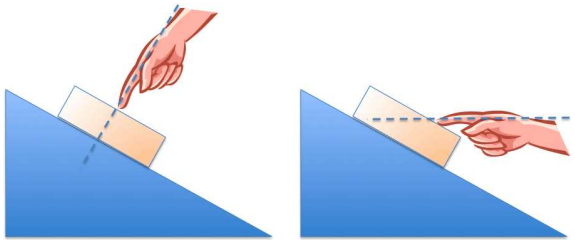
CODE - AACHDA
LB 271 - Introductory Physics Lecture
Version A

Name:

LB271 Fall 2009 Final Exam Version A

Gravitational Acceleration on Earth	$g = 9.81 m/s^2$
Gravitational Constant	$G = 6.67 \cdot 10^{-11} m^3/(kg \cdot s^2)$
Absolute Zero	-273.15°C
Gas Constant	$R = 8.31 J/(K \cdot \text{mol})$
Boltzmann Constant	$k = 1.38 \cdot 10^{-23} J/K$
Avogadro's number	$N_A = 6.02 \cdot 10^{23}$ particles/mol
Specific heat of water vapor	$c_{\text{vapor}} = 0.48 kcal/(kg \cdot K)$
Specific heat of liquid water	$c_{\text{water}} = 1 kcal/(kg \cdot K) = 4186 J/(kg \cdot K)$
Specific heat of water ice	$c_{\text{ice}} = 0.5 kcal/(kg \cdot K)$
Latent heat of fusion for water	$L_{\text{f}} = 80 kcal/kg$
Latent heat of vaporizationfor water	$L_{\text{v}} = 540 kcal/kg$



A block is being held in place on an incline. The magnitude of the force applied by the hand on the block is the same in the left and the right scenarios.

1 pt In which scenario does the incline exert a lower normal force on the block?

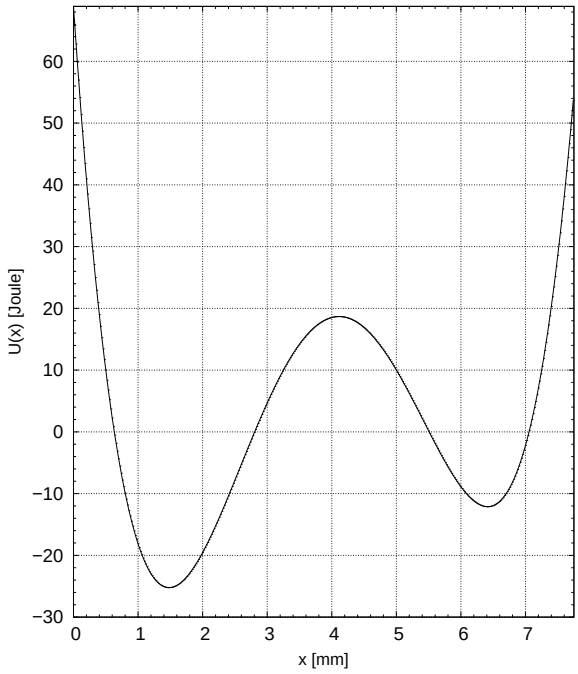
1. **A**◯ The left scenario.
   B◯ The right scenario.
   C◯ Same in both scenarios.

1 pt In which scenario does the incline exert a lower frictional force on the block?

2. **A**◯ The left scenario.
   B◯ The right scenario.
   C◯ Same in both scenarios.

1 pt By how many decibels does the sound intensity from a point source decrease if you increase the distance to it by a factor 6?

3.A◯ 12.2 **B**◯ 13.8 **C**◯ 15.6 **D**◯ 17.6
E◯ 19.9 **F**◯ 22.5 **G**◯ 25.4 **H**◯ 28.7



1 pt

A particle is located at x=2.0 mm and has a kinetic energy of 29.5 Joule. What is the maximum x-coordinate the particle could reach? *(in* `mm`*)*

4.A◯ 0.1 **B**◯ 0.7 **C**◯ 1.6 **D**◯ 2.6
E◯ 3.2 **F**◯ 4.7 **G**◯ 5.3 **H**◯ 7.6

Deep Space Nine sees Enterprise and a shuttle approach from exactly opposite directions with 0.8 c and 0.5 c, respectively.

1 pt At what fraction of the speed of light (β) does Enterprise see the shuttle approach?

5.A◯ 0.00 **B**◯ 0.50 **C**◯ 0.83 **D**◯ 0.91
E◯ 0.93 **F**◯ 1.00 **G**◯ 1.25 **H**◯ 1.30

1 pt The shuttle has a length of 9 meters when at rest. How long is it in the system of Deep Space 9? *(in* `m`*)*

6.A◯ 1.8 **B**◯ 2.6 **C**◯ 3.7 **D**◯ 5.4
E◯ 7.8 **F**◯ 11.3 **G**◯ 16.4 **H**◯ 23.8

1 pt Captain Picard on the Enterprise takes a 49 minute tea break. How long is this break in the system of Deep Space 9? *(in* `min`*)*

7.A◯ 27 **B**◯ 33 **C**◯ 42 **D**◯ 52
E◯ 65 **F**◯ 82 **G**◯ 102 **H**◯ 128

CODE - AACHDA
LB 271 - Introductory Physics Lecture
Version A

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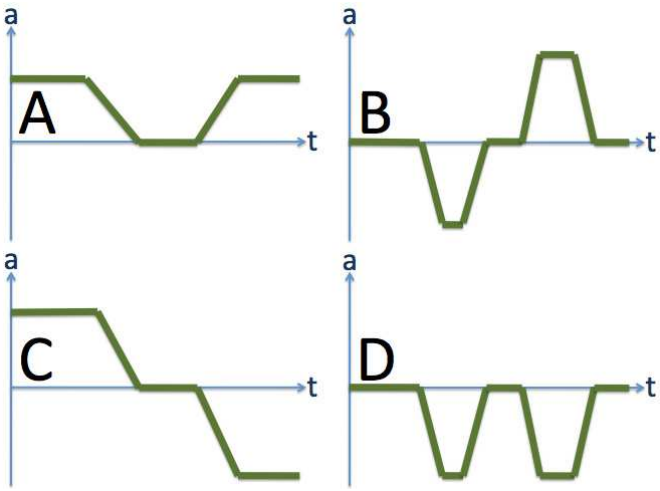
1 pt You have two organ pipes of the same length, one closed at both ends, one half open. Which one has a lower fundamental frequency?

