Physics 40S Exam Review

Sample Extended Answer Questions

I: Mechanics

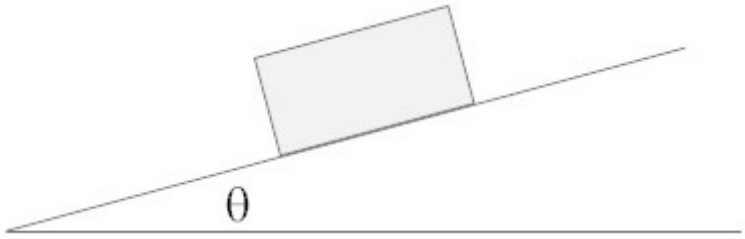
1. A turtle and a bunny decide to have a race. The turtle (at t=0) is running with a constant velocity of 0.2 m/s. The bunny waits 160 s before starting to hop. Once the bunny starts hopping, he hops with a constant acceleration and catches up to the turtle. The turtle takes 200 s to finish the race.

   a) If the race ends in a tie, what is the acceleration of the bunny?

   b) How fast is the bunny hopping at the end of the race?

   c) The fastest the bunny can hop is 4 m/s. What is the longest time he could wait before starting to hop?

2. A 30 kg block is stationary on a rough inclined plane as shown.



a) Draw and label arrows representing the forces acting on the block.

b) The coefficient of static friction is 0.1. Calculate the angle θ.

c) Would the angle be different if the mass was greater? Explain.

3. A boy is pulling his wagon along a horizontal sidewalk with a force of 50 N. The handle makes an angle of 37^{o} with the ground. The wagon is moving with a constant velocity.

   a) A force is being exerted on the wagon. Why is the wagon moving with constant velocity?

   b) Calculate the frictional force acting on the wagon.

   c) The coefficient of kinetic friction, μ, is 0.2. Calculate the normal force the ground exerts on the wagon.

   d) Calculate the mass of the wagon.

   e) What causes the frictional force on the wagon?

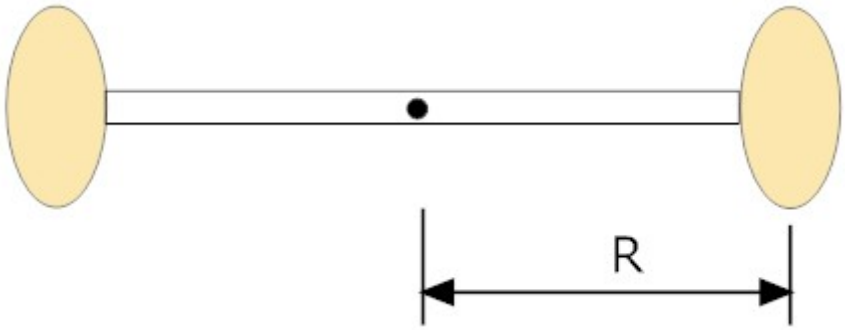
4. A train car of mass M = 1000 kg moving with a velocity 15 m/s hits a second train car of mass 4M moving in the opposite direction with a velocity of 5 m/s. The two cars connect together as a result of the collision.

   a) Ignoring friction, calculate the velocity of the cars after the collision.

   b) Assuming the train cars are traveling at the same velocities for each car as given above, calculate the ratio of the masses, such that after the collision the connected cars have a velocity of zero.

5. A car is found 20 m away from the bottom of a 5 m high cliff. The road at the top of the cliff is horizontal. What was the speed of the car, in km/h, when it drove off the cliff?

6. A carnival ride consists of two carts that spin in a horizontal circle around a center point. The top view of the ride is as shown:

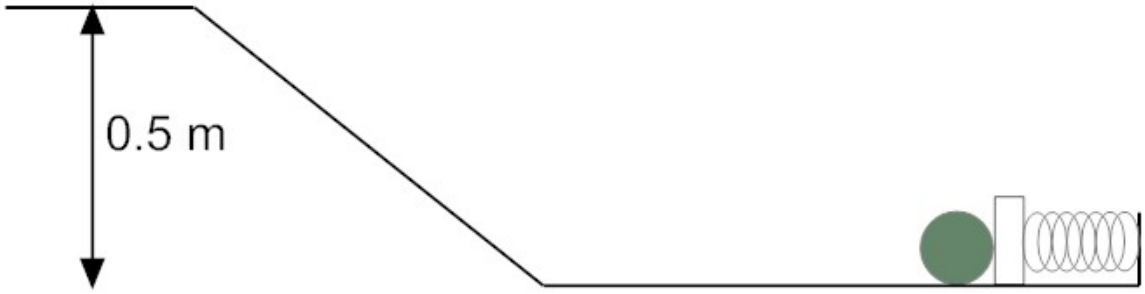


A 70 kg rider on the ride experiences a centripetal force of 2g. The radius R, is 3 m.

