NOVA SCOTIA
Department of Education
Testing and Evaluation

1408219

NOVA SCOTIA EXAMINATIONS

PHYSICS 12

JANUARY 2003

Comment Box—For Use by Teacher

What accommodations have been made?

By whom?

Position/Title:

Why?

Name:_____

General Instructions

This examination is composed of three sections, each with an estimated time allotment shown.

Question Type	Value	Suggested Time
Selected Response	40	60 minutes
Constructed Response	50	90 minutes
Case Study	10	30 minutes

NOTE: Times are suggestions only.

Total Time: 3 Hours

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 point. Read each question carefully and decide which of the choices best answers the question asked. You are provided with a separate response 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. 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
○ ○ ● ○

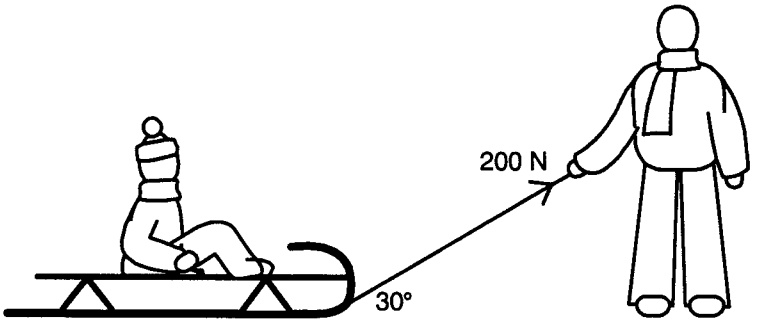
If you wish to change an answer, erase your first mark completely.

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

1. A balloon is rising vertically at a velocity of 4.0 m/s while a west wind is blowing at 10. m/s. Relative to the ground, what is the angle of ascent of the balloon?

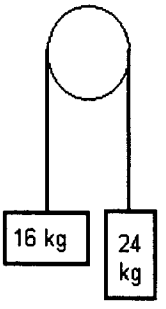
   A. 22°
   B. 24°
   C. 66°
   D. 68°

2. The diagram below shows a sled holding a 40.0 kg child being pulled along a level surface by a rope that applies a 200. N force at an angle of 30 ° to the horizontal.
   What is the magnitude of the vertical component of the 200. N force?



   A. 50.0 N
   B. 100. N
   C. 150. N
   D. 173 N

3. The diagram at the right shows a rope that passes over a fixed frictionless pulley. Two masses are attached, as shown, and held in place. Which of the following is closest to the magnitude of the acceleration that will result if the masses are released?

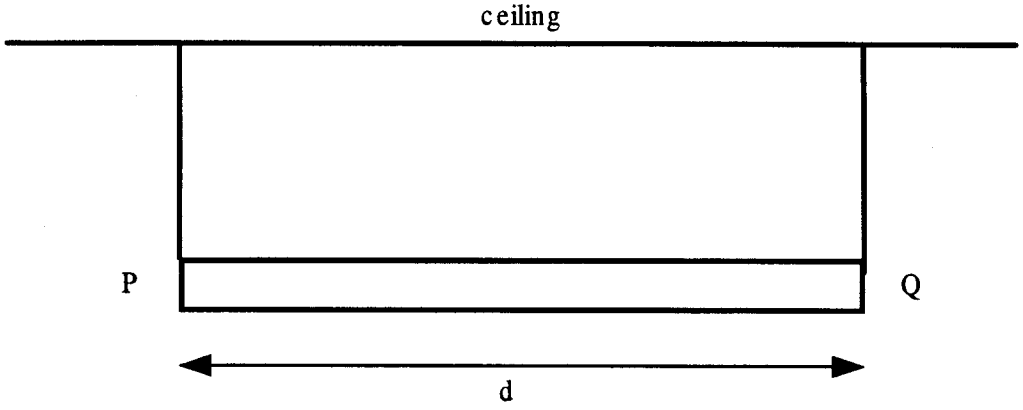


   A. 2 m/s^2
   B. 6 m/s^2
   C. 10. m/s^2
   D. 15 m/s^2

4. A block of mass 15 kg is raised along a frictionless inclined plane that makes a 30° angle with the horizontal. What force is needed to move the object up the plane at a constant velocity?

