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Physics 12

AUGUST 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. .

(7)

Question 9:

9. .

(4)

Question 2:

2. .

(9)

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

AUGUST 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.*

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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. Newton's second law of motion is best shown by which of the following equations?

A. $a = \frac{v}{t}$

B. $a = \frac{F_{net}}{m}$

C. $F_{net} = mv$

D. $F_{net} = a\left(\frac{d}{t^2}\right)$

2. A 45 kg rock experiences a force of gravity of 168 N on the surface of Mars. What is the gravitational field strength on the surface of Mars?

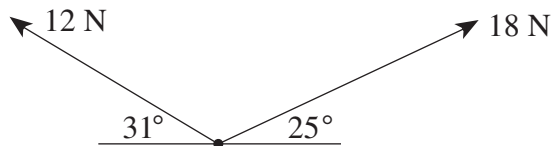
A. 1.6 N/kg

B. 2.6 N/kg

C. 3.7 N/kg

D. 9.8 N/kg

3. Two forces act at a single point as shown.



What is the magnitude of the resulting force?

A. 15 N

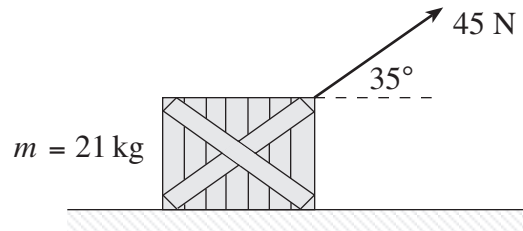
B. 22 N

C. 27 N

D. 30 N

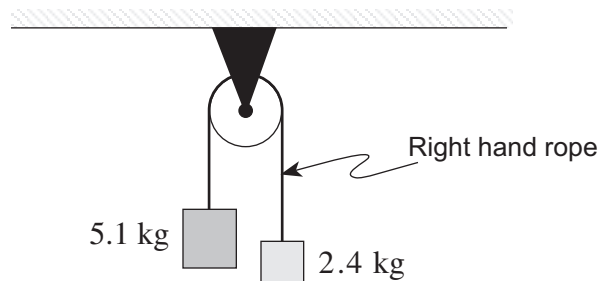
OVER

4. A force of 45 N is applied at an angle of 35° above the horizontal to pull a 21 kg crate across a floor as shown below.



What is the normal force on the crate?

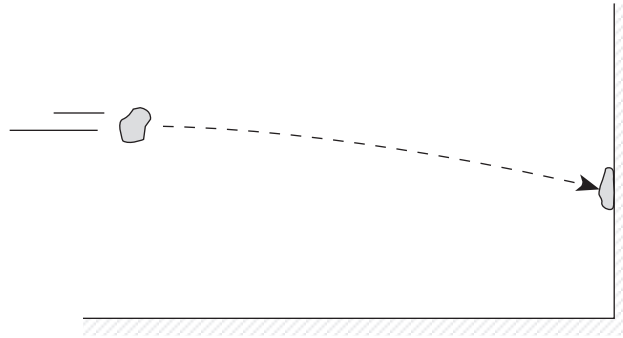
- A. 26 N
 - B. 170 N
 - C. 180 N
 - D. 210 N
5. A frictionless pulley is set up with two hanging masses as shown below.



What is the tension in the right hand rope while the masses move freely?

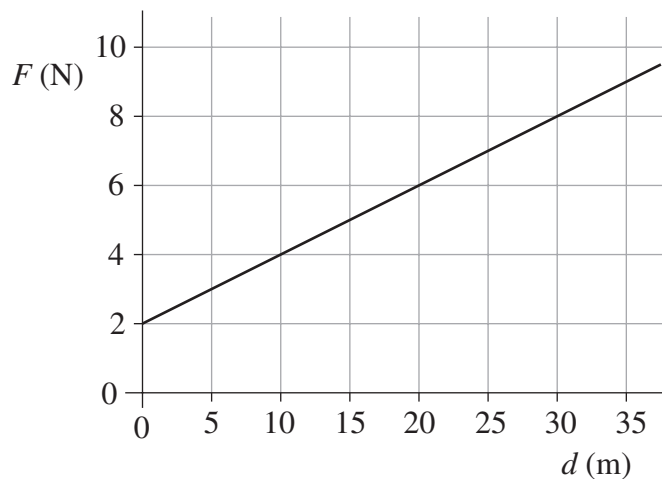
- A. 8.5 N
 - B. 24 N
 - C. 26 N
 - D. 32 N
6. Which of the following best represents efficiency?
- A. Final time compared to initial time
 - B. Work output compared to work input
 - C. Final velocity compared to initial velocity
 - D. Momentum after compared to momentum before

7. A wad of putty is thrown against a wall as shown. The wad of putty sticks against the wall.



Which of the following statements best applies the application of the law of conservation of energy to this collision?

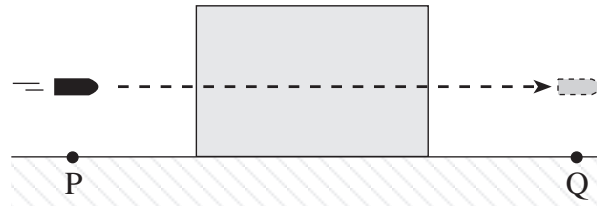
- A. All energy has been lost.
 - B. Kinetic energy is converted to heat.
 - C. Kinetic energy is converted to momentum.
 - D. Kinetic energy is converted to potential energy.
8. The graph below shows how the force applied to an object varies with distance.



