



A book is held in place against a wall. The magnitude of the force applied by the hand on the book is the same in the left and the right scenarios.



**1 pt** In which scenario does the wall exert a higher frictional force on the book?

1.  A The left scenario.
- B The right scenario.
- C Same in both scenarios.
- D Not enough information given.

**1 pt** In which scenario does the wall exert a higher normal force on the book?

2.  A The left scenario.
- B The right scenario.
- C Same in both scenarios.
- D Not enough information given.

**1 pt** Which one of the following is the "Newton 3" force associated with the frictional force that the wall exerts on the book?

3.  A The force of the hand on the book.
- B The normal force of the wall on the book.
- C The weight of the book.
- D None of the above.

**1 pt** A sound wave travels through a liquid. It is found that the wavelength is 0.5 m and the speed of propagation is 3300 m/s. What is the frequency of the oscillation of the density of the liquid? (in Hz)

4.  A 6600     B 7458     C 8428     D 9523     E 10761     F 12160     G 13741     H 15527

**You are correct.** Your receipt no. is 156-4890



**1 pt** Your ice tea is at a refreshing 273.15 K while 0.13 kg of ice are slowly melting in it. What is the magnitude of the entropy change of the ice once it's gone? (in J/K)

5.  A 159     B 180     C 204     D 230     E 260     F 294     G 332     H 375

**You are correct.** Your receipt no. is 156-304



**1 pt** Water flows from a pipe A with a small diameter into a pipe B with a larger diameter. Which one of the following statements is true?

6.  A The velocity of the water in sections A and B is the same.
- B The pressure is higher in section B than in section A.
- C The pressure is higher in section A than in section B.
- D The flow in section A is larger than in section B.
- E The flow in section B is larger than in section A.

**You are correct.** Your receipt no. is 156-7984

**1 pt** The water in your bathtub is getting cold. You currently have 34 liters at  $35^{\circ}\text{C}$ . What is the new temperature after you add 6 liters of  $68^{\circ}\text{C}$  hot water? (in degC)

7. A 38.6    B 40.0    C 41.3    D 47.9    E 49.2    F 51.8    G 55.1    H 59.8

**You are correct.** Your receipt no. is 156-1468

**1 pt** A car is starting at the origin and driving with a velocity of

$$\vec{v}_1 = \begin{pmatrix} v_{1x} \\ v_{1y} \end{pmatrix} = \begin{pmatrix} 7 \\ 10 \end{pmatrix} \frac{\text{m}}{\text{s}}$$

for 16 seconds, and then with a velocity of

$$\vec{v}_2 = \begin{pmatrix} v_{2x} \\ v_{2y} \end{pmatrix} = \begin{pmatrix} 10 \\ -3 \end{pmatrix} \frac{\text{m}}{\text{s}}$$

for 33 seconds. What is the x-component of its final position? (in m)

8. A -757    B -372    C 164    D 277    E 442    F 546    G 773    H 934

**You are correct.** Your receipt no. is 156-2712

**1 pt** A mass of 0.9 kg is hanging from a spring with a spring constant of 2.5 N/m. At a distance of 0.2 m above the equilibrium it has a velocity of 0.8 m/s in the upward direction. What is the amplitude of the oscillation? (in m)

9. A 0.25    B 0.33    C 0.35    D 0.39    E 0.52    F 0.57    G 0.61    H 0.69

**You are correct.** Your receipt no. is 156-3500

**1 pt** You have two objects A and B. Object A has four times the mass and double the specific heat capacity of Object B. If they start out at the same temperature, and you supply the same amount of heat, which one will be warmer in the end?

10. A Object B  
 B Object A  
 C Same  
 D Cannot tell.

**You are correct.** Your receipt no. is 156-4847

**1 pt**

A 307000 kg jet has a take-off speed of 75 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)

11. A  $2.6 \times 10^5$     B  $3.0 \times 10^5$     C  $3.3 \times 10^5$     D  $3.8 \times 10^5$   
 E  $4.3 \times 10^5$     F  $4.8 \times 10^5$     G  $5.5 \times 10^5$     H  $6.2 \times 10^5$

**You are correct.** Your receipt no. is 156-6930



**1 pt** Figure skaters Emil and Emma collide totally inelastically during a competition. Emil has double the mass of Emma, and their velocities are

$$\vec{v}_{\text{Emil}} = \begin{pmatrix} 1 \\ 1 \end{pmatrix} \frac{\text{m}}{\text{s}} \quad \vec{v}_{\text{Emma}} = \begin{pmatrix} 2 \\ 1 \end{pmatrix} \frac{\text{m}}{\text{s}}$$

What is their final speed? (in m/s)

12. A 1.16    B 1.31    C 1.47    D 1.67    E 1.88    F 2.13    G 2.40    H 2.72

**You are correct.** Your receipt no. is 156-8827

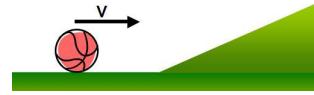
**1 pt** Which one of the following could be a unit of energy?

