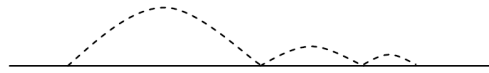
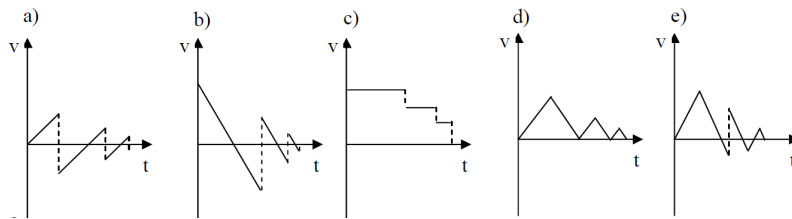


1. A footballer kicks the ball so that it bounces twice before coming to rest on the third contact with the ground (see diagram).

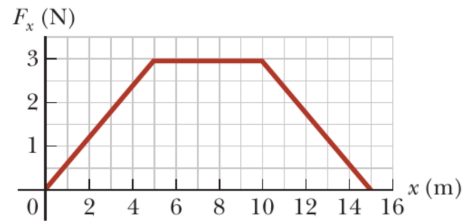


Which curve best represents the vertical component of the ball's velocity?



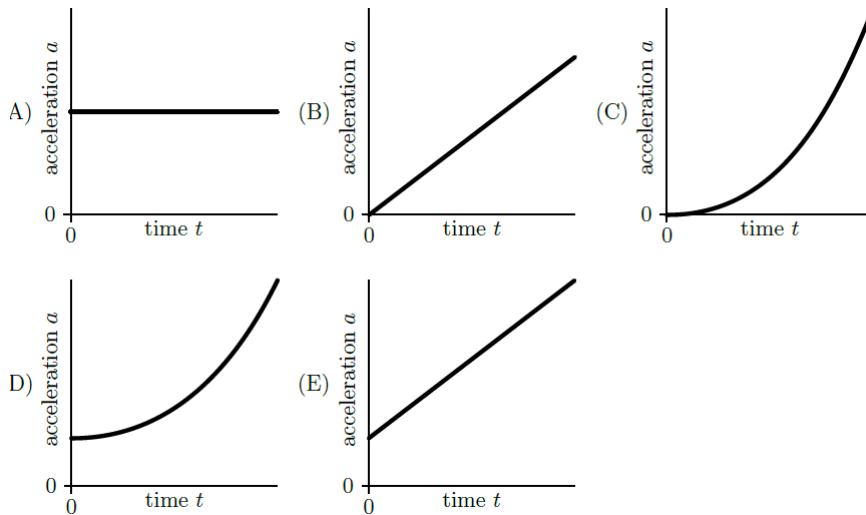
- a. a)
b. b)
 c. c)
 d. d)
 e. e)
2. A ferry crosses the Moselle. The banks are 90 m apart. The ferry moves at a constant speed of 18 km/h relative to the water, at right angles to the bank. The current of the Moselle is 3 km/h and carries the ferry sideways. How long will the ferry take to cross?
- a. 10
 b. 15 s
c. 18 s
 d. 21 s
 e. 30 s
3. An apple falls from a tree starting from a height h with zero initial velocity. It then reaches half its final velocity:
- a. $\frac{3}{4}h$ above the ground
b. $\frac{1}{2}h$ above the ground
 c. $\frac{1}{4}h$ above the ground
 d. $\frac{\sqrt{2}}{2}h$ above the ground
 e. $\frac{\sqrt{2}}{4}h$ above the ground
4. A sled with a mass of $m = 60$ kg starts at the top of a mountain with a slope of $\alpha = 30^\circ$. Its initial velocity is $v = 2$ m/s. After which distance along the slope will it come to rest if the friction coefficient is $\mu = 0.6$?
- a. 2.3 m
 b. 5.9 m
c. 10.4 m
 d. 12.3 m

5. A particle with a mass of 1 kg is accelerated by a force F_x that varies according to position x as shown in the graph below.



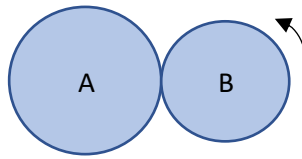
Find the velocity of the particle at position $x = 15$ m.

- 4.50 m/s
 - 5.25 m/s
 - 5.75 m/s
 - 6.35 m/s
 - 7.75 m/s**
6. A small bead slides from rest along a wire that is shaped like a vertical uniform helix. Which graph below shows the magnitude of the acceleration a as a function of time t ?



- A)
- B)
- C)
- D)**
- E)

7. Two coins with respective radii r_A and r_B are in contact. Coin B rolls without slipping around coin A for one complete turn of A.

