

## Physics 40S Exam Review

### Sample Extended Answer Questions

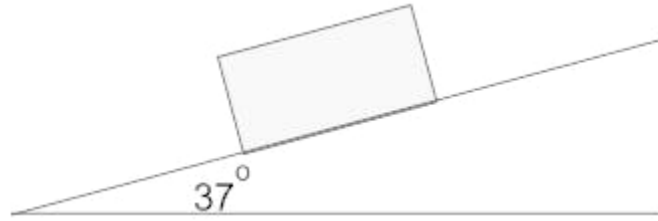
#### I: Mechanics

1. A truck is traveling down the highway with a constant velocity of 120 km/h. The truck passes a stationary police car at time  $t = 0$ . The police car drives after the speeding truck with an acceleration of  $10.0 \text{ m/s}^2$ .

a) If the truck does not slow down, how long does it take the police car to catch up with the truck?

b) How fast is the police car traveling in **km/h** when it reaches the truck?

2. A 25 kg block is stationary on a rough inclined plane as shown.



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

b) Calculate the force of friction acting on the block.

c) Calculate the coefficient of friction.

3. A lawnmower is pushed with a force of 150 N at an angle of  $42^\circ$  with the ground. The lawnmower is moving with a constant velocity.

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

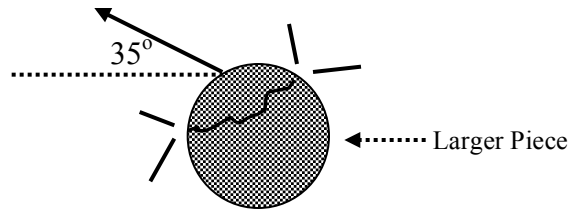
b) Calculate the frictional force acting on the lawnmower.

b) The lawnmower has a mass of 12 kg. Calculate the normal force the ground exerts on the lawnmower.

d) Calculate the coefficient of kinetic friction,  $\mu$ .

e) What causes the frictional force on the lawnmower?

4. A physics student lights a firecracker placed inside of an apple and throws it into the air. When the apple reaches its maximum height it explodes into two unequal pieces.



The larger piece is three times the mass of the smaller piece.

The smaller piece moves upward with a velocity of  $60 \text{ m/s}$  at an angle of  $35^\circ$  with the horizontal.

a) In what direction does the larger piece move?

b) Calculate the magnitude of the velocity of the larger piece of apple.

5. An arrow is fired horizontally at the center of a target 20 m away. The arrow leaves the bow with a velocity of 30 m/s.

a) Calculate the length of time for the arrow to reach the target.

b) Calculate the displacement of the arrow from the center of the target.

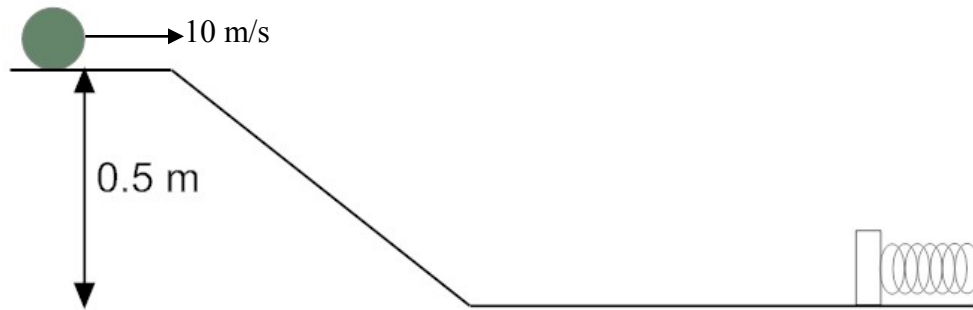
c) Explain what you would do so that you hit the centre of the target.

6. A 0.1 kg ball attached to a string of negligible mass is rotated horizontally in a circle with a radius of 0.5 m. The ball revolves 10 times in 5 seconds.

a) Calculate the centripetal force on the ball.

b) Calculate the force of tension in the string.

7. Consider the following situation:



The ball has an initial velocity of 10 m/s.

