NOVA SCOTIA
Department of Education
Testing and Evaluation

1410227

NOVA SCOTIA EXAMINATIONS

PHYSICS 12

JUNE 2003

Comment Box—For Use by Teacher

What adaptations have been made?

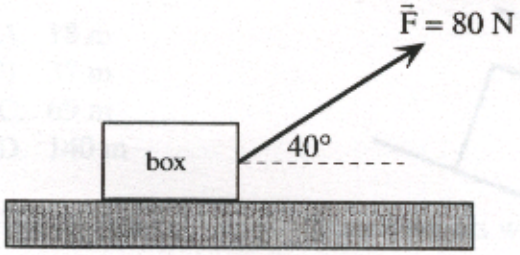
By whom?

Position/Title:

Why?

Name:_____

1. A force of 80 N is applied to a box by pulling on a rope at an angle of 40° with a horizontal table as shown in the following diagram.



What is the horizontal component of the force?

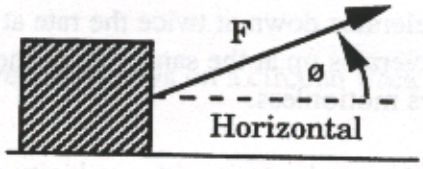
A. 32 N
B. 51 N
C. 61 N
D. 67 N

2. Which of the following phrases best completes this statement?

The equilibrant force is _____ the resultant force.

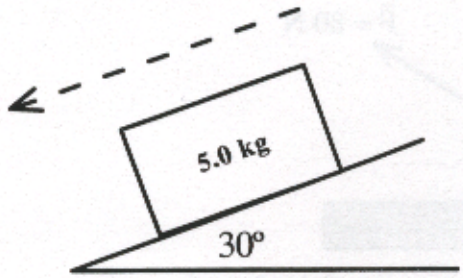
A. equal in magnitude but opposite in direction to
B. equal in magnitude and in the same direction as
C. greater in magnitude and in the same direction as
D. smaller in magnitude and in the opposite direction to

3. 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

4. A block slides down a frictionless ramp surface as shown in the following diagram. What is the magnitude of the resulting acceleration?



A. 4.9 m/s^2
B. 5.7 m/s^2
C. 8.5 m/s^2
D. 9.8 m/s^2

5. A 4.00 kg mass moving at 10.0 m/s, south collides with a stationary 8.00 kg mass. The 4.00 kg mass comes to a stop and the 8.00 kg mass breaks into two equal pieces. One piece moves at 7.08 m/s, southeast. What is the velocity of the other piece?

A. 2.92 m/s, southeast
B. 2.92 m/s, southwest
C. 7.08 m/s, southeast
D. 7.08 m/s, southwest

6. Two people are hanging on opposite ends of a rope that passes over a frictionless pulley mounted on the ceiling above them. If the person on one end starts to pull himself up, what happens to the other person?

A. The second person accelerates down at the same rate as the other person accelerates up.
B. The second person accelerates down at twice the rate at which the other person goes up.
C. The second person accelerates up at the same rate as the other person accelerates up.
D. The second person stays motionless.

7. Object X has a mass of 2.00 kg and moves with a velocity of 3.00 m/s, east. Object Y has a mass of 1.75 kg and moves with a velocity of 5.00 m/s, north. The two objects collide and stick together. After the collision, what is the system's direction of motion?

A. east of north
B. west of north
C. east of south
D. west of south

8. 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

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. 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. 3.0:1

11. A projectile is launched horizontally off a cliff. It is in the air for a time, t. If the cliff was twice as high, how long would the projectile be in the air, assuming all other factors are unchanged?

    A. no different
    B. 1.4t
    C. 2.0t
    D. 4.0t

12. If a student runs at a constant speed of 10. m/s on a circular track of radius 240 m, what is his acceleration?

    A. 0.042 m/s^2
    B. 0.21 m/s^2
    C. 0.42 m/s^2
    D. 2.4 m/s^2

13. A ball is whirled in a circle of radius r and speed v. If the speed is doubled and the radius is cut in half, what will happen to the centripetal force?

    A. It will increase by a factor of 2.
    B. It will increase by a factor of 4.
    C. It will increase by a factor of 8.
    D. It will increase by a factor of 16.

14. When the displacement of an object moving in simple harmonic motion is greatest, the magnitude of the acceleration is at which of the following values?

