APEF

PHYSICS 12 EXAMINATION

JUNE 1999

Student Name FULLER

Name of School COPY

Nova Scotia Department of Education and Culture
Testing and Evaluation Division

General Instructions

This examination is composed of four (4) sections:

Section 1	30 multiple choice
Section 2	10 restricted short answer
Section 3	3 extended problem solving and/or intermediate essay question
Section 4	1 extended essay question

The estimated time allotment for each type of question is as follows:

multiple choice.....1 minute for each question (30 minutes total)
restricted short answer ..... 3 minutes for each question (30 minutes total)
extended problem solving/intermediate essay..15 minutes for each question (45 minutes total)
extended essay .....25 minutes total
(Include an additional 20 minutes for organization and extra writing time.)

TOTAL TIME - 2 1/2 HOURS

Use these estimates to guide you in the completion of the examination. It is not necessary to spend the estimated time on each question. Plan your time so as to enable you to complete the examination.

A complete examination requires that you do all questions.

Students are permitted to use their own calculators.

All problems involving measurements must have the appropriate significant digits taken into account in the solution.

SECTION 1

INSTRUCTIONS **Estimated Time - 30 minutes** **Value 30 points**

In this part of the examination, there are thirty (30) multiple choice questions, each with a value of one point. All numbers used in the question are to be considered as the result of a measurement.

Read each question carefully and decide which of the choices **best** answers the question asked. You are provided with a separate answer form. Fill in the space that corresponds to the choice. **Use HB pencil only.**

Fill in the answers to the multiple choice questions in this part of the examination in 1 to 30 of Section 1 on Side 1 of the Response Form supplied by the test administrator. At the completion of the examination, place the Response Form in the examination booklet.

Example

Which unit is an SI unit of distance?

A. feet
B. inches
C. metres
D. cubits

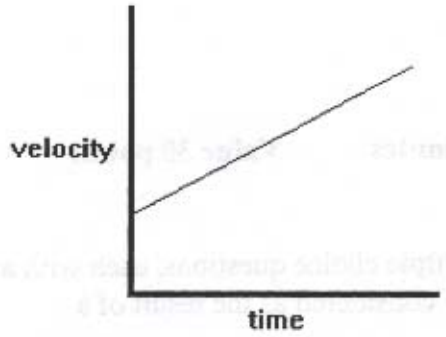
Answer sheet

A	B	C	D
0	0	■	0

If you wish to change an answer, erase your first mark completely.

Do not turn the page to start the examination until told to do so by the presiding examiner.

1.



What statement correctly describes the motion of an object depicted by the graph?

A. The object is travelling at constant speed.
B. The object is accelerating uniformly.
C. The object is moving to the right.
D. The object is at rest.

2. When can accelerated motion occur?

A. when speed changes
B. when speed and direction remain unchanged
C. when either speed or direction changes
D. only when both speed and direction change simultaneously

3. Which is the feature of displacement that leads us to call it a vector quantity?

A. Displacement and vector quantities have direction only to describe them.
B. Displacements add in the same way that vectors do.
C. Three numbers are needed to specify any vector quantity and three are needed to specify a displacement.
D. Displacement and vector quantities have magnitude only to describe them.

4. Which example is a vector quantity?

A. Grimsley lies 24 km east of Hamilton.
B. The density of aluminum is 2700 $\frac{kg}{m^3}$.
C. The jogger runs 3 km around the track.
D. The speed limit on a highway is 100 $\frac{km}{h}$.

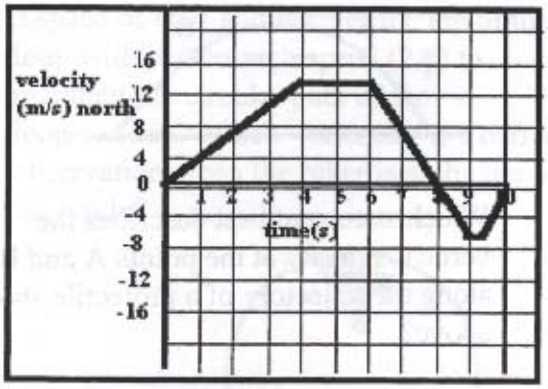
5. When the instrument panel of a car indicates 55 $\frac{km}{h}$ at all times, what property of the car's motion remains constant?

A. speed
B. velocity
C. distance
D. position

6. A motorist drives at a constant 50. $\frac{km}{h}$ for 3.0 h, and then at $1.0 \times 10^2 \frac{km}{h}$ for 2.0 h. What is the motorist's average speed?

