

Physics 12



Complete Workbook

- ★ Aligned with Alberta curriculum
- ★ Contains Physics 30 practice questions and answers

2020 EDITION

TABLE OF CONTENTS

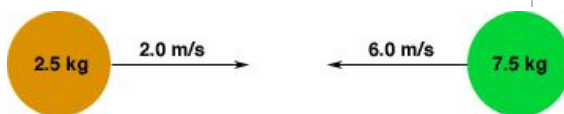
Momentum and Impulse	2
Forces and Fields	5
Electromagnetic Radiation	13
Atomic Physics	20
Answer Key	24

Momentum and Impulse

1. A 0.010 kg bullet travelling at 4.00×10^2 m/s hits and is embedded in a stationary 0.500 kg block of wood. The velocity of the block and bullet after impact is
A) 4.00 m/s
B) 7.84 m/s
C) 8.00 m/s
D) 0.80 m/s
2. A mass undergoes a change in momentum of 50 kg·m/s from a force of 12.5 N. The time of interaction is
A) 12.5 s
B) 6.3×10^2 s
C) 4.0 s
D) 0.25 s
3. Which of the following are correct units for kinetic energy?
A) 0.5 kg·m/s
B) kg·m/s
C) kg·m/s²
D) kg·m²/s²
4. In an inelastic collision between two bodies
A) momentum is not conserved
B) kinetic energy is conserved
C) neither momentum nor kinetic energy is conserved
D) momentum is conserved but kinetic energy is not conserved
5. A 2400 kg truck collides with a 1500 kg car that is going at 20.0 km/h in the opposite direction. They lock together and move together at a speed of 10.0 km/h in the direction of the truck. The initial speed of the truck (to the nearest tenth) was _____ km/h.
6. Which of the following quantities is a *vector* quantity?
A) work
B) kinetic energy
C) power
D) impulse
7. The sum of two momenta is *smallest* when the angle between them is ____ degrees.
A) 0
B) 45
C) 90
D) 180
8. A freight car of mass 1.0×10^4 kg is coasting along the track at 2.0 m/s. A second freight car of 2.0×10^4 kg mass comes toward it in the opposite direction. If both cars come to rest upon collision, how fast was the second car moving?
A) 1.0 m/s
B) 2.0 m/s
C) 2.8 m/s
D) 4.0 m/s
9. A 0.010 kg bullet travelling at 4.00×10^2 m/s hits and is embedded in a stationary 0.500 kg block of wood. The momentum of the block and bullet after impact is
A) 4.00 kg·m/s
B) 20.4 kg·m/s
C) 40.0 kg·m/s
D) 204 kg·m/s

10. A freight car of mass 1.5×10^4 kg is coasting along the track at 3.0 m/s. A second freight car of 4.5×10^4 kg mass comes toward it in the opposite direction. If both cars come to rest upon collision, which of the following is true?
- A) the collision was elastic
 - B) the velocity of the second car was 3.0 m/s
 - C) the velocity of the second car was 1.0 m/s
 - D) momentum was not conserved
11. Which of the following quantities is a *vector* quantity?
- A) work
 - B) kinetic energy
 - C) power
 - D) impulse

12.



After the two objects above collide, the velocity of the heavier object is 5.0 m/s to the left.

What is the velocity of the 2.5 kg mass after the collision?

- A) 1.0 m/s left
 - B) 1.0 m/s right
 - C) 0.33 m/s left
 - D) 0.33 m/s right
13. When a rock climber falls, they are usually saved from serious injury by a climbing rope that is slightly elastic. The climbing rope serves to
- A) decrease the force while increasing the stopping time.
 - B) decrease the force while decreasing the stopping time.
 - C) increase the force while increasing the stopping time.

D) increase the force while decreasing the stopping time.

14. Two boys, A and B, push each other apart on a frictionless surface. Boy A has a mass of 40 kg and boy B has a mass of 60 kg. As the boys move apart, boy A has a velocity of 15 m/s. Boy A has
- A) more momentum than boy B
 - B) less momentum than boy B
 - C) more kinetic energy than boy B
 - D) less kinetic energy than boy B
15. One car is travelling southbound towards an intersection at 80 km/h. Another is travelling westbound towards the same intersection at 100 km/h. Not seeing each other in time, they collide and their front bumpers become interlocked. Which of the following statements best describe such an inelastic collision?
- A) Momentum is not conserved, and kinetic energy is not conserved.
 - B) Momentum is conserved, and kinetic energy is not conserved.
 - C) Momentum is not conserved, and kinetic energy is conserved
 - D) Momentum is conserved, and kinetic energy is conserved.

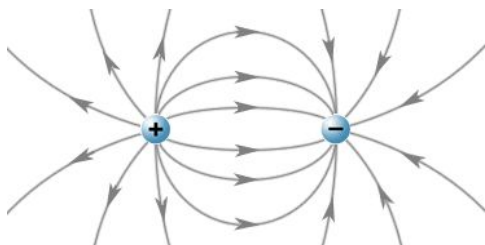
16. A mass undergoes a change in momentum of 50 kg·m/s from a force of 12.5 N. The time of interaction is
- A) 12.5 s
 - B) 6.3×10^2 s
 - C) 4.0 s
 - D) 0.25 s

17. When catching a baseball barehanded, you move your hand in the same direction as the moving ball because:
- A) this decreases the momentum of the ball in order to reduce the force
 - B) this increases the momentum of the ball in order to reduce the force
 - C) this increases the time of "collision" in order to reduce the force
 - D) this decreases the time of "collision" in order to reduce the force
18. Which of the following quantities is a *scalar* quantity?
- A) displacement
 - B) force
 - C) momentum
 - D) power
19. The sum of two momenta is *greatest* when the angle between them is ____ degrees.
- A) 0
 - B) 45
 - C) 90
 - D) 180
20. A 0.010 kg bullet travelling at 4.00×10^2 m/s hits and is embedded in a stationary 0.500 kg block of wood. The velocity of the block and bullet after impact is
- A) 4.00 m/s
 - B) 7.84 m/s
 - C) 8.00 m/s
 - D) 0.80 m/s

