PART A: MULTIPLE CHOICE

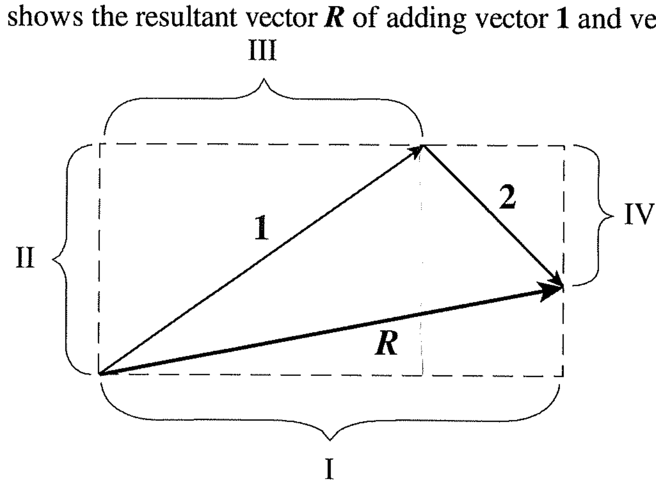
Value: 70 marks (2 marks per question) **Suggested Time: 70 minutes**

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.

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

1. The diagram below shows the resultant vector ***R*** of adding vector **1** and vector **2**.



Which of the following represents the magnitude of the vertical component of vector **1**?

A. I
B. II
C. III
D. IV

2. A car accelerates from 30 m/s to 50 m/s in 1.4 s. How far does it travel during this time?

A. 28 m
B. 42 m
C. 56 m
D. 70 m

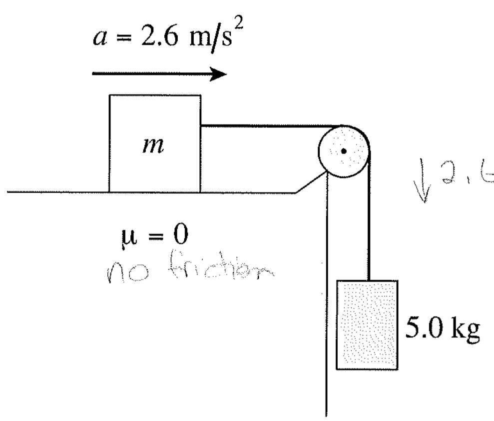
3. A red ball is launched over level ground with an initial velocity of 28 m/s, 40° above the horizontal. How long does it take to reach its maximum height above the ground?

   A. 1.8 s
   B. 2.2 s
   C. 2.4 s
   D. 2.9 s

4. A box of mass *m* is moving across a floor with an acceleration equal to *a*. Its velocity at any given instant is equal to *v*. Which of the following is equal to the net force acting on the box?

   A. m/a
   B. $m \cdot a$
   C. m/v
   D. $m \cdot v$

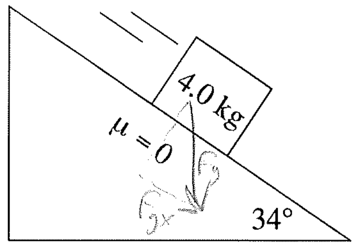
5. A block of mass *m* on a frictionless surface is attached to a hanging 5.0 kg mass as shown below. The system accelerates at 2.6 m/s^2.



What is the mass of the block?

   A. 1.3 kg
   B. 14 kg
   C. 19 kg
   D. 24 kg

6. A 4.0 kg silver block is sliding down a frictionless inclined plane as shown below.



What is the block's acceleration?

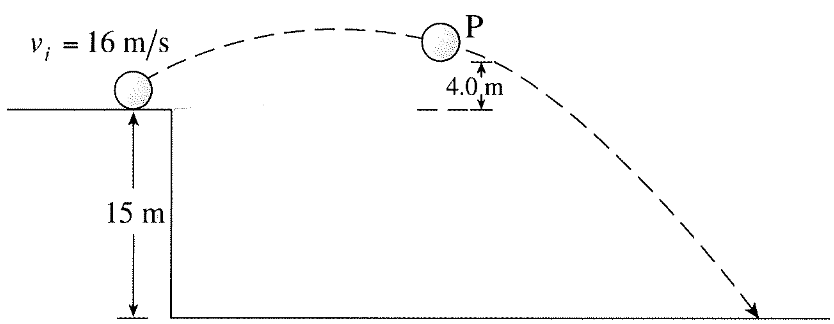
A. 2.5 m/s²
B. 5.5 m/s²
C. 6.6 m/s²
D. 8.1 m/s²

$F_{gx} = F_g \sin 34° = ma$

$4 \times 9.8\,N \sin 34° = 4\,kg\,(a)$

$a = 5.48\ m/s^2$

7. A 1.2 kg lead ball is launched off a cliff top at 16 m/s as shown below.



Determine the ball's kinetic energy (E_k) at position P. (Ignore friction.)