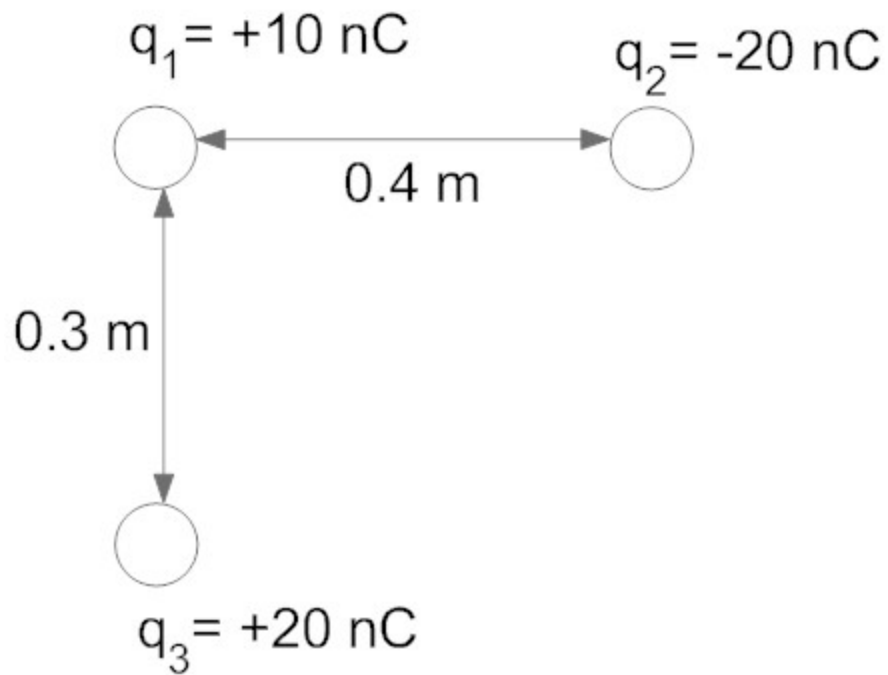
a) Calculate the velocity of the ball at the bottom of the ramp.

b) The ball continues along the flat surface and compresses the spring (spring force constant = 200 N/m) a distance of 20 cm. Calculate the mass of the ball.

c) Describe the energy conversion that occurs when the spring rebounds to its original shape.

## II: Fields

8 Three charges are placed as shown:

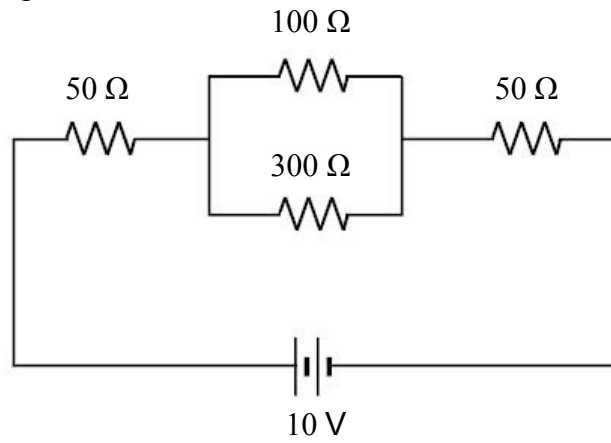


a) Calculate the net electrostatic force on  $q_3$ .



### III: Electricity

9. Consider the following circuit.

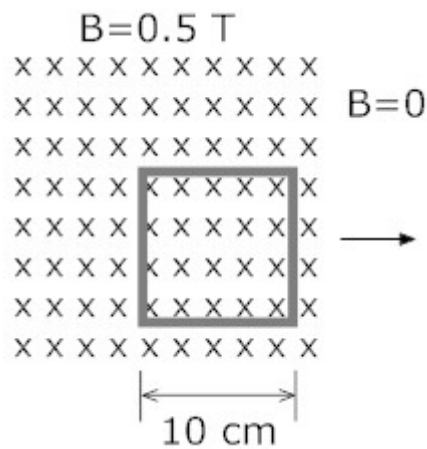


a) Calculate the equivalent resistance of the circuit.

b) Calculate the voltage drop across the 100 Ω resistor.

c) Calculate the current flowing through the 100 Ω resistor.

10. A 10 cm by 10 cm square 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 quickly and uniformly pulled from the field (moving perpendicular to the magnetic field) to a region where the magnetic field drops abruptly to zero. It takes 1 second for the whole coil to reach the field-free region. Calculate the induced EMF.
- c) What is the direction of the induced EMF in the wire as it leaves the field?

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.

