2026

AP® Physics 2: Algebra-Based

Free-Response Questions

PHYSICS 2
SECTION II
TIME – 1 HOUR AND 40 MINUTES

Directions:

Section II has 4 questions and lasts 1 hour and 40 minutes.

You may use the available paper for scratch work and planning, but only work written in the free-response booklet will be scored. Any work done on scratch paper will not be scored. Label parts (e.g., A, B, C) and sub-parts (e.g., i, ii, iii) as needed. Use a pencil or a pen with black or dark blue ink to write your responses.

A calculator is allowed in this section, as well as a ruler and straightedge. You may use a handheld four-function, scientific, or graphing calculator, or the calculator available in this application. Reference information, including lists of equations, can be used throughout the exam. A digital version is available in this application.

All final numerical answers should include appropriate units when applicable. Credit for your work depends on demonstrating that you know which physical principles to apply in a particular situation. Credit will be awarded only for work that is clearly designated as the solution to a specific part of a question. Credit also depends on the quality of your solutions and explanations. Therefore, you should show your work for each part in the space provided for that part. If you need more space, be sure to clearly indicate where you continue your work. When constructing a graph or diagram, use only one color of ink or pencil.

You may pace yourself as you answer the questions in this section, or you may use these optional timing recommendations:

It is suggested that you spend about 25 minutes each on Questions 1 and 3, about 30 minutes on Question 2, and about 20 minutes on Question 4.

You can go back and forth between questions in this section until time expires. The clock will turn red when 5 minutes remain—**the proctor will not give you any time updates or warnings.**

Note: This exam was originally administered digitally. It is presented here in a format optimized for teacher and student use in the classroom.

During the AP Exam administration, students have access to reference information. To see the reference information for this course, please visit AP Central: https://apcentral.collegeboard.org/exam-administration-ordering-scores/administering-exams/subject-specific/reference-information

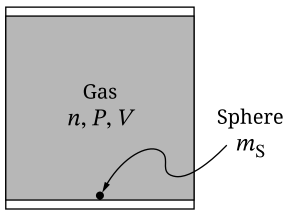
Question 1: Version J

1. Part A

A sample of n moles of a monatomic, ideal gas is in a large, sealed, thermally conducting container with fixed volume. A small sphere of mass m_S is in the container. The volume of the sphere is much less than the volume of the container.

The gas is initially in State X with pressure P and volume V, as shown in Figure 1.

Figure 1



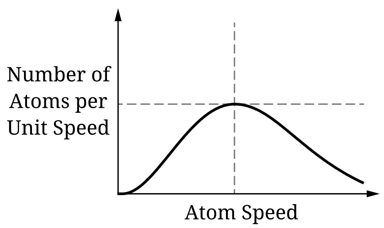
State X

Note: Figure not drawn to scale.

The sphere is initially in thermal equilibrium with the gas. The gas undergoes a heating process until the gas is in State Y with pressure $3P$ and the sphere is again in thermal equilibrium with the gas. The total energy transferred to the sphere during the heating process is Q_S.

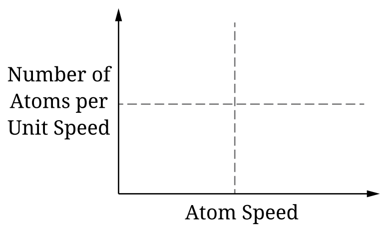
i. The graph in Figure 2 represents the number of atoms per unit speed as a function of atom speed for the gas when the gas is in State X. On Figure 3, **sketch** a curve that could represent the number of atoms per unit speed as a function of atom speed for the gas when the gas is in State Y.

Figure 2



State X

Figure 3



State Y

AP PHYSICS 2: ALGEBRA-BASED 2026 ▪ **FREE-RESPONSE QUESTIONS**

ii. **Derive** an expression for the change ΔT in temperature of the gas for the heating process that the gas undergoes as the gas changes from State X to State Y. Express your answer in terms of n, P, V, and physical constants, as appropriate. Begin your derivation by writing a fundamental physics principle or an equation from the reference information.

iii. **Derive** an expression for the specific heat c_S of the sphere. Express your answer in terms of n, m_S, P, V, Q_S, and physical constants, as appropriate. Begin your derivation by writing a fundamental physics principle or an equation from the reference information.

