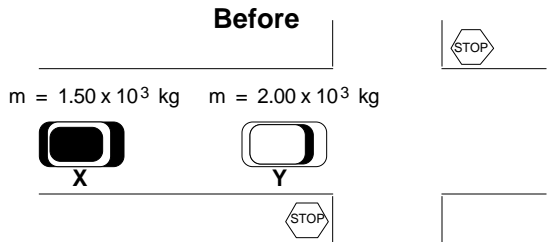
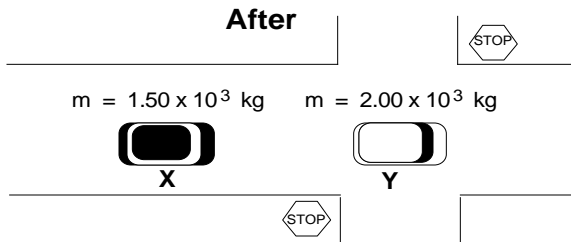


1. A 0.240 kg ball moving at 32.0 m/s strikes a brick wall perpendicularly and rebounds with a speed of 28.0 m/s. The wall received an impulse of
  - A. 14.4 N.s
  - B. 7.2 N.s
  - C. 0.96 N.s
  - D. 3.8 N.s

A police officer's investigation of an accident involving a collision between vehicles X and Y provided the following information:



1. a test on the road surface with a  $2.00 \times 10^3$  kg vehicle showed that the vehicle slowed down at the rate of  $5.00 \text{ m/s}^2$  due to friction
2. each vehicle, X and Y, received some damage
3. after impact, vehicle Y travelled 19.6 m before stopping
4. vehicle X did not have the brakes applied before the collision
5. vehicle Y was stationary before the collision
6. vehicle X was stationary after the collision



2. What was the speed of vehicle Y just after the collision?
  - A. 11.0 m/s
  - B. 1.56 m/s
  - C. 19.6 m/s
  - D. 14.0 m/s
3. Immediately before the collision, the speed of vehicle X in m/s was expressed in scientific notation  $b \times 10^w$ . The value of b is \_\_\_\_\_.  
(Round and record your answer to three digits.)
4. In analyzing the scene of the accident, the officer most often applied her understanding of
  - A. the Law of Conservation of Energy
  - B. the Law of Conservation of Momentum
  - C. Newton's First Law
  - D. Newton's Second Law

5. A 200 g dinky car moving at 6.0 m/s North hits a 300 g dinky truck moving North at 2.0 m/s. After the collision the dinky truck travels 4.0 m/s North.
- Draw a sketch of the collisions below and label all masses and velocities.
  - Calculate the velocity of the dinky car after the collision.
  - Calculate the amount of kinetic energy lost during the collision.  
(6 marks)
6. A stationary rock explodes into four pieces. After the explosion a 2.0 kg piece moves west at 5.0 m/s. A 5.0 kg piece moves north at 8.0 m/s. A 1.0 kg piece moves east at 40 m/s. Calculate the mass of the missing piece if its speed is 25 m/s.

Round and record your answer to two digits

7. Use your answer from the last question to answer this question.

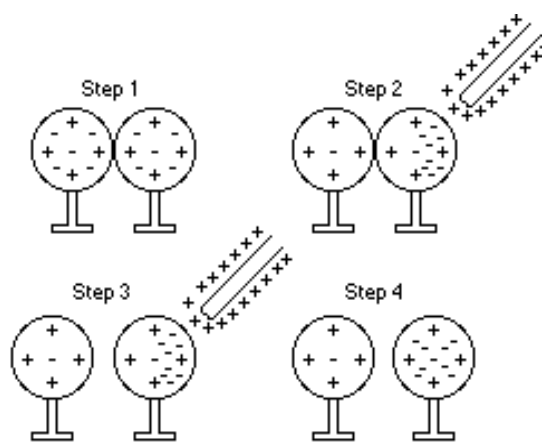
If the explosion released 10 kJ of energy, what percentage ended up as kinetic energy?

Round and record your answer to two digits

8. During an elastic collision, which of the following is conserved?
- |                                     |                                       |
|-------------------------------------|---------------------------------------|
| A. both momentum and kinetic energy | B. neither momentum or kinetic energy |
| C. momentum                         | D. kinetic energy                     |
9. When two train cars of equal mass and speed are moving towards each other, which of the following is true about the sum of their momentum and energies?
- |                          |                              |
|--------------------------|------------------------------|
| A. $p = 0$ , $Ke = mv^2$ | B. $p = mv$ , $Ke = 1/2mv^2$ |
| C. $p=0$ , $Ke = 0$      | D. $p= 2mv$ , $Ke = 2mv^2$   |

10. Charge Redistribution

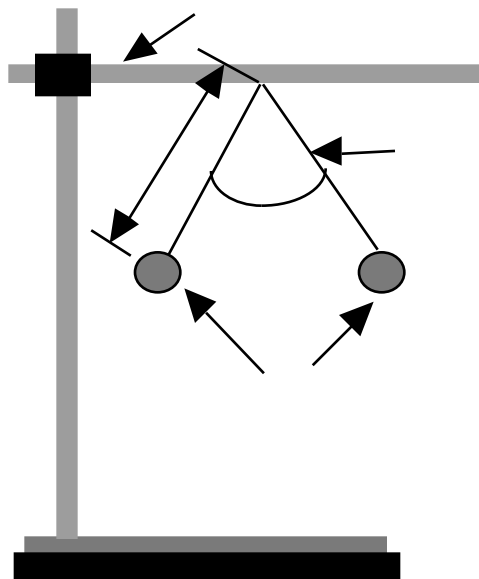
The overall process indicated by steps 1 to 4 is