a) What is the frequency of rotation of the ride?

b) If the radius was doubled, would the frequency of rotation need to increase or decrease to maintain a force of 2g?

7. Consider the following situation:



The spring, with a spring force constant of 100 N/m, is compressed 20 cm. The ball has a mass of 1 kg.

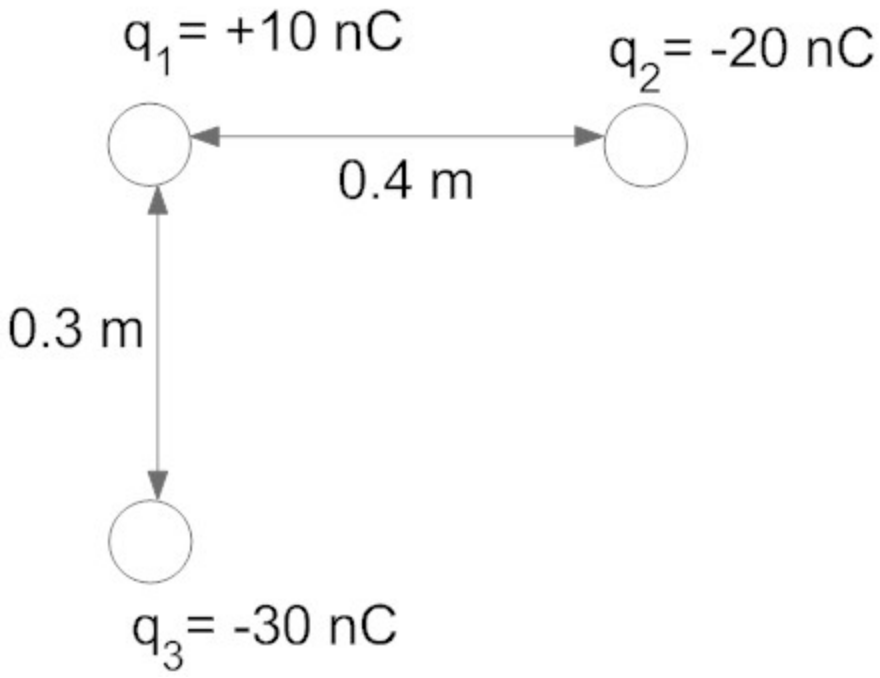
a) The spring is released causing the ball to move to the left. Calculate the velocity of the ball as soon as it leaves the spring.

b) The ball then travels up the ramp. Does the ball make it to the top of the ramp? Provide proof.

c) How much must the spring be compressed so that the ball just makes it to the top of the ramp?

II: Fields

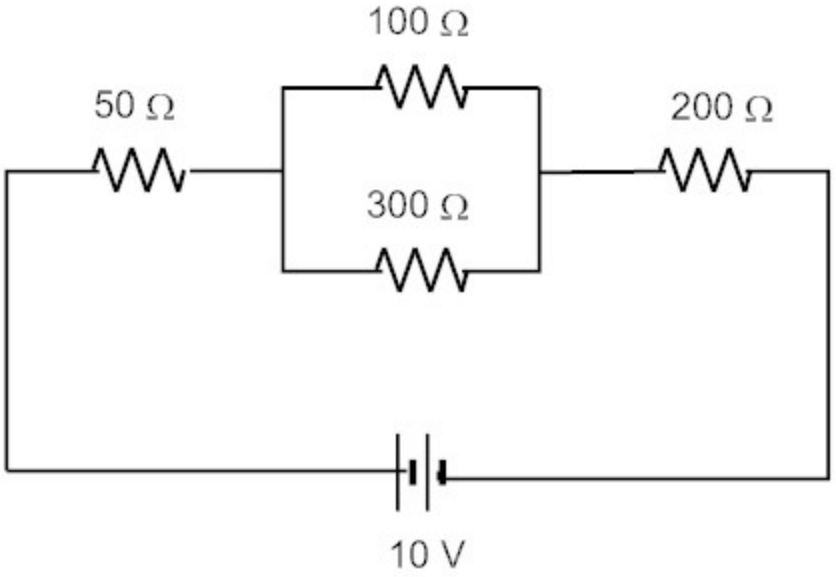
8. Three charges are placed as shown:



Calculate the net electrostatic force on q_3.