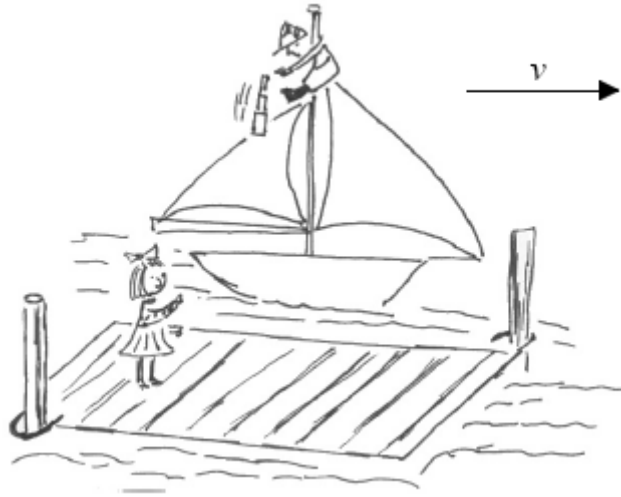
b) Manitoba Hydro transmits the electricity from Northern Manitoba as direct current on two trunk lines. Why is the electricity transmitted as direct current instead of alternating current?

c) Recently Manitoba Hydro decided to build a third trunk line. Discuss the **environmental** and **economic** impacts of building the line referring to the necessity of it and the location.

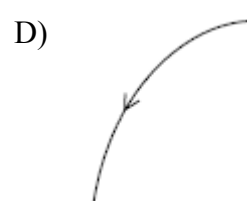
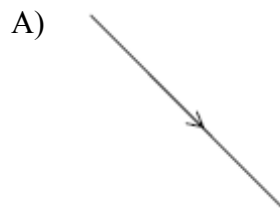
## Sample Multiple Choice Questions

### I: Mechanics

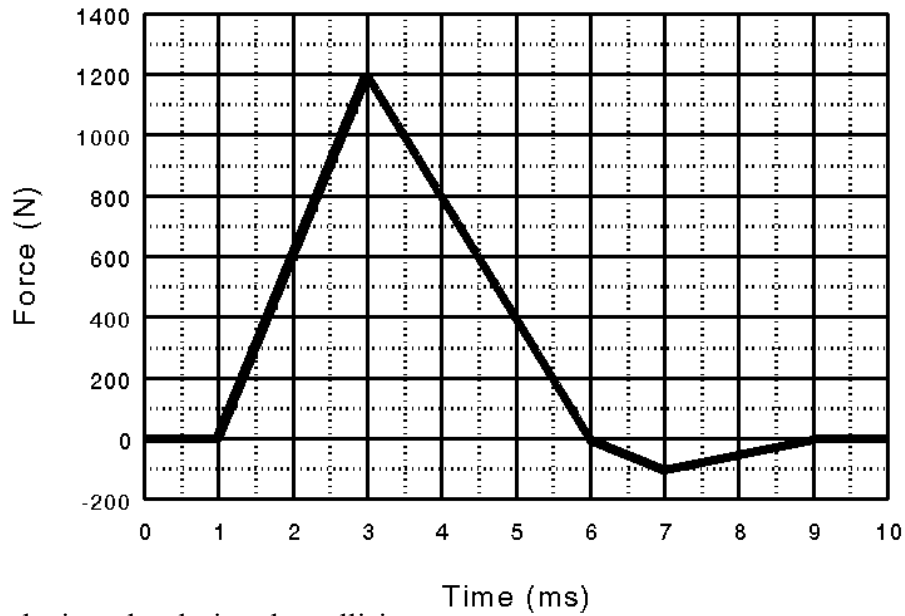
1. A sailing boat is moving with constant velocity  $v$  to the right parallel to the dock.



Captain Jack, up on the mast, drops his telescope at the moment he is opposite Sally who is standing on the dock. Which one of the following **best** shows the path of the falling telescope as seen by Sally?

