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BRITISH COLUMBIA

Physics 12

JANUARY 2003

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. ☐ . ☐

(7)

Question 8:

8. ☐ . ☐

(5)

Question 2:

2. ☐ . ☐

(9)

Question 9:

9. ☐ . ☐

(4)

Question 3:

3. ☐ . ☐

(7)

Question 4:

4. ☐ . ☐

(7)

Question 5:

5. ☐ . ☐

(7)

Question 6:

6. ☐ . ☐

(7)

Question 7:

7. ☐ . ☐

(7)

PHYSICS 12

JANUARY 2003

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

1. This examination consists of **two** parts:

		Value	Suggested Time
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 be capable of performing graphing functions. Computers, calculators with a QWERTY keyboard or symbolic manipulation abilities, and electronic writing pads will not be allowed. Students must not bring any external devices (peripherals) to support calculators such as manuals, printed or electronic cards, printers, memory expansion chips or cards, CD-ROMs, libraries or external keyboards. Students may have more than one calculator available during the examination, of which one may be a scientific calculator. 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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PART A: MULTIPLE CHOICE

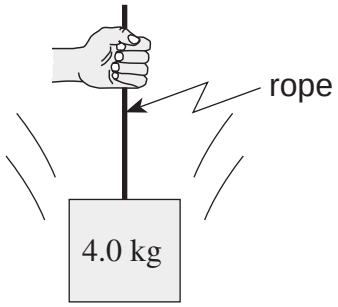
Value: 60 marks (2 marks per question) **Suggested Time: 60 minutes**

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. Inertia is directly related to which of the following quantities?

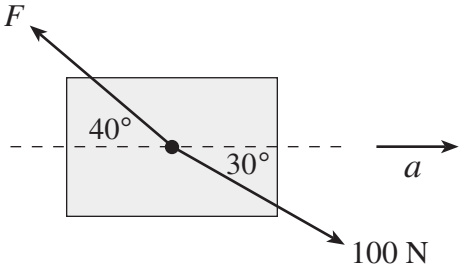
   A. mass
   B. charge
   C. velocity
   D. position

2. The 4.0 kg block shown below is accelerating downwards at $3.0\ \mathrm{m/s^2}$ near the earth's surface. What is the tension in the rope attached to it?



   A. 12 N
   B. 27 N
   C. 39 N
   D. 51 N

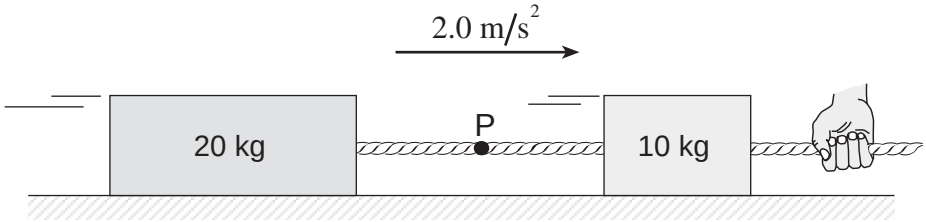
3. The mass shown below is accelerating to the right due to the two forces acting on it. What is the size of the force F ?



   A. 32 N
   B. 50 N
   C. 65 N
   D. 78 N

OVER

4. The system of masses shown below is accelerating to the right at $2.0\ \mathrm{m/s^2}$. If the tension in the rope at point P is 70 N, what is the coefficient of friction between the masses and the surface?



A. 0.15
B. 0.20
C. 0.43
D. 0.57

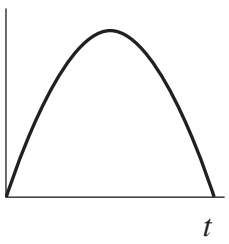
5. A 6.0 kg penguin in a zoo exhibit starts from rest and slides 5.0 m along a very slippery rock slope (ignore friction) into the water in 1.4 s. What angle does the rock slope make with the horizontal?

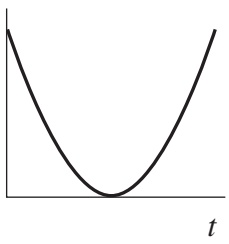
A. 21°
B. 28°
C. 31°
D. 59°

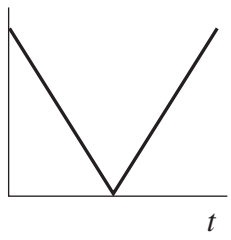
6. In which of the following would a person do the **least** amount of work?

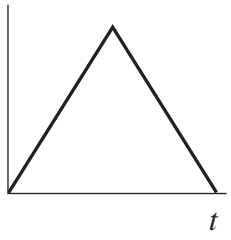
A. Lifting a 10 kg box a vertical height of 1.2 m.
B. Lifting a 10 kg box a vertical height of 1.2 m using a ramp.
C. Pushing a 10 kg box along a smooth floor a distance of 1.2 m.
D. Dragging a 10 kg box along a rough floor a distance of 1.2 m.