III: Electricity

9. Consider the following circuit.



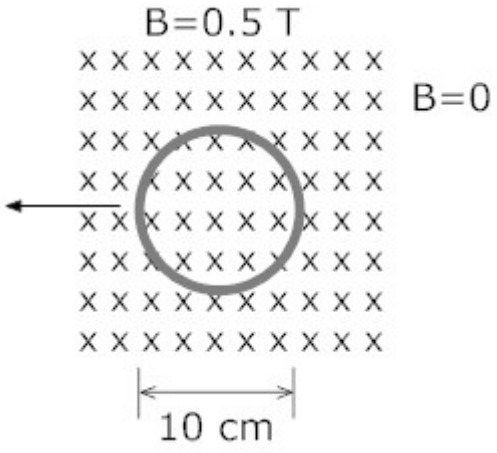
a) Calculate the equivalent resistance of the circuit.

b) Calculate the current flowing through the 200 Ω resistor.

c) Calculate the voltage drop across the 200 Ω resistor.

d) What would happen to the voltage drop across the 200 Ω resistor if the 300 Ω resistor was removed from the circuit?

10. A 10 cm diameter circular coil of 100 loops is positioned perpendicular to a magnetic field of 0.5 T going into the page.



a) List two ways that an EMF can be induced in the coil.

b) The loop is uniformly pulled from the field (moving perpendicular to the magnetic field) to a region where the magnetic field drops abruptly to zero. It takes 2 seconds for the whole coil to reach the field-free region. Calculate the induced EMF.

c) What is the direction of the induced current in the wire?

11. Manitoba Hydro produces AC current in Northern Manitoba using hydroelectric dams and AC generators.

    a) Referring to electromagnetic induction, explain briefly how an AC generator works.

    b) Manitoba Hydro's transmission system transports electricity in a range from 24 kV to 500 kV. Why is the electricity transmitted on high voltage lines instead of 240 V lines?

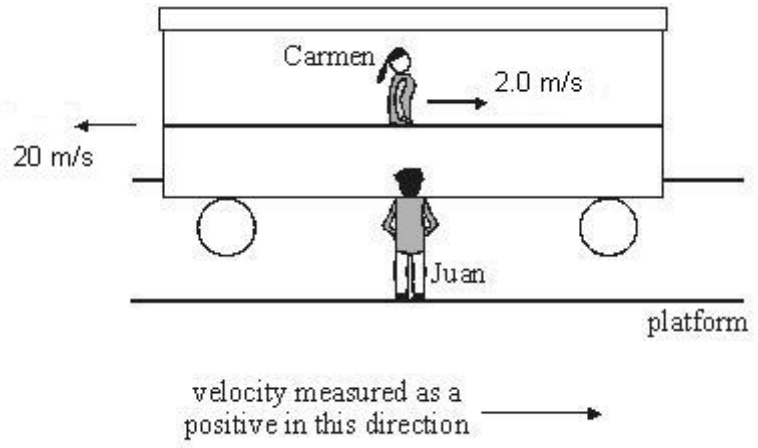
    c) Manitoba Hydro transmits the electricity from Northern Manitoba as direct current on two trunk lines. Why is the electricity transmitted as direct current instead of alternating current?

    d) Manitoba Hydro is in the process of building 3 new power generating stations in Northern Manitoba. These generating stations are scheduled to be completed by 2012. All of the power produced by these stations would be for export until around 2020. Give an environmental or economic reason why this is a good or bad idea.

