Shaftesbury High School
Physics
Physics
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PHYSICS 40S - FINAL EXAM REVIEW

Use this review to prepare for your final exam. There are 60 multiple choice questions (60 points) and 10 problems (50 points). Use the answers on the last page to determine your score out of 110.

FUNDAMENTAL CONSTANTS AND USEFUL PHYSICAL DATA

(Tear Off)

speed of light in a vacuum, c	3.00×10^{8} m/s
Gravitational constant, G	6.67×10^{-11} N·m^2/kg^2
charge on the electron, e	1.60×10^{-19} C
Coulomb's Constant, k	9.0×10^{9} N·m^2/C^2
Permittivity of free space, ε_o	8.85×10^{-12} C^2/N·m^2
Permiability of free space, μ_o	$4\pi \times 10^{-7}$ T·m/A
Avogadro's number, N_A	6.02×10^{23} mol^{-1}
Planck's Constant, h	6.63×10^{-34} J·s
Electron rest mass, m_e	9.11×10^{-31} kg (0.511 MeV/c^2)
Proton rest mass, m_p	1.6726×10^{-27} kg (938.3 MeV/c^2)
Neutron rest mass, m_n	1.6749×10^{-27} kg (939.6 MeV/c^2)
Atomic mass unit, u	1.6605×10^{-27} kg (931.5 MeV/c^2)
speed of sound at S.T.P.	331.5 m/s
pi, π	3.1415927

Earth:

Mass	5.97×10^{24} kg
Radius (mean)	6.38×10^{6} m
standard gravitational acceleration, g	9.80 m/s^2

Moon:

Mass	7.4×10^{22} kg
Radius (mean)	1.74×10^{6} m
Mean Distance from Earth	3.85×10^{8} m/s

PART I: Questions (60 marks) Choose the best answer.

1. A projectile launched at an angle of _____ to the horizontal has the greatest time aloft (hang time).

A) 0º B) 45º C) 60º
D) 90º E) none of the above

2. A projectile is launched from level ground at some angle to the horizontal. Which of the following must be zero for a projectile to achieve maximum range?

A) $\bar{v}_x$ B) v_y
B) Δd_x D) Δd_y E) a

3. Which of the following must be zero for a projectile to be at its maximum height?

A) $\bar{v}_x$ B) v_y
B) Δd_x D) Δd_y E) a

4. A constant force of 90.0 N does 45.0 J of work on a brick. What is the magnitude of the displacement of the brick?

A) 0.500 m
B) 45.0 m
C) 2.00 m
D) 135 m
E) 270 m

5. A 20 gram bullet travels at 600 m/s, almost twice the speed of sound in air. How far in cm will it penetrate into a block of wood if the average force resisting its motion is 3.6×10^4 newtons?

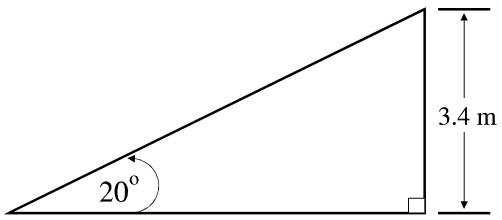
A) 5
B) 100
C) 50
D) 10
E) 20

6. Which of the following is equivalent to 1 kg•m^2/s^2?

A) one hertz
B) one joule
C) one newton
D) one watt
E) one tesla

7. How much work is done in moving the 60.0 kg crate to the top of the incline shown below if the coefficient of friction is 0.28?

A) 1500 J
B) 2000 J
C) 3500 J
D) 5500 J
E) 7000 J



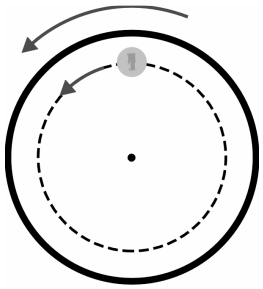
8. A satellite makes two revolutions per day around the Earth. The radius of its orbit is:

A) 3×10^8 m
B) 2.67×10^6 m
C) 2.67×10^7 m
D) 3×10^9 m
E) 3×10^6 m

9. A horizontal spring can be compressed 8.0 cm by an applied force of 4.0 N. A 5.0 kg block moving at 1.2 m/s, collides with the spring. What will be the maximum compression of the spring?

A) 0.20 m
B) 16 cm
C) 38 cm
D) 1.6 m
E) 3.2 m

10. The horizontal turntable shown rotates at a constant rate. As viewed from above, a coin on the turntable moves counterclockwise in a circle as shown. Which of the following vectors best represents the direction of the frictional force exerted on the coin by the turntable when the coin is in the position shown?

