

ATLANTIC CANADA EXAMINATIONS

PHYSICS 12

JANUARY 2001

Comment Box—For Use by Teacher

What accommodations have been made?

By whom?

Position/Title:

Why?



Name: _____

Selected Response Questions

(Total Value 40)

General Instructions

This examination is composed of three sections, with an estimated time allotment as listed below:

Selected Response Questions, value 40, 40 minutes total

Constructed Response Questions, value 50, 100 minutes total

Case Study, value 10, 20 minutes total

Include an additional 20 minutes for organization and extra writing time.

Total time: 3 hours

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

Non-programmable calculators are permitted, but are not to be shared.

Selected Response Questions

(Total Value: 40)

In this part of the examination, there are 40 multiple choice questions, each with a value of one. 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 your choice. **Use HB pencil only.**

Fill in the answers to the multiple choice questions in this part of the examination in 1 to 40 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

Answer Sheet

A B C D

Which unit is an SI unit of distance?

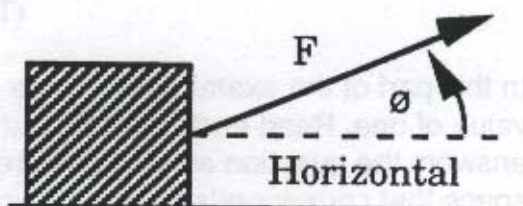
- A. feet
- B. inches
- C. metres
- D. cubits

○ ○ ● ○

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

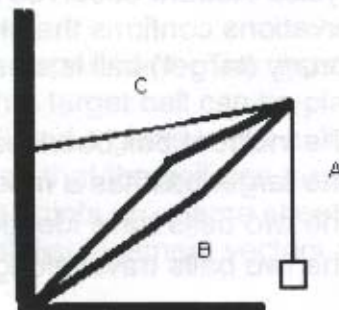
Do not turn the page to start the examination until told to do so by the presiding examiner.

1. The diagram represents a constant force F acting on a box located on a frictionless horizontal surface. As the angle between the force and the horizontal increases, the acceleration of the box will do which of the following?



- A. remain the same
B. increase
C. decrease proportionally with the sine of the indicated angle
D. decrease proportionally with the cosine of the indicated angle
2. A boat travelling at a speed of 4.0 m/s relative to the water is steered North, directly across a river that is flowing East at 3.0 m/s. What is the velocity of the boat?
- A. 5.0 m/s, 37° East of North
B. 5.0 m/s, 49° East of North
C. 5.0 m/s, 51° East of North
D. 5.0 m/s, 53° East of North
3. Kim walks 0.60 km North and then 0.80 km East. What is the magnitude of her total displacement?
- A. 0.20 km
B. 0.48 km
C. 1.0 km
D. 1.4 km

4. The diagram shows a typical boom crane used to unload ships. Which force will be the largest?



- A. The tension in cable A
B. The tension in cable C
C. The thrust in boom B
D. The weight of the object being lifted
5. A plumber pulls perpendicularly with a force of 100. N on the handle of a wrench with an effective length of 40.0 cm. What torque is produced?
- A. 2.5 N/cm
B. 40. N-m
C. 250 N/m
D. 4.0 N-m
6. A particular fireworks rocket explodes into three equal mass fragments just as it reaches its highest point. The fragments move out along a common plane parallel to the surface of the earth. One fragment has a velocity of 100. m/s at a 37° angle clockwise from North (bearing 037°). A second fragment has a velocity of 75 m/s at an angle of 37° clockwise from West (bearing 307°). What would be the velocity of the third fragment?
- A. 120. m/s, North
B. 120. m/s, South
C. 125 m/s, North
D. 125 m/s, South

7. A physics student observes collisions between billiard balls. Which of the following observations confirms that the collision between a moving (incident) ball and a stationary (target) ball is elastic?

