ATLANTIC CANADA EXAMINATIONS

PHYSICS 12

JUNE 2001

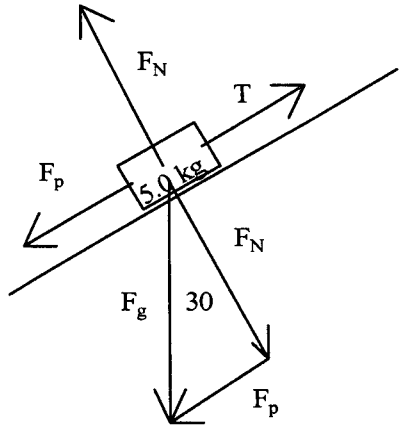
MARKING GUIDE

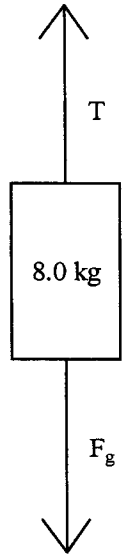
NOVA SCOTIA
Department of Education

ATLANTIC CANADA PHYSICS EXAM
SELECTED RESPONSE SOLUTIONS
JUNE 2001

1	C	9	B	17	C	25	C	33	B
2	C	10	D	18	C	26	C	34	D
3	B	11	C	19	D	27	D	35	C
4	C	12	A	20	A	28	B	36	B
5	D	13	B	21	D	29	B	37	A
6	B	14	C	22	B	30	C	38	C
7	A	15	C	23	C	31	C	39	D
8	A	16	C	24	B	32	A	40	D

41.





$F_g = mg = 5.0\ kg \times 9.8\ m/s^2$
$= 49\ N$

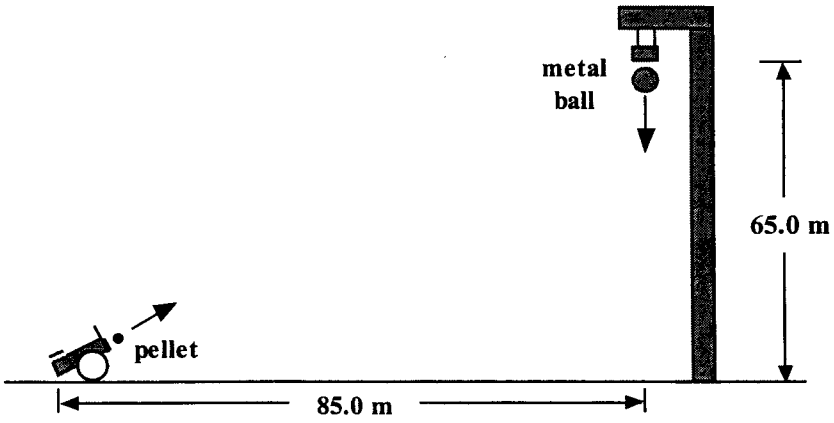
$F_g = mg = 8.0\ kg \times 9.8\ m/s^2$
$= 78\ N$

assuming that the system will move in the clockwise direction,

$$\Sigma F = ma$$
$$F_A - T + T - F_p - F_f = ma$$
$$mg - T + T - F_g \sin\theta - \mu F_g \cos\theta = ma$$
$$(8.0kgx9.8m/s^2) - (49Nx.50) - 0.10(49Nx0.866) = 13kg(a)$$
$$78N - 24.5N - 4.2N = 13kg(a)$$
$$49N = 13kg(a)$$
$$a = 3.8m/s^2$$

Free body diagrams - 1, Acceleration of the system - 1, Solution - 2

42. A metal ball is dropped at the same instant that a pellet is fired from a launcher as shown in the diagram below. The pellet leaves the muzzle of the launcher at a velocity of 53.0 m/s in the direction of the metal ball.



In a few sentences explain why the fall of the pellet from its initial path is the same as the vertical distance fallen by the metal ball. Your answer should include appropriate physics terminology. **value: 3**

The line of sight from the launcher to the initial position of the metal ball represents the path the pellet would have traveled if not for the influence of gravity. As the pellet goes through the air, its deviation from this line of sight is due to gravity. The effect of gravity on both the pellet and the metal ball is the same since the acceleration due to gravity is independent of mass. Therefore, the drop from the line of sight for the pellet at any time is equal to the drop for the metal ball at the same time.

