system?



(1) 2.5v (2) 1.67v (3) 1.75v (4) 2v (5) 0.5v

21. Two point particles move toward the right as shown in the figure. If particle 1 has mass M and speed v, and particle 2 has mass $3M$ and speed 2v, what is the speed of the center-of-mass of this two particle system?



(1) 1.75v (2) 2.5v (3) 1.67v (4) 2v (5) 0.5v

22. At time $t = 0$ a 2-kg particle is located at $\vec{r} = (2m)\hat{x} + (4m)\hat{y}$, and its velocity is $\vec{v} = -(6m/s)\hat{x}$, and it is subject to the force $\vec{F} = (8N)\hat{y}$, where $\hat{x}$ and $\hat{y}$ are unit vectors in the x and y-direction, respectively. What is the magnitude of the angular momentum of the particle about the origin at $t = 0$?

(1) 48 kg·m^2/s (2) 56 kg·m^2/s (3) 64 kg·m^2/s (4) 24 kg·m^2/s (5) 16 kg·m^2/s

23. At time $t = 0$ a 2-kg particle is located at $\vec{r} = (2m)\hat{x} + (4m)\hat{y}$, and its velocity is $\vec{v} = -(7m/s)\hat{x}$, and it is subject to the force $\vec{F} = (8N)\hat{y}$, where $\hat{x}$ and $\hat{y}$ are unit vectors in the x and y-direction, respectively. What is the magnitude of the angular momentum of the particle about the origin at $t = 0$?

(1) 56 kg·m^2/s (2) 48 kg·m^2/s (3) 64 kg·m^2/s (4) 24 kg·m^2/s (5) 16 kg·m^2/s

24. At time $t = 0$ a 2-kg particle is located at $\vec{r} = (2m)\hat{x} + (4m)\hat{y}$, and its velocity is $\vec{v} = -(8m/s)\hat{x}$, and it is subject to the force $\vec{F} = (8N)\hat{y}$, where $\hat{x}$ and $\hat{y}$ are unit vectors in the x and y-direction, respectively. What is the magnitude of the angular momentum of the particle about the origin at $t = 0$?

(1) 64 kg·m^2/s (2) 56 kg·m^2/s (3) 48 kg·m^2/s (4) 24 kg·m^2/s (5) 16 kg·m^2/s

25. A turntable must spin at 33.3 rpm to play an old-fashioned vinyl record. How much constant torque (in N·m) must the motor deliver if the turntable is to reach its final angular speed in 2 revolutions, starting from rest? The turntable is a uniform disk of radius 15 cm and mass 0.16 kg.

(1) 8.71×10^{-4} (2) 5.81×10^{-4} (3) 4.35×10^{-4} (4) 2.37×10^{-3} (5) 1.16×10^{-3}

26. In the previous problem, how much work (in mJ) must the motor do if the turntable is to reach its final angular speed in 2 revolutions, starting from rest?

(1) 10.9 (2) 8.5 (3) 5.4 (4) 21.8 (5) 2.9

27. A turntable must spin at 33.3 rpm to play an old-fashioned vinyl record. How much constant torque (in N·m) must the motor deliver if the turntable is to reach its final angular speed in 3 revolutions, starting from rest? The turntable is a uniform disk of radius 15 cm and mass 0.16 kg.

(1) 5.81×10^{-4} (2) 8.71×10^{-4} (3) 4.35×10^{-4} (4) 2.37×10^{-3} (5) 1.16×10^{-3}

28. In the previous problem, how much work (in mJ) must the motor do if the turntable is to reach its final angular speed in 3 revolutions, starting from rest?

(1) 10.9 (2) 8.5 (3) 5.4 (4) 21.8 (5) 2.9

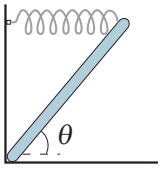
29. A turntable must spin at 33.3 rpm to play an old-fashioned vinyl record. How much constant torque (in N·m) must the motor deliver if the turntable is to reach its final angular speed in 4 revolutions, starting from rest? The turntable is a uniform disk of radius 15 cm and mass 0.16 kg.