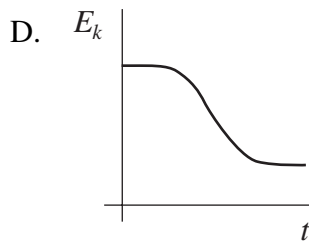
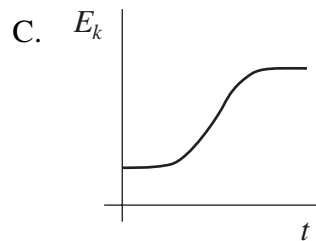
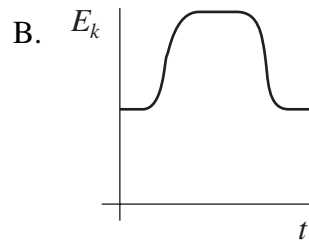
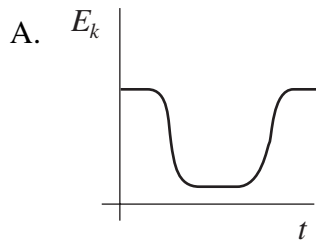
What is the work done to move the object from 10 m to 30 m?

- A. 40 J
- B. 80 J
- C. 120 J
- D. 240 J

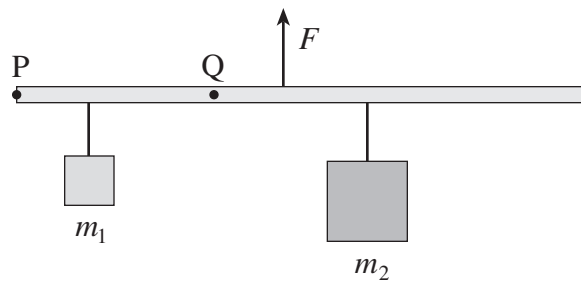
9. A projectile is fired through a fixed block of wood. The diagram shows the projectile above point P just before it enters the block and again above point Q just after leaving the block.



Which of the graphs best illustrates how the kinetic energy of the projectile varies over the time it takes to travel from P to Q?



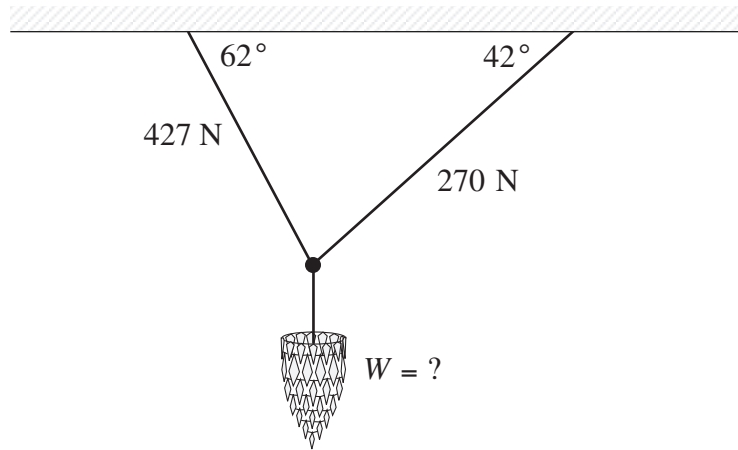
10. A beam holding two masses is in static equilibrium.



Compare the sum of the torques about point P to the sum of the torques about point Q.

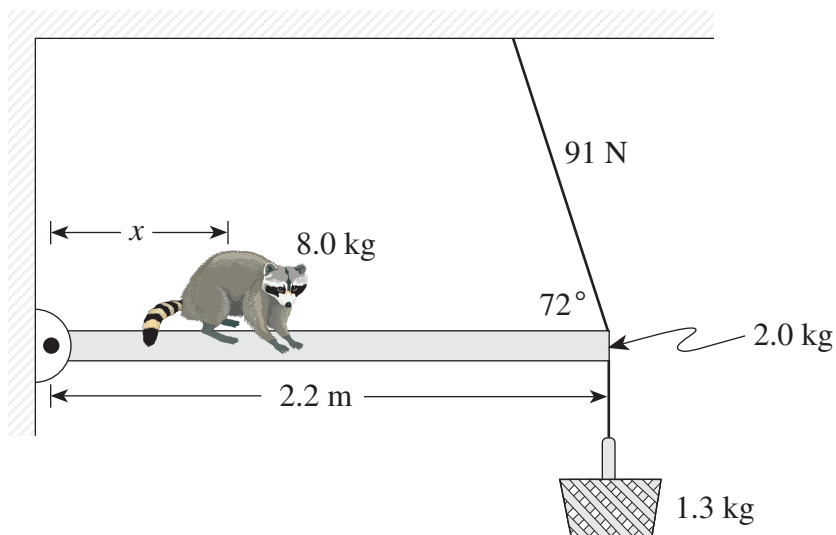
- The sum of the torques is the same about both point P and point Q.
- You need to know the mass of the beam to compare the sum of the torques.
- The sum of the torques about point P is less than the sum of the torques about point Q.
- The sum of the torques about point P is greater than the sum of the torques about point Q.

11. In the diagram below, the tension in each wire is shown.



What is the weight of the chandelier supported by these wires?

- A. 300 N
 - B. 510 N
 - C. 560 N
 - D. 620 N
12. A hungry 8.0 kg raccoon walks out on a 2.0 kg, 2.2 m long uniform beam in an attempt to reach a 1.3 kg food basket hanging at the end. A cord that can withstand 91 N is used to support the beam at the end as shown.