8. **A**◯ The closed pipe.
B◯ Same.
C◯ The half-open pipe.

---

1 pt In a very simple model of the lower atmosphere, air has a constant density of 1.26 kg/m^3. How much would the air pressure change over a height difference of 130 m? *(in* `Pa`*)*

9. **A**◯ 986 **B**◯ 1110 **C**◯ 1260 **D**◯ 1420
E◯ 1610 **F**◯ 1820 **G**◯ 2050 **H**◯ 2320



1 pt

A car drives in the forward (positive) direction. It first has a constant speed, then drives into a parking spot, waits for a few moments, and then drives out again backwards. Which one of the acceleration graphs could describe this scenario?

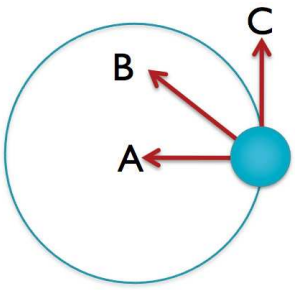
10. **A**◯ Scenario A
B◯ Scenario B
C◯ Scenario C
D◯ Scenario D
E◯ None of the above.

---

1 pt

A box is sliding uphill as shown. What is the direction of the frictional force on the box?

11. **A**◯ Downhill.
B◯ Perpendicular to the surface.
C◯ Uphill.
D◯ None of the above.



An object is rotating on a circular trajectory as shown. The indicated direction A is toward the center of the trajectory, C is tangential to the trajectory. The object is **rotating clockwise** and **slowing down**.

1 pt What could be the direction of the (linear) acceleration?

12. **A**◯ Direction A.
B◯ Direction B.
C◯ Direction C.
D◯ Into the paper.
E◯ Out of the paper.

1 pt What could be the direction of the angular acceleration?

13. **A**◯ Direction A.
B◯ Direction B.
C◯ Direction C.
D◯ Into the paper.
E◯ Out of the paper.

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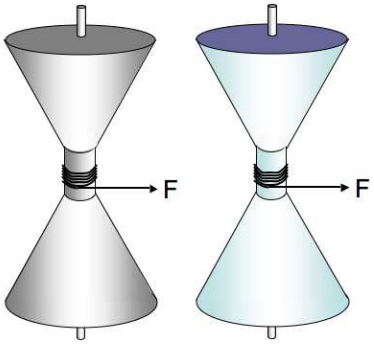
1 pt



You have two identical looking spools (same mass, same shape, same size). However, one is hollow, made from iron, the other is solid, made from aluminum. A string is wound around each spool. If you pull on both strings with equal forces, which spool is going to have the larger angular acceleration?

14. **A**◯ Same
B◯ The solid spool
C◯ The hollow spool

CODE - AACHDA
LB 271 - Introductory Physics Lecture
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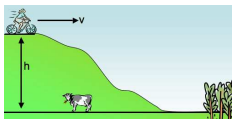
1 pt

A bicyclist on an old bike (combined mass: 89 kg) is rolling down (no pedaling or braking) a hill of height 117 m. Over the course of the 397 meters of downhill road, she encounters a constant friction force of 250 Newton. If her speed at the top of the hill is 5 m/s, what is her speed at the bottom of the hill? *(in* `m/s`*)*

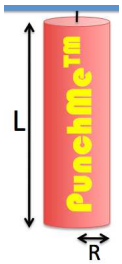


15. **A**◯ 6.08 **B**◯ 7.60 **C**◯ 9.50 **D**◯ 11.9
E◯ 14.8 **F**◯ 18.5 **G**◯ 23.2 **H**◯ 29.0

---

1 pt

A punch bag can be modeled as a rigid uniform cylinder of mass 15 kg, length 1.3 m, and radius 0.15 m, which can freely pivot from the ceiling (neglect the short cable with which it is attached). With what frequency should a frustrated physics student punch the bag for maximum effect (i.e., to have it swing back and forth in resonance, assuming small oscillations)? *(in* `Hz`*)*



16. **A**◯ 0.294 **B**◯ 0.426 **C**◯ 0.618 **D**◯ 0.897
E◯ 1.30 **F**◯ 1.88 **G**◯ 2.73 **H**◯ 3.96

---

1 pt What is the dimension of ft/min?

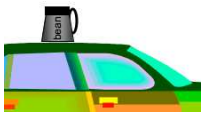
17. **A**◯ Velocity
B◯ Acceleration
C◯ Angular acceleration
D◯ Position
E◯ Angular velocity

---

1 pt

A 304000 kg jet has a take-off speed of 95 m/s. Neglecting drag, what constant thrust force would the engines have to provide to take off at the end of a 1400 m runway? *(in* `N`*)*

18.
A◯ 6.0×10^5 **B**◯ 6.8×10^5 **C**◯ 7.7×10^5
D◯ 8.7×10^5 **E**◯ 9.8×10^5 **F**◯ 1.1×10^6
G◯ 1.3×10^6 **H**◯ 1.4×10^6



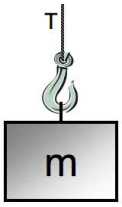
1 pt A professor drives off with his car (mass 900 kg), but forgot to take his coffee mug (mass 0.3 kg) off the roof. The coefficient of static friction between the mug and the roof is 0.7, and the coefficient of kinetic friction is 0.4. What is the maximum acceleration of the car, so the mug does not slide off? *(in* `m/s^2`*)*

19. **A**◯ 3.27 **B**◯ 4.74 **C**◯ 6.87 **D**◯ 9.96
E◯ 14.44 **F**◯ 20.93 **G**◯ 30.36 **H**◯ 44.02

---

1 pt

A mass of 910 kg is hanging from a crane (neglect the mass of the cable and the hook). While the mass is being lifted up, it is speeding up with 2 m/s^2. What is the tension on the cable? *(in* `N`*)*



20. **A**◯ 2817 **B**◯ 3522 **C**◯ 4402 **D**◯ 5503
E◯ 6878 **F**◯ 8598 **G**◯ 10747 **H**◯ 13434

A car accelerates from rest to a certain velocity in a certain time. Assume no friction and constant engine power.

