

AP Physics 1 2019-Style Full Practice Exam

2019-style legacy-format practice exam

Original practice paper. Every question in this PDF was written for Salar Cafe. It does not reproduce official AP exam wording. Models the 2019 paper structure, including 45 single-select and 5 multiple-select MCQs. It intentionally includes retired legacy topics such as circuits and waves because they appeared in the historical AP Physics 1 course.

Section I	50 multiple-choice questions - 90 minutes - 50% (45 single-select + 5 multiple-select)
Section II	5 free-response questions - 90 minutes - 50%
Calculator	Scientific or graphing calculator may be used for this practice paper.
Scoring	MCQ answer key and explanations plus FRQ scoring guidance are included after the exam.
Use	Complete the exam first. Do not consult the answer key until both sections are finished.

Topic emphasis

Spring launch + friction; two-block pulley dynamics; projectile-launcher experiment; legacy circuits/power; open-tube standing waves.

SECTION I - Multiple Choice

50 questions | 90 minutes | Questions 1-45: choose one answer. Questions 46-50: select the TWO correct answers.

1. A motor lifts a load at constant speed. If the same load is lifted through the same height in half the time, what happens to the motor's mechanical output power?
 - A. It doubles
 - B. It halves
 - C. It is unchanged
 - D. It becomes four times as large
2. An open-open tube resonates at its fundamental frequency. If the tube length is doubled while the speed of sound is unchanged, what happens to the fundamental frequency?
 - A. It halves
 - B. It doubles
 - C. It is unchanged
 - D. It becomes four times as large
3. An ideal spring-mass oscillator has spring constant 60 N/m and amplitude 0.05 m. What is the total mechanical energy?
 - A. 1.50 J
 - B. 3.00 J
 - C. 0.15 J
 - D. 0.08 J
4. A cart starts from rest and reaches 18 m/s in 3 s with constant acceleration. What is the magnitude of its acceleration?
 - A. 3.0 m/s²
 - B. 6.0 m/s²
 - C. 21.0 m/s²
 - D. 54.0 m/s²
5. A velocity-time graph is a straight line from 6 m/s at $t = 0$ to 4 m/s at $t = 3$ s. What is the displacement during the interval?
 - A. 12.0 m
 - B. -0.7 m
 - C. 15.0 m
 - D. 6.0 m
6. A 0.40 kg object moves in a horizontal circle of radius 1.2 m at speed 5.0 m/s. What is the required inward net force?
 - A. 8.3 N
 - B. 2.4 N
 - C. 1.7 N
 - D. 0.02 N

7. A force of 12 N is applied at radius 0.20 m from a pivot, making 90 degrees with the radius. What is the torque magnitude about the pivot?
- A. 3.0 N m
 - B. 2.4 N m
 - C. 60.0 N m
 - D. 0.0 N m
8. A rigid body with rotational inertia 0.25 kg m^2 experiences a net torque of 2.5 N m. What is its angular acceleration?
- A. 0.6 rad/s^2
 - B. 10.0 rad/s^2
 - C. 0.10 rad/s^2
 - D. 5.0 rad/s^2
9. A wheel starts from rest with constant angular acceleration 2.5 rad/s^2 . What is its angular speed after 4.0 s?
- A. 10.0 rad/s
 - B. 20.0 rad/s
 - C. 0.6 rad/s
 - D. 40.0 rad/s
10. A cart starts from rest and reaches 10 m/s in 4 s with constant acceleration. What is the magnitude of its acceleration?
- A. 2.5 m/s^2
 - B. 1.2 m/s^2
 - C. 14.0 m/s^2
 - D. 40.0 m/s^2

