



Version 1994 R

| Section A Mechanics | | Section B Waves, Optics, & Sound | Section C Heat & Kinetic Theory | Section D Electricity & Magnetism | |
|------------------------|-------|--|---------------------------------------|---|-------|
| 1. B | 13. C | 25. E | 41. C | 49. B | 59. B |
| 2. E | 14. B | 26. D | 42. E | 50. E | 60. B |
| 3. B | 15. E | 27. A | 43. A | 51. A | 61. A |
| 4. C | 16. E | 28. B | 44. D | 52. B | 62. C |
| 5. E | 17. D | 29. C | 45. D | 53. E | 63. A |
| 6. B | 18. A | 30. A | 46. B | 54. E | 64. E |
| 7. A | 19. C | 31. D | 47. B | 55. A | 65. A |
| 8. C | 20. B | 32. C | 48. E | 56. C | 66. D |
| 9. C | 21. E | 33. B | | 57. D | 67. E |
| 10. D | 22. A | 34. C | | 58. D | 68. C |
| 11. A | 23. A | 35. A | | | |
| 12. D | 24. D | 36. D | | | |
| | | 37. D | | | |
| | | 38. E | | | |
| | | 39. E | | | |
| | | 40. C | | | |

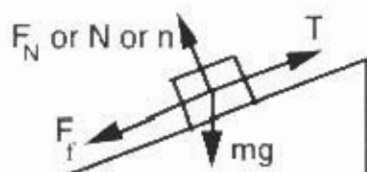
| Section E Modern Physics | Section F Mechanics | Section G Electricity & Magnetism |
|-----------------------------|--|--|
| 69. D | 1a. 110m | 1a. 0.22 N toward Q |
| 70. D | 1b. 2.2m/s^2 | 1b. $7.2 \times 10^5 \text{ V/m}$ (or N/C) |
| 71. E | 1c. $4.8 \times 10^3 \text{ N}$ | toward Q |
| 72. A | 1d. $5.3 \times 10^5 \text{ J}$ | 1c. $-3.6 \times 10^4 \text{ V}$ |
| 73. E | | |
| 74. C | 2b. 96N | 2a. 120Ω |
| 75. B | 2c. 19N down incline | 2b. $1/3$ |
| 76. C | 2d. 0.75m/s^2 (0.73m/s^2 if | 2c. $16/5$ |
| 77. A | not rounded until end) | 2d. $20/3$ |
| 78. B | | |
| 79. A | 3a. 10 m/s | 3a. 0.090 N to right |
| 80. B | 3b. $5.0 \times 10^2 \text{ N}$ | 3b. 0.040 m/s to left |
| | 3c. 8.0 m/s | 3c. $1.2 \times 10^{-6} \text{ T}$ out of the page |
| | 3d. 3.2 m | and perpendicular to it |



Optional Scoring Standards
Free Response Questions
(10 points per Question)

Section F - Mechanics**Points**

1. a. $x = \bar{v}t$ 1
 $x = \left(\frac{22\text{m/s} + 0}{2} \right) \times 10\text{s} = 110\text{m}$ 1
- b. $a = \frac{\Delta v}{t}$ 1
 $a = \left(\frac{22\text{m/s} - 0}{10\text{s}} \right) = 2.2\text{m/s}^2$ 1
- c. $F_{\text{net}} = ma$ 1
 $F_{\text{net}} = (1825\text{kg})(\text{part } b \cdot \text{ans})$ 1
 $F_{\text{net}} = (1825\text{kg})(2.2\text{m/s}^2) = 4.0 \times 10^3 \text{N}$
 $F_{\text{eng}} = F_{\text{net}} + F_{\text{friction}}$ 1
 $F_{\text{eng}} = (F_{\text{net}} \cdot \text{above}) + 0.8 \times 10^3 \text{N}$ 1
 $F_{\text{eng}} = 4.0 \times 10^3 \text{N} + 0.8 \times 10^3 \text{N} = 4.8 \times 10^3 \text{N}$
- d. $W = F_{\text{eng}} \cdot d$ 1
 $W = (\text{part } c \cdot \text{ans.})(\text{part } a \cdot \text{ans.})$ 1
 $W = (4.8 \times 10^3 \text{N})(110\text{m}) = 5.3 \times 10^5 \text{J}$



2. a. 1/2 point for each force 2
- b. $F_N = mg \cos \theta$ 1
 $F_N = (12\text{kg})(10\text{m/s}^2)(\cos 37^\circ) = 96\text{N}$ 1
- c. $F_f = \mu F_N$ 1
 $F_f = (0.2)(96\text{N}) = 19\text{N}$ down plane 1
- d. $a = \frac{F_{\text{net}}}{m}$ 1
 $F_{\text{net}} = T - mg \sin \theta - F_f$ 1
 $F_{\text{net}} = 100\text{N} - (12\text{kg})(10\text{m/s}^2)(\sin 37^\circ) - (\text{part } c \cdot \text{ans.})$ 1
 $F_{\text{net}} = 100\text{N} - (12\text{kg})(10\text{m/s}^2)(\sin 37^\circ) - 19\text{N} = 9\text{N}$
 $a = \frac{(F_{\text{net}} \cdot \text{above})}{12\text{kg}}$ 1
 $a = \frac{9\text{N}}{12\text{kg}} = 0.75\text{m/s}^2$