1 pt How long would it take to reach the same velocity if the mass of the car was doubled?

21. **A**◯ Half the time.
B◯ Same time.
C◯ Double the time.
D◯ Four times the time.

1 pt The car has a mass of 1120 kg. Assuming no friction and a constant engine power of 90 kW, what velocity can it reach from rest in 8 seconds? *(in* `m/s`*)*

22. **A**◯ 35.9 **B**◯ 47.7 **C**◯ 63.4 **D**◯ 84.4
E◯ 112 **F**◯ 149 **G**◯ 198 **H**◯ 264

---

1 pt The potential energy of an object is given by

$$U(\vec{r}) = \alpha xy + \beta(x^2 + z^2)$$

What is the magnitude of the x-component of the force on the object at

$$\vec{r} = \begin{pmatrix} 4 \\ 7 \\ -1 \end{pmatrix} \text{ m}$$

if α=7 J/m^2 and β=5 J/m^2? *(in* `N`*)*

23. **A**◯ 23 **B**◯ 29 **C**◯ 36 **D**◯ 46
E◯ 57 **F**◯ 71 **G**◯ 89 **H**◯ 111

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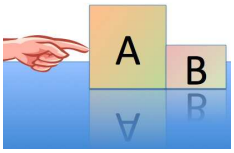


Two blocks A and B ($m_A > m_B$) are pushed for a certain distance along a frictionless surface.

1 pt How does the magnitude of the work that A does on B compare to the magnitude of the work that B does on A?

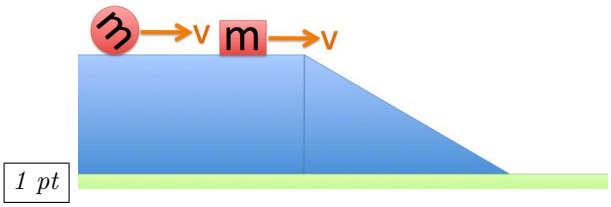
24. **A**◯ The magnitude of the work of B on A is larger
B◯ Same (and not zero)
C◯ Both zero
D◯ The magnitude of the work of A on B is larger

1 pt How does the magnitude of the net work on A compare to the magnitude of the net work on B?

25. **A**◯ More net work on A
B◯ More net work on B
C◯ Same

1 pt How does the magnitude of the net work on A compare to the magnitude of the work of the hand on A?

26. **A**◯ Magnitude of the work by the hand on A is larger
B◯ Magnitude of the net work on A is larger
C◯ Same



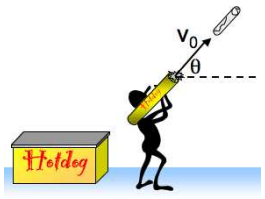
1 pt

A block and a sphere of equal mass are moving toward the head of an incline with equal speed. The block is sliding without friction, and the sphere is rolling without slipping (but encountering no other friction). At the bottom of the incline, which object will have the higher speed?

27. **A**◯ The block.
B◯ Same speed.
C◯ The sphere.

---

1 pt



In the break between two periods of a show ice hockey game, a pressured air cannon is used to launch hot dogs into the audience. The hot dog man (mass m_{man}) launches the hot dogs (mass m_{dog}) with a speed v_0 at an angle of θ with the horizontal. Since the ice is extremely slippery, with what speed v_{man} is the hot dog man (initially at rest) going to recoil?

28. **A**◯ $v_{\text{man}} = v_0$
B◯ $v_{\text{man}} = m_{\text{dog}} v_0 \cos\theta / m_{\text{man}}$
C◯ $v_{\text{man}} = m_{\text{man}} v_0 / m_{\text{dog}}$
D◯ $v_{\text{man}} = m_{\text{man}} v_0 \sin\theta / m_{\text{dog}}$
E◯ $v_{\text{man}} = m_{\text{man}} v_0 \cos\theta / m_{\text{dog}}$
F◯ $v_{\text{man}} = 0$

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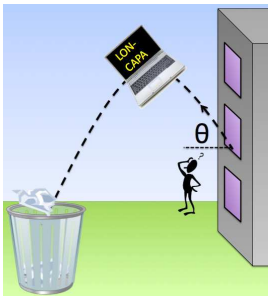
1 pt



After less-than-careful consideration, a physics student decides that the best way to accelerate an outdated laptop is to throw it out of the window. Neglecting friction, if it was launched at an angle θ with respect to the horizontal, what will be its acceleration at the highest point of its trajectory?

29. **A**◯ $g \sin\theta$ down
B◯ g down
C◯ g horizontal
D◯ zero

---

1 pt Did you

- write your name on the question sheet?
- bubble in your name?
- bubble in your PID and double-check it?
- bubble in the CODE from this sheet and double-check it?
- sign your bubble sheet?
- check that you provided one and only one answer for every question?

The correct answer is "Yes."

30. **A**◯ Yes
B◯ No

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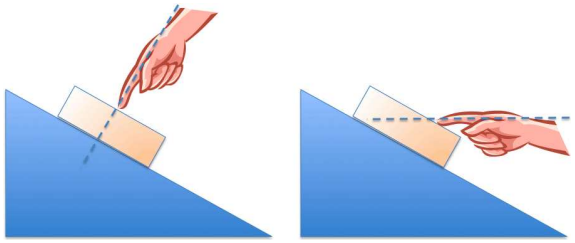

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1 pt In which scenario does the incline exert a higher frictional force on the block?

1. **A**◯ The left scenario.
   B◯ The right scenario.
   C◯ Same in both scenarios.

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2. **A**◯ The left scenario.
   B◯ The right scenario.
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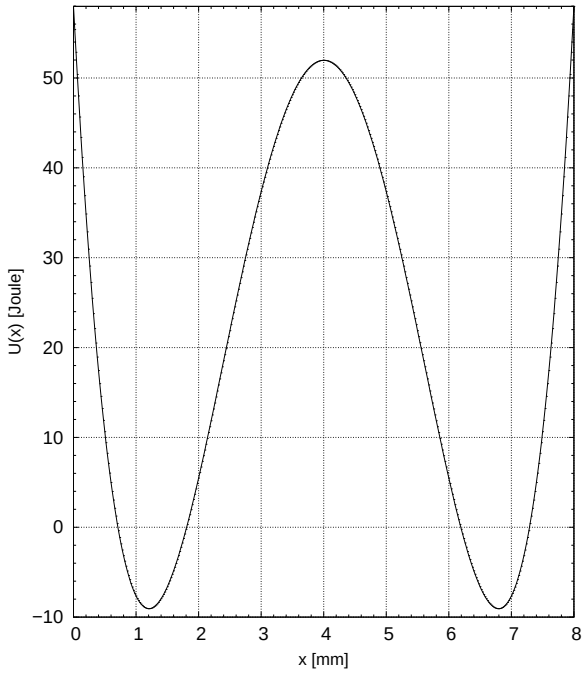
1 pt By how many decibels does the sound intensity from a point source decrease if you increase the distance to it by a factor 6?