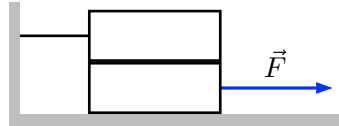


Let n be the ratio of the radii: $n = \frac{r_A}{r_B}$

When part B has made a complete revolution around A, how many revolutions will part B have made around its own axis?

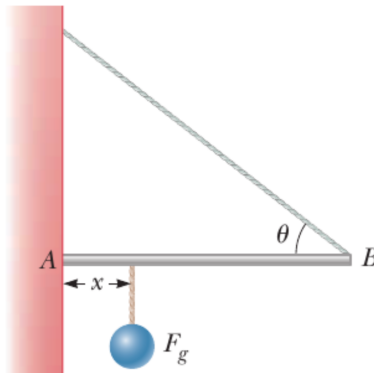
- a. n
- b. $n - 1$
- c. **$n + 1$**
- d. None of the above

8. A lift with a mass of 3,2 t rises with an acceleration of $1,5 \text{ m/s}^2$. What is the tension in the cable holding it?
- e. 27 kN
 f. 31 kN
g. 36 kN
 h. 47 kN
9. Two identical blocks, each with the weight P , are placed one on top of the other as shown in the figure. The upper block is connected to a wall by a wire, while the lower block is pulled by a horizontal force of intensity F . The coefficient of static friction μ is identical for all surfaces in contact.



What is the maximum value of F for the blocks to remain stationary?

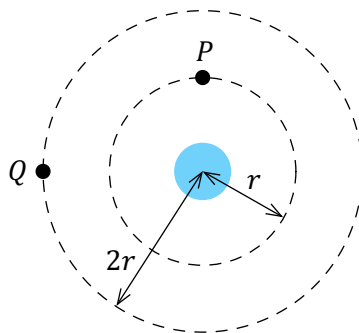
- a. $1.0\mu P$
 b. $1.5\mu P$
 c. $2.0\mu P$
d. $3.0\mu P$
10. One end of a uniform rod 4 m long and weighing P is supported by a cable at an angle $\theta = 37^\circ$ to the rod. The other end rests against a wall, where it is held by friction, as shown in the figure. The coefficient of static friction between the wall and the rod is $\mu_s = 0.5$.



Determine the minimum distance x from point A at which an additional object, also weighing P , can be suspended without the rod slipping at point A.

- a. 1.75 m
 b. 2.00 m
 c. 2.60 m
d. 2.81 m
 e. 3.05 m

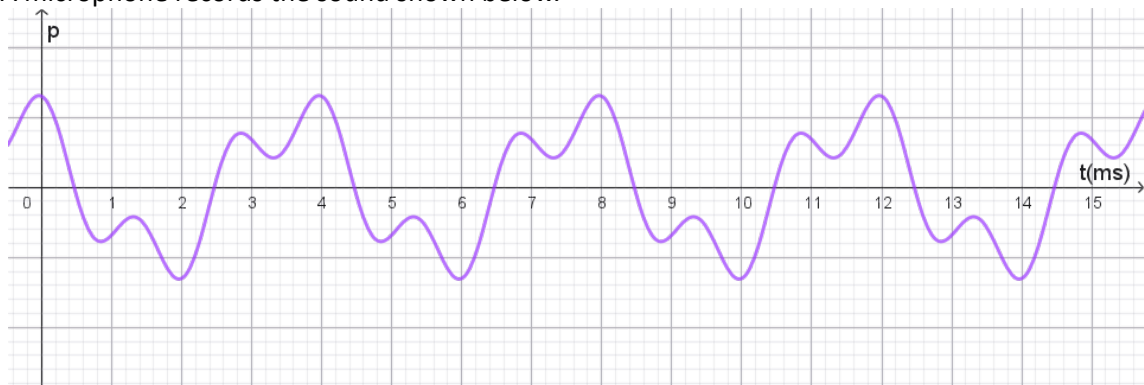
11. A 5 kg projectile travels - just before exploding - along a horizontal trajectory at a speed of 200 m/s. The explosion breaks the projectile into two pieces, which travel horizontally in the same direction as the initial projectile. One of the two pieces has a mass of 3 kg and a speed of 100 m/s. What is the speed of the second piece?
- 150 m/s
 - 200 m/s
 - 300 m/s
 - 350 m/s**
 - 750 m/s
12. Two satellites, P and Q , move in circular orbits around a planet. The radii of their orbits are r and $2r$, respectively.



What is the ratio of their velocities and the ratio of their accelerations?

	$\frac{v_P}{v_Q}$	$\frac{a_P}{a_Q}$
a.	$\sqrt{2}$	2
b.	$\sqrt{2}$	4
c.	$\frac{1}{\sqrt{2}}$	2
d.	$\frac{1}{\sqrt{2}}$	4

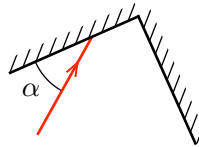
13. A microphone records the sound shown below.