Sample Multiple Choice Questions

I: Mechanics

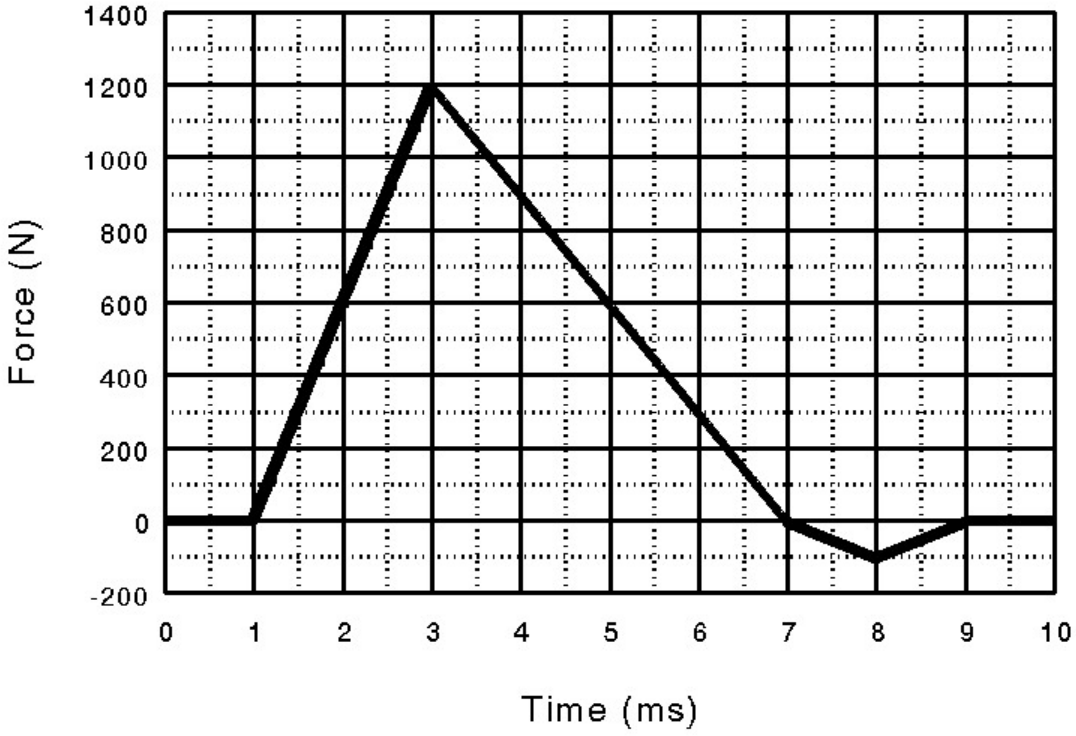
1. Juan is standing on the platform at a railway station. A train passes through the station with speed 20 m/s in the direction shown measured relative to the platform. Carmen is walking along one of the cars of the train with speed 2.0 m/s measured relative to the car in the direction shown. Velocity is measured as positive in the direction shown on the diagram.



The velocity of Carman relative to Juan is

A) +22 m/s.
B) +18 m/s.
C) -22 m/s.
D) -18 m/s.

2. A car is crash tested by driving it into a concrete barrier. The crash lasts 8 ms. The force measured during the time of impact is shown in the following graph.

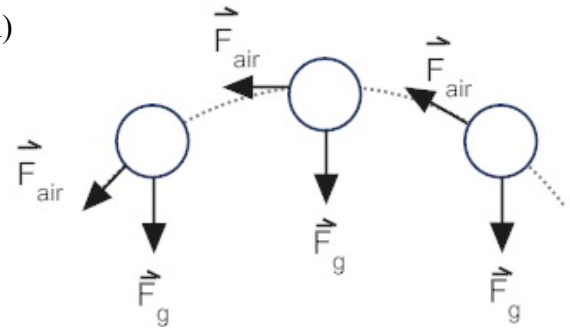


Calculate the impulse during the collision.

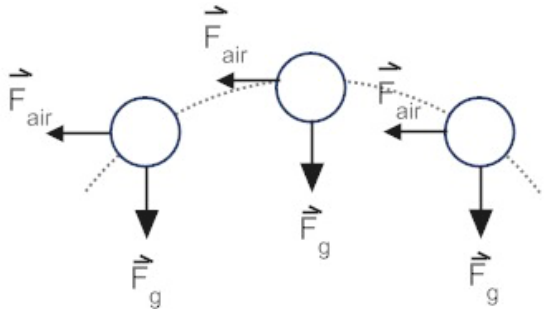
A) 3.5 Ns
B) 3.7 Ns
C) 7.0 Ns
D) 7.4 Ns

3. A basketball player is making a free throw. Which of the following diagrams **best** represents the forces on the ball during the flight?