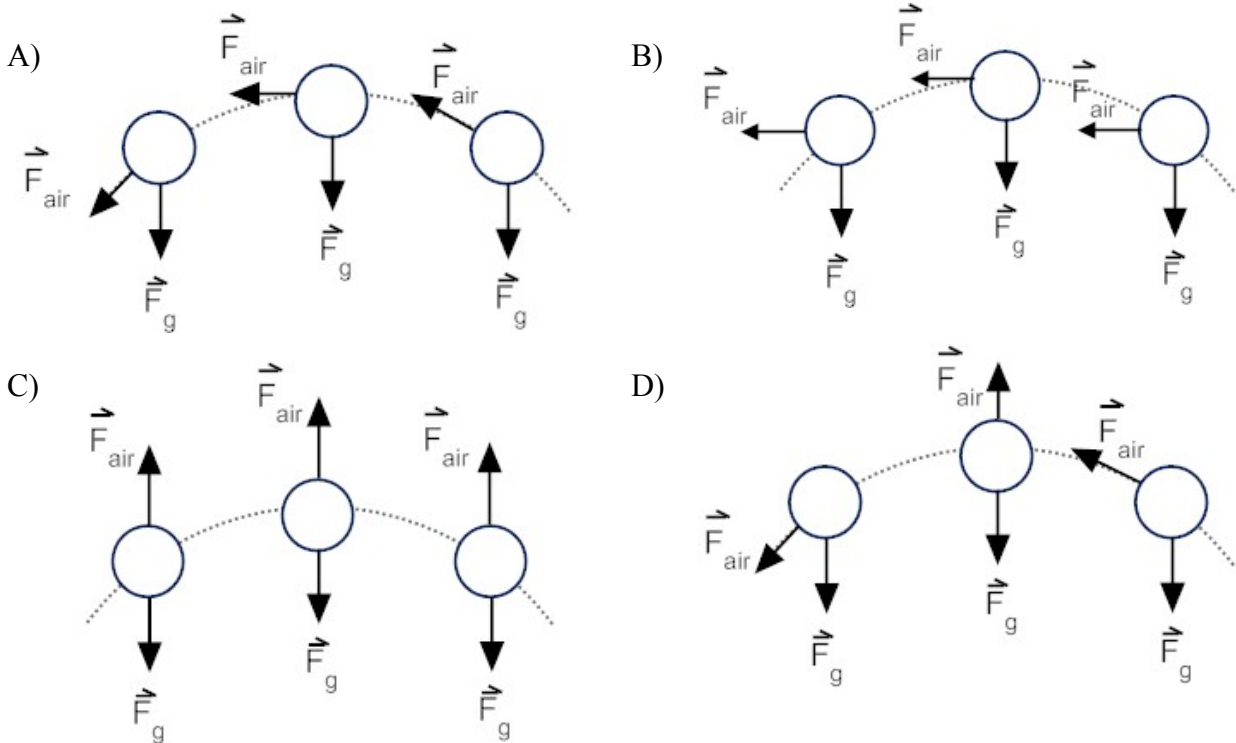


2. A car is crash tested by driving it into a concrete barrier. The crash lasts 9 ms. The force measured during the time of impact is shown in the following graph.



Calculate the impulse during the collision.

- A) 6.3 Ns  
 B) 5.7 Ns  
 C) 3.2 Ns  
 D) 2.9 Ns
3. A pitcher throws a baseball to first base. Which of the following diagrams **best** represents the forces on the ball during the flight?



4. A 1000 kg car is travelling clockwise around a curve with a radius of 50 m at a speed of 25 m/s. What is the magnitude and direction of the centripetal force?

- A) 12 500 N towards the center
- B) 12 500 N away from the center
- C) 12 500 N in the clockwise direction
- D) 12 500 N in the counter-clockwise direction

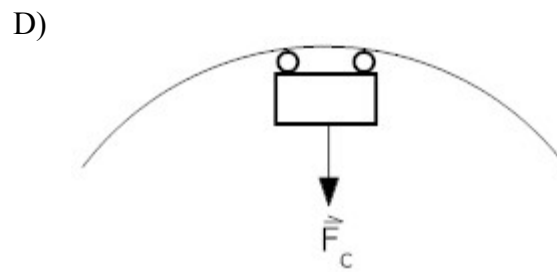
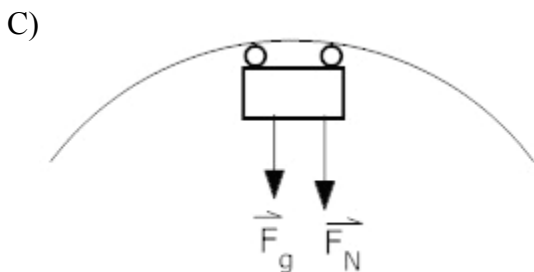
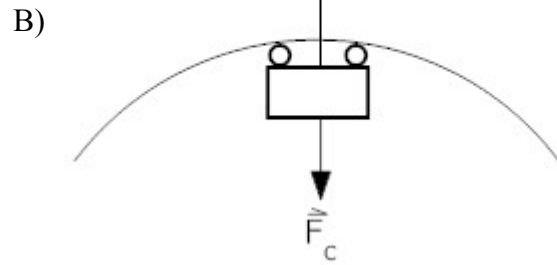
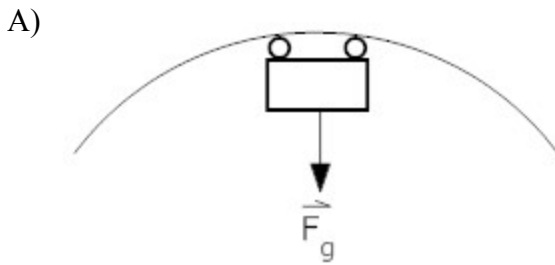
5. Which of the following statements about **centrifugal force** are true?

