



NOVA SCOTIA EXAMINATIONS

PHYSICS 12

JUNE 2004

MARKING GUIDE

June 2004 Physics 12
Selected Response Questions Answer Key
Total Value 40

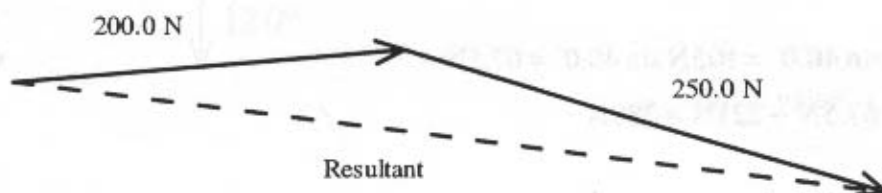
- | <u>SCO</u> | <u>SCO</u> |
|-------------------|----------------------|
| 1. A 326-3 | 21. A 328-6 |
| 2. B 326-4 | 22. B ACP-4 |
| 3. B 325-6 | 23. C 328-7 |
| 4. C 325-6 | 24. B 329-3 |
| 5. A 325-6 | 25. B 329-2 |
| 6. C 325-6 | 26. D 327-10 |
| 7. C 325-6 | 27. D 327-11 |
| 8. C 325-12 | 28. A 329-1 |
| 9. C 325-12 | 29. D 329-1 |
| 10. C 325-13 | 30. A 327-11 |
| 11. A 327-4 | 31. D 329-5 |
| 12. A 327-4 | 32. B 115-7 (quanta) |
| 13. B 215-2 (SHM) | 33. A 327-9 |
| 14. C ACP-2 | 34. B 327-10 |
| 15. B ACP-2 | 35. C 327-9 |
| 16. D 328-1 | 36. D 329-3 |
| 17. A 328-3 | 37. C 329-1 |
| 18. B 328-6 | 38. C 329-4 |
| 19. C 328-5 | 39. C 329-4 |
| 20. B 328-9 | 40. A 329-4 |

CONSTRUCTED RESPONSE ANSWER KEY

Alternative solutions should be scored appropriately.

Rounding of chained calculations in a calculator may result in small differences.

41.



value: 1

Component Solution

$$\Sigma F_x = (200.0\text{ N} \cdot \cos 7.00^\circ) + (250.0\text{ N} \cdot \cos 30.0^\circ)$$

$$\Sigma F_x = (200.0\text{ N} \cdot 0.993) + (250.0\text{ N} \cdot 0.866)$$

$$\Sigma F_x = 199\text{ N} + 217\text{ N} = 416\text{ N}$$

value: 1

$$\Sigma F_y = (200.0\text{ N} \cdot \sin 7.00^\circ) + (-250.0\text{ N} \cdot \sin 30.0^\circ)$$

$$\Sigma F_y = (200.0\text{ N} \cdot 0.122) + (-250.0\text{ N} \cdot 0.500)$$

$$\Sigma F_y = 24.4\text{ N} - 125\text{ N} = -101\text{ N}$$

value: 1

$$|\vec{R}| = \sqrt{(416\text{ N})^2 + (-101\text{ N})^2} = 428\text{ N}$$

$$\tan \theta = \frac{y}{x} = \frac{101\text{ N}}{416\text{ N}} = 0.243$$

$$\theta = 13.6^\circ$$

The resultant force is 428N [E13.6°S]

value: 1

42.