- 11.** A ball rolls horizontally from a table 1.0 m high with speed 2.5 m/s. Neglect air resistance. Approximately how far from the table does it land?
- A. 0.3 m
 - B. 2.3 m
 - C. 1.1 m
 - D. 0.8 m
- 12.** A velocity-time graph is a straight line from 2 m/s at $t = 0$ to -2 m/s at $t = 3$ s. What is the displacement during the interval?
- A. -1.3 m
 - B. -6.0 m
 - C. 12.0 m
 - D. 0.0 m
- 13.** A net horizontal force of 15 N acts on a 2.0 kg object. What is the object's acceleration?
- A. 30.0 m/s^2
 - B. -2.3 m/s^2
 - C. 7.5 m/s^2
 - D. 0.13 m/s^2
- 14.** A 3.0 kg block slides on a horizontal surface with coefficient of kinetic friction 0.35. What is the kinetic-friction force?
- A. 29.4 N
 - B. 10.3 N
 - C. 20.6 N
 - D. 1.05 N
- 15.** A 0.30 kg object moves in a horizontal circle of radius 1.0 m at speed 2.0 m/s. What is the required inward net force?
- A. 0.8 N
 - B. 0.07 N
 - C. 0.6 N
 - D. 1.2 N
- 16.** A spring with $k = 40 \text{ N/m}$ is stretched 0.12 m from equilibrium. Which best describes the spring force on the attached object?
- A. 0.3 N opposite the displacement
 - B. 4.8 N in the direction of displacement
 - C. 333.3 N opposite the displacement
 - D. 4.8 N opposite the displacement

- 17.** A 2.0 kg object starts from rest and drops through a vertical height of 0.8 m with negligible friction. What is its speed after the drop?
- A. 7.8 m/s
 - B. 2.8 m/s
 - C. 4.0 m/s
 - D. 15.7 m/s
- 18.** A constant force of 10 N pulls an object 4.0 m. The force makes an angle of 30 degrees with the displacement. How much work does the force do?
- A. 2.5 J
 - B. 20.0 J
 - C. 40.0 J
 - D. 34.6 J
- 19.** A motor does 240 J of work in 5.0 s. What is its average power output?
- A. 48.0 W
 - B. 24.0 W
 - C. 1200.0 W
 - D. 0.021 W
- 20.** A spring of constant 40 N/m is compressed by 0.10 m. How much elastic potential energy is stored?
- A. 4.00 J
 - B. 2.00 J
 - C. 0.40 J
 - D. 0.20 J

- 21.** A 1.5 kg cart moving at 5.0 m/s collides with and sticks to a stationary 1.5 kg cart. What is their common speed immediately after the collision?
- A. 2.50 m/s
 - B. 5.00 m/s
 - C. 6.25 m/s
 - D. 1.25 m/s
- 22.** A 0.50 kg ball changes velocity from 4.0 m/s to -5.0 m/s along the x-axis. What is the x-component of the impulse on the ball?
- A. -0.5 N s
 - B. -4.5 N s
 - C. -18.0 N s
 - D. 4.5 J
- 23.** A constant force of 25 N acts for 0.40 s. What impulse is delivered?
- A. 10.0 N s
 - B. 5.0 N s
 - C. 62.5 N s
 - D. 25.4 N s
- 24.** A force of 12 N is applied at radius 0.25 m from a pivot, making 90 degrees with the radius. What is the torque magnitude about the pivot?
- A. 3.8 N m
 - B. 48.0 N m
 - C. 3.0 N m
 - D. 0.0 N m
- 25.** A rigid body with rotational inertia 0.30 kg m^2 experiences a net torque of 3.0 N m. What is its angular acceleration?
- A. 0.9 rad/s^2
 - B. 10.0 rad/s^2
 - C. 5.0 rad/s^2
 - D. 0.10 rad/s^2
- 26.** An object rolls without slipping down an incline at 25 degrees. Its rotational inertia is $I = 0.50MR^2$. What is its center-of-mass acceleration?
- A. 2.76 m/s^2
 - B. 5.92 m/s^2
 - C. 6.21 m/s^2
 - D. 4.14 m/s^2

27. A wheel starts from rest with constant angular acceleration 2.0 rad/s^2 . What is its angular speed after 3.0 s ?
- A. 9.0 rad/s
 - B. 18.0 rad/s
 - C. 6.0 rad/s
 - D. 0.7 rad/s
28. A 0.25 kg mass oscillates on an ideal spring with $k = 25 \text{ N/m}$. What is the period?
- A. 62.83 s
 - B. 0.06 s
 - C. 0.63 s
 - D. 0.10 s
29. An ideal spring-mass oscillator has spring constant 50 N/m and amplitude 0.10 m . What is the total mechanical energy?
- A. 0.25 J
 - B. 0.50 J
 - C. 5.00 J
 - D. 2.50 J
30. An ideal small-angle pendulum is moved to a planet where gravitational field strength is 0.36 times Earth's value. Its length is unchanged. What is the new period relative to its Earth period?
- A. 1.67 times the Earth period
 - B. 0.60 times the Earth period
 - C. 2.78 times the Earth period
 - D. 0.36 times the Earth period