(1) 4.35×10^{-4} (2) 8.71×10^{-4} (3) 5.81×10^{-4} (4) 2.37×10^{-3} (5) 1.16×10^{-3}

30. In the previous problem, how much work (in mJ) must the motor do if the turntable is to reach its final angular speed in 4 revolutions, starting from rest?

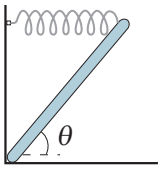
(1) 10.9 (2) 8.5 (3) 5.4 (4) 21.8 (5) 2.9

31. A modern sculpture has a large horizontal spring, that is attached to a 60-kg piece of uniform metal at its end and holds the metal at rest at an angle of θ above the horizontal direction as shown in the figure. The other end of the metal is wedged into a corner and is free to rotate. If the spring is stretched 0.2 m and is the spring constant $k = 1,752$ N/m, what is the angle θ?



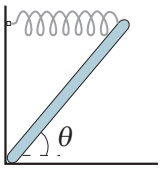
(1) 40° (2) 50° (3) 60° (4) 45° (5) 30°

32. A modern sculpture has a large horizontal spring, that is attached to a 60-kg piece of uniform metal at its end and holds the metal at rest at an angle of θ above the horizontal direction as shown in the figure. The other end of the metal is wedged into a corner and is free to rotate. If the spring is stretched 0.2 m and is the spring constant $k = 1,233$ N/m, what is the angle θ?



(1) 50° (2) 40° (3) 60° (4) 45° (5) 30°

33. A modern sculpture has a large horizontal spring, that is attached to a 60-kg piece of uniform metal at its end and holds the metal at rest at an angle of θ above the horizontal direction as shown in the figure. The other end of the metal is wedged into a corner and is free to rotate. If the spring is stretched 0.2 m and is the spring constant $k = 849$ N/m, what is the angle θ?



(1) 60° (2) 50° (3) 40° (4) 45° (5) 30°

34. An airtight box, having a lid of area 80 cm^2, is partially evacuated to 75% 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) 202 (2) 404 (3) 606 (4) 101 (5) 808

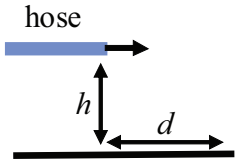
35. An airtight box, having a lid of area 80 cm^2, is partially evacuated to 50% of the atmospheric pressure. The atmospheric pressure is 1.01×10^5Pa. What is the minimum force required to pull the lid off of the box (in N)?

(1) 404 (2) 202 (3) 606 (4) 101 (5) 808

36. An airtight box, having a lid of area 80 cm^2, is partially evacuated to 25% 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)?

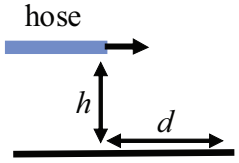
(1) 606 (2) 404 (3) 202 (4) 101 (5) 808

37. A garden hose of inner radius 0.6 cm carries water at 1.8 m/s. The nozzle at the end has radius R and is held in a horizontal position a height of $h = 2$ m above the level ground as shown in the figure. If the water hits the ground a horizontal distance $d = 4.60$ m from the nozzle, what is the radius R (in cm)?



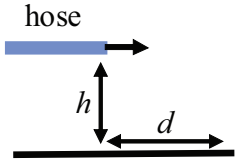
(1) 0.30 (2) 0.25 (3) 0.35 (4) 0.10 (5) 0.60

38. A garden hose of inner radius 0.6 cm carries water at 1.8 m/s. The nozzle at the end has radius R and is held in a horizontal position a height of $h = 2$ m above the level ground as shown in the figure. If the water hits the ground a horizontal distance $d = 6.62$ m from the nozzle, what is the radius R (in cm)?