A. maximum
B. minimum
C. half the maximum
D. halfway between the maximum and minimum

15. What is the period of a pendulum with a length of 1.47 m?

A. 0.414 s
B. 0.943 s
C. 1.06 s
D. 2.43 s

16. When a mass oscillates on a vertically mounted spring, which of the following variables will cause an increase in the period?

A. acceleration due to gravity
B. length of spring is increased
C. mass is increased
D. spring is replaced by one of a higher spring (force) constant

17. Astronauts in an orbiting space shuttle experience a sensation of weightlessness. Which of the following statements best explains this phenomenon?

A. The mass of the shuttle decreases as the distance from Earth increases.
B. The shuttle is falling freely toward the Earth.
C. The shuttle is moving away from the Earth.
D. The shuttle is not affected by Earth's gravity.

18. If a positively charged strip is brought near the knob of a positively charged electroscope, what will the leaves of the electroscope do?

A. converge and then diverge
B. converge only
C. diverge and then converge
D. diverge only

19. Electric field strength is to newtons per coulomb as gravitational field strength is to which of the following:

A. kilograms per joule
B. kilograms per newton
C. newtons per joule
D. newtons per kilogram

20. The hand rule for motors uses the thumb, the index finger, and the second finger or palm to represent various properties. What does the thumb represent?

A. The direction of the applied force.
B. The direction of the current.
C. The direction of the magnetic field.
D. The direction of the magnetic force.

21. Which of the following principles best explains how motors and generators work?

A. conduction
B. induction
C. resonance
D. transfer of charge

22. Which of the following phenomena could not be explained by the Bohr model of the atom?

A. wavelength of the Balmer series
B. electron transitions of all elements
C. ionization energy of hydrogen gas
D. frequency of hydrogen spectral lines

23. The Compton Effect refers to which of the following phenomena?

A. electron scattering
B. electron transfer
C. photon scattering
D. photon transfer

24. 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

25. 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

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26. Calculate the wavelength in nanometers of a photon with 3.2×10^{-19} J of energy.

A. 210 nm
B. 420 nm
C. 530 nm
D. 620 nm

27. Theoretically, all matter has wave characteristics, according to deBroglie. What characteristic of a large object, such as a baseball, makes its wave nature insignificant?

A. amplitudes are too small
B. energies are too small
C. wavelengths are too long
D. wavelengths are too short

28. Which of the following phrases correctly describes the wavelength of a particle?

A. directly proportional to the momentum of the particle
B. directly proportional to the product of the mass and velocity of the particle
C. indirectly (inversely) proportional to Planck's constant
D. indirectly (inversely) proportional to the momentum of the particle

29. What isotope of carbon is used in carbon dating?

A. carbon 8
B. carbon 10
C. carbon 12
D. carbon 14

30. What is the final product in the decay of $^{238}_{92}\mathrm{U}$?

A. $^{206}_{82}\mathrm{Pb}$
B. $^{226}_{88}\mathrm{Ra}$
C. $^{222}_{86}\mathrm{Rn}$
D. $^{234}_{90}\mathrm{Th}$

31. An atom of $^{234}_{92}\mathrm{U}$ absorbs a neutron as shown in the equation $^{234}_{92}\mathrm{U} + ^{1}_{0}\mathrm{n} \rightarrow \mathrm{X}$. What is the mass number and atomic number of element X, respectively?

A. 233 and 91
B. 233 and 92
C. 235 and 91
D. 235 and 92

32. The half-life of radioactive element Y is 65.0 minutes. After 260 minutes, how much of a 40.0 g sample of pure Y will be left as Y?

A. 2.50 g
B. 5.00 g
C. 10.0 g
D. 20.0 g

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

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

34. Binding energy refers to the amount of energy required to do which of the following?

A. combine individual nucleons
B. separate the nucleus into individual nucleons
C. separate the nucleus into individual neutrons
D. separate the nucleus into individual protons

35. The atomic number of an atom refers to which of the following?

A. half the atomic mass of the atom
B. the number of isotopes of the atom
C. the number of protons in a neutral atom
D. the sum of its neutrons and protons

36. All nuclides of an element have which of the following?

A. different numbers of electrons
B. different numbers of neutrons
C. the same number of electrons
D. the same number of neutrons

