APEF

APEF CURRICULUM

JUNE 2000

PHYSICS 12

EXAMINATION

Comment Box—For Use by Teacher

What accommodations have been made?

By whom?

Position/Title:

Why?

NOVA SCOTIA
Department of Education

Name:

LIST OF EQUATIONS (Assume quantities are vectors where appropriate.)

speed

1. $v_{avg} = \Delta d/\Delta t$

acceleration

2. $a = (v_2 - v_1)/(t_2 - t_1)$

distance

3. $d = v_1 t + \frac{1}{2} at^2$

speed

4. $v_2^2 = v_1^2 + 2ad$

average speed

5. $v_{avg} = (v_2 + v_1)/2$

force

6. $F_{net} = ma$

electric force

7. $F_e = kq_1q_2/d^2$

gravitational force

8. $F_g = Gm_1m_2/d^2$

gravitational field strength

9. $g = F/m$

electric field strength

10. $E = F/q$

centripetal acceleration

11. $a_c = v^2/r$

tangential speed

12. $v = 2\pi r/T$

impulse

13. impulse $= F_{avg}\, t$

momentum

14. $p = mv$

impulse = change of momentum

15. $F(t_2 - t_1) = (p_2 - p_1)$

conservation of momentum

16. $m_1v_1 + m_2v_2 = m_1v'_1 + m_2v'_2$

conservation of energy

17. $\frac{1}{2} m_1v_1^2 + \frac{1}{2} m_2v_2^2 = \frac{1}{2} m_1v'^2_1 + \frac{1}{2} m_2v'^2_2$

work

18. $W = FdCos\theta$

work

19. $W = mad$

kinetic energy

20. $KE = \frac{1}{2} mv^2$

potential energy

21. $PE_{grav} = mgh$

electric potential

22. $PE_{elect} = qEd$

power

23. $P = W/t$

power

24. $P = (E_2 - E_1)/t$

centripetal force

25. $F = mv^2/r$

coefficient of friction

26. $\mu = F_f/F_n$

SOME IMPORTANT CONSTANTS

1. Magnitude of the electron charge.....$e = 1.60 \times 10^{-19}$ C
2. Vacuum permittivity.....$\varepsilon_o = 8.85 \times 10^{-12}$ C^2/Nm^2
3. Coulomb's law constant ..... $k = 9.0 \times 10^9$ Nm^2/C^2
4. Acceleration due to gravity at the Earth's surface ..... $g = 9.80$ m/s^2
5. Universal Gravitational Constant ..... $G = 6.67 \times 10^{-11}$ Nm^2/kg^2

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. Considering all cases of linear and curved motion, under which condition does an object have uniform acceleration?

   A. when its speed is constant
   B. when it travels in a straight line
   C. when its velocity is changing uniformly
   D. when its acceleration is changing uniformly

2. The slope of a velocity-time curve yields which quantity?

   A. distance
   B. speed
   C. acceleration
   D. time

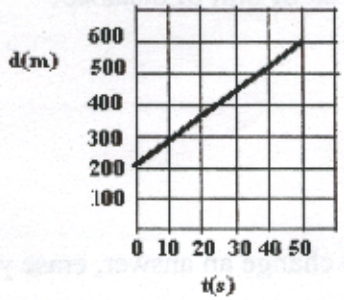
3. Which best defines average speed?

   A. speed that is constant
   B. $\frac{\text{maximum speed} + \text{minimum speed}}{2}$
   C. ratio of the total distance travelled to total time of travel
   D. the most commonly occurring speed

4. Astronauts conduct free-fall experiments on the surface of the planet Leptoff and find the acceleration of free-fall to be approximately 20 $\frac{m}{s^2}$. Which statement is a correct statement based on the information given above?

   A. Objects on Leptoff weigh one-half their weight on the Earth.
   B. Falling from rest, an object's speed on Leptoff is 10 $\frac{m}{s}$ at 1 s.
   C. Falling from rest, the objects on Leptoff fall 40 m in 2 s.
   D. The speed during free-fall on Leptoff is directly proportional to the square of the distance fallen.