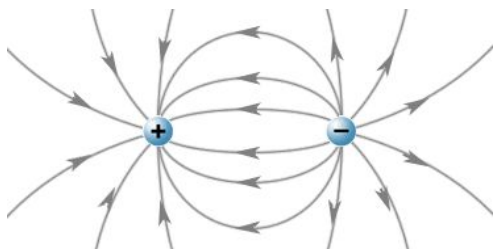
Forces and Fields

1. The electric field between a positive point charge and a negative point charge is represented by

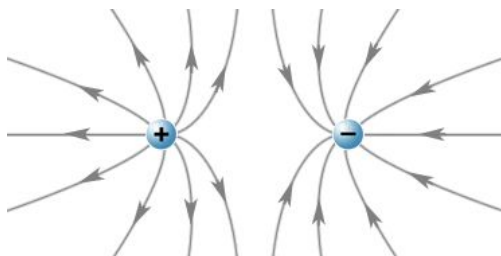
A)



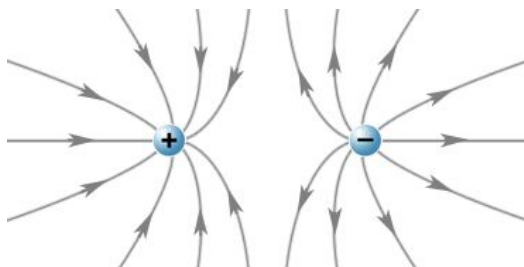
B)



C)



D)



2. If a generator produces only a *small* current, then the opposing force on the armature will be _____ and the

armature will be _____ to turn.

- A) large, easy
- B) large, hard
- C) small, easy
- D) small, hard

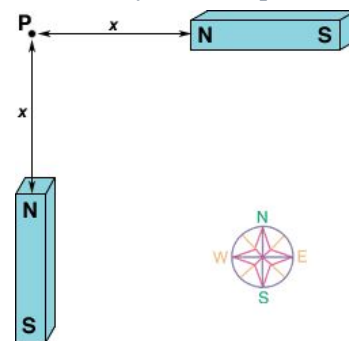
3. Electrons travel through the wire below



What is the direction of the magnetic field at point **P**?

- A) into the page
- B) out of the page
- C) toward the left
- D) toward the right

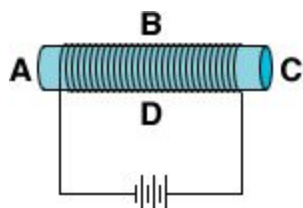
4. Two bar magnets of equal strength are placed, one directly east of point **P**, and the other the same distance and directly south of point **P**.



The direction of the resulting magnetic field at **P** is:

- A) southeast
- B) southwest
- C) northwest
- D) northeast

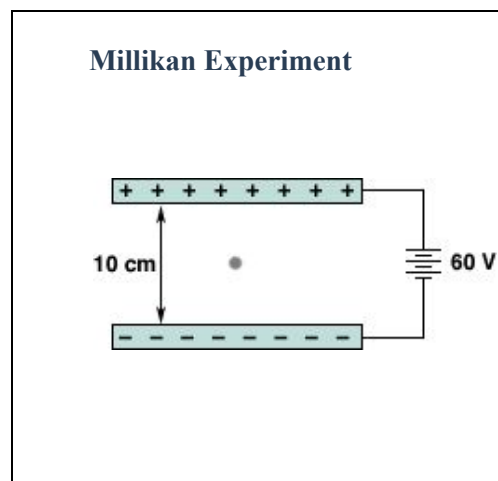
5. As a motor begins to turn, a back-EMF (as explained by Lenz's law) is induced that _____ the current flow.
- opposes
 - is in the same direction as
 - is perpendicular to
 - has no effect on
6. A particle experiences a deflecting force of 3.0×10^{-3} N as it passes perpendicularly across a magnetic field of strength 0.500 T. If the particle has a charge of 2.0×10^{-5} C, its speed is _____ m/s.
7. The unit V/m is equivalent to a
- N/C
 - C/N
 - C/J
 - J/C



8. Where is the south pole in the solenoid shown above?
- A
 - B
 - C
 - D
9. If a metal leaf electroscope is charged positively, and then a negatively charged rod is slowly brought near the top of the electroscope, the leaves will
- slowly diverge further.
 - immediately converge and later collapse.
 - slowly diverge and later collapse.
 - slowly collapse

10. If a positively charged test body is placed in an electric field that is directed downward, the direction of the force on the test body is
- up
 - down
 - left
 - right
11. During a lightning strike, 40 C of charge may move through a potential difference of 2.0×10^8 V in 1.5×10^{-2} s. The total energy released by this lightning bolt is
- 8.0×10^9 J
 - 1.2×10^8 J
 - 5.3×10^{11} J
 - 2.0×10^8 J

12.

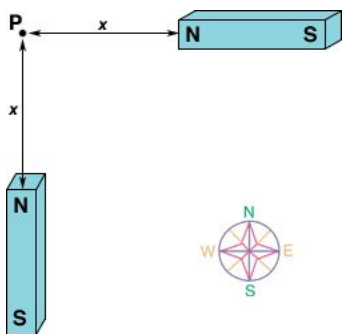


A mass with a +2.00 elementary charge placed between the plates in the diagram will experience an electric force, expressed in scientific notation, of magnitude $\mathbf{b} \times 10^{-w}$ N. The value of \mathbf{b} (to the nearest hundredth) is _____.

13. The electronvolt is a unit measuring
 A) energy
 B) power
 C) quantity of charge
 D) potential difference
14. The electrostatic force between a $+3.00 \mu\text{C}$ charge and a $-7.00 \mu\text{C}$ charge 0.25 m apart would be
 A) 3.0 N and repulsive
 B) 3.0 N and attractive
 C) 0.76 N and repulsive
 D) 0.76 N and attractive

15.

Two bar magnets of equal strength are placed, one directly east of point **P**, and the other the same distance and directly south of point **P**.



