AP® Physics C
1985 Scoring Guidelines

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Mechanics

	Distribution of points
Mech. 1. (a) 5 points	
$v_{0y} = (50 \text{ m/s}) \sin 37° = (50 \text{ m/s})(.60) = 30 \text{ m/s}$	1 point
$y = y_0 + v_{0y}t + \frac{1}{2}at^2$	1 point
$0 = (35 \text{ m}) + (30 \text{ m/s})t - \frac{1}{2}(10 \text{ m/s}^2)t^2$	2 points
(1 point for $y = 0$, 1 point for correct substitutions on right-hand side)	
For corretion solution, $t = 7$ s	1 point
Full credit was given for alternate equivalent solutions.	
(b) 3 points	
$R = v_{0x}t$	1 point
$R = (50 \text{ m/s})(\cos 37°)(7 \text{ s})$ (i.e., for correct substitution)	1 point
For correct solution, $R = 280$ m	1 point
(c) 5 points	
$v_A = v_{0x} = 40 \text{ m/s}$	1 point
$v_B = v_0 = 50 \text{ m/s}$	1 point
For v_C: For any mention of energy	1 point
For conserving energy	1 point
$\frac{1}{2}mv_C^2 = \frac{1}{2}mv_0^2 + mgh$	
$v_C = \sqrt{v_0^2 + 2gh}$	
$= \sqrt{(50 \text{ m/s})^2 + 2(10 \text{ m/s}^2)(35 \text{ m})} = \sqrt{3200 \text{ m}^2/\text{s}^2}$	
$v_C = 56.6$ m/s	1 point
Full credit was given for alternate equivalent solutions (e.g., if time of travel from point B to point C is known from part (a), kinematic equations can be used)	
(d) 2 points	
For any use of momentum or center of mass	1 point
$x(10 \text{ kg}) = (30 \text{ m})(6 \text{ kg})$	
$x = 18$ m	1 point
Mech. 2. (a) 5 points	
$f_s = \mu_s N$	1 point
$f_s = mg \sin\theta$ or $w \sin\theta$	1 point
$N = mg \cos\theta$ or $w \cos\theta$	1 point
$\mu_s = \frac{f_s}{N} = \frac{mg \sin\theta}{mg \cos\theta} = \tan\theta$	2 points
Alternate solution using $F = ma$:	*(Alternate points)*
$N - mg\cos\theta = 0$	(1 point)
$f_s - mg\sin\theta = ma$	(1 point)
$f_s = \mu_s N$	(1 point)
$\mu_s mg\cos\theta - mg\sin\theta = ma$	
$\mu_s = \frac{mg\sin\theta + ma}{mg\cos\theta} = \tan\theta + \frac{a}{g\cos\theta}$	(1 point)
$a = 0$, therefore $\mu_s = \tan\theta$	(1 point)

Distribution of points

(b) 5 points

$\Delta E = \Delta K + \Delta U$

The initial and final points are at the highest point on the incline and the point of full spring compression, respectively.

$\Delta K = 0$ — 1 point

$\Delta U = \Delta U_{gravity} + \Delta U_{spring}$

$\Delta U_{gravity} = mgh = mg(d + x)\sin\theta$ — 2 points

$\Delta U_{spring} = -\frac{1}{2}kx^2$ — 2 points

$\Delta E = mg(d + x)\sin\theta - \frac{1}{2}kx^2$

1 point was deducted if the student did not write down the final expression for ΔE.

2 points were awarded if the student tried to solve this part using frictional force and showed

$\Delta E = f_k(d + x)$ *or* $\Delta E = \mu_k N(d + x)$ *or* $\Delta E = \mu_k mg\cos\theta\,(d + x)$

(c) 5 points

$W_{fric} = \Delta E = f_k(d + x)$ — 1 point

$f_k = \mu_k N$ — 1 point

$\mu_k N(d + x) = mg\sin\theta\,(d + x) - \frac{1}{2}kx^2$ — 2 points

1 point was deducted if the factor of $(d + x)$ was missing from left hand side.

$N = mg\cos\theta$

$$\mu_k = \frac{mg\sin\theta\,(d + x) - \frac{1}{2}kx^2}{mg\cos\theta\,(d + x)}$$

$$\mu_k = \tan\theta - \frac{kx^2}{2(d + x)mg\cos\theta}, \text{ or}$$ — 1 point

$$\mu_k = \mu_s - \frac{kx^2}{2(d + x)mg\cos\theta}$$

Since $\mu_k < \mu_s$, the minus sign in the above expression is important. If the signs were interchanged in this expression, 1 point was deducted.

