BRITISH
COLUMBIA
The Best Place on Earth

Physics 12
Examination Booklet
2009/2010 Release Exam
January 2010
Form A

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

You have **Examination Booklet Form A**. In the box above #1 on your **Answer Sheet**, fill in the bubble as follows.

	A	B	C	D	E	F	G	H
Exam Booklet Form/ Cahier d'examen	●	○	○	○	○	○	○	○

1. Which of the following is a vector quantity?

   A. work
   B. electric field
   C. potential energy
   D. potential difference

2. An aircraft is flying due south. Some time later it is flying due east. Which vector best represents the aircraft's change in velocity?
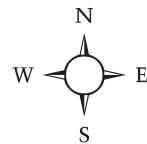
   A.   B.   C.   D.

3. A projectile is launched horizontally from a cliff edge as shown.

$v = 15$ m/s

25 m
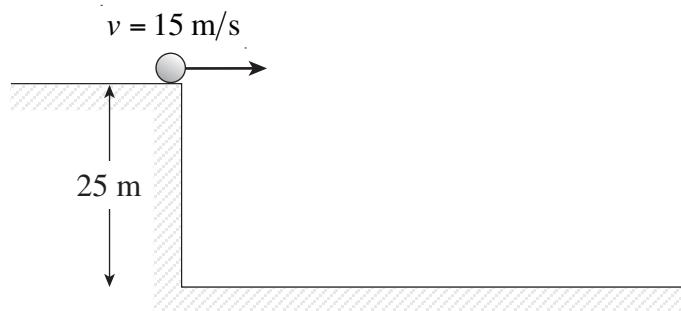
What is the projectile's time of flight?

A. 1.2 s
B. 1.7 s
C. 2.3 s
D. 2.7 s

4. The gravitational field strength of the earth at its surface can be expressed as

A. 9.8 J
B. $9.8 \text{ kg} \cdot \text{m/s}^2$
C. 9.8 N/kg^2
D. 9.8 N/kg

5. A 15 N force is applied to a 5.0 kg block as shown.

15 N
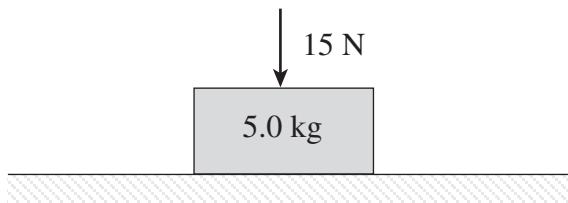
5.0 kg

What is the normal force on the block?

A. 15 N
B. 34 N
C. 49 N
D. 64 N

6. A 5.0 kg block is on an incline. The friction force acting on the block is 25 N.


   F

   $34°$
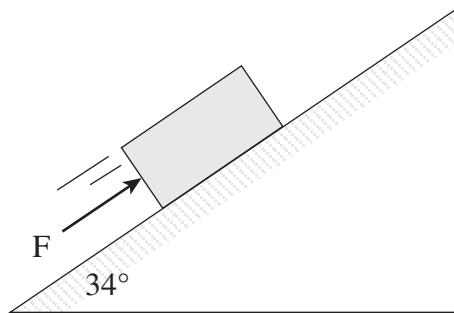
   What is the magnitude of the force, F, parallel to the incline, needed to move the block up the slope at constant speed?

   A. 14 N
   B. 25 N
   C. 52 N
   D. 74 N

7. A varying force applied to an object is described by the F vs. d graph below.
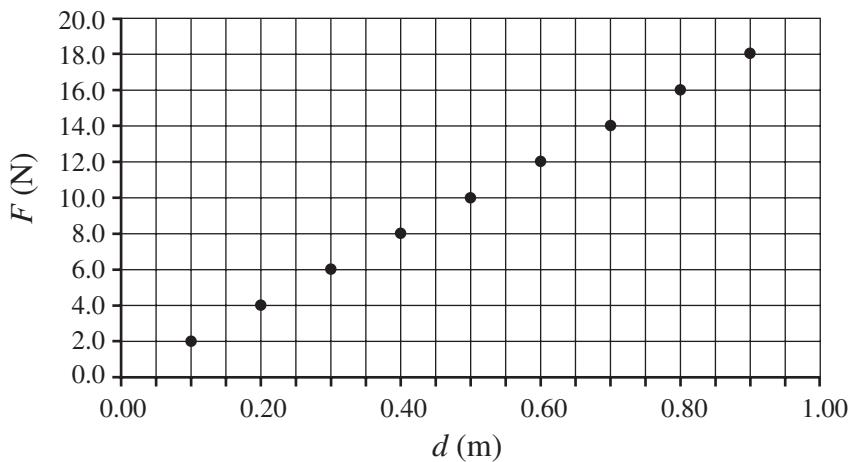
   What is the work done by this force as it moves the object from 0.40 to 0.60 m?

   A. 0.80 J
   B. 2.0 J
   C. 3.2 J
   D. 20 J

8. Joe ascends a small hill from an elevation of 250 m to an elevation of 490 m. In doing so he expends 2.8×10^5 J. If Joe's mass is 75 kg, what is the efficiency of his climb?

A. 0.37
B. 0.63
C. 0.66
D. 0.78

9. A 0.22 kg ball moving due south at 27 m/s is struck by a wooden bat, changing its velocity to 36 m/s north. If the bat is in contact with the ball for 0.57 s, what is the magnitude of the impulse on the ball?

A. $2.0 \, \text{N} \cdot \text{s}$
B. $8.0 \, \text{N} \cdot \text{s}$
C. $14 \, \text{N} \cdot \text{s}$
D. $24 \, \text{N} \cdot \text{s}$

10. A 150 kg cart moving at 13 m/s east collided with a 420 kg wagon moving at 5.0 m/s east. The cart rebounded westward with a speed of 3.0 m/s. What was the speed of the wagon after the collision?