A. 74 N
B. 85 N
C. 130 N
D. 150 N

5. A beam, PQ, is suspended at its ends by cords as shown.



If the tension in the right hand cord is T_r, what is the sum of the torques about point P?

A. 0 N·m
B. Td
C. Td/2
D. T/d

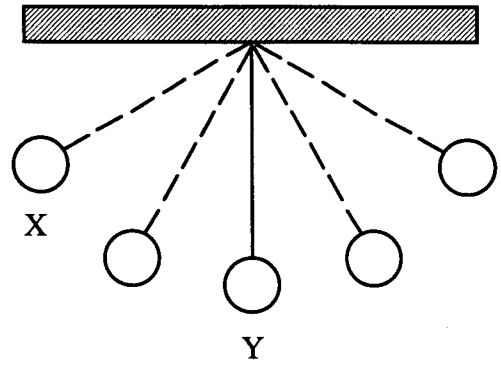
6. For small displacements from the rest position, the period of a pendulum depends most upon which of the following variables?

A. amplitude
B. length of the pendulum
C. mass of the bob
D. shape of the bob

7. What is the frequency of a pendulum with a length of 1.47 m?

A. 0.411 Hz
B. 0.942 Hz
C. 1.06 Hz
D. 2.43 Hz

8. The diagram shows a swinging pendulum mass.



As the pendulum swings from X to Y, the relationship between the potential energy of the mass and the kinetic energy of the mass is best described by which of the following statements?

A. The potential energy decrease is equal to the kinetic energy increase.
B. The potential energy decrease is less than the kinetic energy increase.
C. The potential energy increase is equal to the kinetic energy increase.
D. The potential energy increase is less than the kinetic energy increase.

9. Which of the following launch angles will give a projectile maximum range?

A. 30.0 degrees
B. 45.0 degrees
C. 60.0 degrees
D. 86.6 degrees

10. A 1.0 kg block is dropped from the roof of a tall building at the same time as a 3.0 kg ball is thrown horizontally from the same height. Which of the following statements describes the motions of the block and the ball?

A. The 1.0 kg block hits the ground first because it has no horizontal velocity.
B. The 3.0 kg ball hits the ground first because it has more mass.
C. The 3.0 kg ball hits the ground first because the force of gravity acting on it is larger.
D. Both hit the ground at the same time because they experience the same vertical acceleration.

11. An object is launched with a velocity of 20.0 m/s at an angle 30° above the horizontal surface. What is the magnitude of the velocity at athe highest point in the path?

A. 0 m/s
B. 10.0 m/s
C. 17.3 m/s
D. 20.0 m/s

12. A student standing on top of a building throws a ball with a horizontal velocity of 12 m/s. If the ball strikes the ground 45 m from the base of the building, how high is the building?

A. 18 m
B. 37 m
C. 69 m
D. 140 m

13. A mass attached to a string is whirled at a constant speed of 2.0 m/s in a horizontal circle of radius 0.50 m. What is the magnitude of the centripetal acceleration of the mass?