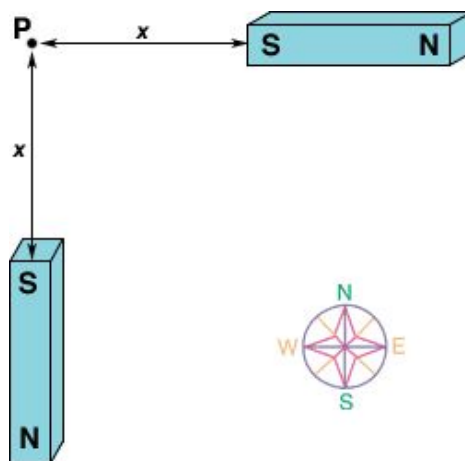
The direction of the resulting magnetic field at **P** is:

- A) southeast
 B) southwest
 C) northwest
 D) northeast

16. Permanent magnets can be produced when small magnetic regions in a metal line up their poles. These regions are called:
 A) fields.
 B) domains.
 C) atoms.
 D) ions.

17.

Two bar magnets of equal strength are placed, one directly east of point **P**, and the other the same distance and directly south of point **P**.



The direction of the resulting magnetic field at **P** is:

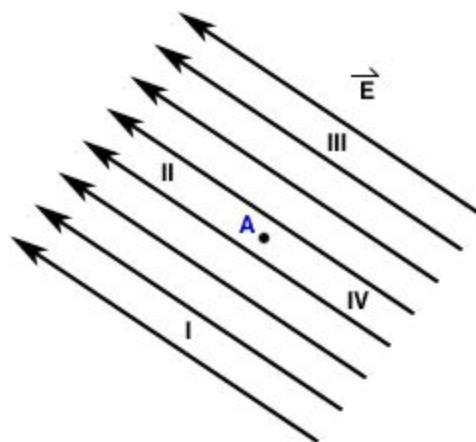
- A) southeast
 B) southwest
 C) northwest
 D) northeast

18. As a motor begins to turn, a back-EMF (as explained by Lenz's law) is induced that _____ the current flow.
- A) opposes
 - B) is in the same direction as
 - C) is perpendicular to
 - D) has no effect on
19. When iron filings are used to show the lines of force around a bar magnet, each of the filings becomes:
- A) a north magnetic pole.
 - B) a south magnetic pole.
 - C) a temporary magnet.
 - D) a permanent magnet.
20. The number of excess electrons on a ball that has a charge of $-2.01 \times 10^{-16} \text{ C}$, expressed as scientific notation, is **a.bc** $\times 10^d$. The values of **a**, **b**, **c**, and **d** are _____, _____, _____, and _____.
Write the four digits separated by commas, in the blank provided
21. The electronvolt is a unit measuring
- A) energy
 - B) power
 - C) quantity of charge
 - D) potential difference
22. A charge of $2.0 \times 10^{-6} \text{ C}$ experiences a force of $8.0 \times 10^{-2} \text{ N}$ at a certain point in an electric field. The strength of the field at this point is _____ N/C.
- A) 2.0×10^6
 - B) 4.0×10^4
 - C) 2.5×10^{-5}
 - D) 1.6×10^{-7}
23. The electrostatic force between a $+3.00 \mu\text{C}$ charge and a $-7.00 \mu\text{C}$ charge 0.25 m apart would be
- A) 3.0 N and repulsive
 - B) 3.0 N and attractive

- C) 0.76 N and repulsive
- D) 0.76 N and attractive

24.

The arrows in the diagram represent the direction of an electric field.

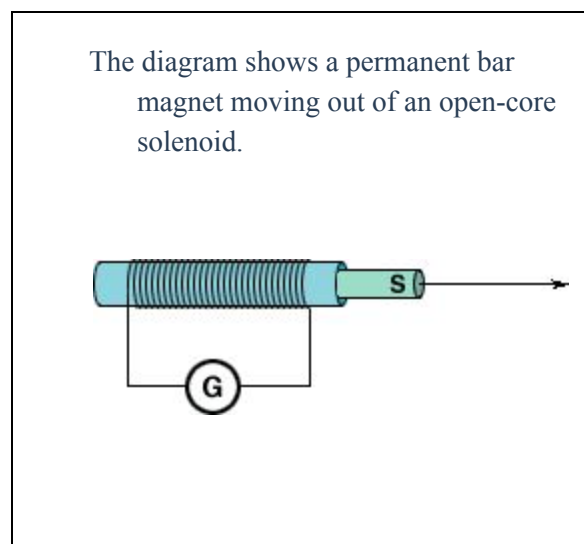


An electron is placed in point A. It will accelerate toward region

- A) I
 - B) II
 - C) III
 - D) IV
25. A wire carrying electrons due west lies along the ground. If you were to measure the magnetic field **above** the wire, which direction would it be pointing?
- A) up
 - B) parallel to the current
 - C) south
 - D) north

26. The direction of the magnetic field **below** a wire carrying electrons due west is
- A) up
 - B) parallel to the current
 - C) south
 - D) north

27.



As the permanent magnet is withdrawn from the solenoid as shown in the diagram, it will induce a

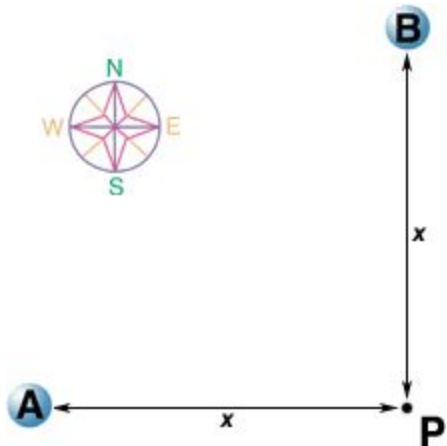
- A) north pole in the solenoid on its left and a conventional current in the galvanometer from left to right
- B) south pole in the solenoid on its left and a conventional current in the galvanometer from left to right
- C) north pole in the solenoid on its right and a conventional current in the galvanometer from right to left
- D) south pole in the solenoid on its right and a conventional current in the galvanometer from right to left

28. When any charged particle accelerates in an electric field, there is always a decrease in its
- A) volume
 - B) electric field strength
 - C) potential energy
 - D) kinetic energy
29. If a positively charged test body is placed in an electric field that is directed downward, the direction of the force on the test body is
- A) up
 - B) down
 - C) left
 - D) right
30. The magnitude of the magnetic force exerted on a current carrying wire in a magnetic field will be tripled by tripling any one of:
- A) the current, or the length, or the magnetic field.
 - B) the magnitude of the field or the angle of entry of the wire.
 - C) the current, or the speed, or the magnetic field.
 - D) the length, or the velocity, or the magnetic field.
31. Two scientists who conducted experiments that led to the determination of the mass of an electron were:
- A) Compton and de Broglie.
 - B) Rutherford and Planck.
 - C) Thomson and Millikan.
 - D) Bohr and Einstein.