7. A rock is thrown straight up. Which of the following represents the kinetic energy versus time graph of the rock while it is in the air?

A. 

B. 

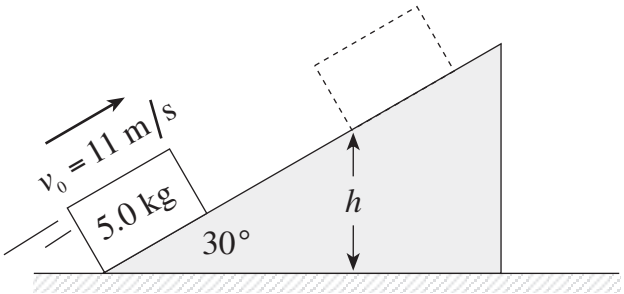
C. 

D. 

8. What minimum force applied over a distance of 35.0 m would be needed to accelerate a 925 kg car from rest to 13.9 m/s ?

A. 367 N
B. 2550 N
C. 12 900 N
D. 89 400 N

9. A 5.0 kg block initially travelling at 11 m/s moves up a 30° incline as shown.



A frictional force of 9.4 N acts on the block as it moves up the incline. What maximum vertical height, *h*, will the block reach?

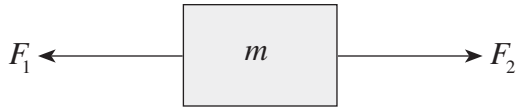
A. 4.5 m
B. 5.2 m
C. 6.2 m
D. 6.7 m

OVER

10. Which of the following are correct units for torque?

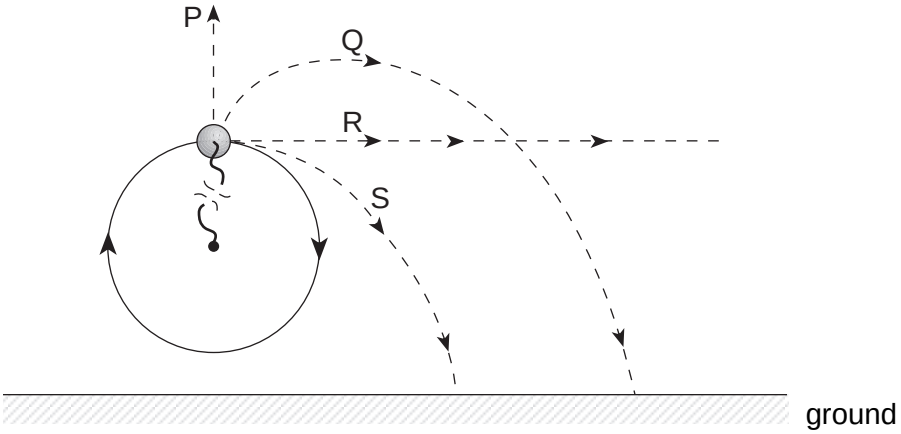
A. N/m
B. N/kg
C. N · s
D. N · m

11. If the only forces acting on the object shown below are equal in magnitude, which of the following is **not possible**?



A. The object is at rest.
B. The object is accelerating to the left.
C. The object is moving with constant velocity to the right.
D. The object is moving with constant velocity towards the top of the page.

12. A ball moves at a constant speed in a **vertical** circle when the string breaks at the position shown.



The ball would then move along which of the indicated paths?

A. P
B. Q
C. R
D. S

13. A 0.090 m **diameter** computer floppy disk spins at a constant speed of 1.40 m/s measured at its rim. What is the centripetal acceleration at the rim of this floppy disk?

A. $16\ m/s^2$
B. $22\ m/s^2$
C. $31\ m/s^2$
D. $44\ m/s^2$

14. A 960 kg car is travelling on a 65 m radius horizontal circular track. The coefficient of friction between the tires and the track surface is 0.57. What is the minimum time for the car to complete one lap of the track?

A. 0.69 s
B. 12 s
C. 21 s
D. 67 s

15. A satellite is brought from a higher circular orbit to a lower circular orbit around the earth. Which of the following describes what has happened to the satellite's period?

A. The satellite's period decreased.
B. The satellite's period increased.
C. The satellite's period did not change.
D. You cannot determine this without more information.

16. A 2500 kg satellite is placed into a circular orbit at an altitude of 1.2×10^5 m above the earth's surface. What is the period of this satellite?

A. 13 s
B. 700 s
C. 5100 s
D. 5200 s

OVER

17. A 3500 kg piece of space debris is brought from an altitude of 2.1×10^{5} m back to the earth's surface. What is the change in potential energy of this space debris?