A. 1.0 m/s^2
B. 2.0 m/s^2
C. 4.0 m/s^2
D. 8.0 m/s^2

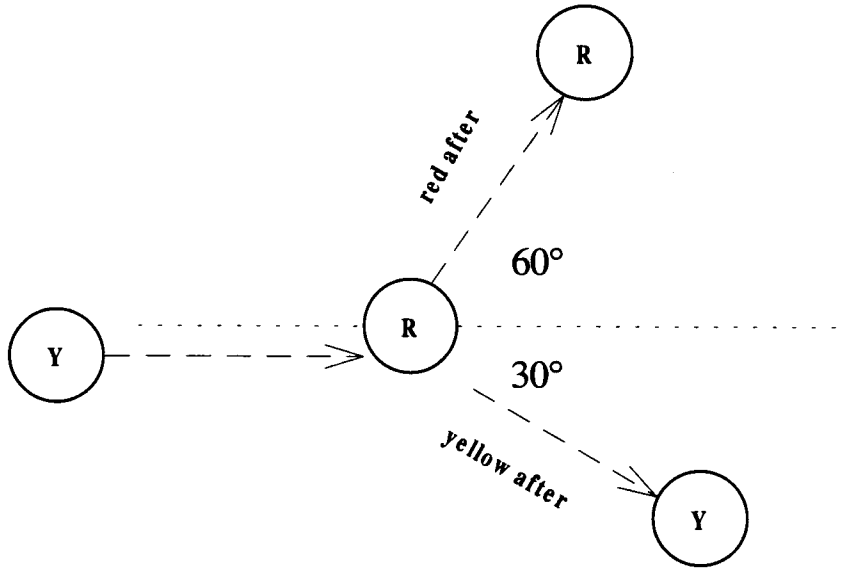
14. Which of the following statements actually describes an aspect of the force that acts on an object and causes it to move in a circle?

A. It balances all other forces.
B. It is in the same direction as the object's velocity.
C. It is directed toward the center of the circle.
D. It is directed away from the center of the circle.

15. In an inelastic collision, what quantity can be conserved?

A. kinetic energy
B. momentum
C. potential energy
D. velocity

16. A yellow curling stone travels straight down the ice at 0.72 m/s and hits a stationary red stone. After contact, the red stone moves off at 0.28 m/s at an angle of 60° as shown. The yellow stone moves off at 30° as shown. The mass of a curling stone is 20. kg. What is the speed of the yellow stone after the collision?

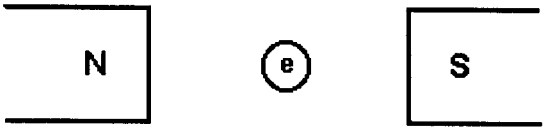


A. 0.30 m/s
B. 0.44 m/s
C. 0.66 m/s
D. 0.69 m/s

17. The gravitational force of attraction between two objects is F_g. If the distance between the objects is tripled, what will the force become?

A. $\frac{1}{9}F_g$
B. $\frac{1}{3}F_g$
C. $3F_g$
D. $9F_g$

18. The diagram below shows an electron in a magnetic field. The electron will experience no magnetic force if it moves in which of the following directions?



A. to the right
B. up (toward the top of the page)
C. into the page
D. out of the page

19. A direct current source is used to operate a simple demonstration electric motor. Which of the following statements best explains what happens at each half rotation of the split ring commutator?

A. increases the current in the armature
B. increases the strength of the field magnet
C. reverses the direction of the current in the armature
D. reverses the polarity of the magnetic field

20. An ideal (100% efficient) transformer has a 400 turn primary coil connected to a 120 Volt source. If the secondary coil has 200 turns, what is the voltage induced in the secondary coil?

A. 30 V
B. 60 V
C. 240 V
D. 480 V

21. Suppose a magnetic compass is held directly above a straight conductor that is lying horizontally across this page. If electrons flow from left to right through the conductor, to which edge of the page does the North-seeking pole of the compass point?