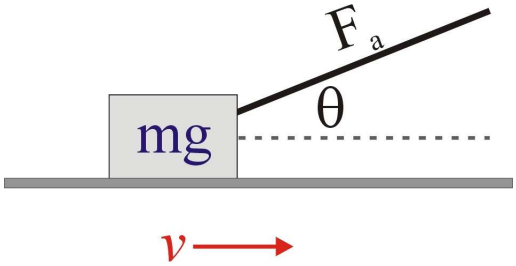

View from Above

A) ← B) →

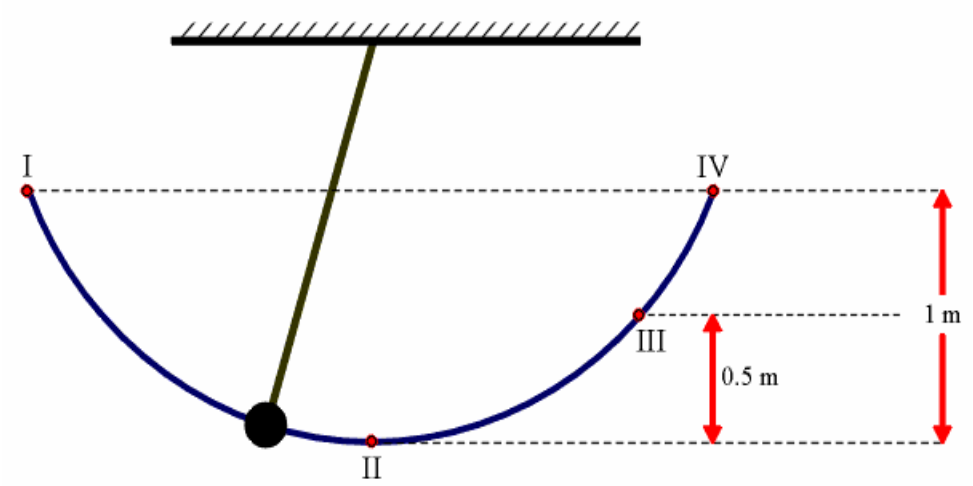
C) ↓ D) ↑ E) ↘

11. A block of weight mg is pulled along a horizontal surface at a constant speed v by a force F_a, which acts at an angle of θ with the horizontal, as shown. The normal force exerted on the block by the surface has magnitude

A) $mg - F_a \cos\theta$
B) $mg - F_a \sin\theta$
C) mg
D) $mg + F_a \sin\theta$
E) $mg + F_a \cos\theta$



Questions 12 - 13



A ball swings freely back and forth in an arc from point I to point IV, as shown above. Point II is the lowest point in the path, III is located 0.5 metres above II, and IV is 1 metre above II. Air resistance is negligible.

12. If the potential energy is zero at point II, where will the kinetic and potential energies of the ball be equal?
A) At point II
B) At some point between II and III
C) At point III
D) At some point between III and IV
E) At point IV

13. The speed of the ball at point II is most nearly
A) 3.0 m/s
B) 4.5 m/s
C) 9.8 m/s
D) 14 m/s
E) 20 m/s

14. A plane travels in a horizontal circle of radius 800 m at a constant speed of 80 m/s. What force in newtons does the plane exert on the 48 kg pilot to keep her traveling in this circle?
A) zero
B) 384
C) 38.4
D) 60
E) 64

15. A child is riding on a merry-go-round that is rotating at a constant rate. The child has:
A) constant velocity
B) constant acceleration
C) constant speed
D) constant acceleration and speed
E) constant velocity, acceleration and speed

16. During training, an astronaut is strapped into a seat which revolves in a circle of diameter 20 m at a speed of 40 m/s. If **g** represents standard gravitational acceleration due to gravity on the Earth's surface, the astronaut is said to be subjected to a “force” of about
A) 16 g
B) 18 g
C) 20 g
D) 24 g
E) 30 g

17. A 15 kg mass is pushed against a horizontal spring, compressing it 20 cm. The spring constant is k = 800 N/m. If the mass is released from rest, what is its speed at the equilibrium point of the spring?

A) 2.74 m/s B) 3.27 m/s
C) 10.7 m/s D) 6.28 m/s
E) 1.46 m/s

18. A counter-weight on the end of a horizontal rod is being whirled in a circle of radius r = 0.65 m with a frequency of 90.0 revolutions per second. Should the counter-weight come loose it will move with a velocity

A) straight down
B) 6.1 m/s along a tangent to the circle
C) 6.1 m/s along the radius away from the centre
D) 57.7 m/s along the radius toward the centre
E) none of the above

19. Negative work is a concept which implies:
A) kinetic energy is reversed
B) the force causing motion is decreasing
C) the force is perpendicular to the line of movement
D) the applied force is opposite to the displacement
E) the object moves below ground level

