Grade 11 Physics (30S)

Midterm Practice Exam

Answer Key

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Instructions

The final exam will be weighted as follows:

Modules 1–6	100%

The format of the examination will be as follows:

Part A: Multiple Choice	40 x 1 = 40 marks
Part B: Fill-in-the-Blanks	12 x 0.5 = 6 marks
Part C: Short Explanations and Diagrams	5 x 3 = 15 marks
Part D: Problems	39 marks

The following instructions are meant to assist you when you are writing your midterm examination. Please note the following instructions:

- Show your work for the problems.
- Include directions with all vector answers.
- Round off answers to the correct number of significant digits.

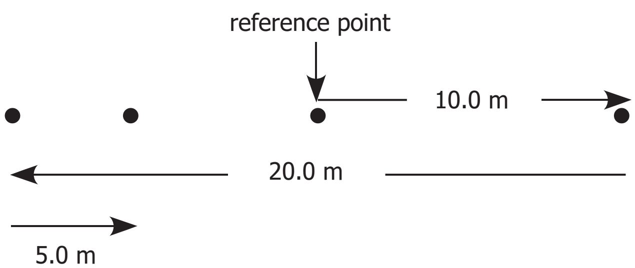
Part A: Multiple Choice (40 x 1 = 40 Marks)

Circle the letter of the choice that best completes each statement.

1. Those two quantities that are vectors are
   a) distance and position
   b) position and displacement
   c) displacement and speed
   d) speed and velocity

Answer (b)
Outcome S3P.3.01

2. An object moves to the right 10.0 m from the starting point in a time of 1.0 s, then to the left 20.0 m in a time of 3.0 s, and then to the right 5.0 m in a time of 1.0 s. The diagram below represents this motion.

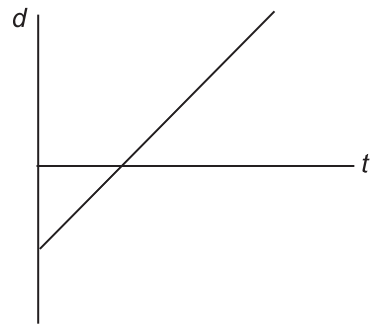


The average velocity of the object over the whole time interval is best written as
   a) –1.0 m/s
   b) 0.8 m/s
   c) 1.2 m/s
   d) 7.0 m/s

Answer (a)
Outcome S3P-3-01

3. Of the position-time graphs below, the one that shows the highest speed in the negative direction is

a)



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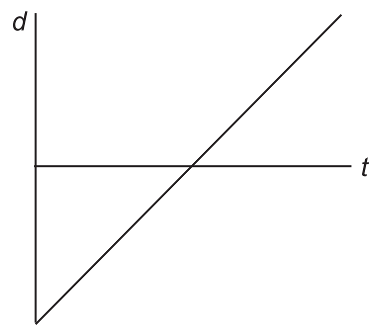
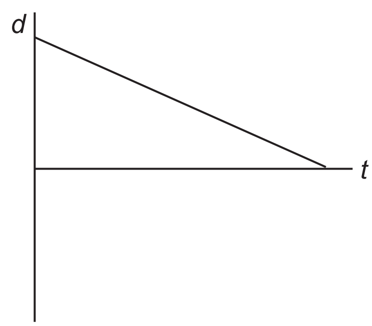
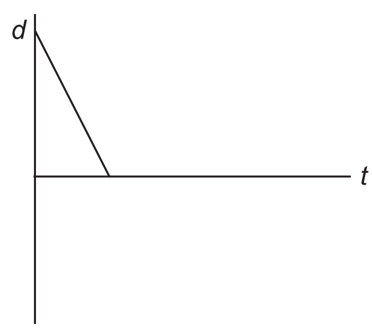


c)

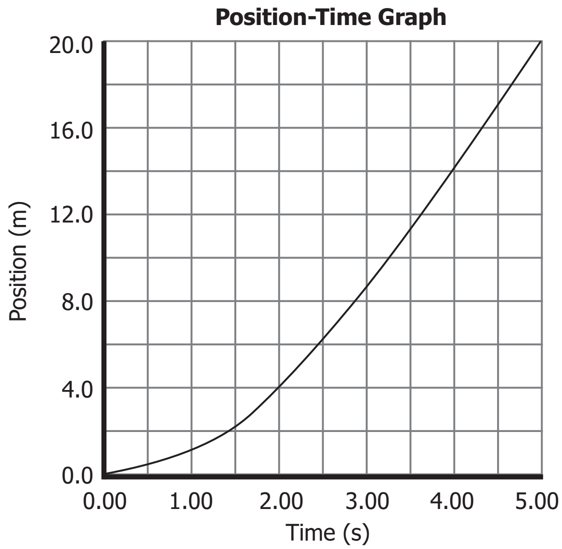


d)

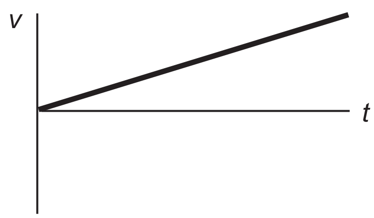


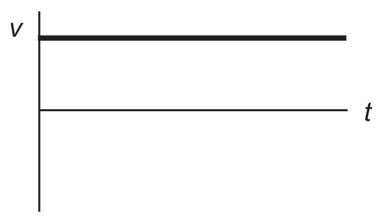
Answer (d)
Outcome S3P-3-04

4. The following is a position-time graph.

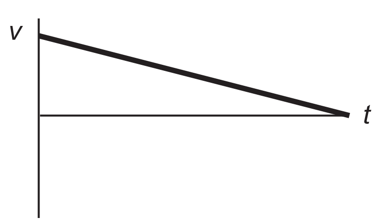


The shape of the velocity-time graph that would best correspond with this position-time graph is

a) 

b) 

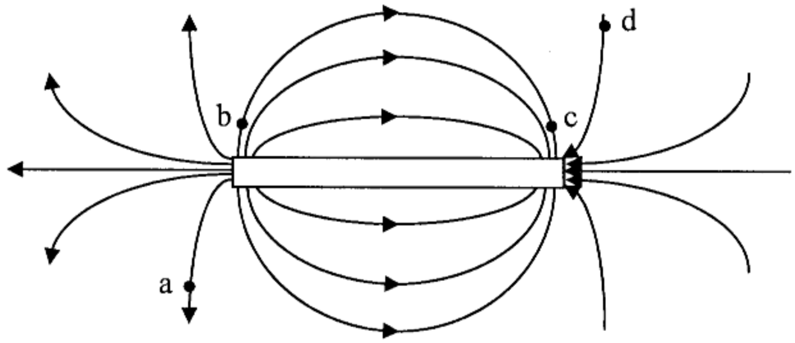
c) 

d) 

Answer (a)

Outcome S3P-3-04

5. The following diagram shows a possible magnetic field line pattern between two poles of a bar magnet. Four positions *a*, *b*, *c*, and *d*, are indicated on the diagram.



The positions that would most show the magnetic field vector pointing in the same direction are

a) *a* and *b*
b) *a* and *d*
c) *b* and *c*
d) *b* and *d*

Answer (b)
Outcome S3P-4-17

6. The term "uniform motion" means

a) acceleration is constant
b) speed is constant
c) velocity is constant
d) displacement is constant

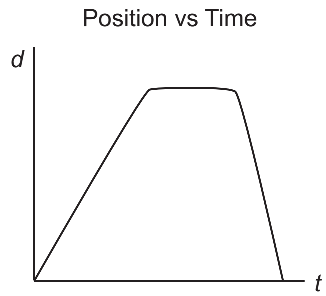
Answer (c)
Outcome S3P-3-04

7. The magnetic pole found in the northern hemisphere of our earth acts like the

a) north pole of a bar magnet and the north pole of a compass needle would point towards it
b) north pole of a bar magnet and the south pole of a compass needle would point towards it
c) south pole of a bar magnet and the north pole of a compass needle would point towards it
d) south pole of a bar magnet and the south pole of a compass needle would point towards it

Answer (c)
Outcome S3P-4-20

8. Study the position-time graph pictured below and select the statement that is true.



a) The object's speed is greatest during the last segment.
b) The object's acceleration is greatest during the last segment.
c) The object's average acceleration is zero.
d) The object travels a greater distance in the first segment than in the last segment.