$$T_{2x} = 235\text{N} \cdot \cos 70.0^\circ = 80.4\text{N}$$

value: 0.5

$$T_{2y} = 235\text{N} \cdot \sin 70.0^\circ = 221\text{N}$$

value: 0.5

$$|T_{1x}| = |T_{2x}| = 80.4\text{N}$$

value: 1

$$|T_{1x}| = |\vec{T}_1| \cos 40.0^\circ$$

$$|\vec{T}_1| = \frac{|T_{1x}|}{\cos 40.0^\circ} = 105\text{N}$$

$$T_{1y} = \vec{T}_1 \sin 40.0^\circ = 105\text{N} \sin 40.0^\circ = 67.5\text{N}$$

value: 1

$$\sum T_y = 67.5\text{N} + 221\text{N} = 289\text{N}$$

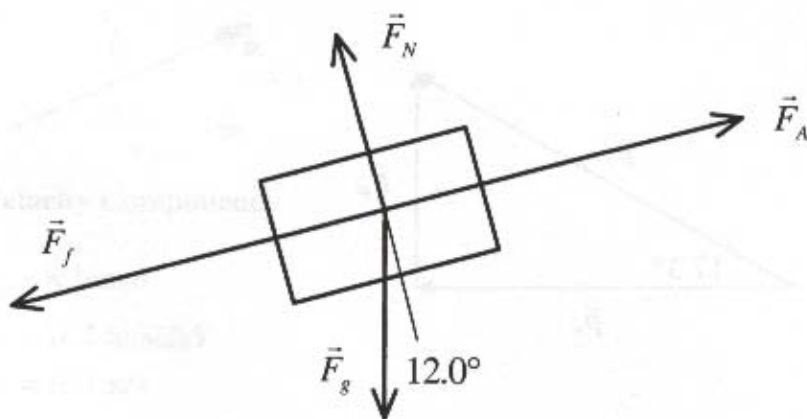
$$|\vec{F}_g| = |\sum T_y|$$

$$\vec{F}_g = m\vec{g} \quad \text{and} \quad m = \frac{\vec{F}_g}{\vec{g}} = \frac{289\text{N}}{9.80\text{m/s}^2} = 29.5\text{ kg}$$

value: 1

The mass of the suspended block is 29.5 kg.

43.



value: 1

$$\vec{F}_g = m\vec{g} = 35.0 \text{ kg} \cdot 9.80 \text{ m/s}^2 = 343 \text{ N}$$

$$F_{g\perp} = mg \cos 12.0^\circ$$

$$F_N = mg \cos 12.0^\circ = (35.0 \text{ kg} \cdot 9.80 \text{ m/s}^2 \cdot 0.978) = 336 \text{ N}$$

value: 1

$$F_{g\parallel} = mg \sin 12.0^\circ = (35.0 \text{ kg} \cdot 9.80 \text{ m/s}^2 \cdot 0.208) = 71.3 \text{ N}$$

value: 1

$$F_f = \mu F_N = 0.100 \cdot 336 \text{ N} = 33.6 \text{ N}$$

value: 1

$$\vec{F}_{\text{NET}} = m\vec{a}$$

$$-F_f - F_{g\parallel} + F_A = ma$$

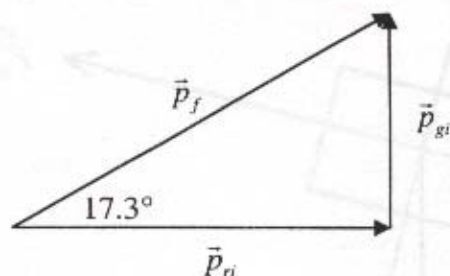
$$-33.6 \text{ N} - 71.3 \text{ N} + F_A = (35.0 \text{ kg} \cdot 2.30 \text{ m/s}^2)$$

$$F_A = 185 \text{ N}$$

value: 1

44.

A)



value: 2

B)

$$\vec{p}_f = m_f \vec{v}_f$$

$$|\vec{p}_f| = (5.00 \times 10^3 \text{ kg} + 3.00 \times 10^3 \text{ kg})(16.4 \text{ m/s}) = (8.00 \times 10^3 \text{ kg})(16.4 \text{ m/s}) = 1.31 \times 10^5 \text{ kg m/s}$$

value: 1

$$p_{fx} = (1.31 \times 10^5 \text{ kg m/s}) \cos 17.3^\circ = 1.25 \times 10^5 \text{ kg m/s East}$$