3.A◯ 7.10 **B**◯ 8.31 **C**◯ 9.72 **D**◯ 11.4
E◯ 13.3 **F**◯ 15.6 **G**◯ 18.2 **H**◯ 21.3



1 pt

A particle is located at x=5.5 mm and has a kinetic energy of 9.8 Joule. What is the minimum x-coordinate the particle could reach? *(in* `mm`*)*

4.A◯ 1.6 **B**◯ 2.6 **C**◯ 2.7 **D**◯ 2.9
E◯ 3.0 **F**◯ 3.8 **G**◯ 5.2 **H**◯ 6.9

Deep Space Nine sees Enterprise and a shuttle approach from exactly opposite directions with 0.8 c and 0.4 c, respectively.

1 pt At what fraction of the speed of light (β) does Enterprise see the shuttle approach?

5.A◯ 0.00 **B**◯ 0.47 **C**◯ 0.50 **D**◯ 0.59
E◯ 0.78 **F**◯ 0.91 **G**◯ 1.00 **H**◯ 1.20

1 pt The shuttle has a length of 12 meters when at rest. How long is it in the system of Deep Space 9? *(in* `m`*)*

6.A◯ 3.6 **B**◯ 4.5 **C**◯ 5.6 **D**◯ 7.0
E◯ 8.8 **F**◯ 11.0 **G**◯ 13.7 **H**◯ 17.2

1 pt Captain Picard on the Enterprise takes a 35 minute tea break. How long is this break in the system of Deep Space 9? *(in* `min`*)*

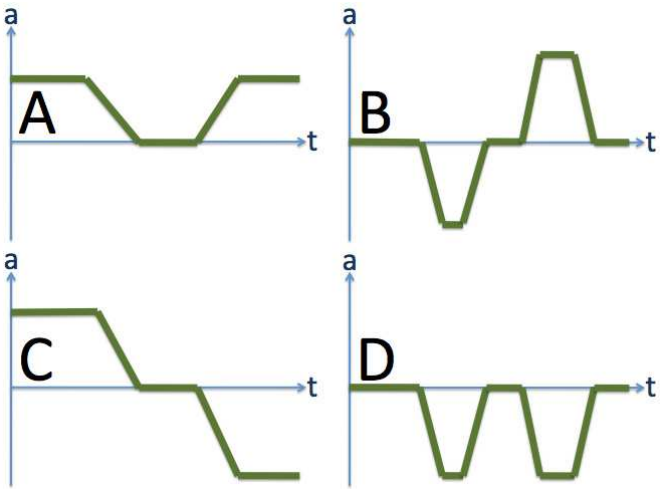
7.A◯ 19 **B**◯ 28 **C**◯ 40 **D**◯ 58
E◯ 85 **F**◯ 123 **G**◯ 178 **H**◯ 258

1 pt You have two organ pipes of the same length, one closed at both ends, one half open. Which one has a lower fundamental frequency?

8. **A**◯ Same.
B◯ The closed pipe.
C◯ The half-open pipe.

1 pt In a very simple model of the lower atmosphere, air has a constant density of 1.22 kg/m^3. How much would the air pressure change over a height difference of 110 m? *(in* `Pa`*)*

9. **A**◯ 1320 **B**◯ 1490 **C**◯ 1680 **D**◯ 1900
E◯ 2150 **F**◯ 2430 **G**◯ 2740 **H**◯ 3100



1 pt

A car drives in the forward (positive) direction. It first has a constant speed, then drives into a parking spot, waits for a few moments, and then drives out again backwards. Which one of the acceleration graphs could describe this scenario?

10. **A**◯ Scenario A
B◯ Scenario B
C◯ Scenario C
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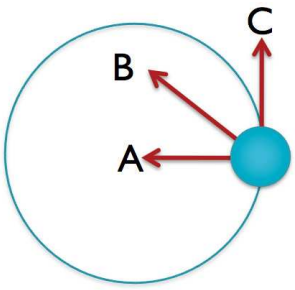
1 pt

A box is sliding uphill as shown. What is the direction of the frictional force on the box?

11. **A**◯ Perpendicular to the surface.
B◯ Downhill.
C◯ Uphill.
D◯ None of the above.



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1 pt What could be the direction of the angular acceleration?

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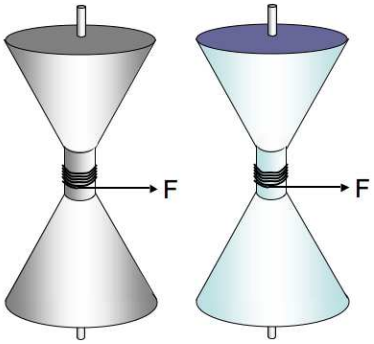
1 pt

You have two identical looking spools (same mass, same shape, same size). However, one is hollow, made from iron, the other is solid, made from aluminum. A string is wound around each spool. If you pull on both strings with equal forces, which spool is going to have the larger angular acceleration?