13. A  $N \cdot m/s$   
 B  $N \cdot s$   
 C  $kg \cdot m^2/s^3$   
 D  $N \cdot m$

**You are correct.** Your receipt no. is 156-3890

**1 pt**

A ball (radius 0.15 m) is rolling on level ground toward an incline. If its velocity is 1.8 m/s, to what maximum height above the ground does it roll up the incline? *The ball is a hollow sphere with a moment of inertia  $I = (2/3)mr^2$  (m is the mass of the ball, r its radius). (in m)*

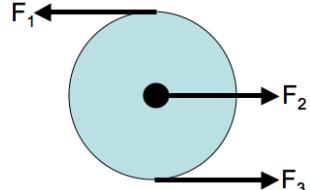


14. A 0.11    B 0.14    C 0.18    D 0.22    E 0.28    F 0.34    G 0.43    H 0.54

**You are correct.** Your receipt no. is 156-1667

**1 pt**

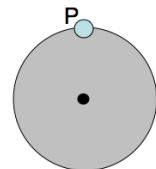
Three forces of equal magnitude are applied to a disk as shown. The disk can rotate around an axis through its center. What is the direction of the net torque?



15. A Into the paper  
 B Out of the paper  
 C Right  
 D Left  
 E Zero

**You are correct.** Your receipt no. is 156-1957

A point (labelled P in the figure) is attached to the rim of a disk of radius 0.3 m, which can turn around an axis through its center. It is rotating counterclockwise with a speed of 3.1 m/s.



**1 pt** What is the magnitude of its angular velocity? (in rad/s)

16. A 10.3    B 12.1    C 14.1    D 16.6    E 19.4    F 22.7    G 26.5    H 31.0

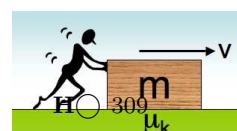
**1 pt** What is the direction of its angular velocity vector?

17. A Left  
 B Toward the center  
 C Into the paper  
 D Right  
 E Out of the paper

**1 pt**

How much power is needed to push a box (mass 28 kg) over a surface (coefficient of friction  $\mu_k=0.4$ ) with a velocity of 1.5 m/s? (in W)

18. A 103    B 120.    C 141    D 165    E 193    F 226    G 264

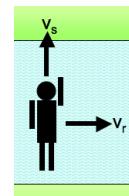


**You are correct.** Your receipt no. is 156-2767

1 pt

A swimmer is heading straight for the other shore of a river with a velocity of  $v_s = 0.8 \text{ m/s}$  relative to the water, but is carried away by the current, which has a velocity of  $v_r = 0.4 \text{ m/s}$ . It takes her 26.9 s to get across. How far downstream does she end up? (in m)

19. A 3.81    B 4.63    C 5.96    D 6.78  
 E 10.76    F 21.52    G 24.06    H 32.28



You are correct. Your receipt no. is 156-1520

A ball that had been placed in a glass of liquid sank all the way to the bottom.



1 pt

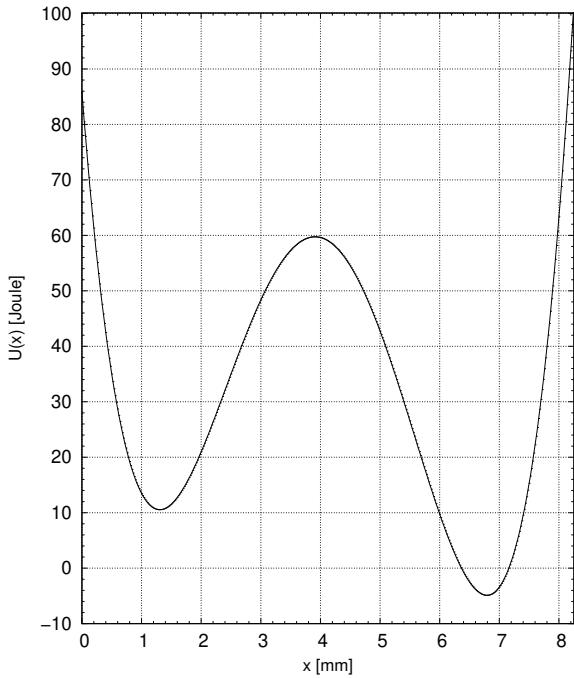
Compare the densities of the ball and the liquid.