value: 0.5

$$p_{fy} = (1.31 \times 10^5 \text{ kg m/s}) \sin 17.3^\circ = 3.90 \times 10^4 \text{ kg m/s North}$$

value: 0.5

$$p_{ri} = p_{fx} = m_{red} v_{red}$$

$$v_{red} = \frac{p_{fx}}{m_{red}} = \frac{1.25 \times 10^5 \text{ kg m/s}}{5.00 \times 10^3 \text{ kg}} = 25.0 \text{ m/s East}$$

value: 0.5

$$p_{gi} = p_{fy} = m_{green} v_{green}$$

$$v_{green} = \frac{p_{fy}}{m_{green}} = \frac{3.90 \times 10^4 \text{ kg m/s}}{3.00 \times 10^3 \text{ kg}} = 13.0 \text{ m/s North}$$

value: 0.5

A speed limit of 50.0 km/h is equivalent to 13.9 m/s ($50.0 \text{ km/h} \div 3.6 \frac{\text{km/h}}{\text{m/s}}$).

Therefore, only the red truck was speeding ($25.0 \text{ m/s} > 13.9 \text{ m/s}$).

value: 1

C)

$$KE_{initial} = KE_{red} + KE_{green} = \frac{1}{2} m_{red} v_{red}^2 + \frac{1}{2} m_{green} v_{green}^2$$

$$KE_{initial} = \frac{1}{2} (5.00 \times 10^3 \text{ kg})(25.0 \text{ m/s})^2 + \frac{1}{2} (3.00 \times 10^3 \text{ kg})(13.0 \text{ m/s})^2$$

$$KE_{initial} = 1.56 \times 10^6 \text{ J} + 2.54 \times 10^5 \text{ J} = 1.81 \times 10^6 \text{ J}$$

value: 0.5

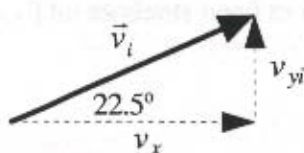
$$KE_{final} = \frac{1}{2} m v^2 = \frac{1}{2} (8.00 \times 10^3 \text{ kg})(16.4 \text{ m/s})^2 = 1.08 \times 10^6 \text{ J}$$

value: 0.5

$$KE_{lost} = KE_{initial} - KE_{final} = 1.81 \times 10^6 \text{ J} - 1.08 \times 10^6 \text{ J} = 7.30 \times 10^5 \text{ J}$$

value: 1

45.

**Velocity Components**

$$v_x = |\vec{v}_i| \cos \theta$$

$$v_x = 18.1 \cos 22.5^\circ$$

$$v_x = 16.7 \text{ m/s}$$

$$v_{yi} = |\vec{v}_i| \sin \theta$$

$$v_{yi} = 18.1 \sin 22.5^\circ$$

$$v_{yi} = 6.93 \text{ m/s}$$

value: 1

Horizontal Analysis

$$\Delta d_x = v_x \Delta t$$

$$\Delta t = \frac{\Delta d_x}{v_x}$$

$$\Delta t = \frac{16.5 \text{ m}}{16.7 \text{ m/s}}$$

$$\Delta t = 0.988 \text{ s}$$

value: 1

Vertical Analysis

$$\Delta d_y = v_{yi} \Delta t + 0.5 a_y \Delta t^2$$

$$\Delta d_y = (6.93 \text{ m/s})(0.988 \text{ s}) + 0.5(-9.8 \text{ m/s}^2)(0.988 \text{ s})^2$$

$$\Delta d_y = (6.85 \text{ m}) + (-4.78 \text{ m})$$

$$\Delta d_y = 2.07 \text{ m}$$

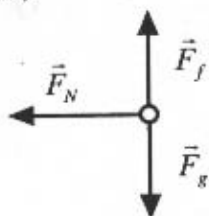
value: 2

The ball is 2.07m high when it has travelled 16.5m, which is below the top of the net (which is 2.42m high). She scores a goal!

value: 1

46.

