2026

AP® Physics 1: Algebra-Based

Scoring Guidelines

Question 1: Mathematical Routines (MR) — 10 points

A **(i)** For sketching a nonzero, horizontal line for the horizontal component of the velocity — **Point A1**

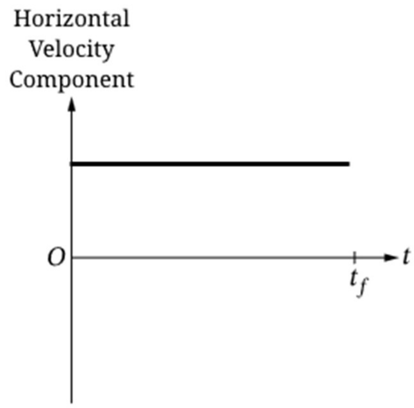
Scoring Notes:

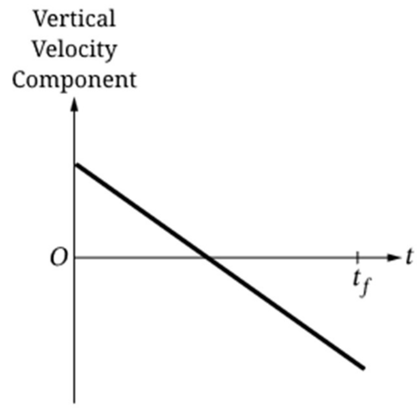
- This point may be earned for either a positive or negative horizontal velocity.
- Disregard anything sketched for $t \geq t_f$.

For sketching a line with a constant, negative slope that crosses the horizontal axis for the vertical velocity — **Point A2**

Scoring Note: Disregard anything sketched for $t \geq t_f$.

Example Response





(ii)	For a multistep derivation that includes **one** of the following: • A kinematic equation or combination of equations that can be used to solve for the speed of the water • A conservation of energy equation • Bernoulli's equation	**Point A3**
	For including a component of the initial velocity using any trigonometric function of θ	**Point A4**
	For indicating **one** of the following: • h_1 is the maximum vertical displacement of the water. • The vertical velocity at the maximum height is zero. • The pressure at the nozzle and at the maximum height are equal. **Scoring Note:** A correct, isolated, algebraic equivalent of $\frac{\sqrt{2gh_1}}{\sin\theta_0}$ or $\sqrt{\frac{2gh_1}{1-(\cos\theta_0)^2}}$ earns points A4 and A5.	**Point A5**

Example Response

$$v_y^2 = v_{y0}^2 + 2a_y(y - y_0)$$
$$v_y^2 = (v\sin\theta_0)^2 + 2a_y(y - y_0)$$
$$0 = (v\sin\theta_0)^2 - 2gh_1$$
$$v = \frac{\sqrt{2gh_1}}{\sin\theta_0}$$

OR

$$E_i = E_f$$
$$K_i = U_{gf} + K_f$$
$$\frac{1}{2}mv_i^2 = mgh + \frac{1}{2}mv_f^2$$
$$\frac{1}{2}v^2 - \frac{1}{2}v^2(\cos\theta_0)^2 = gh_1$$
$$v^2\left(1 - (\cos\theta_0)^2\right) = 2gh_1$$
$$v = \sqrt{\frac{2gh_1}{1 - (\cos\theta_0)^2}}$$

OR

$$P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$$
$$\frac{1}{2}\rho v^2 = \rho g h_1 + \frac{1}{2}\rho(v\cos\theta_0)^2$$
$$\frac{1}{2}v^2 = gh_1 + \frac{1}{2}(v\cos\theta_0)^2$$
$$v^2 = 2gh_1 + v^2(\cos\theta_0)^2$$
$$v^2\left(1 - (\cos\theta_0)^2\right) = 2gh_1$$
$$v = \sqrt{\frac{2gh_1}{1 - (\cos\theta_0)^2}}$$

(iii)	For including the product of area and speed	**Point A6**
	For a correct expression for the volume flow rate of the water	**Point A7**

Scoring Notes:

- A correct, isolated, algebraic equivalent of $\pi r_0^2\left(\dfrac{\sqrt{2gh_1}}{\sin\theta_0}\right)$ or $\pi r_0^2\sqrt{\dfrac{2gh_1}{1-(\cos\theta_0)^2}}$ earns points A4, A5, A6, and A7.
- Correct subscripts are not required to earn this point.