Part B

An insulated container is filled with a liquid of mass m_L and specific heat c_L. The original sphere is submerged in the liquid. The sphere has mass m_S, where $m_S < m_L$, and specific heat c_S, where $c_S < c_L$. The initial temperature of the sphere is greater than the initial temperature of the liquid. Later, the liquid and the sphere reach thermal equilibrium. The absolute values of the changes in the temperatures of the liquid and the sphere are $|\Delta T_L|$ and $|\Delta T_S|$, respectively.

Indicate whether $|\Delta T_S|$ is greater than, less than, or equal to $|\Delta T_L|$. Include one of the following relationships in your response.

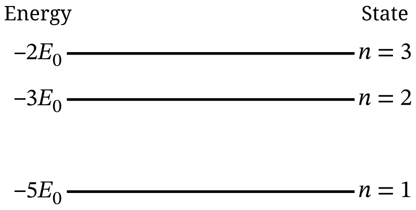
- $|\Delta T_S| > |\Delta T_L|$
- $|\Delta T_S| < |\Delta T_L|$
- $|\Delta T_S| = |\Delta T_L|$

Justify your answer. Your justification may include expressions/equations but must include conceptual reasoning beyond algebraic solutions.

Question 2: Version J

2. Figure 1 represents the energy levels and their corresponding states for a hypothetical atom.

Figure 1



Part A

On Figure 1, **draw** arrows to represent all possible atomic transitions that could result in the emission of a photon.

Part B

Derive an expression for the wavelength of the highest-energy photon that can be emitted from the atom. Express your answer in terms of E_0 and physical constants, as appropriate. Begin your derivation by writing a fundamental physics principle or an equation from the reference information.

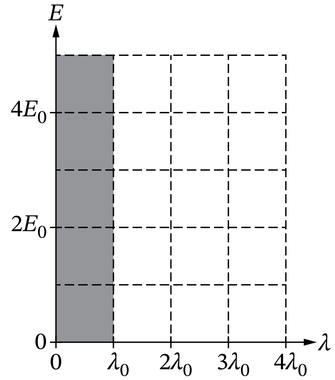
The following information applies to parts C and D.

A device can emit monochromatic electromagnetic radiation. The wavelength λ of the radiation can be varied over a continuous range of wavelengths.

Part C

On Figure 2, **sketch** the energy E of emitted photons from the device as a function of λ for $\lambda_0 < \lambda < 4\lambda_0$. Photons with wavelength λ_0 have energy $4E_0$. Sketches made in the shaded region will not be scored.

Figure 2



Part D

A student claims that, based on the energy states shown in Figure 1, the atom can emit a photon of wavelength λ_0 and energy $4E_0$ like the device described in part C.

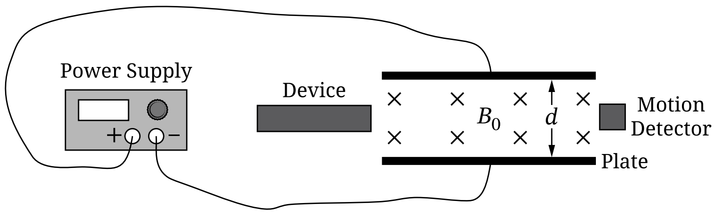
Indicate whether the claim is correct or incorrect. Briefly **justify** your answer by referencing the representation in part A.

Question 3

The following information applies to parts A and B.

3. In Experiment 1, scientists want to collect data that can be graphed to determine the magnitude B_0 of an external, uniform magnetic field. The field is directed into Figure 1 in the region between identical, parallel, conducting plates that are connected to a power supply of variable emf ε. The plates are a known distance d apart, where d is much smaller than the dimensions of the plates.

Figure 1



Note: Figure not drawn to scale.

In each trial, a device emits small, charged spheres with speed v through the region between the plates. ε is varied until the spheres move undeflected toward a motion detector. The scientists can vary v between trials. Gravitational effects are negligible.

In addition to the equipment shown in Figure 1, the scientists also have access to a voltmeter. The scientists do not have access to other measuring tools, devices, sensors, or equipment.

Part A

i. **Indicate** quantities that could be measured using the available equipment that would allow the scientists to determine B_0 by using a linear graph.

ii. Briefly **describe** a method to reduce experimental uncertainty for the measured quantities indicated in part A (i).

Part B

i. **Indicate** what quantities the scientists could graph on the horizontal and vertical axes to create a linear graph that can be used to determine B_0. Clearly indicate which quantity corresponds to each axis.