Answer (a)
Outcome S3P-3-04

9. Contact forces such as the force of friction and the force of a glove on a punching bag are examples of
   a) gravitational force
   b) electromagnetic force
   c) strong nuclear force
   d) weak nuclear force

Answer (b)
Outcome S3P-3-08

10. If an object is already moving and the sum of all the vector forces on a mass is zero, then the object will
    a) move at a constant speed in a straight line
    b) accelerate at a constant rate in a straight line
    c) come to rest
    d) increase its amount of inertia

Answer (a)
Outcome S3P-3-11

11. A net force acts on a mass of 8.00 kg causing it to move from rest to a speed of 10.0 m/s in a time of 5.00 s. The net force must have a magnitude of
    a) 8.00 N
    b) 16.0 N
    c) 40.0 N
    d) 80.0 N

Answer (b)
Outcome S3P-3-13

12. Two forces are acting on a mass of 20.0 kg. One force is to the right at 400.0 N while the other force is to the left at a magnitude of 600.0 N. The acceleration of the wagon is

a) -50.0 m/s^2

b) -10.0 m/s^2

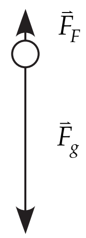
c) 10.0 m/s^2

d) 50.0 m/s^2

Answer (b)
Outcome S3P-3-11

13. A free-body diagram for a ball in free fall in a vacuum is

a)



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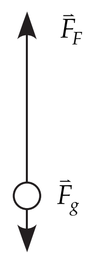

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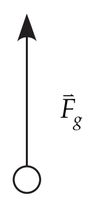
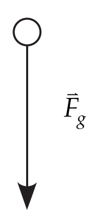


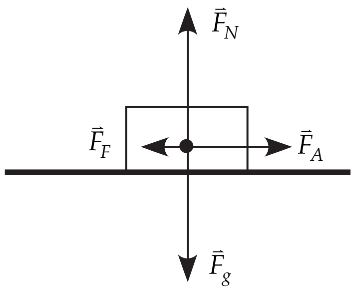
d)



Answer (d)
Outcome S3P-3-12

14. An object is being pulled to the right. The object is accelerating to the right, and friction is present. The correct free-body diagram for this situation is

a)



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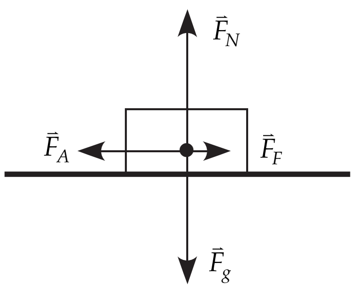

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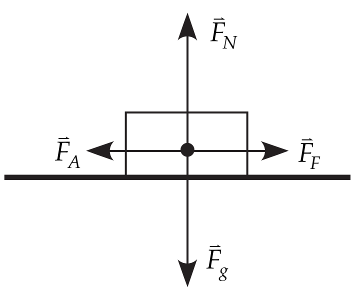
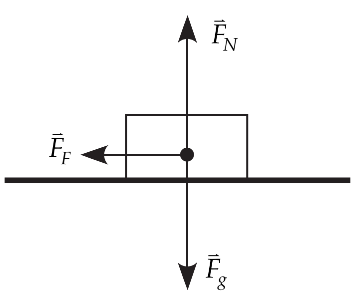


d)

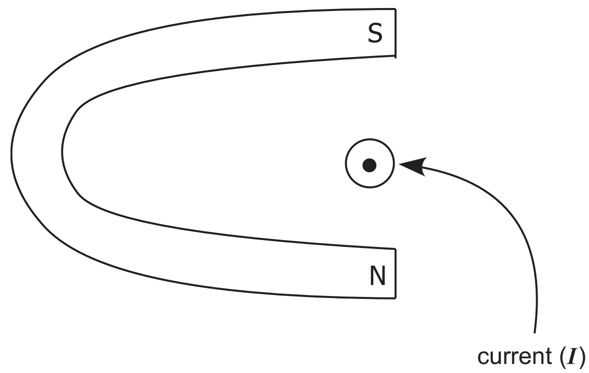


Answer (a)
Outcome S3P-3-12

15. Which of the following fundamental forces is the strongest?
   a) strong nuclear
   b) electrostatic
   c) weak nuclear
   d) They are equally strong.

Answer (a)
Outcome S3P-3-08

16. The diagram below shows a horseshoe magnet with the north pole and south pole as indicated. A wire is placed between the poles and the current moves as shown.



The direction of the force on the wire is

a) up out of the page
b) down into the page
c) towards the interior of the magnet (west)
d) towards the outside of the magnet (east)

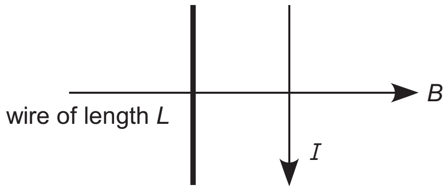
Answer (c)
Outcome S3P-3-08

17. The gravitational field can be defined as the

a) region of space around a mass where another mass experiences a force
b) acceleration due to gravity which is equal to approximately 9.80 m/s^2 for our Earth
c) force divided by the mass for an object in free fall
d) the amount of the contact force between a mass at rest on the surface of the Earth and the Earth

Answer (a)
Outcome S3P-4-01

18. A straight wire has a current of 2.0 A passing through it. The wire is 10.0 cm long. The wire, which is oriented so that it is perpendicular to a magnetic field, is 5.0 T.



The magnitude of the force on the wire is

a) 0.0 N
b) 1.0 N
c) 1.0×10^1 N — **Answer (b)**
d) 1.0×10^2 N — Outcome S3P-4-28

19. The value of the acceleration due to gravity, $\vec{g}$, can be determined experimentally by recording and analyzing the time and position of a ball while it is

a) rolling freely across a horizontal table
b) pulled across a horizontal table by a constant force
c) dropped in free fall — **Answer (c)**
d) pushed upwards by a constant force — Outcome S3P-4-07

20. When an object has reached terminal velocity, the shape of the line in a velocity-time graph is

a) horizontal
b) straight and oblique with a positive slope
c) straight and oblique with a negative slope — **Answer (a)**
d) curving upwards — Outcome S3P-4-09

21. The coefficient of friction can be defined as the ratio of the

a) force of gravity over the force of friction
b) force of friction over the normal force
c) normal force over the force of gravity — **Answer (b)**
d) force of gravity over the applied force — Outcome S3P-4-10

22. How much would a 60.0 kg person weigh on the moon where the gravitational field strength has a magnitude of 1.60 N/kg?
    a) 60.0 kg
    b) 96.0 N
    c) 98.0 kg
    d) 98.0 N

Answer (b).0
Outcome S3P-4-04

23. Two magnetic fields are acting on a 2.0 m long wire carrying a current of 8.0 A to the east. One of the magnetic fields is acting vertically downward into the paper. It has a magnitude of 5.0×10^{-5} T. A second magnetic field is acting at 4.0×10^{-5} T to the south. The magnitude of the net force on the wire is
    a) 1.0×10^{-6} N
    b) 4.8×10^{-4} N
    c) 1.0×10^{-3} N
    d) 3.8×10^{-2} N

Answer (c)
Outcome S3P-4-28, S3P-2h

24. Objects onboard an orbiting space station appear to be "floating" because
    a) they're in the vacuum of space
    b) they're weightless
    c) they're outside Earth's gravitational pull
    d) they're falling together with the space station

Answer (d)
Outcome S3P-4-05

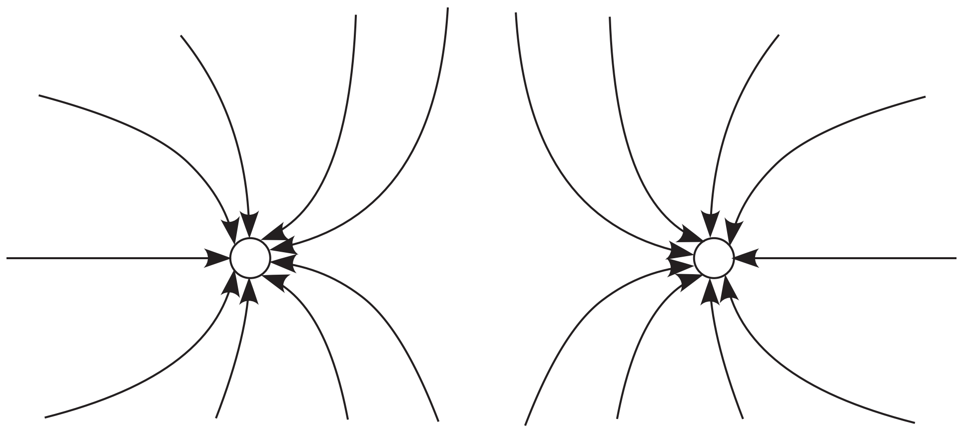
25. If a positive charge A is twice as large as a positive charge B, we could show this by drawing
    a) the field lines in the opposite direction for one of the charges
    b) the same number of field lines as B but shorter
    c) twice as many field lines for charge A
    d) half as many field lines for charge A