31. The distance from a planet's center to a satellite is increased from r to $2r$ while the planet mass stays fixed. How does the gravitational force magnitude change?
- A. one-half as large
 - B. four times as large
 - C. one-fourth as large
 - D. twice as large
32. An ideal spring-mass oscillator has spring constant 60 N/m and amplitude 0.08 m . What is the total mechanical energy?
- A. 0.38 J
 - B. 2.40 J
 - C. 0.19 J
 - D. 4.80 J
33. A cart starts from rest and reaches 12 m/s in 3 s with constant acceleration. What is the magnitude of its acceleration?
- A. 36.0 m/s^2
 - B. 4.0 m/s^2
 - C. 15.0 m/s^2
 - D. 2.0 m/s^2
34. A velocity-time graph is a straight line from 6 m/s at $t = 0$ to 4 m/s at $t = 5 \text{ s}$. What is the displacement during the interval?
- A. 25.0 m
 - B. 20.0 m
 - C. -0.4 m
 - D. 10.0 m
35. A 0.20 kg object moves in a horizontal circle of radius 0.5 m at speed 3.0 m/s . What is the required inward net force?
- A. 0.01 N
 - B. 0.3 N
 - C. 3.6 N
 - D. 1.2 N
36. A force of 10 N is applied at radius 0.30 m from a pivot, making 30 degrees with the radius. What is the torque magnitude about the pivot?
- A. 2.6 N m
 - B. 1.5 N m
 - C. 33.3 N m
 - D. 3.0 N m
37. A rigid body with rotational inertia 0.25 kg m^2 experiences a net torque of 3.0 N m . What is its angular acceleration?
- A. 6.0 rad/s^2
 - B. 12.0 rad/s^2
 - C. 0.08 rad/s^2
 - D. 0.8 rad/s^2

- 38.** A wheel starts from rest with constant angular acceleration 2.0 rad/s^2 . What is its angular speed after 5.0 s ?
- A. 50.0 rad/s
 - B. 10.0 rad/s
 - C. 25.0 rad/s
 - D. 0.4 rad/s
- 39.** A cart starts from rest and reaches 15 m/s in 3 s with constant acceleration. What is the magnitude of its acceleration?
- A. 2.5 m/s^2
 - B. 45.0 m/s^2
 - C. 5.0 m/s^2
 - D. 18.0 m/s^2
- 40.** A ball rolls horizontally from a table 1.0 m high with speed 2.5 m/s . Neglect air resistance. Approximately how far from the table does it land?
- A. 2.3 m
 - B. 1.1 m
 - C. 0.3 m
 - D. 0.8 m

41. A velocity-time graph is a straight line from 4 m/s at $t = 0$ to 2 m/s at $t = 3$ s. What is the displacement during the interval?
- A. 9.0 m
 - B. -0.7 m
 - C. 7.5 m
 - D. 6.0 m
42. A net horizontal force of 10 N acts on a 2.5 kg object. What is the object's acceleration?
- A. -5.8 m/s^2
 - B. 4.0 m/s^2
 - C. 25.0 m/s^2
 - D. 0.25 m/s^2
43. A 2.5 kg block slides on a horizontal surface with coefficient of kinetic friction 0.15. What is the kinetic-friction force?
- A. 24.5 N
 - B. 7.4 N
 - C. 0.38 N
 - D. 3.7 N
44. A 0.20 kg object moves in a horizontal circle of radius 1.2 m at speed 5.0 m/s. What is the required inward net force?
- A. 1.2 N
 - B. 4.2 N
 - C. 0.8 N
 - D. 0.01 N
45. A spring with $k = 40 \text{ N/m}$ is stretched 0.08 m from equilibrium. Which best describes the spring force on the attached object?
- A. 500.0 N opposite the displacement
 - B. 3.2 N in the direction of displacement
 - C. 0.1 N opposite the displacement
 - D. 3.2 N opposite the displacement
46. An object moves at constant speed in a circle. Which TWO statements are correct? **Select TWO.**
- A. Its velocity is tangent to the path.
 - B. Its net force points toward the center.
 - C. Its acceleration is zero because speed is constant.
 - D. Its net force is tangent to the path.
47. A cart moves with constant positive acceleration. Which TWO statements must be true during any interval in which the acceleration remains constant? **Select TWO.**
- A. The velocity-time graph has constant slope.
 - B. The acceleration-time graph is horizontal.
 - C. The position-time graph must be a straight line.
 - D. The speed must be increasing.