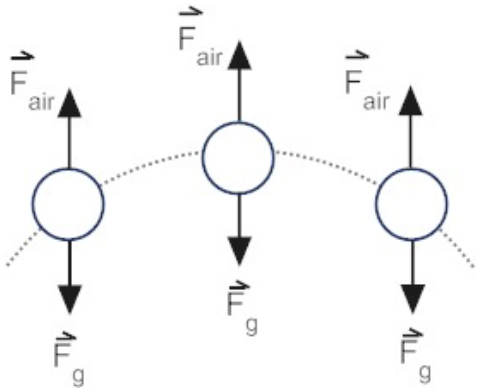
A)



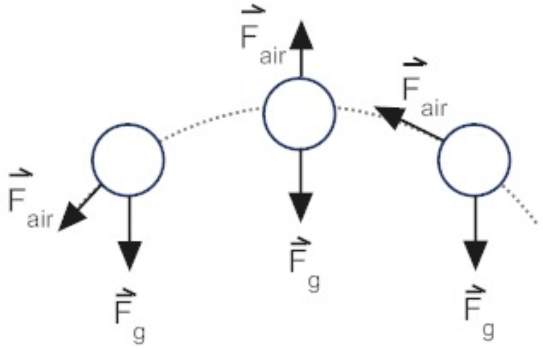
B)



C)



D)



4. A 200 kg rollercoaster car is traveling through a vertical circle of radius 5 m with a velocity of 10 m/s. What is the magnitude and direction of the centripetal force?

A) 4000 N towards the center of the circle
B) 4000 N away from the center of the circle
C) 4000 N up
D) 4000 N down

5. Which of the following statements about an object moving in a circle are **true**?

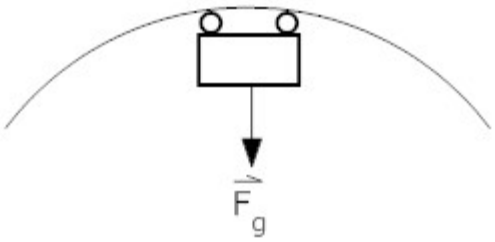
I. The centripetal force always points towards the center of the circular path
II. The centrifugal force always points towards the center of the circular path.
III. The centrifugal force always points away from the center of the circular path.

A) I and II
B) I and III
C) I only
D) III only

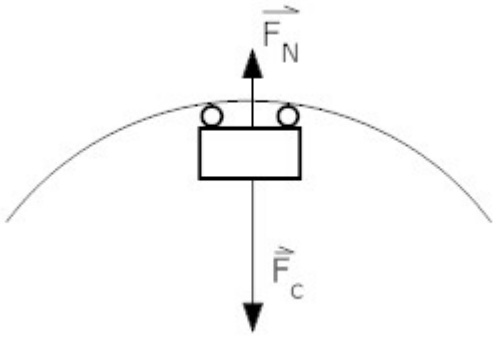
6. A rollercoaster car is at the top of a loop. Which of the following free body diagrams properly represents the forces acting on the car if the car is moving faster than the critical velocity?

F_g = force of gravity
F_N= normal force
F_c = centripetal force

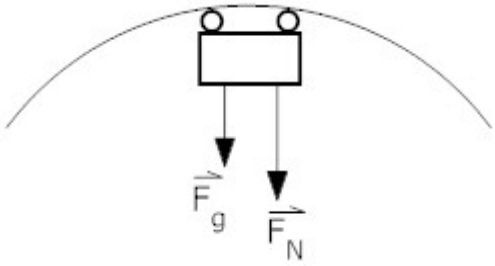
A)



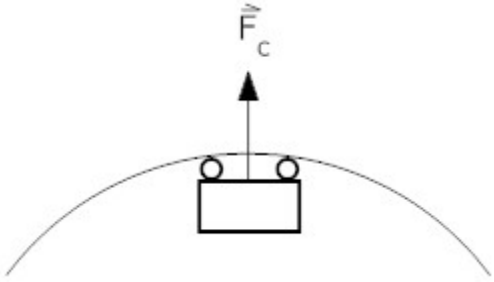
B)



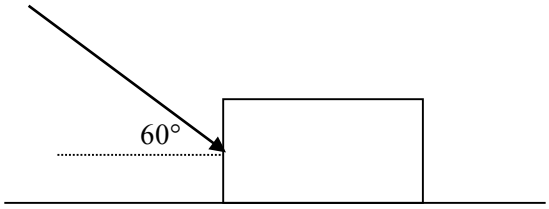
C)



D)



7. A box is pushed with a force of 50 N at an angle of 60° with the horizontal.



What is the work required to pushed the box a distance of 10 m?