Answer (c)
Outcome S3P-4-15

26. If we were to compare the field lines for the gravitational situation to the electric situation, we would find that the electric field line pattern that is identical to the gravitational pattern around the Earth occurs when there is
    a) a neutral charge
    b) a combination of positive and negative charges
    c) one positive charge
    d) one negative charge

Answer (d)
Outcome S3P-4-15

27. The diagram below shows an electric field line pattern for two charges.



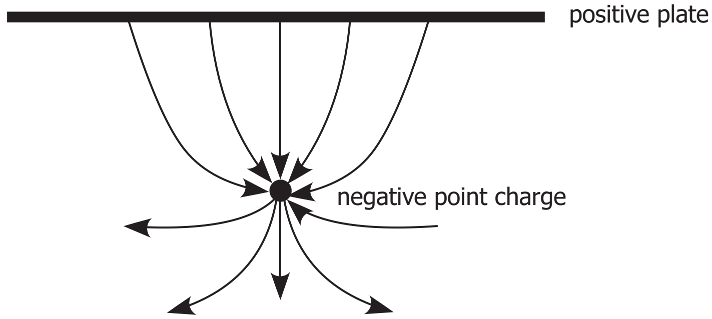
This is an electric field line pattern for two

a) negative charges
b) positive charges
c) neutral charges
d) opposite charges

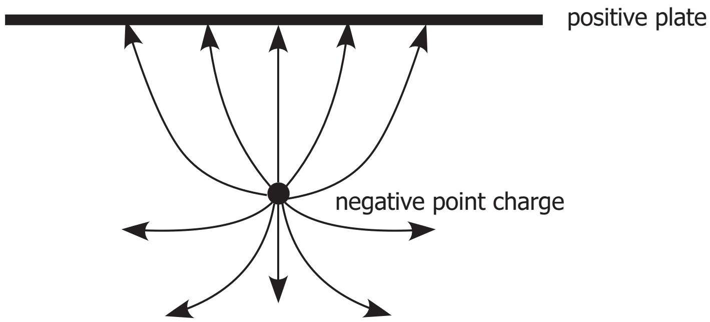
Answer (a)
Outcome S3P-4-15

28. The diagrams below show a positively charged plate and a negative point charge. The electric field line pattern for this situation is best shown by

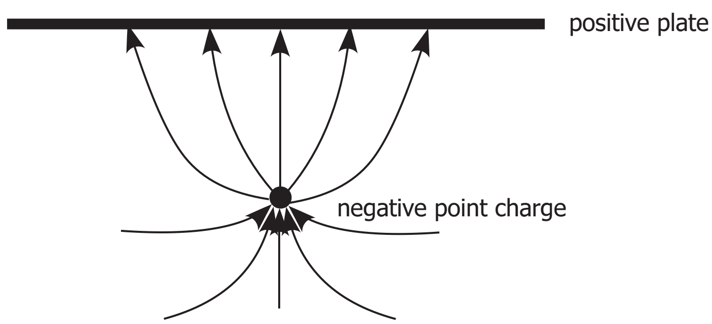
a)



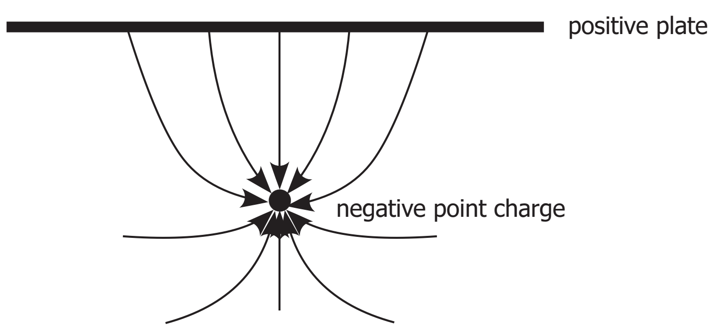
b)



c)



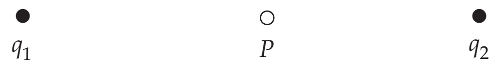
d)



Answer (d)

Outcome S3P-4-15

29. The negative charge, $-q_1$, to the left of point P, creates an electric field, $\vec{E}_1$, of magnitude 10.0 N/C at position P. The positive charge to the right of point P, q_2, creates an electric field, $\vec{E}_2$, of magnitude 25.0 N/C at position P.

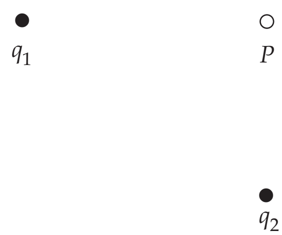


The directions of the electric fields at position P are

a) both to the west
b) both to the east
c) $\vec{E}_1$ to the east and $\vec{E}_2$ to the west
d) $\vec{E}_1$ to the west and $\vec{E}_2$ to the east

Answer (a)
Outcome S3P-4-16

30. The negative charge, $-q_1$, to the west of point P, creates an electric field, $\vec{E}_1$, of magnitude 10.0 N/C at position P. The positive charge, q_2, to the south of point P, creates an electric field, $\vec{E}_2$, of magnitude 25.0 N/C at position P.



The direction of the total electric field at position P is

a) 68.2° S of W
b) 68.2° N of W
c) 21.8° S of W
d) 21.8° N of W

Answer (b)
Outcome S3P-4-16, S3P-0-2h

31. In a Millikan apparatus, a sphere of mass 4.0×10^{-15} kg is stationary in an electric field whose intensity is 2.00×10^4 N/C. The top plate is positive. The magnitude of the charge on the sphere must be

a) 2.0×10^{-18} C
b) 1.3×10^4 C
c) 5.1×10^{17} C
d) 3.2×10^{36} C

Answer (a)
Outcome S3P-4-18

32. A ferromagnetic material is placed in a strong magnetic field that points from the left to the right.

The domains in the material point

a) in the up direction
b) in the down direction
c) to the right
d) to the left

Answer (c)
Outcome S3P-4-19

33. State the number of significant digits in 0.0089076500

a) 8
b) 9
c) 10
d) 11

Answer (a)
Outcome S3P-0-2d

34. The correct answer for the product of 6.9530 x 0.07843 is

a) 0.5453
b) 0.54532
c) 0.545323
d) 0.5453238

Answer (a)
Outcome S3P-0-2d

35. The correct answer for the sum of 18.3 + 6.92 + 2.0084 is

a) 27.2282
b) 27.22
c) 27.2
d) 27.228

Answer (c)
Outcome S3P-0-2d

36. Which of the following is NOT a mode of representation used in physics?

a) visual mode
b) graphical mode
c) diagram mode
d) symbolic mode

Answer (c)
Outcome S3P-2-02

37. The slope of a chord on a position-time graph represents which of the following quantities?
  a) average acceleration
  b) average velocity
  c) average displacement
  d) average distance

Answer (b)
Outcome S3P-3-05

38. Which of the following is not a characteristic of the components of a vector?
  a) The components are parallel to each other.
  b) The components add to give the vector.
  c) The components are independent of each other.
  d) The magnitudes of the components can be added using the Theorem of Pythagoras.