A. top
B. left
C. right
D. bottom

22. Which of the following phenomena is the best evidence for energy quanta in the hydrogen atom?

A. alpha particle scattering
B. emission spectra
C. radioactive decay
D. the photoelectric effect

23. If an electron has a kinetic energy of 2.366×10^{-18} J, what is its deBroglie wavelength?

A. 2.80×10^{-16} m
B. 4.37×10^{-14} m
C. 1.74×10^{-13} m
D. 3.19×10^{-10} m

24. Which of the following motions would be associated with the **largest** deBroglie wavelength?

A. a baseball moving at 90 km/hr
B. an alpha particle moving at near the speed of light
C. an automobile moving at 90 km/hr
D. an electron moving at near the speed of light

25. In a vacuum, what factor is the same for all types of electromagnetic radiation?

A. amplitude
B. frequency
C. speed
D. wavelength

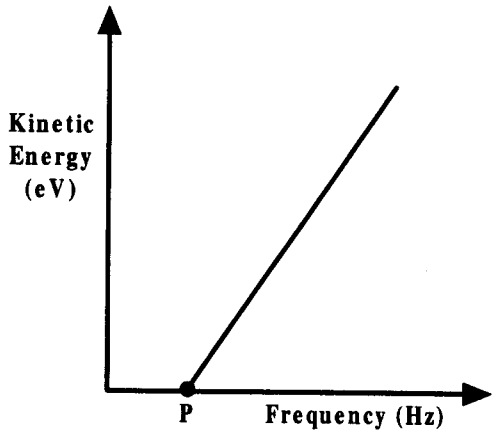
26. Which model(s) of the nature of light successfully explain(s) the reflection of light?

A. wave model but not particle model
B. particle model but not wave model
C. both particle and wave models
D. neither particle nor wave model

27. What is the momentum of a photon when the wavelength is 7.0×10^{-7} m?

A. 4.6×10^{-40} kg m/s
B. 9.5×10^{-28} kg m/s
C. 1.9×10^{-27} kg m/s
D. 1.1×10^{27} kg m/s

28. The graph below shows the relationship between the frequency of radiation incident on a photosensitive surface and the maximum kinetic energy of the emitted photoelectrons.



What does point P represent?

A. fundamental frequency
B. photoelectron frequency
C. photon escape frequency
D. threshold frequency

29. The mass defect for a Boron-11 nucleus is 1.3184×10^{-28} kg. What is the binding energy for this nucleus?

A. 1.5644×10^{-39} J
B. 3.9552×10^{-20} J
C. 1.1866×10^{-11} J
D. 1.1866×10^{-8} J

30. The binding energy for a $^{56}_{26}Fe$ nucleus is 492.4 MeV. What is the binding energy per nucleon?

A. 6.005 MeV
B. 8.793 MeV
C. 16.41 MeV
D. 18.94 MeV

31. Which of the following decay products has the greatest penetrating power?

A. alpha
B. beta
C. gamma
D. neutron

32. What is X in the following equation: ${}^{214}_{83}Bi \rightarrow X + \beta$

A. ${}^{213}_{82}Pb$
B. ${}^{214}_{82}Pb$
C. ${}^{214}_{84}Po$
D. ${}^{210}_{81}Ti$

33. What major elementary particles are contained in the nucleus of the radioisotope ${}^{239}_{92}U$?

A. 92 protons and 239 neutrons
B. 92 protons and 147 neutrons
C. 239 protons and 92 neutrons
D. 147 protons and 331 neutrons

34. During the process of nuclear fission, what happens to the nuclei of atoms?

A. Individual nuclei are split into lighter nuclei.
B. They are converted to heavier nuclei.
C. They are forced together to form lighter nuclei.
D. They are transmuted, with the emission of heavier nuclei.

35. When there is a decrease in both the mass number and atomic number of a radioactive element, what particle has been emitted?

A. Alpha
B. Beta
C. Gamma
D. X ray

36. In the fission process in a nuclear reactor, what particles are regulated in order to control the nuclear reaction?

A. electrons
B. neutrons
C. positrons
D. protons

37. $^{210}_{84}Po$ decays by alpha decay. Which of the following is the resulting isotope?

