Instructor(s): Field/Rinzler

PHYSICS DEPARTMENT

PHY 2053 Exam 2 April 4, 2012

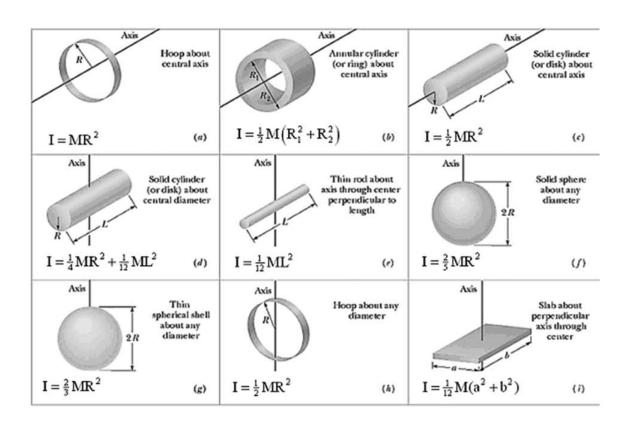
Name (print, last first):	Signature:

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.

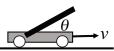
- (1) Code your test number on your answer sheet (use lines 76–80 on the answer sheet for the 5-digit number). Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. Code your UFID number on your answer sheet.
- (2) Print your name on this sheet and sign it also.
- (3) Do all scratch work 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 <u>blue</u> or <u>black</u> 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 $g = 9.80 \text{ m/s}^2$



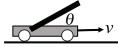
1.	What is the mass (in kg) of a particle with a momentum of 4 kg·m/s and kinetic energy equal to 5 J?							
	(1) 1.6	(2) 3.6	(3) 6.4	(4) 0.8	(5) 7.2			
2.	what is the mass (in kg) of a particle with a momentum of 6 kg·m/s and kinetic energy equal to 5 J?							
	(1) 3.6	(2) 1.6	(3) 6.4	(4) 0.8	(5) 7.2			
3.	What is the mass (in k	g) of a particle with a n	nomentum of 8 kg·m/s ε	and kinetic energy equal	to 5 J?			
	(1) 6.4	(2) 1.6	(3) 3.6	(4) 0.8	(5) 7.2			
4.	clay first touches the w	0.30 kg is thrown straig all until it has stopped all (in N) during this col	deforming is 6 ms, after	a speed of 22 m/s. The transition which the lump sticks	ime taken from when the to the wall. What is the			
	(1) 1100	(2) 1650	(3) 2200	(4) 800	(5) 700			
5.	clay first touches the w		deforming is 6 ms, after		ime taken from when the to the wall. What is the			
	(1) 1650	(2) 1100	(3) 2200	(4) 800	(5) 700			
6.	clay first touches the w	0.60 kg is thrown straig all until it has stopped all (in N) during this col	deforming is 6 ms, after	a speed of 22 m/s. The transition which the lump sticks	ime taken from when the to the wall. What is the			
	(1) 2200	(2) 1650	(3) 1100	(4) 800	(5) 700			
7.	strikes the block and b along the surface and	ne figure. A bullet of mecomes embedded in it. up a frictionless incline.	rest on a frictionless homass 50 g traveling at 1 The block-bullet syster What is the maximum tem reaches before sliding	00 m/s m slides n height → ■	θ			
	(1) 1.16	(2) 2.60	(3) 4.63	(4) 0.76	(5) 5.32			
8.	strikes the block and b along the surface and	ne figure. A bullet of mecomes embedded in it. up a frictionless incline.	rest on a frictionless homass 50 g traveling at 1 The block-bullet syster What is the maximum mem reaches before sliding	50 m/s m slides n height	θ			
	(1) 2.60	(2) 1.16	(3) 4.63	(4) 0.76	(5) 5.32			
9.	strikes the block and b along the surface and	ne figure. A bullet of mecomes embedded in it. up a frictionless incline.	rest on a frictionless homass 50 g traveling at 2 The block-bullet syster What is the maximum mem reaches before slidin (3) 2.60	000 m/s m slides n height •→ ■	(5) 5.32			