Answer (a)
Outcome S3P-0-2h

39. What is the displacement of a cyclist who starts at highway marker +3 km and ends at marker –7 km? Consider positive numbers as representing positions east of the centre of town.
  a) l0 km [W]
  b) 10 km [E]
  c) 4 km [W]
  d) 4 km [E]

Answer (a)
Outcome S3P-3-02

40. What is the magnitude of the net force acting on an object if the following forces are each pulling horizontally on the object: force one = 5.2 N [E] and force two = 6.8 N [S]?
  a) 12.0 N
  b) 1.6 N
  c) 8.6 N
  d) 73 N

Answer (c)
Outcomes S3P-0-2h, S3P-3-12

Part B: Fill-in-the-Blanks (12 x 0.5 = 6 Marks)

Using a term from the word bank provided below, complete each of the following statements. Some of the terms will not be used and some of the terms may be used more than once.

distance	inertia	positive
balanced	mass	resultant
chord	negative	tangent
external	normal	velocity
free fall	position	weight
gravitational field intensity		

1. The ***gravitational field intensity*** is the quotient of the gravitational force and the magnitude of the test mass at a given point in the field.
2. Any force exerted by an object that is not part of the system on an object within the system is known as a(n) ***external force***.
3. ***Mass*** is amount of matter present in an object.
4. The length of a path travelled by an object is called the ***distance***.
5. The ***resultant*** is the vector representing the sum of two or more vectors.
6. The rate of change of position is known as ***velocity***.
7. The ***normal*** force is a force that acts in a direction perpendicular to the common contact surface between two objects.
8. The location of an object as measured from the origin of a frame of reference is known as ***position***.
9. The tendency of an object to resist changes in its state of motion is called ***inertia***.
10. The direction of the electric field at a given point in space is determined by the direction of the electric force acting on a charge with a ***positive*** sign.
11. A(n) ***tangent*** is a line that intersects a curve at only one particular point.
12. ***Free fall*** describes the situation in which the only force acting on an object is the force of gravity.

Part C: Short Explanations and Diagrams (5 x 3 = 15 Marks)

Answer any five (5) of the following questions. Be sure to indicate clearly which five questions are to be marked.

Outcome S3P-3-01

1. Distinguish between vectors and scalars. Give an example of each.

   Answer:

   The scalar is a quantity with magnitude only. An example would be a time interval (5 s). The vector is a quantity with magnitude and direction. An example would be displacement or velocity (5 m/s [east]).

Outcome S3P-3-04

2. Indicate whether you would use slope or area to convert between the following graphs:
   a) velocity to position
   b) velocity to acceleration
   c) position to velocity

   Answer:

   a) uses area
   b) uses slope
   c) uses slope

Outcome S3P-3-13

3. Using Newton's Laws of Motion, explain the following:
   a) A child is sitting on a motionless toboggan. The rope of the toboggan is given a sharp tug forward. The child falls off the back of the toboggan.

      Answer:

      The child sitting at rest has inertia of rest. This is Newton's First Law: Objects at rest remain at rest. The toboggan is pulled out from under the child by the force. This is Newton's Second Law: An object accelerates in the direction of the unbalanced force.

   b) A person kicks a football. The person breaks his toe while kicking the ball.

      Answer:

      This is Newton's Third Law: For every action force, there is an equal but opposite reaction force. The action force is the foot kicking the ball. The reaction force is exerted by the ball on the foot. This force breaks the toe.

Outcome S3P-1-21

4. Using the Domain Theory of Magnetism, explain the following.

   a) When placed in a strong magnetic field, a bar of iron becomes a bar magnet. When the field is removed, the piece of iron is no longer a bar magnet.

   Answer:

   When the bar of iron is placed in a strong magnetic field, the magnetic domains within the piece of iron align themselves with the magnetic field. The bar of iron then acts like a bar magnet. When the magnetic field is removed, the magnetic domains return to their original random arrangement. The piece of iron is no longer a bar magnet.

   b) Over a period of years, the steel girders in a building become magnetized.

   Answer:

   Over a period of years, the magnetic domains within the steel girders align themselves with the Earth's magnetic field, thus becoming magnetized.

Outcome S3P-4-03

5. Describe two methods of measuring the gravitational field at the Earth's surface.

   Answer:

   The first method involves using a scale to find the weight of an object of known mass. Then the gravitational field is calculated as the ratio of the force of gravity over the mass.

   The second method involves allowing a dense, heavy object to fall freely. The acceleration of this object is measured and equals the gravitational field at that point.

Outcome S3P-4-05

6. An astronaut circling the Earth in a space shuttle at an altitude of 400 km is weightless. Do you agree or disagree with this statement? Justify your choice.

   Answer:

   This astronaut is not truly weightless but only apparently weightless. To be truly weightless, the gravitational field at that point must be 0 N/kg. At 400 km altitude, the gravitational field is still quite large so the astronaut still has weight. He appears to be weightless because he is really falling along with his surroundings.

Outcome S3P-4-15

7. Give three bits of information given by a pattern of electric force field lines.

   Answer:

   The pattern of force field lines has the lines closer together where the force field is stronger.

   The direction of the field at any point points in a direction that is tangent to the force field line.

   Electric force field lines begin on negative charge and end on positive charge.

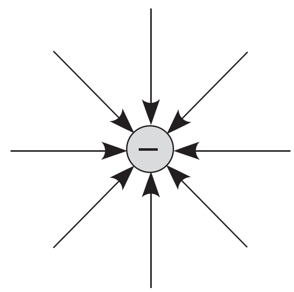
   Electric field lines meet the surface of a conductor at a 90° angle.

Outcome S3P-4-15

8. Draw the electric field around

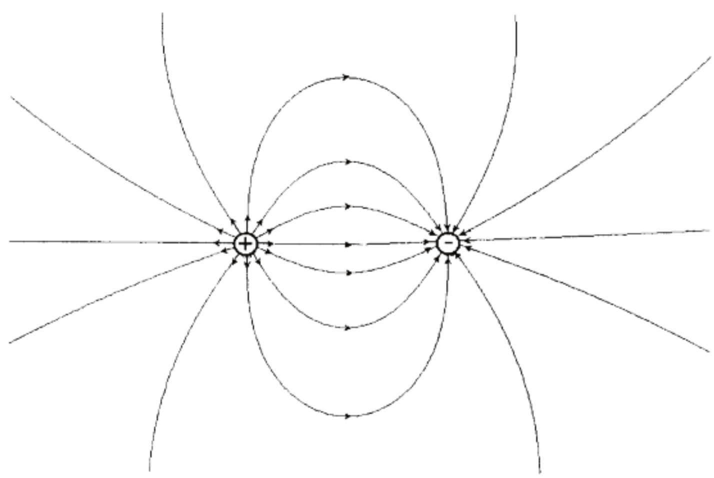
   a) a negative point charge. *(1 mark)*

   Answer:



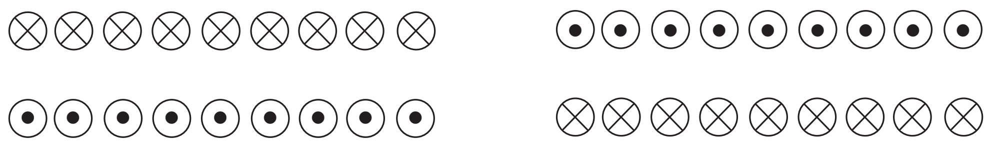
   b) a dipole made of a positive point charge and a negative point charge. *(2 marks)*

   Answer:



Outcome S3P-4-27

9. Will the two solenoids given below attract each other or repel each other? Explain your answer.



Answer:

The solenoid on the left will have the north end of the phantom bar magnet on the left and the south pole on the right (near the centre).

The solenoid on the right will have the south end of the phantom magnet on the left side (near the centre).