A. $0.71 \, \text{m/s}$
B. $1.4 \, \text{m/s}$
C. $8.6 \, \text{m/s}$
D. $11 \, \text{m/s}$

11. A 27 kg object moving eastward at 25 m/s exploded into a 17 kg fragment and a smaller
     10 kg fragment. After the explosion, the 10 kg fragment moved at 18 m/s, 33° north of east.
     What was the speed of the 17 kg fragment after the explosion?

A. 14 m/s
B. 28 m/s
C. 29 m/s
D. 31 m/s

12. A 25 kg block is shown suspended by two ropes. What is the tension in rope 2?
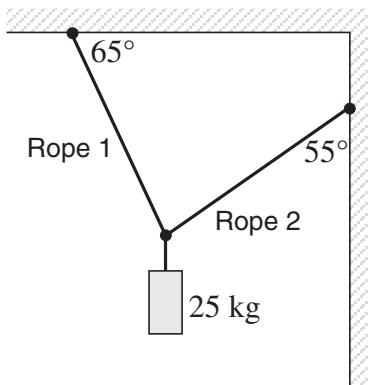
A. 110 N
B. 120 N
C. 260 N
D. 430 N

13. A 5.0 kg mass is suspended from a cord. The mass is held as shown with a horizontal
     23 N force.
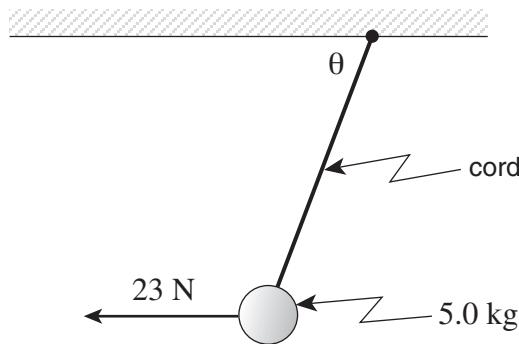
Find angle θ.

A. 12°
B. 62°
C. 65°
D. 78°

14. A uniform 3.5 m beam of mass 54 kg is supported by a cord attached at the 3.0 m position and at an angle as shown in the diagram. The tension in the cord is 730 N.
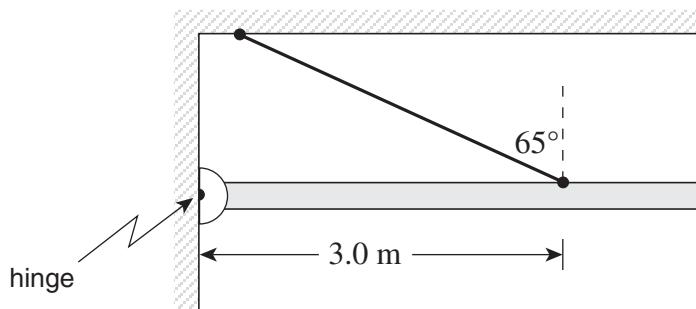
What is the magnitude of the torque produced by the cord about the hinge?

A.　　310 N · m
B.　　930 N · m
C.　　2000 N · m
D.　　2200 N · m

15. The horizontal uniform beam shown below is 4.0 m long and has a mass of 120 kg.
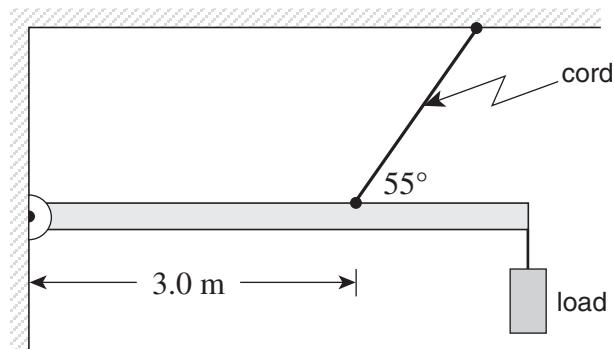
If the maximum tension allowed in the cord is 2.7×10^3 N, what is the maximum load that can be hung from the end of the beam?

A.　　59 kg
B.　　110 kg
C.　　150 kg
D.　　230 kg

16. A car completes a horizontal circle of radius r in time T. The same car then completes a larger horizontal circle of radius $2r$ in half the time. What is the ratio of the centripetal acceleration a_c for the car in the second circle to that in the first circle a_{c2}/a_{c1} ?

    A. 1/8
    B. 1/2
    C. 2/1
    D. 8/1

17. An object is in uniform horizontal circular motion.


Top View
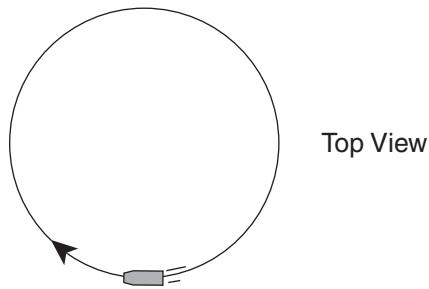
Which of the following shows the correct direction for the velocity, centripetal acceleration, and centripetal force on the object at the point shown?