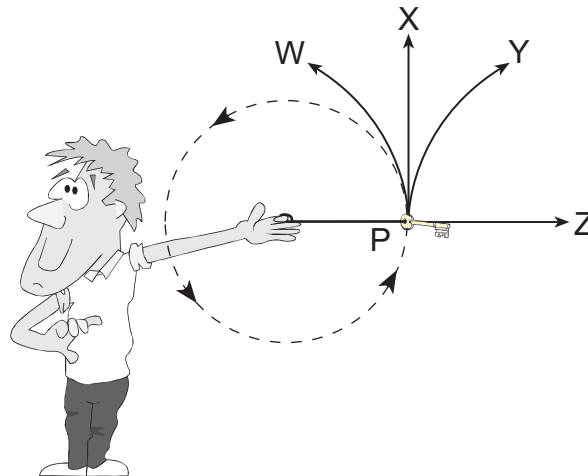


What is the maximum distance, x , the raccoon can walk out onto the beam before the cord breaks?

- A. 1.8 m
- B. 1.9 m
- C. 2.0 m
- D. 2.2 m

OVER

13. The diagram shows a student “twirling” a car key in a circular path on the end of a string.



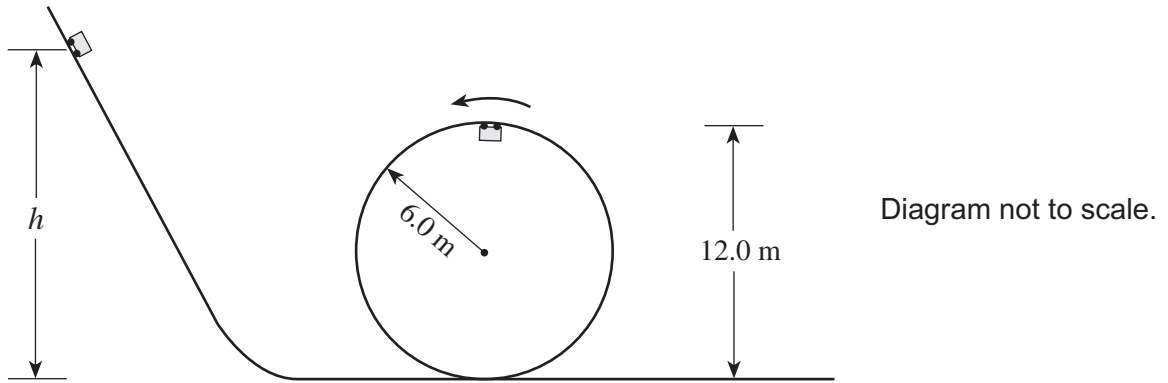
If the string snaps at P, which path will the keys follow?

- A. W
- B. X
- C. Y
- D. Z

14. An athlete runs, at a constant speed, around a circle of radius 5.0 m in 12 s. What are the athlete’s speed and acceleration?

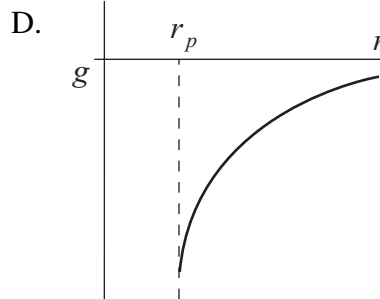
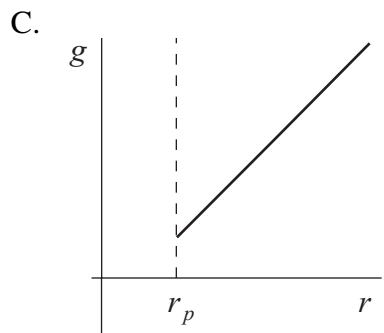
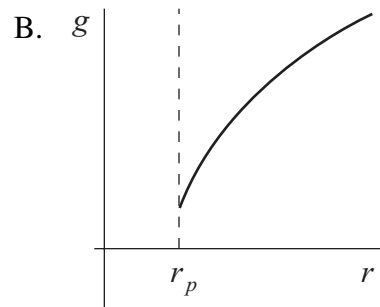
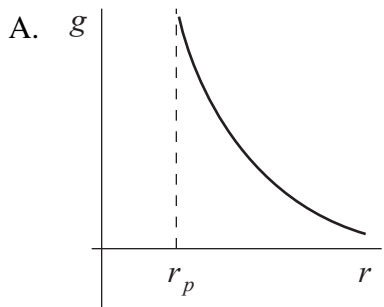
	SPEED	MAGNITUDE OF ACCELERATION
A.	0.42 m/s	0.22 m/s ²
B.	0.42 m/s	1.4 m/s ²
C.	2.6 m/s	0.22 m/s ²
D.	2.6 m/s	1.4 m/s ²

15. A frictionless 3.0 kg cart rolls down an incline, and then “loops the loop.”



From what minimum height, h , should the cart be released so that it does not fall off the circular track?

- A. 12.0 m
 - B. 15.0 m
 - C. 18.0 m
 - D. 24.0 m
16. Which graph best shows how the gravitational field strength, g , varies with the distance, r , from the centre of a planet? (r_p is the radius of the planet.)