A) 250 J
B) 433 J
C) 500 J
D) 610 J

8. An object is moved horizontally 10 m by a horizontal force. The force exerted on the object is shown in the following graph:

Calculate the work done by the force over the 10 m.

A) 170 J
B) 160 J
C) 150 J
D) 140 J

9. A 0.1 kg can slides across a counter. It travels a distance of 1 m before stopping. The initial velocity of the can is 2 m/s. Calculate the work done by friction on the car.

A) +0.1 J
B) -0.1 J
C) +0.2 J
D) -0.2 J

10. Which of the following situations has zero kinetic energy?

    A) water falling over a waterfall
    B) a car traveling with a constant velocity
    C) a train accelerating from 0 to 20 m/s
    D) a truck parked at the side of the road

II: Fields

11. Which of the following statements is **true** according to Kepler's laws of planetary motion?

    A) Planets revolve around the sun in perfect circular orbits.
    B) The velocity of the planet as it travels around the sun is slowest when it is closest to the sun.
    C) The ratio of period of revolution to the orbital radius is a constant.
    D) None of the above.

12. A satellite revolves around the earth once every 24 hours. What is the orbital radius of the satellite?

    A) 2.7×10^{6} m
    B) 4.2×10^{7} m
    C) 7.1×10^{12} m
    D) 7.4×10^{22} m

13. Object A has a mass three times that of object B. When the objects are separated by a distance of 0.25 m the gravitational force between them is 6.67×10^{-7} N. What is the mass of object A?

    A) 624 kg
    B) 208 kg
    C) 43.2 kg
    D) 14.4 kg

14. Two object of identical mass experience a force F when placed a distance r from each other. If the objects are now placed 2r apart, what is the new gravitational force?

    A) 4F
    B) F
    C) 0.5F
    D) 0.25F

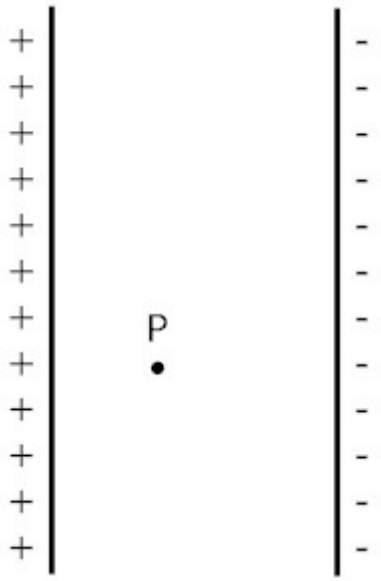
15. What is the gravitational acceleration at the top of Mount Kilimanjaro (4600 m above the surface of the Earth)?

A) 9.81 m/s^2
B) 9.79 m/s^2
C) 9.65 m/s^2
D) 1.89×10^7 m/s^2

16. What is the gravitational acceleration on Mercury?

A) 8.53×10^{-9} m/s^2
B) 3.31 m/s^2
C) 9.81 m/s^2
D) 8.51×10^6 m/s^2

17. Two infinitely long uniformly charged parallel plates are positioned as shown.



Which vector represents the direction of the electric field at point P?

A) 

B) 

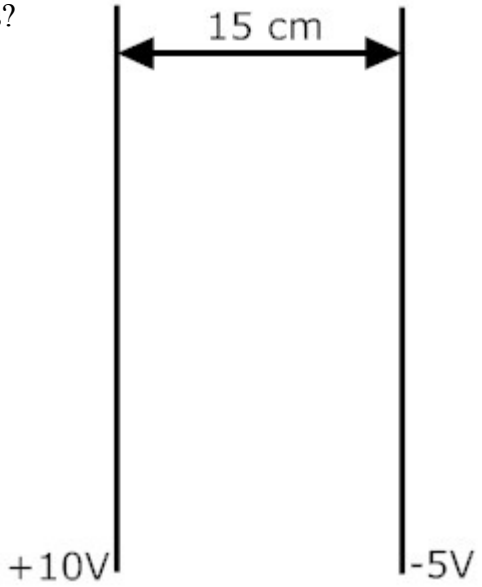
C) 

D) 

18. Two parallel plates, 15 cm apart, are charged as shown:

What is the electric field between the plates?