	DIRECTION OF THE VELOCITY	DIRECTION OF THE CENTRIPETAL ACCELERATION	DIRECTION OF THE CENTRIPETAL FORCE
A.	↑	↑	↑
B.	↑	←	↓
C.	←	←	↓
D.	←	↑	↑

18. A roller coaster car carrying a 75.0 kg man has a speed of 24.3 m/s at the bottom of a circular loop.

$r = 12.0 \, \text{m}$
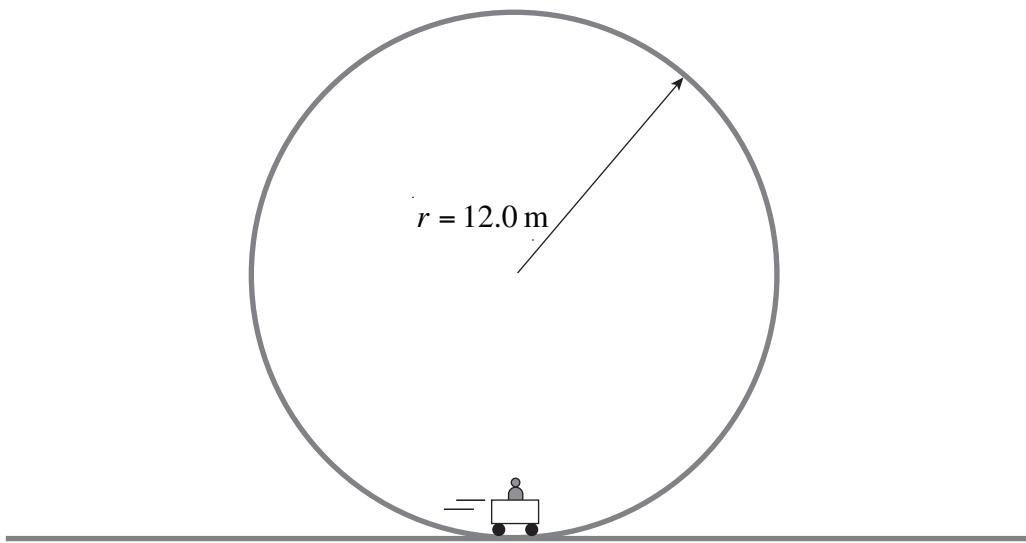
What is the normal force acting on the man when the coaster is at the bottom of the loop? (Ignore friction.)

A. 735 N
B. 2960 N
C. 3690 N
D. 4430 N

19. A satellite is placed in an orbit at a distance $8R$ away from the centre of the earth. It is then moved to a new orbit of radius $2R$ away from the earth's centre. Which of the following is the correct ratio of the gravitational force in the new orbit to that in the old orbit?

A. $2:1$
B. $4:1$
C. $8:1$
D. $16:1$

20. A 1600 kg object is initially at rest 400 km above the earth's surface. The object falls straight down and generates 8.3×10^8 J of heat energy while descending to an altitude of 100 km.
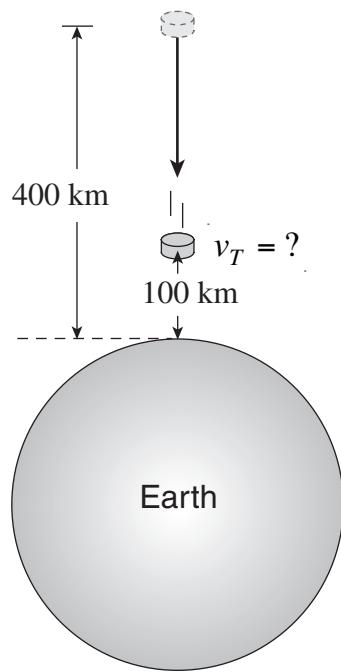
What is the velocity (v_T) of the object at this altitude?

A. 2 100 m/s
B. 2 200 m/s
C. 2 600 m/s
D. 11 000 m/s

21. A planet is in an orbit of radius R around a star. The gravitational force exerted by the star on the planet is F. The star expands to 5 times its original volume while maintaining all of its mass.

Before expansion
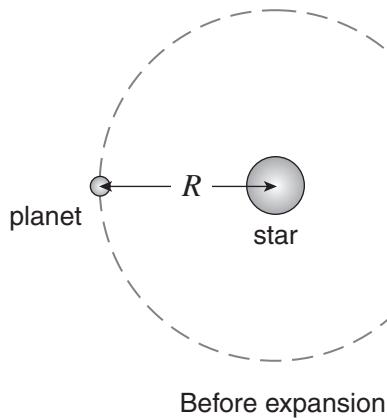
What happens to the gravitational force exerted by the star on the planet due to the expansion of the star?

A. reduced to $\frac{1}{5}F$
B. remains unchanged
C. increased to 5F
D. increased to 25F

22. Three point charges are arranged as shown below.
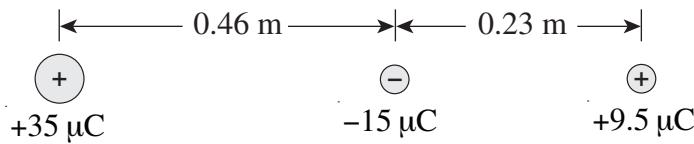
What are the magnitude and direction of the electric force on the $-15\,\mu C$ charge due to the other two point charges?

	MAGNITUDE OF ELECTRIC FORCE	DIRECTION OF ELECTRIC FORCE
A.	1.9 N	right
B.	1.9 N	left
C.	47 N	right
D.	47 N	left

23. Each diagram shows two points X and Y in the electric field near a positive charge. In which case is the difference in the magnitudes of the electric field strengths for the two points greatest?

A.

Y
●

(+)

●
X

B.

(+)

●
X

●
Y

C.

●
Y

(+)

●
X

D.