A. $^{206}_{82}Pb$
B. $^{208}_{81}Bi$
C. $^{210}_{81}Bi$
D. $^{210}_{82}Pb$

38. Which of the following is used as a moderator in a CANDU reactor?

A. graphite
B. heavy water
C. hydrogen
D. uranium

39. Which of the following terms describes the combining of lighter nuclei to form one heavier nucleus?

A. Beta decay
B. neutron activation
C. nuclear fission
D. nuclear fusion

40. The half life of $^{90}_{38}Sr$ is 28 years. If 60.0 g of this isotope is found in a sample, what mass will be found in the same sample 56 years later?

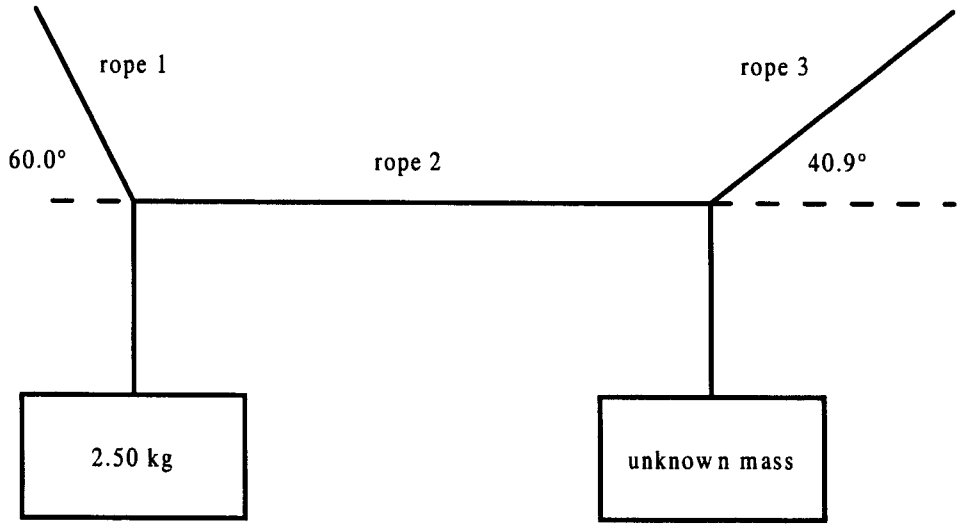
A. 3.75 g
B. 7.50 g
C. 15.0 g
D. 30.0 g

Constructed Response Questions
(Total Value: 50)

Read each question carefully and write your response in the space provided. Be as neat and organized as possible. Solutions to numerical problems must include:

✓ ***appropriate formulae***
✓ ***correct substitution of values***
✓ ***final answer clearly indicated***

41.



Two signs are suspended in equilibrium using three ropes of negligible mass as shown above. The sign on the left has a mass of 2.50 kg, and the rope connecting it to the ceiling makes an angle of 60.0° with the horizontal. The rope connecting the sign on the right to the ceiling makes an angle of 40.9° with the horizontal. Determine the mass of the sign on the right.

value: 5

42. Two cars collide at an intersection. The first car has a mass of 925 kg and was travelling North. The second car has a mass of 1075 kg and was travelling West. Immediately after impact, the first car had a velocity of 52.0 km/hr, 40.0 ° North of West, and the second car had a velocity of 40.0 km/hr, 50.0 °North of West. What was the speed of each car prior to the collision?

value: 8

43. A soccer ball is kicked into the air at a speed of 20.0 m/s and an angle of 37.0° from the horizontal and lands on the same level ground.

