BRITISH COLUMBIA

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Physics 12

JUNE 2001

Course Code = PH

Student Instructions

1. Place the stickers with your Personal Education Number (PEN) in the allotted spaces above. **Under no circumstance is your name or identification, other than your Personal Education Number, to appear on this booklet.**

2. Ensure that in addition to this examination booklet, you have an **Examination Response Form**. Follow the directions on the front of the Response Form.

3. **Disqualification** from the examination will result if you bring books, paper, notes or unauthorized electronic devices into the examination room.

4. When instructed to open this booklet, **check the numbering of the pages** to ensure that they are numbered in sequence from page one to the last page, which is identified by

   END OF EXAMINATION .

5. At the end of the examination, place your Response Form inside the front cover of this booklet and return the booklet and your Response Form to the supervisor.

Question 1:

1. ☐ . ☐
   (9)

Question 9:

9. ☐ . ☐
   (4)

Question 2:

2. ☐ . ☐
   (7)

Question 3:

3. ☐ . ☐
   (7)

Question 4:

4. ☐ . ☐
   (7)

Question 5:

5. ☐ . ☐
   (7)

Question 6:

6. ☐ . ☐
   (7)

Question 7:

7. ☐ . ☐
   (7)

Question 8:

8. ☐ . ☐
   (5)

PHYSICS 12

JUNE 2001

COURSE CODE = PH

GENERAL INSTRUCTIONS

1. Aside from an approved calculator, electronic devices, including dictionaries and pagers, are **not** permitted in the examination room.

2. All multiple-choice answers must be entered on the Response Form using an **HB pencil**. Multiple-choice answers entered in this examination booklet will **not** be marked.

3. For each of the written-response questions, write your answer in the space provided in this booklet. Rough-work space has been incorporated into the space allowed for answering each written-response question. You may not need all of the space provided to answer each question.

4. Ensure that you use language and content appropriate to the purpose and audience of this examination. Failure to comply may result in your paper being awarded a zero.

5. This examination is designed to be completed in **two hours**. *Students may, however, take up to 30 minutes of additional time to finish*.

PHYSICS 12 PROVINCIAL EXAMINATION

		Value	Suggested Time
1.	This examination consists of **two** parts:		
	PART A: 30 multiple-choice questions worth two marks each	60	60
	PART B: 9 written-response questions	60	60
	Total:	**120 marks**	**120 minutes**

2. The last **three** pages inside the back cover contain the **Table of Constants**, **Mathematical Equations**, **Formulae,** and **Rough Work for Multiple-Choice**. These pages may be detached for convenient reference prior to writing this examination.

3. **A calculator is essential for the Physics 12 Provincial Examination.** The calculator must be a hand-held device designed primarily for mathematical computations involving logarithmic and trigonometric functions and may also include graphing functions. Computers, calculators with a QWERTY keyboard, and electronic writing pads will not be allowed. Students must not bring any external devices to support calculators such as manuals, printed or electronic cards, printers, memory expansion chips or cards, or external keyboards. Students may have more than one calculator available during the examination. Calculators may not be shared and must not have the ability to either transmit or receive electronic signals. In addition to an approved calculator, students will be allowed to use rulers, compasses, and protractors during the examination.

4. a) Final answers must include appropriate **units**.

   b) Marks will not be deducted for answers expressed to **two** or **three** significant figures.

   c) In this examination the zero in a number such as 30 shall be considered to be a significant zero.

5. You are expected to communicate your knowledge and understanding of physics principles in a clear and logical manner. Partial marks will be awarded for steps and assumptions leading to a solution. Full marks will **not** be awarded for providing **only** a final answer.

   If you are unable to determine the value of a quantity required in order to proceed, you may assume a reasonable value and continue toward the solution. Such a solution, however, may not be eligible for full marks.

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INSTRUCTIONS:	For each question, select the **best** answer and record your choice on the Response Form provided. Using an HB pencil, completely fill in the circle that has the letter corresponding to your answer.

1. Which one of the following contains only vector quantities?

    A. mass, time
    B. force, velocity
   C. time, momentum
    D. acceleration, speed

2. A 35 kg object released from rest near the surface of a planet falls 7.3 m in 1.5 s. What is the acceleration due to gravity on this planet?

    A. 4.9 m/s^2

    B. 6.5 m/s^2

    C. 9.7 m/s^2

    D. 170 m/s^2

3. A projectile is fired with an initial velocity of 65 m/s at an angle of 23° above the horizontal. If air resistance is negligible, how much time elapses before the projectile reaches its maximum height?

    A. 2.6 s
    B. 2.8 s
    C. 6.1 s
    D. 6.6 s

4. A large mass, M, collides with a stationary small mass, m. During the collision, the forces exerted on each mass are measured. Which of the following is correct about the magnitude of the forces?

    A. No force is exerted during the collision.
    B. The large mass, M, exerts a greater force on the small mass, m.
    C. The small mass, m, exerts a greater force on the large mass, M.
    D. Both masses exert equal forces on each other during the collision.

OVER

5. Two masses are connected together by a rope and pulley on a frictionless inclined plane as shown.
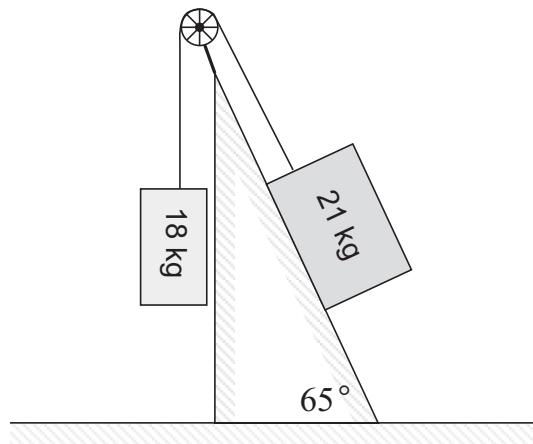
When the system is released, what is the initial acceleration of the 21 kg mass?