A. -7.0×10^{9} J

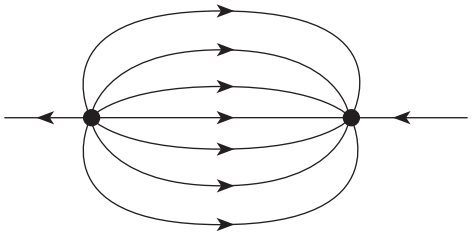
B. -7.2×10^{9} J

C. -2.1×10^{11} J

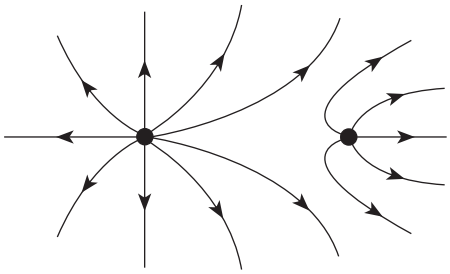
D. -2.2×10^{11} J

18. Which of the following represents the electric field between two opposite point charges of different magnitudes?

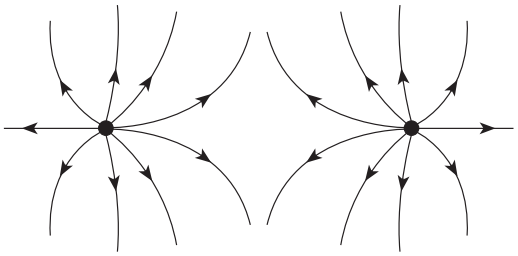
A.



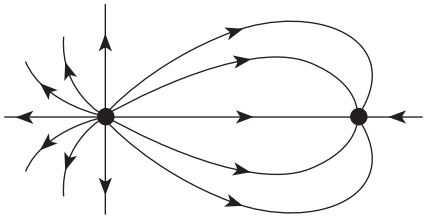
B.



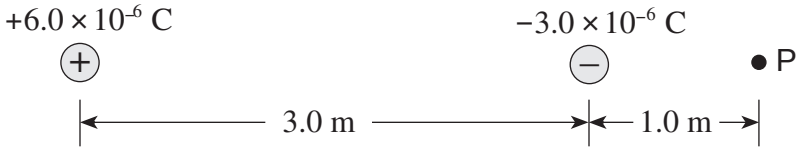
C.



D.

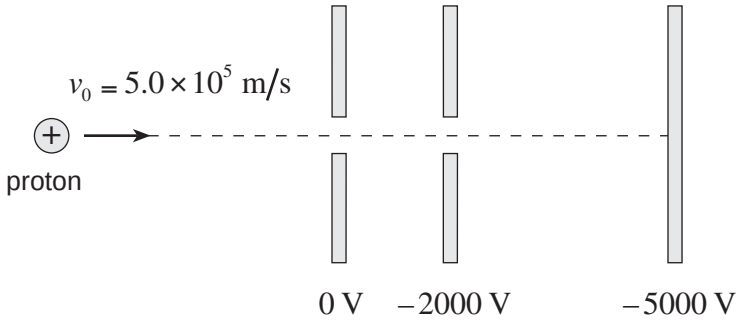


19. What are the magnitude and direction of the electric field at point P?



	MAGNITUDE OF ELECTRIC FIELD AT P	DIRECTION OF ELECTRIC FIELD AT P
A.	2.4×10^{4} N/C	left
B.	2.4×10^{4} N/C	right
C.	3.0×10^{4} N/C	left
D.	3.0×10^{4} N/C	right

20. A proton moving at 5.0×10^5 m/s enters a series of charged parallel plates. What is the impact speed on the last plate?

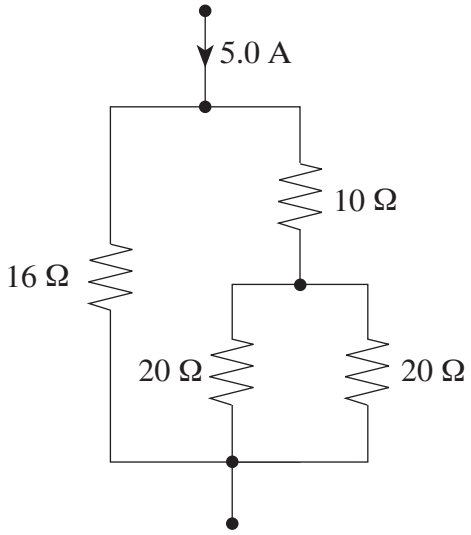


A. 9.1×10^5 m/s
B. 9.8×10^5 m/s
C. 1.1×10^6 m/s
D. 1.3×10^6 m/s

21. Which of the following is a correct statement?

A. The current in a typical resistor is directly proportional to the applied voltage.
B. The current in a typical resistor is inversely proportional to the applied voltage.
C. The total current into a junction is less than the total current out of the junction.
D. The total current into a junction is greater than the total current out of the junction.