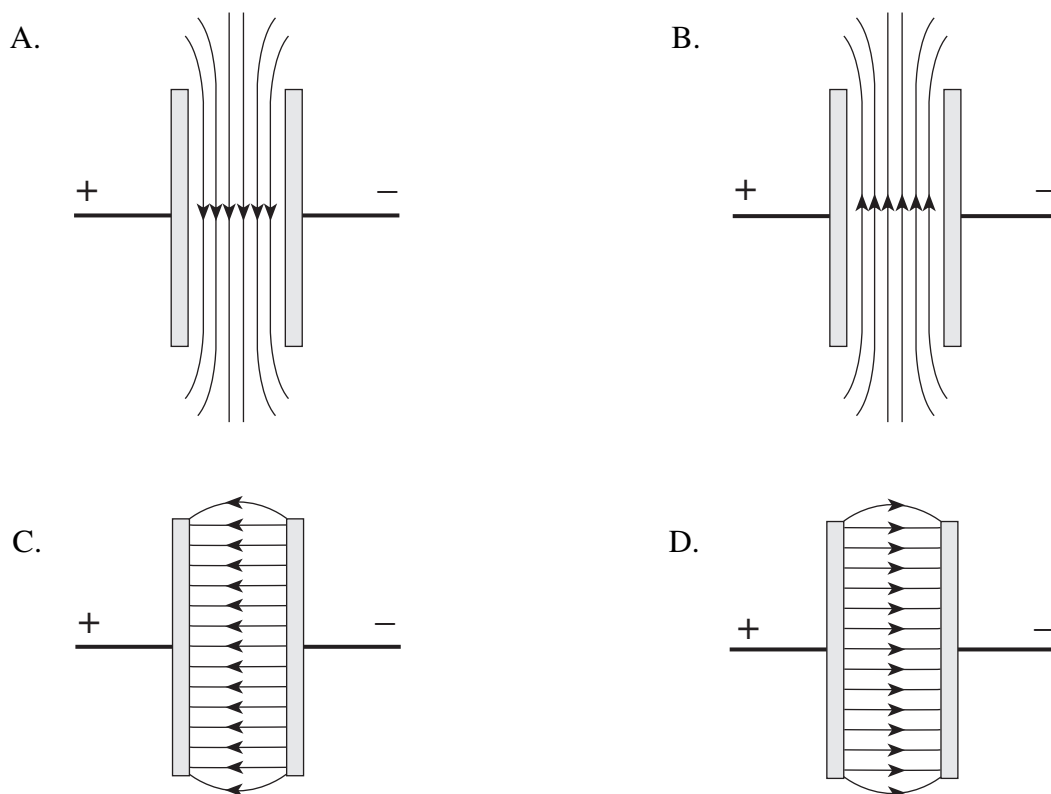


17. A satellite is in a stable circular orbit around the earth. Another satellite in a stable circular orbit at a greater altitude must have
- A. a smaller speed and a shorter period.
 - B. a smaller speed and a longer period.
 - C. a greater speed and a shorter period.
 - D. a greater speed and a longer period.

18. Which of the following could represent the kinetic energy, the gravitational potential energy and the total energy for an orbiting satellite in a stable circular orbit?

	KINETIC ENERGY	GRAVITATIONAL POTENTIAL ENERGY	TOTAL ENERGY
A.	40 000 J	-80 000 J	-40 000 J
B.	40 000 J	40 000 J	80 000 J
C.	80 000 J	40 000 J	120 000 J
D.	80 000 J	-40 000 J	40 000 J

19. Which of the following best illustrates the electric field between parallel plates with opposite electric charges?



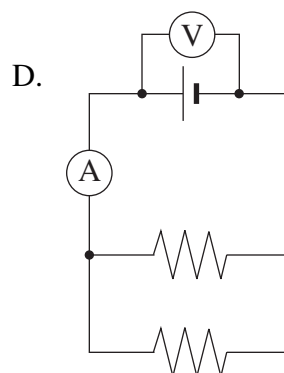
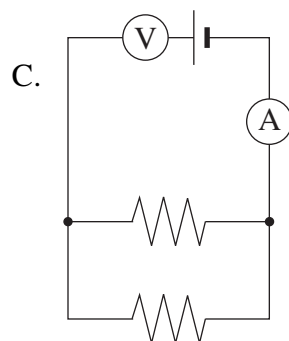
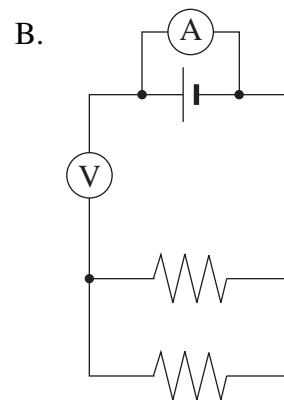
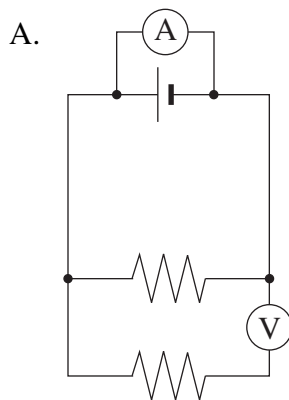
20. The atomic nucleus of uranium contains 92 protons. What is the direction and magnitude of the electric field 2.5×10^{-10} m from this nucleus?

	DIRECTION OF ELECTRIC FIELD	MAGNITUDE OF ELECTRIC FIELD
A.	towards nucleus	5.3×10^2 N/C
B.	away from nucleus	5.3×10^2 N/C
C.	towards nucleus	2.1×10^{12} N/C
D.	away from nucleus	2.1×10^{12} N/C

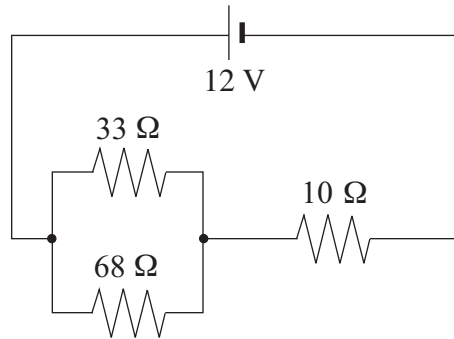
21. A 0.16 C charge is moved in an electric field from a point with a potential of 25 V to another point with a potential of 95 V. How much work was done to move this charge?