A)



value: 2

(0.5pt for proper arrow directions, 0.5pt for labeling each force)

B) The force that is responsible for the centripetal force is the normal force created by the wall of the ride.

value: 1

C) Applying Newton's Second Law to the vertical forces, we get

$$\vec{F}_{net} = m\vec{a}$$

$$\vec{F}_f + \vec{F}_g = m\vec{a}$$

But $\vec{a} = 0$, so

$$\vec{F}_f = -\vec{F}_g$$

$$\vec{F}_f = -m\vec{g}$$

value: 1

$$\vec{F}_f = -(75.0\text{kg})(-9.80\text{m/s}^2)$$

$$\vec{F}_f = 735\text{N}$$

D) In this situation, the required centripetal force is provided by the normal force of the wall

$$F_c = \frac{mv^2}{r}$$

$$F_N = \frac{mv^2}{r}$$

value: 1

$$F_N = \frac{(75.0\text{kg})(17.6\text{m/s})^2}{7.00\text{m}}$$

$$F_N = 3320\text{N}$$

$$\mu = \frac{F_f}{F_N}$$

$$\mu = \frac{735\text{N}}{3320\text{N}}$$

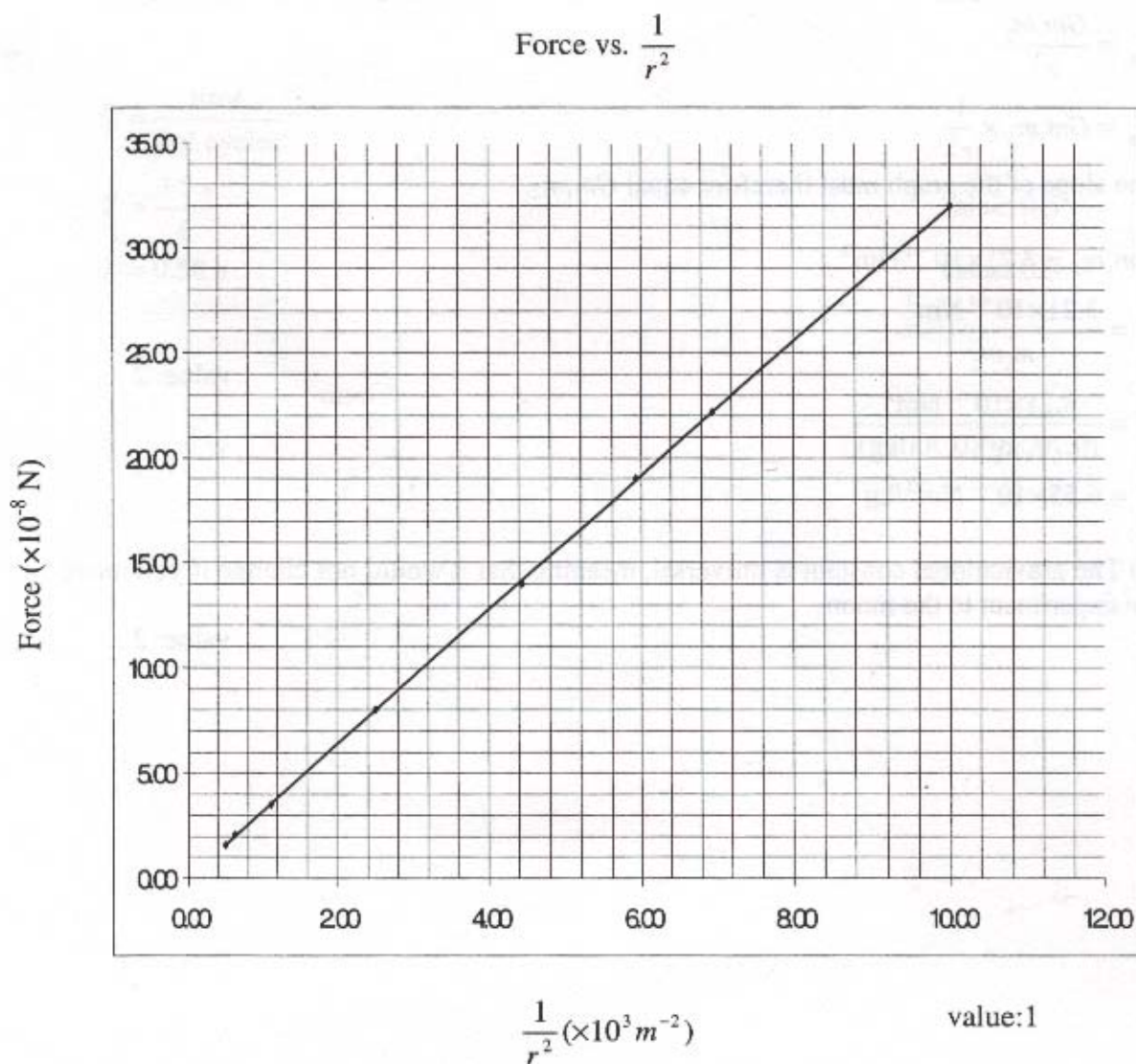
value: 1

$$\mu = 0.221$$

The minimum coefficient of friction required is 0.221.

47.

A) The students need to draw an appropriate line of best fit similar to the one shown.



B) The slope of the line of best fit will be equal to:

$$m = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

sample points chosen are $(1.60 \times 10^3, 5.00 \times 10^{-8})$ and $(10.00 \times 10^3, 32.00 \times 10^{-8})$