	MAGNITUDE OF THE ACCELERATION	DIRECTION THE MASS WILL TRAVEL
A.	0.26 m/s^2	up the incline
B.	0.26 m/s^2	down the incline
C.	0.48 m/s^2	up the incline
D.	0.48 m/s^2	down the incline

6. In order to use the joule as a unit of energy in an experiment, measurements must be converted to

   A. cm, g and s
   B. m, kg and s
   C. cm, N and s
   D. m, g and min

7. Which of the following best represents the work done by an adult in ascending a typical flight of stairs in a home?

   A. 10^0 J
   B. 10^1 J
   C. 10^2 J
   D. 10^3 J

8. A 0.055 kg bullet was fired at 250 m/s into a block of wood as shown in the diagram below.
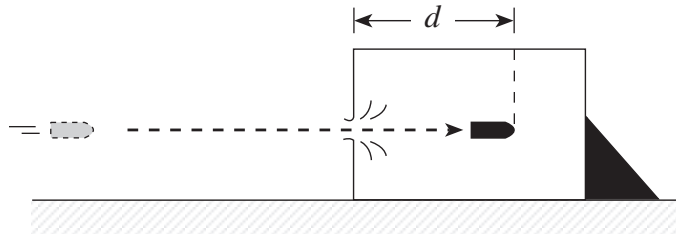
Assuming an average force of $9\,500$ N brings the bullet to rest in the wood, what distance d did the bullet penetrate the block?

A. 1.4×10^{-3} m
B. 1.4×10^{-2} m
C. 1.8×10^{-1} m
D. 3.6×10^{-1} m

9. An electric winch operates from a 120 V source at 3.5 A. The winch lifts a 360 kg object 2.5 m vertically in 45 s. What is the efficiency of the winch?

A. 4.8%
B. 17%
C. 19%
D. 47%

10. A 0.40 kg ball rolls at 8.5 m/s towards a player. The player kicks the ball so that it then travels at 15.2 m/s in the opposite direction. What is the magnitude of the impulse that the ball sustained?

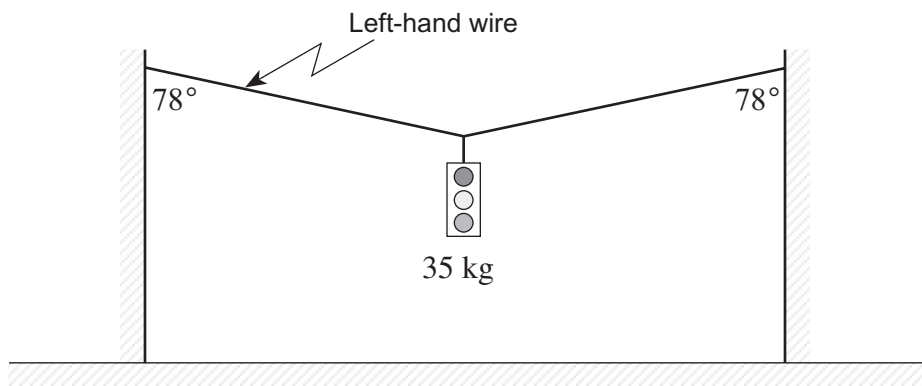A. 1.3 N·s
B. 2.7 N·s
C. 4.7 N·s
D. 9.5 N·s

11. A student uses a wrench to loosen a very tight nut in the position shown.
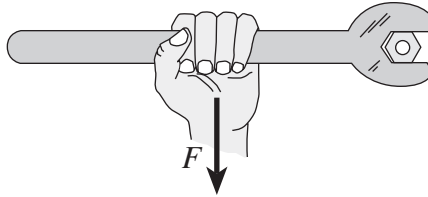
In which of the following would the student have more success at loosening the nut?
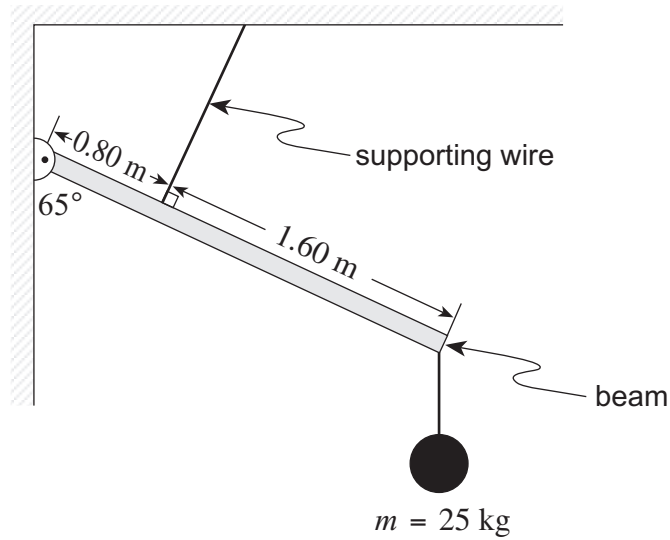
A.

B.

C.