A. 50. $\frac{km}{h}$
B. 70. $\frac{km}{h}$
C. 75 $\frac{km}{h}$
D. $1.0 \times 10^2 \frac{km}{h}$

7.



The velocity of a bicycle is graphed during a period of 10 s. Which statement best describes the motion of the bike between 6 s and 8 s?

A. It is moving north at an increasing rate of velocity.
B. It is moving south at an increasing rate of velocity.
C. It is moving north at a decreasing rate of velocity.
D. It is moving south at a decreasing rate velocity.

8. A car starts from town A, goes to town B, and returns. The round trip distance of 100. km takes 2.0 h. What is the average speed for the round trip?

A. $0.0 \frac{km}{h}$
B. $0.020 \frac{km}{h}$
C. $50. \frac{km}{h}$
D. $2.0 \times 10^2 \frac{km}{h}$

9. Two trains meet on parallel tracks. Train A is headed west at $80.0 \frac{km}{h}$ while train B travels east at $100. \frac{km}{h}$. If a passenger on train B is walking towards the rear of the train at $5.00 \frac{km}{h}$, what is the magnitude of the passenger's velocity relative to a person on train A?

A. $75.0 \frac{km}{h}$
B. $95.0 \frac{km}{h}$
C. $175 \frac{km}{h}$
D. $185 \frac{km}{h}$

10. Action and reaction forces always occur in pairs. Why don't they cancel each other out?

A. The action force is greater than the reaction force.
B. The action and reaction forces act on different objects.
C. The action and reaction forces act in the same direction.
D. The reaction force is greater than the action force.

11. Which statement best describes the variation of the gravitational force on a spaceship as it approaches the Earth?

A. It varies inversely with the distance.
B. It varies inversely with the square root of the distance.
C. It varies directly with the inverse of the distance squared.
D. It varies directly with the distance.

12. A 10.-kg mass is lifted so that it rises with an acceleration of $2.0\,\frac{m}{s^2}$. What is the net force, causing acceleration, exerted upwards?

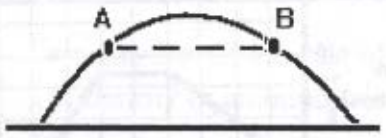
A. 9.8 N
B. 20. N
C. 29. N
D. 78 N

13. Four planets A, B, C, D have masses and radii as given below in terms of the mass M and radius R of the Earth. On which planet would the gravitational field strength at the surface be the same as at the Earth's surface?

Planet A - mass 2M and radius 2R
Planet B - mass 2M and radius $\frac{R}{2}$
Planet C - mass 2M and radius $\frac{R}{\sqrt{2}}$
Planet D - mass $\frac{M}{2}$ and radius $\frac{R}{\sqrt{2}}$

A. Planet A
B. Planet B
C. Planet C
D. Planet D

14.



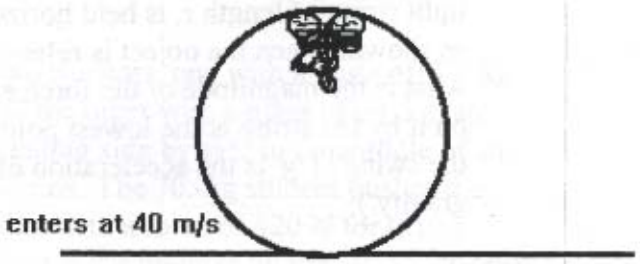
Which statement best describes the vertical velocity at the points A and B along the trajectory of a projectile shown above?

A. They are equal in magnitude and in the same direction.
B. They are equal in magnitude and in the opposite direction.
C. The velocity at B is twice the velocity at A and in the same direction.
D. The velocity at A is twice the velocity at B and in the opposite direction.

15. A satellite is approximately 300 km above the surface of the Earth orbiting at constant speed. Which statement best describes this motion?

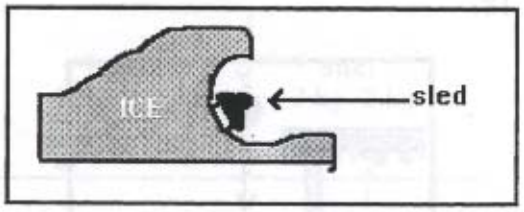
A. parabolic motion
B. geosynchronous motion
C. ballistic motion
D. circular motion

16. A motorcyclist enters a loop-to-loop at a speed of 40 $\frac{m}{s}$ and reaches the top of the loop with just enough speed (2 $\frac{m}{s}$) to maintain the circular path of the loop-to-loop. Which statement is a correct observation when the biker is at the top of the circle?