The fundamental frequency of the sound is approximately:

- 2 ms
- 4 ms
- 12 ms
- 250 Hz**
- 500 Hz

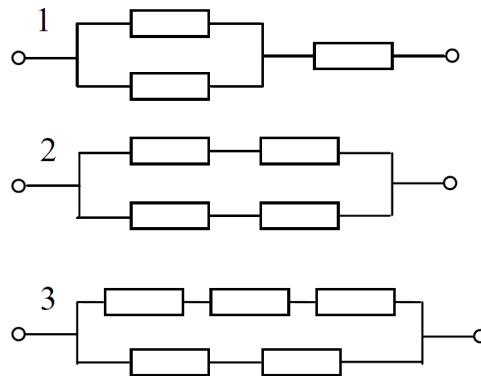
14. A mass of 2 kg is attached to a spring with an unknown spring constant D and oscillates with a period of $T = 1$ s. What is the value of D ?
- 23 N/m
 - 56 N/m
 - 79 N/m**
 - 107 N/m
15. A simple pendulum hanging from the ceiling of an elevator is oscillating with a small amplitude. When the elevator accelerates upwards
- the frequency of the pendulum increases**
 - the frequency of the pendulum decreases
 - the frequency of the pendulum does not change
 - the pendulum stops oscillating
16. A pipe of length L has one open end and one closed end. The frequency of the first harmonic is 220 Hz. A hole is drilled in the pipe at a distance $L/3$ from the closed end. This hole behaves like an open end. Consider the harmonic with the lowest frequency in this case. What is the frequency of this harmonic?
- 110 Hz
 - 165 Hz
 - 440 Hz
 - 660 Hz**
17. The figure shows a ray of light arriving at an angle α on the first of two perfectly reflective mirrors that form a right angle.



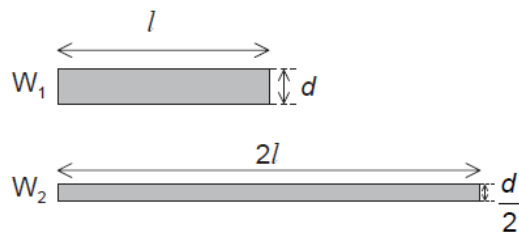
At what angle relative to the second mirror does the ray leave?

- α
- $180^\circ - \alpha$
- 2α
- $90^\circ - \alpha$**

18. A student needs a resistor with a resistance of $15\ \Omega$ and a tolerance of $\pm 4\ \Omega$. He only has $10\ \Omega$ resistors (with very high precision) at his disposal. Which of the following circuits meets the condition?



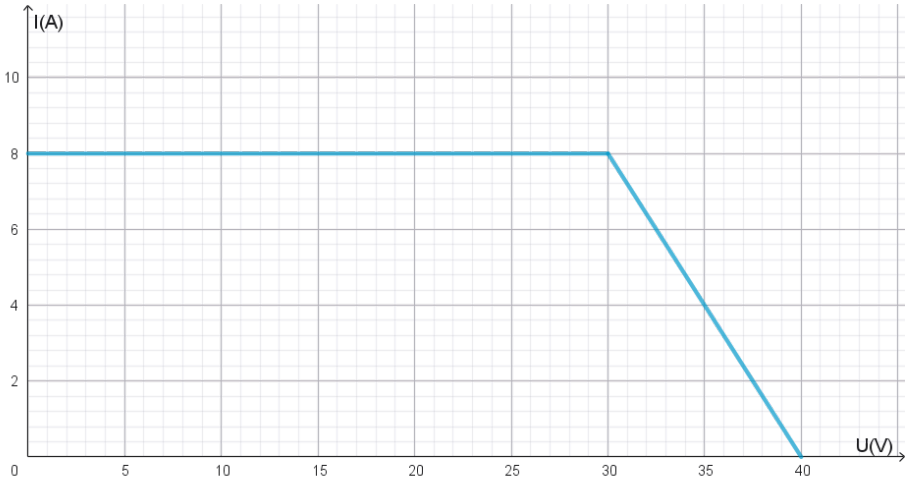
- a. All three
 b. Only 1
 c. Only 1 and 2
 d. Only 2 and 3
 e. **Only 1 and 3**
19. Two cylindrical copper wires, W_1 and W_2 , are kept at the same temperature. W_2 is twice as long and half as wide as W_1 .



What is the ratio $\frac{\text{resistance of } W_2}{\text{resistance of } W_1}$?

- a. 1
 b. 2
 c. 4
 d. **8**

20. The graph below shows the approximate $U - I$ characteristic of a solar panel.



Its maximum power is:

- a. 8 A
- b. 40 V
- c. **240 W**
- d. 280 W
- e. 320 W