5. Which choice represents the specific equation of motion as shown by the graph?



   A. d = 6.0 $\frac{m}{s}$ (t)
   B. d = 12 $\frac{m}{s}$ (t)
   C. d = 200 m + 12 $\frac{m}{s}$ (t)
   D. d = 200 m + 8 $\frac{m}{s}$ (t)

6. A stream is flowing at a speed of 3.0 $\frac{km}{h}$ relative to the bank. A student who can swim at 2.0 $\frac{km}{h}$ in still water enters the stream and proceeds to swim downstream (with the current). At a certain point the student is approaching a boat going upstream. The boat has a speed of 20 $\frac{km}{h}$ relative to the stream. To an observer on the shore, with what speed are the student and the boat approaching each other?

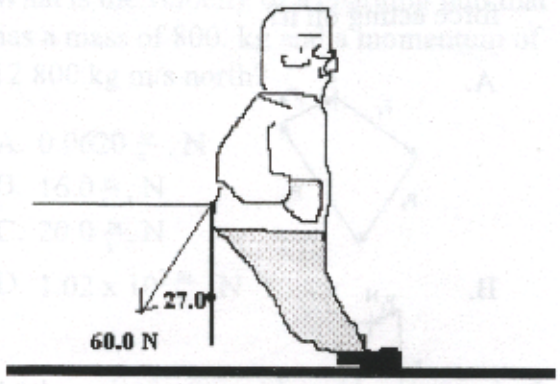
A. 28 $\frac{km}{h}$
B. 25 $\frac{km}{h}$
C. 22 $\frac{km}{h}$
D. 18 $\frac{km}{h}$

7. Which statement about inertia is correct?

A. Inertia is related to an object's mass.
B. Motion is caused by inertia.
C. Friction and inertia are the same.
D. Gravity causes inertial effects.

8. An applied force **F** opposes the motion of an object that slides along a horizontal surface. A force of friction $\mathbf{F_f}$, that is smaller than **F**, also acts on the object. Which statement is true?

A. The ratio $\frac{F}{F_f}$ has a variable magnitude during the motion.
B. The applied force and the force of friction act in opposite directions.
C. The object is slowing down.
D. The object is speeding up.

9. 

The person in the figure above is leaning against a counter and exerts a force of 60.0 N at 27.0° to the vertical. What is the horizontal component of this force?

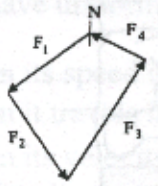
A. 15.3 N
B. 27.2 N
C. 30.6 N
D. 53.5 N

10. Planet X has the same diameter as Earth, but three times the mass of Earth. What would be the ratio of the force of gravity on the surface of Planet X to the force of gravity on the surface of the Earth?

A. 9:1
B. 6:1
C. 3:1
D. 1:1

11. Which diagram is of an object with no net force acting on it?

A.



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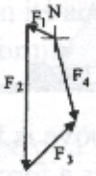

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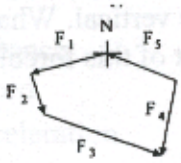
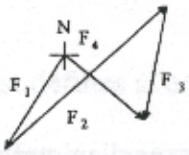


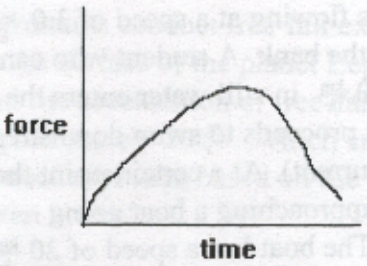
D.



12. Which statement about electric force between two point charges is correct?

A. It is dependent upon the material between the charges only.
B. It is dependent upon the material between the charges and the separation distance.
C. It is dependent upon the separation distance only.
D. It is always an attractive force.

13.



The graph shown above is the plot of a collision force of a car hitting a wall during a time interval. What physics quantity does the area under the curve give?