777	777						
10.	0. 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 150 m/s at an angle of θ above the horizontal as shown in the figure. The cannon plus railway car have a mass of 5,000 kg. If the cannon and one cannon ball are travelling to the right on the railway car a speed of $v=2$ m/s, at what angle θ must the cannon be fired in order to bring the railway car to rest? Assume that the track is horizontal and there is no friction.						
	(1) 48.2°	$(2) 60.0^{\circ}$	$(3)\ 36.9^{\circ}$	$(4) \ 45.0^{\circ}$			
11.	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 200 m/s at an angle of θ above the horizontal as shown in the figure. The cannon plus railway car have a mass of 5,000 kg. If the cannon and one cannon ball are travelling to the right on the railway car a speed of $v = 2$ m/s,						



 $(5)\ 28.5^{\circ}$

at what angle θ must the cannon be fired in order to bring the railway car to rest? Assume that the track is horizontal and there is no friction.



 $(1) 60.0^{\circ}$

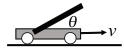
 $(2) 48.2^{\circ}$

 $(3) 36.9^{\circ}$

 $(4) 45.0^{\circ}$

 $(5)\ 28.5^{\circ}$

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 125 m/s at an angle of θ above the horizontal as shown in the figure. The cannon plus railway car have a mass of 5,000 kg. If the cannon and one cannon ball are travelling to the right on the railway car a speed of v = 2 m/s, at what angle θ must the cannon be fired in order to bring the railway car to rest? Assume that the track is horizontal and there is no friction.



 $(1) 36.9^{\circ}$

 $(2) 48.2^{\circ}$

 $(3) 60.0^{\circ}$

 $(4) 45.0^{\circ}$

 $(5)\ 28.5^{\circ}$

13. A point particle with mass 2M is traveling to the right along the x-axis at speed V and another point particle with mass M is traveling the left along the x-axis at the same speed V. If V = 12 m/s, what is the speed (in m/s) of the center-of-mass of the two-particle system? (Remember that the total momentum of the system can be written as $\vec{P}_{tot} = M_{tot} \vec{V}_{COM}$, where M_{tot} is the total mass of the system.)

(1) 4

 $(2)\ 5$

(3) 6

 $(4) \ 3$

 $(5)\ 10$

14. A point particle with mass 2M is traveling to the right along the x-axis at speed V and another point particle with mass M is traveling the left along the x-axis at the same speed V. If V=15 m/s, what is the speed (in m/s) of the center-of-mass of the two-particle system? (Remember that the total momentum of the system can be written as $\vec{P}_{tot} = M_{tot} \vec{V}_{COM}$, where M_{tot} is the total mass of the system.)

 $(1)\ 5$

(2) 4

(3) 6

 $(4) \ 3$

 $(5)\ 10$

15. A point particle with mass 2M is traveling to the right along the x-axis at speed V and another point particle with mass M is traveling the left along the x-axis at the same speed V. If V = 18 m/s, what is the speed (in m/s) of the center-of-mass of the two-particle system? (Remember that the total momentum of the system can be written as $\vec{P}_{tot} = M_{tot} \vec{V}_{COM}$, where M_{tot} is the total mass of the system.)

(1) 6

(2) 4

 $(3)\ 5$

 $(4) \ 3$

 $(5)\ 10$

16. Hercules (mass 130 kg) and his wife Deianeira (mass 60 kg) stand on (frictionless) ice separated by 12 meters, with a light rope stretched between them. They both pull on the rope. At what distance (in m) from Hercules' original position do they meet?