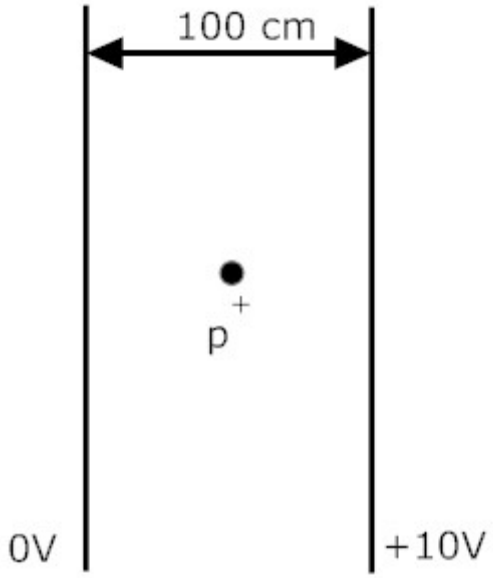
A) 1 V/m towards the left
B) 1 V/m towards the right
C) 100 V/m towards the left
D) 100 V/m towards the right



19. A proton is placed between two charged parallel plates as shown:

What is the electrical force acting on the proton?

A) 1.6×10^{-18} N to the right
B) 1.6×10^{-18} N to the left
C) 1.6×10^{-20} N to the right
D) 1.6×10^{-20} N to the left

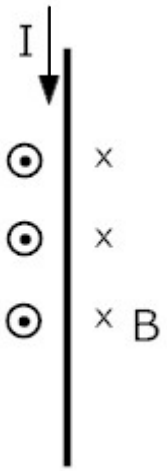


20. Which of the following diagrams represents the direction of the magnetic field around the wire?

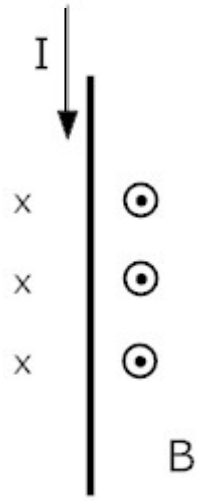
x – B going into page

⊙ – B coming out of the page

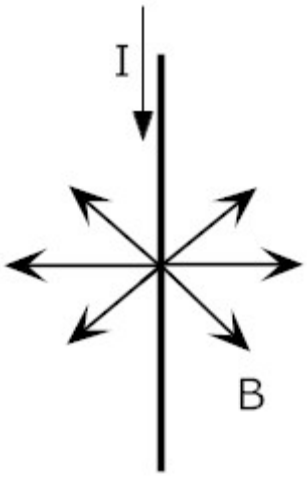
A)



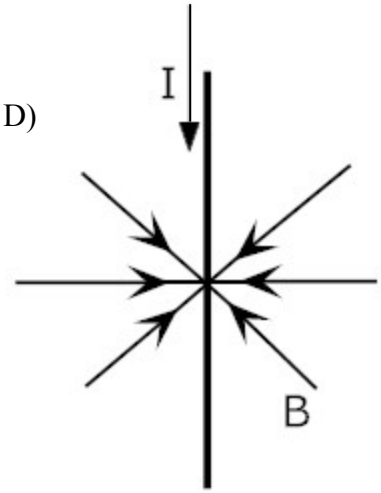
B)



C)



D)



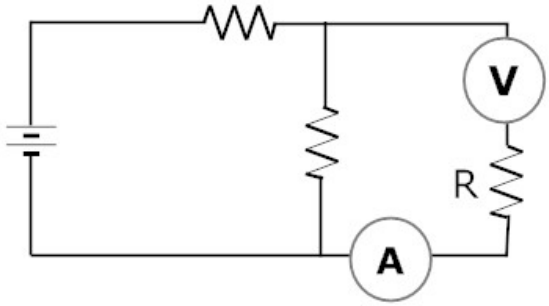
III: Electricity

21. A wire with resistivity ρ, length L, and cross-sectional area A has a resistance R. A second wire with identical resistivity has a length 0.5L and cross-sectional area 2A. What is the resistance of the second wire?