Example Response

$$\frac{V}{t} = Av$$
$$\frac{V}{t} = \left(\pi r_0^2\right)v$$
$$\frac{V}{t} = \pi r_0^2\left(\frac{\sqrt{2gh_1}}{\sin\theta_0}\right)$$

OR

$$\frac{V}{t} = Av$$
$$\frac{V}{t} = \left(\pi r_0^2\right)v$$
$$\frac{V}{t} = \pi r_0^2\left(\sqrt{\frac{2gh_1}{1-(\cos\theta_0)^2}}\right)$$

B	For indicating $h_2 > h_1$	**Point B1**
	For indicating **one** of the following:	**Point B2**

- A smaller radius results in a greater speed.
- A smaller area results in a greater speed.
- A larger radius results in a smaller speed.
- A larger area results in a smaller speed.

For indicating **one** of the following: **Point B3**

- A higher speed results in a greater height.
- A lower speed results in a lower height.
- The same speed results in the same height.

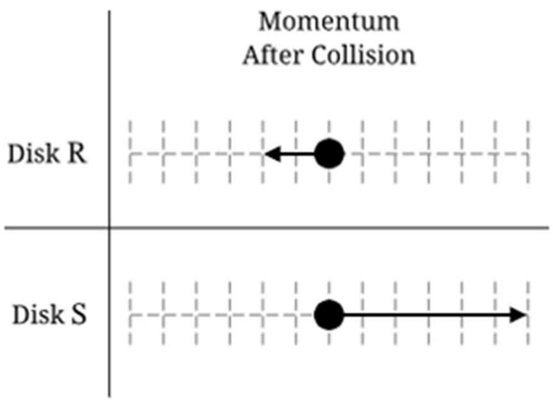
Example Response

$h_2 > h_1$. From the same volume rate of flow, if the radius of the nozzle decreases, the speed of the water leaving the nozzle will increase. Because the speed of the water leaving the nozzle increases, the maximum height reached by the water will also increase.

Question 2: Translation Between Representations (TBR) — 12 points

A	For drawing a single arrow pointing to the left for Disk R	**Point A1**
	For drawing a single arrow pointing to the right for Disk S	**Point A2**
	For drawing arrows for Disk R and Disk S that add to be 4 units to the right	**Point A3**

Example Response



B	For a multistep derivation that includes conservation of momentum	**Point B1**
	For indicating that the final momentum includes the momentums of both Disk R and Disk S	**Point B2**
	For indicating the speed of Disk S immediately after the collision is $\frac{1}{2}v_0$ **Scoring Note:** This point can be earned regardless of the subscript used for the velocity.	**Point B3**
	For indicating **both** of the following in the expression for the kinetic energy of Disk S: • $3m_0$ for the mass of Disk S • A velocity consistent with the derived expression for speed of Disk S immediately after the collision **Scoring Notes:** • This point can be earned regardless of the subscripts used in the individual terms. • A correct, isolated, algebraic equivalent of $\frac{3}{8}m_0v_0^2$ earns points B2, B3, and B4.	**Point B4**