A. 23 J
B. 47 J
C. 1.1×10^2 J
D. 1.3×10^2 J

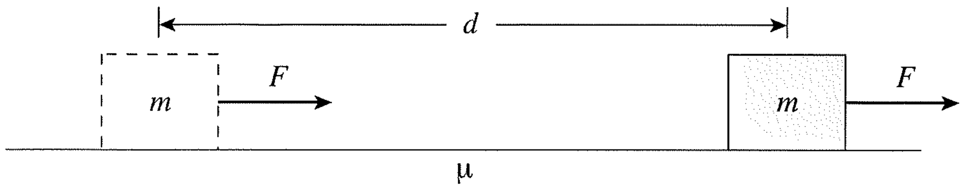
$E_k + E_p = E_k' + E_p'$

$\frac{1}{2} m (16\,m/s)^2 = E_k' + mg\,4m$

$E_k' = \frac{1}{2}(1.2)(16)^2 - (1.2)(9.8)(4)$

$= 107\ J$

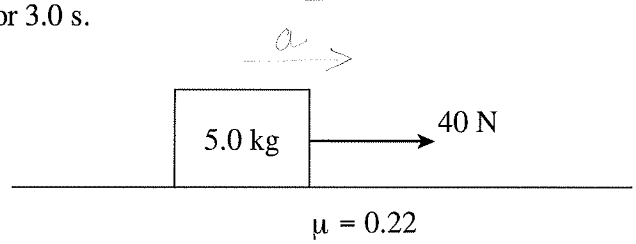
8. The force F shown below pulls a block of mass m from rest a distance d across a concrete floor. The coefficient of sliding friction between the floor and the block is μ.



What happens to the block's final kinetic energy and the amount of heat energy produced if μ is **increased**?

	FINAL KINETIC ENERGY	HEAT ENERGY
A.	increases	decreases
B.	decreases	increases
C.	increases	increases
D.	decreases	decreases

9. The 5.0 kg block shown below is accelerated from rest across a wood floor ($\mu = 0.22$) by a 40 N pulling force for 3.0 s.



What is the block's final momentum?

A. 32 kg m/s
B. 88 kg m/s
C. 120 kg m/s
D. 150 kg m/s

= mv

$F_{net} = 40N - F_f = ma$ ($F_f = \mu mg$)

$a = \frac{40 - 0.22(5)(9.8)}{(5)}$

$a = 5.844\ m/s^2$

$v_i = 0$
$v_f = ?$
$a = 5.844\ m/s^2$
$t = 3s$

$v_f = v_i + at$
$= 17.5\ m/s$

$p = mv = 87.66\ kgm/s$

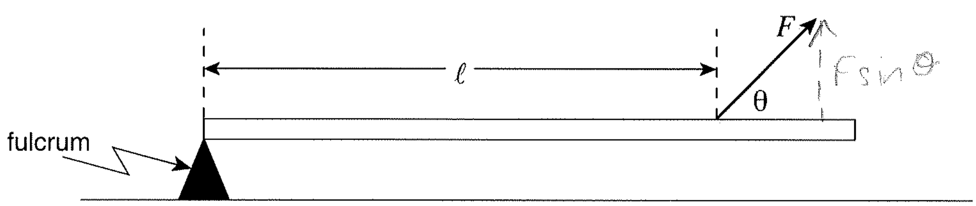
10. A 10 kg rock is at rest when a boulder of unknown mass collides with it. After the collision the 10 kg rock travels at 3.0 m/s south. What is the boulder's change in momentum due to the collision?

A. 15 kg m/s south
B. 15 kg m/s north
C. 30 kg m/s south
D. 30 kg m/s north

11. A 1.5 kg physics block is sliding at 8.0 m/s north when it is hit by a 0.40 kg ball of putty going 20 m/s west. The putty sticks to the block. What is the magnitude of their combined momentum after the collision?

A. 4.0 kg m/s
B. 8.9 kg m/s
C. 14 kg m/s
D. 20 kg m/s

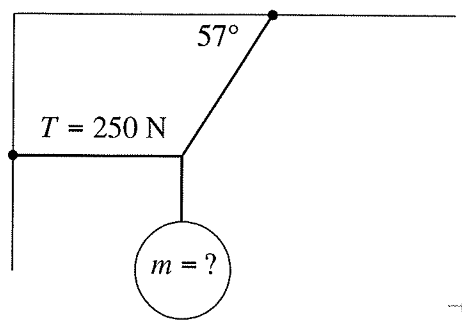
12. A force is used to apply a torque to a beam as shown.