20. How much work is done in accelerating a 1000 kg rocket sled on horizontal frictionless rails from 20 m/s to 40 m/s?
A) 6×10^5 J
B) 5.88×10^6 J
C) 2×10^5 J
D) 4×10^5 J
E) 1.96×10^6 J

21. A 1000 kg car can just travel without slipping around a curve of radius 110 m at a speed of 21 m/s (76 km/h) so the centripetal force is provided by friction alone. A truck of mass 3000 kg travelling around the same horizontal curve

A) will not make it at that speed
B) can make it if its speed is no faster than 7 m/s
C) can make it at a speed of 63 m/s
D) can make it at 21 m/s
E) requires more centripetal acceleration

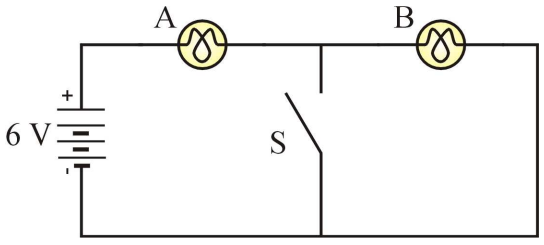
22. A total resistance of 4.0 Ω is to be produced by connecting an unknown resistance to a 12 Ω resistance. What must be the value of the unknown resistance and how should it be connected?

A) 3.0 Ω in parallel
B) 3.0 Ω in series
C) 4.0 Ω in parallel
D) 4.0 Ω in series
E) 6.0 Ω in parallel

23. The copper conductor having the least resistance would be

A) thin, long and hot
B) thick, short and cool
C) thick, long and hot
D) thin, short and cool
E) thin, short and hot

24. Two identical light bulbs are arranged in a circuit with a battery, and a switch S, as shown. When the switch is closed, the brightness of bulb B will



A) increase a little
B) decrease a little
C) increase a lot
D) decrease a lot
E) none of the above

25. A 10 Ω and a 20 Ω resistor are placed in parallel, and a 60 V battery is connected across them. The power dissipated by the 10 Ω resistor is

A) 40 W
B) 180 W
C) 80 W
D) 120 W
E) 360 W

26. A 2.5 m long wire has a resistance of 0.17 Ω and a diameter of 1.2 mm. Find its specific resistivity.

A) 7.7×10^{-8} Ω·m
B) 3.1×10^{-7} Ω·m
C) 1.2×10^{-6} Ω·m
D) 3.2×10^{6} Ω·m
E) none of the above

27. A horizontal wire carries a conventional current directly away from you. What is the magnetic field produced by this current from your viewpoint?

A) points directly towards you
B) points directly away from you
C) circles the wire in a clockwise direction
D) circles the wire in a counterclockwise direction
E) none of the above

28. An electron moving with a velocity of 5.3×10^{4} m/s to the right enters a region of uniform magnetic field that points up in the plane of the paper. How will the electron be deflected after it enters this region?

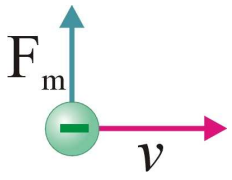
A) out of the plane of the paper
B) into the plane of the paper
C) toward the top of the paper
D) toward the bottom of the paper
E) none of the above

29. A 4 m long straight wire carrying a current of 0.5 A is placed perpendicular to a uniform magnetic field of 0.05 T. What is the magnitude of the force on the wire?

A) 0.0 N
B) 0.1 N
C) 1.0 N
D) 10 N
E) none of the above

30. At a particular instant in time, an electron has a velocity *v* to the right. A uniform magnetic field, which is perpendicular to the velocity, acts on the electron, applying a force up as shown in the diagram. What direction is the magnetic field?

A) left
B) out
C) down
D) in
E) none of the above



31. A proton is accelerated from rest through a 200-volt potential difference and emerges with a speed of 1.3×10^5 m/s. The proton then enters perpendicularly into a 2.0×10^{-2} T magnetic field. What is the radius of the circular path of the proton in this magnetic field?
A) 2.8×10^{-5} m
B) 0.069 m
C) 0.14 m
D) 0.24 m
E) none of the above

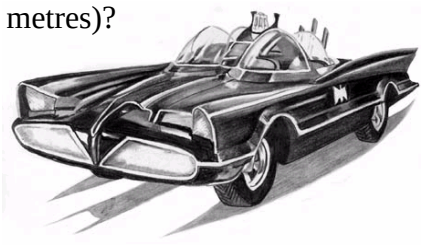
32. What potential difference must exist between the ends of a wire that has a resistance of 20 Ω, so that 40 C of charge pass through it in 10 s?
A) 5.0 V
B) 20 V
C) 80 V
D) 8.0×10^2 V
E) 8.0×10^3 V