- A. 4.0 J
 B. 11 J
 C. 15 J
 D. 19 J

22. Which of the following diagrams shows an ammeter correctly placed to measure the circuit current and a voltmeter correctly placed to measure the potential difference across the battery?



23. What is the current through the $10\ \Omega$ resistor in the circuit shown below?

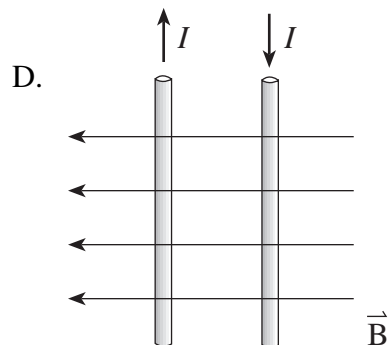
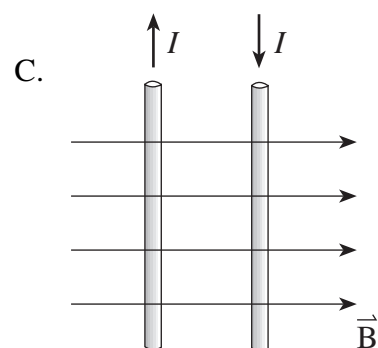
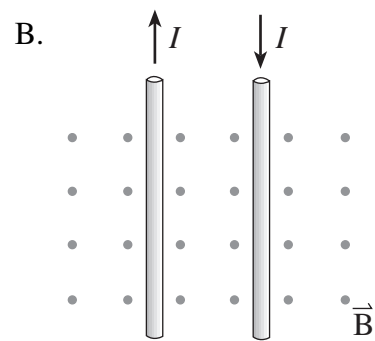
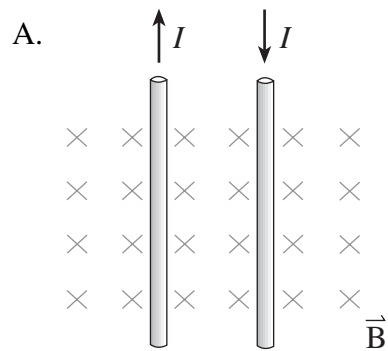


- A. 0.11 A
- B. 0.37 A
- C. 1.2 A
- D. 1.7 A

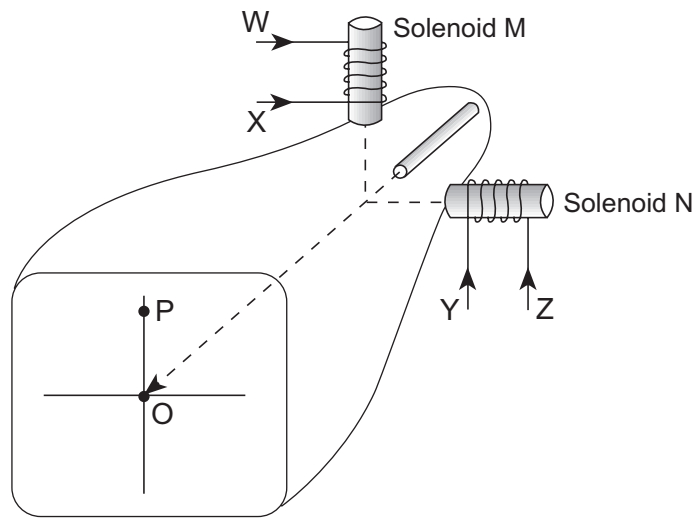
24. Transformers are commonly used in which electrical device?

- A. toaster
- B. television set
- C. electric kettle
- D. incandescent bulb

25. In which diagram would an **external** magnetic field, \vec{B} , cause two current-carrying wires to move towards one another?



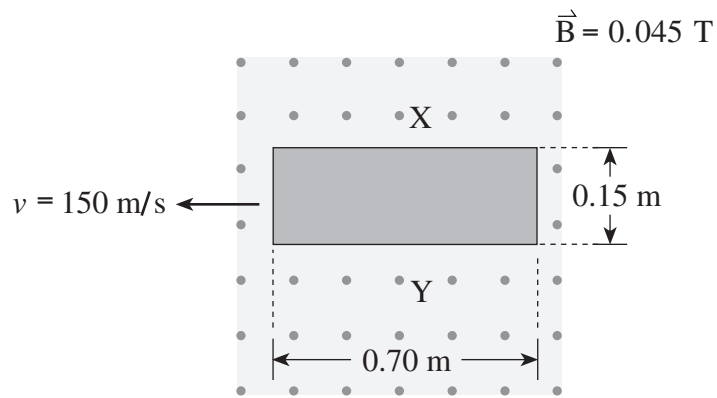
26. When there is no current in the solenoids, the electron beam in the cathode ray tube strikes the screen at the origin O.



In order to move the beam to position P, which solenoid is used and what is the direction of the current applied?