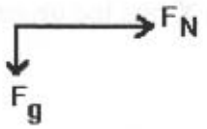
A. The centripetal force exceeds the gravitational force on the biker and bike.
B. The gravitational force exceeds the centripetal force on the biker and bike.
C. The centripetal force equals the gravitational force on the biker and bike.
D. No forces exist on the biker at the very top of the loop.

17.



A bobsled rises up the side of an ice track when it follows a horizontal circular path at high speed. The diagram above shows a cross-section of the ice track and sled. Which vector diagram shows the forces exerted on the sled by the ice track $\mathbf{F_N}$ and gravity $\mathbf{F_g}$?

A.



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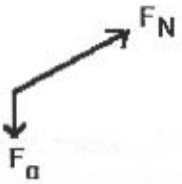

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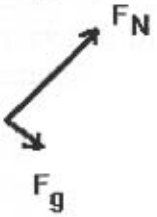

D.

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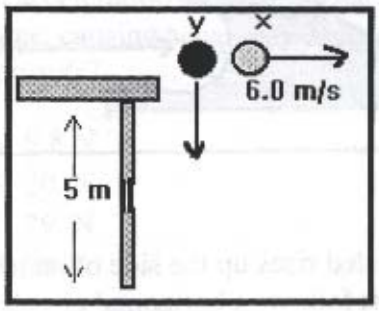
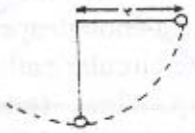


In the diagram above two balls X and Y are initially 5.0 m above the ground. At the moment Y is dropped off the edge, X is shot off the edge horizontally with an initial velocity of $6.0\frac{m}{s}$. How far is X from Y when X hits the ground?

A. 1 m
B. 3 m
C. 5 m
D. 6 m

19.



A small object of mass M, on the end of a light string of length r, is held horizontally as shown. When the object is released, what is the magnitude of the force exerted on it by the string at the lowest point of the swing? ('g' is the acceleration of gravity.)

A. $\frac{Mg}{2}$
B. Mg
C. 2 Mg
D. 3 Mg

20. When an object collides with a fixed wall, with what quantity does the magnitude of the impact force vary inversely?

A. duration of the impact
B. density of the surface
C. mass of the object
D. change in speed of the object

21. Which of the following is a vector?

A. density
B. energy
C. momentum
D. speed

22. Which of the following physical properties is conserved in every collision?

A. momentum only
B. kinetic energy only
C. momentum and kinetic energy
D. mass and velocity

23. Two students, one with a mass of 70. kg and the other with a mass of 60. kg, are standing side by side in the middle of an ice rink. The 70.-kg student pushes the other with a force of 420 N for 0.10 s. What is the impulse on the 70.-kg student?

A. 0.0 Ns
B. 6.0 Ns
C. 42 Ns
D. 4200 Ns

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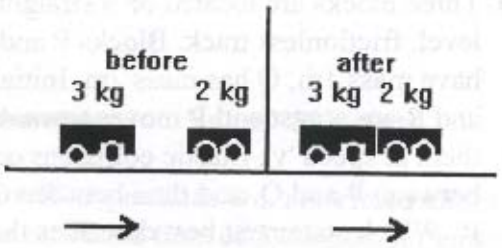


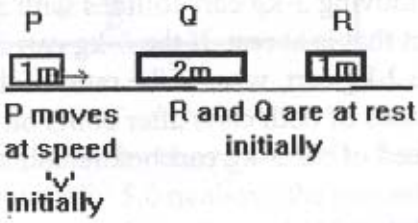
A moving 3-kg cart collides with a 2-kg cart that is at rest. If the 3-kg cart sticks to the 2-kg cart, what is the ratio of the speeds of both carts after collision to the speed of the 3-kg cart before collision?

A. $\frac{1}{1}$
B. $\frac{2}{3}$
C. $\frac{3}{5}$
D. $\frac{5}{3}$

25. A football, mass 0.50 kg, is kicked with an average force of 1000 N. The duration of the kick is 0.10 s. What is the change of momentum?