D.
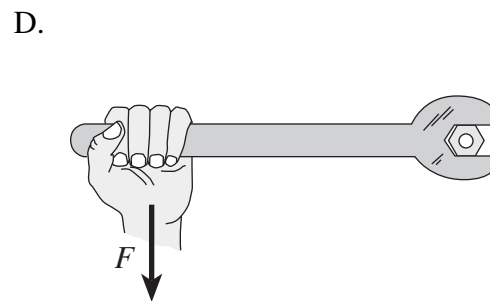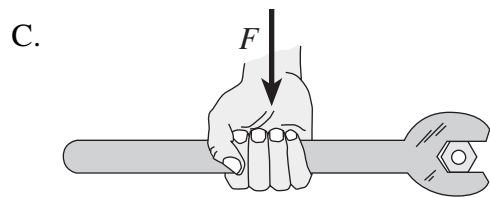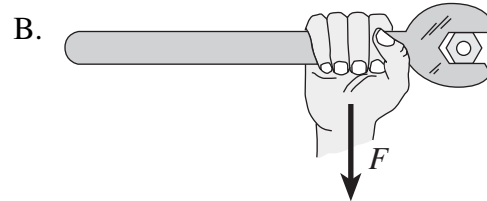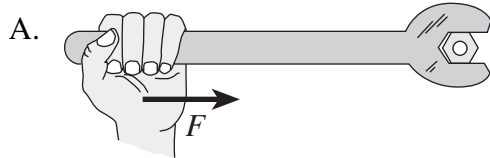
12. A 35 kg traffic light is suspended by two wires as shown.


What is the tension in the left-hand wire?

A. 84 N
B. 410 N
C. 820 N
D. 1 600 N

13. A 15 kg uniform beam 2.40 m long is suspended from a wall and a ceiling as shown.

0.80 m

65°

1.60 m

supporting wire

beam

$m = 25$ kg

What is the tension in the supporting wire?

A. 670 N
B. 740 N
C. 870 N
D. 960 N

14. A car travels at 25 m/s along a horizontal curve of radius 450 m. What minimum coefficient of friction is necessary between its tires and the road in order for the car not to skid?

A. 0.14
B. 0.54
C. 0.72
D. 1.4

15. In a series of test runs, a car travels around the same circular track at different velocities. Which graph best shows the relationship between its centripetal acceleration, a_c, and its velocity, v?

A. a_c vs v

B. a_c vs v

C. a_c vs v

D. a_c vs v

OVER
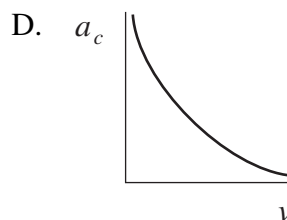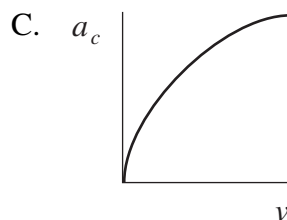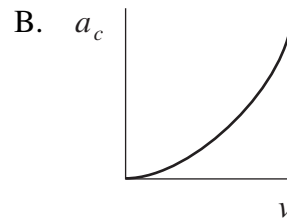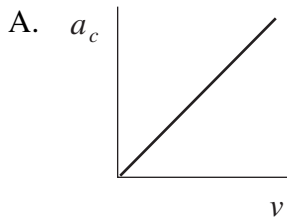
16. Tarzan, of mass 85 kg, holds on to a horizontal vine of length 8.0 m and jumps off a cliff. What is the tension force in the vine as Tarzan passes the lowest point of his circular path?

   A. 830 N
   B. 1 700 N
   C. 2 500 N
   D. 6 700 N

17. Which graph shows gravitational potential energy plotted as a function of distance r from the centre of the earth?

   A. E_p

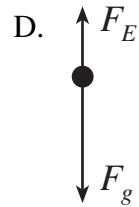
   B. E_p

   C. E_p

   D. E_p
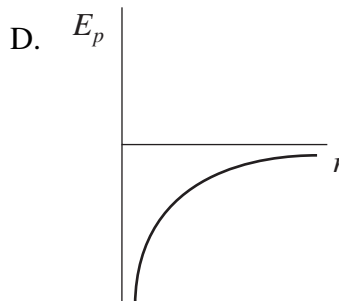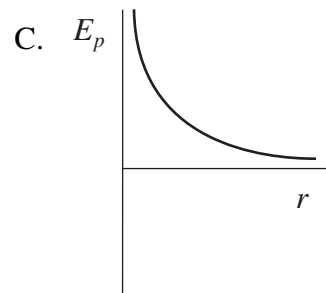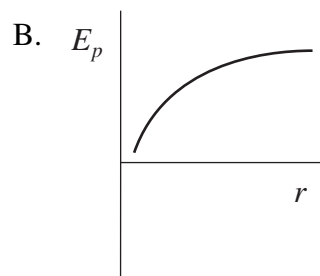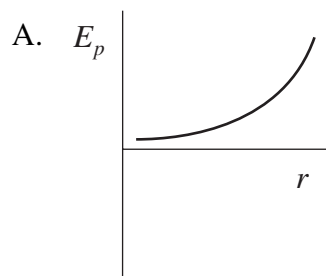
18. How much work must be done to lift a 4.00×10^4 kg object from Earth's surface to a height of 3.00×10^5 m?

   A. 1.12×10^{11} J
   B. 1.18×10^{11} J
   C. 2.39×10^{12} J
   D. 5.32×10^{13} J

19. A positively charged oil droplet is in a vertical electric field.
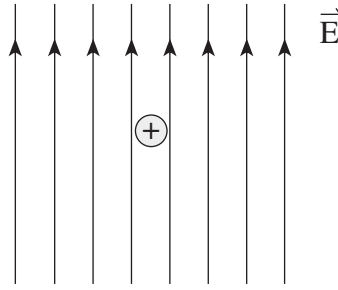
Which of the following is a correctly labelled free-body diagram showing the forces acting on the oil droplet?

A.

F_E

F_g

B.

F_E

F_g

C.

F_E

F_g

D.

F_E

F_g
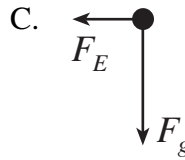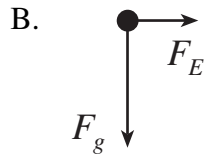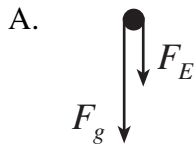
20. What are the magnitude and direction of the electric field between the plates in the situation shown below?