33. A point charge produces a 5.0×10^{20} N/C electric field at a distance of 2.5×10^{-10} m from the charge. The electric field points away from the charge. What is the charge?
A) $+1.4 \times 10^{-9}$ C
B) $+3.5 \times 10^{-9}$ C
C) $-1.4 \text{ X } 10^{-9}$ C
D) $+3.8 \times 10^{14}$ C
E) none of the above

34. Which of the following laws of conservation is related to Lenz's law?
A) energy
B) mass
C) lines of force
D) charge
E) momentum

35. Resistors in parallel have the same
A) current
B) voltage
C) power
D) resistance
E) resistivity

36. The batmobile, moving with a speed of 54 km/h, decelerates at a constant 2.0 m/s^2. What distance does it cover before coming to a stop (in metres)?

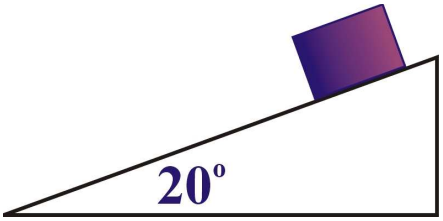


A) 730 m
B) 3.8 m
C) 56 m
D) 110 m
E) 38 m

37. A baseball is thrown vertically upward at +20 m/s. How high will it be when it has reached a velocity of +10 m/s?

A) 0.5 m
B) 26 m
C) 15 m
D) 31 m
E) 0 m

38. Determine the coefficient of friction that would allow a 10 kg object to slide down the 20° incline shown at constant speed.



A) 0.22
B) 0.36
C) 0.19
D) 0.46
E) 0.28

39. A horizontal force of 200 N is required to pull a 50 kg box across a floor at constant speed. What is the coefficient of kinetic friction?

A) 0.1 B) 0.2 C) 0.3 D) 0.4 E) 0.5

The following information is to be used to answer questions 40 and 41.

A snowboarder of mass 50 kg coasts to the bottom of a hill with a 30° incline and a length of 75 m, starting from a speed of 2.0 m/s. The coefficient of friction between the board and the snow is 0.15.

40. What is the magnitude of the force of friction?

A) 74 N B) 64 N C) 490 N D) 7.5 N E) 17.5 N

41. What is the snowboarder's acceleration at the bottom of the hill (in m/s^2)?

A) 1.2 B) 2.4 C) 3.6 D) 4.8 E) 6.0

42. A proton with a velocity of 3.0×10^6 m/s enters a 0.25 T, perpendicular magnetic field. What is the radius of the proton's path?

A) 8.0 m B) 2.8×10^{-3} m C) 1.3×10^{-1} m D) 6.8×10^{-5} m E) none of these

43. A transformer has 50 turns on the primary coil and 200 turns on the secondary coil. If the output current is 5.0 A, what is the current in the primary coil?

A) 20 A B) 1.0 A C) 5.0 A D) 1.3 A E) none of these

The following information refers to questions 44, 45 and 46.

A student is whirling a 15 kg ball at the end of a 0.75 m string in a horizontal circle. The ball has a frequency of 2 Hz.

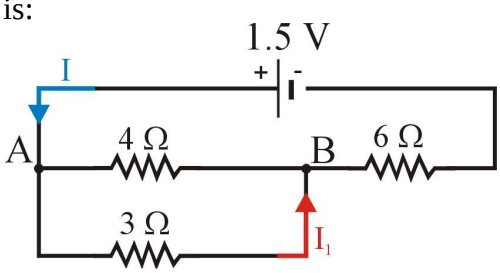
44. Which of the following statements is **incorrect**?
A) The centripetal acceleration is tangent to the circle at any given moment.
B) The centripetal acceleration is toward the student's hand.
C) The velocity of the ball is tangent to the circle at any given moment.
D) The speed of the ball is constant.
E) The centripetal force is toward the student's hand at any given moment.

45. What is the magnitude of the centripetal force acting on the ball just before the student releases it?
A) 111 N B) 6 N C) 888 N D) 147 N E) 1777 N

46. What is the kinetic energy of the ball?
A) 666 J B) 942 J C) 1333 J D) 444 J E) 111 J

47. A projectile is fired from a cannon at ground level at 45 degrees with respect to the horizontal. The initial horizontal and vertical components of the velocity of the projectile are 30 m/s. Neglect air resistance. When the projectile reaches maximum height, the horizontal distance it has traveled is
A) zero
B) greater than the vertical distance it has traveled
C) undetermined since there are two angles which give the same range
D) equal to the vertical distance it has traveled
E) less than the vertical distance it has traveled