37. Which of the following describes nuclear fusion?

A. chemical reaction in which atoms dissociate into ions
B. the combining of two nucleii
C. the division of an atomic nucleus
D. the separation of two atoms

38. When a gamma ray is emitted from an unstable nucleus, which of the following events will occur?

A. the number of neutrons and the number of protons drop by two
B. the number of neutrons drops by one and the number of protons drops by one
C. the number of protons decreases by two
D. there will be no change in either the number of neutrons or the number of protons

39. Which of the following particles is the most massive?

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

40. In the same medium how would gamma radiation compare to visible light?

A. higher frequency
B. higher speed
C. longer period
D. longer wavelength

Constructed Response Questions

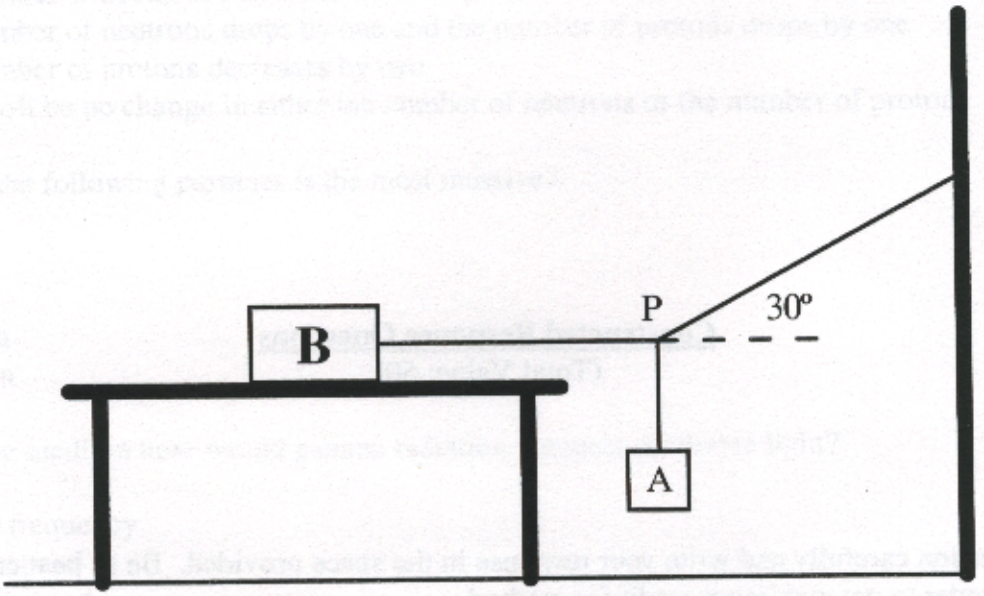
(Total Value: 50)

Read each question carefully and write your response in the space provided. Be as neat and organized as you can in order to get maximum credit for method.

Solutions to numerical problems must include:

✓appropriate formulae
✓correct substitution of values
✓final answer, with units, clearly indicated

41. In the diagram shown below, block A has a mass of 10.5 kg and block B has a mass of 72.6 kg. The string runs from block B to the wall. The segment of string from block B to point P on the string is horizontal. The friction between block B and the table is unknown.



A) Draw the free body diagrams for mass B and point P. **value: 2**

B) Find the minimum coefficient of friction between block B and the table that would prevent block B from moving. **value: 3**

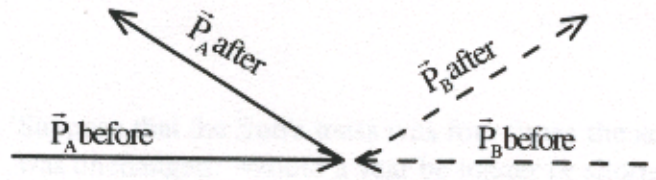
42. A) A stationary firecracker with a mass of 125 g explodes into three sections. All three pieces travel in the horizontal plane. A 36.0 g piece flies off to the East at 4.25 m/s. A 42.0 g piece goes North at 5.38 m/s.