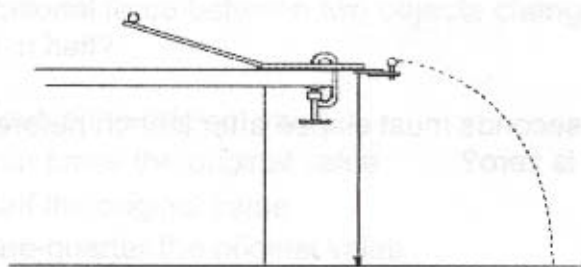
- A. The incident ball bounces back.
- B. The target ball has a much higher velocity after impact.
- C. The two balls have identical speeds after impact.
- D. The two balls travel along paths separated by a 90° angle after impact.

8. A curling stone travelling 10. m/s undergoes an elastic collision with an identical stationary stone. The target stone has a speed of 8.0 m/s after impact. What speed should the incident stone have after impact?

- A. 2.0 m/s
- B. 4.0 m/s
- C. 6.0 m/s
- D. 8.0 m/s

The next two questions relate to the following information.

Two students conduct trials for a two-dimensional collision experiment. The apparatus consists of a ramp at the bottom of which is a pin on which a target ball can be placed. The students are conducting trials with a steel incident ball and a glass target ball, which is half the mass of the steel ball. The pin is placed so that the collision takes place at a glancing angle. The students record the impact points on a large sheet of paper on the floor using carbon paper, and draw horizontal displacement vectors on the sheet.



9. Which of the following statements best describes the displacement vectors?
- A. The displacement of the glass ball will be larger than the displacement of the steel ball.
 - B. The displacement of the steel ball will be larger than the displacement of the glass ball.
 - C. The arithmetic sum of the two displacements will be the same as if the steel ball had flown freely off the end of the ramp without striking anything.
 - D. The vector sum of the two displacements will be the same as if the steel ball had flown freely off the end of the ramp without striking anything.
10. Which of the following statements best describes how the displacement vectors can be used to represent momentum?
- A. They may be used as they are.
 - B. The displacement of the glass ball must be cut in half.
 - C. The displacement of the glass ball must be doubled.
 - D. The displacement of the steel ball must be cut in half.

The next four questions relate to the situation described below.

A cannon fires a ball at 30 degrees above the horizontal. The horizontal component of the launch velocity is 86.6 m/s. Neglect air friction in your calculations.

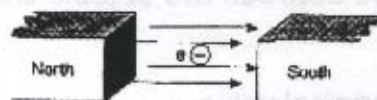
11. Which of the following is the magnitude of the muzzle velocity?
 - A. 100. m/s
 - B. 500. m/s
 - C. 866 m/s
 - D. 1000. m/s
12. Approximately how many seconds must elapse after launch before the vertical component of the velocity is zero?
 - A. 5.1 s
 - B. 8.7 s
 - C. 10. s
 - D. 51. s
13. What is the maximum height to which the ball will rise?
 - A. 50.0 m
 - B. 130. m
 - C. 435 m
 - D. 870. m
14. Which of the following is closest to the maximum horizontal displacement of the ball if the height of the muzzle of the cannon above the horizontal surface is ignored?
 - A. 250. m
 - B. 500. m
 - C. 900. m
 - D. 1800. m

15. Suppose the launch angle of a projectile is changed from 30 degrees to 60 degrees. Which of the following represents the ratio one would get by comparing the maximum height in the second case to the maximum height in the first case?
- A. 0.58:1
 - B. 1.5:1
 - C. 1.7:1
 - D. 2.0:1
16. How would the gravitational force between two objects change if the distance between the two objects is cut in half?
- A. the force will be double the original value
 - B. the force will be four times the original value
 - C. the force will be half the original value
 - D. the force will be one-quarter the original value
17. In order to experience weightlessness, you and your immediate environment must experience exactly the same value of which of the following?
- A. acceleration
 - B. inertia
 - C. mass
 - D. speed
18. The gravitational force between two masses is inversely proportional to which of the following?
- A. mass
 - B. mass squared
 - C. separation
 - D. separation squared
19. In order for a satellite to have a geosynchronous orbit around the earth, which of the following must be the period of the orbit?
- A. one day
 - B. one hour
 - C. one month
 - D. one year

20. Which of these people performed an experiment in 1798 that measured the force of attraction between two small spheres?