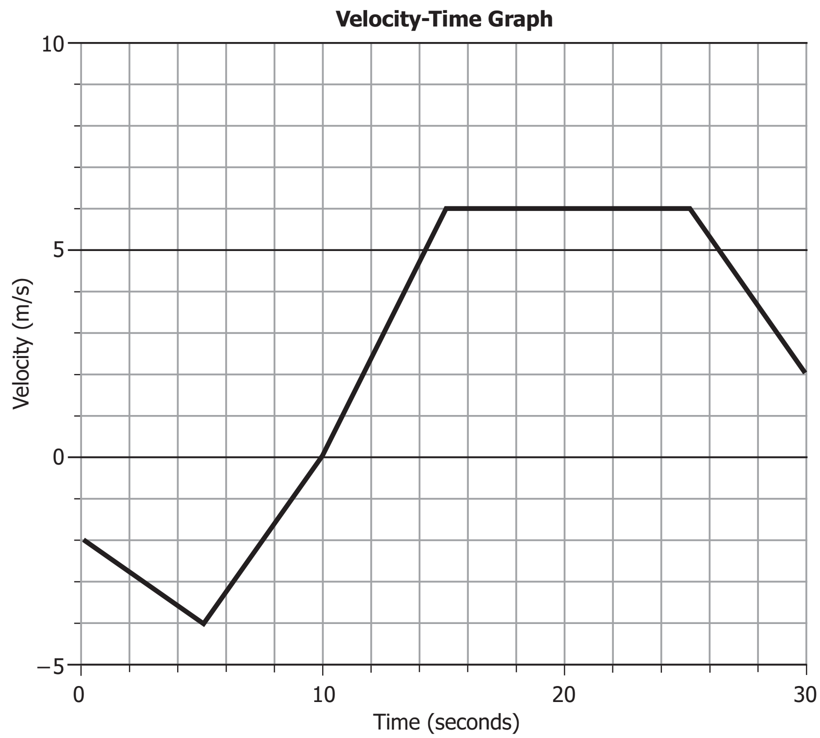
Since the two south poles are closest together, the solenoids will repel each other.

Part D: Problems (39 Marks)

Answer Question 1 plus any five (5) other problems.

Outcome S3P-3-04, S3P-3-05

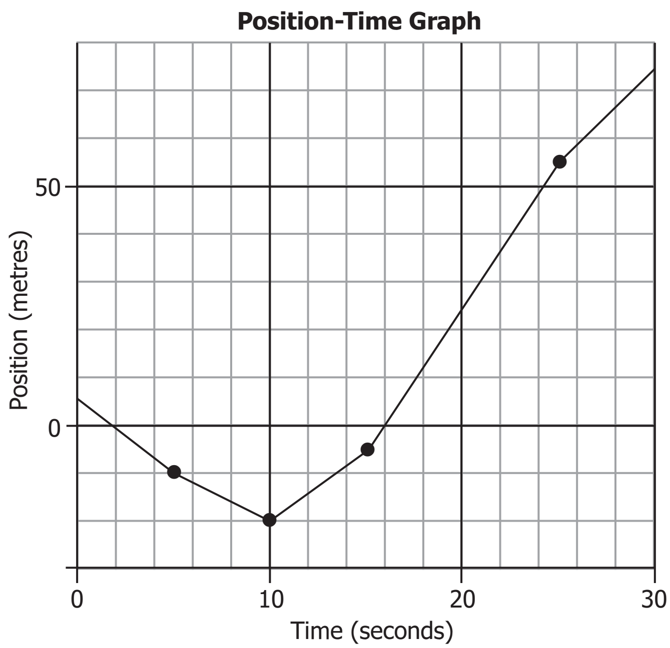
1. Use the velocity-time graph below to answer the questions that follow.



a) Fill in the table for position-time data, assuming the object starts at +5.0 m. Graph these data on a sheet of graph paper. *(5 + 2 marks)*

Answer:

Time Interval (seconds)	Displacement (m) Find area	Position at End of the Interval (m) $Pos_2 = Pos_1 + \vec{d}$
0		+5.0
0 – 5	$\frac{1}{2}(a + b)h$ = $\frac{1}{2}(-2 + (-4))(5) = -15$	(+5.0) + (–15) = –10
5–10	$\frac{1}{2}bh = \frac{1}{2}(5)(-4) = -10$	(–10) + (–10) = –20
10–15	$\frac{1}{2}bh = \frac{1}{2}(5)(+6) = +15$	(–20) + (+15) = –5
15 – 25	$lw = (10)(+6) = +60$	(–5) + (+60) = +55
25–30	$\frac{1}{2}(a + b)h$ = $\frac{1}{2}(+6 - (+2))(5) = +20$	(+55) + (+20) = +75



b) Calculate the average velocity. *(1 mark)*

Answer:

The average velocity is the slope of the chord on a position-time graph joining the initial position (0 s, 5 m) to the final position (30 s, 75 m).

$$\vec{v}_{\text{avg}} = \frac{\text{rise}}{\text{run}} = \frac{75\text{ m} - 5\text{ m}}{30\text{ s} - 0\text{ s}} = \frac{70\text{ m}}{30\text{ s}} = +2.3\text{ m/s}$$

c) Calculate the average acceleration. *(1 mark)*

Answer:

The average acceleration is the slope of the chord on a velocity-time graph joining the initial velocity (0 s, –2 m/s) to the final position (30 s, +2 m/s).

$$\vec{a}_{\text{avg}} = \frac{\text{rise}}{\text{run}} = \frac{+2\text{ m/s} - (-2\text{ m/s})}{30\text{ s} - 0\text{ s}} = \frac{+4\text{ m/s}}{30\text{ s}} = +0.13\text{ m/s}^2$$

Answer any five (5) of the remaining questions. Be sure to indicate clearly which questions you are submitting for evaluation.

2. A car travelling at 24.2 m/s decelerates at the rate of 2.10 m/s^2. Calculate

Outcome S3P-3-06

a) the time required by the car to stop. *(2 marks)*

Answer:

Let to the right be positive.

Given: Initial velocity $\vec{v}_1 = +24.2 \text{ m/s}$

Acceleration $\vec{a} = -2.10 \text{ m/s/s}$

Final velocity $\vec{v}_2 = 0 \text{ m/s}$

Unknown: Time interval $\Delta t = ?$

Equation: $\vec{a} = \dfrac{\Delta \vec{v}}{\Delta t} = \dfrac{\vec{v}_2 - \vec{v}_1}{\Delta t}$ rearranged to $\Delta t = \dfrac{\vec{v}_2 - \vec{v}_1}{\vec{a}}$

Substitute and solve: $\Delta t = \dfrac{\vec{v}_2 - \vec{v}_1}{\vec{a}} = \dfrac{0 \text{ m/s} - (+24.2 \text{ m/s})}{-2.10 \text{ m/s/s}} = 11.5 \text{ s}$

The time required to stop is 11.5 s.

Outcome S3P-3-06

b) the distance the car travels before it comes to a stop *(2 marks)*

Answer:

Unknown: Displacement $\vec{d} = ?$

Equation: $\vec{d} = \dfrac{(\vec{v}_1 + \vec{v}_2)}{2} \Delta t$

Substitute and solve:

$$\vec{d} = \frac{(\vec{v}_1 + \vec{v}_2)}{2} \Delta t = \frac{(+24.2 \text{ m/s}) + (0 \text{ m/s})}{2} (11.5 \text{ s})$$

$$= +139 \text{ m}$$

The car travels 139 m [right].

Outcome S3P-3-06

c) how far the car travels from the time it starts decelerating until the speed is 12.00 m/s. *(2 marks)*

Answer:

Let to the right be positive.

Given: Initial velocity $\vec{v}_1 = +24.2\ \text{m/s}$

Acceleration $\vec{a} = -2.10\ \text{m/s/s}$

Final velocity $\vec{v}_2 = 12.0\ \text{m/s}$

Unknown: Displacement $\vec{d} = ?$

Equation: $2ad = v_2^{\,2} - v_1^{\,2}$ rearranged to $d = \dfrac{v_2^{\,2} - v_1^{\,2}}{2a}$

Substitute and solve:

$$d = \frac{v_2^{\,2} - v_1^{\,2}}{2a} = \frac{(+12.0\ \text{m/s})^2 - (+24.2\ \text{m/s})^2}{2(-2.10\ \text{m/s/s})}$$

$$= +105\ \text{m}$$

The car travels +105 m.

3. A crate has a mass of 35.0 kg. The crate is pulled along a level concrete floor by a force of 95.0 Newtons [east] acting in the horizontal direction. The crate accelerates at 1.20 m/s^2 [east].

Outcome S3P-4-03

a) Calculate the force of gravity acting on the crate. *(1.5 marks)*

Answer:

Given: Mass $m = 35.0$ kg

Applied force $\vec{F}_A = 95.0 \text{ N [E]}$

Acceleration $\vec{a} = 1.20 \text{ m/s/s [E]}$

Unknown: Force of gravity $\vec{F}_g = ?$

Equation: $\vec{F}_g = m\vec{g}$

Substitute and solve:

$$\vec{F}_g = m\vec{g} = (35.0 \text{ kg})(9.80 \text{ N/kg [down]})$$
$$= 343 \text{ N [down]}$$

The force of gravity is 343 N [down].