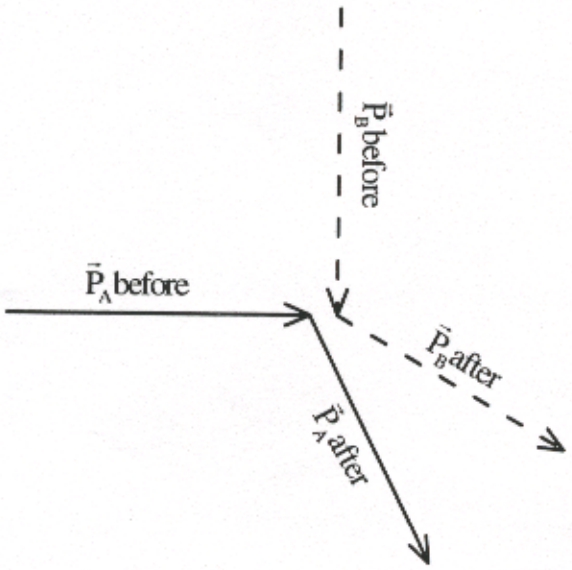
Calculate the velocity of the third fragment. Include an appropriate vector diagram in your solution.

value: 4

B) Indicate whether each of the diagrams below could correctly represent a conservation of momentum situation. In each case, explain your reasoning.

value: 4





43. A quarterback throws a football at 20.0 m/s at an angle of 40° from the horizontal. Suppose a receiver is going to catch the ball at the same height it is released.

A) How long will the ball be in the air? **value: 3**

B) How far must the receiver be from the quarterback? **value: 2**

C) A defender jumps between the quarterback and the receiver at a point 1.20 m from the receiver. If the receiver would have caught the ball at a position 1.80 m above the ground, how much higher must the defender reach to make the interception? **value: 4**

44. A) A geosynchronous satellite circles the Earth at an altitude of 3.59×10^7 m. What is the speed of this satellite? **value: 2**

B) The period of the Moon's orbit of the Earth is 27.3 days. What is the distance from the surface of the Earth to the center of the Moon? **value: 3**

45. Suppose that the Sun's mass was four times the actual value, and that the Earth's radius of orbit was unchanged. Would a year be longer or shorter? By what factor would the period change? Explain your reasoning/calculations. **value: 3**

46. Suppose a mass is oscillating at the end of a spring that is hung vertically. Explain the relationship among displacement, velocity, and acceleration when the mass is at its lowest position. **value: 2**

47. You are given two 7.0 g pith balls, one with a charge of $-1.3\,\mu C$, and the other with a charge of $+1.3\,\mu C$. The negatively charged pith ball is placed on a table; the positively charged pith ball is suspended several metres over the table and lowered until the negatively charged pith ball begins to lift off the table. Assume both charges are maintained.

A) How many excess electrons are on the negatively charged pith ball? **value: 1**

B) Draw a free body diagram indicating the forces acting on the negative pith ball at the time it begins to lift. **value: 1**

C) Calculate the height (separation) of the negative pith ball above the bottom pith ball when it begins to lift. **value: 3**

D) Show that the gravitational force between the two pith balls is not significant in this problem and can be ignored. **value: 2**

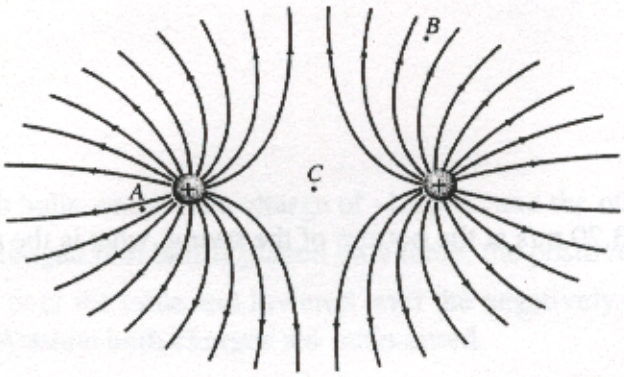
48. Tarzan has a mass of 80.0 kg. He swings in a circular arc on a vine that is 4.00 m long.