- |                  |                 |
|------------------|-----------------|
| A. conduction    | B. induction    |
| C. magnetization | D. polarization |

11. A neutral pith ball is attracted to a positively charged pith ball because of
- the electric field around the positive pith ball
  - a loss of charge by the positive pith ball
  - an induced charge separation on the neutral pith ball
  - electron transfer from the surrounding air

12. How many electrons are transferred in a 30 C bolt of lightning?  
2 marks
13. Three equally charged spheres, X, Y and Z, lie in a straight line with Y between X and Z. The distance between the centres of X and Y is 3.0 cm and the distance between the centres of Y and Z is 1.0 cm. The ratio of the force that Y exerts on Z compared with the force that Y exerts on X is
- A. 3:1  
B. 4:1  
C. 1:2  
D. 9:1
14. The distance between two protons in a nucleus is about  $5 \times 10^{-13}$  cm. Using appropriate formulas and showing a method, find the electrostatic repulsion between two protons and the mass of matter that could be supported against gravity by this force of repulsion. In a sentence, discuss the significance of this force of repulsion.
15. Two pithballs are hung from a ring stand by two threads. The Left pithball is charged to  $20 \times 10^{-9}$  C. The right pithball which is neutral ( same mass and volume) is touched to the left and the two seperated to make a  $15^\circ$  angle.
- A) If the charge on the original pithball was  $20 \times 10^{-9}$  C, determine the charge on the two pithballs after contact
- B) If the angle between the threads is  $15^\circ$ , what is the force between the charged pithballs.
- C) Determine the mass of each pithball.  
(If you cannot get an answer for parts A and B write out the fomulas for full credit.)

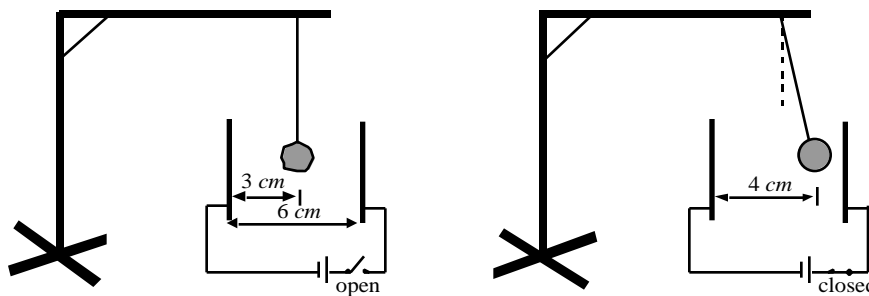


9 marks

16. How many extra electrons does an object have if it has a negative charge of  $1.58 \times 10^{-17} \text{C}$  ?
- A. 123  
C. 33
- B. 44  
D. 99
17. As part of a Millikan experiment performed on the surface of the Earth, an oil drop of mass  $2.20 \times 10^{-15} \text{ kg}$  is suspended in a vertical-uniform electric field of magnitude  $5.20 \times 10^3 \text{ N/C}$ . The charge on the oil drop is  $b \times 10^{-w} \text{ C}$ . The value of  $b$  is \_\_\_\_\_.  
(Round and record your answer to three digits.)
18. How much work does it require to move 1000 ionized hydrogen atoms across a 5.4 V potential difference expressed as  $b \times 10^{-w}$ . What is the value for  $b$ ?
19. The electron gun in the back of a black-and-white TV set has a length of  $1.2 \times 10^{-2} \text{ m}$  and an accelerating voltage of  $2.0 \times 10^3 \text{ V}$ . The acceleration of the electron while in this gun is
- A.  $4.2 \times 10^{12} \text{ m/s}^2$   
C.  $1.8 \times 10^{-5} \text{ m/s}^2$
- B.  $3.0 \times 10^8 \text{ m/s}^2$   
D.  $2.9 \times 10^{16} \text{ m/s}^2$

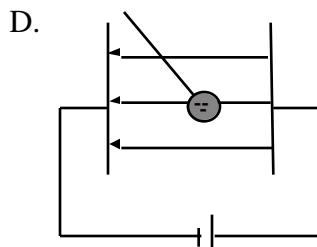
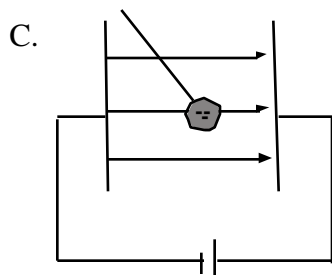
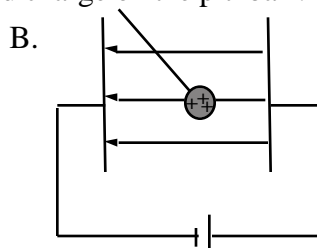
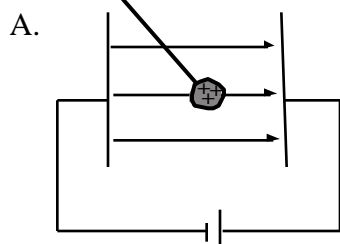
20. Use this information to answer the next 2 questions

Two parallel plates separated by 6.0 cm have 10,000 V potential difference between them.