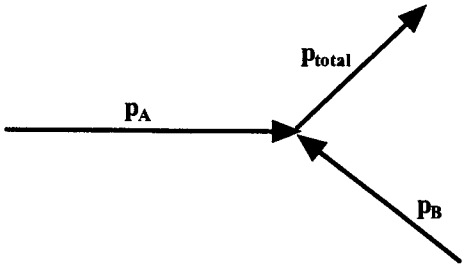
Points should be assigned based on the clarity of the explanation.

Suggestion: recognizing pellet is affected by acceleration of gravity 1
recognizing and stating that g is the same for both pellet and ball 1
making the appropriate connection to the sight line 1

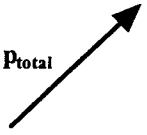
43.

A)

Before Collision



After Collision



value: 2

B) Before the Collision

$p_A = m_a v_a$

$p_A = (1500 \text{ kg})(50.0 \text{ km/hr})$

$p_A = 75000 \text{ kg•km/hr, east}$

$p_B = m_B v_B$

$p_B = (1200 \text{ kg})(40.0 \text{ km/hr})$

$p_B = 48000 \text{ kg•km/hr}$

Resolving p_B into x and y components:

$p_{Bx} = (48000 \text{ kg} \bullet \text{km/hr})\cos 30°$

$p_{Bx} = 41600 \text{ kg} \bullet \text{km/hr, west}$

$p_{By} = (48000 \text{ kg•km/hr})\sin 30°$

$p_{By} = 24000 \text{ kg•km/hr, north}$

Total momentum

$\sum p_x = 75000 \text{ kg•km/hr} - 41600 \text{ kg•km/hr}$

$\sum p_x = 33400 \text{ kg•km/hr, east}$

$\sum p_y = 24000 \text{ kg•km/hr, north}$

$$p_{total} = \sqrt{(33400 \text{ kg•km/hr})^2 + (24000 \text{ kg•km/hr})^2}$$

$p_{total} = 41100 \text{ kg•km/hr}$

$$\tan\theta = \frac{24000 \text{kg•km/hr}}{33400 \text{kg•km/hr}}$$

$\theta = 35.6°$ north of east

After the collision

$p_{tot} = mv$

$v = p_{tot} / m$

$v = (41100 \text{ kg•km/hr})/(2700 \text{ kg})$

$v = 15.2 \text{ km/hr } 35.6° \text{ N of E}$ **value: 1**

Students should not be penalized if they convert velocities to m/s before solution. If students use m/s, the correct speed is 4.22 m/s.

C) The kinetic energy of car A before the collision is 145 000 J and for car B is 73 900 J for a total kinetic energy before of 219 000 J. After the collision, the combined mass has a kinetic energy of 24 100 J. **value: 1**
(final KE = 11% of initial KE)

total momentum before and after is: 41 100 kg• km/hr, 35.6° N of E **value: 1**

44. The initial velocity of the snowball can be determined from the horizontal data.

$$v = \frac{d}{t}$$

$$v = \frac{15\text{ m}}{0.60\text{ s}}$$

$v = 25$ m/s

The vertical displacement can be determined as follows

$$\Delta d = v_i t + \frac{1}{2}at^2$$

$$\Delta d = (0\text{ m/s})(0.60\text{ s}) + \frac{1}{2}(9.8\text{ m/s}^2)(0.60\text{ s})^2$$

$\Delta d = 1.8$ m

Since we were asked for the distance above the ground that the snowball hits the tree, we must subtract the vertical displacement from the launch height and obtain a value of 2.2 m above the ground.

values: v_x, 1 d_{down}, 1 d_{up}, 1

45. What is the orbital speed of a satellite in orbit about the earth at an altitude of 150 km above the earth's surface? **value: 3**