Which of the following is a correct equation for finding the torque about the fulcrum due to this force?

A. $\tau = F \times \ell$
B. $\tau = F/\ell$
C. $\tau = F \times \cos\theta \times \ell$
D. $\tau = F \times \sin\theta \times \ell$

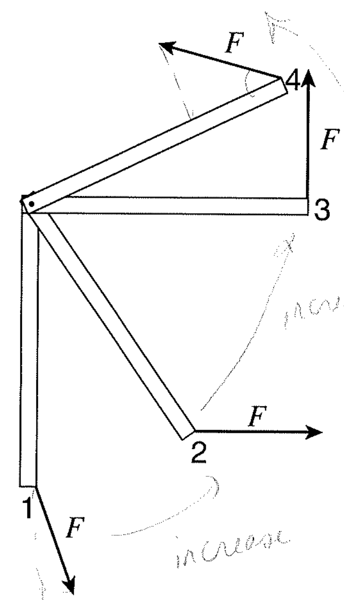
13. A mass is suspended by two ropes from a ceiling and a wall.



Determine the mass m.

A. 13 kg
B. 17 kg
C. 26 kg
D. 39 kg

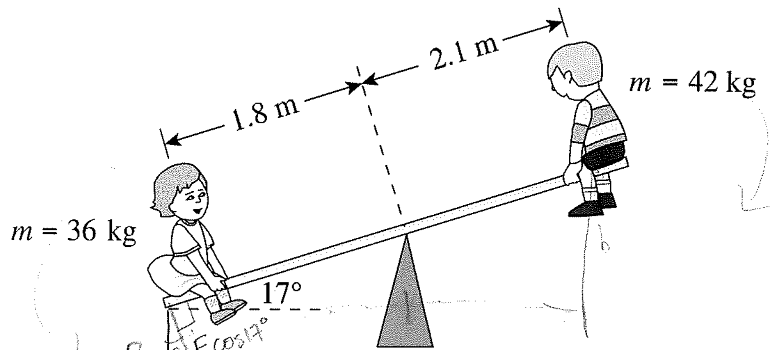
14. A force is used to rotate a beam. As the beam rotates, the direction of the force changes but its magnitude does not.



What happens to the torque on the beam due to this force as the beam is rotated from position 1 to position 4?

A. always increases
B. always decreases
C. increases then decreases
D. decreases then increases

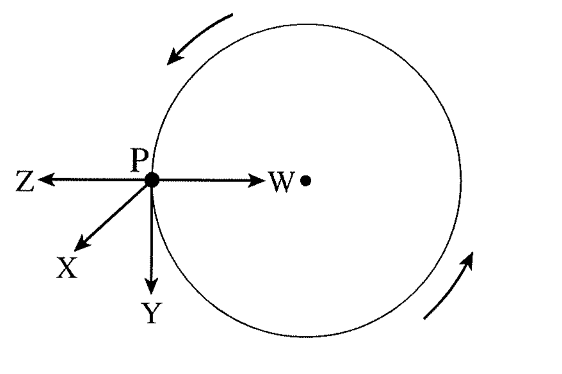
15. Two young children are playing on a seesaw.



What is the magnitude of the net torque, due to the two children, about the seesaw pivot in the position shown?

A. 220 Nm
B. 230 Nm
C. 1400 Nm
D. 1500 Nm

16. An object moves in uniform circular motion in a vertical plane. Which is the direction of the acceleration at P?

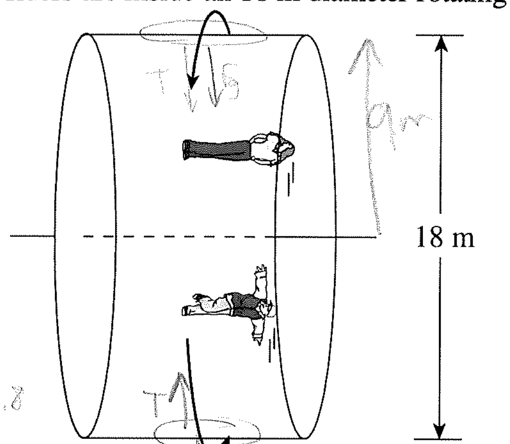


A. W
B. X
C. Y
D. Z

17. A 1600 kg car moves at a constant speed of 28 m/s around a level 100 m radius circular track. What is the minimum coefficient of friction between the tires and the road surface?