(1) 0.25 (2) 0.30 (3) 0.35 (4) 0.10 (5) 0.60

39. A garden hose of inner radius 0.6 cm carries water at 1.8 m/s. The nozzle at the end has radius R and is held in a horizontal position a height of $h = 2$ m above the level ground as shown in the figure. If the water hits the ground a horizontal distance $d = 3.38$ m from the nozzle, what is the radius R (in cm)?



(1) 0.35 (2) 0.25 (3) 0.30 (4) 0.10 (5) 0.60

40. When a stone of weight $W = 24$ N is suspended from a scale and submerged in water the scale reads 9 N. If the density of oil is 0.8 the density of the water (*i.e.*, $\rho_{\text{oil}} = 0.8\rho_{\text{water}}$), what does the scale read (in N) when the same stone is suspended from a scale and submerged in oil?

(1) 12 (2) 17 (3) 18 (4) 10 (5) 20

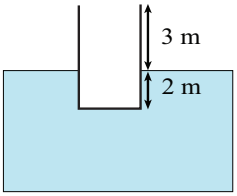
41. When a stone of weight $W = 32$ N is suspended from a scale and submerged in water the scale reads 12 N. If the density of oil is 0.75 the density of the water (*i.e.*, $\rho_{\text{oil}} = 0.75\rho_{\text{water}}$), what does the scale read (in N) when the same stone is suspended from a scale and submerged in oil?

(1) 17 (2) 12 (3) 18 (4) 10 (5) 20

42. When a stone of weight $W = 45$ N is suspended from a scale and submerged in water the scale reads 15 N. If the density of oil is 0.9 the density of the water (*i.e.,* $\rho_{\text{oil}} = 0.9\rho_{\text{water}}$), what does the scale read (in N) when the same stone is suspended from a scale and submerged in oil?

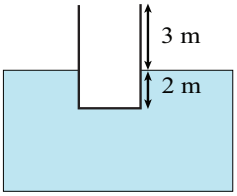
(1) 18 (2) 12 (3) 17 (4) 10 (5) 20

43. A large cargo container has a square base with an area of 4 m^2 and height $H = 5$ m. When empty it floats on the water ($\rho_{\text{water}} = 1,000$ kg/m^3) with 3 meters above the surface of the water and 2 m below the surface as shown in the figure. The cargo container is being loaded with small 50-kg boxes. What is the maximum number of boxes the cargo container can hold without sinking?



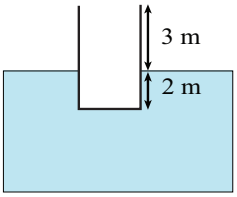
(1) 240 (2) 300 (3) 200 (4) 150 (5) 400

44. A large cargo container has a square base with an area of 4 m^2 and height $H = 5$ m. When empty it floats on the water ($\rho_{\text{water}} = 1,000$ kg/m^3) with 3 meters above the surface of the water and 2 m below the surface as shown in the figure. The cargo container is being loaded with small 40-kg boxes. What is the maximum number of boxes the cargo container can hold without sinking?



(1) 300 (2) 240 (3) 200 (4) 150 (5) 400

45. A large cargo container has a square base with an area of 4 m^2 and height $H = 5$ m. When empty it floats on the water ($\rho_{\text{water}} = 1,000$ kg/m^3) with 3 meters above the surface of the water and 2 m below the surface as shown in the figure. The cargo container is being loaded with small 60-kg boxes. What is the maximum number of boxes the cargo container can hold without sinking?



(1) 200 (2) 240 (3) 300 (4) 150 (5) 400

46. A marble statue of volume 2.5 m^3 is being transported from New York to England by ship. The statue falls into the ocean and ends up on the ocean floor, a distance d below the surface. If the bulk modulus of marble is 70×10^9Pa and the density of sea water is 1,025 kg/m^3 and the decrease in volume of the statue due to the pressure of the water is 431 cm^3, what is the depth d of the statue below the surface (in km)?