A. energy
B. force
C. distance
D. impulse

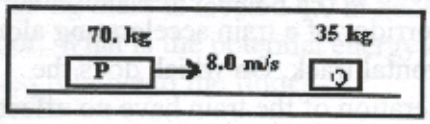
14. In a collision, to what is force inversely proportional?

A. time of impact
B. speed at impact
C. mass of objects
D. acceleration at impact

15. Which of the following describes momentum?

A. It has magnitude only.
B. It has direction only.
C. It has magnitude and direction.
D. It adds arithmetically only.

16.



Block P (70. kg), moving to the right at 8.0 m/s, collides elastically with block Q (35 kg), exerting a force of 1.4×10^2 N. What is the acceleration of P during the collision?

A. 2.0 $\frac{m}{s^2}$, left
B. 0.50 $\frac{m}{s^2}$, left
C. 0.50 $\frac{m}{s^2}$, right
D. 2.0 $\frac{m}{s^2}$, right

17. A rocket with a mass of 1000 kg is moving at a speed of 20 $\frac{m}{s}$. The magnitude of the momentum is which of the following?

A. 50 kg $\frac{m}{s}$
B. 200 kg $\frac{m}{s}$
C. 20 000 kg $\frac{m}{s}$
D. 400 000 kg $\frac{m}{s}$

18. An object of mass 'm' moves at velocity 'v' horizontally to the right and strikes a vertical, rigid wall. If the collision is perfectly elastic, what is the change in the momentum of the wall?

A. 0 mv
B. 2mv to the right
C. 2mv to the left
D. 4mv to the left

19. What is the velocity of a charging bull that has a mass of 800. kg and a momentum of 12 800 kg m/s north?

A. 0.0620 $\frac{m}{s}$, N
B. 16.0 $\frac{m}{s}$, N
C. 20.0 $\frac{m}{s}$, N
D. $1.02 \times 10^7 \frac{m}{s}$, N

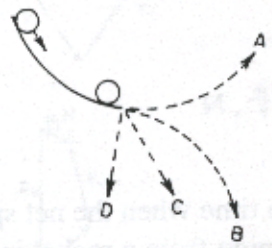
20. At the point in time when the net speed of the gases escaping from a rocket is in the same direction as the rocket is moving, which statement accurately describes the result?

A. The rocket stops gaining speed.
B. The gas is unable to leave the rocket nozzles.
C. The rocket undergoes a reduction in momentum.
D. The rocket starts to gain in mass significantly.

21. A small, plastic dart is fired by air pressure from a model cannon. The target is a 10-cm diameter metal ring that falls freely when the dart is fired. What is the best initial direction for the dart so that it will pass through the ring?

A. towards the highest point of the ring
B. towards the centre of the ring
C. towards the lowest point of the ring
D. below the lowest point of the ring

22. A ball rolls down a curved ramp as shown in the diagram below. Which dotted line best represents the path of the ball after leaving the ramp?



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

23.

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.

24. A person drops a ball while standing in the corridor of a train accelerating along a horizontal track. On which does the acceleration of the train have no effect?

A. the position of the ball's impact with the floor
B. the change in momentum of the ball upon impact with the floor
C. time for the ball to reach the floor
D. the change in the kinetic energy of the ball upon impact with the floor

25. A car of mass 2500. kg turns a corner at 15.0 $\frac{m}{s}$. The car's tires provide 1.96×10^4 N of friction. What is the shortest possible turning radius before the car spins out?

A. 1.91 m
B. 18.7 m
C. 28.7 m
D. 57.4 m

26. A rifle bullet is brought to rest by striking a brick wall. Which statement is valid?

A. Some energy is lost during the collision.
B. All energy is lost during the collision.
C. The energy of the bullet is conserved.
D. All energy is transferred to the bricks.

27. A force of 25 N moves a 3.0 kg mass through a distance of 2.0 m in a straight line. What is the work done by the force?