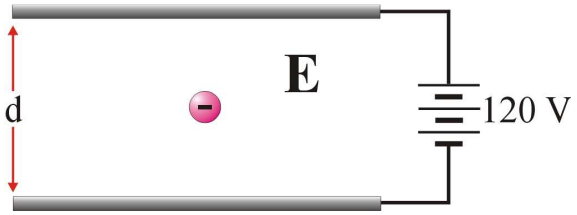
48. The total resistance for the circuit shown is:
A) 2 Ω
B) 13 Ω
C) 0.75 Ω
D) 1.33 Ω
E) 7.71 Ω



49. A catapult launches a stone from ground level with a velocity of 10 m/s, 35° above the horizontal. How long will the stone fly in the air before impacting the ground. Assume level ground.
A) 1.2 s B) 1.7 s C) 2.0 s D) 3.0 s E) 3.4 s

50. The distance from the centre of the Sun to the centre of the Earth is 1.5×10^{11} m and the period of the Earth is 365 days. The speed of the Earth around the Sun is:

A) 3.0×10^{4} m/s B) 1.0×10^{3} m/s C) 0.077 m/s D) 2000 m/s E) none of these



Questions 51 and 52

51. A difference in potential of 120 V exist between two parallel plates as shown above. The plates are 0.5 cm apart. A single electron (not to scale :) is between the plates. What is the force on the electron?

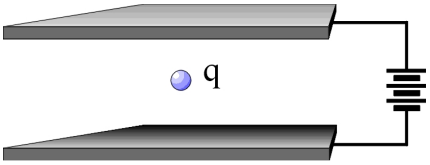
A) 60 N B) 240 V/m C) 1.2×10^{6} N D) 3.8×10^{-15} V·C/m E) 8.3 m/s^2

52. What is the acceleration of the electron?

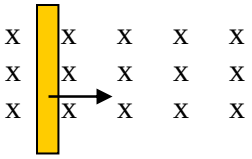
A) 60 m/s^2 B) 240 V·C/kg·m C) 4.2×10^{15} N/kg
D) 3.0×10^{12} m/s^2 E) 1.2×10^{8} V·C/kg·m

53. A tiny, negatively charged oil drop of mass 3.2×10^{-14} kg is held balanced between two charged plates as shown. If the intensity of the electric field is 3.92×10^{5} N/C, how many **excess** electrons are on the oil drop?

A) 1 B) 2 C) 3 D) 4 E) 5



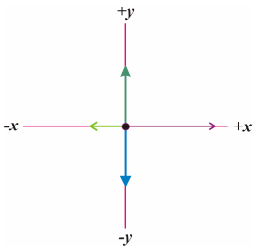
54. In the diagram below, a copper wire is shown moving to the right through a magnetic field which is pointing into the page. The direction of **electron flow** will be:



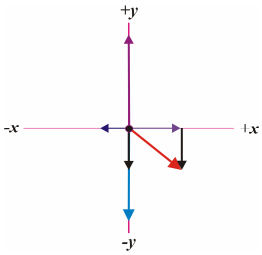
A) left B) right
C) up D) down E) into the page

55. A square loop of wire lies in the plane of the page. A decreasing magnetic field is directed into the page and through the loop. The induced conventional current in the loop is:
A) counterclockwise
B) clockwise
C) zero
D) depends upon whether or not B is decreasing at a constant rate
E) clockwise in two of the loop sides and counterclockwise in the other two

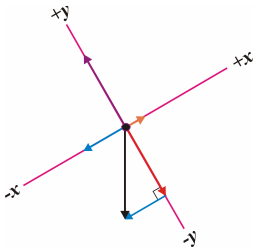
56. A lawnmower is pushed across a lawn so that it accelerates. The free-body diagram which best represents this situation is:



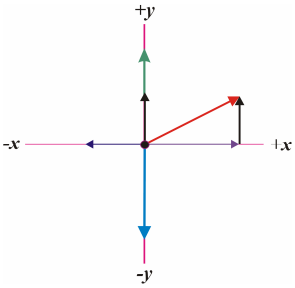
A)



B)



C)



D)

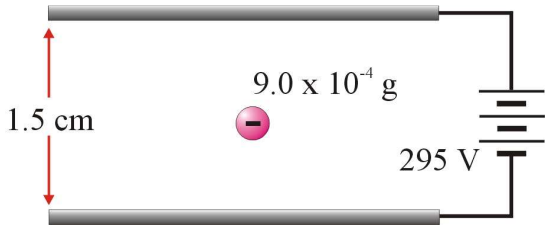
E) none of these

57. Astronauts working on the international space station are *weightless* because...

A) there is no gravity in space and they do not weigh anything.
B) space is a vacuum and there is no gravity in a vacuum.
C) space is a vacuum and there is no air resistance in a vacuum.
D) the astronauts are far from earth's surface at a location where gravitation has a minimal effect.
E) the astronauts are falling.