Outcome S3P-3-13

b) Calculate the net force acting on the cart. *(1.5 marks)*

Answer:

Unknown: Net force $\vec{F}_{\text{NET}} = ?$

Equation: $\vec{F}_{\text{NET}} = m\vec{a}$

Substitute and solve:

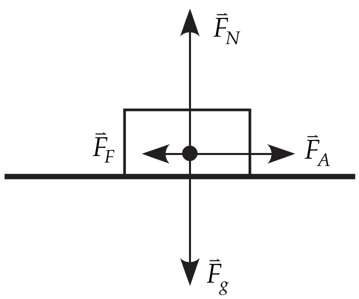
$$\vec{F}_{\text{NET}} = m\vec{a} = (35.0 \text{ kg})(1.20 \text{ m/s/s [E]}) = 42.0 \text{ N [E]}$$

The net force is 42.0 N [E].

Outcome S3P-3-12

c) Draw a free-body diagram of this situation. Label each force and give its size. *(2 marks)*

Answer:



Force of gravity	$\vec{F}_g = 343 \text{ N [down]}$
Normal force	$\vec{F}_N = 343 \text{ N [up]}$
Applied force	$\vec{F}_A = 95.0 \text{ N [east]}$
Force of friction	$\vec{F}_F = ?$

Outcome S3P-4-13

d) Calculate the force of friction acting on the cart. *(1 mark)*

Answer:

The net force is $\vec{F}_{\text{NET}} = \Sigma\vec{F} = \vec{F}_g + \vec{F}_N + \vec{F}_A + \vec{F}_F$.

Since the force of gravity and the normal force cancel out, the net force is given by the sum of the applied force and the force of friction.

$\vec{F}_{\text{NET}} = \Sigma\vec{F} = \vec{F}_A + \vec{F}_F$

The force of friction is

$\vec{F}_F = \vec{F}_{\text{NET}} - \vec{F}_A$

$\vec{F}_F = 42.0 \text{ N [E]} - 95.0 \text{ N [E]}$

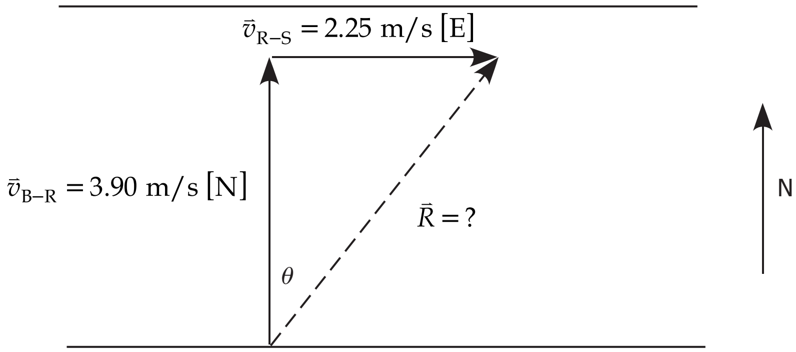
$\vec{F}_F = 42.0 \text{ N [E]} + 95.0 \text{ N [W]}$

$\vec{F}_F = 53.0 \text{ N [W]}$

4. A boat can be paddled at 3.90 m/s in still water. If the boat is aimed straight across a river flowing at 2.25 m/s and the river is 72.0 m wide,

Outcome S3P-0-2h

a) what is the velocity of the boat as observed from the shore? *(4 marks)*



Answer:

Unknown: Velocity of boat next to the shore $\vec{R} = \vec{v}_{B-S} = ?$

Equation: $\vec{R} = \vec{v}_{B-S} = \vec{v}_{B-R} + \vec{v}_{R-S}$

Substitute and solve: You must add the vectors by placing them "tip to tail" as in the diagram.

$$\vec{R} = \vec{v}_{B-S} = \vec{v}_{B-R} + \vec{v}_{R-S}$$

$$\vec{R} = \vec{v}_{B-S} = 3.90 \text{ m/s [E]} + 2.25 \text{ m/s [N]}$$

Using Pythagoras:

$$v_{B-S}{}^2 = (3.90 \text{ m/s})^2 + (2.25 \text{ m/s})^2 = 20.27$$

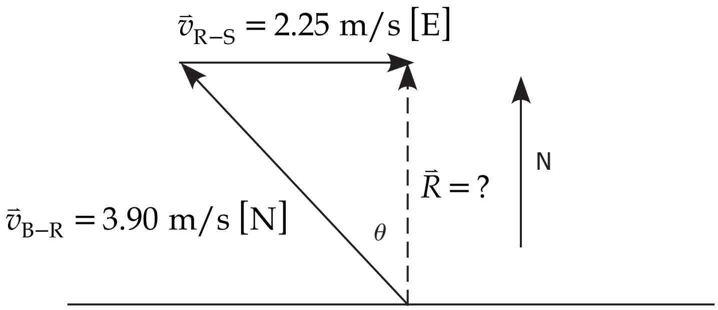
$$v_{B-S} = \sqrt{20.27} = 4.50 \text{ m/s}$$

$$\theta = \tan^{-1}\frac{2.25}{3.90} = 30.0°$$

The velocity of the boat next to the shore is 4.50 m/s [30.0° E of N].

Outcome S3P-0-2h

b) what heading must the boat take to land on the opposite shore directly opposite the starting point? *(2 marks)*



Answer:

The boat must head upstream (to the west) in order to go straight across the river.

$$\theta = \sin^{-1}\frac{2.25}{3.90} = 35.2°$$

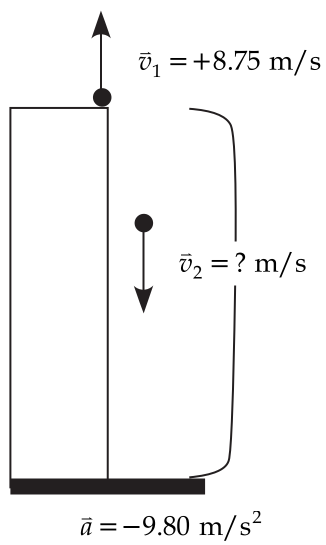
The boat must head at 35.2° West of North.

5. A stone is thrown upwards at 8.75 m/s from the top of a building that is 55.0 m high.
Outcome S3P-4-08

a) Calculate the stone's velocity 2.15 s after being thrown. *(3 marks)*

Answer:

Let up be the positive direction.



Given: Time interval $\Delta t = 2.15$ s

Unknown: Final velocity $\vec{v}_2 = ?$

Equation: $\vec{a} = \dfrac{\Delta \vec{v}}{\Delta t} = \dfrac{\vec{v}_2 - \vec{v}_1}{\Delta t}$ rearranged to $\vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$

Substitute and solve:

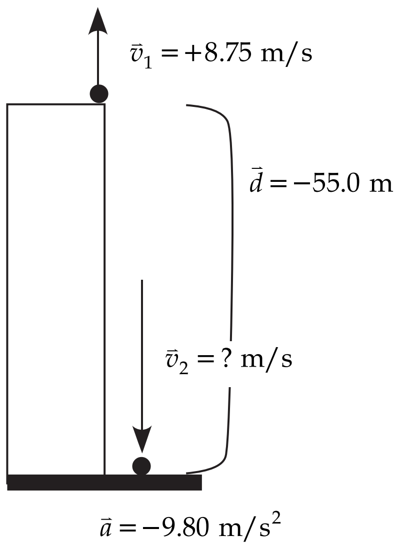
$$\vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$$
$$\vec{v}_2 = (+8.75 \text{ m/s}) + (-9.80 \text{ m/s/s})(2.15 \text{ s})$$
$$\vec{v}_2 = -12.3 \text{ m/s}$$

The final velocity is 12.3 m/s [down].

Outcome S3P-4-08

b) Calculate the final velocity of the stone as it strikes the sidewalk at the base of the building. *(3 marks)*

Answer:



Unknown: Final velocity $\quad \vec{v}_2 = ?$

Equation: $\quad v_2^{\,2} = v_1^{\,2} + 2ad$

Substitute and solve:

$$v_2^{\,2} = v_1^{\,2} + 2ad$$
$$v_2^{\,2} = (8.75)^2 + 2(-9.80)(-55.0) = 1154.56$$
$$\vec{v}_2 = 34.0 \text{ m/s [down]}$$

The final velocity is 34.0 m/s [down].