A. 0.18
B. 0.57
C. 0.80
D. 1.25

18. In an amusement park ride, riders are inside an 18 m diameter rotating cylinder.



If the cylinder rotates once every 5.4 s, what force does the wall exert on a 58 kg rider at the top and bottom of the ride?

	TOP	BOTTOM
A.	140 N	140 N
B.	140 N	1300 N
C.	570 N	710 N
D.	710 N	710 N

19. Matter is orbiting around a collapsed star of mass 3.6×10^{30} kg at an orbital radius of 8.5×10^{4} m. What is the orbital period of this matter?

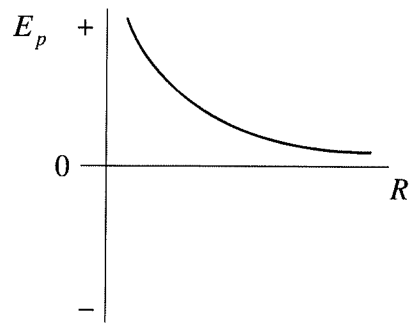
A. 1.2×10^{-7} s
B. 1.0×10^{-4} s
C. 1.0×10^{-2} s
D. 1.0×10^{1} s

20. A 4.5×10^{4} kg vehicle is orbiting the earth with an orbital radius of 9.38×10^{6} m and a speed of 6.52×10^{3} m/s. What minimum energy is needed for this vehicle to reach a position infinitely far from the earth?

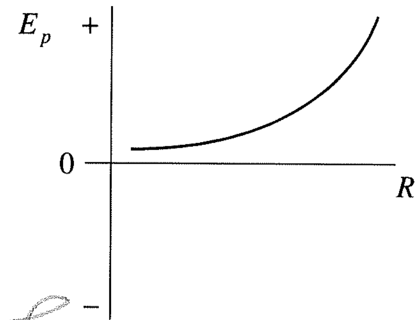
A. 9.6×10^{11} J
B. 1.9×10^{12} J
C. 2.9×10^{12} J
D. 4.1×10^{12} J

21. Which of the following graphs shows how the gravitational potential energy of an object varies with its distance from the earth?

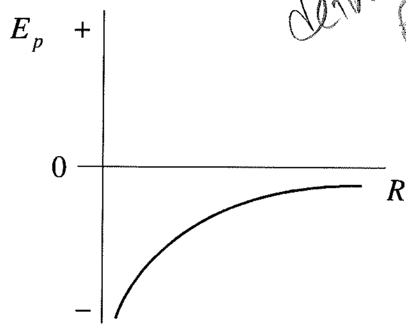
A.



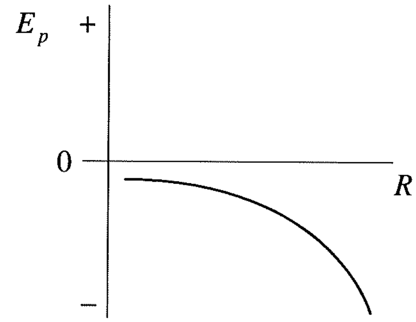
B.



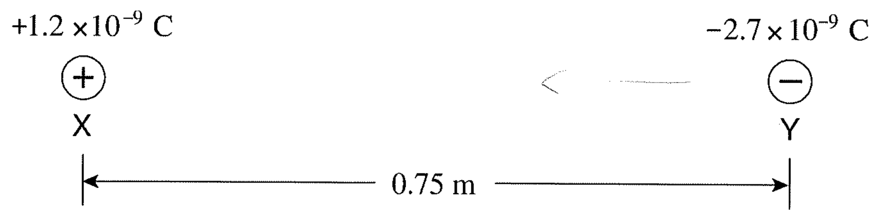
C.



D.

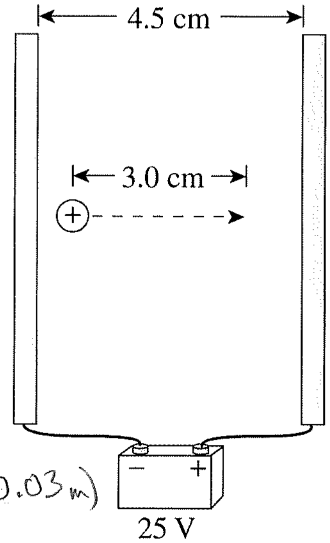


22. What are the magnitude and direction of the electric force on charge Y due to charge X?



	MAGNITUDE	DIRECTION
A.	3.9×10^{-8} N	left
B.	3.9×10^{-8} N	right
C.	5.2×10^{-8} N	left
D.	5.2×10^{-8} N	right

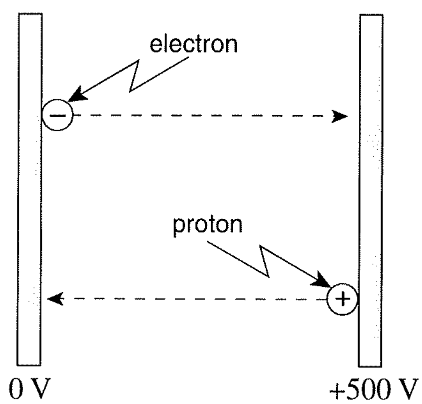
23. A proton is moved 3.0 cm in the electric field between parallel plates. (Diagram not to scale.)