20. A  $\rho_{\text{ball}} > \rho_{\text{displaced liquid}}$   
 B  $\rho_{\text{ball}} = \rho_{\text{displaced liquid}}$   
 C  $\rho_{\text{ball}} < \rho_{\text{displaced liquid}}$

1 pt

Compare the masses of the ball and the displaced liquid.

21. A  $m_{\text{ball}} > m_{\text{displaced liquid}}$   
 B  $m_{\text{ball}} = m_{\text{displaced liquid}}$   
 C  $m_{\text{ball}} < m_{\text{displaced liquid}}$



1 pt

A particle is located at  $x=6.2 \text{ mm}$  and has a kinetic energy of 32.3 Joule. What is the maximum x-coordinate the particle could reach? (in mm)

22. A 0.0    B 1.0    C 1.7    D 3.9    E 4.3    F 5.7    G 6.2    H 7.8

You are correct. Your receipt no. is 156-1839

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

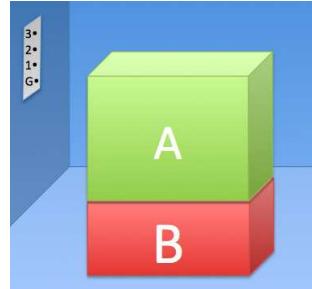
**1 pt** How long would it take to reach the same velocity if the mass of the car was doubled?

23. 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 65 kW, what velocity can it reach from rest in 4 seconds? (in m/s)

24. A 17.9    B 21.0    C 24.6    D 28.7    E 33.6    F 39.3    G 46.0    H 53.8
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Two boxes are located in an elevator, box A on top of box B ( $m_A > m_B$ ). The elevator is moving upward and about to arrive at its destination, so it is slowing down. At no time is the magnitude of the acceleration of the elevator higher than  $g$ . Let  $F_{g,A}$  be the weight of A, and  $F_{A \rightarrow B}$  be the force that A exerts on B.



**1 pt** Which one of the following is true?

25. A  $|F_{g,A}| < |F_{A \rightarrow B}|$   
B  $|F_{g,A}| > |F_{A \rightarrow B}|$   
C  $|F_{g,A}| = |F_{A \rightarrow B}|$

**1 pt** Let  $F_{B \rightarrow A}$  be the force that B exerts on A. Which one of the following is true?

26. A  $|F_{B \rightarrow A}| > |F_{A \rightarrow B}|$   
B  $|F_{B \rightarrow A}| = |F_{A \rightarrow B}|$   
C  $|F_{B \rightarrow A}| < |F_{A \rightarrow B}|$

**1 pt** Let  $F_{\text{net},A}$  and  $F_{\text{net},B}$  be the net forces on A and B, respectively. Which one of the following is true?

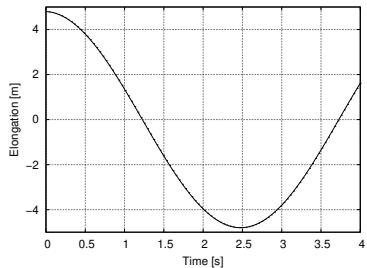
27. A  $|F_{\text{net},A}| < |F_{\text{net},B}|$   
B  $|F_{\text{net},A}| = |F_{\text{net},B}|$   
C  $|F_{\text{net},A}| > |F_{\text{net},B}|$
- 

**1 pt** A stone is being thrown straight up into the air. What is the magnitude of its acceleration at the highest point of the motion?

28. A 0  
B g

**You are correct.** Your receipt no. is 156-2224

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1 pt

What is the angular frequency of the harmonic oscillation shown? (in rad/s)

29. A 0.40    B 0.53    C 0.71    D 0.94    E 1.3    F 1.7    G 2.2    H 3.0

You are correct. Your receipt no. is 156-1093

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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

You are correct. Your receipt no. is 156-6030

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