14. **A**◯ The solid spool
B◯ The hollow spool
C◯ Same

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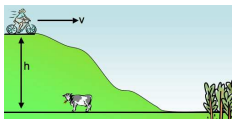
Version A

1 pt

A bicyclist on an old bike (combined mass: 87 kg) is rolling down (no pedaling or braking) a hill of height 123 m. Over the course of the 455 meters of downhill road, she encounters a constant friction force of 222 Newton. If her speed at the top of the hill is 6 m/s, what is her speed at the bottom of the hill? *(in* `m/s`*)*



15. **A**◯ 2.37 **B**◯ 2.96 **C**◯ 3.70 **D**◯ 4.62
E◯ 5.77 **F**◯ 7.22 **G**◯ 9.02 **H**◯ 11.3

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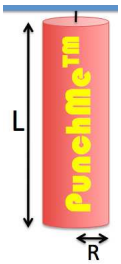
1 pt

A punch bag can be modeled as a rigid uniform cylinder of mass 15 kg, length 1.4 m, and radius 0.14 m, which can freely pivot from the ceiling (neglect the short cable with which it is attached). With what frequency should a frustrated physics student punch the bag for maximum effect (i.e., to have it swing back and forth in resonance, assuming small oscillations)? *(in* `Hz`*)*



16. **A**◯ 0.125 **B**◯ 0.156 **C**◯ 0.195 **D**◯ 0.244
E◯ 0.305 **F**◯ 0.381 **G**◯ 0.477 **H**◯ 0.596

---

1 pt What is the dimension of ft/min?

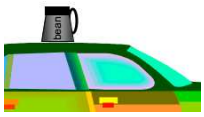
17. **A**◯ Position
B◯ Angular acceleration
C◯ Acceleration
D◯ Angular velocity
E◯ Velocity

---

1 pt

A 240000 kg jet has a take-off speed of 95 m/s. Neglecting drag, what constant thrust force would the engines have to provide to take off at the end of a 1400 m runway?
(in `N`*)*

18.
A◯ 3.0×10^5 **B**◯ 3.5×10^5 **C**◯ 4.1×10^5
D◯ 4.8×10^5 **E**◯ 5.7×10^5 **F**◯ 6.6×10^5
G◯ 7.7×10^5 **H**◯ 9.1×10^5



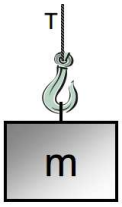
1 pt A professor drives off with his car (mass 900 kg), but forgot to take his coffee mug (mass 0.49 kg) off the roof. The coefficient of static friction between the mug and the roof is 1.3, and the coefficient of kinetic friction is 0.5. What is the maximum acceleration of the car, so the mug does not slide off? *(in* `m/s^2`*)*

19. **A**◯ 3.06 **B**◯ 4.08 **C**◯ 5.42 **D**◯ 7.21
E◯ 9.59 **F**◯ 12.75 **G**◯ 16.96 **H**◯ 22.56

---

1 pt

A mass of 830 kg is hanging from a crane (neglect the mass of the cable and the hook). While the mass is being lifted up, it is slowing down with 3.4 m/s^2. What is the tension on the cable?
(in `N`*)*



20. **A**◯ 4000 **B**◯ 5320 **C**◯ 7076 **D**◯ 9411
E◯ 12517 **F**◯ 16647 **G**◯ 22141 **H**◯ 29447

A car accelerates from rest to a certain velocity in a certain time. Assume no friction and constant engine power.

1 pt How long would it take to reach the same velocity if the mass of the car was doubled?

21. **A**◯ Half the time.
B◯ Same time.
C◯ Double the time.
D◯ Four times the time.

1 pt The car has a mass of 1090 kg. Assuming no friction and a constant engine power of 65 kW, what velocity can it reach from rest in 8 seconds? *(in* `m/s`*)*

22. **A**◯ 21.4 **B**◯ 24.2 **C**◯ 27.3 **D**◯ 30.9
E◯ 34.9 **F**◯ 39.4 **G**◯ 44.6 **H**◯ 50.4

---

1 pt The potential energy of an object is given by

$$U(\vec{r}) = \alpha xy + \beta(x^2 + z^2)$$

What is the magnitude of the x-component of the force on the object at

$$\vec{r} = \begin{pmatrix} 4 \\ 6 \\ -1 \end{pmatrix} \text{ m}$$

if α=7 J/m^2 and β=3 J/m^2? *(in* `N`*)*

23. **A**◯ 14 **B**◯ 17 **C**◯ 22 **D**◯ 27
E◯ 34 **F**◯ 42 **G**◯ 53 **H**◯ 66

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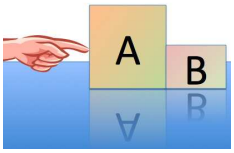
Version A



Two blocks A and B ($m_A > m_B$) are pushed for a certain distance along a frictionless surface.

1 pt How does the magnitude of the work that A does on B compare to the magnitude of the work that B does on A?

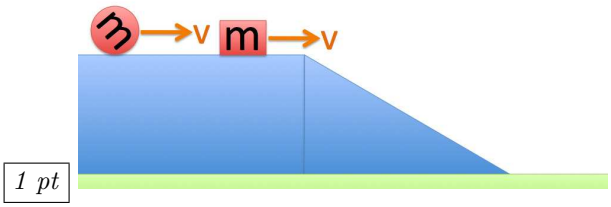
24. **A**◯ Both zero
B◯ Same (and not zero)
C◯ The magnitude of the work of B on A is larger
D◯ The magnitude of the work of A on B is larger

1 pt How does the magnitude of the net work on A compare to the magnitude of the net work on B?

25. **A**◯ More net work on A
B◯ More net work on B
C◯ Same

1 pt How does the magnitude of the net work on A compare to the magnitude of the work of the hand on A?

26. **A**◯ Magnitude of the work by the hand on A is larger
B◯ Magnitude of the net work on A is larger
C◯ Same



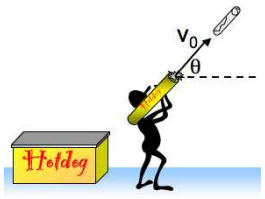
1 pt

A block and a sphere of equal mass are moving toward the head of an incline with equal speed. The block is sliding without friction, and the sphere is rolling without slipping (but encountering no other friction). At the bottom of the incline, which object will have the higher speed?

27. **A**◯ The sphere.
B◯ The block.
C◯ Same speed.

1 pt

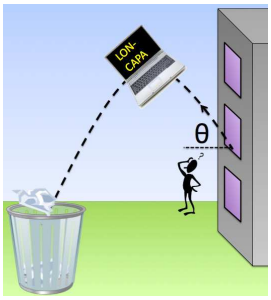
In the break between two periods of a show ice hockey game, a pressured air cannon is used to launch hot dogs into the audience. The hot dog man (mass m_{man}) launches the hot dogs (mass m_{dog}) with a speed v_0 at an angle of θ with the horizontal. Since the ice is extremely slippery, with what speed v_{man} is the hot dog man (initially at rest) going to recoil?