A. $2.\frac{kgm}{s}$
B. $10\frac{kgm}{s}$
C. $100\frac{kgm}{s}$
D. $1000\frac{kgm}{s}$

26. Three blocks are located on a straight, level, frictionless track. Blocks P and R have mass 1m, Q has mass 2m. Initially Q and R are at rest and P moves towards them at speed 'v'. Elastic collisions occur between P and Q, and then between Q and R. Which statement best describes the blocks after the collisions?



A. P and Q are stationary, R moves to the right at speed v.
B. P is stationary, Q and R move to the right.
C. Q is stationary, P and R both move away from it.
D. P moves to the left, Q and R move to the right.

27. What must be known in order to calculate the work done by a force?

A. the magnitude of the force and distance moved by the force along the line of action
B. the moment of the force about a point and the force magnitude
C. the resolved components of the force in the horizontal and vertical directions and the force magnitude
D. the resolved component of the force in the vertical direction only and the force magnitude

28. An engine does 1.2×10^4 J of work in sixty minutes. What is the power developed?

A. 3.3 W
B. 2.0×10^2 W
C. 1.2×10^4 W
D. 4.3×10^7 W

29. What is the potential energy of a bird, of mass 1.50 kg, perched 8.00 m above the ground?

A. 12.0 J
B. 15.0 J
C. 78.0 J
D. 118 J

30. A 20.- kg mass is located at a height of 8.0 m above the Earth and moves sideways at a constant speed of 10. $\frac{m}{s}$. What is the kinetic energy of the mass?

A. 1.0×10^3 J
B. 2.6×10^3 J
C. 8.0×10^3 J
D. 1.0×10^4 J

SECTION 2

INSTRUCTIONS **Estimated Times - 30 minutes** **Value - 30 points**

In this section of the examination there are 10 questions. The questions are **restricted short answer.** Each question has a value of **3 points** with an estimated time of 3 minutes for each.

It is expected that the answers will be written out in complete sentences, and terminology appropriate to physics is to be used when explanations or descriptions are required. When mathematical solutions are required, complete solutions are to be given.

Note: Units and significant figures will be considered when marking.

Restricted Short Answer - Example

A ball takes 2.00 s to reach the water when dropped from a bridge. Calculate the distance the bridge is above the water.

Write your answer in the space below **Sample Only**

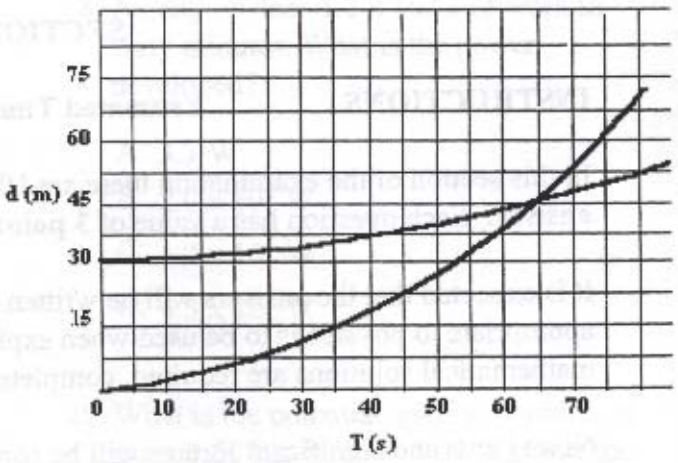
$d = v_1 t + (1/2)at^2$

$d = 0 + (1/2)\ (9.80\ m/s^2)(2\ s)^2$

$d = 19.6\ m$

1. The graph to the right represents two objects accelerating at the beginning of a race.

   a. At any point in time, what does the vertical distance between the curves represent? **(1.5 points)**
   b. What is the interpretation of the graph, in relation to the position of the objects, at the point the curves intersect? **(1.5 points)**



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2. A ball is allowed to drop from rest towards the surface of the Earth. What is the speed of the ball after 4.2 s? **(3 points)**

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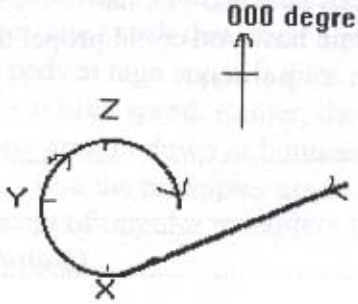

The diagram above shows the path followed by an aircraft, travelling horizontally at constant speed, with points X, Y and Z positioned on the circular arc as shown. At what point is the acceleration of the aircraft directed towards the East (or 90° from North (000°))? (See frame of reference above.) Explain. **(3 points)**