48. Two carts collide on a horizontal track with negligible external impulse. Which TWO statements are always true for the two-cart system? **Select TWO.**

- A. Total momentum is conserved.
- B. The center-of-mass velocity is constant.
- C. Total kinetic energy is conserved.
- D. Each cart has the same momentum magnitude before and after.

49. Which TWO changes can increase the magnitude of torque produced by a force about a fixed pivot? **Select TWO.**

- A. Increase the force magnitude.
- B. Increase the perpendicular lever arm.
- C. Move the force line of action through the pivot.
- D. Make the force more parallel to the radius vector.

50. For an ideal mass-spring oscillator, which TWO statements are correct? **Select TWO.**

- A. Speed is greatest at equilibrium.
- B. Acceleration points toward equilibrium.
- C. Acceleration is zero at maximum displacement.
- D. Spring potential energy is greatest at equilibrium.

SECTION II - Free Response

5 questions | 90 minutes | Show reasoning, equations, units, graphs, and experimental logic when requested.

Legacy paper format: two longer 12-point FRQs and three shorter 7-point FRQs, with mixed derivation, argumentation, graphing, and experimental design.

Question 1 - Short FRQ: Spring launch, rough surface, and energy (7 points)

A. Two identical blocks start from rest after being pushed by identical spring plungers. One crosses a rough patch before reaching a target. Use energy reasoning to compare their speeds immediately before the target.

B. For the block that crosses the rough patch, derive an expression for its speed after crossing a rough length d with coefficient of kinetic friction μ , given launch speed v_0 .

C. Explain how increasing the block mass changes the fractional kinetic-energy loss on the rough patch if v_0 , μ , and d remain fixed.

Question 2 - Long FRQ: Two-block pulley dynamics (12 points)

A. Block A of mass m_A rests on a frictionless table and is connected over a light pulley to hanging block B of mass m_B . Draw separate free-body diagrams after release.

B. Derive the acceleration magnitude of the two-block system.

C. Predict the acceleration in the limits $m_A \gg m_B$ and $m_A \ll m_B$ and explain physically.

D. Sketch acceleration as a function of the ratio m_B/m_A and identify its limiting behavior.

Question 3 - Long FRQ: Projectile launcher spring experiment (12 points)

A. A spring launcher can be compressed by several measured distances x and launches the same sphere horizontally from table height H . Design an experiment to test whether the spring constant is independent of compression.

B. Identify the measurements and equipment needed to determine launch speed for each compression.

C. Derive an expression for k using measured x , H , horizontal range R , sphere mass m , and g .

D. State what graph or repeated calculation would provide evidence that k is constant and describe one uncertainty-reduction step.

Question 4 - Short FRQ: Motor power and legacy circuit reasoning (7 points)

A. A motor lifts mass M through height H at constant speed in time Δt . Write the mechanical output power.

B. The motor is powered by a battery through a series resistor. Explain qualitatively why reducing the effective series resistance can increase the lifting speed, assuming the motor receives a larger terminal voltage.

C. Identify one reason electrical input power can exceed mechanical output power.

Question 5 - Short FRQ: Open-tube resonance and standing waves (7 points)

A. An air column open at both ends resonates at its fundamental frequency f . Derive the tube length L in terms of sound speed v and f .