Example Response

$$p_i = p_f$$

$$m_0v_{\mathrm{R}i} = m_0v_{\mathrm{R}f} + 3m_0v_{\mathrm{S}f}$$

$$m_0v_0 = m_0\left(-\frac{1}{2}v_0\right) + 3m_0v_{\mathrm{S}f}$$

$$m_0v_0 + m_0\left(\frac{1}{2}v_0\right) = 3m_0v_{\mathrm{S}f}$$

$$v_0 + \frac{1}{2}v_0 = \frac{3}{2}v_0 = 3v_{\mathrm{S}f}$$

$$v_{\mathrm{S}f} = \frac{1}{2}v_0$$

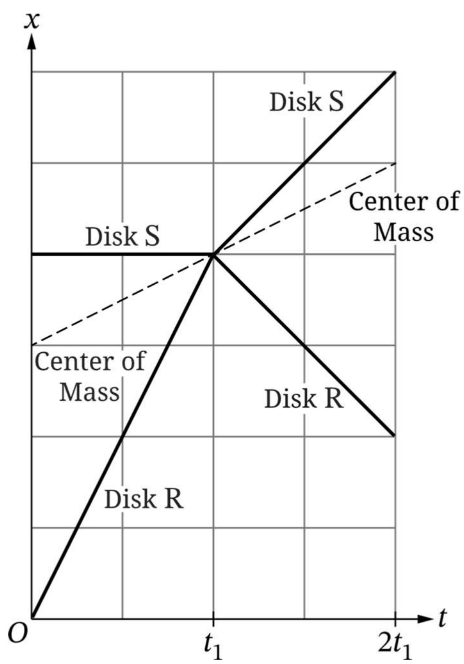
$$K_{\mathrm{S}f} = \frac{1}{2}m_{\mathrm{S}}v_{\mathrm{S}f}^2$$

$$K_{\mathrm{S}f} = \frac{1}{2}(3m_0)\left(\frac{1}{2}v_0\right)^2$$

$$K_{\mathrm{S}f} = \frac{3}{8}m_0v_0^2$$

C	For drawing a continuous, straight line for the center of mass for $t > t_1$ with the same slope as the line drawn for $0 < t \le t_1$	**Point C1**
	For drawing and labeling the correct straight line for Disk R for $t > t_1$	**Point C2**
	For **one** of the following: • Drawing and labeling a continuous, straight line for Disk S for $t > t_1$ where the slope is positive and greater than the slope of the center of mass line for $0 < t \le t_1$ • Drawing and labeling a continuous, straight line for Disk S for $t > t_1$ where the center of mass line falls between the lines drawn for Disk S and Disk R, and for any one time for $t > t_1$, Disk S is closer to the center of mass than Disk R is	**Point C3**

Example Response



D	For a single claim that indicates $\lvert\Delta p_R\rvert = \lvert\Delta p_S\rvert$	**Point D1**
	For a justification that indicates **one** of the following: • Momentum is conserved. • Momentum is constant. • The net external force exerted on the system is zero. • The internal forces are equal in magnitude and opposite in direction (Newton's third law). • The net impulse exerted on the system is zero. • The magnitude of the impulse delivered to Disk R by Disk S is equal to the magnitude of the impulse delivered to Disk S by Disk R.	**Point D2**
	Example Response $\lvert\Delta p_R\rvert = \lvert\Delta p_S\rvert$, *because the net external force exerted on the system is zero.*	

Question 3: Experimental Design and Analysis (LAB) — 10 points

A **(i)** For indicating **both** of the following measurements: **Point A1**

- Release height (h)
- Sliding distance (d)

Scoring Note: Providing symbols for the measured quantities is not required to earn this point. The symbols given in part A and B are provided to streamline examples of acceptable responses in part B.

(ii) For describing an acceptable method of reducing experimental uncertainty **Point A2**

Examples of acceptable responses may include the following:

- Complete multiple trials with different release heights
- Complete multiple trials for a single release height

Example Response

Release the block from a height on the ramp and allow the block to slide down onto the surface, slide across, and come to rest. Measure the height (h) of release and the distance (d) the block slides across the surface before coming to rest. Repeat this for various initial release heights.

B **(i)** For describing a graph that could be used to determine the coefficient of kinetic friction **Point B1**

Examples of acceptable responses may include the following:

- A graph of release height (h) as a function of sliding distance (d)
- A graph of sliding distance (d) as a function of release height (h)

Scoring Notes:

- Any response that correctly identifies the functional dependence between release height and sliding distance earns this point, regardless of any coefficients that contain numbers or physical/fundamental constants.
- This point may be earned independently of the response in part A.

(ii) For describing how the slope of the graph can be used to determine the coefficient of kinetic friction **Point B2**

Examples of acceptable responses may include the following:

Graph	Analysis
h vs. d	Slope $= \mu_k$ OR μ_k = Slope
d vs. h	Slope $= \dfrac{1}{\mu_k}$ OR $\mu_k = \dfrac{1}{\text{Slope}}$

Example Response

Graph the release height (h) as a function of the distance the block slides across the surface of the table (d). The slope of this graph will be equal to μ_k .