32. The power produced by an electric generator
- A) is the product of the resistance and the current
 - B) can be positive or negative
 - C) has a lower average value for alternating currents than for direct currents
 - D) is none of the above

33.

Two charges are placed at an equal distance x from point **P**, as shown in the following diagram. Charge **A** is placed directly west of **P** and **B** is placed directly north of **P**.



If **A** is given a charge of $-Q$ and **B** is given a charge of $-Q$, what is the direction of the resulting electric field at point **P**?

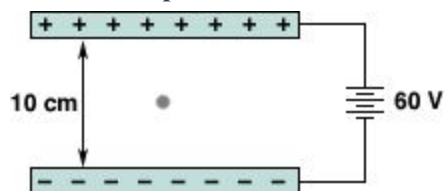
A) southeast, B) northwest,

C) northeast, D) southwest

34. Refer to the information in question 3. If **A** is given a charge of $-Q$ and **B** is given a charge of $+Q$, what is the direction of the resulting electric field at point **P**?
- A) southeast
 - B) northwest
 - C) northeast
 - D) southwest

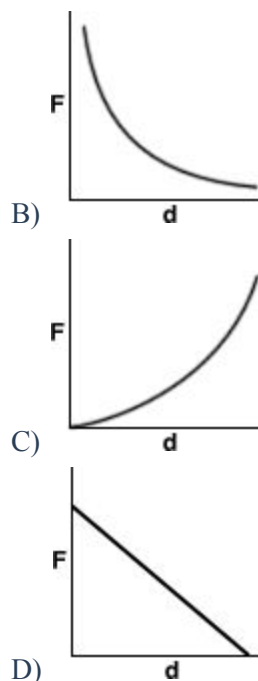
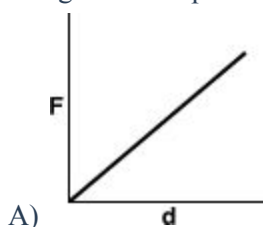
35. The direction of the magnetic field **west** of a wire carrying protons into the page is
- A) up
 - B) parallel to the current
 - C) south
 - D) north

36. Millikan Experiment



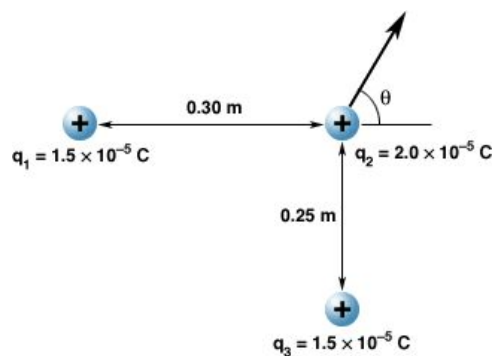
A mass with a $+2.00$ elementary charge placed between the plates in the diagram will experience an electric force, expressed in scientific notation, of magnitude $b \times 10^{-w}$ N. The value of b (to the nearest hundredth) is _____.

37. As a motor begins to turn, a back-EMF (as explained by Lenz's law) is induced that _____ the current flow.
- A) opposes
B) is in the same direction as
C) is perpendicular to
D) has no effect on
38. The direction of the magnetic field **below** a wire carrying electrons due east is
- A) up
B) parallel to the current
C) south
D) north
39. A charge of 2.0×10^{-6} C experiences a force of 8.0×10^{-2} N at a certain point in an electric field. The strength of the field at this point is _____ N/C.
- A) 2.0×10^6
B) 4.0×10^4
C) 2.5×10^{-5}
D) 1.6×10^{-7}
40. A voltage of 1.50 V is induced in a 30.0 m long wire as it moves perpendicularly to a 3.50×10^{-3} T magnetic field. At what speed is the wire moving?
- A) 14.2 m/s
B) 0.158 m/s
C) 571 m/s
D) 7.78×10^{-5} m/s
41. Which of the following graphs represents the relationship between the force and the distance between two charged metal spheres?



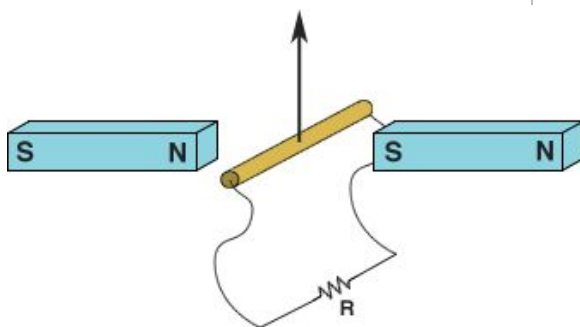
42.

The charge q_1 is placed 0.3 m to the left of q_2 , and q_3 is placed 0.25 m below q_2 , as shown in the picture below:



The angle labeled θ indicates the net electrostatic force on q_2 . The value of θ (to the nearest tenth) is _____ $^\circ$.

43.



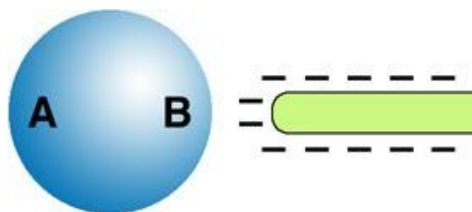
The bar in the diagram is moving up through the magnetic field. The force, due to Lenz's law, acts:

- A) upward
- B) downward
- C) into the page
- D) out of the page

44. The direction of the magnetic field **east** of a wire carrying electrons out of the page is

- A) up
- B) parallel to the current
- C) south
- D) north

45.