A) What is the total time the soccer ball is in the air? **value: 3**

B) What is the range? **value: 2**

C) What is the maximum height reached by the soccer ball? **value: 2**

D) What are the components of the velocity as it hits the ground? **value: 2**

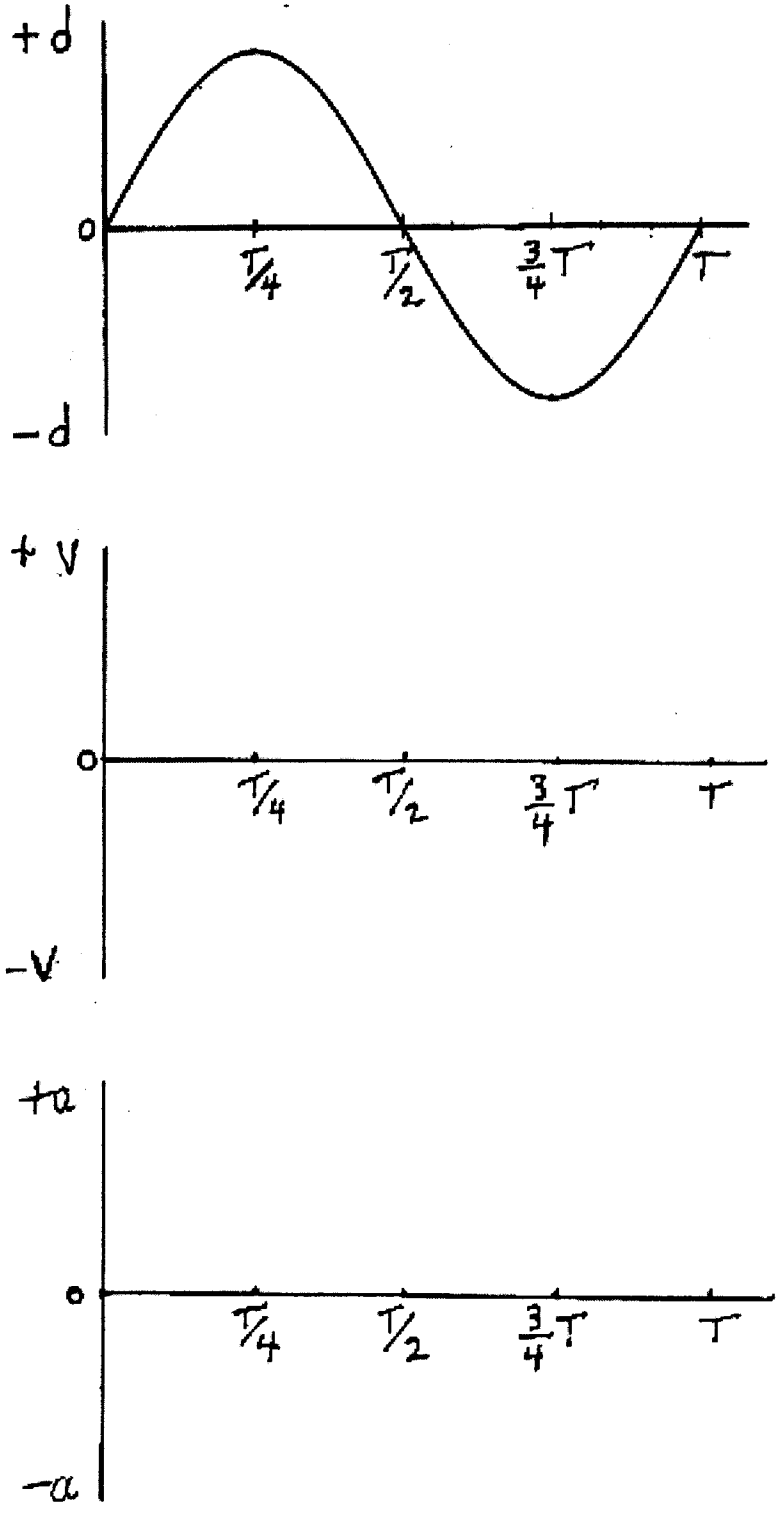
44. Suppose that an object is discovered orbiting the sun at a mean distance ten times that of Earth's distance from the sun.

