

# **AP**<sup>®</sup> Physics C 1977 Scoring Guidelines

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## 1977 C: Mech.-1

(or correct application of limits)

Solution	Distribution
a) 3 points	of Points
$W = \triangle KE$	2
$W = -\frac{1}{2} m v_0^2$	1
b) 3 points	
$\overline{F} = ma$	1
$\vec{F} = -k\vec{v}$	1
$a = -\frac{k\overline{v}}{m}$	1
c) 5 points	
$\frac{\mathrm{d}\mathbf{v}}{\mathbf{v}} = -\frac{\mathbf{k}}{\mathbf{m}}\mathrm{d}\mathbf{t}$	1
$\ln v = -\frac{k}{m}t + K$	2
where $K = ln v_0$	1
Thus, $v = v_0 e^{-(k/m)t}$	1

28

#### d) 4 points

$$\frac{ds}{dt} = v_0 e^{-(k/m)t} \text{ or } ds = v_0 e^{-(k/m)t} dt$$

$$s = -\frac{mv_0}{k}\,e^{-(k/m)\,t} + K$$

where 
$$K = mv_0/k$$

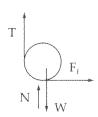
Thus, 
$$s = \frac{mv_0}{k} [1 - e^{-(k/m)t}]$$

as 
$$t \to \infty$$
,  $s \to mv_0/k$ 

#### 1977 C: Mech.-2

Solution Distribution of Points

## a) 4 points



T = tension in string
N = normal force of surface
W = weight of cylinder

W = weight of cylinder  $F_f$  = frictional force

1 point for each force whose direction was correctly shown

#### b) 5 points

$$N = W - T = Mg - \frac{3}{5}Mg = \frac{2}{5}Mg$$

$$F_f = \mu N = \frac{1}{2} \cdot \frac{2}{5} Mg = \frac{1}{5} Mg$$

 $F_f$  is the force which causes horizontal acceleration.

$$a = \frac{F_f}{M} = \frac{1/5}{M} \frac{Mg}{M} = 1/5 g$$

The above points were awarded even if previous steps were incorrect or if algebra was wrong; a fifth point was awarded for correct algebra leading to a multiple of g as an answer.

1

1

## c) 4 points

$$\alpha = \frac{\tau}{1}$$

$$\tau = \tau_{\text{string}} - \tau_{\text{friction}}$$

$$\tau = FR$$
 (whatever force was used)

$$I = \frac{1}{2}MR^2$$
 and correct algebra

$$\alpha = \frac{4}{5} g/R$$

#### d) 2 points

a  $\neq \alpha R$  because the cylinder *slips* on the surface 2

(because energy is lost due to friction)

1

#### 1977 C: Mech.-3

DistributionSolution of Points

## a) 5 points

$$F_{g} = \frac{GMM}{(2R)^{2}}$$

$$F_{c} = \frac{Mv^{2}}{R}$$

$$1$$

$$F_{g} = F_{c} \Longrightarrow \frac{GMM}{4R^{2}} = \frac{Mv^{2}}{R}$$

$$1$$

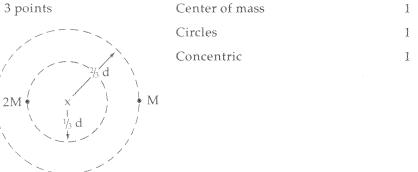
$$v = \frac{1}{2} \sqrt{\frac{GM}{R}}$$

$$1$$

# b) 5 points

$$\begin{split} E_T &= PE + KE & 1 \\ KE &= 2(\frac{1}{2}Mv^2) & 1 \\ &= \frac{M}{4} \, \sqrt{\frac{GM}{R}}^2 = \frac{GM^2}{4R} & 1 \\ PE &= -\frac{GMM}{2R} & 1 \\ E_T &= \frac{GM^2}{4R} - \frac{GM^2}{2R} = -\frac{GM^2}{4R} & 1 \end{split}$$

# c) 3 points



## d) 2 points

$$\begin{split} F_{G2m} &= F_{Gm} \\ \frac{2Mv_{2m}^2}{^{1}\!\!/_{\!3}\;d} &= \frac{Mv_m^2}{^{2}\!\!/_{\!3}\;d} \, \bigg\} \\ &\qquad \qquad 1 \\ \frac{v_2}{v_1} &= \frac{1}{2} \end{split}$$