28. **A**◯ $v_{\text{man}} = v_0$
B◯ $v_{\text{man}} = m_{\text{dog}} v_0 \cos\theta / m_{\text{man}}$
C◯ $v_{\text{man}} = m_{\text{man}} v_0 \sin\theta / m_{\text{dog}}$
D◯ $v_{\text{man}} = m_{\text{man}} v_0 \cos\theta / m_{\text{dog}}$
E◯ $v_{\text{man}} = m_{\text{man}} v_0 / m_{\text{dog}}$
F◯ $v_{\text{man}} = 0$

1 pt

After less-than-careful consideration, a physics student decides that the best way to accelerate an outdated laptop is to throw it out of the window. Neglecting friction, if it was launched at an angle θ with respect to the horizontal, what will be its acceleration at the highest point of its trajectory?



29. **A**◯ g down
B◯ g horizontal
C◯ $g \sin\theta$ down
D◯ zero

1 pt Did you

- write your name on the question sheet?
- bubble in your name?
- bubble in your PID and double-check it?
- bubble in the CODE from this sheet and double-check it?
- sign your bubble sheet?
- check that you provided one and only one answer for every question?

The correct answer is "Yes."

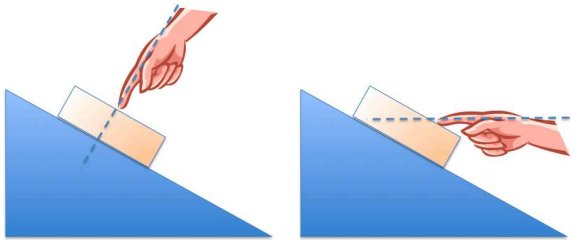
30. **A**◯ Yes
B◯ No

CODE - ACHCFB
LB 271 - Introductory Physics Lecture
Version A

Name:

LB271 Fall 2009 Final Exam Version A

Gravitational Acceleration on Earth	$g = 9.81 m/s^2$
Gravitational Constant	$G = 6.67 \cdot 10^{-11} m^3/(kg \cdot s^2)$
Absolute Zero	-273.15°C
Gas Constant	$R = 8.31 J/(K \cdot \text{mol})$
Boltzmann Constant	$k = 1.38 \cdot 10^{-23} J/K$
Avogadro's number	$N_A = 6.02 \cdot 10^{23}$ particles/mol
Specific heat of water vapor	$c_{\text{vapor}} = 0.48 kcal/(kg \cdot K)$
Specific heat of liquid water	$c_{\text{water}} = 1 kcal/(kg \cdot K) = 4186 J/(kg \cdot K)$
Specific heat of water ice	$c_{\text{ice}} = 0.5 kcal/(kg \cdot K)$
Latent heat of fusion for water	$L_{\text{f}} = 80 kcal/kg$
Latent heat of vaporizationfor water	$L_{\text{v}} = 540 kcal/kg$



A block is being held in place on an incline. The magnitude of the force applied by the hand on the block is the same in the left and the right scenarios.

1 pt In which scenario does the incline exert a higher normal force on the block?

1. **A**◯ The left scenario.
   B◯ The right scenario.
   C◯ Same in both scenarios.

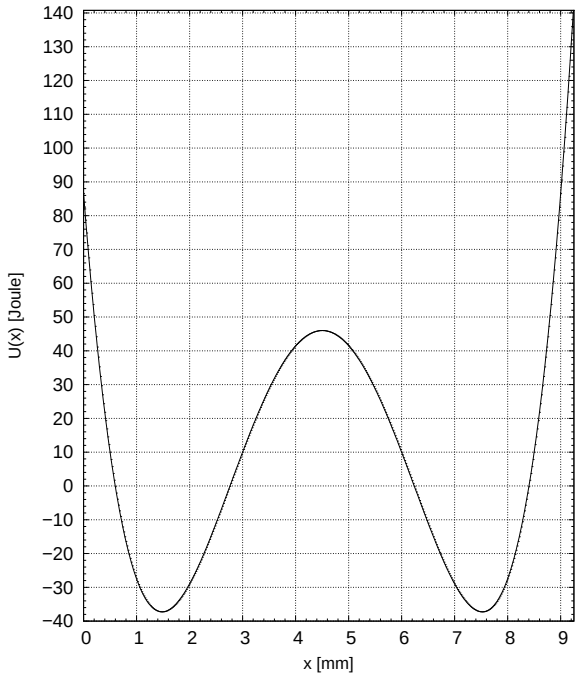
1 pt In which scenario does the incline exert a higher frictional force on the block?

2. **A**◯ The left scenario.
   B◯ The right scenario.
   C◯ Same in both scenarios.

---

1 pt By how many decibels does the sound intensity from a point source decrease if you increase the distance to it by a factor 5?

3.A◯ 10.9 **B**◯ 12.4 **C**◯ 14.0 **D**◯ 15.8
E◯ 17.9 **F**◯ 20.2 **G**◯ 22.8 **H**◯ 25.8



1 pt

A particle is located at x=1.6 mm and has a kinetic energy of 46.8 Joule. What is the minimum x-coordinate the particle could reach? *(in* `mm`*)*

4.A◯ 0.5 **B**◯ 2.2 **C**◯ 3.8 **D**◯ 4.7
E◯ 5.5 **F**◯ 6.3 **G**◯ 8.2 **H**◯ 9.0

Deep Space Nine sees Enterprise and a shuttle approach from exactly opposite directions with 0.7 c and 0.4 c, respectively.

1 pt At what fraction of the speed of light (β) does Enterprise see the shuttle approach?