●
Y

(+)

●
X
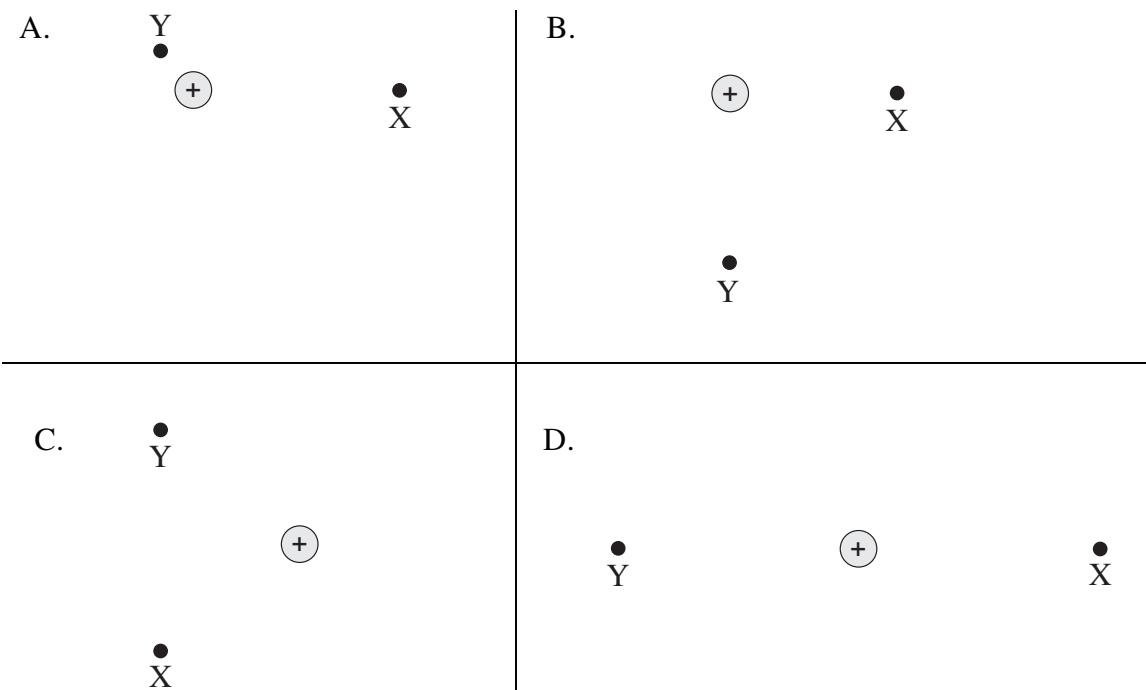
24. What is the change in potential energy of a 6.0 μC charge when it is moved 3.0 m closer to a 45 μC charge as shown?

6.0 μC   45 μC

(+) ⟶ (+)   (+)

|← 3.0 m →|← 2.0 m →|
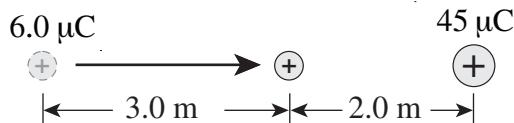
A. 0.49 J
B. 0.73 J
C. 1.2 J
D. 1.7 J

25. An electron travelling at 1.4×10^7 m/s enters the region between two charged parallel plates as shown.

$v = 1.4 \times 10^7$ m/s

1200 V   V = ?
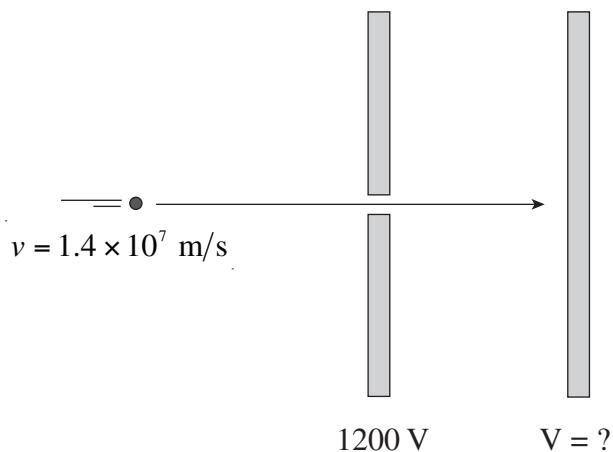
What voltage applied to the second plate would result in the electron just reaching this plate $(v_f = 0$ at second plate$)$ and what is the direction of the electric field between the plates?

	VOLTAGE APPLIED TO SECOND PLATE	DIRECTION OF E-FIELD
A.	640 V	right
B.	640 V	left
C.	1800 V	right
D.	1800 V	left

26. Consider the circuit element shown below.
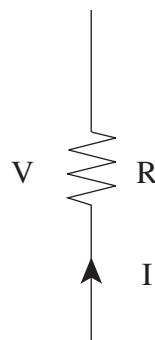
The voltage across the resistor increases from V to 2V. The current remains the same. By what factor has the resistance changed?

A. $\frac{1}{4}$

B. $\frac{1}{2}$

C. 2

D. 4

27. A current of 2.0 A flows through resistor R_1 as shown below.

$R_3 = 5.0\ \Omega$

2.0 A

R_1

R_2

$V_2 = 8.0\ \text{V}$
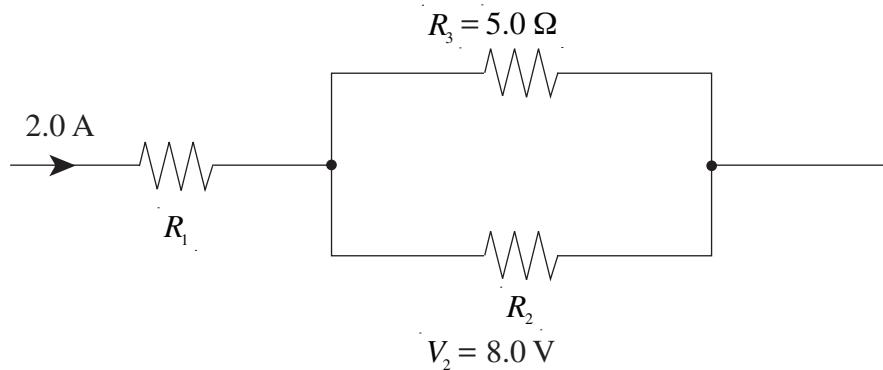
What is the current flowing through the 5.0 Ω resistor?