Distribution of points

Mech. 3. (a) 4 points

For indicating tension vectors	1 point
For indicating weight vectors	1 point
For indicating different tensions on each block	1 point
For indicating different weights for each block	1 point
(The last 2 points were also awarded if such indications were made in the solution of subsequent parts.)	

(b) 5 points

i. For applying $F = ma$	1 point
$T_1 - mg = ma$	1 point
$2mg - T_2 = 2ma$	1 point
The sign of the acceleration is arbitrary in these two equations.	
ii. $I\alpha = (T_2 - T_1)r$	2 points
1 point for torque $= I\alpha$	
1 point for torque $= (T_2 - T_1)r$	

(c) 3 points

$\alpha = \frac{a}{r}$	1 point
For using the system of three equations obtained in part (b)	1 point

$$\left.\begin{aligned} T_1 &= m(g + a) \\ T_2 &= 2m(g - a) \end{aligned}\right] \rightarrow T_2 - T_1 = mg - 3ma$$

$$I\frac{a}{r} = \frac{3}{2}mr^2\frac{a}{r} = (mg - 3ma)r$$

$a = \frac{2}{9}g$ — 1 point

(d) 1 point

$T_1 = m(g + a) = m(g + \frac{2}{9}g) = \frac{11}{9}mg$ — 1 point

Full credit was awarded for answer that was consistent with previous work.

Distribution of points

(e) 2 points

$N = 7mg + T_1 + T_2$ or a clear indication that the normal force is different from the static weight — 1 point

$$T_2 = 2m\left(g - \frac{2}{9}g\right) = \frac{14}{9}mg$$

$$N = 7mg + \frac{11}{9}mg + \frac{14}{9}mg = \frac{88}{9}mg$$ — 1 point

Electricity and Magnetism

E&M 1. (a) 4 points

$\int \vec{E} \cdot d\vec{A} = q/\varepsilon_0$ *or* $4\pi kq$ — 2 points

$E(2\pi rL) = q/\varepsilon_0$ *or* $4\pi kq$ — 1 point

$E = \frac{q}{2\pi\varepsilon_0 rL}$ *or* $\frac{2kq}{rL}$ — 1 point

(b) 5 points

$V = -\int_a^b \vec{E} \cdot d\vec{\ell}$ ($V = \int E d\ell$ was acceptable) — 2 points

$V = -\int_a^b \frac{q}{2\pi\varepsilon_0 L}\frac{dr}{r}$ — 1 point

$V = -\frac{q}{2\pi\varepsilon_0 L}[\ln r]_b^a$ — 1 point

$V = \frac{q}{2\pi\varepsilon_0 L}\ln\left(\frac{b}{a}\right)$ *or* $\frac{2kq}{L}\ln\left(\frac{b}{a}\right)$ — 1 point

No deduction was taken for reversal of limits of integration.

(c) 3 points

$C_0 = \frac{q}{V}$ — 2 points

$C_0 = \frac{2\pi\varepsilon_0 L}{\ln(b/a)}$ *or* $\frac{L}{2k\ln(b/a)}$ — 1 point

1 point was deducted if the value of C_0 was negative, as would be the case if the expression contained $\ln(a/b)$.

(d) 3 points

$C = C_1 + C_2$ *or* the capacitors are parallel — 1 point

$C_1 = k\frac{1}{3}C_0 = \frac{2}{3}C_0$ — 1 point

$C_2 = \frac{2}{3}C_0$ — 1 point

$C = \frac{4}{3}C_0$

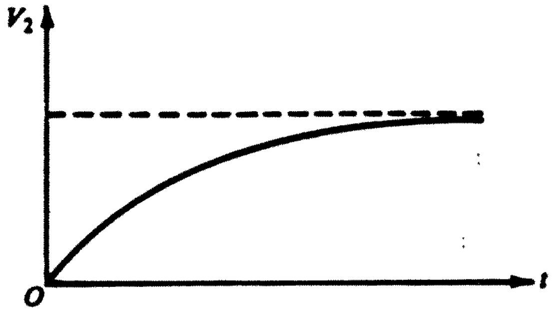
Full credit was awarded for correct final answer, regardless of the method used by the student.