$$m = \frac{32.00 \times 10^{-8} \text{ N} - 5.00 \times 10^{-8} \text{ N}}{10.00 \times 10^3 \text{ m}^{-2} - 1.60 \times 10^3 \text{ m}^{-2}}$$

$$m = \frac{27.0 \times 10^{-8} \text{ N}}{8.40 \times 10^3 \text{ m}^{-2}}$$

$$m = 3.21 \times 10^{-11} \text{ Nm}^2$$

The slope of the line of best fit is approximately $3.21 \times 10^{-11} \text{ Nm}^2$.

value: 1

C) To determine the value of G , the students should show the universal gravitation formula and indicate that the slope of the line represents Gm_1m_2 and solve.

$$F_g = \frac{Gm_1m_2}{r^2}$$

$$F_g = Gm_1m_2 \times \frac{1}{r^2}$$

The slope of the graph must therefore equal Gm_1m_2 .

$$Gm_1m_2 = 3.21 \times 10^{-11} \text{ Nm}^2$$

$$G = \frac{3.21 \times 10^{-11} \text{ Nm}^2}{m_1m_2}$$

value: 2

$$G = \frac{3.21 \times 10^{-11} \text{ Nm}^2}{(0.700 \text{ kg})(0.700 \text{ kg})}$$

$$G = 6.55 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$$

D) The gravitational constant is universal, meaning that it would not change if you move the experiment to the moon.

value: 2

48.

A) Six oscillations

value: 1

B)

$$T = \frac{\text{time}}{\text{\#of cycles}}$$

$$T = \frac{3.5 \text{ s}}{6}$$

$$T = 0.58 \text{ s}$$

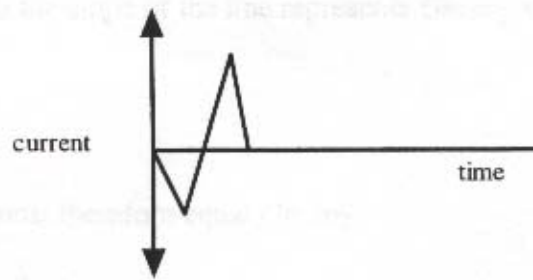
value: 0.5

value: 0.5



49.