(1) 3.8

(2) 4.7

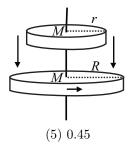
(3) 6.3

(4) 2.5

(5) 0

17.	Hercules (mass 130 kg) light rope stretched bet do they meet?	and his wife Deianeira ween them. They both p	(mass 60 kg) stand on pull on the rope. At what	(frictionless) ice separa at distance (in m) from I	ted by 15 meters, with a Hercules' original position	
	(1) 4.7	(2) 3.8	(3) 6.3	(4) 2.5	(5) 0	
18.					ted by 20 meters, with a Hercules' original position	
	(1) 6.3	(2) 3.8	(3) 4.7	$(4) \ 2.5$	$(5) \ 0$	
19.	0. A 1000 kg piece of space debris has velocity $(10m/s)\hat{y}$ when it collides with a second piece of space debris of mass 2500 kg and moving with velocity $(5m/s)\hat{x}$, where \hat{x} and \hat{y} are unit vectors in the x and y-direction, respectively. If after the collision the two pieces are locked together, what is their speed (in m/s)?					
	(1) 4.6	(2) 6.7	(3) 9.3	(4) 2.5	(5) 10.2	
20.	and moving with veloc	e debris has velocity (200 ity $(5m/s)\hat{x}$, where \hat{x} a are locked together, wh	$\operatorname{nd} \hat{y}$ are unit vectors in	the x and y-direction,	ace debris of mass 2500 kg respectively. If after the	
	(1) 6.7	(2) 4.6	(3) 9.3	(4) 2.5	(5) 10.2	
21.	and moving with veloc	e debris has velocity (30a ity $(5m/s)\hat{x}$, where \hat{x} a are locked together, wh	$\operatorname{nd} \hat{y}$ are unit vectors in	the x and y-direction,	ace debris of mass 2500 kg respectively. If after the	
	(1) 9.3	(2) 4.6	(3) 6.7	(4) 2.5	(5) 10.2	
22.	2. At time $t = 0$ a 2 kg particle is located at $\vec{r} = (2m)\hat{x} + (4m)\hat{y}$, and its velocity is $\vec{v} = -(6m/s)\hat{y}$, and it is subject to the force $\vec{F} = (8N)\hat{x}$, 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 $t = 0$?					
	$(1)~24~{\rm kg\cdot m^2/s}$	(2) $32 \text{ kg} \cdot \text{m}^2/\text{s}$	(3) $36 \text{ kg} \cdot \text{m}^2/\text{s}$	(4) $12 \text{ kg} \cdot \text{m}^2/\text{s}$	(5) 16 kg·m 2 /s	
23.	3. At time $t = 0$ a 2 kg particle is located at $\vec{r} = (2m)\hat{x} + (4m)\hat{y}$, and its velocity is $\vec{v} = -(8m/s)\hat{y}$, and it is subject to the force $\vec{F} = (8N)\hat{x}$, 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 $t = 0$?					
	$(1)~32~{\rm kg\cdot m^2/s}$	$(2)~24~{\rm kg}{\cdot}{\rm m}^2/{\rm s}$	(3) $36 \text{ kg} \cdot \text{m}^2/\text{s}$	(4) $12 \text{ kg} \cdot \text{m}^2/\text{s}$	(5) 16 kg·m 2 /s	
24.					\hat{y} , and it is subject to the t is the magnitude of the	
	$(1)~36~{\rm kg\cdot m^2/s}$	$(2)~24~{\rm kg\cdot m^2/s}$	$(3)~32~\rm kg\cdot m^2/s$	(4) $12 \text{ kg} \cdot \text{m}^2/\text{s}$	(5) 16 kg·m 2 /s	

25. A uniform solid disk of mass M and radius R is initially rotating with angular speed ω about the axis shown in the figure. An initially non-rotating uniform solid disk with the same mass M but a different radius r is suddenly dropped onto the rotating disk so that their central axes are coincident. The two disks stick together and rotate at the same new angular speed. If the new angular speed of the two disk system is 0.8ω , what is the ratio r/R?



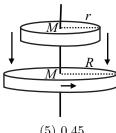
(1) 0.50

(2) 0.71

(3) 0.58

(4) 0.33

26. A uniform solid disk of mass M and radius R is initially rotating with angular speed ω about the axis shown in the figure. An initially non-rotating uniform solid disk with the same mass M but a different radius r is suddenly dropped onto the rotating disk so that their central axes are coincident. The two disks stick together and rotate at the same new angular speed. If the new angular speed of the two disk system is $2\omega/3$, what is the ratio r/R?