A 10 gram charged pithball is hung between the plates. When the switch is closed it moves 1.0 cm closer to one of the plates.

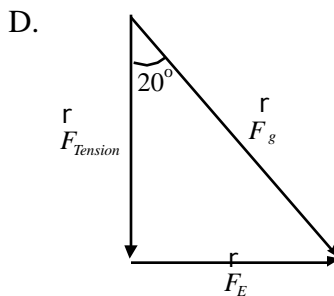
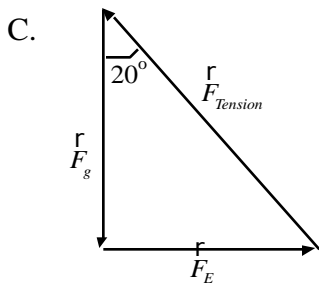
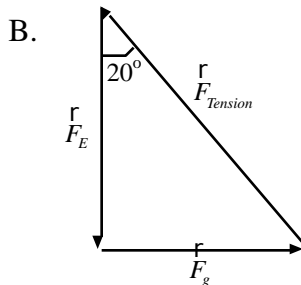
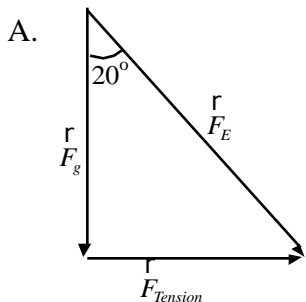
Which diagram shows the correct electric field and charge on the pithball?



21.

In the previous experiment, the force on the pithball was determined to be  $3.57 \times 10^{-3}$  N. Therefore the charge on the pithball must be **a.bc**  $\times 10^{-d}$  C

22. To determine the force on the pithball the experimtor used the relationship between the angle the rope makes with vertical. Which diagram will allow the student to correctly determine the electrical force?

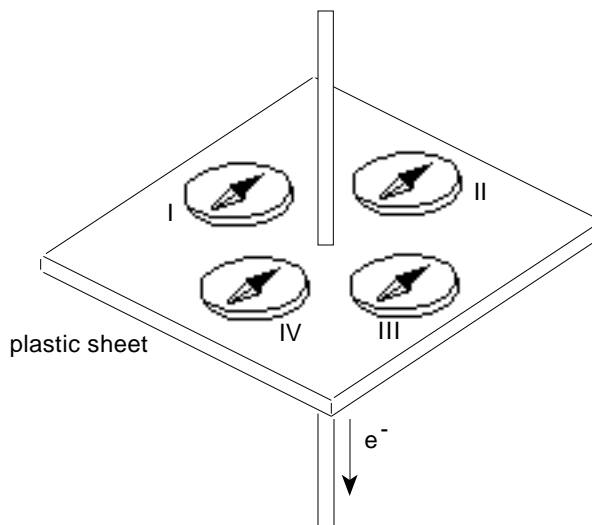


23. An electric current in a conductor produces magnetic lines of force that

- A. are directed perpendicularly outward from the conductor
- B. surround the conductor and are parallel to the conductor
- C. circle the conductor
- D. are directed toward the conductor

24. Current and Its Magnetic Field

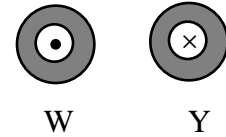
If the effects of the Earth's magnetic field are ignored, which compass needle is oriented correctly? (note: the black end is a northpole of a magnet)



- A. III
- C. I

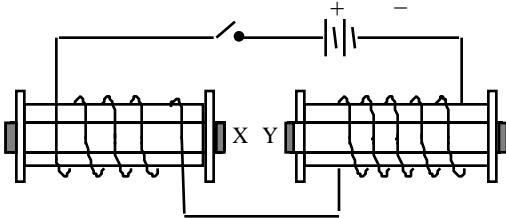
- B. IV
- D. II

25. The diagram shows two long straight and parallel conductors with currents as shown. The electrons are flowing out of the page for Conductor W [shown with a (•)] and flowing into the page for Conductor Y [shown with a (×)]



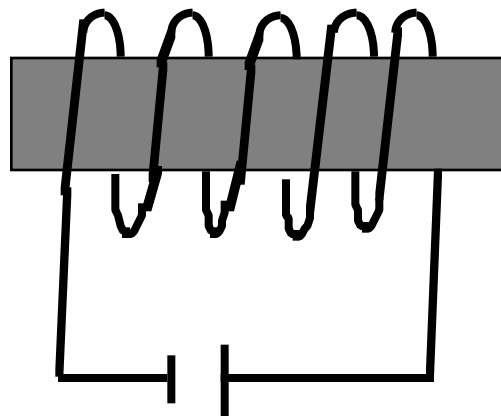
The force that Conductor W experiences because of the presence of Conductor Y is

- A. attraction due to the interaction of their magnetic fields  
 B. repulsion due to the interaction of their magnetic fields  
 C. attraction due to the interaction of their electric fields  
 D. repulsion due to the interaction of their electric fields
26. The diagram shows two solenoids connected to a battery through a switch.