(1) 1.2 (2) 1.4 (3) 1.6 (4) 1.0 (5) 1.8

47. A marble statue of volume 2.5 m^3 is being transported from New York to England by ship. The statue falls into the ocean and ends up on the ocean floor, a distance d below the surface. If the bulk modulus of marble is 70×10^9Pa and the density of sea water is 1,025 kg/m^3 and the decrease in volume of the statue due to the pressure of the water is 502 cm^3, what is the depth d of the statue below the surface (in km)?

(1) 1.4 (2) 1.2 (3) 1.6 (4) 1.0 (5) 1.8

48. A marble statue of volume 2.5 m^3 is being transported from New York to England by ship. The statue falls into the ocean and ends up on the ocean floor, a distance d below the surface. If the bulk modulus of marble is 70×10^9Pa and the density of sea water is 1,025 kg/m^3 and the decrease in volume of the statue due to the pressure of the water is 574 cm^3, what is the depth d of the statue below the surface (in km)?

(1) 1.6 (2) 1.2 (3) 1.4 (4) 1.0 (5) 1.8

49. As indicated in the figure, a cart of mass M is tied between two ideal springs with spring constants, k_1 and k_2, respectively. If $k_1 = k_2 = 10$ N/m, the cart oscillates with angular frequency ω. If the spring constants are changed to $k_1 = 50$ N/m and $k_2 = 30$ N/m, what is the new angular frequency of the oscillation?

(1) 2ω (2) 3ω (3) 4ω (4) 5ω (5) 9ω

50. As indicated in the figure, a cart of mass M is tied between two ideal springs with spring constants, k_1 and k_2, respectively. If $k_1 = k_2 = 10$ N/m, the cart oscillates with angular frequency ω. If the spring constants are changed to $k_1 = 100$ N/m and $k_2 = 80$ N/m, what is the new angular frequency of the oscillation?

(1) 3ω (2) 2ω (3) 4ω (4) 5ω (5) 9ω

51. As indicated in the figure, a cart of mass M is tied between two ideal springs with spring constants, k_1 and k_2, respectively. If $k_1 = k_2 = 10$ N/m, the cart oscillates with angular frequency ω. If the spring constants are changed to $k_1 = 200$ N/m and $k_2 = 120$ N/m, what is the new angular frequency of the oscillation?

(1) 4ω (2) 2ω (3) 3ω (4) 5ω (5) 9ω

52. An ideal spring-and-mass system is undergoing simple harmonic motion (SHM). If the speed of the block is 1.0 m/s when the displacement from equilibrium is 2.0 m, and the speed of the block is 3.0 m/s when the displacement from equilibrium is 1.0 m, what is the period of the oscillations (in s)?

(1) 3.85 (2) 2.81 (3) 2.22 (4) 1.65 (5) 4.95

53. An ideal spring-and-mass system is undergoing simple harmonic motion (SHM). If the speed of the block is 1.0 m/s when the displacement from equilibrium is 2.0 m, and the speed of the block is 4.0 m/s when the displacement from equilibrium is 1.0 m, what is the period of the oscillations (in s)?

(1) 2.81 (2) 3.85 (3) 2.22 (4) 1.65 (5) 4.95

54. An ideal spring-and-mass system is undergoing simple harmonic motion (SHM). If the speed of the block is 1.0 m/s when the displacement from equilibrium is 2.0 m, and the speed of the block is 5.0 m/s when the displacement from equilibrium is 1.0 m, what is the period of the oscillations (in s)?

(1) 2.22 (2) 3.85 (3) 2.81 (4) 1.65 (5) 4.95

THE FOLLOWING QUESTIONS, NUMBERED IN THE ORDER OF THEIR APPEARANCE ON THE ABOVE LIST, HAVE BEEN FLAGGED AS CONTINUATION QUESTIONS: 26 28 30 FOLLOWING GROUPS OF QUESTIONS WILL BE SELECTED AS ONE GROUP FROM EACH TYPE

TYPE 1
Q# S 4
Q# S 5
Q# S 6
TYPE 2
Q# S 7
Q# S 8
Q# S 9
TYPE 3
Q# S 10
Q# S 11
Q# S 12
TYPE 4
Q# S 13
Q# S 14
Q# S 15

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