A) Draw a free body diagram of the forces acting on Tarzan at the bottom of the swing. **value: 1**

B) If his speed is 3.20 m/s at the bottom of the swing, what is the tension in the vine? **value: 3**

C) If the maximum tension the vine can withstand is 1800. N, what is the minimum speed Tarzan would have to have at the bottom in order to break the vine? **value: 2**

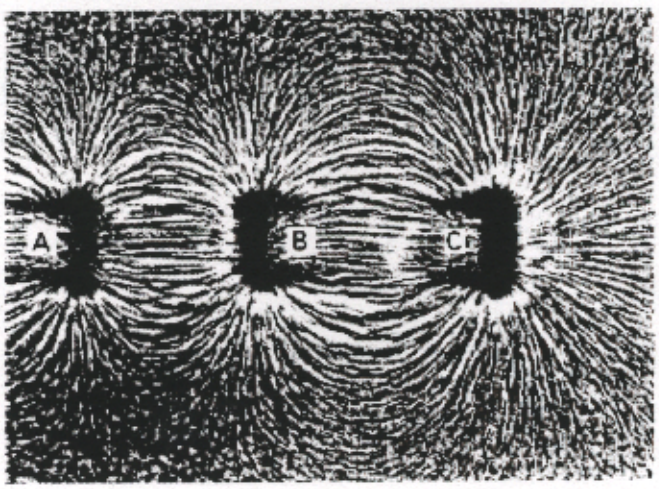
49. A) Three points are indicated as A, B, and C on the diagram below, which shows the electric field lines between two charges. To the right of the diagram, list the letters in order of increasing field strength (weakest first). **value: 1**



B) Draw appropriate electric field lines in each of the following diagrams. **value: 2**

(a) (b)

C) The diagram below shows three magnetic poles, labelled A, B, and C, mapped by iron filings. In the space at the right, identify which two poles are alike, and explain your reasoning. **value: 2**



Case Study

(Total Value: 10)

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

50. # Photoelectric Effect

In your physics studies, you have learned about the photoelectric effect. Under the right conditions, light shining on a metal surface, can result in the ejection of an electron from the surface of the metal.

In 1902 a physicist named Philipp Lenard (1862-1947) used a sensitive apparatus to measure the current produced when ultraviolet light was directed onto the surface of a metal. Lenard's data showed that ultraviolet light with a constant intensity ejected electrons with a variety of energies, but that there was always a maximum energy. In further studies with a prism that restricted the light to a narrow range of frequencies, his data led him to the conclusion that the light of higher frequency always ejected electrons with a higher maximum kinetic energy than the maximum kinetic energy from light having lower frequency. Lenard discovered that the more intense the light, the greater the number of electrons emitted. He also discovered that the maximum kinetic energy of the ejected electrons depends only on the frequency of the light and **not** on the intensity of the light.

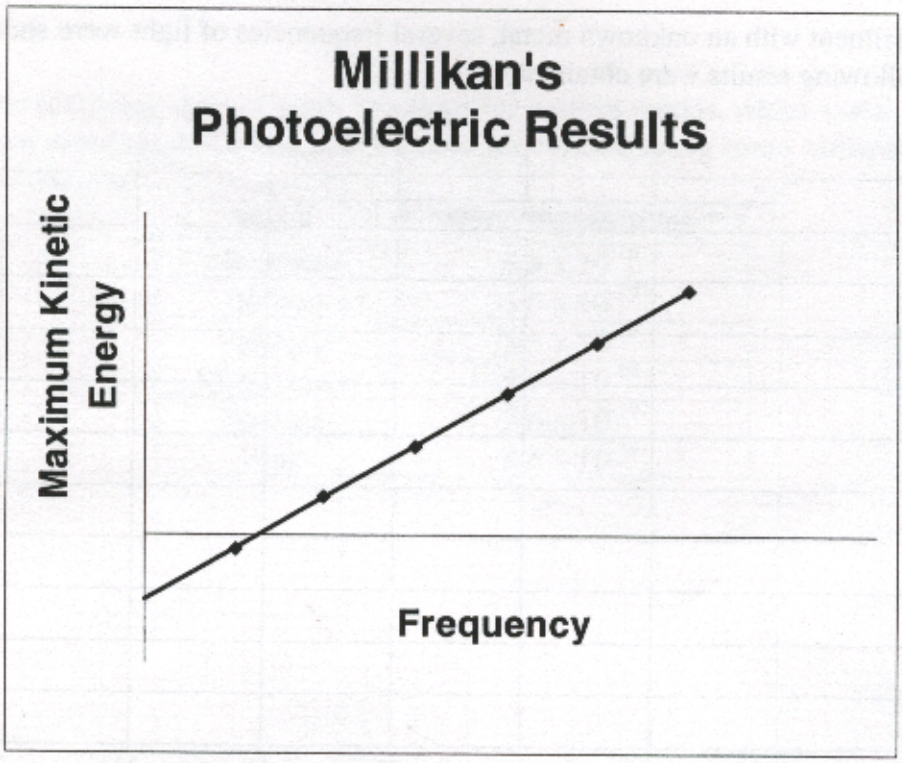
Later on, Albert Einstein (1879-1955) linked Max Planck's (1858-1947) quantum of energy and the photoelectric effect. Einstein proposed that light be considered as quanta or **photons**. By doing this Einstein was able to explain the photoelectric effect. According to Planck, the energy (E) is related to the frequency (f) by the formula E=hf where h is the constant known as Planck's constant. Einstein explained that, since light of higher frequency would have more energy, then this would explain why the higher frequency light has a higher maximum kinetic energy than the lower frequency light seen by Lenard. As to the range of kinetic energies of the emitted electrons at any given frequency, Einstein suggested that since the kinetic energies of the emitted electrons varied, some of the energy must be converted to forms other than kinetic. Electrons farther from the surface of the metal use some of the energy from the photon to become surface electrons and then be ejected. Electrons with the most kinetic energy are the ones that are most loosely bound to the surface. Einstein called the minimum amount of energy needed to eject the electron the work function (W). The maximum kinetic energy would be the difference between the energy of the photon (hf) and the work function W.