(1) 0.71

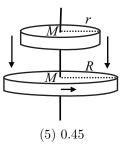
(2) 0.50

(3) 0.58

(4) 0.33



27. A uniform solid disk of mass M and radius R is initially rotating with angular speed ω about the axis shown in the figure. An initially non-rotating uniform solid disk with the same mass M but a different radius r is suddenly dropped onto the rotating disk so that their central axes are coincident. The two disks stick together and rotate at the same new angular speed. If the new angular speed of the two disk system is $3\omega/4$, what is the ratio r/R?



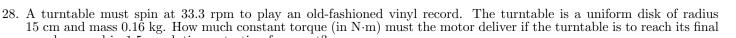
(1) 0.58

 $(2)\ 0.71$

angular speed in 1.5 revolutions, starting from rest?

 $(3)\ 0.50$

(4) 0.33



- $(1) 1.16 \times 10^{-3}$
- (2) 8.71×10^{-4} (3) 6.97×10^{-4} (4) 2.37×10^{-3} (5) 4.65×10^{-4}

- 29. In the previous problem, how much work (in mJ) must the motor do if the turntable is to reach its final angular speed in 1.5 revolutions, starting from rest?
 - $(1)\ 10.9$
- (2) 8.5
- (3) 5.4
- (4) 21.8
- (5) 2.9
- 30. A turntable must spin at 33.3 rpm to play an old-fashioned vinyl record. The turntable is a uniform disk of radius 15 cm and mass 0.16 kg. How much constant torque (in N⋅m) must the motor deliver if the turntable is to reach its final angular speed in 2.0 revolutions, starting from rest?
 - $(1) 8.71 \times 10^{-4}$

- (2) 1.16×10^{-3} (3) 6.97×10^{-4} (4) 2.37×10^{-3} (5) 4.65×10^{-4}
- 31. In the previous problem, how much work (in mJ) must the motor do if the turntable is to reach its final angular speed in 2.0 revolutions, starting from rest?
 - $(1)\ 10.9$
- (2) 8.5
- (3) 5.4
- (4) 21.8
- (5) 2.9

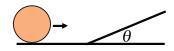
32.	A turntable must spin at 33.3 rpm to play an old-fashioned vinyl record. The turntable is a uniform disk of radius
	15 cm and mass 0.16 kg. How much constant torque (in N·m) must the motor deliver if the turntable is to reach its fina
	angular speed in 2.5 revolutions, starting from rest?

- (1) 6.97×10^{-4}
- (2) 1.16×10^{-3}
- (3) 8.71×10^{-4}
- $(4) \ 2.37 \times 10^{-3}$
- (5) 4.65×10^{-4}

33. In the previous problem, how much work (in mJ) must the motor do if the turntable is to reach its final angular speed in 2.5 revolutions, starting from rest?

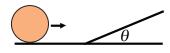
- $(1)\ 10.9$
- (2) 8.5
- (3) 5.4
- (4) 21.8
- (5) 2.9

34. A solid sphere of mass M and moment of inertia $2MR^2/5$ rolls without slipping along a horizontal surface with a translational speed of 5 m/s as shown in the figure. It comes to an incline that makes an angle of 20° with the horizontal surface. Ignoring energy losses due to friction, how far does the sphere travel along the incline (in m) before coming to rest and rolling back down?



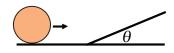
- (1) 5.22
- (2) 3.57
- (3) 2.78
- (4) 6.42
- (5) 1.80

35. A solid sphere of mass M and moment of inertia $2MR^2/5$ rolls without slipping along a horizontal surface with a translational speed of 5 m/s as shown in the figure. It comes to an incline that makes an angle of 30° with the horizontal surface. Ignoring energy losses due to friction, how far does the sphere travel along the incline (in m) before coming to rest and rolling back down?



- $(1)\ 3.57$
- (2) 5.22
- (3) 2.78
- (4) 6.42
- (5) 1.80

36. A solid sphere of mass M and moment of inertia $2MR^2/5$ rolls without slipping along a horizontal surface with a translational speed of 5 m/s as shown in the figure. It comes to an incline that makes an angle of 40° with the horizontal surface. Ignoring energy losses due to friction, how far does the sphere travel along the incline (in m) before coming to rest and rolling back down?