How much work was done on the proton?

A. 1.2×10^{-19} J
B. 2.7×10^{-18} J
C. 4.0×10^{-18} J
D. 6.0×10^{-18} J

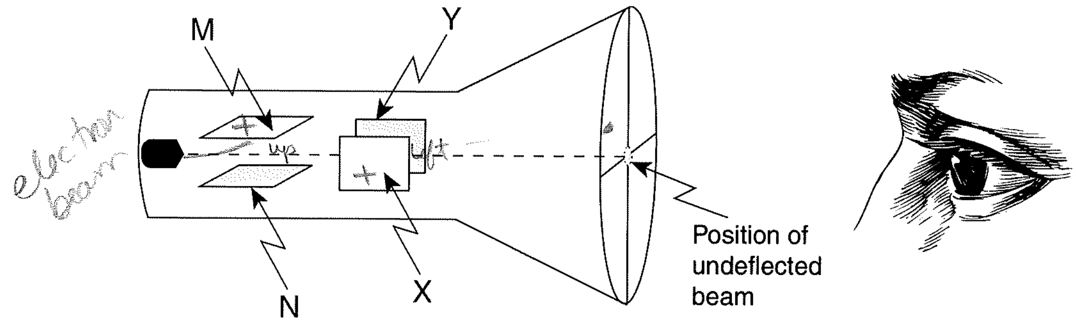
24. A proton and an electron, initially at rest as shown, are accelerated across parallel plates.



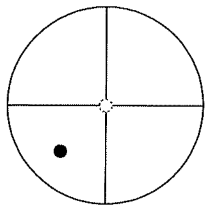
Which of the following best describes the final kinetic energies and speeds of the two particles?

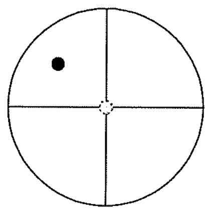
	FINAL KINETIC ENERGY	FINAL SPEED
A.	same	same
B.	same	different
C.	different	same
D.	different	different

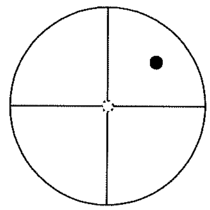
25. In the cathode ray tube shown, plates M and X are charged positively.

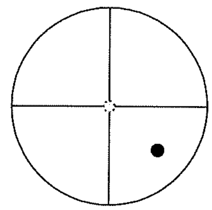


Which of the following shows the resulting position of the beam as seen on the screen?

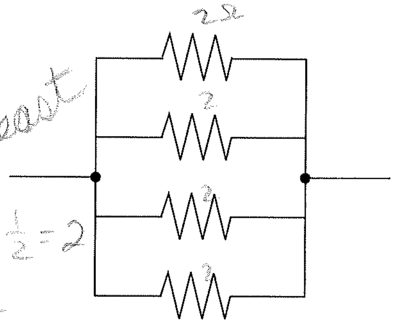
A. 

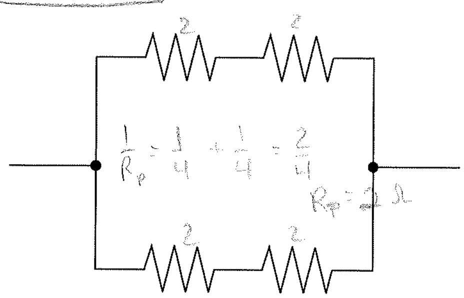
B. 

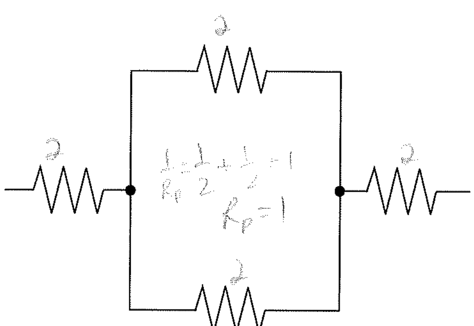
C. 