250 V

3.0×10^{-2} m

4.0×10^{-3} m
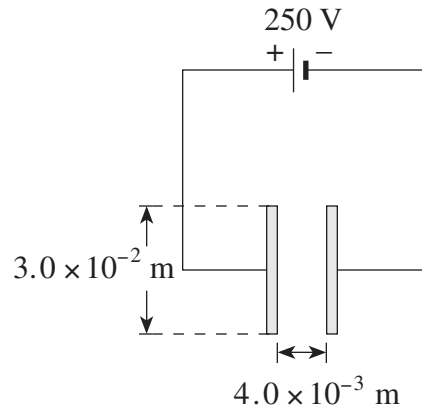
	DIRECTION OF FIELD	MAGNITUDE OF FIELD (V/m)
A.	left	8.3×10^3
B.	right	8.3×10^3
C.	left	6.3×10^4
D.	right	6.3×10^4

21. Current is a measure of

    A. the number of charges stored in a cell.
    B. the amount of energy given to a charged object.
    C. the charge passing a point in a circuit in a given time.
    D. the resistance to the flow of charged particles in a circuit.

22. The battery in the diagram below is delivering a current of 2.0 A.

$\varepsilon = 6.0$ V

$r = 0.50$ Ω

$I = 2.0$ A
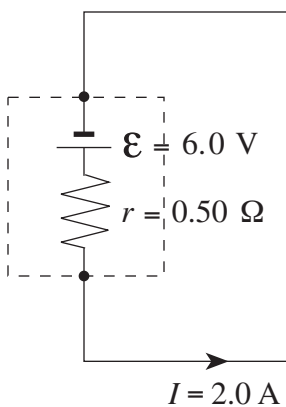
What will be the reading on a voltmeter connected to the battery terminals?

    A. 1.0 V
    B. 5.0 V
    C. 6.0 V
    D. 7.0 V

23. What is the total power dissipated by the three resistors in the circuit shown below?

10 Ω

24 V

33 Ω
9.2 W

R

    A. 12 W
    B. 16 W
    C. 23 W
    D. 30 W

- 8 -
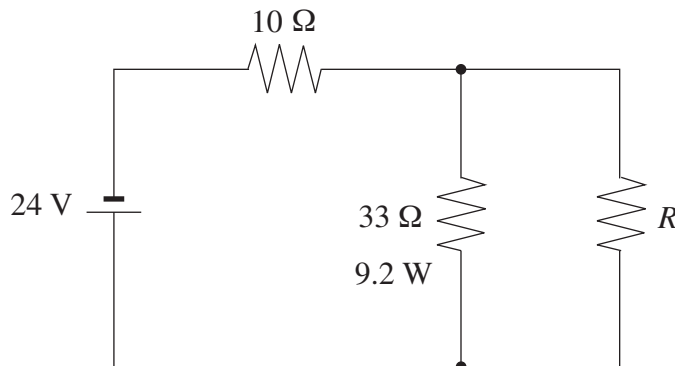
24. Which of the following devices commonly uses a solenoid?

   A. kettle
   B. battery
   C. television set
   D. incandescent bulb

25. An electron, travelling with a constant velocity, enters a region of uniform magnetic field. Which of the following is **not** a possible pathway?

A.

B.

C.

D.
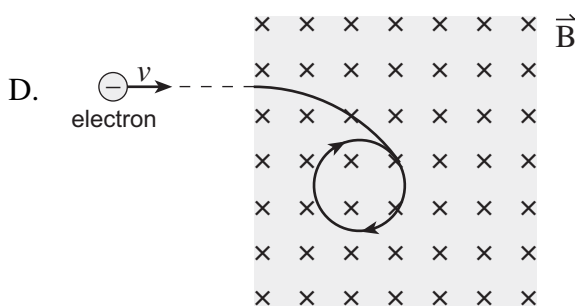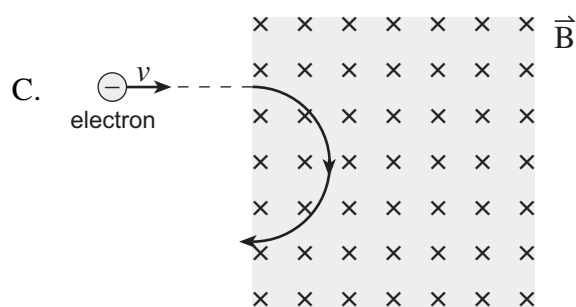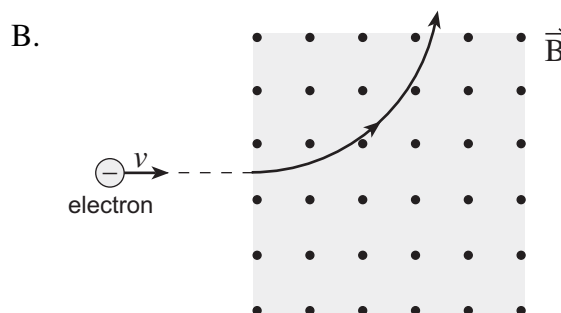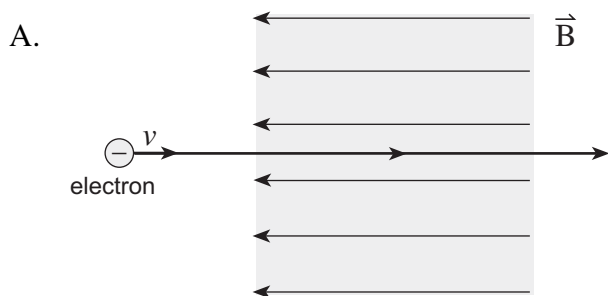
26. A bar magnet is at rest, next to a fixed coil. When switch S is closed, the bar magnet will move
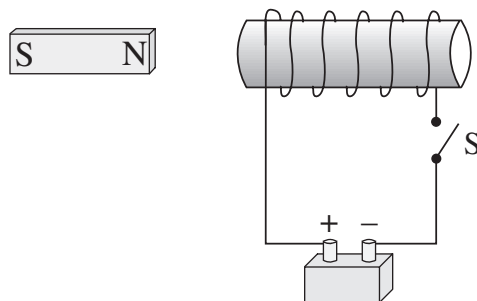
   A. to the left.
   B. to the right.
   C. up the page.
   D. down the page.