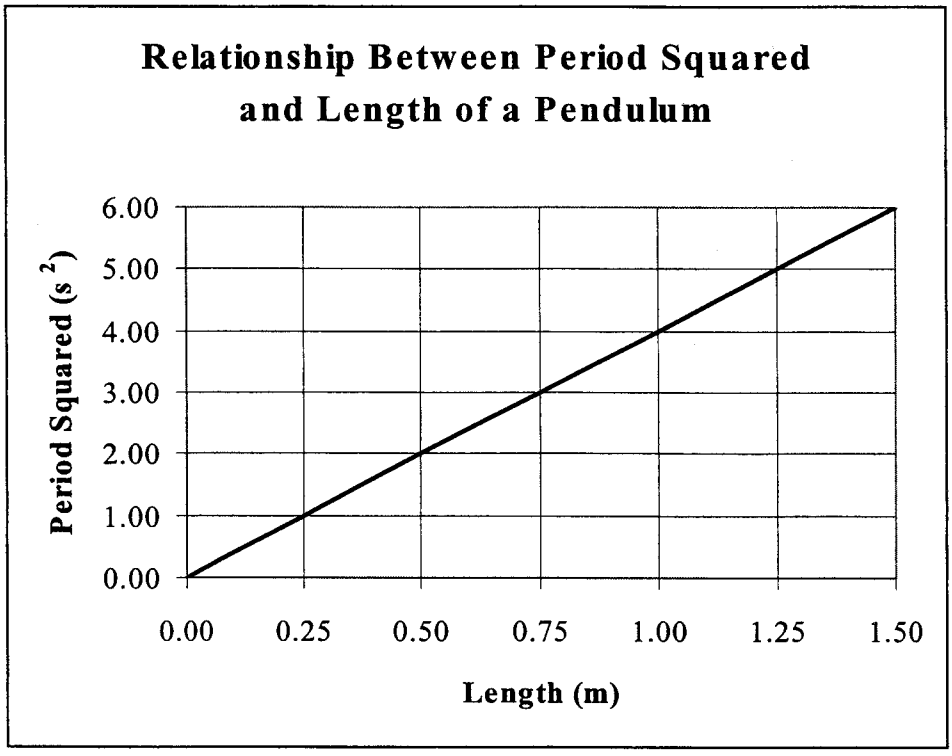
Since the centripetal force required is entirely provided by the gravitational force, their magnitudes are equal.

$$F_c = F_g \qquad \frac{m_s v^2}{r} = G\frac{M_e m_s}{r^2} \qquad v = \sqrt{\frac{GM_e}{r}} \qquad v = \sqrt{\frac{(6.67\text{x}10^{-11})(5.98\text{x}10^{24})}{(6.37\text{x}10^{6} + 1.50\text{x}10^{5})}}$$

$v = 7.82 \times 10^3$ m/s

values: $\frac{m_s v^2}{r} = G\frac{M_e m_s}{r^2}$ **1 use of correct radius (including Earth) 1 final answer 1**

46. Some students conducted an experiment to determine the gravitational field strength of Earth. They timed pendula of various lengths and used the data to plot the following graph of period squared vs length.



Using this graph, determine the acceleration of gravity. **value: 3**

The equation for the period of a pendulum is $T = 2\pi\sqrt{\frac{l}{g}}$.

Therefore, $T^2 = 4\pi^2 \frac{l}{g}$ and the slope of the graph gives us $\frac{4\pi^2}{g}$.

The slope of the graph is 4.00 s^2/m. Therefore, g = 9.87 m/s^2.

values: slope magnitude and unit 1 recognition that slope = $\frac{4\pi^2}{g}$ 1 final value for g 1

47. A) The period of the glider will not be affected by the amplitude of the displacement.

B) The restoring force will increase as the glider moves farther from equilbrium.

C) The speed of the glider decreases as the glider moves farther from equilibrium.

D) As the mass of the glider increases, the period of the glider will increase.

48. On the surface of Earth, an astronaut is able to run and jump a maximum horizontal distance of 1.3 m. During the jump, the astronaut is in the air 0.52 seconds.

A) Determine the horizontal and vertical components of the astronaut's velocity at the beginning of the jump. **value: 2**

B) On the moon, the gravitational field strength is 1/6 (0.17) of the Earth's. What is the maximum horizontal distance the astronaut can expect to jump on the moon? **value: 3**

A) Horizontal motion

$$v = \frac{d}{t} = \frac{1.3 \text{ m}}{0.52 \text{ s}} = 2.5 \text{ m/s}$$

value: 1

Vertical motion

$$d = \frac{1}{2}at^2 = \frac{1}{2}(9.8 \text{ m/s}^2)(0.26 \text{ s})^2 = 0.33 \text{ m}$$

value: 1

B) The astronaut will be able to jump 6 times as high since the acceleration due to gravity is 6 times less. Thus he will be able to jump 2.0 m vertically.