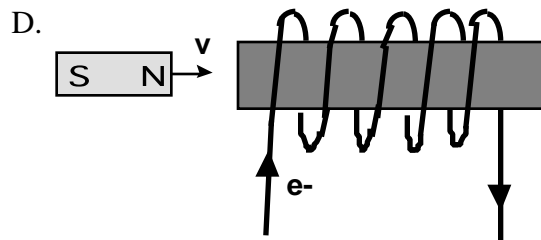
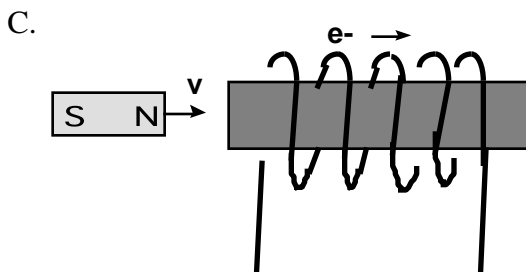
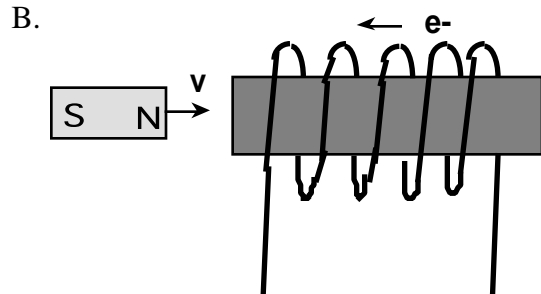
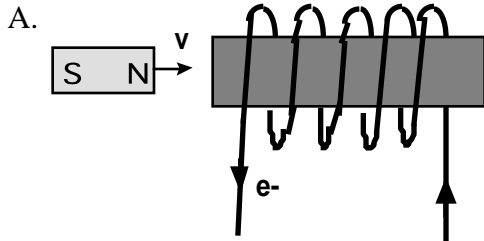
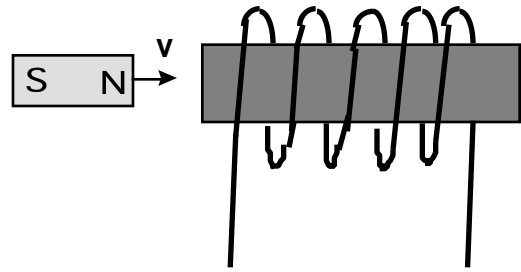


When the switch is closed, the two solenoids will

- A. attract each other with X being a north pole and Y being a south pole  
 B. attract each other with X being a south pole and Y being a north pole  
 C. repel each other with X and Y being north poles  
 D. repel each other with X and Y being south poles
27. Indicate
- the direction of electron flow
  - the north pole of the electromagnet
  - Draw the magnetic field lines around the magnet



28. Indicate the direction of the induced electron flow and north pole of the electromagnet.

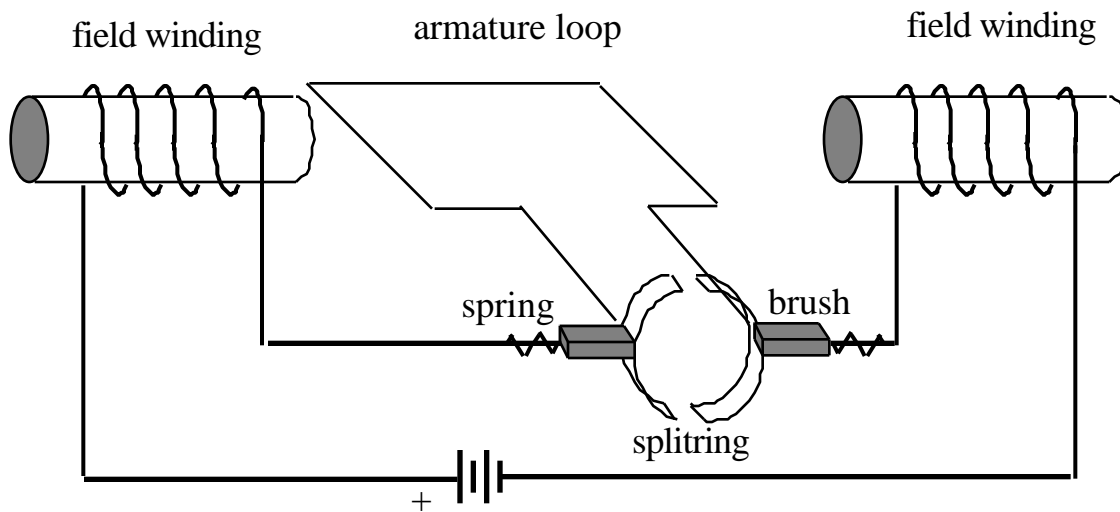


29. Alpha particles, trapped by a magnetic field, are in an orbit of radius 4.36 cm. If the velocity of the particles is exactly doubled, the new radius will be \_\_\_\_\_ cm. (Round and record your answer to three digits.)