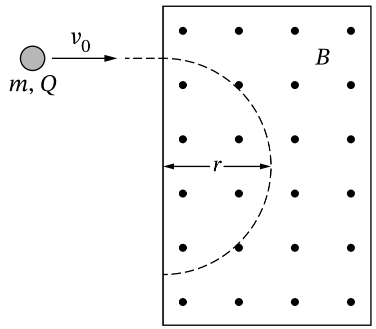
ii. Briefly **describe** the relationship between B_0 and one feature of the graph from part B (i). Your answer may include an equation that relates B_0 and the indicated feature of the graph.

The following information applies to parts C and D.

In Experiment 2, scientists want to use a graph to determine the mass m of identical, charged particles that are emitted from a device. Each particle has charge $Q = +6.4 \times 10^{-19}$ C.

In each trial, a particle is emitted with speed $v_0 = 3.0 \times 10^6$ m/s toward a region of external, uniform magnetic field of variable magnitude B. The radius r of the path along which the particle moves while in the field, shown in Figure 2, is recorded.

Figure 2



In subsequent trials, B is increased and the resulting r is recorded. Gravitational effects are negligible. Collected data are provided in Table 1.

Table 1

B (T)	r (m)
0.04	1.8
0.06	1.2
0.14	0.5
0.16	0.4
0.20	0.3

Part C

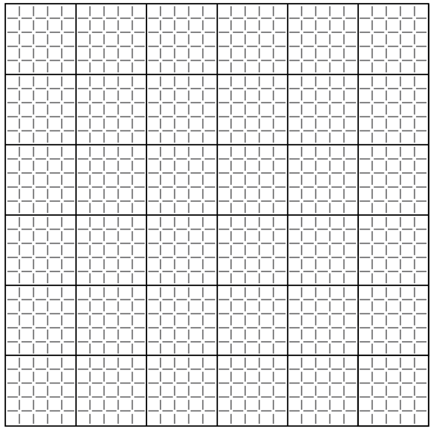
i. **Label** the axes of the grid provided with measured or calculated quantities. Include units, as appropriate. The graphed quantities should yield a linear graph that can be used to determine m.

ii. On the grid, create a graph of the quantities indicated in part C (i).

- **Label** the vertical and horizontal axes with numerical scales.
- **Plot** the corresponding data points on the grid.
- Table 2 is provided in your booklet for scratch work, but the table will not be scored.

Quantity (units, if appropriate)

__________ __________



Quantity (units, if appropriate)

__________ __________

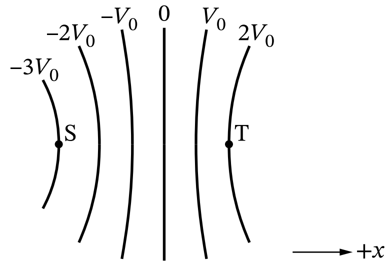
iii. **Draw** a best-fit line for the data graphed in part C (ii).

Part D

Calculate m from the best-fit line drawn on the grid.

Question 4

4. Equipotential lines for a region with an electric field are shown.



A small sphere (not shown) with positive charge $+Q$ has initial speed v_S in the $+x$-direction and kinetic energy K_S when the sphere is at Point S. The sphere moves to Point T. The force from the electric field is the only force that is exerted on the sphere as the sphere moves between Points S and T.

The sphere has final speed v_T and kinetic energy K_T when the sphere is at Point T.

Part A

Indicate whether v_T is greater than, less than, or equal to v_S. Include one of the following relationships in your response.

- $v_T > v_S$
- $v_T < v_S$
- $v_T = v_S$

Justify your answer. Your justification may include expressions/equations but must include conceptual reasoning beyond algebraic solutions.

Part B

Derive an expression for K_T in terms of V_0, Q, K_S, and physical constants, as appropriate. Begin your derivation by writing a fundamental physics principle or an equation from the reference information.

Part C

A new, small sphere of the same mass as the original sphere but with negative charge $-Q$ has the same initial speed v_S as the original sphere in the $+x$-direction when the sphere is at Point S. The force from the electric field is the only force that is exerted on the new sphere as the new sphere moves between Points S and T. The new sphere has kinetic energy K_{new} when the new sphere is at Point T.

Indicate whether K_{new} is greater than, less than, or equal to K_T. Include one of the following relationships in your response.

- $K_{new} > K_T$
- $K_{new} < K_T$
- $K_{new} = K_T$

Briefly **justify** your answer by referencing your derivation in part B.

STOP

END OF EXAM