	SOLENOID	CURRENT DIRECTION
A.	M	W
B.	M	X
C.	N	Y
D.	N	Z

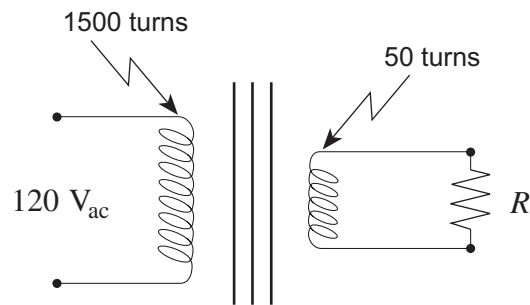
27. A solid conductor travels at 150 m/s across a uniform 0.045 T magnetic field. Which side is positively charged and what is the emf across this block?



	POSITIVE SIDE	EMF
A.	X	1.0 V
B.	X	4.7 V
C.	Y	1.0 V
D.	Y	4.7 V

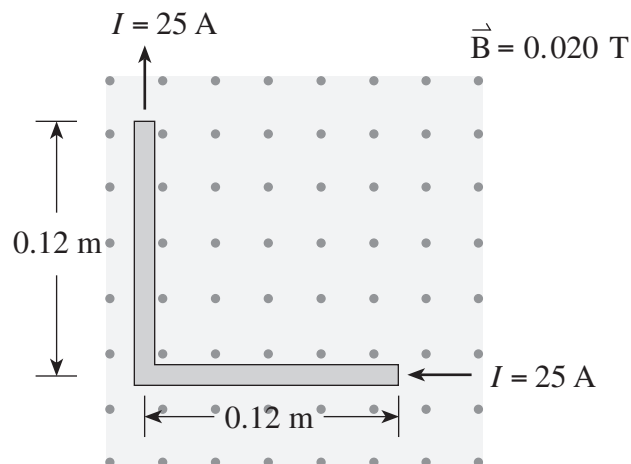
28. A motor operating at full speed draws a current of 4.0 A when connected to a 110 V source. The motor has an armature resistance of 3.5Ω . What is the back emf at full speed?
- A. 14 V
 B. 96 V
 C. 110 V
 D. 124 V

29. An ideal transformer with 120 V_{ac} on the primary coil supplies power to the resistor R . If this resistor dissipates 35 W , what is the current in the primary coil and in the secondary coil?



	CURRENT IN PRIMARY	CURRENT IN SECONDARY
A.	0.29 A	0.29 A
B.	0.29 A	8.8 A
C.	8.8 A	0.29 A
D.	8.8 A	8.8 A

30. What is the magnitude of the magnetic force on the L-shaped conductor?



- A. 0 N
 B. $6.0 \times 10^{-2}\text{ N}$
 C. $8.5 \times 10^{-2}\text{ N}$
 D. $1.2 \times 10^{-1}\text{ N}$

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

OVER

PART B: WRITTEN RESPONSE

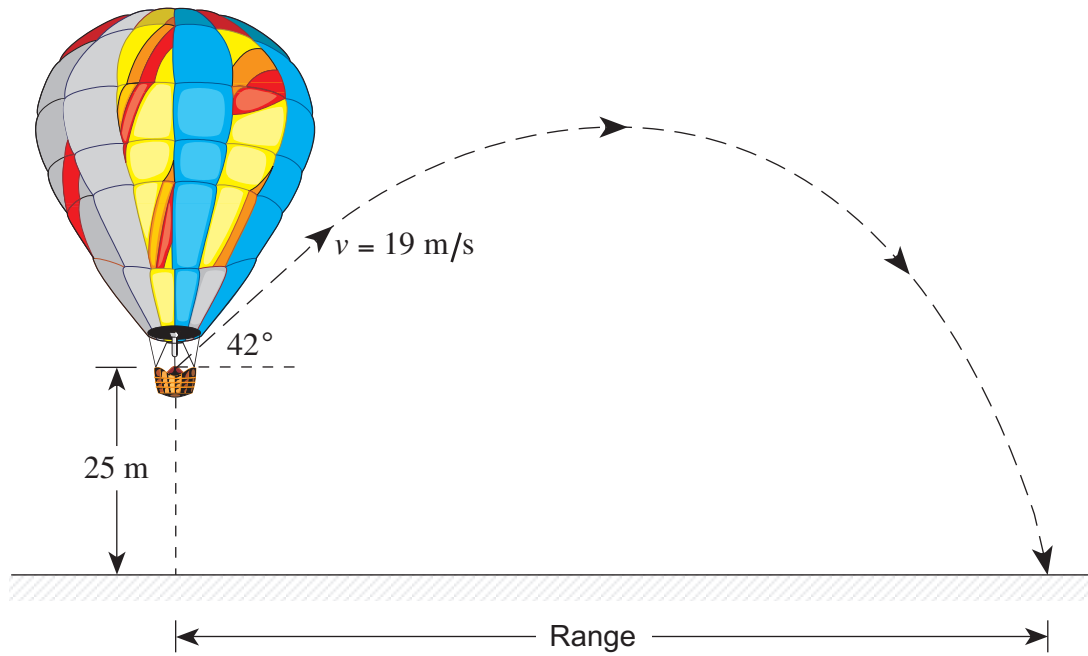
Value: 60 marks

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.**

1. A 0.50 kg ball is thrown at 42° above the horizontal at 19 m/s from a stationary hot air balloon 25 m above the ground.



What is the range?

(7 marks)

ANSWER:

range: _____

2. A rocket motor, capable of generating a $24 \text{ N} \cdot \text{s}$ impulse, is attached to a stationary frictionless 3.0 kg cart. The rocket motor is ignited.

a) What will the velocity of the cart be immediately after the rocket motor burns out?