30. An ion with a charge of  $2+$  enters perpendicularly to a magnetic field of strength 0.12 T. If the speed of the ion is  $2.4 \times 10^4$  m/s and it follows an arc of radius  $9.4 \times 10^{-3}$  m, the mass of the ion is

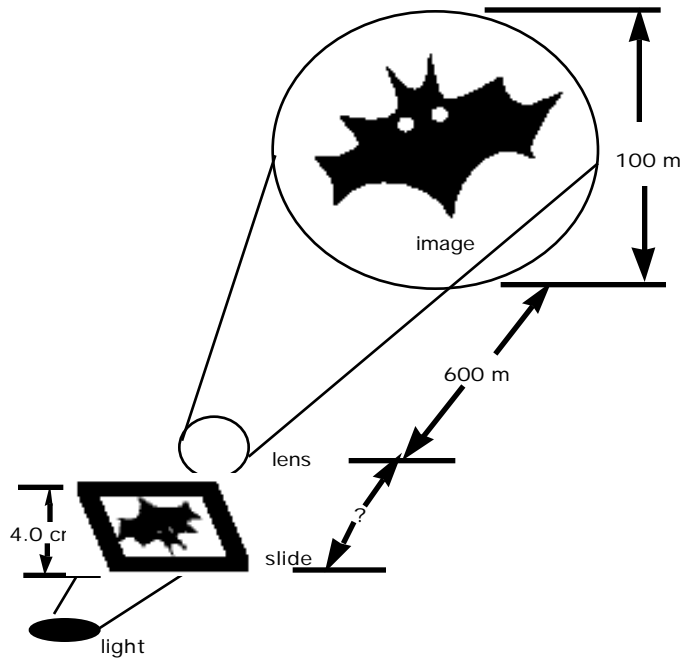
- A.  $7.5 \times 10^{-27}$  kg
- B.  $6.7 \times 10^{-27}$  kg
- C.  $9.2 \times 10^{-16}$  kg
- D.  $1.5 \times 10^{-26}$  kg

31. Explain what the following diagram is and how it works.  
6 marks



32. A 2.3 g wire is suspended in a magnetic field of 0.12 T. What must the current be if the wire exposed to the magnetic field is 3.6 cm long?  
4 marks
33. An electron and an alpha particle traveling at the same speed pass through the same magnetic field. Compared to the force exerted on the electron, the force exerted on the alpha particle is
- greater because the alpha particle mass is greater
  - greater because the alpha particle charge is greater
  - less because the alpha particle mass is greater
  - less because the alpha particle charge is greater
34. Which statement best represents a definition of Lenz's law?
- A current can only be induced when the magnetic field surrounding a conductor is changing.
  - The potential difference across a conductor is directly proportional to the current through it.
  - A conductor in a magnetic field experiences a force perpendicular to itself and the field.
  - The magnetic field of an induced current opposes the change in magnetic field causing it.
35. An observation supporting the hypothesis that cathode rays are charged particles is that
- when silver (Ag) salts are bombarded with cathode rays, the colors of the salts change
  - no matter what the cathode is made of, the cathode rays produced have the same characteristics
  - cathode rays can be bent by magnetic fields
  - cathode rays are observed only in tubes that contain low-pressure gases
36. An object is 16.7 cm from a convex lens of focal length 12.3 cm. What is the position of the image?
- +46.7 cm
  - +7.08 cm
  - +29.0 cm
  - +4.40 cm

37. The police department at Gotham City has set up a searchlight to project an image to let Batman know his services are needed. The batman slide is 4.0 cm across and is placed behind a convex lens so as to project a real image onto some clouds. The size of the projected image is to be 100.0 m across, and the average cloud base in Gotham city has an altitude of 600.0 m.

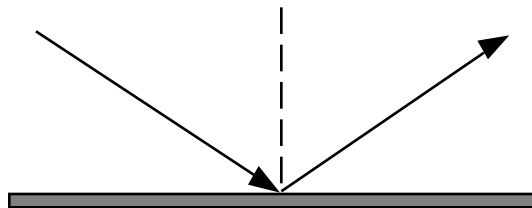


The focal length of the lens to be used is 5 marks

38. An object 4 cm tall is placed 3 cm in front of a mirror. If the real image produced is 1.5 cm tall.  
 A) What is the focal length of the mirror?  
 4 marks  
 B) What type of mirror is being used?  
 1 mark

39. In "Young's double slit" experiment, the colour of light used was changed from blue to red. What effect will this have on the interference pattern produced?  
 A. no change expected  
 B. more fringes are seen  
 C. fringes are closer together  
 D. fringes are farther apart

40. The diagram shows ordinary light striking a reflecting surface such as pavement on a road.

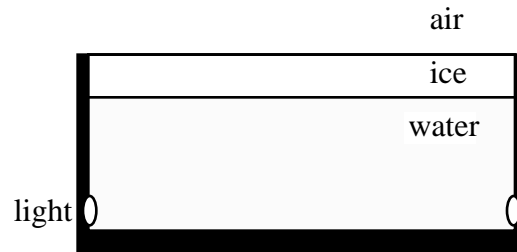


On the diagram, draw arrows to show the orientation of the electromagnetic vibrations of the unpolarized light before striking the surface, and draw arrows to show the vibration plane of the reflected polarized light.

3 marks

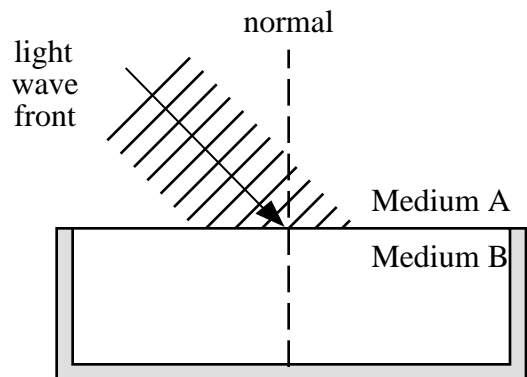
41. 500 nm light is incident on a pair of slits, producing an interference pattern on a distant screen. The position of the third dark fringe is marked on the screen by placing a piece of tape at its location. The 500 nm source is replaced by a new source of unknown wavelength. This new source produces its third bright fringe exactly on the piece of tape. What is the wavelength of the new source?
- A. 417 nm  
 B.  $1000 \times 10^3$  nm  
 C. 500 nm  
 D. 600 nm

42. The diagram shows a pool where a layer of solid ice with an index of refraction of 1.31 has formed on top of the water .