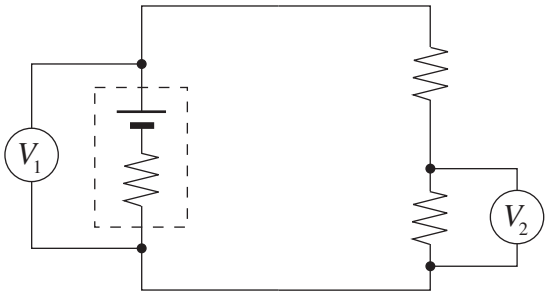
22. The following diagram shows part of a complete circuit. What is the power dissipated in one of the 20 Ω resistors?



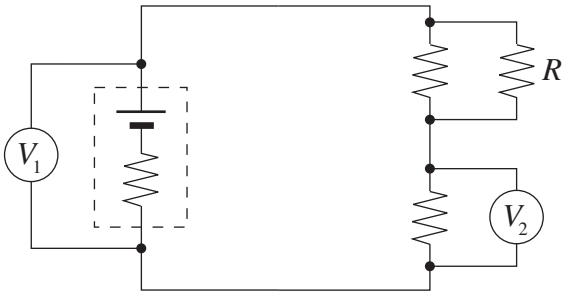
A. 16 W
B. 25 W
C. 33 W
D. 99 W

OVER

23. Circuit 1 is shown below. Resistor *R* is added to form circuit 2.



Circuit 1



Circuit 2

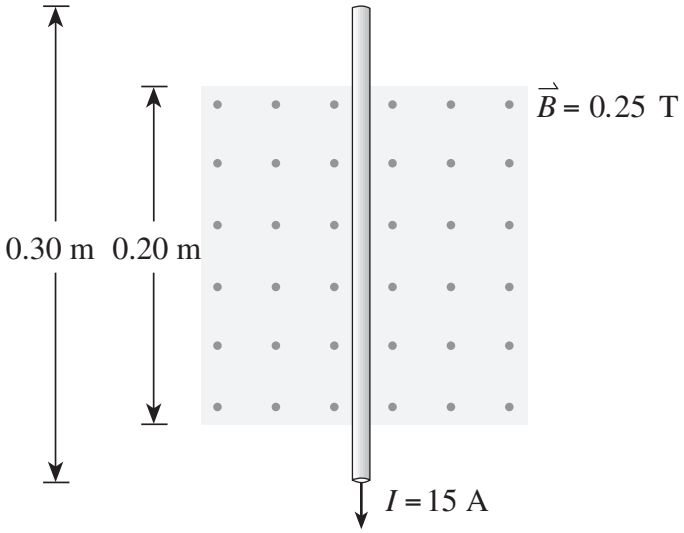
When resistor *R* is added, how do the voltmeter readings change?

	V_1	V_2
A.	decrease	decrease
B.	decrease	increase
C.	increase	decrease
D.	increase	increase

24. Which of the following are correct units for magnetic flux?

A. T
B. $\mathrm{T/m}$
C. Wb
D. $\mathrm{Wb \cdot m^2}$

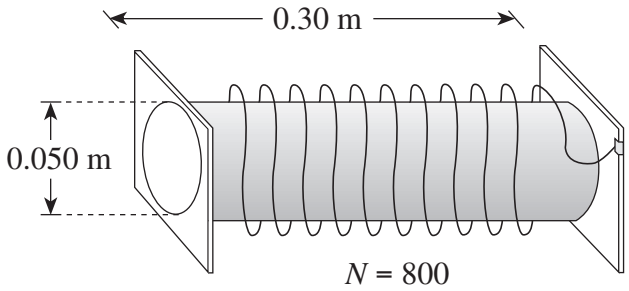
25. A conductor is placed in a magnetic field as shown.



What are the magnitude and direction of the magnetic force acting on this conductor when it carries a 15 A current?

	MAGNITUDE OF MAGNETIC FORCE	DIRECTION OF MAGNETIC FORCE
A.	0.75 N	To the left
B.	0.75 N	To the right
C.	1.1 N	To the left
D.	1.1 N	To the right

26. Consider the 800-turn solenoid shown in the diagram below.

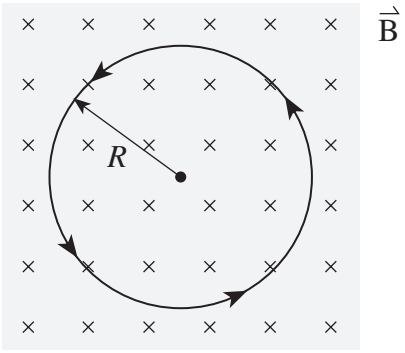


What is the current in the windings that would produce a magnetic field of 0.060 T at the centre of this solenoid?