A) Determine the orbital period of this object. **value: 3**

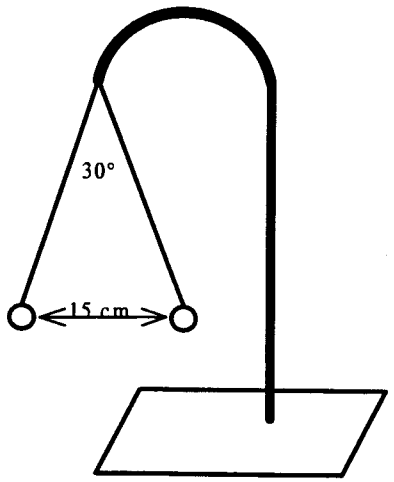
B) Determine the average speed of this object. **value: 2**

45. The mass of Jupiter is approximately 320 times the mass of Earth, yet the surface gravity of Jupiter is approximately three times the surface gravity of Earth. Explain why this seeming discrepancy occurs. **value: 3**

46. Suppose a mass is oscillating at the end of a spring that is hung vertically. A position vs time graph is given. Sketch the corresponding velocity vs time and acceleration vs time graphs on the axes provided. **value: 2**



47. Two 2.0 g pith balls carrying identical charges are suspended from a stand as shown. The pith balls repel each other and are shown hanging in equilibrium at an angle of 30.0° between the strings. The distance between the centers of the two pith balls is 15 cm.



A) Calculate the tension in either string. **value 2**

B) Find the magnitude of the charge on each sphere. **value: 5**

48. An electron is fired into a 4.0×10^{-2} T magnetic field with a speed of 5.0×10^{5} m/s. The magnetic field is directed into this page and the electron is initially travelling to the right.

A) Draw a diagram indicating the magnetic field, the initial direction and path of the electron, and the path of the electron in the field. **value: 1**

B) Calculate the radius of the circular path the electron follows. **value: 3**

C) Will the kinetic energy of the electron change? Justify your answer. **value: 2**

49. A) An electron in a hydrogen atom drops from the third energy level to the second energy level. Calculate the energy emitted. **value: 3**

B) Given that the visible spectrum falls between 450 nm and 750 nm, determine if the energy emitted in part A falls in the visible spectrum. **value: 2**

Case Study
(Total Value:10)

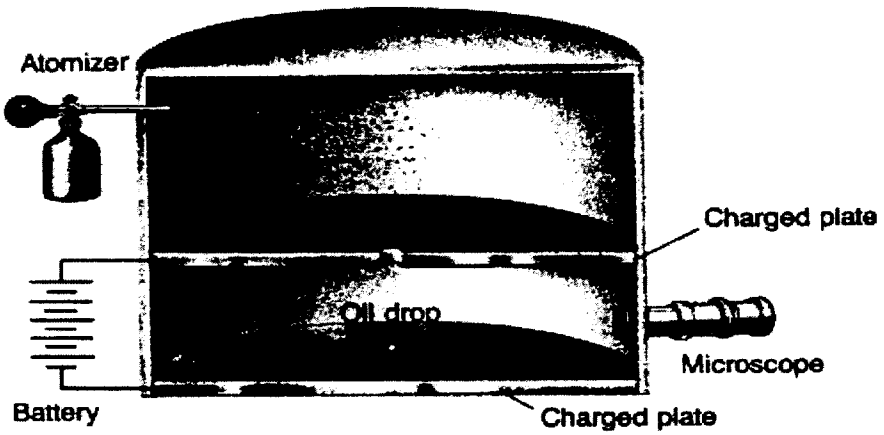
This section is an extension of the fields concepts you learned in Physics 12. Any additional information you require is given.

50. Read the article below and answer the questions that follow it.

The Millikan Oil Drop Experiment

Robert Andrews Millikan performed a very important series of experiments during the years 1909 to 1913 that were dependent on the uniform electric field between a pair of parallel plates. The results of these experiments, together with his contributions to research on the photoelectric effect, led to his Nobel Prize in Physics in 1923. Millikan verified the existance of a fundamental electric charge, carried by the electron, and provided the precise charge carried by the electron. This had tremendous impact on the further development of the theory of the structure of matter.