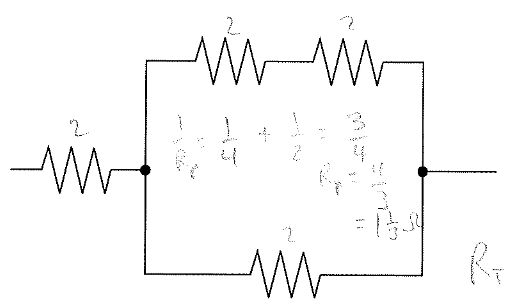
D. 

26. Which arrangement of four identical resistors has the highest equivalent resistance?

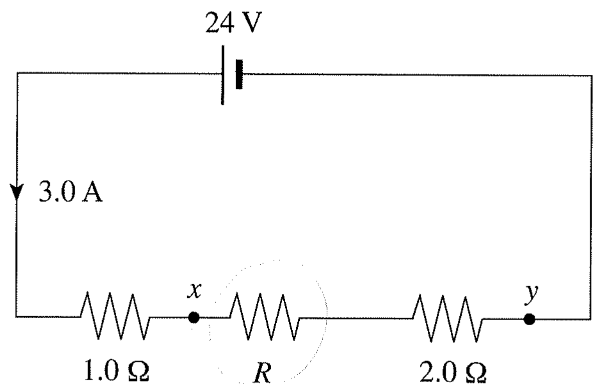
A. 

B. 

C. 

D. 

27. A series circuit consists of a battery and three resistors arranged as shown in the diagram below.



$R_T = \frac{V_o}{I_o} = \frac{24V}{3A} = 8\Omega$

$R = 8\Omega - 1\Omega - 2\Omega = 5\Omega$

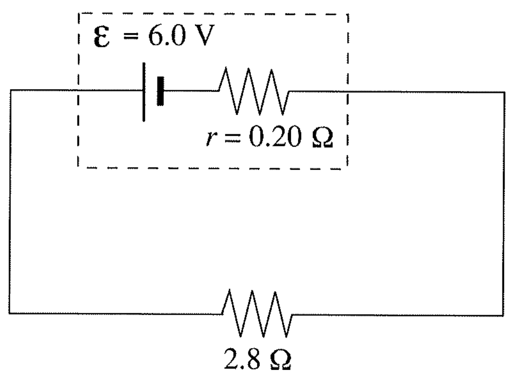
$R_{xy} = 5\Omega + 2\Omega = 7\Omega$

$V = I_o R_{xy} = 3A \times 7\Omega = 21V$

What is the potential difference V_{xy}?

A. 3.0 V
B. 6.0 V
C. 9.0 V
D. 21 V

28. What is the battery's terminal voltage in the circuit below?



$V_t = \varepsilon - Ir$

$I = \frac{\varepsilon}{R+r} = \frac{6V}{3\Omega} = 2A$

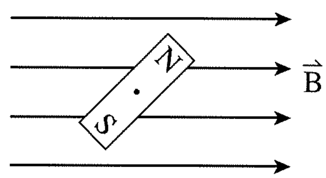
$V_t = 6V - 2A(.2\Omega) = 5.6V$

A. 0.40 V
B. 5.6 V
C. 6.0 V
D. 6.4 V

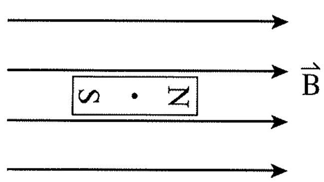
29. A student is instructed to determine the amount of charge flowing past a point in a circuit of unknown resistance during an experiment. What equipment will permit the student to do this?

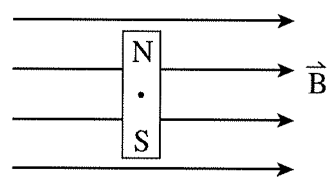
A. voltmeter
B. ammeter, voltmeter
C. ammeter, stopwatch
D. voltmeter, stopwatch

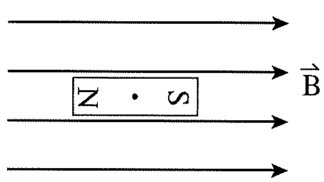
30. A bar magnet is free to rotate while in a magnetic field. It is initially positioned as shown.

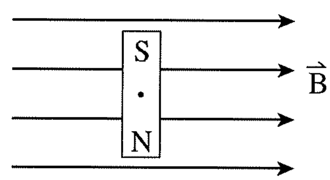


Which diagram shows the final orientation of the bar magnet?

A.


B.