A negatively charged rod is placed near a neutral metal sphere without touching it. As a result of the rod's position, side A of the sphere becomes relatively

- A) negative and the sphere is repelled from the rod
- B) positive and the sphere is repelled from the rod
- C) negative and the sphere is attracted to the rod
- D) positive and the sphere is attracted to

the rod

46. A magnetic field always exerts a force on a/an:

- A) stationary charge.
- B) stationary wire.
- C) plastic rod.
- D) nickel bar.

47. A magnetic field never exerts a force on a/an:

- A) magnet.
- B) unmagnetized nickel bar.
- C) current.
- D) stationary charge.

48. The magnitude of the electrical force on an alpha particle that is 2.0×10^{-10} m from a proton is

- A) 1.2×10^{-19} N
- B) 2.3×10^{-18} N
- C) 5.8×10^{-9} N
- D) 1.2×10^{-8} N

49. The voltage required to stop an alpha particle with an initial speed of 5.18×10^5 m/s, is _____ V. Assume that the mass of an alpha particle is 6.65×10^{-27} kg, and specify your answer to the nearest volt.

50. The volt is the SI unit of potential difference. This is the same as

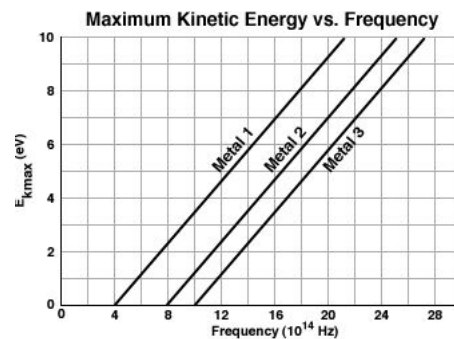
- A) N·m
- B) N/C
- C) J/C
- D) V/m

Electromagnetic Radiation

- While experimenting with the photoelectric effect, electromagnetic radiation is projected at the cathode of a photocell, but no photoelectric current is observed in the circuit. No current is produced because the
 - intensity of the radiation is too small
 - intensity of the radiation is too high
 - work function is too high
 - work function is too low
- A photoelectric current is produced by an incident light striking the cathode of a photocell with a work function of $2.70 \times 10^{-19} \text{ J}$. If 15.8 V are required to cut off the flow of photoelectrons, what is the frequency of the incident light?
 - $3.21 \times 10^{15} \text{ Hz}$
 - $3.13 \times 10^{15} \text{ Hz}$
 - $4.23 \times 10^{15} \text{ Hz}$
 - $4.33 \times 10^{15} \text{ Hz}$
- In a wave tank experiment, waves are generated at a wavelength of 1.3 cm and a speed of 7.0 cm/s. If the waves move into deeper water and have a new wavelength of 1.8 cm, what is their new speed?
 - 5.1 cm/s
 - 9.7 cm/s
 - 9.1 cm/s
 - 13 cm/s
- What are the characteristics of an image formed on the convex side of a highly polished spoon?
 - smaller and erect
 - larger and erect
 - smaller and inverted
 - larger and inverted
- When high speed electrons hit a metallic plate and stop suddenly, the EMR primarily produced are called:
 - X-rays.
 - gamma rays.
 - ultraviolet rays.
 - light rays.
- If the angle between an incident ray and a reflecting surface is 25° , what is the angle of incidence?
 - 25°
 - 65°
 - 90°
 - 0°
- An example of EM radiation with a frequency less than that of visible light is
 - gamma
 - x-ray
 - microwave
 - ultraviolet
- What is the orientation and location of virtual images formed by lenses?
 - Erect and on the same side as the object
 - Inverted and on the same side as the object
 - Erect and on the opposite side of the object
 - Inverted and on the opposite side of the object
- If an orbiting satellite is 240 km above a transmitter, how long would it take for a signal to be received by the satellite?
 - $8.00 \times 10^{-4} \text{ s}$
 - $1.25 \times 10^3 \text{ s}$
 - $1.60 \times 10^{-6} \text{ s}$
 - $6.25 \times 10^5 \text{ s}$

10. The magnitude of the momentum of a 15.0 eV photon is
 - A) $1.07 \times 10^{-20} \text{ kg}\cdot\text{m/s}$
 - B) $9.38 \times 10^{19} \text{ kg}\cdot\text{m/s}$
 - C) $5.00 \times 10^{-8} \text{ kg}\cdot\text{m/s}$
 - D) $8.00 \times 10^{-27} \text{ kg}\cdot\text{m/s}$
11. If a light ray travelling through air enters glass and is refracted,
 - A) the light ray speeds up and bends towards the normal
 - B) the light ray speeds up and bends away the normal
 - C) the light ray slows down and bends towards the normal
 - D) the light ray slows down and bends away the normal
12. Which of the following electromagnetic radiations has the shortest wavelength?
 - A) x-ray
 - B) ultraviolet light
 - C) infrared
 - D) gamma
13. All of the following are electromagnetic waves except:
 - A) light rays.
 - B) cathode rays.
 - C) gamma rays.
 - D) radio rays.

14.



The graph above shows the maximum kinetic energy of photoelectrons emitted from three different metals

Which of the metals will emit photoelectrons when illuminated by visible light?