5.A◯ 0.00 **B**◯ 0.42 **C**◯ 0.65 **D**◯ 0.73
E◯ 0.75 **F**◯ 0.86 **G**◯ 1.00 **H**◯ 1.10

1 pt The shuttle has a length of 8 meters when at rest. How long is it in the system of Deep Space 9? *(in* `m`*)*

6.A◯ 5.7 **B**◯ 6.5 **C**◯ 7.3 **D**◯ 8.3
E◯ 9.4 **F**◯ 10.6 **G**◯ 12.0 **H**◯ 13.5

1 pt Captain Picard on the Enterprise takes a 34 minute tea break. How long is this break in the system of Deep Space 9? *(in* `min`*)*

7.A◯ 48 **B**◯ 69 **C**◯ 100 **D**◯ 145
E◯ 210 **F**◯ 305 **G**◯ 442 **H**◯ 642

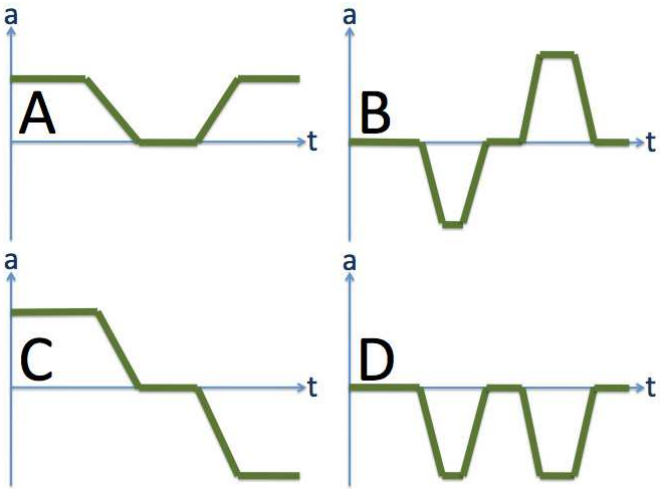
CODE - ACHCFB
LB 271 - Introductory Physics Lecture
Version A

1 pt You have two organ pipes of the same length, one closed at both ends, one half open. Which one has a lower fundamental frequency?

8. **A**◯ The closed pipe.
B◯ Same.
C◯ The half-open pipe.

1 pt In a very simple model of the lower atmosphere, air has a constant density of 1.24 kg/m^3. How much would the air pressure change over a height difference of 170 m? *(in* `Pa`*)*

9. **A**◯ 1550 **B**◯ 2070 **C**◯ 2750 **D**◯ 3660
E◯ 4870 **F**◯ 6470 **G**◯ 8610 **H**◯ 11400



1 pt

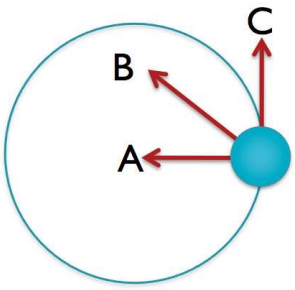
A car drives in the forward (positive) direction. It first has a constant speed, then comes to a stop at a red light, waits for a few moments, and then drives off again. Which one of the acceleration graphs could describe this scenario?

10. **A**◯ Scenario A
B◯ Scenario B
C◯ Scenario C
D◯ Scenario D
E◯ None of the above.

1 pt

A box is sliding uphill as shown. What is the direction of the frictional force on the box?

11. **A**◯ Uphill.
B◯ Downhill.
C◯ Perpendicular to the surface.
D◯ None of the above.



An object is rotating on a circular trajectory as shown. The indicated direction A is toward the center of the trajectory, C is tangential to the trajectory. The object is **rotating clockwise** and **slowing down**.

1 pt What could be the direction of the (linear) acceleration?

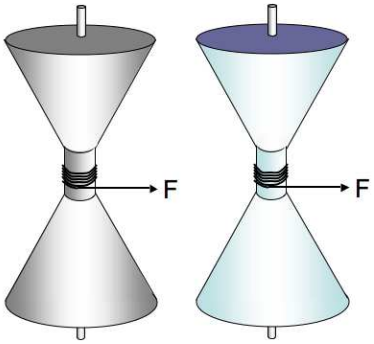
12. **A**◯ Direction A.
B◯ Direction B.
C◯ Direction C.
D◯ Into the paper.
E◯ Out of the paper.

1 pt What could be the direction of the angular acceleration?

13. **A**◯ Direction A.
B◯ Direction B.
C◯ Direction C.
D◯ Into the paper.
E◯ Out of the paper.

1 pt

You have two identical looking spools (same mass, same shape, same size). However, one is hollow, made from iron, the other is solid, made from aluminum. A string is wound around each spool. If you pull on both strings with equal forces, which spool is going to have the larger angular acceleration?



14. **A**◯ The solid spool
B◯ Same
C◯ The hollow spool

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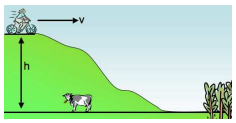
LB 271 - Introductory Physics Lecture
Version A

1 pt

A bicyclist on an old bike (combined mass: 98 kg) is rolling down (no pedaling or braking) a hill of height 125 m. Over the course of the 350 meters of downhill road, she encounters a constant friction force of 351 Newton. If her speed at the top of the hill is 10 m/s, what is her speed at the bottom of the hill? *(in* `m/s`*)*

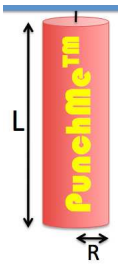


15. **A**◯ 6.73 **B**◯ 7.61 **C**◯ 8.60 **D**◯ 9.72
E◯ 11.0 **F**◯ 12.4 **G**◯ 14.0 **H**◯ 15.8

---

1 pt

A punch bag can be modeled as a rigid uniform cylinder of mass 13 kg, length 1.4 m, and radius 0.13 m, which can freely pivot from the ceiling (neglect the short cable with which it is attached). With what frequency should a frustrated physics student punch the bag for maximum effect (i.e., to have it swing back and forth in resonance, assuming small oscillations)? *(in* `Hz`*)*



16. **A**◯ 0.143 **B**◯ 0.190 **C**◯ 0.253 **D**◯ 0.337
E◯ 0.448 **F**◯ 0.596 **G**◯ 0.792 **H**◯ 1.05

---

1 pt What is the dimension of ft/min?