Use the following information to answer questions 58 - 59.

The tiny plastic sphere in the diagram has an electric charge of -1.96 x 10^{-10} C and a mass of 9.0 x 10^{-4} g. It is suspended (held motionless) between two charged plates – the electric force balancing the gravitational force.



Side-view of Electrically Charged Parallel Plates

58. The size of the electric force acting on the sphere must be

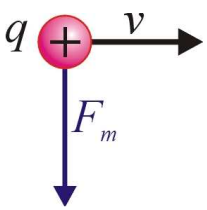
A) 3.9 x 10^{-3} N B) 2.0 x 10^{4} N C) 3.9 x 10^{-6} N D) 8.8 x 10^{-6} N E) none of these

59. The size of the electric field between the plates must be

A) 4.5 x 10^{4} N/C B) 3.9 x 10^{-6} N/C C) 0.26 N/C D) 2.0 x 10^{4} N/C E) none of these

60. A positive electric charge **q** moves through a uniform magnetic field as shown here. The magnetic force points down. What is the direction of the magnetic field?

A) into the page
B) out of the page
C) left
D) up
E) down



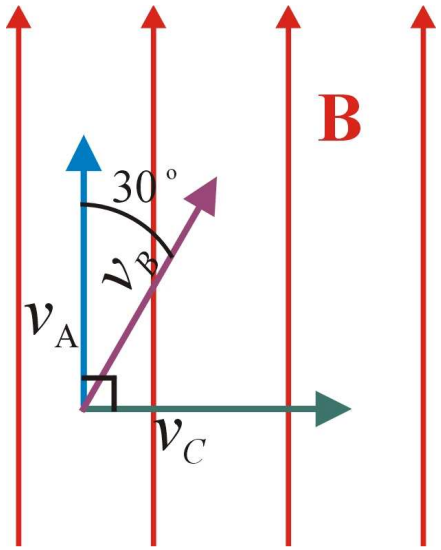
PART II: Problems (50 marks)
Show all your work. Enter your final answer in the blank space below the problem.

1. A small car is coasting along on a horizontal track with a speed of 12.5 m/s, when the car starts to roll up a hill. If we assume that there is negligible friction in the bearings of the car's wheels, how high above its original level will the car reach before stopping? **(2 marks)**

ANS _____

2. In the figure below, the uniform magnetic field has a strength of 0.75 T. Three charged particles A, B, and C, each with a speed of 5.0 x 10^2 m/s and charge of 4.0 mC travel with the directions shown. **(3 marks)**

What is the **magnitude** of the force on each particle?

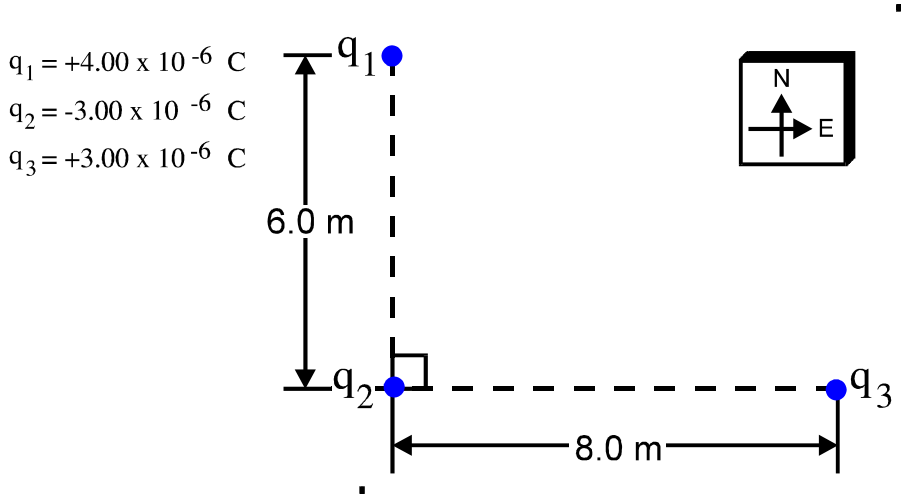


ANS: charge A _____

ANS: charge B _____

ANS: charge C _____

Refer to the diagram below to answer questions 3. a) and b).