- I. It is a force exerted on an object moving in a circle
- II. It points towards the center of the circular path.
- III. It points towards the outside of the circular path.

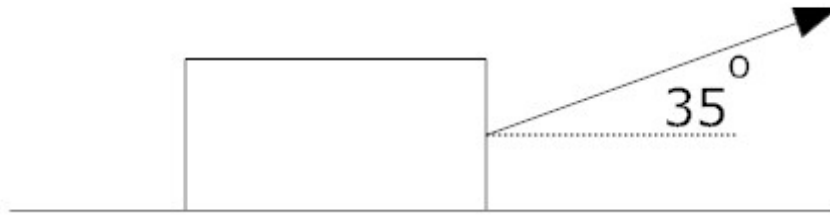
- A) I and II
- B) I and III
- C) I only
- D) None of the statements are true.

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

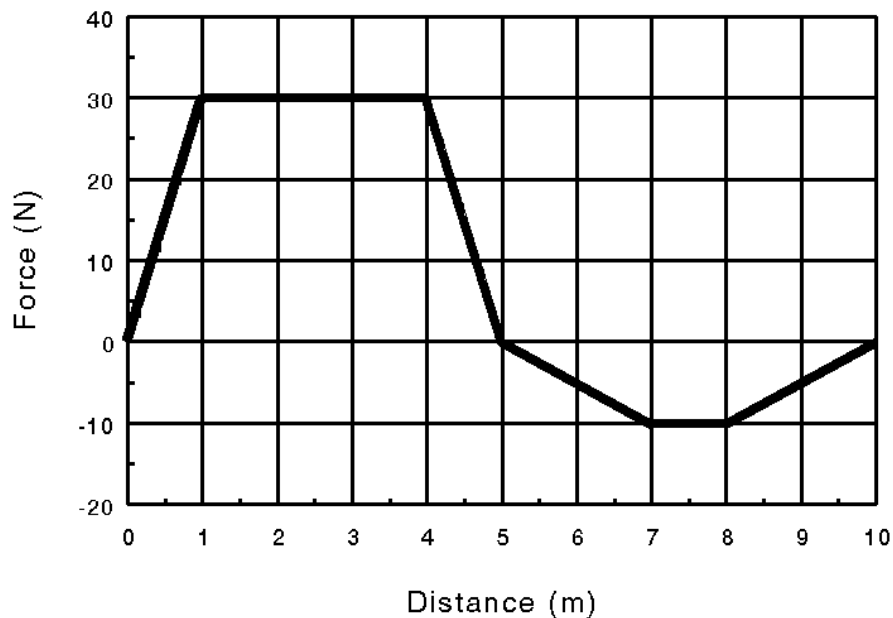


7. A box is pulled with a force of 50 N at an angle of  $35^\circ$  with the horizontal.



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

- A) 290 J  
B) 410 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) 200 J  
B) 150 J  
C) 100 J  
D) 90 J

9. The driver of a 1000 kg car puts on the brakes. The friction in the brakes causes the car to stop in a distance of 10 m. If the car was originally traveling 25 m/s, calculate the work done by friction in stopping the car.
- A)  $3.1 \times 10^5$  J
  - B)  $-3.1 \times 10^5$  J
  - C)  $3.1 \times 10^4$  J
  - D)  $-3.1 \times 10^4$  J
10. Which of the following represents forms of potential energy?
- A) water at the top of a waterfall
  - B) a wound spring in a clock
  - C) a cylinder of compressed propane gas
  - D) all of the above