- A. Cavendish
- B. Einstein
- C. Faraday
- D. Newton

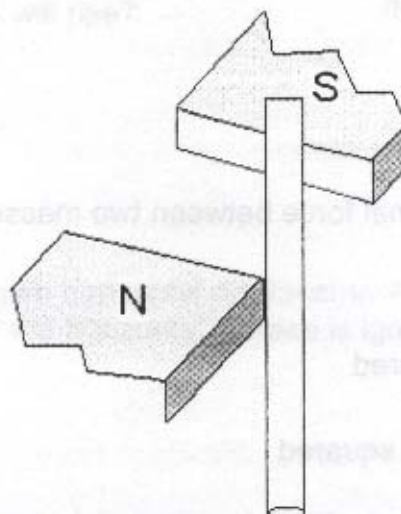
21. This diagram shows an electron in a magnetic field.



Under which of the following conditions will there be no magnetic force?

- A. when the electron moves into the page
- B. when the electron moves out of the page
- C. when the electron moves toward the right side of the page
- D. when the electron moves toward the top of the page

22. The diagram at the right shows a wire moving from left to right through a permanent magnetic field. Which of the following statements best describes the resulting current?



- A. electrons will flow from bottom to top in the wire
- B. electrons will flow from top to bottom in the wire
- C. positive charges will flow from top to bottom in the wire
- D. no current will result

23. The direction of the induced current is such that the magnetic field resulting from the induced current opposes the change in flux that caused the induced current. This is a statement of which of the following laws?
- Ampere's Law
 - Faraday's Law
 - Gauss's Law
 - Lenz's Law
24. An ideal transformer (100% efficient) has 20 turns of wire in the primary coil and 40 turns of wire in the secondary coil. If 25 watts of power is supplied to the primary coil, what power is developed in the secondary coil?
- 5.00 watts
 - 12.5 watts
 - 25.0 watts
 - 50.0 watts
25. In a certain transformer, the primary coil has 5.00×10^2 turns and the secondary coil has 1.50×10^3 turns. If the voltage applied to the primary coil is 5.33 volts, what is the voltage in the secondary circuit?
- 1.78 V
 - 3.00 V
 - 3.33 V
 - 16.0 V
26. Which of the following scientists produced the first electric generator that converted mechanical energy to electrical energy?
- Faraday
 - Gauss
 - Hertz
 - Lenz
27. What type of commutator is found in an AC generator?
- continuous contact commutator
 - slip ring commutator
 - split ring commutator
 - three ring commutator

28. Which of the following will NOT increase the amount of electrical energy produced by a generator?
- A. increasing the number of windings on the armature
 - B. increasing the speed of rotation
 - C. increasing temperature in the windings
 - D. winding the armature on a soft iron core
29. Which of the following is the best description of the current leaving a DC generator?
- A. It increases and decreases once in each revolution of the armature.
 - B. It increases and decreases twice in each revolution of the armature.
 - C. It maintains a constant value.
 - D. It varies in direction.
30. When an electric motor is running, it produces a back EMF because it also acts as which of the following?
- A. a commutator
 - B. a generator
 - C. an induction coil
 - D. a transformer
31. In 1923, Louis-Victor deBroglie suggested which of the following?
- A. an object's momentum and position cannot be determined at the same time
 - B. any mass can be totally converted to energy
 - C. luminous objects radiate light only at specific discrete frequencies
 - D. material particles have wave properties
32. What is the term used to refer to the minimum energy required for a photoelectron to escape from a metal plate in a photocell?
- A. incident frequency
 - B. Planck's constant
 - C. threshold frequency
 - D. work function