OVER

27. A 500-turn circular coil with an area of 1.54×10^{-2} m^2 is perpendicular to a 0.060 T field. The magnetic field changes to 0.020 T in the opposite direction in 0.12 s.

$B_0 = 0.060$ T

$B = 0.020$ T

Initial   Final
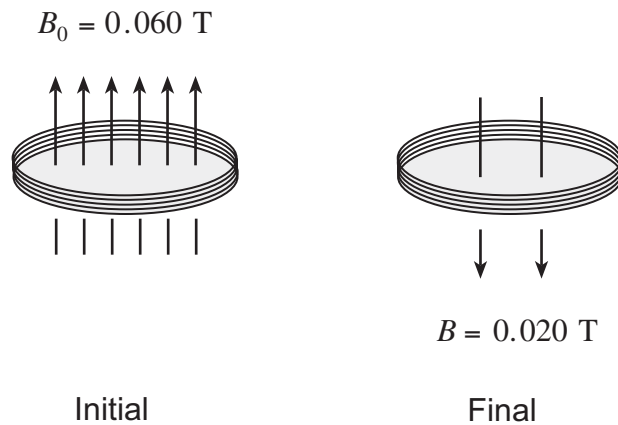
What is the average emf induced in the coil?

A. 5.1×10^{-3} V
B. 1.0×10^{-2} V
C. 2.6 V
D. 5.1 V

28. A metal block moves with a constant speed in a uniform magnetic field.
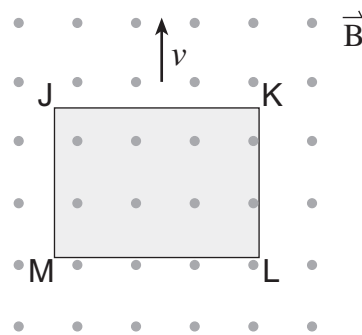
Which side of the block is positive?

A. JK
B. KL
C. LM
D. MJ

29. A 120 V dc motor has an armature resistance of 5.0 Ω and draws 6.0 A when it is operating normally. What is the starting current of the motor and the back emf when it is operating?

	STARTING CURRENT	BACK EMF WHEN OPERATING
A.	6.0 A	30 V
B.	6.0 A	90 V
C.	24 A	30 V
D.	24 A	90 V

30. A 0.75 m conducting rod is moved at 8.0 m/s across a 0.25 T magnetic field along metal rails. The electrical resistance of the system is 5.0 Ω.
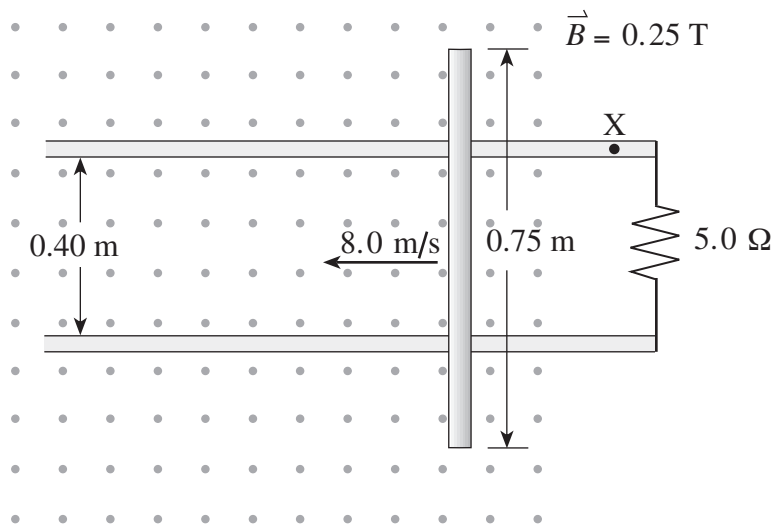
What are the magnitude and direction of the current through point X?

	MAGNITUDE OF CURRENT	DIRECTION OF CURRENT THROUGH X
A.	0.16 A	Left
B.	0.16 A	Right
C.	0.30 A	Left
D.	0.30 A	Right

This is the end of the multiple-choice section.
Answer the remaining questions directly in this examination booklet.

OVER

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PART B: WRITTEN RESPONSE

Value: 60 marks   **Suggested Time: 60 minutes**

1. A 3.0 kg mass hangs at one end of a rope that is attached to a support on a child's wagon as shown in the diagram. The wagon is pulled to the right. (You may ignore air resistance.)

rope

14°

3.0 kg

a) Draw and label a free body diagram showing the forces acting on the mass.   **(2 marks)**

b) What is the acceleration of the wagon?   **(3 marks)**

ANSWER:

b) acceleration of the wagon: _____

c) On the diagram below, sketch the position of the mass when the cart reaches a constant velocity of 6.5 m/s. **(1 mark)**

6.5 m/s
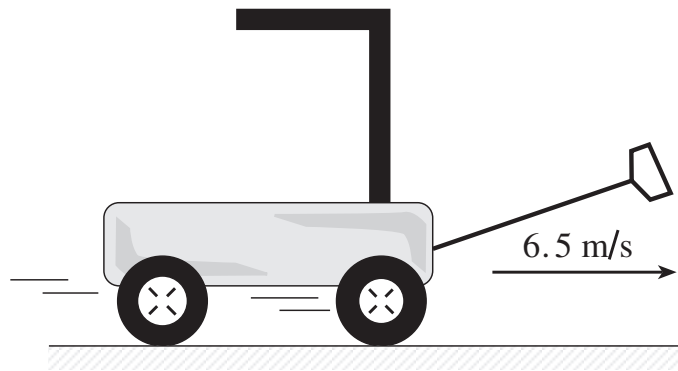
d) Using principles of physics, explain why the mass will be in this position. **(3 marks)**

_____

_____

_____

_____

_____

_____

2. Sally is driving south in her 2 500 kg pickup truck at 3.8 m/s when she collides with Willy driving west in his 1 200 kg car at 4.5 m/s.