# Alternate:

$$\omega_1 = \omega_2$$

$$R_2 \mathbf{v}_2 = R_1 \mathbf{v}_1$$

$$\frac{\mathbf{v}_2}{\mathbf{v}_2} = \frac{1}{2}$$
1

Alternate:

$$\begin{split} T_1 &= T_2 \\ \frac{v_2}{v_1} &= \frac{2\pi R_2}{2\pi R_1} \\ \frac{v_2}{v_1} &= \frac{1/3}{2/3} \frac{d}{d} = \frac{1}{2} \end{split}$$

1977 C: E&M-1

Solution Distribution of Points

a) 4 points

Since all parts of the ring are at the same distance from P,

$$V = \frac{kQ}{\sqrt{R^2 + x^2}}$$
 Positive quantity including kQ or Q/ $\epsilon_0$ 

Dimensionally correct answer 1
Use of  $\sqrt{R^2 + x^2}$  as the relevant distance 1

1

Correct magnitude of answer

If students did c) first, then used  $V=-\int \vec{E}\cdot d\vec{l}$ , the result was graded by these same criteria.

b) 2 points

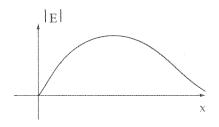
V is maximum at x = 0 where  $\sqrt{R^2 + x^2}$  is smallest.

c) 5 points

$$E = \frac{kQ}{r^2}\cos\theta = \frac{kQ}{R^2 + x^2} \cdot \frac{x}{\sqrt{x^2 + R^2}} = \frac{kQx}{(R^2 + x^2)^{3/2}} \text{ directed to right}$$

Inverse-square 1 
$$r^2 = R^2 + x^2$$
 1 
$$Taking x\text{-component (any indication)}$$
 1 
$$\cos\theta = \frac{x}{\sqrt{x^2 + R^2}}$$
 1 
$$Stating direction (words or a diagram)$$
 1

# d) 4 points



$$|E| = 0 \text{ at } x = 0$$

1

1

$$|E| \rightarrow 0 \text{ as } x \rightarrow \infty$$

# 1977 C: E&M-2

	Distribution
Solution a) 5 points	of Points
$J = \sigma E = E/\rho$	1
J = I/A	1
$E = I\rho/A$	1
Thus $E_1 = I\rho/A$ and $E_2 = 3I\rho/A$	2
or	
V = IR	1
V = EL	1
$R = \rho L/A$	1
$E = I\rho/A$ Thus, $E_1 = I\rho/A$ and $E_2 = 3I\rho/A$	2
b) 5 points	
$V = V_1 + V_2$	2
V = IR	Toward.
$R = \rho L/A$	1.
$V = I\rho (l_1 + 3l_2)/A$	1
c) 5 points	
$\int \vec{\mathrm{E}} \cdot d\vec{\mathrm{S}} = \mathrm{q}/\epsilon_0$	2
(Other units also given credit)	
$(E_2 - E_1) A = q/\epsilon_0$	1
$q = 2I\rho\epsilon_0$	- Personal Control of the Control of
Positive	1.

# 1977 C: E&M-3

1977 C: E&M-3		
3a) 5 points	Solution	Distribution of Points
Counterclockw	ise	2
Explanation:		2
Direction of	current	1
Right hand r	ule or $\vec{F} = I\vec{L} \times \vec{B}$	1
Direction of	force	1
b) 7 points		
$T = (N)(r)(BI\ell)$ $= 0.06 \text{ N} \cdot \text{m}$	for factor (N) for factor (r = 0.1m) for factor (BIQ) for the right combination of the factors for the answer with units	1 2 2 5 1 1
Alternate:		
F = IQB		2
= 6(.2)(.5) = .61	N	1
$\tau = \mathbf{Fr}$		1
= (.6N)(.1m)		2
= .06N · m		1
Alternate:		
$F = I \ell B \sin \theta = I \ell$	В	2
$\tau = \int_0^{\cdot 2} F  d\ell = \int$	IBl dl	2
$=\frac{IB\Omega^2}{2}\Big _{0}^{2}=\frac{6(.5)(}{2}$	.2)2	
= .06 N ⋅ m		1
c) 3 points		
Angular velocit		1
	leration and/or explanation	1
	al angular velocity	1
Alternate:	minal angular velocity	
angular velocity		
***************************************	time	