## II: Fields

11. A satellite revolves around the Earth in a near Earth orbit ( $R_{\text{satellite}} \approx R_{\text{Earth}}$ ). What is the period of revolution of the satellite?
- A)  $5.1 \times 10^3$  s
  - B)  $3.3 \times 10^6$  s
  - C)  $1.6 \times 10^7$  s
  - D)  $1.8 \times 10^{11}$  s
12. A new planet X is discovered to have an average radius of revolution 50 times greater than the radius of revolution of the Earth. What is its period of revolution in Earth years?
- A) 354 years
  - B) 50 years
  - C) 14 years
  - D) 0.003 years
13. Two identical objects are separated by a distance of 0.5 m. If the gravitational force between them is  $6.67 \times 10^{-7}$  N, what is the mass of the objects?
- A) 2500 kg
  - B) 1250 kg
  - C) 71 kg
  - D) 50 kg



14. What is the force of gravity on a 1500 kg satellite orbiting 3000 m above the surface of the Earth?

- A)  $1.5 \times 10^4$  N
- B)  $4.0 \times 10^6$  N
- C)  $6.6 \times 10^{10}$  N
- D)  $9.4 \times 10^{10}$  N

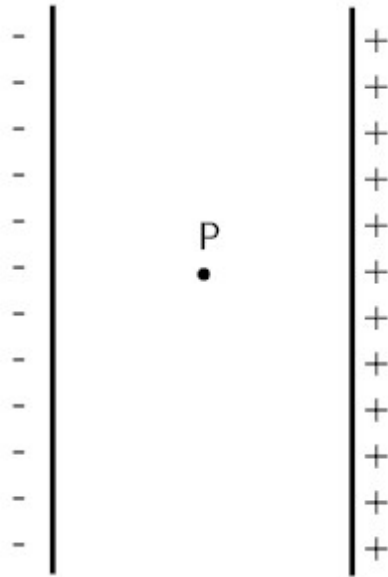
15. A planet has a mass 2 times greater than the mass of Earth and a gravitational field strength 4 times that of Earth. What is the radius of the planet?

- A)  $0.707 R_{\text{earth}}$
- B)  $0.5 R_{\text{earth}}$
- C)  $2 R_{\text{earth}}$
- D)  $4 R_{\text{earth}}$

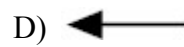
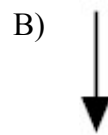
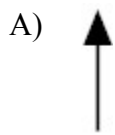
16. What is the gravitational acceleration on the moon?

- A)  $0.12 \text{ m/s}^2$
- B)  $1.62 \text{ m/s}^2$
- C)  $7.67 \times 10^5 \text{ m/s}^2$
- D)  $2.81 \times 10^6 \text{ m/s}^2$

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



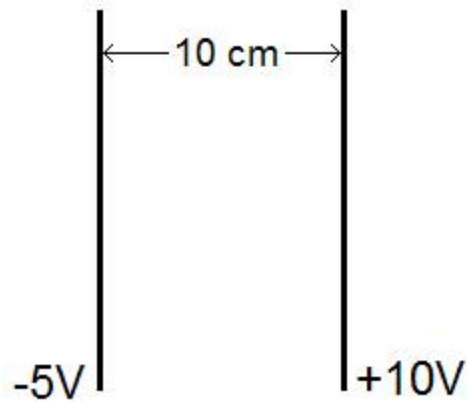
Which vector represents the direction of the electric field at point P?



18. Two parallel plates, 10 cm apart, are charged as shown.

What is the electric field between the plates?

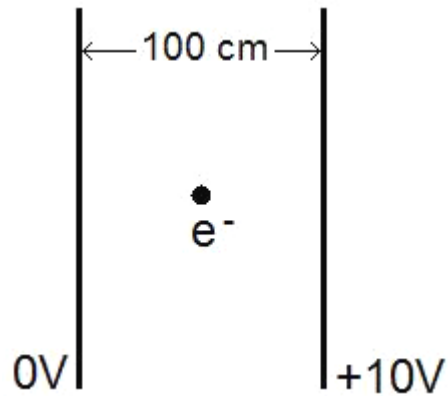
- A) 1.5 V/m
- B) 50 V/m
- C) 100 V/m
- D) 150 V/m



19. An electron is placed between two charged parallel plates as shown.

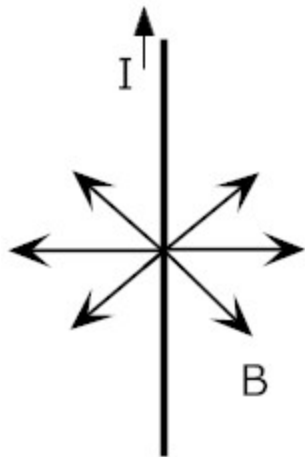
What is the electrical force acting on the electron?