2 500 kg

$v_S = 3.8$ m/s

1 200 kg

$v_W = 4.5$ m/s
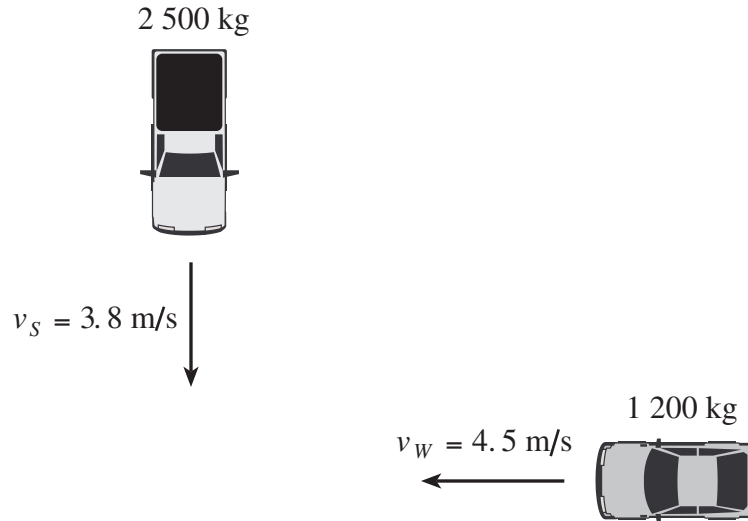
The two vehicles lock together and slide over the wet parking lot. Find the speed and direction of the damaged vehicles immediately after the collision. **(7 marks)**

ANSWER:

speed: _____

direction: _____

OVER

3. A uniform 12 kg beam of length 3.00 m holding a 45 kg mass is attached by a wire to a wall as shown.
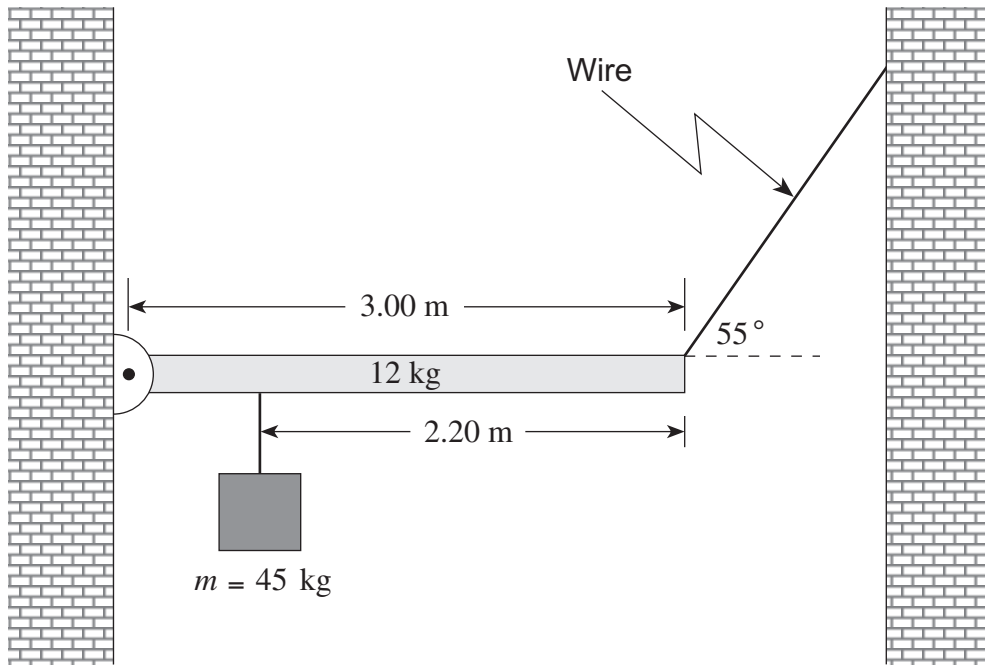
What is the tension in the wire? **(7 marks)**

ANSWER:

tension: _____

4. An 884 kg satellite in orbit around a planet has a gravitational potential energy of -5.44×10^{10} J. The orbital radius of the satellite is 8.52×10^6 m and its speed is 7.84×10^3 m/s.

a) What is the mass of the planet?   **(3 marks)**

ANSWER:

a) mass of the planet: _____

---

b) What is the kinetic energy of the satellite? **(2 marks)**

ANSWER:

b) kinetic energy of satellite: _____

c) What is the total energy of the satellite? **(2 marks)**

ANSWER:

c) total energy of satellite: _____

5. Electric charges Q_1 and Q_2 are arranged as shown in the diagram below.

$Q_1 = 7.5 \times 10^{-6}$ C
$(+)$

$Q_2 = -2.5 \times 10^{-6}$ C
$(-)$

P
•

$\mid\leftarrow$ —————— 0.20 m —————→ $\mid\leftarrow$ ——— 0.15 m ———→$\mid$
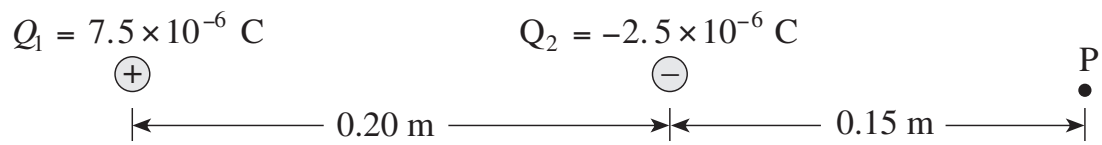
What is the electric potential at point P?   (7 marks)

```
ANSWER:


electric potential at point P: _____
```