- (1) 2.78
- (2) 5.22
- (3) 3.57
- (4) 6.42
- (5) 1.80

37. 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 $\theta = 40^{\circ}$ 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, what is the spring constant k (in N/m)?



- $(1)\ 1752$
- (2) 1233
- (3)849
- (4) 1470



38. 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 $\theta = 50^{\circ}$ 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, what is the spring constant k (in N/m)?



- (1) 1233
- $(2)\ 1752$
- (3)849
- (4) 1470
- (5)785

39.	modern sculpture has a large horizontal spring, that is attached to a 60-kg siece of uniform metal at its end and holds the metal at rest at an angle of $\theta = 60^{\circ}$ 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 tretched 0.2 m, what is the spring constant k (in N/m)?					
	(1) 849	(2) 1752	(3) 1233	(4) 1470	(5) 785	
40.		height of 2 m above th			us 0.30 cm and is held in m) from the nozzle does	
	(1) 4.60	(2) 6.62	(3) 3.38	(4) 5.25	(5) 7.32	
41.		height of 2 m above th			us 0.25 cm and is held in m) from the nozzle does	
	(1) 6.62	(2) 4.60	(3) 3.38	(4) 5.25	(5) 7.32	
42.		height of 2 m above th			us 0.35 cm and is held in m) from the nozzle does	
	(1) 3.38	(2) 6.62	(3) 4.60	(4) 5.25	(5) 7.32	
43.	the top of the tank is a	much larger than the are	all hole in the bottom with a volume of 0.064	ter level is 10.0 m above	Assume that the area of the bottom of the tank, small hole?	
	(1) 9.3	(2) 8.5	(3) 12.0	(4) 6.5	(5) 13.8	
44.	4. A large water tank, open at the top, has a small hole in the bottom with a diameter of 2.5 cm. Assume that the area of the top of the tank is much larger than the area of the hole. If the water level is 12.0 m above the bottom of the tank how long (in s) does it take to fill up a bucket with a volume of 0.064 m ³ with water from the small hole?					
	(1) 8.5	(2) 9.3	(3) 12.0	(4) 6.5	(5) 13.8	
45.	5. A large water tank, open at the top, has a small hole in the bottom with a diameter of 2.5 cm. Assume that the area of the top of the tank is much larger than the area of the hole. If the water level is 6.0 m above the bottom of the tank, how long (in s) does it take to fill up a bucket with a volume of 0.064 m ³ with water from the small hole?					
	(1) 12.0	(2) 9.3	(3) 8.5	(4) 6.5	(5) 13.8	
46.		the empty balloon) off t			ift a total mass of 10-kg re $ ho_{\rm HE}=0.18~{\rm kg/m^3}$ and	