A. 0.40A
B. 1.0 A
C. 1.2 A
D. 1.6 A

28. An electric motor is being supplied with 4.2 A of current at 120 V. The resistance of the motor is 8.0 Ω. How much power is the motor dissipating as heat?

    A. 15 W

    B. 1.4×10^2 W

    C. 5.0×10^2 W

    D. 1.8×10^3 W

29. A power source is providing a constant voltage V to the circuit shown below.
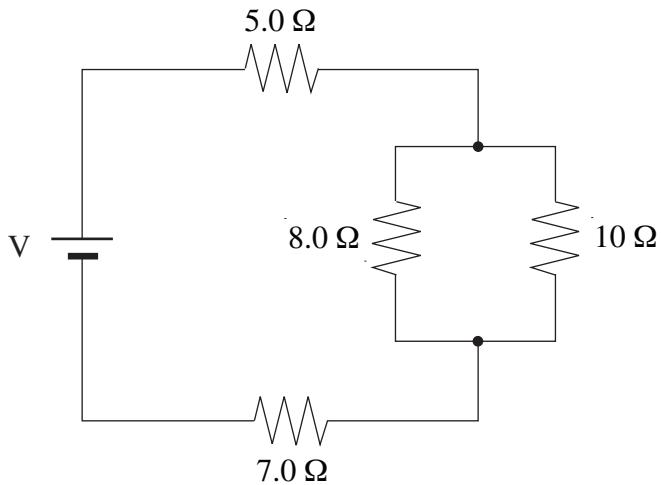
If a 4.0 Ω resistor is added to the circuit in **series** with the 5.0 Ω what happens to the equivalent resistance of the circuit and the current through the 7.0 Ω resistor?

	EQUIVALENT RESISTANCE OF THE CIRCUIT	CURRENT THROUGH 7.0 Ω RESISTOR
A.	increases	decreases
B.	decreases	increases
C.	increases	increases
D.	decreases	decreases

30. A 0.20 m-long solenoid with 700 turns of conducting wire has a current of 1.5 A. What is the strength of the magnetic field inside the solenoid?

    A. 2.4×10^{-10} T

    B. 5.4×10^{-10} T

    C. 2.9×10^{-3} T

    D. 6.6×10^{-3} T

31. A conducting wire is carrying a current towards the top of the page as shown below.
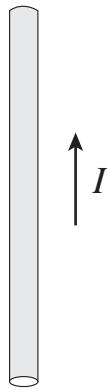
    Due to the presence of a magnetic field the wire is experiencing a magnetic force directed out of the page. What is the direction of the magnetic field?

    A. left
    B. right
    C. into the page
    D. out of the page

32. A proton is travelling in a circular path of radius 0.19 m perpendicular to a 0.55 T magnetic field. What is the momentum of this proton?

   A. 2.8×10^{-47} kg·m/s

   B. 5.8×10^{-28} kg·m/s

   C. 1.7×10^{-20} kg·m/s

   D. 1.0×10^{7} kg·m/s

33. The single rectangular loop of wire shown below is being pulled out of the 0.50 T magnetic field at a constant speed. An emf of 0.60 V is being generated in the loop and the length of side 'ℓ' is 0.30 m.
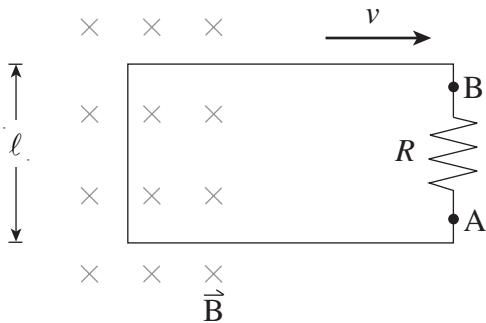
What is the speed of the loop and what is the direction of the current through the resistor?

	SPEED OF LOOP (m/s)	DIRECTION OF CURRENT
A.	4.0	B to A
B.	0.090	A to B
C.	4.0	A to B
D.	0.090	B to A

34. A changing magnetic field induces a current in the loop of wire shown below.
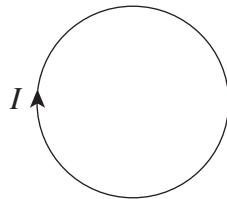
Which of the following correctly describes the magnetic field?

A. directed into the page and decreasing
B. directed out of the page and decreasing
C. directed towards the top of the page and decreasing
D. directed towards the bottom of the page and decreasing

35. The current through an electric motor is increasing. The applied voltage is constant. Which of the following is correct?

A. The motor's back emf is constant.
B. The motor's back emf is increasing.
C. The motor's back emf is decreasing.
D. The motor's back emf is increasing then decreasing.

You have **Examination Booklet Form A**. In the box above #1 on your **Answer Sheet**, ensure you filled in the bubble as follows.

Exam Booklet Form/ Cahier d'examen	A ●	B ○	C ○	D ○	E ○	F ○	G ○	H ○

This is the end of the multiple-choice section.
Answer the remaining questions directly in the Response Booklet.