C **(i)** For labeling the vertical axis with a quantity (including units) that could be plotted to produce a linear graph whose slope can be used to determine μ_k — **Point C1**

Examples of acceptable responses may include the following:

- v^2 $\left(\mathrm{m}^2/\mathrm{s}^2\right)$
- $\dfrac{v^2}{2}$ $\left(\mathrm{m}^2/\mathrm{s}^2\right)$
- $\dfrac{v^2}{g}$ (m)
- $\dfrac{v^2}{2g}$ (m)

Scoring Note: Any response that correctly identifies the functional dependence between speed and distance earns this point, regardless of any coefficients that contain numbers or physical/fundamental constants.

(ii) For labeling the vertical axis with a linear scale — **Point C2**

For correctly plotting data points consistent with quantities indicated in C (i) — **Point C3**

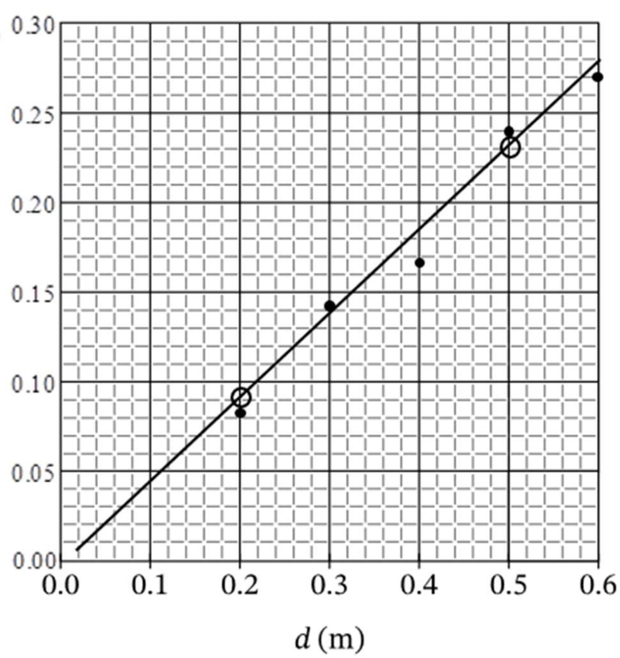
(iii) For drawing an appropriate best-fit line that approximates the trend of the data — **Point C4**

Scoring Note: If the graph produced is nonlinear, then a line or curve that approximates the trend of that data can earn this point.

Example Response

Quantity (units, if appropriate)

v^2 $\left(\mathrm{m}^2/\mathrm{s}^2\right)$



D For correctly relating the slope of the best-fit line to the value of μ_k **Point D1**

Examples of acceptable responses may include the following:

Vertical Axis	**Analysis**
v^2	$\text{Slope} = 2g(\sin\theta - \mu_k \cos\theta)$ OR $\mu_k = \dfrac{\sin\theta - \dfrac{\text{Slope}}{2g}}{\cos\theta}$
$\dfrac{v^2}{2}$	$\text{Slope} = g(\sin\theta - \mu_k \cos\theta)$ OR $\mu_k = \dfrac{\sin\theta - \dfrac{\text{Slope}}{g}}{\cos\theta}$
$\dfrac{v^2}{g}$	$\text{Slope} = 2(\sin\theta - \mu_k \cos\theta)$ OR $\mu_k = \dfrac{\sin\theta - \dfrac{\text{Slope}}{2}}{\cos\theta}$
$\dfrac{v^2}{2g}$	$\text{Slope} = \sin\theta - \mu_k \cos\theta$ OR $\mu_k = \dfrac{\sin\theta - \text{Slope}}{\cos\theta}$

For calculating a value of μ_k within a range of 0.53 to 0.57 **Point D2**

Example Response

$\text{Slope} = 2g(\sin\theta - \mu_k \cos\theta)$

$\text{Slope} = \dfrac{\Delta v^2}{\Delta d} = \dfrac{0.23\ \text{m}^2/\text{s}^2 - 0.09\ \text{m}^2/\text{s}^2}{0.50\ \text{m} - 0.20\ \text{m}}$

$\text{Slope} = 0.47\ \text{m/s}^2$

$0.47\ \text{m/s}^2 = (2)(9.8\ \text{m/s}^2)(\sin 30^\circ - \mu_k \cos 30^\circ)$