$$E_{k(max)} = hf - W$$

As a point of interest, not many physicists believed this quantum explanation because of the historical evidence that supported a wave model of light. If Einstein were correct then this would be supporting evidence for the particle model of light. Without a known charge on the electron at the time, Einstein's explanation could not be supported or contradicted.

Robert Millikan (1868-1953) measured the charge on an electron by 1916 and he used this to measure the kinetic energies of the ejected electrons. He then plotted graphs of the maximum kinetic energy vs. the frequency of the light. This is the graph that you are familiar with from your work in class.

50.

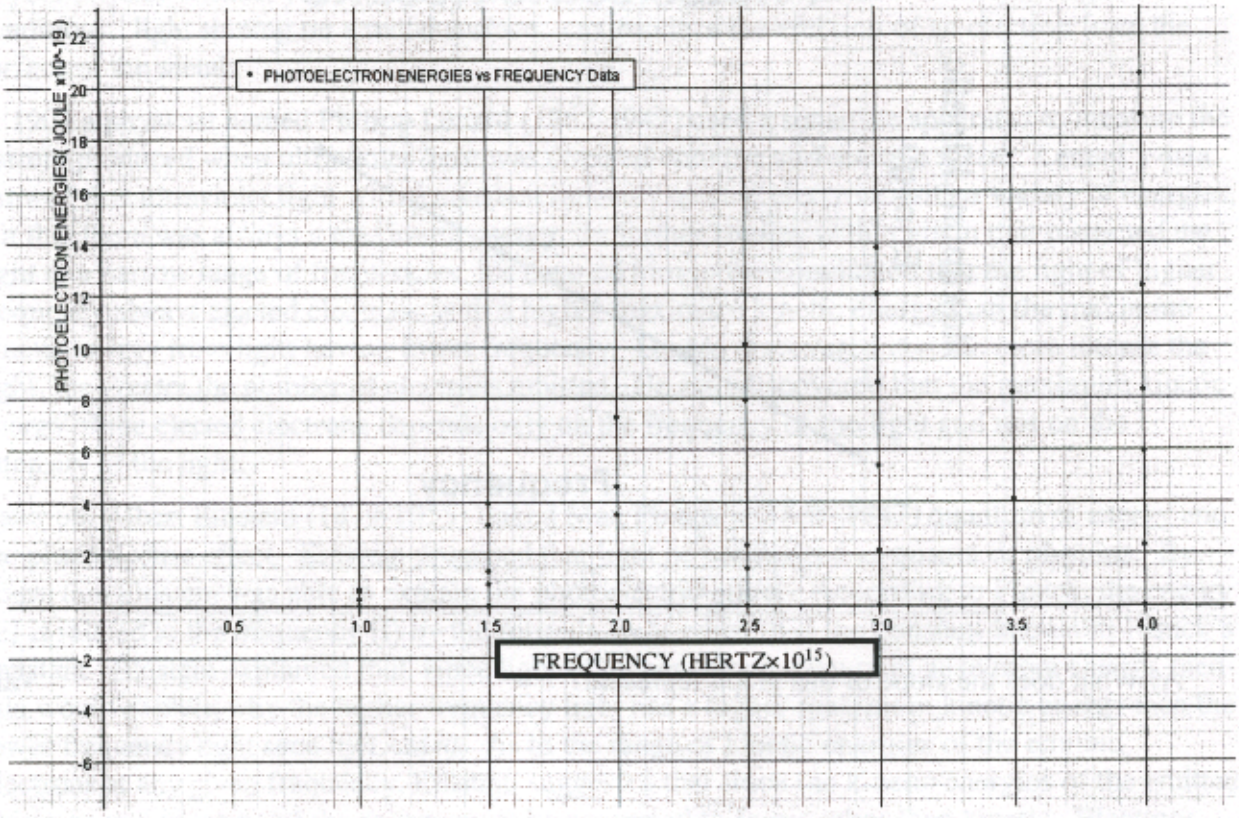


A) What does the slope of this graph represent? **value: 1**

B) What does the y-intercept on this graph represent? **value: 1**

C) What does the frequency at the point where the line crosses the x-axis represent? **value: 1**

50. In an experiment with an unknown metal, several frequencies of light were shone on the metal, and the following results were obtained:



D) What does the fact that there are several data points at each of the frequencies tested mean? **value: 1**

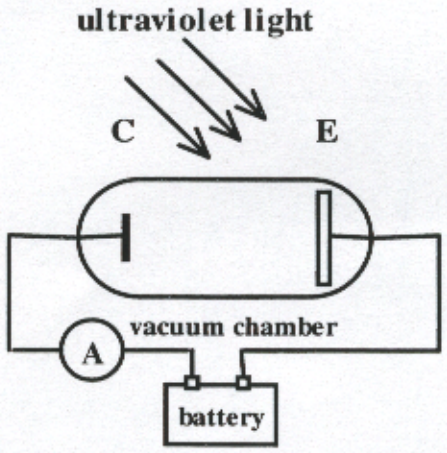
E) By drawing an appropriate line or appropriate lines on this graph, find, state, and show on the graph the frequency below which no electrons would be emitted. **value: 2**

50.

F) Based on the following chart of work functions for various metals, which metal is our unknown metal most likely to be? Explain your choice using some mathematical analysis and the graph. **value: 1**