33. Electromagnetic radiation may be generated by which of the following alternatives?
- A. electrons accelerating
 - B. electrons moving with constant velocity
 - C. neutrons accelerating
 - D. neutrons moving with constant velocity
34. If an electron orbiting an atomic nucleus moves to a lower orbit, which of the following describes what will happen to the total energy of the atom?
- A. cannot be determined
 - B. decreases
 - C. increases
 - D. remains the same
35. Whose atomic theory included the following postulate:
- When moving in an allowed orbit, an electron is exempt from the classical laws of mechanics and electromagnetism, and is said to be in a steady state.*
- A. Bohr
 - B. Compton
 - C. deBroglie
 - D. Rutherford
36. Which of the following phenomena is the best evidence for the quantification of energy in the hydrogen atom?
- A. alpha particle scattering
 - B. emission spectra
 - C. radioactive decay
 - D. the photoelectric effect
37. Threshold frequency is to work function as hertz is to which of the following?
- A. coulomb
 - B. newton
 - C. joule
 - D. watt

38. Electrons are emitted from a photoelectric surface only when the incident light is higher than a value called the threshold frequency. Above this frequency, what happens to the current of photoelectrons when the intensity of incident light increases?
- cannot be determined
 - decreases
 - increases
 - remains the same
39. When electromagnetic radiation with a wavelength of 350 nm falls on a metal, the maximum kinetic energy of the ejected electrons is 1.20 eV. What is the work function of the metal?
- 1.3 eV
 - 2.4 eV
 - 5.4 eV
 - 5.7 eV
40. Calculate the wavelength in nanometers of a photon with 3.2×10^{-19} J of energy.
- 210 nm
 - 420 nm
 - 530 nm
 - 620 nm

Constructed Response Questions

(Total Value: 50)

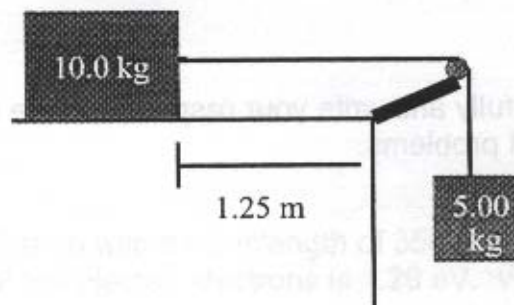
Read each question carefully and write your response in the space provided. Show calculations for numerical problems.

2) Calculate the velocity of the second mass after the collision.

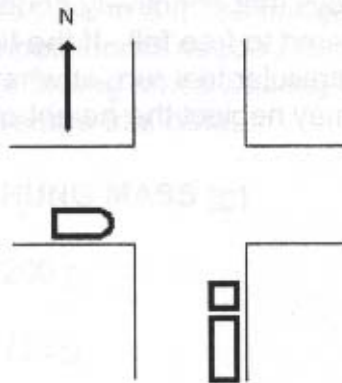
3) What percentage of the original kinetic energy of the system is lost during the collision?

41. Determine the coefficient of friction that would result in the masses in the following system moving with a constant velocity.

value: 5



42. A 2100 kg minivan, travelling East at 20.0 m/s, collides with a 21 000 kg tractor trailer, travelling North at 30.0 m/s. The two vehicles remain stuck together after impact.



- A) In the space provided, construct an appropriate scaled momentum diagram.
value: 2

- B) Determine the velocity of the combined mass immediately after impact.
value: 2

- C) What percentage of the original total kinetic energy of the system is lost during the collision?
value: 1

43. A circus performer does a variation on the human cannonball stunt. A clown dummy is launched from a cannon, which is set at an angle of 53° . At the highest point in the path, a parachute-like device deploys that effectively doubles the time it takes for the dummy to reach the ground compared to free fall. If the time to drop (from deployment to impact) was 4.0 seconds in a particular trial run, at what speed did the dummy leave the muzzle of the cannon? (You may neglect the height of the muzzle above ground in your solution.)

value: 5

44. An airplane is flown through a vertical loop manoeuvre. In the space provided, draw a diagram clearly identifying all the forces acting on the pilot when in an inverted orientation at the highest point of the loop. Can the net force on the pilot be determined? Give an explanation of your answer.

value: 4

45. Two students were conducting centripetal force trials in an experiment in which a mass is rotated in a circular path above the head. The mass is attached to a string that is passed through a vertical glass tube to a mass hanger. The vertical pull on the mass hanger just provides the centripetal force needed to prevent the swung mass from flying off in a straight line. The swung mass was kept in a circle of 0.50 m radius. The following table summarizes average trial data.