- A)  $1.6 \times 10^{-18} \text{ m/s}^2$  to the right
- B)  $1.6 \times 10^{-18} \text{ m/s}^2$  to the left
- C)  $1.6 \times 10^{-20} \text{ m/s}^2$  to the right
- D)  $1.6 \times 10^{-20} \text{ m/s}^2$  to the left

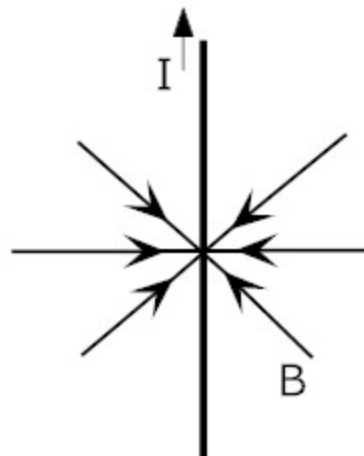


20. Which of the following diagrams represents the direction of the magnetic field around the wire?

A)



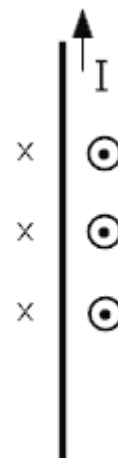
B)



C)



D)



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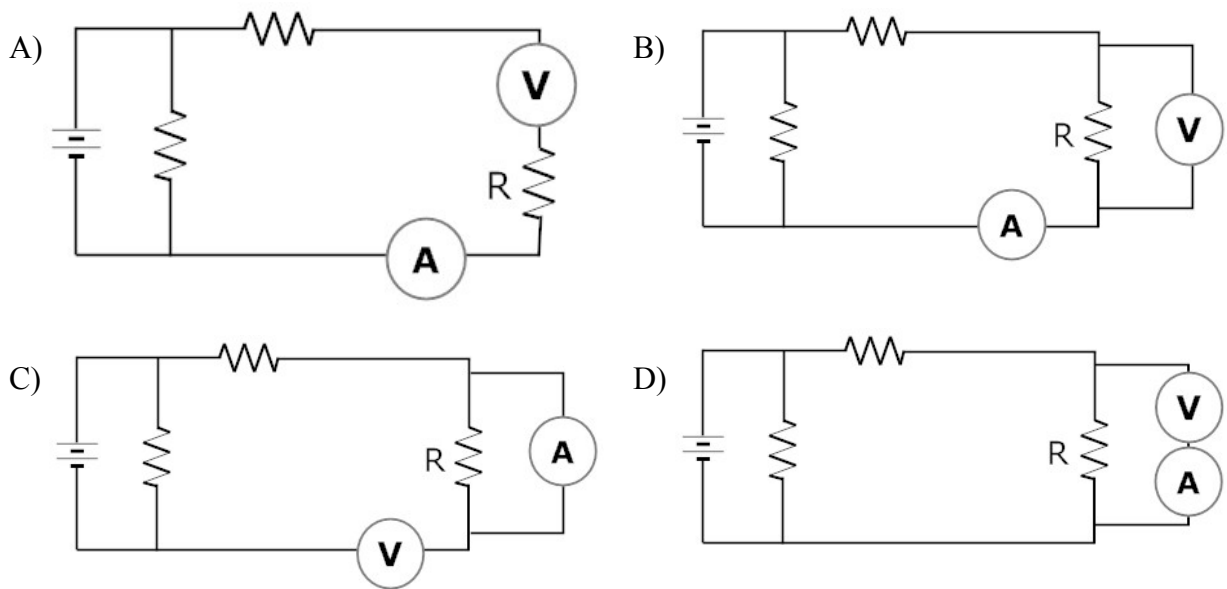
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### III: Electricity

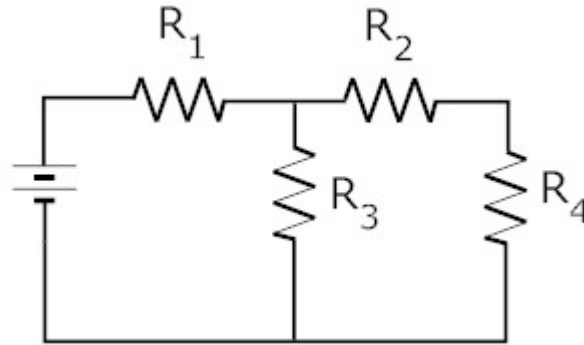
21. A wire with resistivity  $\rho$ , length  $L$ , and cross-sectional area  $A$  has a resistance  $R$ . A second wire with identical resistivity has a length  $2L$  and cross-sectional area  $0.5A$ . What is the resistance of the second wire?