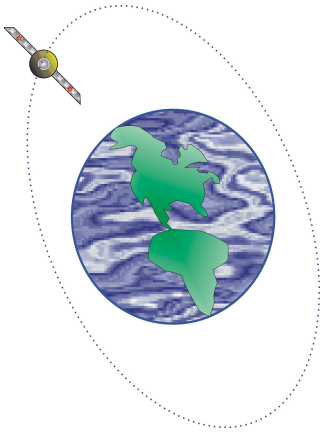


3 a) Show on the diagram the directions of the individual electrostatic forces acting on charge q_2. **(1 mark)**

b) Find the magnitude and direction (in degrees) of the net electrostatic force acting on charge q_2 due to charges q_1 and q_3. **(4 marks)**

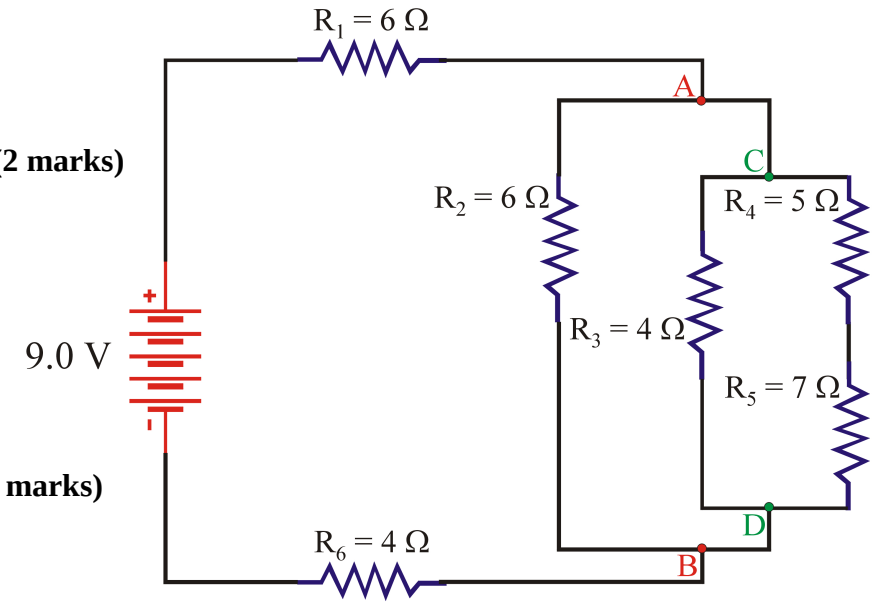
ANS _____

4. An artificial Earth satellite has a circular polar orbit with a period of 2.2 hours. What is the altitude of this satellite? **(4 marks)**



ANS _____

5. For the circuit below calculate:



a) the equivalent circuit resistance. **(2 marks)**

ANS _____

b) the current passing through R_1 **(2 marks)**

ANS _____

c) the current passing through R_2 **(1 mark)**

ANS _____

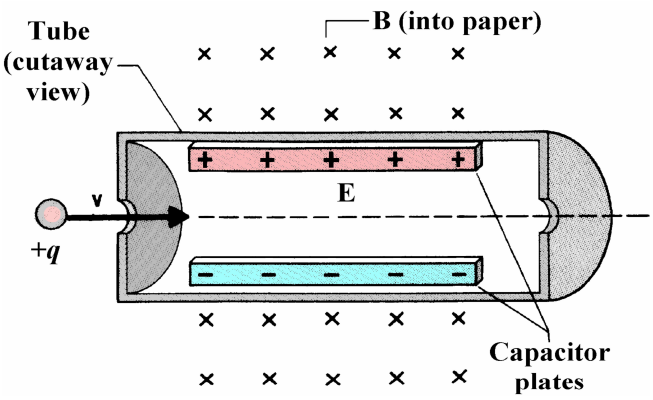
d) the voltage drop across R_5 **(1 mark)**

ANS _____

e) the voltage drop across R_4 **(1 mark)**

ANS _____

6. A *velocity selector* is a device for measuring the speed of a charged particle. The illustration below shows that a velocity selector consists of a cylindrical tube located within a uniform magnetic field ***B***. Inside the tube there is a parallel plate capacitor that produces an electric field ***E***. The magnetic and electric fields are perpendicular to each other. A positive charge enters the left end of the tube and has a velocity that is perpendicular to both ***B*** and ***E***. The charge experiences both a magnetic force and an electric force. However, if the electric field is correctly adjusted, the electric and magnetic forces balance and the net force acting on the charge is zero. The charge then moves along the tube in a straight line at a constant speed ***v***.