FUNDAMENTAL CONSTANTS AND PHYSICAL DATA

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

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

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

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

Earth

    radius .... $=\ 6.38 \times 10^{6}\,\text{m}$

    mass .... $=\ 5.98 \times 10^{24}\,\text{kg}$

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

    period of rotation .... $=\ 8.61 \times 10^{4}\,\text{s}$

    radius of orbit around Sun .... $=\ 1.50 \times 10^{11}\,\text{m}$

    period of orbit around Sun .... $=\ 3.16 \times 10^{7}\,\text{s}$

Moon

    radius .... $=\ 1.74 \times 10^{6}\,\text{m}$

    mass .... $=\ 7.35 \times 10^{22}\,\text{kg}$

    period of rotation .... $=\ 2.36 \times 10^{6}\,\text{s}$

    radius of orbit around Earth .... $=\ 3.84 \times 10^{8}\,\text{m}$

    period of orbit around Earth .... $=\ 2.36 \times 10^{6}\,\text{s}$

Sun

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

MATHEMATICAL FORMULAE

| METRIC PREFIXES			
Prefix	Symbol	Numerical	Exponential
mega	M	1 000 000	10^6
kilo	k	1 000	10^3
hecto	h	100	10^2
deca	da	10	10^1
		1	10^0
deci	d	0.1	10^{-1}
centi	c	0.01	10^{-2}
milli	m	0.001	10^{-3}
micro	µ	0.000001	10^{-6}
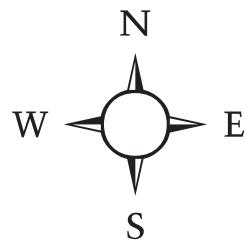
For Right-angled Triangles:
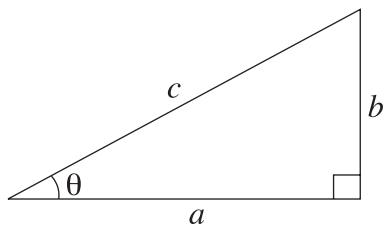
$$a^2 + b^2 = c^2$$

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

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

For All Triangles:
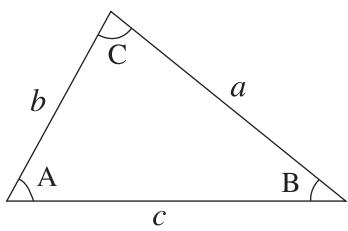
$$\text{area} = \frac{1}{2}\text{base} \times \text{height}$$

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

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

Circle:

$$\text{Circumference} = 2\pi r$$

$$\text{Area} = \pi r^2$$

Quadratic Equation:

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

PHYSICS FORMULAE

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:

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

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

Momentum:

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

Equilibrium:

$$\tau = Fd$$

Circular Motion:

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

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

Gravitation:

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

Electrostatics:

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

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

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

Electric Circuits:

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

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

Electromagnetism:

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

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

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

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

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

Place Personal Education Number (PEN) here.

Course Code = PH   12

JANUARY 2010

Exam Booklet Form/   A   B   C   D   E   F   G   H
Cahier d'examen   ○   ○   ○   ○   ○   ○   ○   ○

Student Instructions

1. Place your Personal Education Number (PEN) label at the top of this Booklet **AND** fill in the bubble (Form A, B, C, D, E, F, G or H) that corresponds to the letter on your Examination Booklet.

2. Use a pencil to fill in bubbles when answering questions on your Answer Sheet.

3. Use a pencil or blue- or black-ink pen when answering written-response questions in this Booklet.

4. Read the Examination Rules on the back of this Booklet.

Question 1								
0	1	2	3	4	5		(.5)	NR
□	□	□	□	□	□		□	□

Question 2								
0	1	2	3	4	5		(.5)	NR
□	□	□	□	□	□		□	□

Question 3								
0	1	2	3	4	5	6	(.5)	NR
□	□	□	□	□	□	□	□	□

Question 4								
0	1	2	3	4	5		(.5)	NR
□	□	□	□	□	□		□	□

Question 5								
0	1	2	3	4	5		(.5)	NR
□	□	□	□	□	□		□	□

Question 6						
0	1	2	3	4		NR
□	□	□	□	□		□

39088

Place Personal Education Number (PEN) here.

Course Code = PH 12

Physics 12
2009/2010 Released Exam
JANUARY 2010
Response Booklet

PART B: WRITTEN RESPONSE
Value: 30% of the examination

Suggested Time: 50 minutes

|	
INSTRUCTIONS:	1. 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.
	2. 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.
	3. 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.
	4. 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.
	5. **Full marks will NOT be awarded for providing only a final answer.**

1. **(5 marks)**

A 1.5 kg ball was moving east at 72 m/s and collided with a stationary 8.3 kg wooden sphere. The ball rebounded at 43 m/s in the direction 55° north of west. What were the speed and direction of the wooden sphere after the collision?