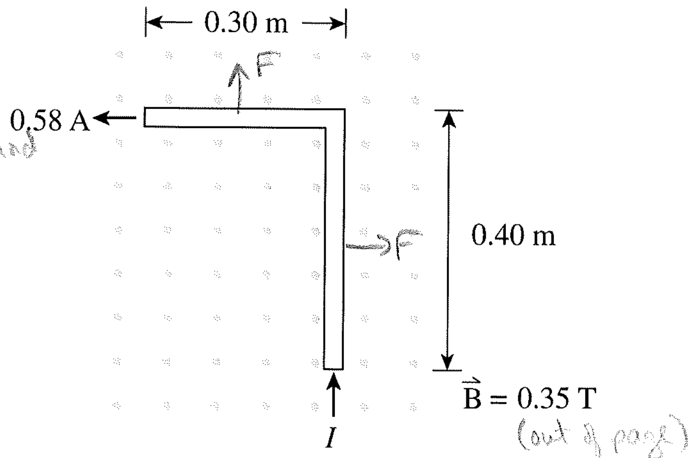
C.


D.


31. A charged particle travels in a circular path of radius R while in a uniform magnetic field. Which change reduces the radius to $\frac{1}{2}R$?

A. halve the charge
B. double the mass
C. double the speed
D. double the magnetic field strength

32. What is the magnitude of the force due to a current of 0.58 A, on the L-shaped conductor in a 0.35 T field?



A. 6.1×10^{-2} N

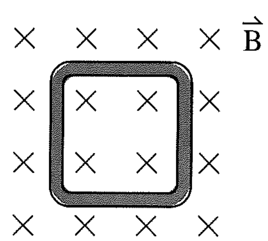
B. 8.1×10^{-2} N

C. 1.0×10^{-1} N

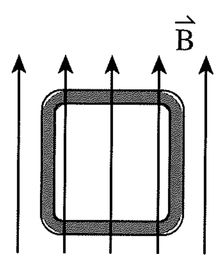
D. 1.4×10^{-1} N

33. Which of the following single loops has the largest magnetic flux?

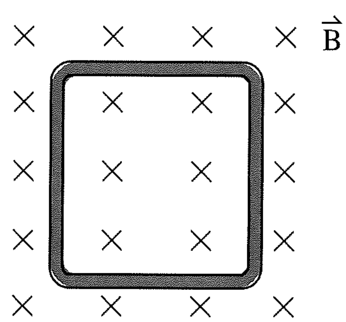
A.



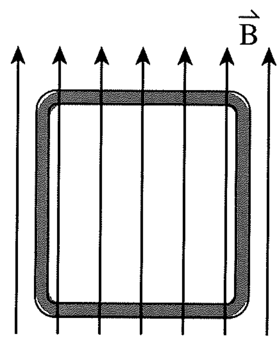
B.



C.

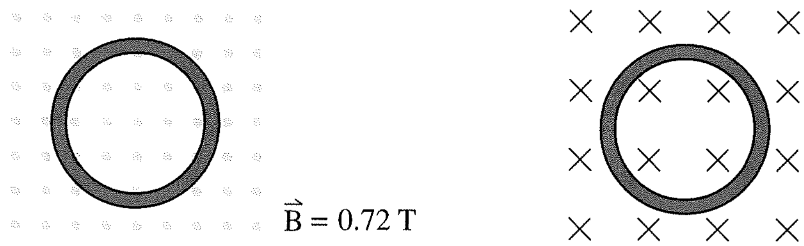


D.



34. A single loop of wire encloses an area of $3.5 \times 10^{-2}\ \text{m}^2$. It is in a magnetic field that changes from $+0.72$ T to -0.25 T in a time of 0.060 s.

Initial　　　　　　　　Final



$\vec{B} = 0.72$ T　　　　$\vec{B} = 0.25$ T

What is the induced emf and the direction of current flow in the loop?

	INDUCED EMF	DIRECTION OF CURRENT FLOW
A.	2.7×10^{-1} V	counter-clockwise
B.	2.7×10^{-1} V	clockwise
(C.)	5.7×10^{-1} V	counter-clockwise
D.	5.7×10^{-1} V	clockwise

$\mathcal{E} = -N\frac{\Delta\Phi}{\Delta t} = -\frac{A(B_f - B_i)}{\Delta t} = -\frac{3.5\times10^{-2}\,\text{m}^2(-.25 - .72)}{0.06\ \text{s}} = 0.5658$

B changed so increased into page ∴ Lenz's says I induced such that increase B out of page so I flow ccw

35. An AC transformer converts 120 V into 3.0 V. A small electronic device draws 4.5×10^{-3} A from this transformer. If the secondary has 50 turns, what is the number of turns and current in the primary coil?