Distribution of points

E&M 2. (a) 3 points

$V = iR$ or equivalent (may appear here or in part (c))	1 point
For correct substitutions, $V = 3000$ V and $R = 5 \times 10^5\ \Omega$	1 point
For correct answer, $i_1 = .006$ A	1 point

(b) 3 points



For starting curve at the origin	1 point
For showing V_2 asymptotic to a positive final value	1 point
For showing V_2 monotonically increasing and exponential	1 point

(c) 2 points

$i_1 = i_2$ *or* $\frac{V}{R} = \frac{3000\text{ V}}{15 \times 10^5\Omega}$ *or* a statement indicating the series nature of the circuit in this situation	1 point
For correct answer, $i_2 = .002$ A	1 point

(d) 2 points

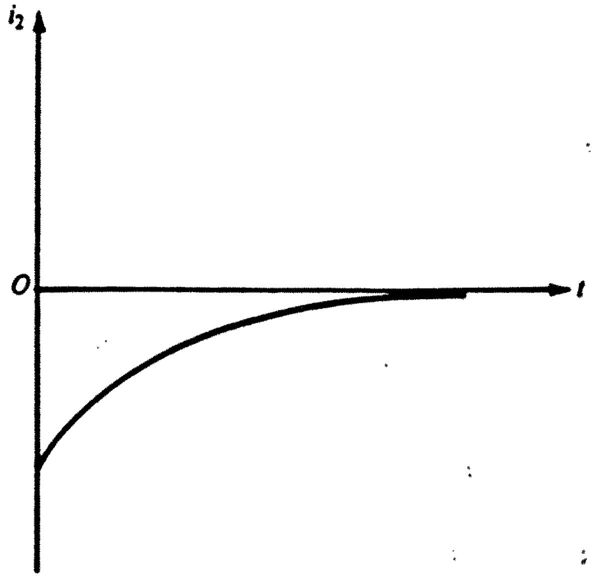
$Q = CV$ and/or $V = 2000$ V	1 point
For correct answer, $Q = .01$ C	1 point

(e) 2 points

$U = \frac{1}{2}QV$ or equivalent	1 point
For correct answer, $U = 10$ J	1 point

Distribution of points

(f) 3 points



For non-zero initial value	1 point
For showing i_2 asymptotic to zero	1 point
For showing i_2 monotonically approaching the final value and exponential.	1 point

1 point was deducted if parts (a) and (c) were both correct but no work was shown.

1 point was awarded if at least one graph showed an exponential form and no other points were available.

E&M 3. (a) 5 points

$\mathcal{E} = -\frac{d\Phi}{dt}$ (negative sign not required) — 2 points

$\Phi = BA$ — 1 point

$\frac{d\Phi}{dt} = \frac{dB}{dt}A$

$A = \pi r^2$ — 1 point

$\mathcal{E} = \frac{dB}{dt}\pi r^2 = (60\ \text{T/s})\pi(.5\ \text{m})^2 = 15\pi\ \text{V} = 47\ \text{V}$ — 1 point

(b) 4 points

For showing $\vec{E}$ directed to the left at point P on diagram — 1 point

$\mathcal{E} = Ed$ — 1 point

$d = 2\pi r$ — 1 point

$E = \frac{\mathcal{E}}{d} = \frac{\mathcal{E}}{2\pi r} = \frac{47\ \text{V}}{2\pi(.5\ \text{m})} = 15\ \text{V/m}$ — 1 point

(c) 3 points

$F = \frac{mv^2}{r}$ — 1 point

$F = qvB$ — 1 point

Thus $\frac{mv^2}{r} = qvB$

$v = \frac{qrB}{m} = \frac{(1.6 \times 10^{-19}\ \text{C})(.5\ \text{m})(10^{-4}\ \text{T})}{9.11 \times 10^{-31}\ \text{kg}} = 8.8\ 10^6\ \text{m/s}$ — 1 point

Distribution of points

(d) 3 points

$F = ma$ — 1 point

$F = qE$ — 1 point

Thus $ma = qE$

$a = \frac{qE}{m} = \frac{(1.6 \times 10^{-19}\ \mathrm{C})(15\ \mathrm{V/m})}{9.11 \times 10^{-31}\ \mathrm{kg}} = 2.6 \times 10^{12}\ \mathrm{m/s^2}$ — 1 point

1 point was awarded for merely stating that $a = \frac{dv}{dt}$