- A)  $0.5R$
- B)  $R$
- C)  $2R$
- D)  $4R$

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



23. Consider the following circuit diagram.

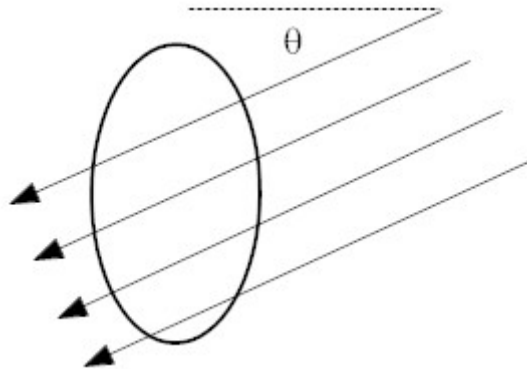


Which of the following statements regarding the circuit is/are **true**?

- I. Resistors  $R_2$  and  $R_4$  are in series.
- II. Resistors  $R_3$  and  $R_4$  are in parallel.
- III. Resistor  $R_3$  is in parallel with  $R_2 + R_4$

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

24. A magnetic force of  $1.5 \times 10^{-5}$  T passes through a circular coil of radius 20 cm as shown.



What is the magnetic flux density passing through the coil when  $\theta = 35^\circ$ ?

- A)  $1.5 \times 10^{-6}$  Wb
- B)  $1.9 \times 10^{-6}$  Wb
- C)  $2.5 \times 10^{-6}$  Wb
- D)  $3.0 \times 10^{-6}$  Wb

25. Which of the following statements about transformers are **true**?
- I. They are a practical application of electromagnetic induction.
  - 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. If the number of secondary turns on a transformer is doubled, what will happen to the current output of the secondary coil?
- A) It will increase by a factor of 4.  
B) It will increase by a factor of 2.  
C) It will decrease by half.  
D) It will be the same.
27. A transformer has an input voltage of 120 V and an output voltage of 6 V. If the transformer has 5000 primary coil turns, how many turns are on the secondary coil?
- A) 250  
B) 500  
C) 2500  
D) 5000

#### IV: Medical Physics

28. Atoms of the same element with the same atomic number but different mass number are known as
- A) isotopes.  
B) ions.  
C) allotropes.  
D) beta particles.
29. Uranium-235 has an atomic number of 92. How many protons and neutrons does an atom of Uranium-235 have?
- |    | Number of Protons | Number of Neutrons |
|----|-------------------|--------------------|
| A) | 235               | 92                 |
| B) | 143               | 92                 |
| C) | 92                | 143                |
| D) | 92                | 235                |

30. Iodine-131 has a half-life of about 8 days. How much of a 200 g sample would be left after 32 days?
- A) 100 g
  - B) 50 g
  - C) 25 g
  - D) 12.5 g
31. The decay process that releases an electron from the nucleus is known as
- A) alpha decay.
  - B) beta decay.
  - C) gamma decay.
  - D) electromagnetic decay.
32. Which of the following **best** describes ionizing radiation?
- A) The particles are ions.
  - B) The particles have enough energy to ionize other atoms.
  - C) The particles only interact with ions.
  - D) The particles combine with ions in matter creating new compounds.
33. Which of the following is an example of non-ionizing radiation?
- A) alpha particles
  - B) beta particles
  - C) gamma rays
  - D) none of the above
34. Cellular phones have the potential to be dangerous because they emit radiation. What type of radiation is emitted by a cellular phone?
- A) microwave radiation, which is ionizing
  - B) microwave radiation, which is non-ionizing
  - C) gamma rays, which are ionizing
  - D) gamma rays, which are non-ionizing
35. Which of the following is an application of ionizing radiation?
- A) irradiation of food
  - B) smoke detectors
  - C) cancer treatment
  - D) all of the above