- A) 1 only
 - B) 1 and 2 only
 - C) 3 only
 - D) 1, 2, and 3
15. In a wave tank experiment, waves are generated at a wavelength of 1.5 cm and a speed of 8.0 cm/s. If the waves move into shallow water and have a new wavelength of 1.2 cm, what is their new speed?
 - A) 6.4 cm/s
 - B) 10 cm/s
 - C) 12 cm/s
 - D) 9.6 cm/s

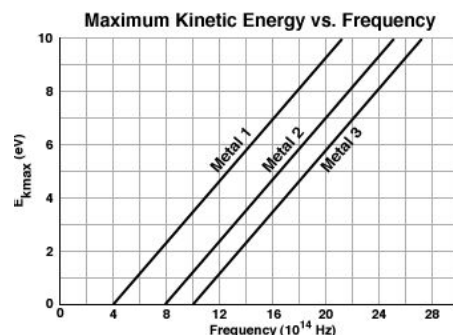
16. The electromagnetic spectrum listed in order from largest to smallest wavelength are:
A) gamma, ultraviolet, visible, microwave, radio.
B) gamma, infrared, visible, ultraviolet, radio.
C) radio, microwave, visible, infrared, gamma.
D) radio, visible, ultraviolet, x-ray, gamma.
17. If the frequency of some light is 2.8×10^{14} Hz, what is its wavelength?
A) 1.07×10^{-6} m
B) 9.33×10^5 m
C) 8.4×10^{22} m
D) 1.2×10^{-23} m
18. Which of the following expressions that deal with electromagnetic waves has a constant value?
A) λ
B) f
C) hc
D) E/f
19. In a photoelectric effect experiment, some students *increased* the intensity of the electromagnetic radiation on a photocell, while keeping its *frequency* constant. Which of the following is true?
A) $I = \text{Increase}$, $E_k = \text{Increase}$
B) $I = \text{Increase}$, $E_k = \text{No change}$
C) $I = \text{No change}$, $E_k = \text{Increase}$
D) $I = \text{No change}$, $E_k = \text{No change}$
20. In an electromagnetic wave, the electric field and magnetic field are
A) parallel
B) inverted
C) constant
D) perpendicular
21. In an experiment, sparks are produced at a frequency of 4.5×10^{10} Hz. The wavelength of the radiation produced is
A) 3.3×10^{-3} m
B) 1.4×10^{19} m
C) 1.5×10^2 m
D) 6.6×10^{-3} m
22. Which scientist explained the photoelectric effect?
A) de Broglie
B) Einstein
C) Hertz
D) Compton
23. A wave travelling from medium A to medium B bends away from the normal. This means that the wave experiences
A) an increase in speed
B) a decrease in speed
C) a decrease in frequency
D) a decrease in wavelength
24. Local radio station CBUZ transmits its signal with 5.00×10^4 W of power at a frequency of 660 kHz. How many photons per second are being emitted by the station's antenna?
A) 1.14×10^{32}
B) 1.28×10^{32}
C) 1.55×10^{32}
D) 1.92×10^{32}
25. When white light is shone through a prism, which colour of light is most refracted?
A) red
B) green
C) blue
D) violet

26. When high speed electrons hit a metallic plate and stop suddenly, the EMR primarily produced are called:
 A) X-rays.
 B) gamma rays.
 C) ultraviolet rays.
 D) light rays.
27. Which group of EMR below, is in order from the lowest to the highest frequency?
 A) radar, ultraviolet radiation, x-rays, visible light.
 B) radar, visible light, ultraviolet radiation, gamma rays.
 C) visible light, microwave, gamma rays, ultraviolet radiation.
 D) visible light, ultraviolet radiation, microwaves, gamma rays.
28. A metal has a work function of 4.8 eV. The corresponding threshold frequency is
 A) 3.2×10^{-33} Hz
 B) 1.2×10^{15} Hz
 C) 7.7×10^{-19} Hz
 D) 1.3×10^{18} Hz
29. In a photoelectric effect experiment, some students increased the frequency of the electromagnetic radiation on a photocell, while keeping its intensity constant. Which of the following is true?
 A) I = Increase, E_k = Increase
 B) I = Increase, E_k = No change
 C) I = No change, E_k = Increase
 D) I = No change, E_k = No change
30. When an object is placed slightly farther away from the principle focus of a complex lens, then the image is
 A) larger and inverted
 B) smaller and inverted
 C) the same size and inverted
 D) virtual
31. When the voltage across a photoelectric effect apparatus is adjusted so that the photoelectric current becomes zero, this measures the photoelectron's maximum:
 A) potential energy.
 B) work function.
 C) kinetic energy.
 D) wavelength.
32. If an object is placed 10.0 cm in front of a concave mirror with a focal length 12.00 cm, what are the characteristics of the image?
 A) The image is larger, erect, and virtual
 B) The image is larger, inverted, and virtual
 C) The image is smaller, erect, and virtual
 D) No image can be formed at this point
33. The frequency of an AM radio wave with a wavelength of 390 m is
 A) 7.69×10^5 Hz
 B) 1.17×10^{11} Hz
 C) 1.30×10^{-6} Hz
 D) 1.54×10^6 Hz
34. A metal has a work function of 4.8 eV. The corresponding threshold frequency is
 A) 3.2×10^{-33} Hz
 B) 1.2×10^{15} Hz
 C) 7.7×10^{-19} Hz
 D) 1.3×10^{18} Hz

35. Diffraction at a small opening occurs because
- A) each point on the wave acts as an individual point source
 - B) the speed of the wave changes upon entering a new medium
 - C) the wave amplitude increases going through the opening
 - D) the wave amplitude decreases going through the opening
36. While experimenting with the photoelectric effect, electromagnetic radiation is projected at the cathode of a photocell, but no photoelectric current is observed in the circuit. No current is produced because the
- A) intensity of the radiation is too small
 - B) intensity of the radiation is too high
 - C) work function is too high
 - D) work function is too low
37. Infra-red rays can penetrate dark clouds because:
- A) scattering is much less for short wavelengths.
 - B) scattering is much less for lower frequencies
 - C) infra-red waves have a higher frequency.
 - D) infra-red waves have a shorter wavelength.
38. A photoelectric current is produced by an incident light striking the cathode of a photocell with a work function of $2.70 \times 10^{-19} \text{ J}$. If 15.8 V are required to cut off the flow of photoelectrons, what is the frequency of the incident light?
- A) $3.21 \times 10^{15} \text{ Hz}$

- B) $3.13 \times 10^{15} \text{ Hz}$
- C) $4.23 \times 10^{15} \text{ Hz}$
- D) $4.33 \times 10^{15} \text{ Hz}$

39.