6. The current through the 50.0 Ω resistor in the circuit below is 0.14 A.

$R_1 = 10.0\ \Omega$

ε

$r = 0.80\ \Omega$

$R_2 = 33.0\ \Omega$

$R_3 = 50.0\ \Omega$
$I = 0.14\ \text{A}$

$R_4 = 68.0\ \Omega$
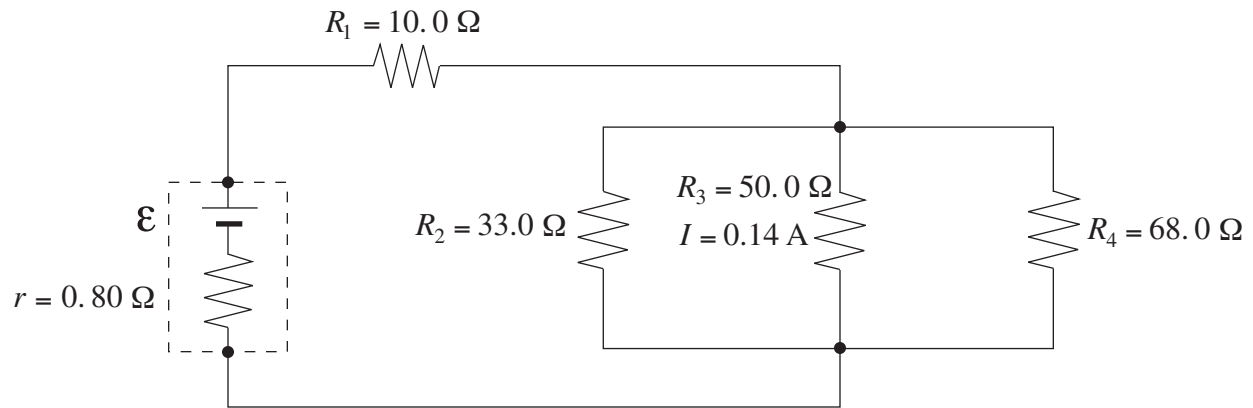
a) Determine the emf of the battery. **(5 marks)**

ANSWER:

a) emf of the battery: _____

b) Determine the power dissipated in the battery's internal resistance. **(2 marks)**

ANSWER:

b) power dissipated: _____

7. Protons travelling at 2.2×10^5 m/s enter at right angles to a magnetic field. The field is produced by a 0.16 m long solenoid. A current of 5.3 A flows through the 820 turns of wire of the solenoid.

a) What is the magnetic field in the solenoid? **(3 marks)**

ANSWER:

a) magnetic field: _____

b) What is the radius of curvature of the proton beam in the magnetic field of the solenoid?

(4 marks)

ANSWER:

b) radius of curvature: _____

8. A rectangular loop is suspended by a spring scale between magnetic poles. The loop is 0.60 m wide by 0.120 m high.
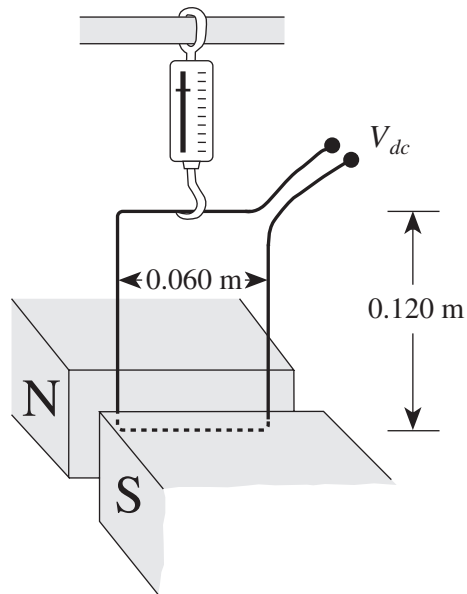
As the current in the loop is varied, the readings of the spring scale and current are plotted on a graph.
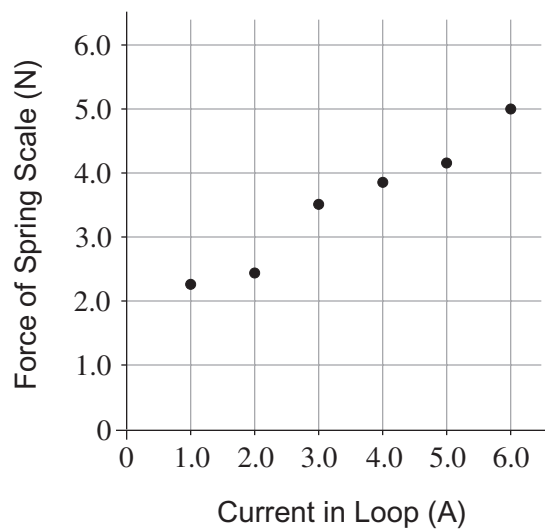
a) What is the weight, in newtons, of the loop? **(1 mark)**

ANSWER:

a) weight of the loop: _____

- 28 -

b) What is the slope of the best fit line?   **(2 marks)**

```
ANSWER:

b) slope of the best fit line:  _____
```

c) What is the magnitude of the magnetic field?   **(2 marks)**

```
ANSWER:

c) magnitude of the magnetic field:  _____
```

OVER

9. A student decides to investigate how electric field varies along the line connecting two positive point charges. Charge Q_2 is greater than charge Q_1.