One of the pool's lights is turned on and a light ray shines upward at an angle. The water has an index of refraction of 1.33. What is the critical angle above which this ray will reflect back into the water off the layer of ice?

- A.  $90.0^\circ$   
 B.  $99.9^\circ$   
 C.  $9.90^\circ$   
 D.  $80.1^\circ$
43. The diagram shows a light wave front incident at the boundary between Medium A and Medium B where Medium B is more optically dense (slower) than Medium A.



In Medium B, how does the light speed and wavelength of the waves compare relative to Medium A?

- A. Slower speed and longer wavelength  
 B. Faster speed and longer wavelength  
 C. Slower speed and shorter wavelength  
 D. Faster speed and shorter wavelength
44. The telephone connection between Edmonton and Calgary, a distance of  $3.0 \times 10^2$  km, can be made with an optical fibre that has an index of refraction of 1.8. The difference in travel time between a message carried by the fibre and a message transmitted by microwaves at ground level would be
- A.  $8.0 \times 10^{-4}$  s  
 B.  $5.0 \times 10^{-4}$  s  
 C.  $1.8 \times 10^{-3}$  s  
 D.  $1.0 \times 10^{-3}$  s



50. I. Oscillating magnet  
 II. Accelerating proton  
 III. Steady electric current  
 IV. Stationary electron

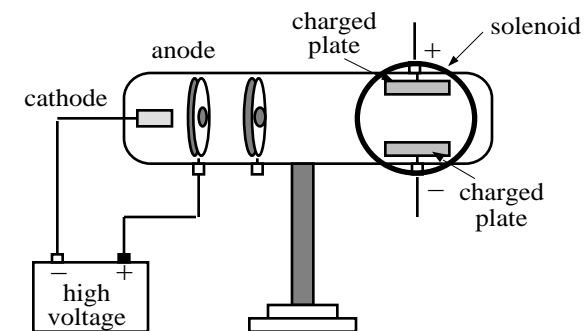
The phenomena that produce an electromagnetic wave are

- A. I and III  
 B. III and IV  
 C. I and II  
 D. II and IV

51. Students use a Thomson's apparatus to send a beam of particles through a region of perpendicular electric and magnetic fields. They set the magnetic field strength at  $1.80 \times 10^{-3}$  T. Then, keeping the same magnetic field, the students place a voltage of  $2.80 \times 10^2$  V across a plate separation of  $2.50 \times 10^{-2}$  m. Under these conditions, they observe there is no deflection of the beam. What is the speed of these particles?

- A.  $6.32 \times 10^6$  m/s  
 B.  $6.42 \times 10^6$  m/s  
 C.  $6.12 \times 10^6$  m/s  
 D.  $6.22 \times 10^6$  m/s

52. Use this diagram to answer the following question.

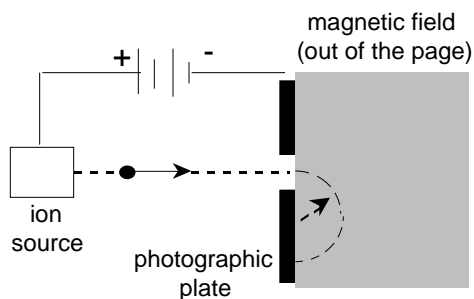


This apparatus would most likely be used for finding the

- A. charge-to-mass ratio of an electron  
 B. wavelength of a cathode-ray particle  
 C. work function of a metal  
 D. value of Planck's constant

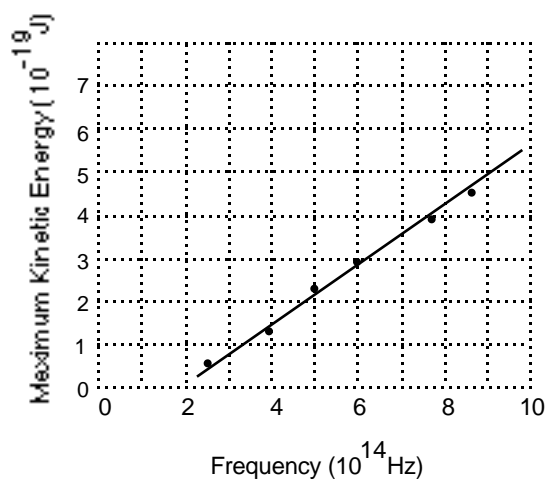
53. Path of an Ion in a Mass Spectrograph

Sodium ions ( $^{23}\text{Na}^+$ ) are deflected in an arc of radius 0.0800 m. What type of ion travelling at the same speed could be detected at a radius of 0.375 m?