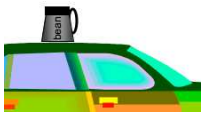
17. **A**◯ Acceleration
B◯ Position
C◯ Angular velocity
D◯ Velocity
E◯ Angular acceleration

---

1 pt

A 359000 kg jet has a take-off speed of 70 m/s. Neglecting drag, what constant thrust force would the engines have to provide to take off at the end of a 1600 m runway?
(in `N`*)*

18.
A◯ 3.4×10^5 **B**◯ 3.8×10^5 **C**◯ 4.3×10^5
D◯ 4.9×10^5 **E**◯ 5.5×10^5 **F**◯ 6.2×10^5
G◯ 7.0×10^5 **H**◯ 7.9×10^5



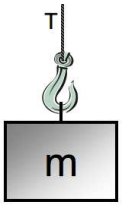
1 pt A professor drives off with his car (mass 820 kg), but forgot to take his coffee mug (mass 0.42 kg) off the roof. The coefficient of static friction between the mug and the roof is 1.1, and the coefficient of kinetic friction is 0.4. What is the maximum acceleration of the car, so the mug does not slide off? *(in* `m/s^2`*)*

19. **A**◯ 0.80 **B**◯ 1.16 **C**◯ 1.68 **D**◯ 2.44
E◯ 3.54 **F**◯ 5.13 **G**◯ 7.44 **H**◯ 10.79

---

1 pt

A mass of 870 kg is hanging from a crane (neglect the mass of the cable and the hook). While the mass is being lifted up, it is slowing down with 2.2 m/s^2. What is the tension on the cable?
(in `N`*)*



20. **A**◯ 491 **B**◯ 712 **C**◯ 1033 **D**◯ 1498
E◯ 2172 **F**◯ 3149 **G**◯ 4566 **H**◯ 6621

A car accelerates from rest to a certain velocity in a certain time. Assume no friction and constant engine power.

1 pt How long would it take to reach the same velocity if the mass of the car was doubled?

21. **A**◯ Half the time.
B◯ Same time.
C◯ Double the time.
D◯ Four times the time.

1 pt The car has a mass of 1180 kg. Assuming no friction and a constant engine power of 85 kW, what velocity can it reach from rest in 7 seconds? *(in* `m/s`*)*

22. **A**◯ 27.1 **B**◯ 31.8 **C**◯ 37.2 **D**◯ 43.5
E◯ 50.9 **F**◯ 59.5 **G**◯ 69.6 **H**◯ 81.5

---

1 pt The potential energy of an object is given by

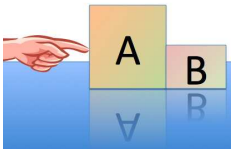
$$U(\vec{r}) = \alpha xy + \beta(x^2 + z^2)$$

What is the magnitude of the x-component of the force on the object at

$$\vec{r} = \begin{pmatrix} 2 \\ 4 \\ -1 \end{pmatrix} \text{ m}$$

if α=8 J/m^2 and β=2 J/m^2? *(in* `N`*)*

23. **A**◯ 25 **B**◯ 29 **C**◯ 34 **D**◯ 40
E◯ 47 **F**◯ 55 **G**◯ 64 **H**◯ 75



Two blocks A and B ($m_A > m_B$) are pushed for a certain distance along a frictionless surface.

1 pt How does the magnitude of the work that A does on B compare to the magnitude of the work that B does on A?

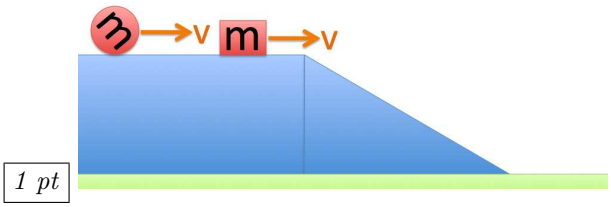
24. **A**◯ Same (and not zero)
B◯ Both zero
C◯ The magnitude of the work of B on A is larger
D◯ The magnitude of the work of A on B is larger

1 pt How does the magnitude of the net work on A compare to the magnitude of the net work on B?

25. **A**◯ More net work on A
B◯ More net work on B
C◯ Same

1 pt How does the magnitude of the net work on A compare to the magnitude of the work of the hand on A?

26. **A**◯ Magnitude of the work by the hand on A is larger
B◯ Magnitude of the net work on A is larger
C◯ Same



1 pt

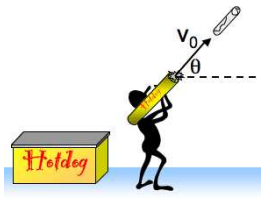
A block and a sphere of equal mass are moving toward the head of an incline with equal speed. The block is sliding without friction, and the sphere is rolling without slipping (but encountering no other friction). At the bottom of the incline, which object will have the higher speed?

27. **A**◯ The block.
B◯ The sphere.
C◯ Same speed.

---

1 pt

In the break between two periods of a show ice hockey game, a pressured air cannon is used to launch hot dogs into the audience. The hot dog man (mass m_{man}) launches the hot dogs (mass m_{dog}) with a speed v_0 at an angle of θ with the horizontal. Since the ice is extremely slippery, with what speed v_{man} is the hot dog man (initially at rest) going to recoil?

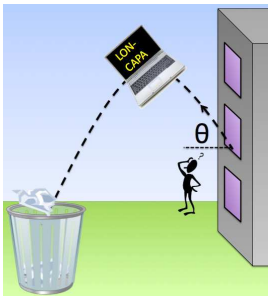


28. **A**◯ $v_{\text{man}} = v_0$
B◯ $v_{\text{man}} = m_{\text{man}} v_0 \sin\theta / m_{\text{dog}}$
C◯ $v_{\text{man}} = m_{\text{man}} v_0 \cos\theta / m_{\text{dog}}$
D◯ $v_{\text{man}} = m_{\text{dog}} v_0 \cos\theta / m_{\text{man}}$
E◯ $v_{\text{man}} = m_{\text{man}} v_0 / m_{\text{dog}}$
F◯ $v_{\text{man}} = 0$

---

1 pt

After less-than-careful consideration, a physics student decides that the best way to accelerate an outdated laptop is to throw it out of the window. Neglecting friction, if it was launched at an angle θ with respect to the horizontal, what will be its acceleration at the highest point of its trajectory?



29. **A**◯ g down
B◯ g horizontal
C◯ $g \sin\theta$ down
D◯ zero

---

1 pt Did you

- write your name on the question sheet?
- bubble in your name?
- bubble in your PID and double-check it?
- bubble in the CODE from this sheet and double-check it?
- sign your bubble sheet?
- check that you provided one and only one answer for every question?

The correct answer is "Yes."

30. **A**◯ Yes
B◯ No