(3) 2.27

(2) 1.91

(1) 1.33

(4) 0.67

(5) 3.12

(1) 0.94

(2) 3.74

47. What is the minimum radius (in m) that a spherical helium balloon must have in order to lift (including the mass of the empty balloon) off the ground? The density of helium and the air are $\rho_{\rm air} = 1.2 \ {\rm kg/m^3}$, respectively.						
	(1) 1.91	(2) 1.33	(3) 2.27	(4) 0.67	(5) 3.12	
48.	What is the minimum radius (in m) that a spherical helium balloon must have in order to lift a total mass of 50-kg (including the mass of the empty balloon) off the ground? The density of helium and the air are $\rho_{\rm HE}=0.18~{\rm kg/m^3}$ and $\rho_{\rm air}=1.2~{\rm kg/m^3}$, respectively.					
	(1) 2.27	(2) 1.91	(3) 1.33	(4) 0.67	$(5) \ 3.12$	
49.	9. At the surface of a freshwater lake the pressure is 101 kPa. What is the pressure increase (in kPa) in going 40 m better the surface?					
	(1) 392	(2) 490	(3) 588	(4) 285	(5) 680	
50.	At the surface of a fr the surface?	reshwater lake the p	ressure is 101 kPa. Wh	at is the pressure incre	ease (in kPa) in going 50 m below	
	(1) 490	(2) 392	(3) 588	(4) 285	(5) 680	
51.	At the surface of a fr the surface?	reshwater lake the p	ressure is 101 kPa. Wh.	at is the pressure incre	ease (in kPa) in going 60 m below	
	(1) 588	(2) 490	(3) 392	(4) 285	(5) 680	
52.	52. As indicated in the figure, an initially empty cart of mass M , tied between two ideal springs, oscillates with $\omega = 12$ rad/s. When a load of mass m is placed in the cart, the new value of the oscillation is $\omega = 6$ rad/s. What is the mass m that was added to the mass of the cart?					
	(1) $3M$	(2) $8M$	$(3) \ 15M$	$(4) \ 2M$	(5) $4M$	
53.	ideal springs, oscillat	tes with $\omega = 12$ rad value of the oscillat	apty cart of mass M , tie /s. When a load of mation is $\omega = 4 \text{ rad/s}$. What?	ss m is placed		
	(1) $8M$	(2) $3M$	$(3) \ 15M$	$(4) \ 2M$	(5) 4M	
54.	ideal springs, oscillat	tes with $\omega = 12$ rad value of the oscillat	apty cart of mass M , tie /s. When a load of mation is $\omega = 3$ rad/s. What?	ss m is placed		
	$(1) \ 15M$	(2) $3M$	(3) 8M	$(4) \ 2M$	(5) 4M	
55.	length of 30 m. The	Young's modulus o	by a crane with a steel of steel is 2.0×10^{11} Pa. he cable stretch (in cm)	Ignoring the weight of	eter of 2.0 cm and an unstretched f the cable itself, when the ball is	

(3) 1.66

 $(4) \ 0.24$

(5) 4.25

56.	6. A 2,000 kg wrecking ball is to be lifted by a crane with a steel cable that has a diameter of 1.0 cm and an unlength of 30 m. The Young's modulus of steel is 2.0×10^{11} Pa. Ignoring the weight of the cable itself, when elifted and held at rest, how much does the cable stretch (in cm)?				
	(1) 3.74	(2) 0.94	(3) 1.66	(4) 0.24	(5) 4.25
57.	length of 30 m. The Y	all is to be lifted by a crown of steel how much does the cab	is 2.0×10^{11} Pa. Ignoria	hat has a diameter of 1. ng the weight of the cab	5 cm and an unstretched le itself, when the ball is
	(1) 1.66	(2) 3.74	(3) 0.94	(4) 0.24	$(5) \ 4.25$
58.	A simple harmonic osc speed of the block is 40 what is the spring cons	0 m/s when the displaces	ek of mass 2 kg attached ment from equilibrium is	to an ideal spring with 3 m and the amplitude	spring constant k . If the of the oscillations is 5 m,
	(1) 200	(2) 50	(3) 450	(4) 800	(5) 600
59.	A simple harmonic osc speed of the block is 20 what is the spring cons	0 m/s when the displaces	ek of mass 2 kg attached ment from equilibrium is	to an ideal spring with 3 m and the amplitude	spring constant k . If the of the oscillations is 5 m,
	(1) 50	(2) 200	(3) 450	(4) 800	(5) 600
60.		0 m/s when the displaces			spring constant k . If the of the oscillations is 5 m,
	(1) 450	(2) 200	(3) 50	(4) 800	(5) 600
	Γ, HAVE BEEN FLAG		TION QUESTIONS: 29 3		NCE ON THE ABOVE OUPS OF QUESTIONS

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TYPE 8Q# S 22 Q# S 23 Q# S 24 TYPE 9 Q# S 25 Q# S 26 Q# S 27 TYPE 10 Q# S 28 29 Q# S 30 31 Q# S 32 33 TYPE 11 Q# S 34 Q# S 35 Q# S 36 TYPE 12 Q# S 37 Q# S 38 Q# S 39 TYPE 13 Q# S 40 Q# S 41 Q# S 42 TYPE 14 Q# S 43 Q# S 44 Q# S 45 TYPE 15 Q# S 46 Q# S 47 Q# S 48 TŸPE 16 Q# S 49 Q# S 50 Q# S 51 TYPE 17 Q# S 52 Q# S 53 Q# S 54 TYPE 18 Q# S 55 Q# S 56 Q# S 57 TYPE 19 Q# S 58 Q# S 59 Q# S 60