(3 marks)

ANSWER:

a) velocity: _____

b) What is the resulting kinetic energy of the cart?

(2 marks)

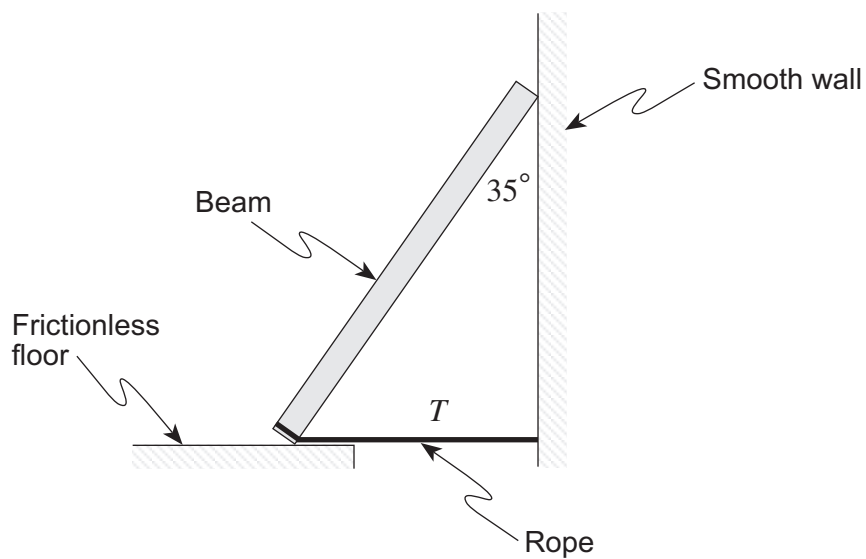
ANSWER:

b) kinetic energy: _____

OVER

- c) A frictionless cart of larger mass will end up with less kinetic energy when powered by an identical rocket motor. Using principles of physics, explain this result. **(4 marks)**

3. A 24 kg beam of length 2.4 m leans against a smooth wall. A horizontal rope tied to the wall and the beam holds the beam on a frictionless floor as shown.



- a) Draw a labelled free-body diagram for the forces acting on the beam.

(2 marks)

b) What is the tension in the rope?

(5 marks)

ANSWER:

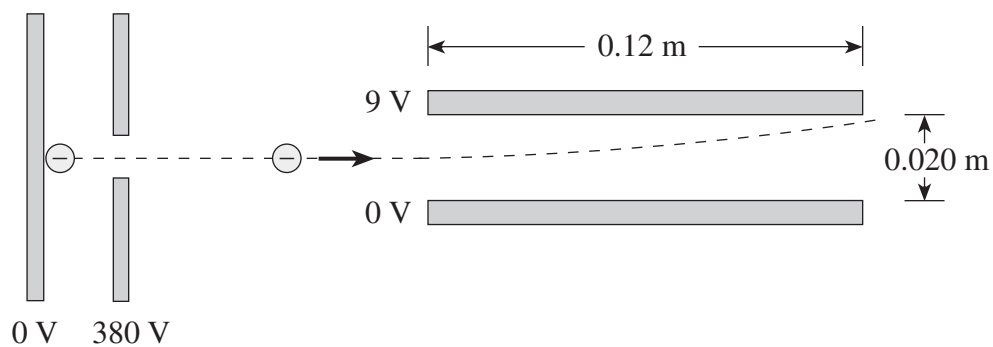
b) tension in the rope: _____

4. A spacecraft of mass 470 kg rests on the surface of an asteroid of radius 1 400 m and mass 2.0×10^{12} kg. How much energy must be expended so that the spacecraft may rise to a height of 2 800 m above the surface of the asteroid? **(7 marks)**

ANSWER:

energy expended: _____

5. A beam of electrons is directed to a region between oppositely charged parallel plates as shown in the diagram below.



- a) The electron beam is produced by accelerating electrons through an electric potential difference of 380 V. What is the speed of the electrons as they leave the 380 V plate?

(3 marks)

ANSWER:

a) speed of the electrons: _____

- b) What is the electrostatic force on electrons in the region between the horizontal plates when they are connected to a 9.0 V potential difference? **(4 marks)**

ANSWER:

b) electrostatic force: _____

6. A 12 V battery transfers 33 C of charge to an external circuit in 7.5 s.

a) What current flows through the circuit?

(2 marks)

ANSWER:

a) current: _____

b) What is the resistance of the circuit?

(2 marks)

ANSWER:

b) resistance: _____

c) What is the power output of the battery?

(2 marks)

ANSWER:

c) power output: _____

d) The external circuit is most likely to consist of

- a bulb.
- a kettle.
- a calculator.

(Check one response.)

(1 mark)

7. An electron travelling at 7.7×10^6 m/s enters at right angles into a uniform magnetic field. Inside the field the path of the electron has a radius of 3.5×10^{-2} m.

a) What is the magnitude of the magnetic field?