The graph above shows the maximum kinetic energy of photoelectrons emitted from three different metals

Which of the metals will emit photoelectrons when illuminated by visible light?

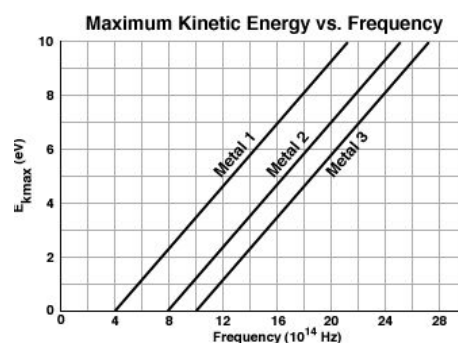
- A) 1 only
 - B) 1 and 2 only
 - C) 3 only
 - D) 1, 2, and 3
40. If a light ray travelling through air enters glass and is refracted,
- A) the light ray speeds up and bends towards the normal
 - B) the light ray speeds up and bends away the normal
 - C) the light ray slows down and bends towards the normal
 - D) the light ray slows down and bends away the normal

41. Roemer predicted the speed of light using data collected from timing the travel time of light
- from Jupiter's moon Io to the Earth
 - between lanterns on two hills
 - reflecting from an octagonal mirror
 - from a laser
42. Infra-red rays can penetrate dark clouds because:
- scattering is much less for short wavelengths.
 - scattering is much less for lower frequencies
 - infra-red waves have a higher frequency.
 - infra-red waves have a shorter wavelength.
43. A Michelson-Morley experiment is set up. If an eight-sided mirror is rotating at 560 revolutions per second, and the light travels out 37.0 km and back, then what is the calculated speed of light?
- 1.66×10^8 m/s
 - 3.32×10^8 m/s
 - 3.00×10^8 m/s
 - 4.14×10^8 m/s
44. If the wavelength of some light is 4.50×10^{-7} m, what is its frequency?
- 7.41×10^{-3} Hz
 - 135 Hz
 - 1.50×10^{-15} Hz
 - 6.67×10^{14} Hz
45. The particle nature of X-ray radiation is best demonstrated by the observation that X-rays
- exhibit the Compton effect (have momentum)
 - have the ability to cause genetic damage

- are not bent in magnetic fields
- are not bent in electric fields

46. If the index of refraction of diamond is 2.42, then the critical angle of diamond is
- 24.4°
 - 65.6°
 - 90.0°
 - 35.2°

47.



The graph above shows the maximum kinetic energy of photoelectrons emitted from three different metals

Which of the metals will emit photoelectrons when illuminated by visible light?

- 1 only
- 1 and 2 only
- 3 only
- 1, 2, and 3

48. Which of the following observations could have been used by early scientists to argue in favor of the wave model of light?
- A) reflection only
 - B) refraction only
 - C) diffraction and reflection
 - D) diffraction, reflection, refraction, and interference
49. A photoelectric current is produced by an incident light striking the cathode of a photocell with a work function of $2.70 \times 10^{-19} \text{ J}$. If 15.8 V are required to cut off the flow of photoelectrons, what is the frequency of the incident light?
- A) $3.21 \times 10^{15} \text{ Hz}$
 - B) $3.13 \times 10^{15} \text{ Hz}$
 - C) $4.23 \times 10^{15} \text{ Hz}$
 - D) $4.33 \times 10^{15} \text{ Hz}$
50. A ray of light travelling from air into an unknown liquid is refracted at an angle of 34° . If the speed of light in the unknown is $2.01 \times 10^8 \text{ m/s}$, what is the angle of incidence?
- A) 56°
 - B) 34°
 - C) 68°
 - D) 22°

Atomic Physics

1.

Different colours in fireworks are produced by using different elements:

Element	Color
Strontium	Red
Potassium	Purple
Copper	Blue-Green
Barium	Green

Given the information above, the element that emits the highest energy photon of visible light is:

- A) barium.
- B) strontium.
- C) potassium.
- D) copper.

2. If the second energy level of a hydrogen-like atom is -18 eV , then the fourth energy level is

- A) -4.5 eV
- B) 4.5 eV

- C) 1.1 eV
- D) -1.1 eV

3. The radius of the fifth Bohr orbit of hydrogen is

- A) $1.3 \times 10^{-9} \text{ m}$
- B) $1.1 \times 10^{-10} \text{ m}$
- C) $2.6 \times 10^{-11} \text{ m}$
- D) $5.3 \times 10^{-11} \text{ m}$

4. An electron drops from the third energy level to the second energy level of an excited hydrogen atom. This emitted photon is a part of the:

- A) Balmer series.
- B) Lyman series.
- C) Bracket series.
- D) Pfund series.

5. In a hydrogen atom, the ratio of the radius of the fourth orbital to the radius of the first orbital is

- A) 4 : 1
- B) 2 : 1
- C) 16 : 1
- D) $\sqrt{2}$: 1

6. An electron in a hydrogen atom is in the fourth orbital and jumps down to the second orbital. The energy released (to the nearest hundredth) is _____ eV.

7. The frequency of light emitted when an electron drops from energy level $n = 3$ to $n = 1$ is

- A) $2.9 \times 10^{15} \text{ Hz}$
- B) $2.2 \times 10^{15} \text{ Hz}$
- C) $1.8 \times 10^{15} \text{ Hz}$
- D) $8.8 \times 10^{14} \text{ Hz}$