The experimental procedures used by Millikan were actually a modification of earlier techniques used by J. J. Thomson (1856-1940). A pair of parallel plates was very finely ground to smoothness, and a tiny hole was drilled in the top plate. An atomizer was mounted above the plates and used to spray tiny droplets of oil into the region above the plates. These droplets acquired an electric charge, presumably from friction, as they were sprayed. The whole apparatus was kept in a constant-temperature enclosure, and the region between the plates was illuminated with an arc lamp. The apparatus is illustrated below.



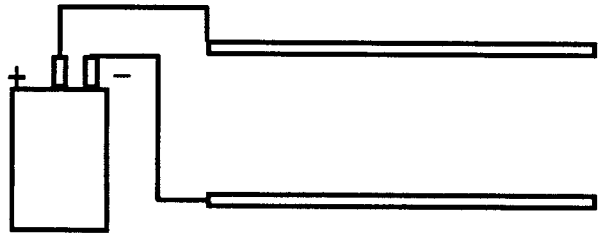
A droplet that fell through the hole and into the region between the two plates could be viewed through a small microscope. The droplet would very quickly reach terminal velocity as it fell under the influence of the force of gravity and the resistance of the air. This terminal velocity, v_0, could be measured by timing the drop as it fell between the lines on a scale in the eyepiece of the microscope.

50. Most of the droplets seemed to attain a negative charge, so the plates were connected to a variable power source that could generate from 3000 V to 8000 V of potential difference with the top plate being positive. In that way, a negatively charged drop could be made to reach an upward terminal velocity under the influences of the applied field and the effective weight of the drop. This second terminal velocity, v_1, was also recorded.

Millikan noted that the terminal velocity of the charged oil drops, which depended on the charge itself, varied from trial to trial. Over a very large number of trials, however, the velocity values could be grouped into categories. Each category represented an integral multiple of the lowest observed value. This led him to conclude that the charge on the oil drops themselves could be quantified as an integral multiple of one fundamental value. Millikan then used mathematical analysis to determine that value.

A. By what process was the oil drop in Millikan's experiment charged? **value: 1**

B. On the diagram below draw electric field lines to indicate the electric field between two parallel plates. **value: 1**



C. If a certain oil drop has a charge of 4.80×10^{-19} C, and the electric field intensity between the plates is 2.62×10^{6} N/C, what is the electric force acting on the oil drop? **value: 1**

D. When the oil drop has achieved terminal velocity, it is no longer accelerating. Draw a free-body diagram showing all the forces that are acting on the oil drop in this state. **value: 1**

50. E. Show that the electric field intensity is given by: $E = mg/q$. **value: 2**

F. The electric field intensity between two parallel plates can be expressed as $E = V/d$, where V is the potential difference applied to the plates, and d is the plate separation. Equate the expression in part E with this expression and solve for q. **value: 1**

G. For one trial, Millikan used a potential difference of 4.20×10^3 V, a plate separation of 1.60×10^{-3} m, and an oil drop of mass 3.00×10^{-15} kg. Determine the charge on the oil drop. **value: 1**

50. *An examination of Millikan's own papers and notebooks reveals that he exercised discrimination with respect to which drops he would include in published accounts of the determination of the value of the charge on one electron. In fact, he left many trials out. Sometimes he mentioned this fact, and sometimes he did not. Of particular concern is the fact that in his 1913 paper, presenting the most complete account of his measurements of the charge on electrons, Millikan states "It is to be remarked that this is not a selected group of drops but represents all of the drops experimented upon during 60 consecutive days." Millikan's notebook appears to contradict this assertion. Of 189 observations during the period in question, only 140 were presented in the paper. In effect, Millikan reported only the data that supported his conclusion.*

H. Do you believe that it was acceptable for Millikan to choose only data that supported his conclusion? Explain your reasoning. **value: 2**