- A.  $^{39}\text{K}^+$   
 B.  $^{85}\text{Rb}^+$   
 C.  $^{107}\text{Ag}^+$   
 D.  $^{64}\text{Cu}^+$

### 54. Photoelectron Energy Data

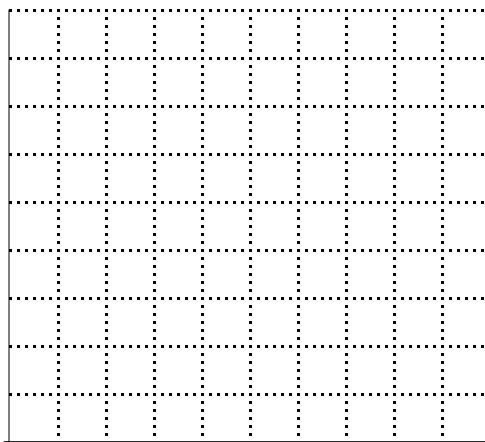


The maximum kinetic energy of the photoelectron is plotted as a function of the incident light frequency.

- Calculate the slope of the graph. (2 marks)
- Use the experimental results to estimate the maximum kinetic energy of the photoelectrons emitted by incident radiation of wavelength  $2.7 \times 10^{-7}$  m. Express your final answer in eV to three digits. (4 marks)

55. You are an electrical engineer designing photoelectrical cells. You are creating various metal alloys for testing. You have tested your latest alloy in your testing apparatus which allows you to vary the frequency of the incident light and measure the required stopping voltage. From the table of information collected below calculate the work function of your metal alloy, using two averaging methods. In addition explain all considerations in making the testing apparatus. (Different types of variables to control manipulate and measure and the equipment required to do it.) (8 marks)

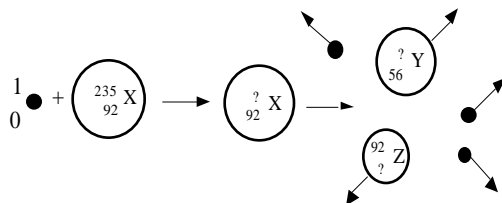
Incident Frequency	Stopping V
$2.00 \times 10^{14}$ Hz	0.325 V
$3.00 \times 10^{14}$ Hz	0.743 V
$4.00 \times 10^{14}$ Hz	1.20 V
$5.00 \times 10^{14}$ Hz	1.56 V
$6.00 \times 10^{14}$ Hz	2.02 V



56. A photon of wavelength  $5.0 \times 10^{-7}$  m has the same momentum as an electron. The speed of this electron is
- A.  $2.7 \times 10^2$  m/s
  - B.  $1.5 \times 10^3$  m/s
  - C.  $6.9 \times 10^{-4}$  m/s
  - D.  $3.8 \times 10^{-1}$  m/s
57. A photon of energy 16.4 eV is incident upon an electron of a hydrogen atom in its first energy level. If the photon ionizes the hydrogen atom, what is the kinetic energy of the ejected electron?
- A. 16.4 eV
  - B. 30.0 eV
  - C. 2.80 eV
  - D. 13.6 eV

58. An electron makes a transition from an orbit where its energy is  $-4.0\text{ eV}$  to another orbit where its energy is  $-12.0\text{ eV}$ . The wavelength of the emitted photon is
- $1.6 \times 10^{-7}\text{ m}$
  - $3.1 \times 10^{-7}\text{ m}$
  - $7.7 \times 10^{-8}\text{ m}$
  - $1.0 \times 10^{-7}\text{ m}$
59. A rock sample from the moon was dated at about 5.0 billion years old. What % of the U 238 used to date the sample was left, given that U 238 has a half life of  $4.468 \times 10^9$  years.  
(4 marks)
60. If the expected radioactivity reading from carbon 14 (*half life of 5730 years*) in a live organism is  $0.23\text{ bq/g}$ . What amount would be present after 1,980 years. The answer is  $b \times 10^{-w}\text{ bq/g}$ . What is the value of  $b$ ?  
(round your answer to three significant digits)

61. The diagram shows nuclear fission induced in element X 235 from the collision of a neutron.

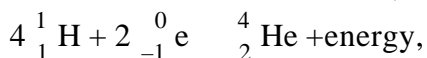


Give the resulting mass numbers of X and Y, and the atomic number of Z.

- 62.

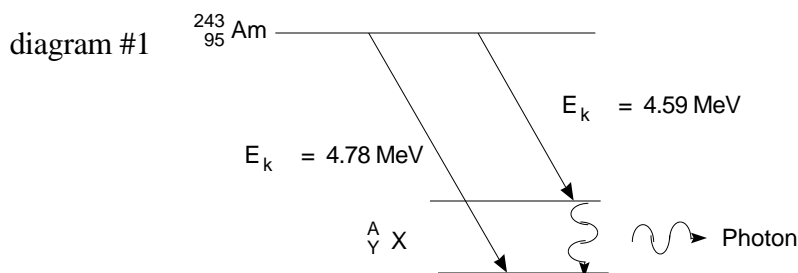
Mass of one ${}^1_1\text{H}$	$1.672\,989\,5 \times 10^{-27}\text{ kg}$
Mass of one ${}^4_2\text{He}$	$6.646\,46 \times 10^{-27}\text{ kg}$

For the nuclear fusion reaction,



find the amount of energy released.