SWUNG MASS (g)	HUNG MASS (g)	FREQUENCY (Hz)
100 g	200 g	1
100 g	750 g	2
100 g	1650 g	3

A) What can you conclude about the relationship between centripetal force and circular speed?

value: 2

B) If there had been no uncontrolled variables or experimental error, what should the hung mass have been for the 3 Hz trials?

value: 3

C) What unmeasured variable or factor do you think resulted in lower than ideal values for the hung masses?

value: 2

46. As a consultant to a motion picture producer, you are asked to describe the gravitational force an astronaut would experience on a roughly spherical asteroid of 6×10^{18} kg mass.

- A) How would an astronaut's weight on the surface of this asteroid compare with his weight on earth? Calculate a specific ratio.

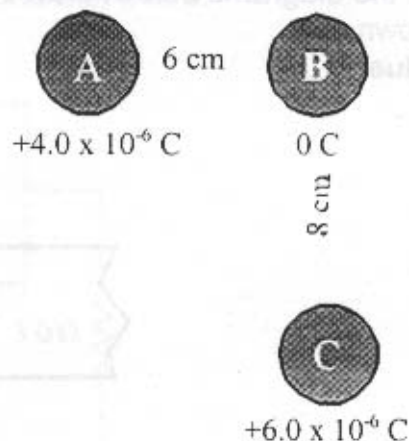
value: 3

- B) How would this ratio affect the astronaut's ability to move about on the asteroid?

value: 1

47. The diagram at the right shows the charge condition and separation of three metal spheres. A and B are 6.0 cm apart. B and C are 8.0 cm apart. Angle ABC is a right angle.

Suppose sphere A is briefly touched to sphere B and then returned to its original position. Then suppose that sphere C is touched to sphere B and returned to its original position.



- A) Determine the resulting charge on each of the three spheres.

value: 2

- B) Determine the net force on sphere B.

value: 4

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

A)

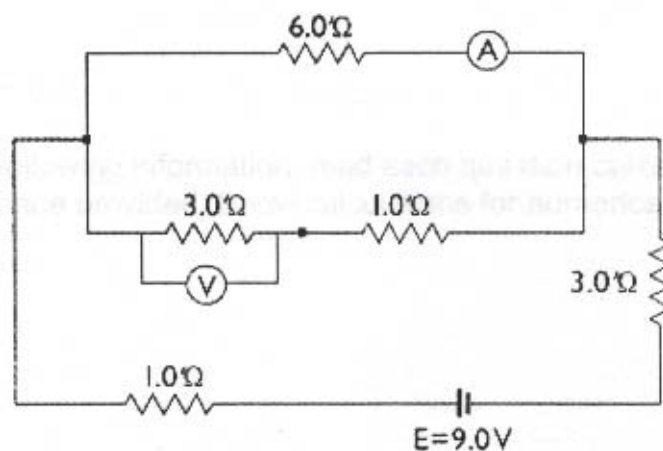


B)



49. You have been asked by a friend for advice on purchasing jumper cables for her car. She notices that some are thin and others are thick. Based on your knowledge of circuit properties and the weather conditions in which the cables will most likely be used, explain which type you would recommend.
value: 2

50. Analyze the circuit diagram below and answer the questions that follow.



A) Calculate the equivalent resistance of the circuit.

value: 3

B) Calculate the value of the ammeter reading, A, indicated on the diagram.

value: 3

C) Calculate the value of the voltmeter reading, V, indicated on the diagram.

value: 2

Case Study
(Total Value:10)

After reading the following information, read each question carefully and write your response in the space provided. Show calculations for numerical problems.