Vertical motion

$$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{(2)(2.0 \text{ m})}{1.6 \text{ m/s}^2}} = 1.6 \text{ s}$$

Horizontal motion

The total time for the motion is 3.2 s.

$d = vt = (2.5 \text{ m/s})(3.2 \text{ s}) = 8.0 \text{ m}$

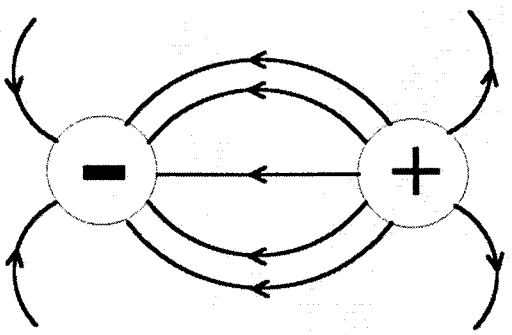
values for B): time in air on moon 2 horizontal displacement 1

49. On the diagrams below, draw in appropriate lines to describe the field near the objects shown.
value: 4

A)

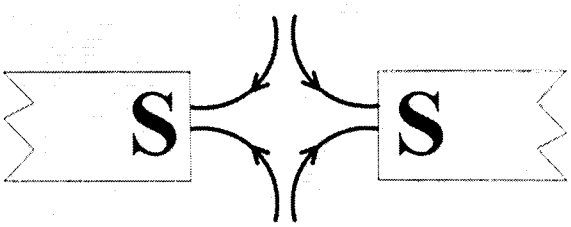
B)

A)



value: 1 point for lines, 1 point for arrows

B)



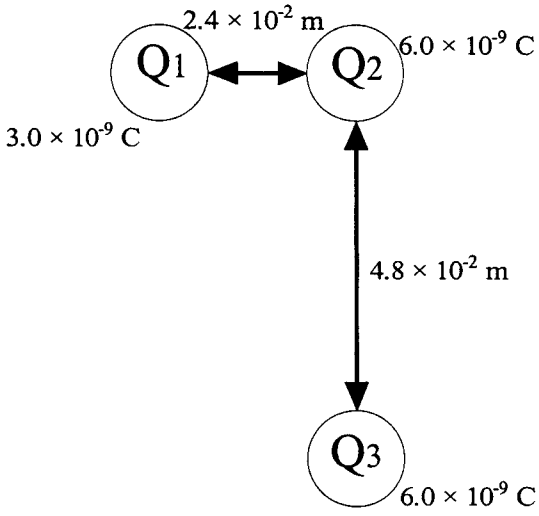
value: 1 point for lines, 1 point for arrows

50. Determine the electric force between two charged spheres placed 5.0 cm apart if one sphere has a charge of 4.0×10^{-6}C and the other sphere has a charge of 6.0×10^{-6}C ? **value: 2**

$$F_e = \frac{kq_1q_2}{r^2} = \frac{\left(9.0\times10^9\ \text{Nm}^2/\text{C}^2\right)\left(4.0\times10^{-6}\ \text{C}\right)\left(6.0\times10^{-6}\ \text{C}\right)}{\left(0.05\ \text{m}\right)^2} = 86\ \text{N}$$

values: proper substitutions but math error 1 correct answer 1

51. Three positively charged spheres are arranged as shown in the diagram below. Q1 has a charge of 3.0×10^{-9}C , Q2 has a charge of 6.0×10^{-9}C , and Q3 has a charge of 6.0×10^{-9}C . Determine the magnitude and direction of the net force exerted on Q2. **value: 4**



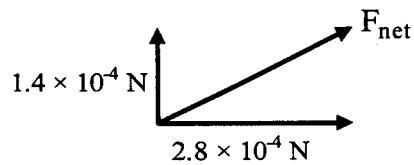
51. For Q_1 and Q_2:

$$F_e = \frac{kq_1q_2}{r^2} = \frac{\left(9.0\times10^9\ \text{Nm}^2/\text{C}^2\right)\left(3.0\times10^{-9}\ \text{C}\right)\left(6.0\times10^{-9}\ \text{C}\right)}{\left(2.4\times10^{-2}\ \text{m}\right)^2} = 2.8\times10^{-4}\ \text{N}\ \text{ to the right (east)}$$