Outcome S3P-0-2h

6. Given the vectors $\vec{A}$ = 350 km [W], $\vec{B}$ = 475 km [N], and $\vec{C}$ = 425 km [E],

   a) find the sum of $\vec{A}$, $\vec{B}$, and $\vec{C}$. *(5 marks)*

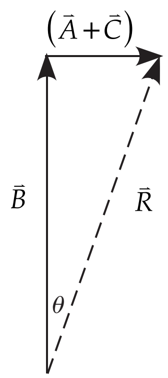
   Answer:

   Use the component method.

   Add the antiparallel vectors $\vec{A}$ and $\vec{C}$.

   $\vec{A}+\vec{C}$ = 350 km [W] + 425 km [E] = 75 km [E].

   Add this sum tip to tail with vector $\vec{B}$ so that you have $\vec{B}+\left(\vec{A}+\vec{C}\right)=\vec{R}$.



$$\vec{R}^2 = \vec{B}^2 + \left(\vec{A}+\vec{C}\right)^2$$
$$\vec{R}^2 = \left(475^2\right)+\left(75\right)^2$$
$$\vec{R}^2 = 231250$$
$$\vec{R} = 480 \text{ km}$$
$$\theta = \tan^{-1}\frac{75}{475}$$
$$\theta = 8.97°$$
$$\theta = 9.0°$$

   The sum of the three vectors is 480 km [9.0° east of north].

   b) find $\vec{A}-\vec{C}$. *(1 mark)*

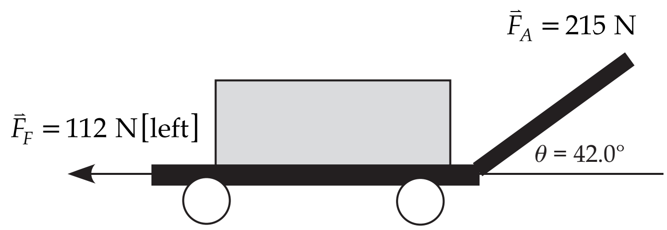
   $\vec{R}=\vec{A}-\vec{C}=\vec{A}+\left(-\vec{C}\right)$ = 350 km [W] + (425 km [W]) = 775 km [W].

7. A crate is pulled along a level floor. The crate rests on a dolly, which has a handle attached to it. The total mass of the crate and dolly is 255 kg. The handle is pulled by a person exerting a force of 215 Newtons at an angle of 42.0° from the horizontal, and the force of friction is 112 newtons.

Outcome S3P-3-13

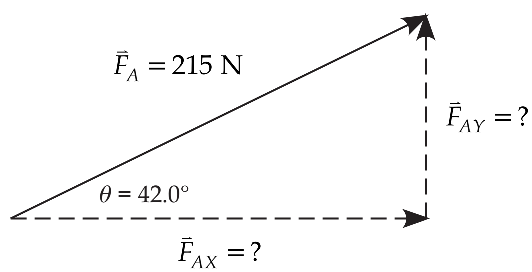
a) Determine the net force acting on the crate. *(3 marks)*

Dynamics

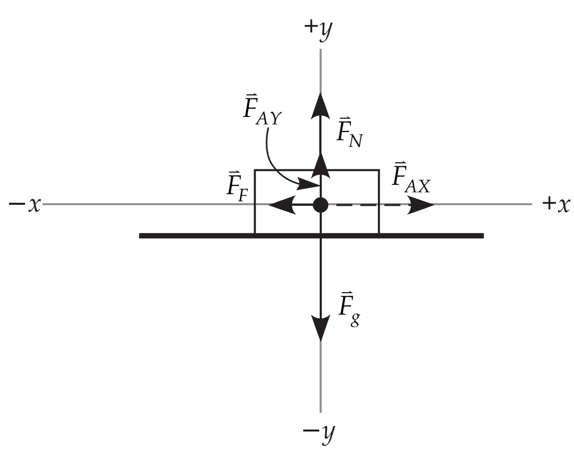


Answer:

You must resolve the applied force into a horizontal component and a vertical component.



$$\vec{F}_{AY} = \vec{F}_A(\sin 42.0°) = (215\text{ N})(\sin\ 42.0°) = 144\text{ N }[\text{up}]$$
$$\vec{F}_{AX} = \vec{F}_A(\cos 42.0°) = (215\text{ N})(\cos\ 42.0°) = 160\text{ N }[\text{right}]$$



The net force is given by $\vec{F}_{\text{NET}} = \Sigma\vec{F} = \vec{F}_g + \vec{F}_N + \vec{F}_{AY} + \vec{F}_F + \vec{F}_{AX}$.

In this case, the force of gravity, the normal force, and the *y*-component of the applied force all add to 0 N.

Therefore,

$$\vec{F}_{\text{NET}} = \Sigma\vec{F} = \vec{F}_{AX} + \vec{F}_F$$
$$\vec{F}_{\text{NET}} = 160\text{ N}\left[\text{right}\right] + 112\text{ N}\left[\text{left}\right]$$
$$\vec{F}_{\text{NET}} = 48\text{ N}\left[\text{right}\right]$$

The net force is 48 N [right].

Outcome S3P-3-13

b) How far would the crate travel during 3.75 seconds if it started from rest? *(3 marks)*

Answer:

You must link the dynamics up with the kinematics using Newton's Second Law.

Given: Net force $\vec{F}_{\text{NET}} = 48\text{ N}\left[\text{right}\right]$

Mass $m = 255\text{ kg}$

Acceleration $\vec{a} = \dfrac{\vec{F}_{\text{NET}}}{m} = \dfrac{48\text{ N}\left[\text{right}\right]}{255\text{ kg}} = 0.19\text{ m/s}^2\left[\text{right}\right]$

Initial velocity $\vec{v}_1 = 0\text{ m/s}$

Time interval $\Delta t = 3.75\text{ s}$

Unknown: Displacement $\vec{d} = ?$

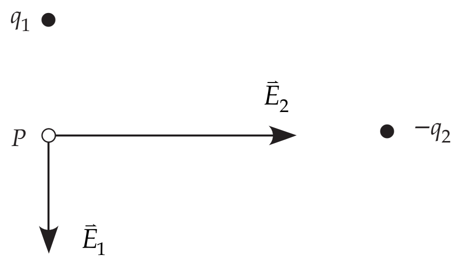
Equation: $\vec{d} = \vec{v}_1\Delta t + \dfrac{1}{2}\vec{a}\Delta t^2$

Substitute and solve: $\vec{d} = \vec{v}_1\Delta t + \dfrac{1}{2}\vec{a}\Delta t^2 = (0\text{ m/s})(3.75\text{ s}) + \dfrac{1}{2}(0.19\text{ m/s}^2)(3.75\text{ s})^2$

$\vec{d} = 1.3\text{ m}\left[\text{right}\right]$

The crate moves 1.3 m [right].

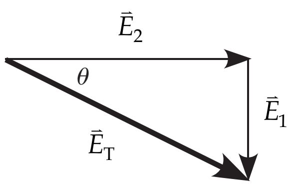
8. A positive point charge, q_1, produces a field, $\vec{E}_1$, of size 5.00 N/C at a location P. A negative point charge, $-q_2$, produces an electric field, $\vec{E}_2$, of size 10.0 N/C at the same location P.



Outcome S3P-4-16

a) Determine the magnitude and direction of the total electric field at P. *(4 marks)*

Answer:



In adding together the two electric field vectors, we attach them tip to tail.

The magnitude of the total electric field vector is

$$\vec{E}_T = \sqrt{(5.00\ \text{N/C})^2 + (10.0\ \text{N/C})^2} = 11.18\ \text{N/C or } 11.2\ \text{N/C}.$$

The direction of this vector is

$$\theta = \tan^{-1}\left(\frac{5.00\ \text{N/C}}{10.0\ \text{N/C}}\right) = 26.57°\ \text{S of E or } 26.6°\ \text{S of E}.$$

The electric field at P is 11.2 N/C [26.6° S of E].