8. A photon may exhibit properties of a particle when we measure its
 - A) speed
 - B) frequency
 - C) mass
 - D) momentum
9. A photon with a wavelength of 2.90×10^{-7} m strikes an electron in a hydrogen atom in its ground state. As a result, the electron will:
 - A) be raised to energy level 3.
 - B) be raised to energy level 4.
 - C) be raised to energy level 5.
 - D) not be raised to a higher energy level.
10. The energy of an electron in the fifth energy level of hydrogen (to the nearest hundredth) is _____ eV.
11. Which of the following types of radioactive decay occurs when a neutron is changed to a proton within a nucleus?
 - A) alpha decay
 - B) beta decay
 - C) gamma decay
 - D) both A and B
12. Two scientists who conducted experiments that led to the determination of the mass of an electron were:
 - A) Compton and de Broglie.
 - B) Rutherford and Planck.
 - C) Thomson and Millikan.
 - D) Bohr and Einstein.
13. An electron is in an $n = 3$ energy level. The number of different possible frequencies of radiation that may be emitted when it falls back to $n = 1$ is
 - A) 1
 - B) 2
 - C) 3
 - D) infinite
14. If an electron is accelerated by a potential difference of 160 V, what is its de Broglie wavelength?
 - A) 9.61×10^{-11} m
 - B) 9.71×10^{-11} m
 - C) 9.81×10^{-11} m
 - D) 9.91×10^{-11} m
15. In hydrogen, the radius of the fifth Bohr orbital is
 - A) 5.08×10^{-11} m
 - B) 1.06×10^{-11} m
 - C) 2.12×10^{-12} m
 - D) 9.60×10^{-10} m
16. A moderator in a nuclear reactor decreases the speed of
 - A) neutrons
 - B) electrons
 - C) protons
 - D) photons
17. The mass of the assembled nucleus is _____ the sum of the masses of the nucleons that compose it.
 - A) greater than
 - B) less than
 - C) the same as
 - D) none of the above
18. The first nuclear model of the atom was proposed by:
 - A) Planck
 - B) Bohr
 - C) Rutherford
 - D) Thomson

19. Pair production results in a
 A) nucleus and an electron
 B) positron and an electron
 C) pair of protons
 D) pair of isotopes
20. For a hydrogen atom, the difference in radii between the sixth Bohr orbital and the third Bohr orbital is
 A) 3.99×10^{-13} m
 B) 4.41×10^{-12} m
 C) 1.59×10^{-10} m
 D) 1.43×10^{-9} m
21. For a hydrogen atom, the difference in radii between the sixth Bohr orbital and the third Bohr orbital is
 A) 3.99×10^{-13} m
 B) 4.41×10^{-12} m
 C) 1.59×10^{-10} m
 D) 1.43×10^{-9} m
22. Two scientists who conducted experiments that led to the determination of the mass of an electron were:
 A) Compton and de Broglie.
 B) Rutherford and Planck.
 C) Thomson and Millikan.
 D) Bohr and Einstein.

23.

Different colours in fireworks are produced by using different elements:

Element	Color
Strontium	Red
Potassium	Purple
Copper	Blue-Green
Barium	Green

The colours are emitted by atoms whose electrons are:

- A) undergoing transitions from higher to lower energy levels.
 B) undergoing transitions from lower to higher energy levels.
 C) colliding within energy levels.
 D) accelerating around the nucleus.

24. If electrons in a cathode-ray tube are accelerated by a potential difference of 1900 V, what is the maximum frequency of the emitted X-rays?
- A) 4.58×10^{17} Hz
 - B) 5.00×10^{17} Hz
 - C) 4.58×10^{18} Hz
 - D) 5.00×10^{18} Hz
25. Which of the following kinds of radioactivity has the greatest penetrating power?
- A) alpha radiation
 - B) beta radiation
 - C) gamma radiation
 - D) omega radiation
26. In a hydrogen emission spectrum, the light with the *longest* wavelength will be produced for the electron moving from
- A) $n = 1$ to $n = 2$
 - B) $n = 2$ to $n = \infty$
 - C) $n = 2$ to $n = 1$
 - D) $n = \infty$ to $n = 2$

27.

An electron drops from the third energy level to the second energy level of an excited hydrogen atom.

The frequency of the photon emitted is

- A) 4.57×10^{14} Hz
- B) 1.89 Hz
- C) 4.84×10^{-38} Hz
- D) 3.88×10^{15} Hz

28. A photon with a wavelength of 2.90×10^{-7} m strikes an electron in a hydrogen

atom in its ground state. As a result, the electron will:

- A) be raised to energy level 3.
- B) be raised to energy level 4.
- C) be raised to energy level 5.
- D) not be raised to a higher energy level.

29. An electron in a hydrogen atom is in the fourth orbital and jumps down to the second orbital. The energy released (to the nearest hundredth) is _____ eV.
30. An electron in a hydrogen atom is in the fifth orbital and jumps down to the first orbital. The energy released (to the nearest tenth) is _____ eV.

Answer Key

Momentum and Impulse

1. B
2. C
3. D
4. D
5. 28.8
6. D
7. D
8. A
9. A
10. C
11. D
12. A
13. A
14. C
15. B
16. C
17. C
18. D
19. A
20. B

Forces and Fields

1. A
2. C
3. A
4. C
5. A
6. 300
7. A
8. A
9. D
10. B
11. A
12. 1.92
13. A
14. B

15. C
16. B
17. A
18. A
19. C
20. 1,2,6,3
21. A
22. B
23. B
24. D
25. C
26. D
27. D
28. C
29. B
30. A
31. C
32. C
33. B
34. D
35. D
36. 1.92
37. A
38. C
39. B
40. A
41. B
42. 55.2
43. B
44. C
45. C
46. D
47. D
48. D
49. 2788
50. C

Electromagnetic Radiation

1. C
2. C
3. B

4. A
5. A
6. B
7. C
8. A
9. A
10. D
11. C
12. D
13. B
14. A
15. A
16. D
17. A
18. D
19. B
20. D
21. D
22. B
23. A
24. A
25. D
26. A
27. B
28. B
29. C
30. A
31. C
32. A
33. A
34. B
35. A
36. C
37. B
38. C
39. A
40. C
41. A
42. B
43. B
44. D
45. A
46. A

47. A
48. D
49. C
50. A

Atomic Physics

1. C
2. A
3. A
4. A
5. C
6. 2.55
7. A
8. D
9. D
10. -0.54
11. B
12. C
13. C
14. B
15. C
16. A
17. B
18. C
19. B
20. D
21. D
22. C
23. A
24. A
25. C
26. D
27. A
28. D
29. 2.55
30. 13.1