A. 3.0 A
B. 8.0 A
C. 18 A
D. 290 A

OVER

27. The path of a charged particle in a uniform magnetic field is circular when the initial velocity is perpendicular to the field.



Which of the following is a valid expression for the radius of this orbit in terms of the magnetic field strength, and the particle's momentum and charge?

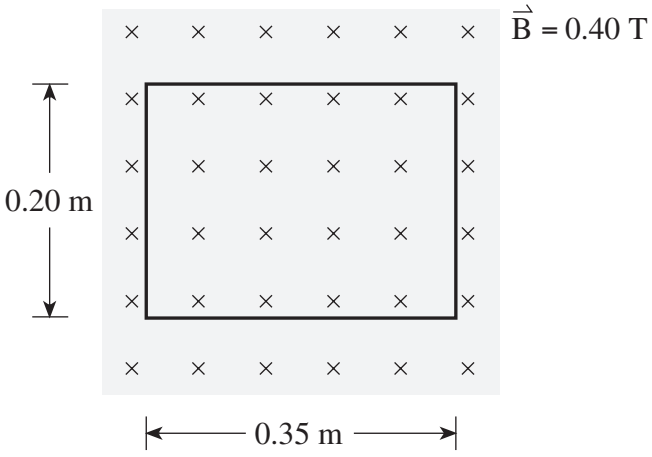
A. Bqp

B. $\frac{Bp}{q}$

C. $\frac{Bq}{p}$

D. $\frac{p}{Bq}$

28. A rectangular loop of wire is placed in a magnetic field as shown in the diagram.



If the loop is removed from the field in a time of 0.050 s, what is the induced emf?

A. 0.028 V
B. 0.28 V
C. 0.56 V
D. 5.7 V

29. A direct current motor operates from a 24.0 V supply. When the motor is operating the current through it is 1.50 A and the back emf is 22.0 V. What is the resistance of the motor's armature?

A. 0.75 Ω
B. 1.3 Ω
C. 15 Ω
D. 16 Ω

30. A certain step-down transformer has a 500-turn primary that operates at 120 V ac. Which one of the following sets of conditions could describe the secondary turns and voltage of this transformer?

	SECONDARY TURNS	SECONDARY VOLTAGE
A.	400	96 V
B.	400	150 V
C.	2000	30 V
D.	2000	480 V

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**

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.

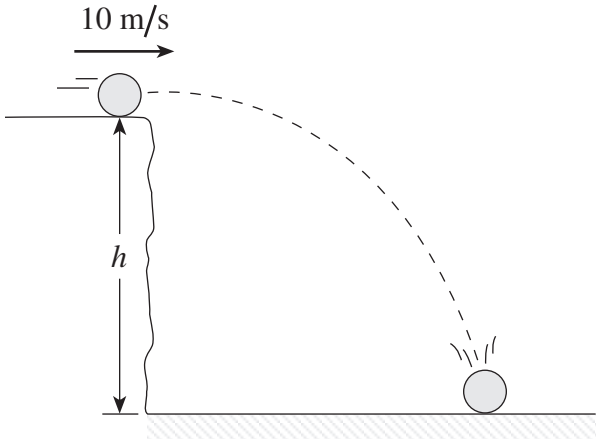
3. You are expected to communicate your knowledge and understanding of physics principles in a clear and logical manner. Partial marks will be awarded for steps and assumptions leading to a solution.

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.**

OVER

1. A blue ball rolls off the cliff shown below at 10 m/s and hits the ground with a speed of 30 m/s.



a) What is the vertical component of the ball's impact velocity? **(4 marks)**

ANSWER:

a) vertical component of velocity:

_____

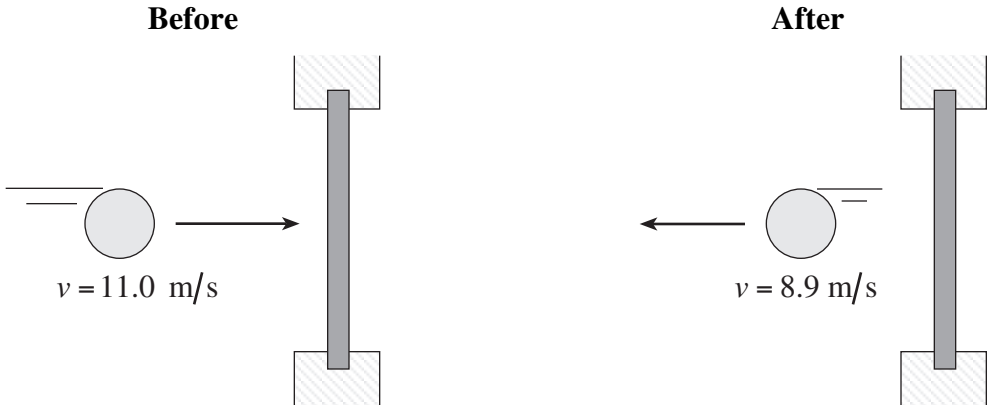
b) How high (h) is the cliff? **(3 marks)**

ANSWER:

b) height of cliff: _____

OVER

2. a) A 0.120 kg ball travelling at 11.0 m/s impacts a solid massive steel wall. The ball bounces straight back at 8.9 m/s.