Metal	Work Function (J)
Aluminum	6.8×10^{-19}
Barium	4.0×10^{-19}
Calcium	5.3×10^{-19}
Magnesium	5.9×10^{-19}
Sodium	3.6×10^{-19}
Zinc	8.5×10^{-19}

In measuring the energies of the ejected electrons, Lenard used an apparatus that included a glass vacuum tube with two electrodes inside the tube. Outside the tube, the electrodes were connected to a source of potential difference. Examine the following schematic diagram.



Ultraviolet light enters the tube and strikes the emitter E, and the ejected electrons then travel from the emitter (E) to the collector (C). Lenard confirmed that the electrons were leaving the emitter by making the emitter negative and the collector positive. When the ultraviolet light struck the emitter, a current was seen to flow. To further investigate the energies, Lenard reversed the connections on the battery so that the electric field between the electrodes would oppose the motion of the electrons. Starting with a small potential difference, he gradually increased the potential until no current flowed. At this point the electric field was opposing the flow of all electrons. The potential difference that stopped all photoelectrons from flowing is now called the stopping potential.

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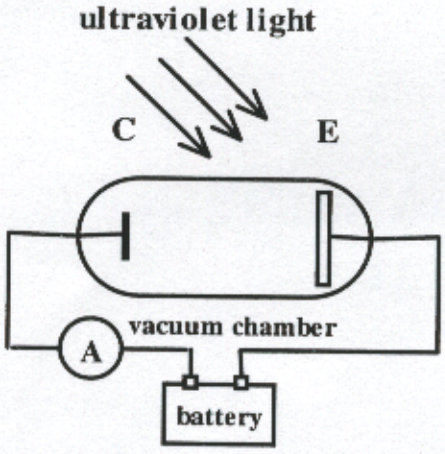

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50.

G) Using data from the graph, determine the speed with which the most energetic electrons were being emitted when the frequency of the light was 4.0×10^{15} Hz. **value: 2**

H) Determine the stopping potential of the electrons in part (g), frequency 4.0×10^{15} Hz. **value: 1**