Outcome S3P-4-16

b) If a 4.00 C charge is placed at P, what is the magnitude and the direction of the force on this charge? *(2 marks)*

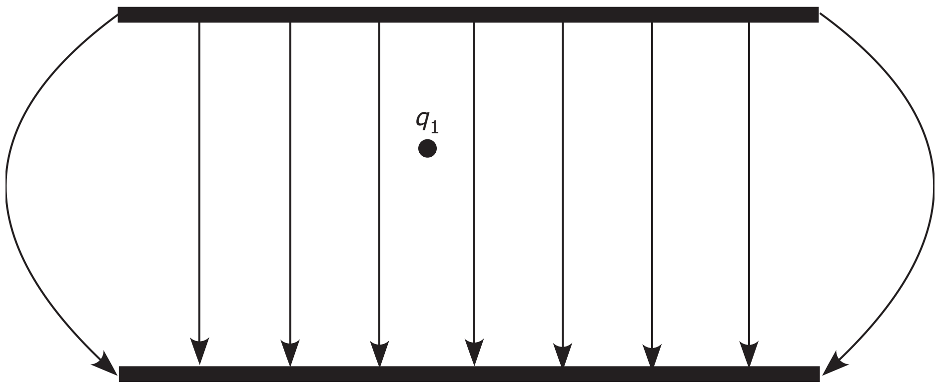
Answer:

The magnitide of the force is $\vec{F} = q\vec{E}_T$ = (4.00 C)(11.2 N/C) = 44.8 N.

The direction of this force is in the same direction as the electric field vector—that is, 26.6° S of E.

The electric force is 44.8 N [26.6° S of E].

9. A charge, q_1 = –2.00 C is placed in an electric field between two charged plates. The electric field strength is $\vec{E}$ = 6.00 N/C. The mass of the charged particle is m = 5.00 x 10^{-4} kg.



Outcome S3P-4-16

a) Determine the magnitude and direction of the electric force on the charged particle between the plates. *(2 marks)*

Answer:

This time the particle carries a negative charge so it will be attracted to the positive plate. The electric force will point up!

Given:	Charge	q_1 = –2.00 C
	Electric field	$\vec{E} = 6.00$ N/C
	Initial velocity	$\vec{v}_1 = 0$ m/s
	Mass	m = 5.00 x 10^{-4} kg.
Unknown:	Electric force	$\vec{F}_E = ?$
Equation:		To find the magnitude of the electric force use $\vec{F}_E = q\vec{E}$
Substitute and solve:		$\vec{F}_E = q\vec{E} = (2.00\ \text{C})(6.00\ \text{N/C}) = 12.0\ \text{N}$

Since the sign of the charge is negative, the directions of the electric force and the electric field are the opposite.

The electric force is 12.0 N [up].

Outcome S3P-3-13

b) Determine the magnitude and direction of the acceleration of the charged particle between the plates. *(2 marks)*

Answer:

Unknown: Acceleration $\quad \vec{a} = ?$

Equation: Use Newton's Second Law. The net force is the electric force.

$$\vec{F}_{\text{NET}} = m\vec{a} \text{ rearranged to } \vec{a} = \frac{\vec{F}_{\text{NET}}}{m}$$

Substitute and solve:

$$\vec{a} = \frac{\vec{F}_{\text{NET}}}{m} = \frac{+12.0 \text{ N}}{5.00 \times 10^{-4} \text{ kg}} = +2.40 \times 10^{4} \text{ m/s}^2$$

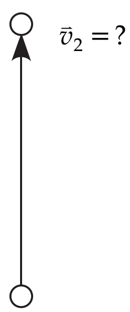
The acceleration of the particle is $+2.40 \times 10^4$ m/s^2.

Outcome S3P-3-13

c) If the particle is released from rest, what will be the final velocity of the particle after a time of 4.00 ms (4.00×10^{-3} s)? *(2 marks)*

Answer:

Given:



$\vec{v}_1 = 0$ m/s

$\vec{a} = 2.40 \times 10^4$ m/s^2

$\Delta t = 4.00 \times 10^{-3}$ s

Equation: Use equation #2.

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t} \text{ rearranged to } \vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$$

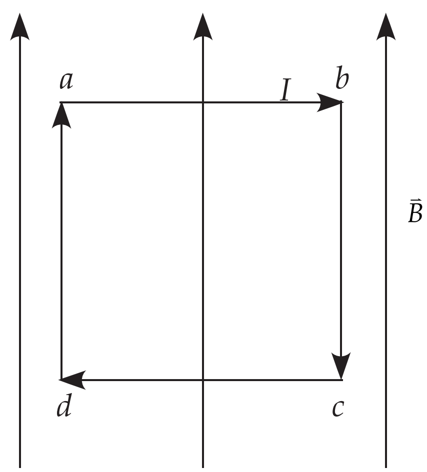
Substitute and solve:

$$\begin{aligned}\vec{v}_2 &= \vec{v}_1 + \vec{a}\Delta t \\ &= (0 \text{ m/s}) + (+2.40 \times 10^4 \text{ m/s})(4.00 \times 10^{-3} \text{ s}) \\ &= +96.0 \text{ m/s}\end{aligned}$$

The final velocity of the particle is 96.0 m/s [up].

Outcome S3P-4-30, S3P 4-32

10. A square coil of wire containing a single turn is placed in a uniform 0.25 T magnetic field, as the drawing shows. Each side has a length of 0.32 m, and the current in the coil is 12 A. The direction of the current is clockwise.



Determine the magnitude and direction of the magnetic force on

a) *ab (2 marks)*

Answer:

The line segment *ab* is perpendicular to the magnetic field. Therefore the magnitude of the force is $\vec{F} = BIL\sin\theta = (0.25\ \text{T})(12\,\text{A})(0.32\ \text{m})(\sin 90°) = 0.96\ \text{N}$. *(1 mark)*

Using the right-hand rule (flat hand), fingertips point in the direction of the field, thumb points in the direction of the current, and the palm points upwards. The direction of the force is vertically upward out of the page. *(1 mark)*

b) *bc (2 marks)*

Answer:

In the line segment *bc*, the current is parallel to the magnetic field. There is no force on the wire (sin 0° = 0).

c) *cd (2 marks)*

Answer:

The magnitude of the force is the same as in (a): 0.96 N.

The direction of the force is in the opposite direction to the force in part (a) because the current is in the opposite direction.

NOTES

Grade 11 Physics
Formula Sheet

Mathematics

$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$\text{hypotenuse}^2 = (\text{Leg }1)^2 + (\text{Leg }2)^2$$

Kinematics

$$v = \frac{d}{\Delta t}$$

$$\Delta = \text{second value} - \text{first value}$$

$$\vec{d} = \text{pos}_2 - \text{pos}_1$$

$$\vec{v} = \frac{\vec{d}}{\Delta t} = \frac{\text{pos}_2 - \text{pos}_1}{\Delta t}$$

$$\vec{a} = \frac{\Delta\vec{v}}{\Delta t} \text{ or } \vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t} \text{ or } \vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$$

$$\vec{d} = \frac{1}{2}(\vec{v}_1 + \vec{v}_2)\Delta t$$

$$\vec{d} = \vec{v}_1\Delta t + \frac{1}{2}\vec{a}\Delta t^2$$

$$v_2^2 = v_1^2 + 2ad$$

Waves

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2} = \frac{n_2}{n_1} = n_{1-2}$$

$$PLD = |PS_1 - PS_2| = \left(n - \frac{1}{2}\right)\lambda$$

$$f = \frac{1}{T}$$

$$T = \frac{1}{f}$$

$$v = f\lambda$$

Light

$$\text{PLD} = |\text{PS}_1 - \text{PS}_2|$$

$$\frac{\Delta x}{L} = \frac{\lambda}{d}$$

Sound

$$v = 332 + 0.6\text{ T}$$

Closed-pipe resonant length

$$L_n = \left(\frac{(2n-1)}{4}\right)\lambda$$

Open-pipe resonant length

$$L_n = \left(\frac{n}{2}\right)\lambda$$

$$f_B = |f_2 - f_1|$$

Dynamics

$$\vec{F}_{\text{NET}} = m\vec{a}$$

$$\vec{F}_{\text{NET}} = \sum \text{Forces}$$

$$F_F = \mu F_N$$

Gravity

$$\vec{F}_g = m\vec{g}$$

$$\vec{F}_N + \vec{F}_g = \vec{F}_{\text{NET}} = m\vec{a}$$

Electricity

$$\vec{E} = \frac{\vec{F}_E}{q}$$

$$q = \text{N}e$$

$$E = \frac{V}{d}$$

Magnetism

$$\vec{F}_B = BIL\sin\theta$$