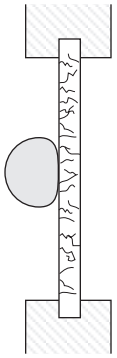


If the ball was in contact with the steel wall for 0.17 s, what is the magnitude of the force that the steel wall imparted on the ball? **(5 marks)**

ANSWER:

a) force: _____

b) An identical ball with the same initial speed as in part a) is then thrown towards a glass window. The glass window cracks and the ball stops in 0.17 s.



Using principles of physics, explain which ball, from part a) or part b), experiences the greater force. **(4 marks)**

_____

_____

_____

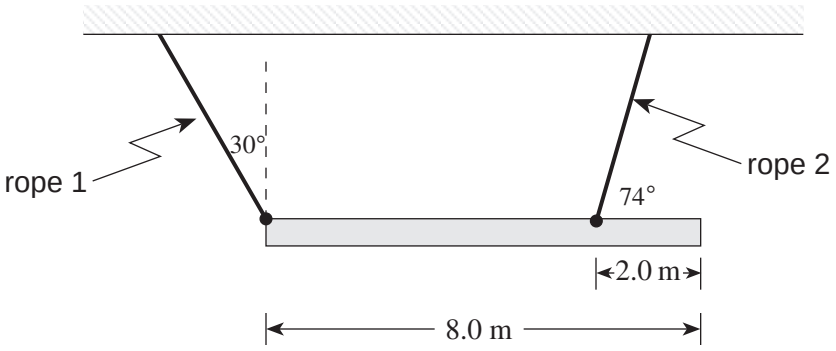
_____

_____

_____

OVER

3. The 8.0 m uniform beam shown below, suspended horizontally by two ropes, has a mass of 75 kg.



Determine the tension in rope 1 and the tension in rope 2. **(7 marks)**

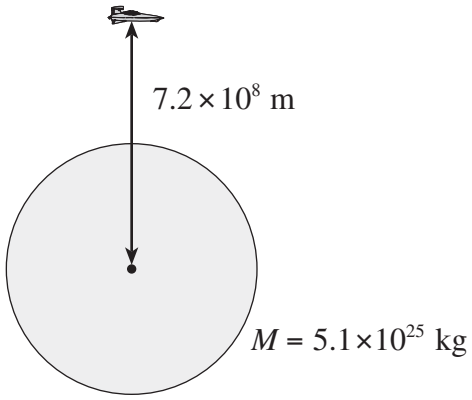
ANSWER:

tension in rope 1: _____

tension in rope 2: _____

OVER

4. A 12 000 kg spaceship is 7.2×10^8 m from the centre of a planet that has a mass of 5.1×10^{25} kg.



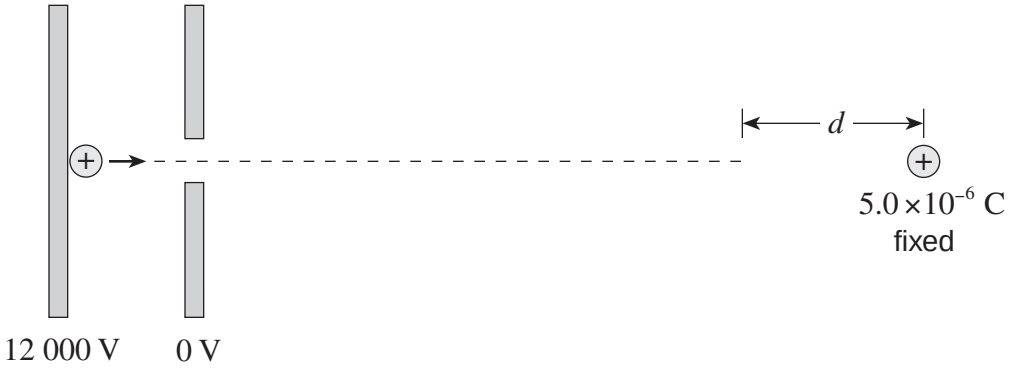
The spaceship gains 9.0×10^{11} J of kinetic energy as it falls to the planet's surface. What is the radius of this planet? **(7 marks)**

ANSWER:

radius of planet: _____

OVER

5. A proton, accelerated from rest through a potential difference of 1.2×10^4 V, is directed at a fixed 5.0×10^{-6} C charge.