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4. Draw a labelled diagram of the magnetic field pattern for these identical bar magnets:

(3 points)

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5. If you were becalmed (not moving due to lack of wind) in a sail boat and you had a large, battery-operated blower with a fan as a source of power, explain how you could propel the boat forward with this fan. Briefly explain why this would work. **(3 points)**

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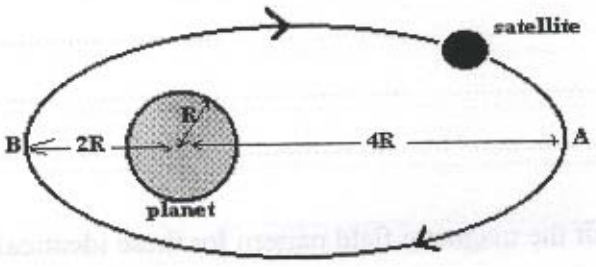
6. a. Describe the change in the speed of the satellite in the figure, if the satellite moves from point A toward point B around a planet of radius R. **(2 points)**

b. What is the cause of this change of speed? Explain. **(1 point)**



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7. The padding in the goalie pad in hockey is designed such that when a puck strikes the pads at high speed it does not rebound off the pads at high speed. Rather, the puck usually drops straight down or bounces back only a little. Use the principles associated with the concept of impulse to explain this event. **(3 points)**

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8. A passenger, of mass 80. kg, is in a car travelling at 20 $\frac{m}{s}$. The car suffers a head-on collision and stops. The seatbelt holding the passenger brings the passenger to rest in 0.20 s. Assuming that the seatbelt exerts a constant force on the passenger while being brought to rest, calculate the value of the force. **(3 points)**

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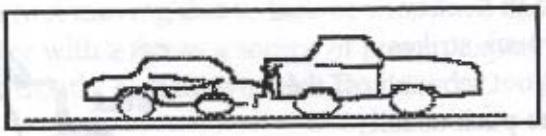

A car travelling at a velocity of 80. $\frac{km}{h}$ collides head-on into a truck twice as massive as itself and moving with a velocity of 50. $\frac{km}{h}$ in the opposite direction. Upon impact, the two vehicles get tangled and remain stuck together. What will be the velocity of the two vehicles after impact? **(3 points)**

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10. A student travels in an elevator that rises with constant velocity. The kinetic energy of the elevator-student system does not appear to change, but the potential energy does, meaning that the total energy of the system does not remain constant, but increases. Explain why this fact does not violate any principle of physics. **(3 points)**

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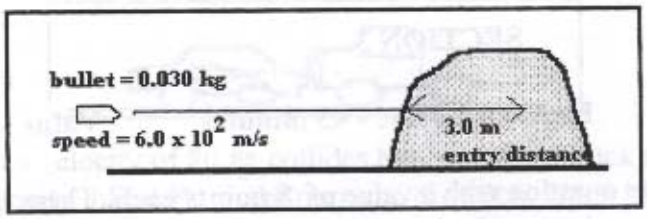
SECTION 3

INSTRUCTIONS **Estimated Time - 45 minutes** **Value - 24 points**

This section contains three question with a value of **8 points each.** These questions are either extended problem solving or intermediate essays. Answers are to be constructed in the space provided on the answer sheet. If there is insufficient room or you need to redo a question, ask the presiding examiner to provide you with additional paper. This paper can be inserted into the answer booklet.

1.



A 0.030-kg bullet, travelling horizontally at $6.0 \times 10^{2} \frac{m}{s}$ enters a bank of earth. It penetrates to a depth of 3.0 m.

a. What is the kinetic energy of the bullet before impact? **(4 points)**
b. Find the average stopping force acting on the bullet. **(4 points)**

2. A projectile is fired over level terrain with an initial velocity of $125\frac{m}{s}$ at an angle of 30.0^{o} with the ground. Assuming that there are no obstacles in its path, and ignoring all possible forces that could act on the projectile, except for the force of gravity,

a. determine how long the projectile will be in flight. **(4 points)**
b. determine the maximum height of the trajectory. **(2 points)**
c. determine the distance travelled over the ground. **(2 points)**