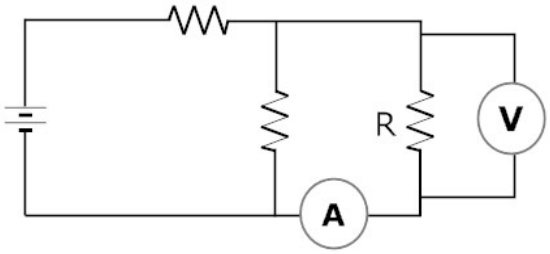
    A) 0.25R
    B) R
    C) 2R
    D) 4R

22. Which of the following circuits **correctly** measures the voltage across and the current through resistor R?

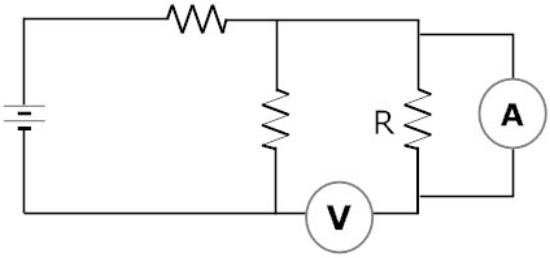
A)



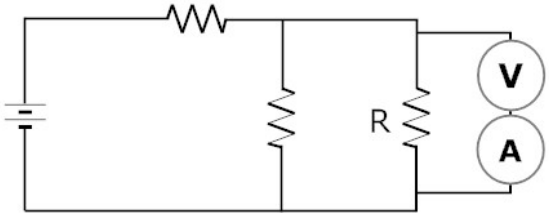
B)



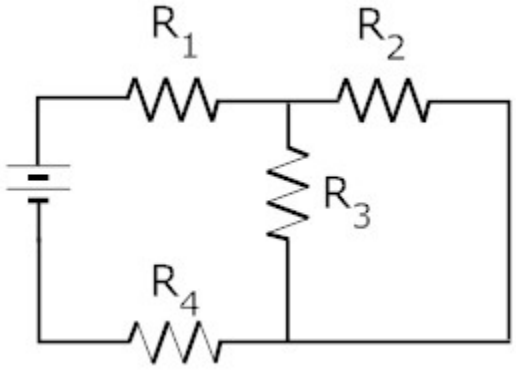
C)



D)



23. Consider the following circuit diagram.

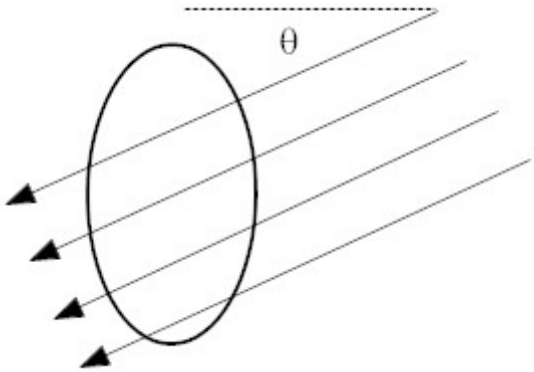


Which of the following statements regarding the circuit are **true**?

I. Resistors R_1 and R_2 are in series.
II. Resistors R_2 and R_3 are in parallel.
III. Resistors R_1 and R_4 are in parallel.

A) I only
B) II only
C) III only
D) II and III

24. A magnetic field of 2.5×10^{-5} T passes through a circular coil of radius 10 cm as shown.



What is the magnetic flux density passing through the coil when $\theta = 30^{o}$?

A) 6.8×10^{-3} Wb
B) 3.9×10^{-3} Wb
C) 6.8×10^{-7} Wb
D) 3.9×10^{-7} Wb

25. Which of the following statements about transformers are **true**?

I. An iron core is used to improve the efficiency of the transformer.
II. Either an alternating current or a direct current can be used to induce a current in the secondary coil.
III. Lenz's law determines the direction of the current in the secondary coil.

A) I and II
B) I and III
C) II and III
D) I, II, and III

26. A 100% efficient transformer converts 120 V to 20 V. The current in the secondary coil is 0.25 A. What is the current in the primary coil?

A) 0.04 A
B) 1.5 A
C) 5 A
D) 25 A

27. A step-up transformer is designed to increase 120 V to 1000 V. What is the value of the ratio $\frac{N_p}{N_s}$?

A) 0.12
B) 8.3
C) 120
D) 1000