**Section F - Mechanics (continued)****Points**

3. a. $mgh = \frac{1}{2}mv^2$ 1
 $v = \sqrt{2gh}$ 1
 $v = \sqrt{2(10\text{ m/s}^2)(5\text{ m})} = 10\text{ m/s}$ 1
- b. $F_C = \frac{mv^2}{r}$ 1
 $F_C = \frac{(100\text{ kg})(\text{part a ans.})^2}{20\text{ m}}$ 1
 $F_C = \frac{(100\text{ kg})(10\text{ m/s})^2}{20\text{ m}} = 5.0 \times 10^2\text{ N}$
- c. $p_i = p_f$ 1
 $mv = (m + m_b)V$ 1
 $V = \frac{(100\text{ kg})(\text{part a ans.})}{125\text{ kg}}$ 1
 $V = \frac{(100\text{ kg})(10\text{ m/s})}{125\text{ kg}} = 8.0\text{ m/s}$
- d. From a, $h = \frac{v^2}{2g}$ 1
 $h = \frac{(\text{part c ans.})^2}{2(10\text{ m/s}^2)}$ 1
 $h = \frac{(8.0\text{ m/s})^2}{2(10\text{ m/s}^2)} = 3.2\text{ m}$

Section G - Electricity and Magnetism

1. a. $F = k \frac{Qq}{r^2}$ 1
 $F = (9.0 \times 10^9\text{ Nm}^2/\text{C}^2) \frac{(3.0 \times 10^{-6}\text{ C})(2.0 \times 10^{-6}\text{ C})}{(0.50\text{ m})^2} = 0.22\text{ N}$ 1
Direction: to the left. 1
- b. $\vec{E}_{\text{net}} = \vec{E}_1 + \vec{E}_2$ 1
Find difference in magnitudes $E_{\text{net}} = \left| k \frac{Q}{r^2} \right| - \left| k \frac{q}{r^2} \right|$ 1
 $E_{\text{net}} = (9.0 \times 10^9) \frac{3.0 \times 10^{-6}}{(0.25)^2} - (9.0 \times 10^9) \frac{2.0 \times 10^{-6}}{(0.25)^2} = 7.2 \times 10^5\text{ N/C (or V/m)}$ 1
Direction: to left 1
- c. $V = V_1 + V_2$ 1
 $V = k \frac{q}{r}$ 1
 $V = (9.0 \times 10^9) \frac{(2.0 \times 10^{-6})}{0.25} + (9.0 \times 10^9) \frac{(-3.0 \times 10^{-6})}{0.25} = -3.6 \times 10^4\text{ V}$ 1



Section G - Electricity and Magnetism (continued)

Points

2. a. $\frac{1}{R_p} = \frac{1}{20} + \frac{1}{60} = \frac{4}{60}$ $R_p = 15\Omega$ 2
- $R_{eq} = 80\Omega + 25\Omega + 15\Omega = 120\Omega$ 1
- b. $I_{60} 60\Omega = I_{20} 20\Omega$ 1
- $\frac{I_{60}}{I_{20}} = \frac{20}{60} = \frac{1}{3}$ 1
- c. $V = IR$ 1
- $V_{80} = I(80\Omega)$ $V_{25} = I(25\Omega)$ $\frac{V_{80}}{V_{25}} = \frac{I(80)}{I(25)} = \frac{16}{5}$ 1
- d. $P = I^2 R$ 1
- $I_{25} = I_{60} + I_{25} = I_{60} + 3I_{60} = 4I_{60}$ 1
- $\frac{P_{25}}{P_{60}} = \frac{(I_{25})^2 25\Omega}{(I_{60})^2 60\Omega} = \frac{(4I_{60})^2 25}{(I_{60})^2 60} = \frac{(16)(25)}{60} = \frac{20}{3}$ 1
- (3 points for any correct method that gets the correct answer.)
3. a. $F = ILB$ 1
- $F = (0.30A)(0.15m)(2.0T) = 0.090N$ 1
- Direction: to the right 1
- b. $V = Blv$ 1
- $V = IR$ 1
- $v = \frac{IR}{Bl} = \frac{(0.30A)(0.04\Omega)}{(2.0T)(0.15m)} = 0.040m/s$ 1
- Direction: to the left 1
- c. $B = \frac{\mu_0 I}{2\pi r}$ 1
- $B = (2.0 \times 10^{-7}) \frac{0.30}{0.050} = 1.2 \times 10^{-6} \frac{N}{A \cdot m}$ (or T) 1
- Direction: out of page 1