Using principles of physics, describe the electric field along the line from Q_1 to Q_2. **(4 marks)**

_____

_____

_____

_____

_____

_____

_____

_____

END OF EXAMINATION

Gravitational constant .... $G = 6.67 \times 10^{-11}\,\text{N} \cdot \text{m}^2/\text{kg}^2$

Acceleration due to gravity at the surface of Earth
      (for the purposes of this examination) .... $g = 9.80\ \text{m/s}^2$

Earth
      radius .... $= 6.38 \times 10^6\,\text{m}$
      radius of orbit about Sun .... $= 1.50 \times 10^{11}\,\text{m}$
      period of rotation.. $= 8.61 \times 10^4\,\text{s}$
      period of revolution about Sun... $= 3.16 \times 10^7\,\text{s}$
      mass... $= 5.98 \times 10^{24}\,\text{kg}$

Moon
      radius .... $= 1.74 \times 10^6\,\text{m}$
      radius of orbit about Earth .... $= 3.84 \times 10^8\,\text{m}$
      period of rotation.. $= 2.36 \times 10^6\,\text{s}$
      period of revolution about Earth .... $= 2.36 \times 10^6\,\text{s}$
      mass... $= 7.35 \times 10^{22}\,\text{kg}$

Sun
      mass... $= 1.98 \times 10^{30}\,\text{kg}$

Constant in Coulomb's Law .... $k = 9.00 \times 10^9\,\text{N} \cdot \text{m}^2/\text{C}^2$

Elementary charge .... $e = 1.60 \times 10^{-19}\,\text{C}$

Mass of electron... $m_e = 9.11 \times 10^{-31}\,\text{kg}$

Mass of proton .... $m_p = 1.67 \times 10^{-27}\,\text{kg}$

Mass of neutron .... $m_n = 1.68 \times 10^{-27}\,\text{kg}$

Permeability of free space .... $\mu_o = 4\pi \times 10^{-7}\,\text{T} \cdot \text{m/A}$

Speed of light... $c = 3.00 \times 10^8\,\text{m/s}$

You may detach this page for convenient reference.
Exercise care when tearing along perforations.

MATHEMATICAL EQUATIONS
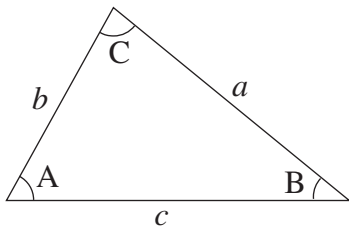
For Right-angled Triangles:
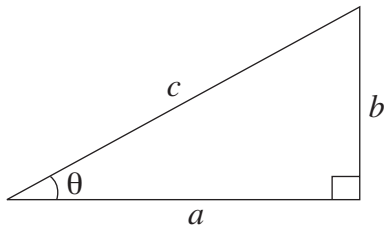
$$a^2 + b^2 = c^2$$

$$\sin\theta = \frac{b}{c} \quad \cos\theta = \frac{a}{c} \quad \tan\theta = \frac{b}{a}$$

$$\text{area} = \frac{1}{2}\,ab$$

For All Triangles:

$$\text{area} = \frac{1}{2}\,\text{base} \times \text{height}$$

$$\sin 2A = 2\sin A\cos A$$

Sine Law: $\dfrac{\sin A}{a} = \dfrac{\sin B}{b} = \dfrac{\sin C}{c}$

Cosine Law: $c^2 = a^2 + b^2 - 2\,ab\,\cos C$

Circle:

Circumference $= 2\pi r$

Area $= \pi r^2$

Sphere:

Surface area $= 4\pi r^2$

Volume $= \dfrac{4}{3}\pi r^3$

Quadratic Equation:

If $ax^2 + bx + c = 0$, then $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Vector Kinematics in Two Dimensions:

$$v = v_0 + at \qquad \bar{v} = \frac{v + v_0}{2}$$

$$v^2 = v_0^2 + 2ad \qquad d = v_0 t + \frac{1}{2}at^2$$

Vector Dynamics:

$$F_{net} = ma \qquad F_g = mg$$

$$F_{fr} = \mu F_N$$

Work, Energy, and Power:

$$W = Fd \qquad E_p = mgh$$

$$E_k = \frac{1}{2}mv^2 \qquad P = \frac{W}{t}$$

Momentum:

$$p = mv \qquad \Delta p = F\Delta t$$

Equilibrium:

$$\tau = Fd$$

Circular Motion:

$$a_c = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$$

Gravitation:

$$F = G\frac{m_1 m_2}{r^2} \qquad E_p = -G\frac{m_1 m_2}{r}$$

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Electrostatics:

$$F = k\frac{Q_1 Q_2}{r^2} \qquad\qquad E = \frac{F}{Q}$$

$$\Delta V = \frac{\Delta E_p}{Q} \qquad\qquad E = \frac{\Delta V}{d}$$

$$E_p = k\frac{Q_1 Q_2}{r} \qquad\qquad V = \frac{kQ}{r}$$

Electric Circuits:

$$I = \frac{Q}{t} \qquad\qquad\qquad V = IR$$

$$V_{\text{terminal}} = \mathcal{E} \pm Ir \qquad\qquad P = IV$$

Electromagnetism:

$$F = BIl \qquad\qquad\qquad F = QvB$$

$$B = \mu_0 nI = \mu_0 \frac{N}{l}I \qquad\qquad \mathcal{E} = Blv$$

$$\Phi = BA \qquad\qquad\qquad \mathcal{E} = -N\frac{\Delta\Phi}{\Delta t}$$

$$V_{\text{back}} = \mathcal{E} - Ir$$

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$$

You may detach this page for convenient reference.
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