Crossed Fields of a Velocity Selector

a) Sketch the free-body diagram for the charge while inside the velocity selector in the space below. **(1 mark)**

b) What is the direction of the electric field between the charged parallel plates? **(1 mark)**

c) For such a situation, derive an expression for the speed of the particle in terms of ***B*** and ***E***. **(3 marks)**

ANS _____

7. A golfer is standing on a fairway and hits a shot to a green that is elevated 9.2 metres above the point where she is standing. If the ball leaves her club with a velocity of 21 m/s at an angle of 51° to the ground, find:

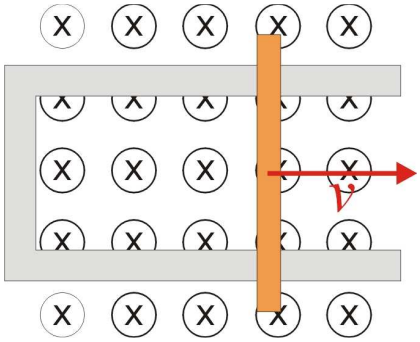
a) the time for the ball to come down on to the green. **(2 marks)**

ANS _____

b) the actual velocity of the ball at impact. **(3 marks)**

ANS _____

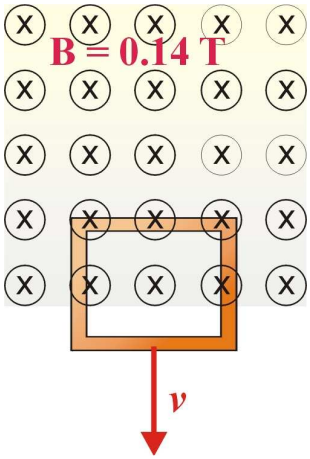
8. In the figure below a conducting rod is moving as shown across conducting rails. The magnetic field is directed into the figure. What is the direction of the induced current in the rectangular loop? **(1 mark)**



ANS _____

9. The rectangular wire loop has dimensions of 4.0 cm by 3.0 cm. Moving at constant speed, the loop completely exits the 0.14 T uniform magnetic field in 0.12 seconds. The wire has a radius of 0.40 mm and a resistivity of 2.15 x 10^{-8} Ω m. Determine:

a) the resistance of the wire **(2 marks)**



ANS _____

b) the voltage induced in the wire loop. **(2 marks)**

ANS _____

c) the current induced in the loop as it leaves the magnetic field. **(2 marks)**

ANS _____

d) the electric power. **(2 marks)**

ANS _____

e) the direction of the induced current. **(1 mark)**

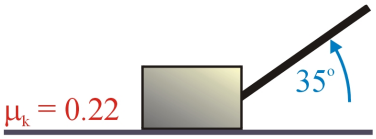
ANS _____

10. An 85 kg box must be moved. Calculate:

a) the weight of the box **(1 mark)**

ANS _____

b) the minimum force needed to slide the box across a level floor when dragged by a rope that makes a 35° angle above the horizontal given a coefficient of kinetic friction of 0.22. **(3 marks)**

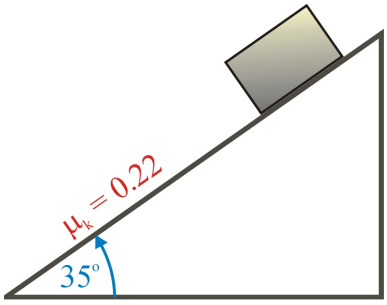


ANS _____

c) the work done in b if the box slides 12 m. **(1 mark)**

ANS _____

d) the force needed to slide the box up a 35° incline at constant speed given a 0.22 coefficient of kinetic friction. **(4 marks)**



ANS _____

Answers: ***(Please report errors to Mr. Striemer rstriemer@pembinatrails.ca). Thanks.***

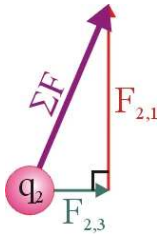
Part I: Multiple Choice Answers:

1) D	2) D	3) B	4) A	5) D	6) B	7) C
8) C	9) C	10) C	11) B	12) C	13) B	14) B
15) D	16) A	17) E	18) E	19) D	20) A	21) D
22) E	23) B	24) E	25) E	26) A	27) C	28) B
29) B	30) B	31) B	32) C	33) B	34) A	35) B
36) C	37) C	38) B	39) D	40) B	41) C	42) C
43) A	44) A	45) E	46) A	47) B	48) E	49) A
50) A	51) D	52) C	53) E	54) D	55) B	56) B
57) E	58) D	59) A	60) B			

Part II: Answers to Problems

1) 7.97 m

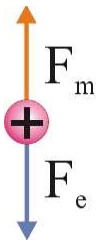
2) 0, 0.75 N, 1.5 N respectively

3) a) 

b) $\Sigma F = 3.3 \times 10^{-3}$ N, 67° N of E

4) 2200 km

5 a) 12 Ω b) 0.75 A c) 0.25 A ($V_{AB} = 1.5$ V) d) 0.875 V e) 0.625 V

6 a) 

b) down c) $v = \frac{E}{B}$

7 a) 2.6 s b) 16 m/s, 35 degrees below the horizontal

8) up towards the top of the page

9 a) 6.0×10^{-3} Ω b) 14 mV c) 2.3 A d) 33 mW

10 a) 830 N b) 190 N c) 1900 N·m d) 630 N