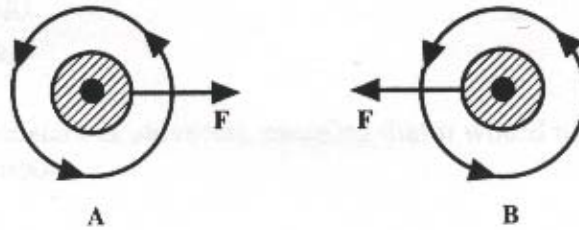
A)



value: 2

(1pt for shape, 1pt for second peak being larger)

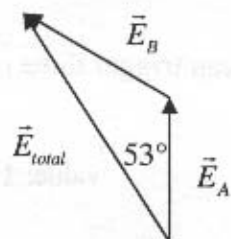
B)



value: 3

(2pts for fields, 1pt for forces)

50.



value: 1

$$|\vec{E}_A| = \frac{kq_A}{r_A^2} = \frac{(9.0 \times 10^9 \text{ Nm}^2/\text{C}^2)(50. \times 10^{-6} \text{ C})}{(2.0\text{m})^2} = 1.1 \times 10^5 \frac{\text{N}}{\text{C}}$$

value: 0.5

Note: This is directed at an angle [N 53° W]

$$|\vec{E}_B| = \frac{kq_B}{r_B^2} = \frac{(9.0 \times 10^9 \text{ Nm}^2/\text{C}^2)(30. \times 10^{-6} \text{ C})}{(1.2\text{m})^2} = 1.9 \times 10^5 \frac{\text{N}}{\text{C}}$$

value: 0.5

$$|\vec{E}_{Ax}| = \left(1.1 \times 10^5 \frac{\text{N}}{\text{C}}\right) \sin 53^\circ = 8.8 \times 10^4 \frac{\text{N}}{\text{C}}$$

value: 0.5

$$|\vec{E}_{Ay}| = \left(1.1 \times 10^5 \frac{\text{N}}{\text{C}}\right) \cos 53^\circ = 6.6 \times 10^4 \frac{\text{N}}{\text{C}}$$

value: 0.5

$$|\vec{E}_y| = |\vec{E}_{Ay}| + |\vec{E}_B| = 6.6 \times 10^4 \frac{\text{N}}{\text{C}} + 1.9 \times 10^5 \frac{\text{N}}{\text{C}} = 2.6 \times 10^5 \frac{\text{N}}{\text{C}}$$

$$|\vec{E}_x| = |\vec{E}_{Ax}| = 8.8 \times 10^4 \frac{\text{N}}{\text{C}}$$

$$|\vec{E}| = \sqrt{|\vec{E}_x|^2 + |\vec{E}_y|^2} = \sqrt{\left(8.8 \times 10^4 \frac{\text{N}}{\text{C}}\right)^2 + \left(2.6 \times 10^5 \frac{\text{N}}{\text{C}}\right)^2} = 2.7 \times 10^5 \frac{\text{N}}{\text{C}}$$

$$\tan \theta = \frac{8.8 \times 10^4 \frac{\text{N}}{\text{C}}}{2.6 \times 10^5 \frac{\text{N}}{\text{C}}} = 0.34$$

$$\theta = 19^\circ$$

$$\vec{E} = 2.7 \times 10^5 \frac{\text{N}}{\text{C}} [\text{N}19^\circ \text{W}]$$

value: 2

51.

- A) One neutron leads to the release of three neutrons, which can trigger three more fissions.

value: 1

- B) Heavy water is used as a coolant and as a moderator.

value: 1

C)

$$\frac{6000\text{MeV}}{200\text{MeV/atom of Uranium}} = 30 \text{ Uranium atoms}$$

value: 2

- D) Possible answers include

- major accident (meltdown) – very low risk
- radiation emission – extremely low risk
- discharge of radioactive material – low risk
- terrorism – variable risk depending on location
- transportation and storage of radioactive waste – low risk

value: 2

- E) Students must note the lack of visible emissions at the plant (CO_2 , NO_x , etc.). They should also mention associated pollution such as spent fuel, uranium mining pollution, and heat discharge into the atmosphere and surface water near the plant. Students may raise other valid points but must address both sides of the statement. One point of the value is to be assigned to the quality of the written presentation.

value: 4

51.

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value: 4