3. a. In the first instance a stone hangs from a cotton thread that is strong enough to support several similar stones. But when the stone is lifted a half metre and dropped, the thread breaks. Give a clear reason as to why the thread breaks in the second case, and not the first, by accounting for any additional factors. **(3 points)**

b. Suppose the thread had been no stronger, but stretched more easily. Would this have made any difference? Explain. **(2 points)**

c. A thread tied to the hanging stone and pulled slowly by a light string horizontally will move the stone in that direction. However, when this string is pulled by a quick jerk, the string breaks. Explain why the light string doesn't break in the first case, and does in the second. **(3 points)**

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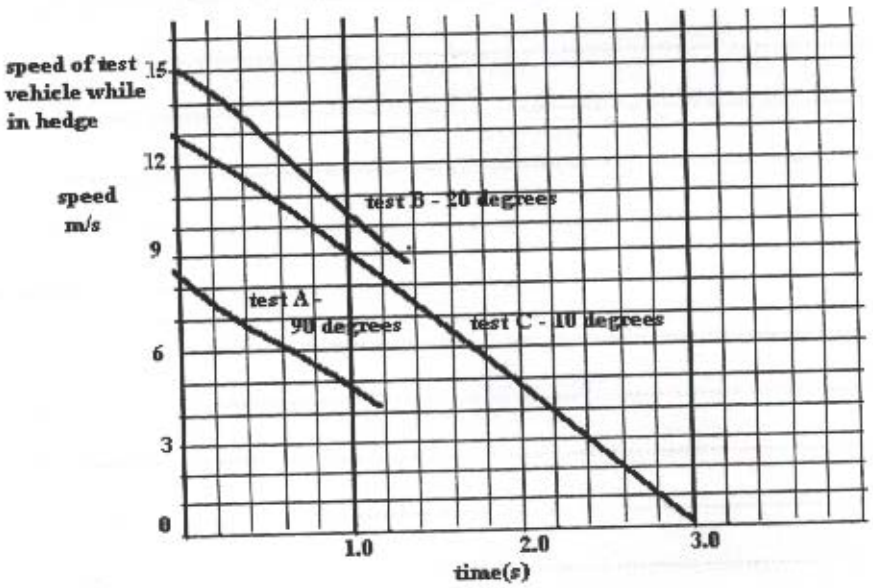
SECTION 4

INSTRUCTIONS **Estimated Time - 25 minutes** **Value - 16 points**

This section is composed of one extended essay question with a value of **16 points**. Since this is a higher level reasoning question, it is expected that your response will not only contain the appropriate physics information related to the topic, but will also demonstrate your ability to write an organized response that shows the development of a line of reasoning appropriate to the issue given in the question. It is also expected that you will demonstrate an effective style of writing in the development of your written response.

1. In terms of the mortlity rate, one of the costliest types of vehicle collisions on a highway occurs when one of the vehicles crosses the median and emerges into the pathway of an oncoming vehicle. Since this type of accident has happened many times on Maritime highways, one wonders whether it would be worth the cost and effort to place barriers on the medians of all Maritime highways, thus reducing crossing accidents.

   It has often been suggested that shrubs would satisfactorily perform the median barrier function. Tests were performed in which a vehicle was driven at different angles into a six-year-old hedge, 6m thick, of Rosa multiflora japonica, a thornless shrub rose. The test results are shown in the graph below.



(The angles shown in the graph above refer to the entry angle into the hedge.)

The results show that a highway median planted with a 3m Rosa multiflora japonica hedge could not provide a sufficient means of preventing vehicles from crossing into the opposite lane. However, impact with the hedge could reduce a car's speed and, for slower impacts at glancing angles, cars could be held within the median area.

Tests in the USA with the same species of shrub barriers showed much better results, but in addition to being planted closer together, the shrubs used were 14 years old.

As an adviser to the government, you are asked to explain the advantages and disadvantages of using shrubs as a highway median barrier. In your argument you are to explain the physics associated with the use of shrubs and why they are effective at slowing down the vehicles. It is important that you bring into your argument technological and socially-relevant factors to persuade the government to adopt your analysis of the data.

Present an argument such that the physics, the technology, and the social aspects form a well-developed and integrated presentation. **(4 points)**
Show how the technology involved helps or hinders the solution to the very real human problems created as a result of motor vehicle accidents. **(4 points)**
Describe or illustrate the physics principles, laws, and concepts that help to explain the events and the physical results of the events given in the question. **(4 points)**
Elaborate on the social consequences when applying new technology for the purpose of solving a human-related problem. This elaboration should be done by considering the advantages and disadvantages of building different types of barriers between highway traffic lanes. **(4 points)**