For Q_2 and Q_3:

$$F_e = \frac{kq_2q_3}{r^2} = \frac{\left(9.0\times10^9\ \text{Nm}^2/\text{C}^2\right)\left(6.0\times10^{-9}\ \text{C}\right)\left(6.0\times10^{-9}\ \text{C}\right)}{\left(4.8\times10^{-2}\ \text{m}\right)^2} = 1.4\times10^{-4}\ \text{N}\quad \text{up (north)}$$

The free body diagram would look like



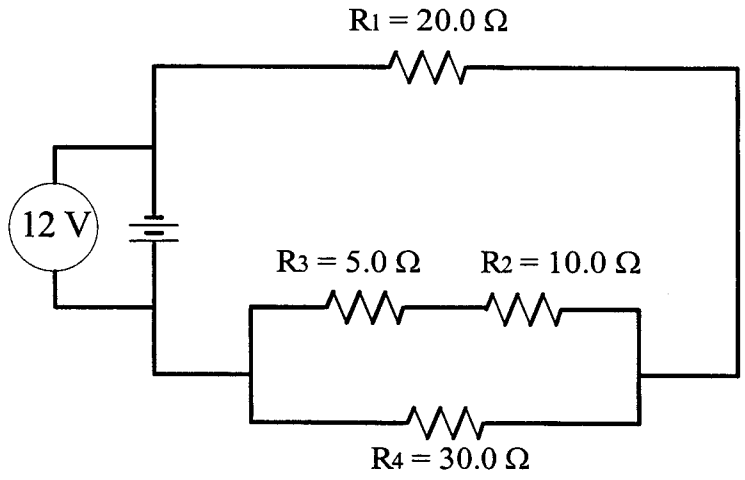
The magnitude of the net force can be determined, using the Pythagorean theorem, to be 3.1×10^{-4} N.

The direction of the net force is 27° north of east.

Therefore, the net force is 3.1×10^{-4} N, 27° N of E (or 63° E of N)

values: **force 1 on 2 = 1**
force 3 on 2 = 1
net force on 2 = 2

52. In the following circuit, determine the equivalent resistance of the circuit, the total current, and the current through R2. **value: 5**



The equivalent resistance for R_2 and R_3 is 15.0 Ω. **value: 1**

The equivalent resistance for R_2, R_3, and R_4 is 10.0 Ω. **value: 1**

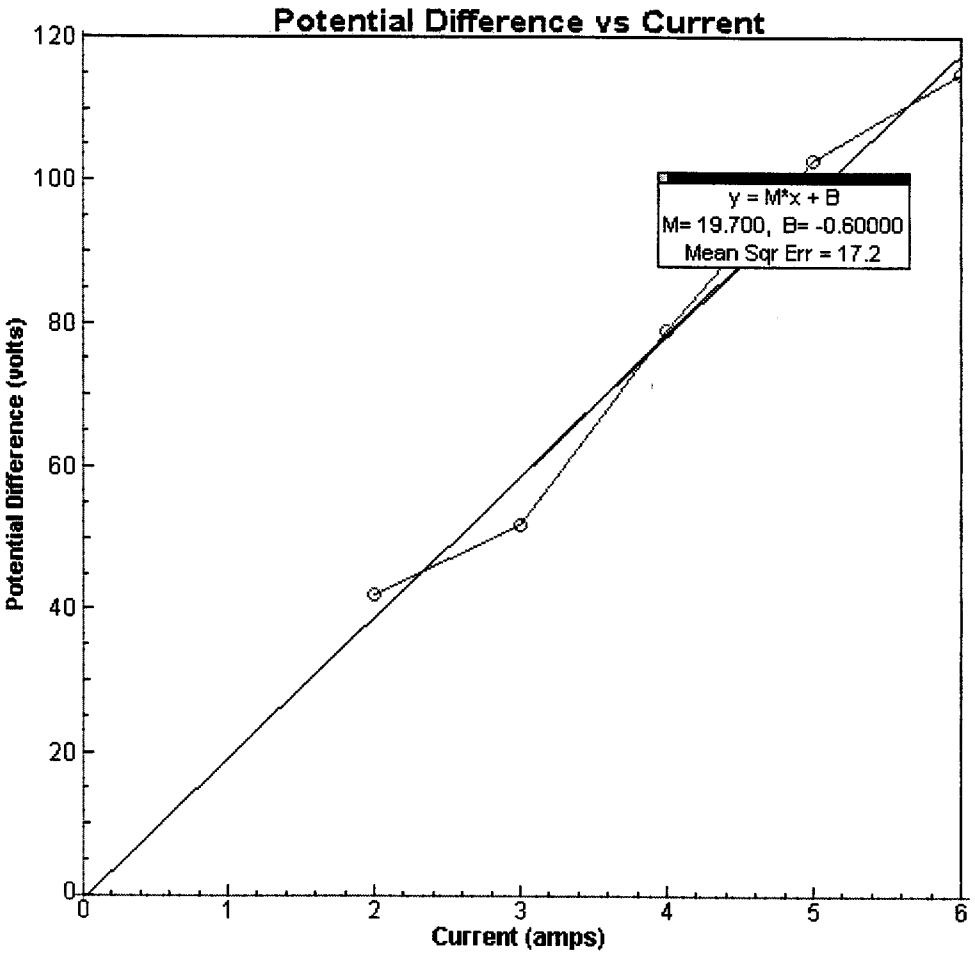
The equivalent resistance of the circuit is 30.0 Ω . **value: 1**