B. Sketch the displacement pattern for the fundamental and identify nodes/antinodes at the tube ends.

C. If the tube length doubles while sound speed is unchanged, determine the new fundamental frequency and explain.

ANSWER KEY - Section I

1. A - Legacy circuits/power Power is work divided by time. The work MgH is unchanged, so halving the time doubles power.	2. A - Legacy waves For an open-open tube $f=v/(2L)$, so doubling L halves f .
3. D - Oscillations At maximum displacement all energy is spring potential: $E = 1/2 kA^2 = 0.08 \text{ J}$.	4. B - Kinematics For constant acceleration, $a = \Delta v / \Delta t = 18/3 = 6.0 \text{ m/s}^2$.
5. C - Kinematics Displacement equals area under v - t graph: average velocity times time $= (6+4)/2 \times 3 = 15.0 \text{ m}$.	6. A - Forces $F_c = mv^2/r = 8.3 \text{ N}$.
7. B - Rotation Torque magnitude is $\tau = rF \sin(\theta) = 2.4 \text{ N m}$.	8. B - Rotation Rotational Newton second law: $\tau_{\text{net}} = I \alpha$, so $\alpha = \tau/I = 10.0 \text{ rad/s}^2$.
9. A - Rotation $\omega = \omega_0 + \alpha t = 10.0 \text{ rad/s}$.	10. A - Kinematics For constant acceleration, $a = \Delta v / \Delta t = 10/4 = 2.5 \text{ m/s}^2$.
11. C - Kinematics Fall time is $\sqrt{2h/g} = 0.45 \text{ s}$, so horizontal range is $v_x t = 1.1 \text{ m}$.	12. D - Kinematics Displacement equals area under v - t graph: average velocity times time $= (2+-2)/2 \times 3 = 0.0 \text{ m}$.
13. C - Forces Newton second law gives $a = F_{\text{net}}/m = 15/2.0 = 7.5 \text{ m/s}^2$.	14. B - Forces $F_k = \mu_k N = \mu_k mg = 0.35(3.0)(9.8) = 10.3 \text{ N}$.
15. D - Forces $F_c = mv^2/r = 1.2 \text{ N}$.	16. D - Forces Hooke law gives $F_s = -kx$. Magnitude is $40(0.12) = 4.8 \text{ N}$ and direction is toward equilibrium.
17. C - Energy Conservation of energy: $mgh = 1/2 mv^2$, so $v = \sqrt{2gh} = 4.0 \text{ m/s}$. Mass cancels.	18. D - Energy $W = Fd \cos(\theta) = 10(4.0)\cos(30) = 34.6 \text{ J}$.
19. A - Energy Average power is work divided by time: $P = W/t = 48.0 \text{ W}$.	20. D - Energy $U_s = 1/2 kx^2 = 0.20 \text{ J}$.
21. A - Momentum Momentum conservation gives $m_1 v_1 = (m_1+m_2) v_f$, so $v_f = 2.50 \text{ m/s}$.	22. B - Momentum Impulse equals change in momentum: $J_x = m(v_f - v_i) = -4.5 \text{ N s}$.
23. A - Momentum The area under a force-time graph is impulse. For constant force, $J = F \Delta t = 10.0 \text{ N s}$.	24. C - Rotation Torque magnitude is $\tau = rF \sin(\theta) = 3.0 \text{ N m}$.
25. B - Rotation Rotational Newton second law: $\tau_{\text{net}} = I \alpha$, so $\alpha = \tau/I = 10.0 \text{ rad/s}^2$.	26. A - Rotation For rolling without slipping, $a = g \sin(\theta)/(1+\beta) = 2.76 \text{ m/s}^2$.
27. C - Rotation $\omega = \omega_0 + \alpha t = 6.0 \text{ rad/s}$.	28. C - Oscillations $T = 2 \pi \sqrt{m/k} = 0.63 \text{ s}$.
29. A - Oscillations At maximum displacement all energy is spring potential: $E = 1/2 kA^2 = 0.25 \text{ J}$.	30. A - Oscillations T is proportional to $1/\sqrt{g}$, so $T_{\text{new}}/T_E = 1/\sqrt{0.36} = 1.67$.