The following information relates to nuclear reactors in use world-wide. Read the material provided and answer the questions that follow. Some of the questions ask you to relate this material to what you have learned in class.

Reactors Operational World-wide

Reactor Type

Advanced Gas Cooled Reactor	AGR
Boiling Water Reactor	BWR
Gas Cooled Reactor	GCR
Liquid Metal Fast Breeder Reactor	LMFBR
Pressurized Heavy Water Reactor	PHWR
Pressurized Water Reactor	PWR
Water Cooled/Graphite Moderated	LGR

Comment

15 operating world-wide
95 operating
21 operating in Japan and U. K.
5 operating in Europe
operating in Canada and India
more than 300 operating world-wide
Chernobyl design

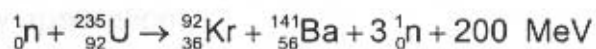
The CANDU reactor was designed by Atomic Energy Canada Limited (AECL) as an alternative to other designs that use slightly enriched uranium (2-5% U-235). The CANDU system does not require a pressure vessel and can, therefore, be built in countries where construction technology is limited. It is fueled with pellets of uranium dioxide made from natural uranium (0.7% U-235). It is cheaper to fuel and theoretically gives higher lifetime capacity. On the other hand, fuel burnup is much lower than PWR reactors (less than 20%). The CANDU reactor has considerable redundancy built in, which permits longer operating cycles.

The design consists of a horizontal calandria (container) that has tubes for the fuel rods and cooling heavy water. These tubes are surrounded by heavy water, which acts as a moderator to slow down neutrons. Heavy water is two atoms of deuterium and one atom of oxide. Since about 1.5% of all hydrogen atoms are deuterium isotopes, a separate plant must be built to separate heavy water molecules from large quantities of natural water. Since heavy water is a much better moderator than natural water, the reactor can function without enriched fuel. The cost of deuterium separation is offset by the lower costs of unenriched fuel.

Like the more common pressurized water reactor, pumps circulate the cooling heavy water through a closed system to a steam generator beside the reactor. The moderator heavy water circulates through a separate heat exchange system.

The CANDU system uses a vacuum building as a separate containment protection feature. There is also more computer-based control in the operating system to protect the reactor. Because of the need for periodic service shutdowns, reactors are usually built in groups of 2-8 per site. There are CANDU powered generators in Ontario, Quebec, and New Brunswick.

51. The fission of uranium in nuclear reactors takes place according to the following equation.



What characteristic of this reaction leads us to call it a "chain" reaction?

value: 1

52. What are two advantages of the CANDU reactor design over other types of reactors?

value: 1

53. Using the uranium decay equation given in problem 51, determine the number of atoms of uranium that would have to decay to generate 6.0×10^3 MeV?

value: 2

Reactor Operational World-wide

What consequences of this reaction leads us to call it a "chain" reaction?

Reactor Type

Comments

Pressurized Water Reactor (PWR)

PWR

15 operating world-wide

Boiling Water Reactor (BWR)

BWR

38 operating

Gas-Cooled Reactor (GCR)

GCR

21 operating in Europe and U.S.

54. What are two serious concerns relating to nuclear power stations? In three or four sentences for each, elaborate on the nature of the concern and the degree of risk.

value: 3

55. One of the criticisms of the CANDU reactor is that it was designed to be sold to third world countries that would then be markets for Canadian uranium and heavy water. This situation would result in the proliferation of nuclear technology, which could be diverted to military application.

Write a 100-150 word essay in which you discuss the following points:

- at least two design characteristics that lead to this conclusion
- at least two concerns about the operation of nuclear facilities in developing countries
- at least two controls or alternatives that might meet the energy needs in developing countries.

value: 3

You have reached the end of this examination. Please check your work before handing in your examination to ensure that you have not left out any questions.