$\mu_k = 0.55$

Question 4: Qualitative Quantitative Translation (QQT) — 8 points

A

For indicating $\omega_Y > \omega_X$ — **Point A1**

For a justification that relates the final angular speed (or acceleration) to the rotational inertia using **one** of the following: — **Point A2**

- The torque exerted on each toy about its axle
- The work done on each toy
- The change in kinetic energy of each toy
- The angular acceleration of each toy about its axle
- The change in angular momentum of each toy about its axle

For a justification that indicates **one** of the following: — **Point A3**

- The torque exerted on each toy about its axle is the same.
- The work done on each toy is the same.
- The change in kinetic energy of each toy is the same.
- The angular acceleration of each toy about its axle is different.
- The change in angular momentum of each toy about its axle is different.

Example Response

The same force is exerted on both toys over the same distance, and so the work done is the same on both toys. This means that the change in kinetic energy of both toys is the same. So, Toy Y has a larger angular speed since it has a smaller rotational inertia with the same change in kinetic energy.

B	For a multistep derivation that includes Newton's second law in rotational form	**Point B1**
	For indicating **one** of the following: • $F_0 r_0$ for the torque exerted on Toy X • A relevant rotational kinematic equation or combination of equations • $\frac{\ell_0}{r_0}$ for the angular displacement of Toy X **Scoring Note:** Subscripts are not required to earn this point.	**Point B2**
	For a correct expression for ω_X in terms of the given quantities **Scoring Note:** A correct, isolated, algebraic equivalent of $\sqrt{\frac{2F_0\ell_0}{I_X}}$ earns points B2 and B3.	**Point B3**
	Example Response $\tau = I_X\alpha = F_0 r_0$ $\ell_0 = r_0\Delta\theta$ $\omega_X^2 - \omega_0^2 = 2\alpha\Delta\theta$ $\omega_X^2 = 2\alpha\Delta\theta$ $\omega_X^2 = 2\left(\frac{F_0 r_0}{I_X}\right)\left(\frac{\ell_0}{r_0}\right)$ $\omega_X = \sqrt{\frac{2F_0\ell_0}{I_X}}$	
	Alternate Solution	***ALT***
	For a multistep derivation that includes work and rotational kinetic energy	***Point B1***
	*For indicating **one** of the following:* • $F_0 r_0$ *for the torque exerted on Toy X* • $\frac{1}{2}I_X\omega_X^2$ *for the kinetic energy of Toy X* • $F_0\ell_0$ *for the work exerted on Toy X* • $\tau\Delta\theta$ *for the work exerted on Toy X* • $\frac{\ell_0}{r_0}$ *for the angular displacement of Toy X* ***Scoring Note:*** *Subscripts are not required to earn this point.*	***ALT*** **Point B2**

	For a correct expression for ω_X in terms of the given quantities ***Scoring Note:*** *A correct, isolated, algebraic equivalent of $\sqrt{\dfrac{2F_0\ell_0}{I_X}}$ earns points B2 and B3.*	***ALT*** **Point B3**
	Alternate Example Response $W = \Delta K$ $F_0\ell_0 = \dfrac{1}{2}I_X\omega_X^2 - 0$ $F_0\ell_0 = \dfrac{1}{2}I_X\omega_X^2$ $\omega_X = \sqrt{\dfrac{2F_0\ell_0}{I_X}}$	
C	For attempting to address the functional dependence between the angular speed and the rotational inertia **Scoring Note:** It is not necessary to use the functional dependence correctly to earn the first point. The response only needs to use functional dependence language such as proportional, inversely proportional, related, numerator, denominator, etc. to relate the angular speed and the rotational inertia.	**Point C1**
	For correctly using functional dependence to evaluate the relationship between the angular speed and the rotational inertia, consistent with the reasoning in part A and derived expression in part B	**Point C2**
	Example Response *The equation I derived in part B shows that the angular speed of the toy is inversely related to the rotational inertia of the toy. Therefore, because the rotational inertia of Toy Y is less than the rotational inertia of Toy X, the angular speed of Toy Y is greater than the angular speed of Toy X. This is consistent with my answer in part A.*	