31. C - Forces Gravitational force varies as $1/r^2$, so doubling r makes the force $1/4$ as large.	32. C - Oscillations At maximum displacement all energy is spring potential: $E = \frac{1}{2} kA^2 = 0.19 \text{ J}$.
33. B - Kinematics For constant acceleration, $a = \Delta v / \Delta t = 12/3 = 4.0 \text{ m/s}^2$.	34. A - Kinematics Displacement equals area under v - t graph: average velocity times time = $(6+4)/2 \times 5 = 25.0 \text{ m}$.
35. C - Forces $F_c = mv^2/r = 3.6 \text{ N}$.	36. B - Rotation Torque magnitude is $\tau = rF \sin(\theta) = 1.5 \text{ N m}$.
37. B - Rotation Rotational Newton second law: $\tau_{\text{net}} = I \alpha$, so $\alpha = \tau/I = 12.0 \text{ rad/s}^2$.	38. B - Rotation $\omega = \omega_0 + \alpha t = 10.0 \text{ rad/s}$.
39. C - Kinematics For constant acceleration, $a = \Delta v / \Delta t = 15/3 = 5.0 \text{ m/s}^2$.	40. B - Kinematics Fall time is $\sqrt{2h/g} = 0.45 \text{ s}$, so horizontal range is $v_x t = 1.1 \text{ m}$.
41. A - Kinematics Displacement equals area under v - t graph: average velocity times time = $(4+2)/2 \times 3 = 9.0 \text{ m}$.	42. B - Forces Newton second law gives $a = F_{\text{net}}/m = 10/2.5 = 4.0 \text{ m/s}^2$.
43. D - Forces $F_k = \mu_k N = \mu_k mg = 0.15(2.5)(9.8) = 3.7 \text{ N}$.	44. B - Forces $F_c = mv^2/r = 4.2 \text{ N}$.
45. D - Forces Hooke law gives $F_s = -kx$. Magnitude is $40(0.08) = 3.2 \text{ N}$ and direction is toward equilibrium.	46. A & B - Forces Circular motion changes velocity direction, requiring inward acceleration and net force; velocity remains tangent.
47. A & B - Kinematics Constant acceleration means a horizontal a - t graph and a v - t graph with constant slope. Speed need not increase if velocity is initially opposite the acceleration.	48. A & B - Momentum Negligible external impulse conserves total momentum, so the center-of-mass velocity is constant. Kinetic energy depends on collision type.
49. A & B - Rotation Torque magnitude is $rF \sin(\theta)$, so increasing F or the perpendicular lever arm increases torque.	50. A & B - Oscillations In SHM speed is maximum at equilibrium and acceleration is restoring, directed toward equilibrium.

SCORING GUIDE - Section II

This compact rubric emphasizes the evidence a strong AP-style response should contain. Equivalent correct reasoning should receive credit.

Question 1 - Short FRQ: Spring launch, rough surface, and energy - 7 points

3 points: Uses work-energy and recognizes that friction removes mechanical energy only from the block crossing the rough patch.

2 points: $\frac{1}{2} mv^2 = \frac{1}{2} mv_0^2 - \mu mgd$, so $v = \sqrt{v_0^2 - 2\mu gd}$.

2 points: The fractional loss is independent of mass because both initial kinetic energy and friction work scale with m .

Question 2 - Long FRQ: Two-block pulley dynamics - 12 points

3 points: Correct force diagrams: A has tension horizontally; B has weight down and tension up.

3 points: $a = m_B g / (m_A + m_B)$.

3 points: If m_A dominates, acceleration approaches zero; if m_B dominates, acceleration approaches g .

3 points: Graph rises from near zero and approaches g asymptotically.

Question 3 - Long FRQ: Projectile launcher spring experiment - 12 points

- 3 points:** Uses projectile range to infer launch speed and spring-energy conversion to infer k .
- 3 points:** Measure x , H , R , and m ; use meterstick/tape and balance, with repeated launches.
- 3 points:** Fall time $t = \sqrt{2H/g}$, $v = R/t$, and $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$, so $k = mR^2g/(2Hx^2)$.
- 3 points:** Consistent k values or a linear plot of v^2 versus x^2 supports constant k ; repeat launches and average ranges.

Question 4 - Short FRQ: Motor power and legacy circuit reasoning - 7 points

- 3 points:** $P_{\text{mech}} = MgH/\Delta t$.
- 2 points:** Lower effective series resistance can reduce voltage loss outside the motor, increasing motor terminal voltage/current and therefore available mechanical power.
- 2 points:** Energy can be dissipated as thermal energy in the motor/resistors and through other inefficiencies.

Question 5 - Short FRQ: Open-tube resonance and standing waves - 7 points

- 3 points:** For an open-open tube, $L = \lambda/2$ and $v = f\lambda$, so $L = v/(2f)$.
- 2 points:** Displacement antinodes occur at both open ends with a node at the center.
- 2 points:** Frequency halves because $f = v/(2L)$.

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