(Diagram not to scale.)

a) What is the speed of the proton as it leaves the parallel plates? **(4 marks)**

ANSWER:

a) speed: _____

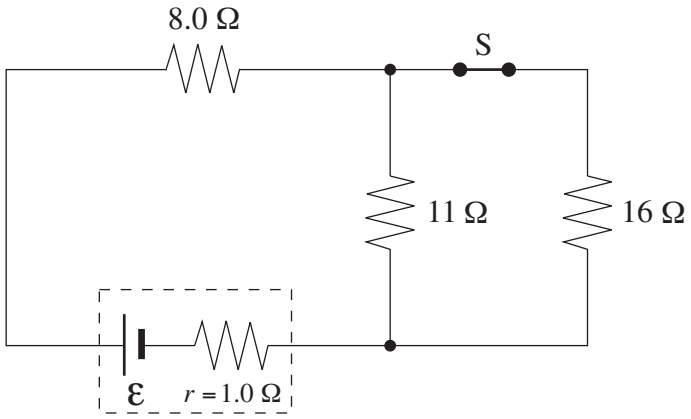
b) What is the distance *d* from the fixed charge when the proton is stopped? **(3 marks)**

ANSWER:

b) distance *d*: _____

OVER

6. The terminal voltage of the battery is 5.8 V.



a) What is the emf of this battery? **(6 marks)**

ANSWER:

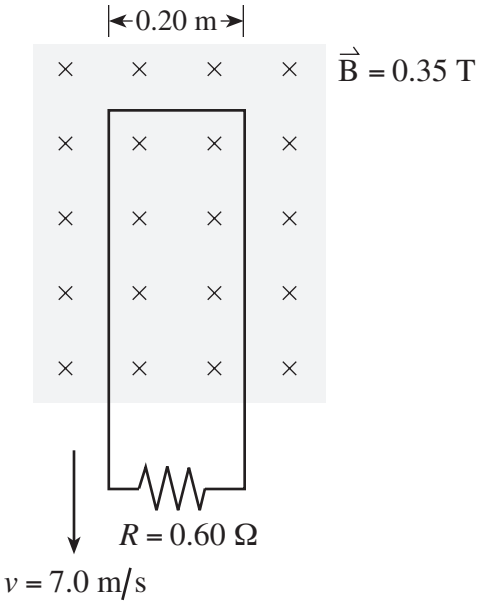
a) emf of the battery: _____

b) What is the effect on the emf of the battery when switch S is opened? **(1 mark)**

_____

OVER

7. A rectangular wire loop with a resistance of $0.60\ \Omega$ is pulled out of a magnetic field at $7.0\ \text{m/s}$ as shown in the diagram.



a) What is the current in the loop? **(5 marks)**

ANSWER:

current: _____

b) What is the direction of the current in the loop? **(2 marks)**

- ❑ clockwise
- ❑ counter-clockwise

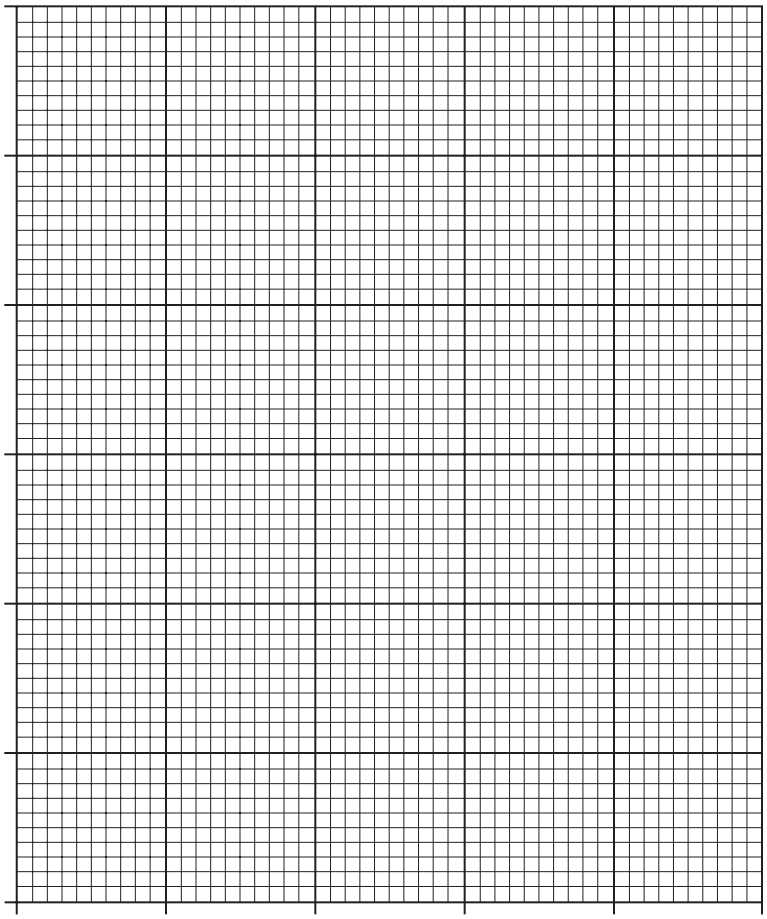
OVER

8. The following data is collected in a kinematics experiment using a toy car.

t (s)	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
$v\left(\mathrm{m/s}\right)$	0.35	0.46	0.59	0.70	0.83	0.94	1.10	1.18

a) Plot the data on a v vs. t graph and extrapolate your line back to $t = 0$. **(2 marks)**

v (m/s)



t (s)

b) What is the displacement of the toy car from $t = 0$ to $t = 0.90$ s? **(2 marks)**

ANSWER:

b) displacement of toy car: _____

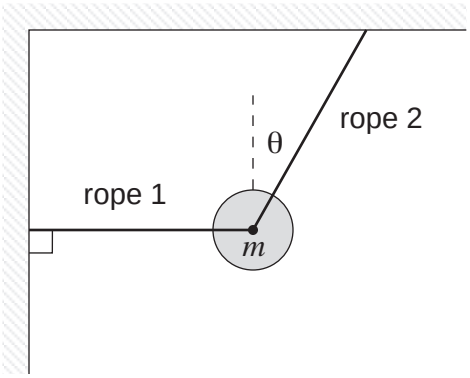
c) What does the *y*-intercept of the graph represent? **(1 mark)**

_____

_____

OVER

9. A mass suspended by two ropes is shown below. It is noticed that for any angle θ used for rope 2, the tension in rope 2 is always greater than the tension in rope 1.



Using principles of physics, explain why this is the case. **(4 marks)**

END OF EXAMINATION

TABLE OF CONSTANTS

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	μ_o	$= 4\pi \times 10^{-7}\ \text{T} \cdot \text{m/A}$
Speed of light	c	$= 3.00 \times 10^{8}\ \text{m/s}$

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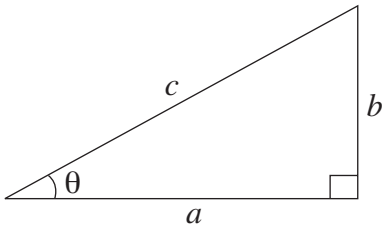
For Right-angled Triangles:

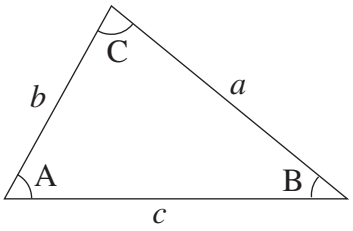


$$a^2 + b^2 = c^2$$

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

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

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

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:

$$F_{\text{net}} = ma \qquad F_{\text{g}} = mg$$

$$F_{\text{fr}} = \mu F_{\text{N}}$$

Work, Energy, and Power:

$$W = Fd \qquad E_{\text{p}} = mgh$$

$$E_{\text{k}} = \frac{1}{2}mv^2 \qquad P = \frac{W}{t}$$

Momentum:

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

Equilibrium:

$$\tau = Fd$$

Circular Motion:

$$a_{\text{c}} = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$$

Gravitation:

$$F = G\frac{m_1 m_2}{r^2} \qquad E_{\text{p}} = -G\frac{m_1 m_2}{r}$$

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Electrostatics:

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

$$\Delta V = \frac{\Delta E_{\mathrm{p}}}{Q} \qquad E = \frac{\Delta V}{d}$$

$$E_{\mathrm{p}} = k\frac{Q_1 Q_2}{r} \qquad V = \frac{kQ}{r}$$

Electric Circuits:

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

$$V_{\mathrm{terminal}} = \varepsilon \pm Ir \qquad P = IV$$

Electromagnetism:

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

$$B = \mu_0 n I = \mu_0 \frac{N}{l} I \qquad \varepsilon = Blv$$

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

$$V_{\mathrm{back}} = \varepsilon - Ir$$

$$\frac{V_{\mathrm{s}}}{V_{\mathrm{p}}} = \frac{N_{\mathrm{s}}}{N_{\mathrm{p}}} = \frac{I_{\mathrm{p}}}{I_{\mathrm{s}}}$$

ROUGH WORK FOR MULTIPLE-CHOICE

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Exercise care when tearing along perforations.