N

W ⊙ E

S

Before Collision

72 m/s

1.5 kg

8.3 kg

After Collision

43 m/s

55°

θ   v
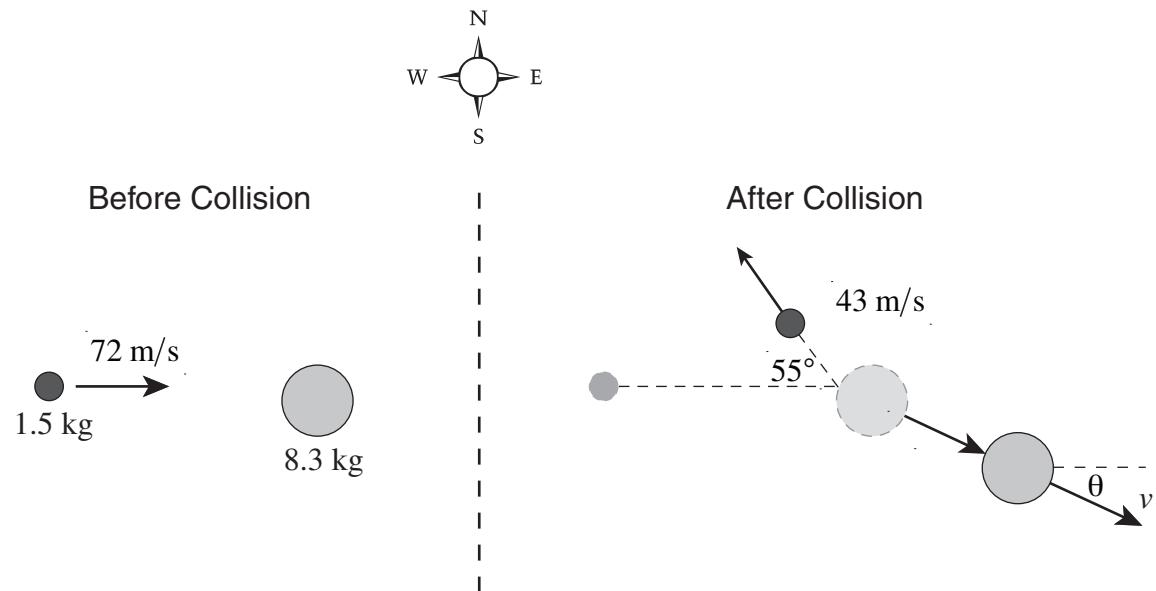
2. **(5 marks)**

A 1.5 m-long uniform beam supports a 120 kg load. The beam is suspended by a wire connected as shown. This wire is under a tension of 3700 N.

Wire

$F_T = 3700$ N

70°

18°

1.5 m beam

120 kg
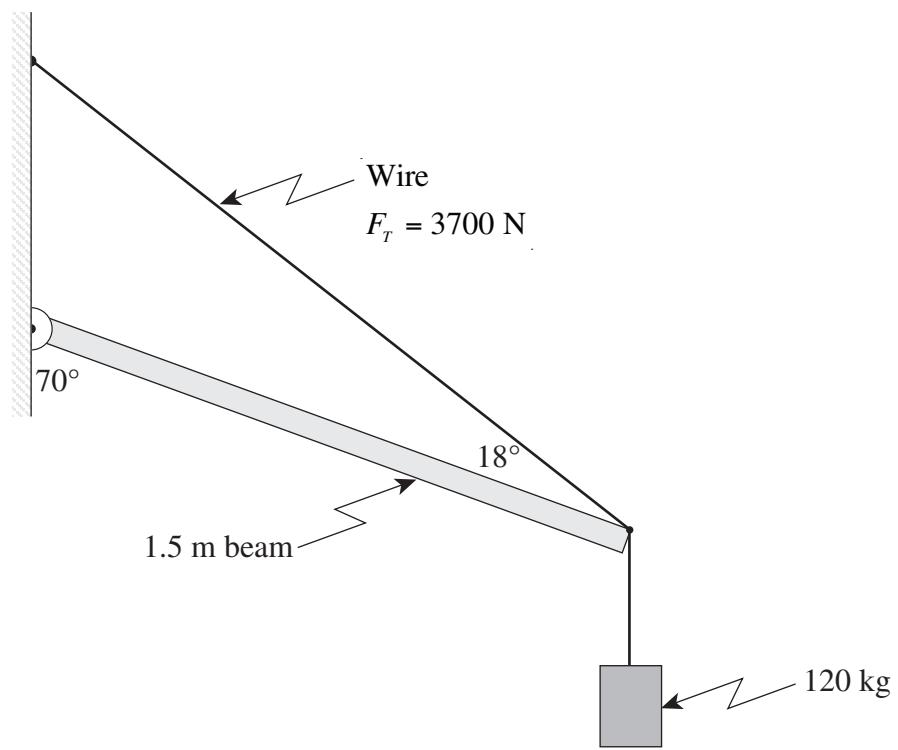
What is the mass of the beam?

3. **(6 marks)**

A battery having an emf of 12.0 V is connected to the circuit as shown.

$I = 0.77$ A

Emf $= 12.0$ V

R

S

$R = 20.0\ \Omega$

$R = 40.0\ \Omega$
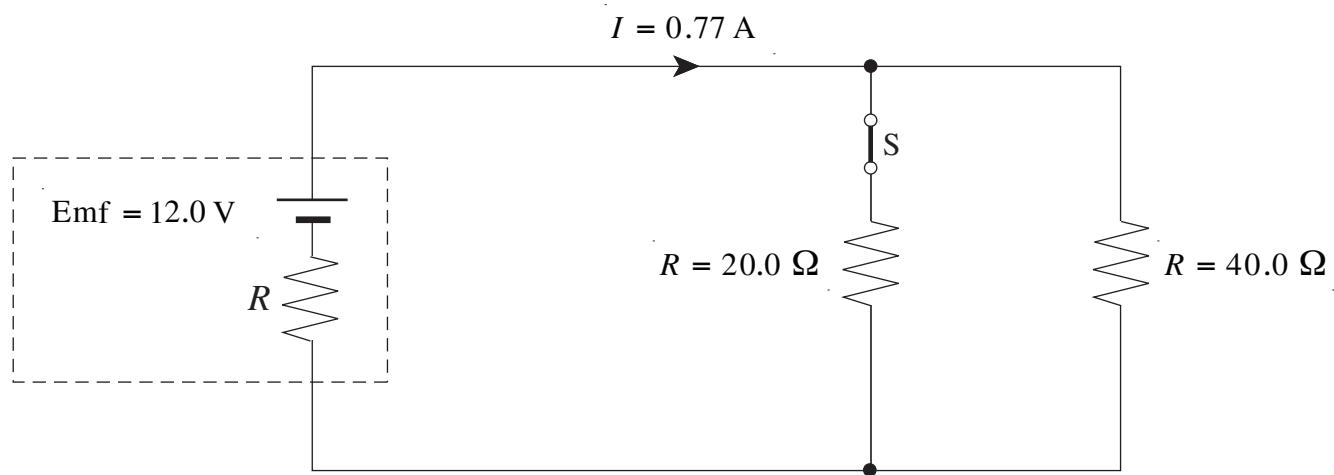
What is the terminal voltage of the battery?