63. The following diagram represents the decay of Americium which has a half life of 7380 years. americium decays both alpha and gamma. The atom can emit an alpha particle with one of two kinetic energies, 4.59MeV and 4.78 MeV. When an atom emits an alpha particle of lower energy it also emits a gamma ray.(see diagram #1)



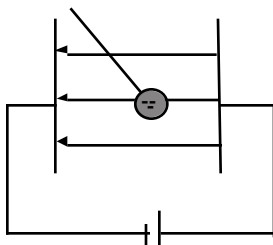
- Determine the series of daughter products if the americium decays alpha gamma, then beta, then alpha.
- Determine the wavelength of the resulting gamma ray.
- Determine the speed of the two alpha particles and the gamma ray.
- If this sample of americium had come from a smoke detector that is 50 years old. Determine the percentage of the sample decayed.

10 marks

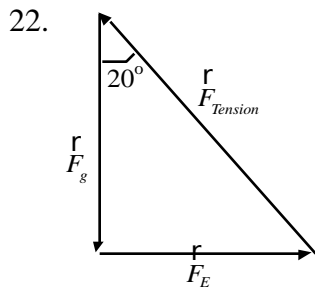
92 <b>U</b> uranium	93 <b>Np</b> neptunium	94 <b>Pu</b> plutonium	95 <b>Am</b> americium	96 <b>Cm</b> curium	97 <b>Bk</b> berkelium
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1. **14.4 N.s**
2. **14.0 m/s**
3. **b is 1.87**
4. **the Law of Conservation of Momentum**
5. **3.0 m/s north**
6. **m= 2.0 kg**
7. **% = 16 %**
8. **both momentum and kinetic energy**
9. **p = 0 , Ke = mv<sup>2</sup>**
10. **induction**
11. **an induced charge separation on the neutral pith ball**
12. **Answers 1.875 x 10<sup>20</sup> electrons**
13. **9:1**
14. **Fe = 9. N**  
**mass = 0.9 kg**
15. **m= 11.4 g**
16. **99**
17. **4.15**
18. **W=Vq 8.64 x 10<sup>-16</sup>J**
19. **2.9 x 10<sup>16</sup> m/s<sup>2</sup>**

20.



21. **2148 answer**



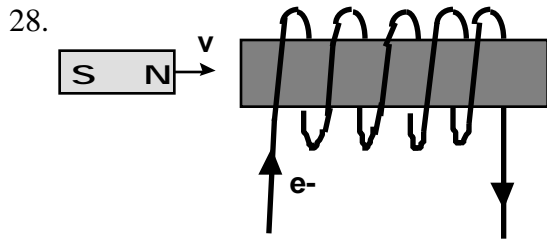
23. circle the conductor

24. III

25. repulsion due to the interaction of their magnetic fields

26. attract each other with X being a north pole and Y being a south pole

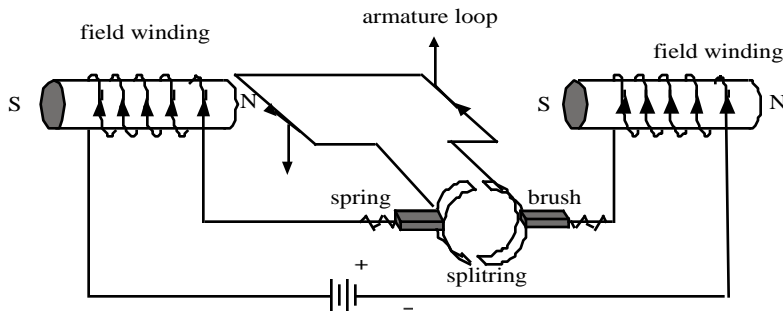
27. North pole is on the right side



29. radius will double

30.  $1.5 \times 10^{-26}$  kg

31. Rotates Counter clock wise.



32.  $I=5.2$  A

33. greater because the alpha particle charge is greater

34. The magnetic field of an induced current opposes the change in magnetic field causing it.

35. cathode rays can be bent by magnetic fields

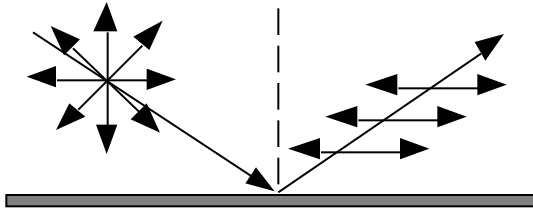
36. +46.7 cm

37.  $f = 0.24 \text{ m}$

38.  $f = 0.818 \text{ cm}$   
concave mirror

39. fringes are farther apart

40.



41.  $417 \text{ nm}$

42.  $80.1$

43. Slower speed and shorter wavelength

44.  $8.0 \times 10^{-4} \text{ s}$

45.

46.  $446 \text{ Hz}$

47. Blue light has a shorter wavelength.

48. answer 4597

49. V, III, II, IV, I

50. I and II

51.  $6.22 \times 10^6 \text{ m/s}$

52. charge-to-mass ratio of an electron

53.  $^{107}\text{Ag}^+$

54.  $E_k = 3.77 \text{ eV}$

55.  $W_0 = 0.41 \text{ eV}$

56.  $1.5 \times 10^3 \text{ m/s}$

57.  $2.80 \text{ eV}$

58.  $1.6 \times 10^{-7} \text{ m}$

59. 46%

60.

61.  $X = 236$ ,  $Y = 141$ , and  $Z = 36$

62.  $4.26 \times 10^{-12} \text{ J}$

63.  $\lambda = 6.54 \times 10^{-12} \text{ m}$

$v = 1.52 \times 10^7 \text{ m/s}$

$v = 1.48 \times 10^7 \text{ m/}$

Gamma is  $3.0 \times 10^8 \text{ m/s}$

99.5% remains