A. 150 J
B. 150 W
C. 50 J
D. 50 W

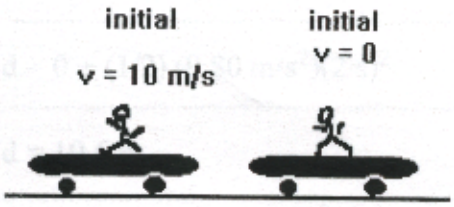
28. A 12-kg mass is located 4.0 m above the floor. What is the potential energy of the mass relative to the floor?

A. 9.8 J
B. 29 J
C. 48 J
D. 470 J

29. A student travels in an elevator that rises with constant velocity. Which of the following quantities shows an increase in value?

A. the force exerted by the student on the elevator
B. the gravitational force
C. the kinetic energy
D. the total mechanical energy

30.



Two people of identical masses are on two identical carts, A and B. Cart A, with an initial speed of $10\frac{m}{s}$, collides with cart B, which is at rest. In order that this collision be perfectly elastic, what would have to be the speed of cart B, relative to the ground, after the collision?

A. a speed equal to Car A's speed before the collision
B. a speed one half of car A's speed before the collision
C. a speed twice car A's speed before the collision
D. a speed of zero

SECTION 2

INSTRUCTIONS **Estimated Time - 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. a Distinguish between average speed and instantaneous speed. Use examples to illustrate your answer, if necessary. ... **1 point**

   b. How does constant speed differ from uniform acceleration? How are they the same?.. **2 points**

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2. A car starts from rest and accelerates uniformly. It travels 80. m in the first 10. s. Calculate its final speed at the end of 10. s. .... **3 points**

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3. A student, on a train leaving the station at time zero, runs down the aisle at 5.0 $\frac{m}{s}$. The train is moving in the same direction as the student at a constant 30. $\frac{m}{s}$. What is the distance between the student and the station after 10. s? ..... **3 points**

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4. In a clothing store, a child walks towards a full length mirror with a speed of $2.0\frac{m}{s}$. Relative to the child, what is the velocity of the reflected image of the child? Explain. ... **3 points**

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5. It is said that a bus driver could keep the passengers *glued* to their seats by driving at a fast enough constant speed in a straight line. Do you agree? Explain. .... **3 points**

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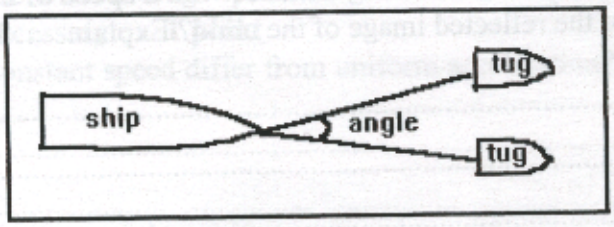

Two tugboats assist a ship to dock in a harbour by a rope tied to each tugboat and the ship. What change in the angle between the ropes causes the rate of forward motion of the ship to increase? Explain. .... **3 points**

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7. Two carts of equal mass collide. One is at rest initially. Show that $\frac{m_2}{m_1} = \frac{v_1}{(v_2)}$ is correct if the collision is perfectly elastic and the motion is along a straight line path. ... **3 points**

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8. A polar bear, wearing a bulletproof vest, is lying on a horizontal sheet of ice. A hunter fires a bullet at him. The bullet bounces back at almost the same speed, causing the bear to glide down the ice. What difference would it make if the bullet had become embedded in the bear's vest? Explain. ... **3 points**

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9. Is the following statement true or false? Give the physics reasoning that supports your answer.