(4 marks)

ANSWER:

a) magnitude of field: _____

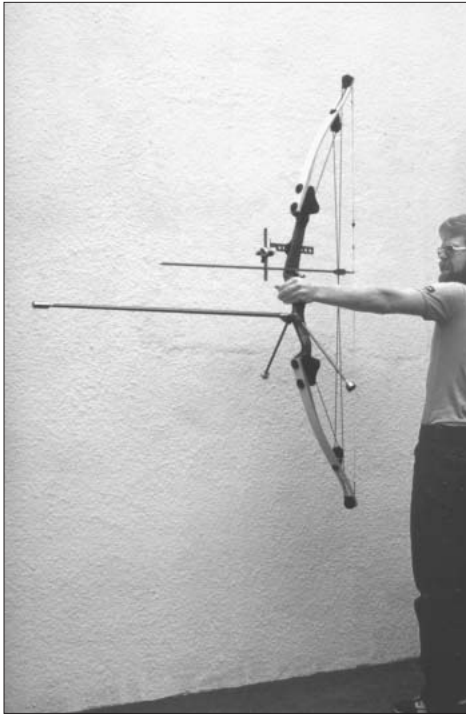
OVER

- b) If the magnetic field is produced at the centre of a solenoid by a current of 0.62 A, what is the number of turns per unit length of the solenoid? **(3 marks)**

ANSWER:

b) # of turns per unit length: _____

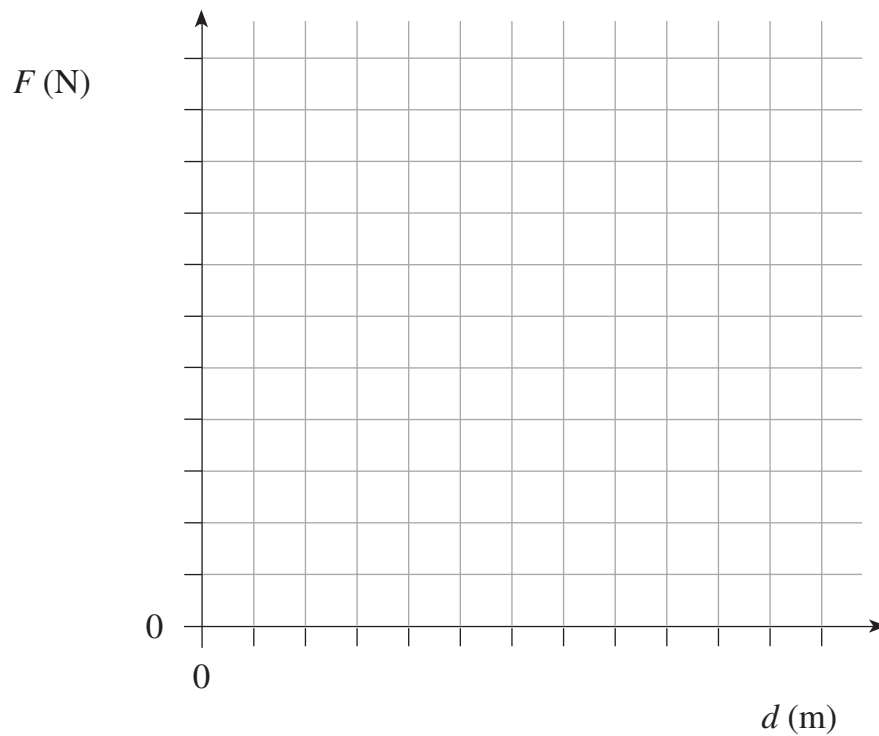
8. As a compound bow was drawn back, the applied forces and displacements were recorded.



F (N)	0	31	65	84	122	160	186	180	175	184	180
d (m)	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50

a) Plot a force vs. displacement graph below.

(2 marks)



b) How much energy was stored in this compound bow?

(3 marks)

ANSWER:

b) energy stored: _____

9. Two identical light bulbs, wired in parallel to a battery, are equally bright. When one of the bulbs burns out, however, the other bulb is observed to glow brighter. Using principles of physics, explain why the battery causes the remaining bulb to glow more brightly. **(4 marks)**

END OF EXAMINATION

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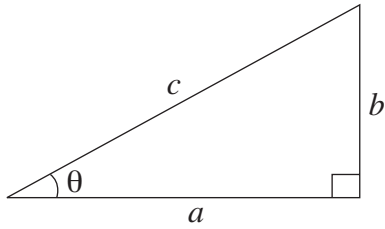
TABLE OF CONSTANTS

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

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MATHEMATICAL EQUATIONS

For Right-angled Triangles:

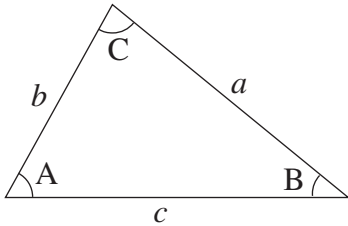


$$a^2 + b^2 = c^2$$

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

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

For All Triangles:



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

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

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

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

Circle:

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

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

Sphere:

$$\text{Surface area} = 4\pi r^2$$

$$\text{Volume} = \frac{4}{3} \pi r^3$$

Quadratic Equation:

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

Vector Kinematics in Two Dimensions:

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

$$v^2 = v_0^2 + 2ad \quad d = v_0t + \frac{1}{2}at^2$$

Vector Dynamics:

$$F_{\text{net}} = ma \quad F_g = mg$$

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

Work, Energy, and Power:

$$W = Fd \quad E_p = mgh$$

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

Momentum:

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

Equilibrium:

$$\tau = Fd$$

Circular Motion:

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

Gravitation:

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

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Electrostatics:

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

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

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

Electric Circuits:

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

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

Electromagnetism:

$$F = BIl \quad F = QvB$$

$$B = \mu_0 n I = \mu_0 \frac{N}{l} I \quad \mathcal{E} = Blv$$

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

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

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

ROUGH WORK FOR MULTIPLE-CHOICE

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ROUGH WORK FOR MULTIPLE-CHOICE