Explain what happens to the terminal voltage of this battery when switch S is opened.

_____

_____

_____

_____

_____

_____

4. **(5 marks)**

Two solenoids, placed side by side as shown, are functioning together as an ideal transformer. The first solenoid has 230 coils and the second has 46 coils. An *ac* power supply provides the first solenoid with a current of 0.35 A.

1st Solenoid   2nd Solenoid

ac power supply

15.0 Ω
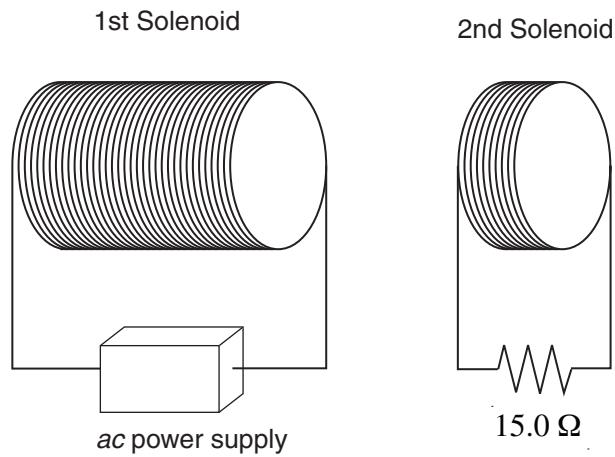
What power is dissipated in the 15.0 Ω resistor connected to the second coil?

5. **(5 marks)**

During an electrostatics experiment to investigate electric potential energy, a positive point charge, q_1, is moved gradually closer to a $10 \, \mu C$ charge that is fixed to a table top. The charges are initially far apart.

The electric potential energy, E_p, of q_1 is determined at several separation distances, r, from the $10 \, \mu C$ fixed charge.

It is possible to use such data (E_p and r) to create a linear graph and obtain a slope.

In the box on the graph below write the function (include units) of the separation distance, r, that must be used on the horizontal axis to produce a linear relation from this data.

$E_p(\text{J})$

function of r including units
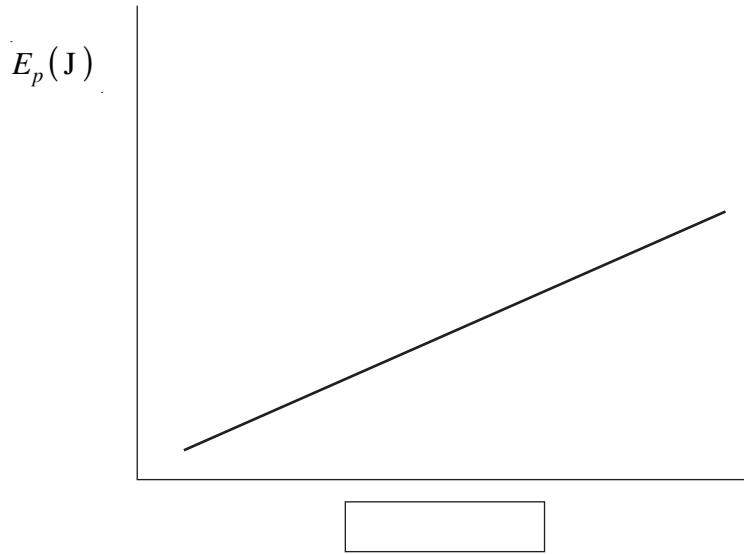
Explain how you can use the slope of this graph to determine the unknown charge q_1.

_____

_____

_____

_____

_____

6. **(4 marks)**

You are pulling a crate across a smooth concrete floor with a constant horizontal force, *F*.
The crate's speed is increasing.
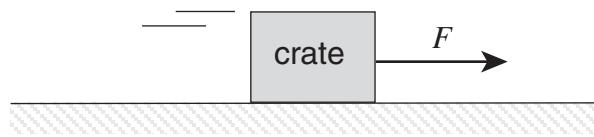
Using principles of physics, explain why your power output is also increasing.

_____

_____

_____

_____

_____

_____

END OF EXAMINATION

Examination Rules

1. The time allotted for this examination is two hours.
   You may, however, take up to 60 minutes of additional time to finish.

2. Answers entered in the Examination Booklet will not be marked.

3. Cheating on an examination will result in a mark of zero. The Ministry of Education considers cheating to have occurred if students break any of the following rules:

   - Students must not be in possession of or have used any secure examination materials prior to the examination session.

   - Students must not communicate with other students during the examination.

   - Students must not give or receive assistance of any kind in answering an examination question during an examination, including allowing their papers to be viewed by others or copying answers from another student's paper.

   - Students must not possess any book, paper or item that might assist in writing an examination, including a dictionary or piece of electronic equipment, that is not specifically authorized for the examination by ministry policy.

   - Students must not copy, plagiarize or present as their own, work done by any other person.

   - Students must immediately follow the invigilator's order to stop writing at the end of the examination time and must not alter an Examination Booklet, Response Booklet or Answer Sheet after the invigilator has asked students to hand in examination papers.

   - Students must not remove any piece of the examination materials from the examination room, including work pages.

4. The use of inappropriate language or content may result in a mark of zero being awarded.

5. Upon completion of the examination, return all examination materials to the supervising invigilator.