"If I swing a bucket in a vertical circle over my head, I do not get wet because there is a force pushing the water into the bucket." ..... **3 points**

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10. Why are road accidents at very high speeds very much worse than at very low speeds? Justify your answers by refering to the magnitude of the changes of energy and energy transformation as the speeds get higher. ... **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. A single stone hangs on a thread of cotton. The thread is strong enough to support several similar stones. But when the single stone is lifted a half metre and dropped, the thread breaks. Give a clear reason as to why the string with the single stone breaks on being dropped, and not in the first case, 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 a hanging stone and pulled slowly by a string horizontally will move the stone in that direction. However, when this string is pulled by a quick jerk, it breaks. Explain why it doesn't break in the first case, and does in the second. ... **3 points**

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2. A field gun is fired at an angle of 37.0° to the horizontal with a muzzle velocity of 1386 $\frac{m}{s}$. The projectile lands at the same level from which it was fired. Assume no air friction.

a. Determine the time the projectile was in the air. ... **4.5 points**
b. How far over the ground would the projectile travel? .... **2 points**
c. At what speed would the projectile hit the ground,
   i. in a direction parallel to the ground?
   ii. in a direction perpendicular to the ground?
   iii. along the tangent to the trajectory? ..... **1.5 points**

3. A cart of mass 1.00 kg and velocity 0.500 $\frac{m}{s}$ collides with another stationary cart of the same mass. A piece of plasticine at the point of impact ensures that the carts stick together after impact.

   a. What is the velocity after impact? .... **2 points**
   b. Calculate the kinetic energy before impact and after impact. ....**4 points**
   c. Explain why the kinetic energy is not conserved. .... **1 points**
   d. What, besides the two carts, must be included in the system if the total energy is to be conserved? .... **1 points**

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. **Read the article below and write an essay following the guidelines provided.**

In North America sports injuries of all types affect about a million children under the age of fifteen, and cost nearly a billion dollars in emergency and extended care. But why do these injuries occur? Many injuries are the result of body contact among participants, but some injuries result from contact with the playing surface - ice, asphalt, concrete, hardwood, etc.

What are the physical and technological properties of different playing surfaces in providing a cushioning or shock-absorbing effect? Consider what happens when a collision occurs. As a foot, hip, or head makes contact with a surface, injury may be sustained by the soft tissue, bones, or cartilage of each body part. The severity of the trauma to these body parts will often be determined by the physical and technological properties of the surface at the point of impact.

The force with which a body part strikes a surface can be broken down into two components and analysed. The horizontal component of the force is caused by the friction that determines whether you stop, start, slide or slip. For example, while running on an asphalt track, the friction prevents the foot from easily slipping backward, as it would on ice. If the surface has low friction, the horizontal forces and horizontal shock will be reduced but will not produce a cushion-like effect. Ice provides an example. A fall on ice, which is hard, can cause severe injury even though the surface is slippery.

The vertical component of the force is affected by the cushioning effect. If the vertical component of the force can be reduced, then the surface will cushion the impact of a fall and less trauma will be sustained by a foot, hip, or foot, on contact. But how can the magnitude of the vertical component be reduced and what are the physical and technological conditions that make this happen?

Please consider Table 1 and Table 2. The two tables provide information that relates to a) surface deformation and b) interaction time for different surfaces.

Table 1

material	**deformation**
concrete	1.2×10^{-3} m
asphalt	2.0×10^{-3} m
running track	4.1×10^{-3} m
clay court	7.1×10^{-3} m
astroturf	13×10^{-3} m

Experiments were performed under similar conditions.

Table 2

material	**interaction time**
concrete	1.8×10^{-3} s
asphalt	2.4×10^{-3} s
running track	3.5×10^{-3} s
clay court	4.5×10^{-3} s
astroturf	6.0×10^{-3} s

Your task is to use the information provided above, the information in the tables, and the physics you have learned as it pertains to force, impulse and momentum, and energy, to write a well-constructed essay that addresses the appropriate technological and social consequences of the nature of contact surfaces and sports injuries. Organize your essay as follows;

(1) show how technology helps or hinders finding solutions to surface-related injuries with reference to the structure and function of different surfaces
(2) describe or illustrate with examples and/or formulae the physics concepts related to the collisions with surfaces
(3) explore the social and personal consequences (advantages and disadvantages) of creating new standards for safe playing surfaces.

Scoring:
technology -- **4 points**
physics -- **4 points**
social -- **4 points**
overall development of argument -- **4 points**

Total: **16 points**