The total current is found, using the potential difference of the battery and the equivalent resistance of the circuit, to be 0.40 A. **value: 1**

The potential difference across R_1 is 8.0 V, so the potential difference across the equivalent resistance for R_2 and R_3 is 4.0 V. Therefore, the current through R_2 and R_3 is 0.27 A. **value: 1**

Students may also use a proportional solution to find the current through R_2.

53. A student's graph may look similar to the following:



The slope of the graph is equal to the resistance. For this graph, the resistance would be 19.7Ω.

Note that the slope of the best fit line must be calculated. It is not sufficient to pick two points from the data table to obtain the slope. A slightly different value for the slope that is consistent with the student's best fit line is an acceptable answer. **value: labelling 1**
plotting 1
best fit 1
slope number 1
slope unit 1

54. Suppose that a bill has been introduced into the Nova Scotia Legislature that would:
   A) ban the use of food irradiation in the province
   B) prevent irradiated foods from coming into the province

As the member of the legislature for Beenthere riding, you will have to make a speech in the House opposing the bill. Prepare a set of notes in outline form using the information in the previous article from the points of view of Nova Scotia consumers and producers. **value: 4**

benefits to consumers 2

better appearance
better quality product selected for irradiation
reduced sprouting
tight national and international regulation
slower ripening, spoilage
reduced bacteria and other contamination

benefits to producers 2

reduced losses to insects, bacteria, and rodents after harvest
product more saleable in international markets
fewer transportation problems because of longer storage life

55. **value: 1.5 for each of: fuel supply**
fuel cost
impact on environment
risk to human life

Students should be marked on their synthesis of the material present in the tables. Typical points are listed below. Students should not include material from other sources, or opinion not in support of the resolution. A maximum of 1 point should be deducted for mechanics of writing/presentation.

fuel supply coal: 100 years; oil: 60-100 years; natural gas: uncertain, discovered reserves growing; uranium: hundreds of years
hydro is limited; large scale projects have enormous environmental impact
energy yield for uranium is very high 1 T uranium = 20 000 T coal
1 uranium bundle = 400 T coal = 1800 barrels oil

fuel cost uranium is cheaper now than in 1988; coal and oil prices have been more volatile and are difficult to project; coal is presently about 10 times as expensive for an energy equivalent; oil is 20 times

impact on the environment The atmospheric pollution table contains a great deal of information. For example: coal use worldwide generates nine billion tonnes of carbon dioxide and 200 million tonnes of waste. Only hydro and nuclear have minimal direct impact.

risk to humans Coal and oil create at least 200 times more person days lost on the job and increased health risk from pollution
Radiation from a nuclear generating plant is less than from a TV or smoke detector, and less than 0.000 001 times safe level.
The loss of life expectancy table shows that peanut butter has a greater impact on life span than living near a nuclear plant.