	PRIMARY COIL	
	NUMBER OF TURNS	CURRENT (A)
(A.)	2.0×10^{3}	1.1×10^{-4} A
B.	2.0×10^{3}	18 A
C.	40	1.1×10^{-4} A
D.	40	18 A

$I_p = \frac{V_s}{V_p} I_s = \frac{3}{120} \times 4.5\times10^{-3} = 1.13 \times 10^{-4}$

$N_p = N_s \frac{V_p}{V_s} = 50 \times \frac{120}{3} = 2000$

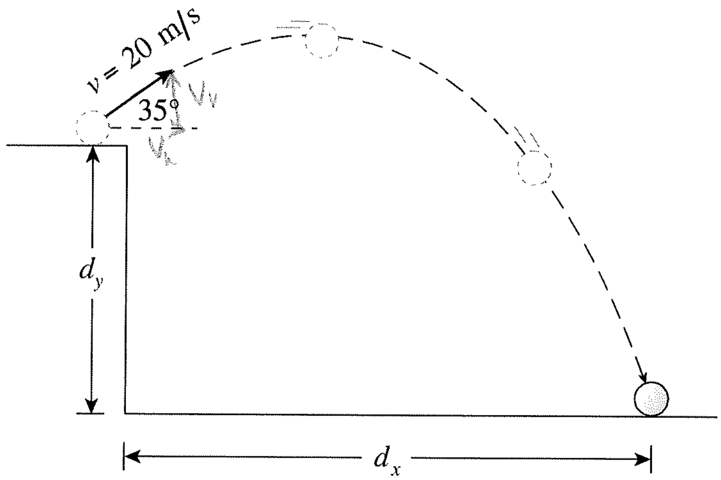
You have **Examination Booklet Form A**. In the box above #1 on your **Answer Sheet**, ensure you filled in the bubble as follows.

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.

1. **(5 marks)**

A projectile is launched from a cliff top at 20 m/s , 35° above the horizontal as shown below. The projectile hits the ground 3.7 s after it is launched.



Determine the height of the cliff (d_y) and the range (d_x) of the projectile.

$v_h = 20\,m/s \cos 35° = 16.383\,m/s$

$v_v = 20\,m/s \sin 35° = 11.472\,m/s$

$d_x = v_h \times t = 16.383\,m/s \times 3.7\,s = \underline{60.6\,m}$ ✓

$d_y = v_0 t + \frac{1}{2}at^2$

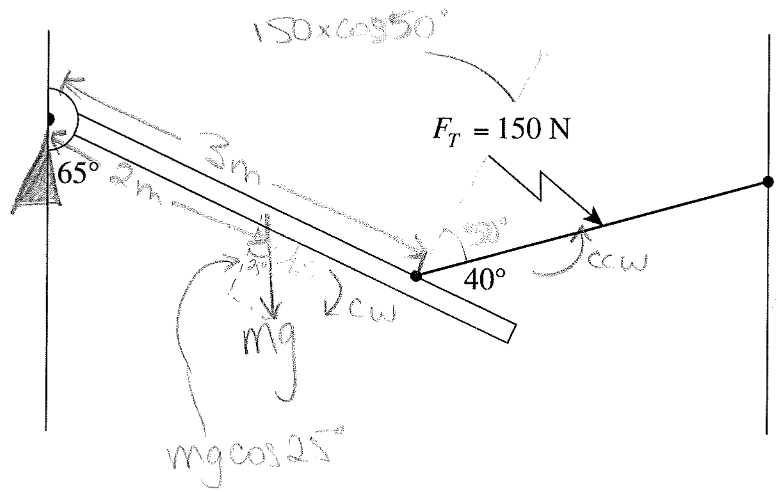
$= 11.472 \times 3.7\,s + \frac{1}{2}(-9.8\,m/s^2)(3.7\,s)^2$

$= \underline{-24.6\,m}$ ✓

neg indicates down

2. **(5 marks)**

A 4.0 m long steel beam is supported 3.0 m from a hinge by a cable attached as shown.



If the tension in the cable is 150 N what is the mass of the steel beam?

$\tau = Fd$

$\tau_{cw} = \tau_{ccw}$

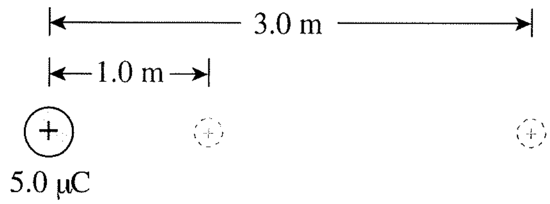
$mg\cos 25° \times 2m = 150 \times \cos 50° \times 3m$

$m = \frac{(150\cos 50) \times 3}{(9.8\cos 25) \times 2}$

$= 16\ Kg$ ✓

3. **(6 marks)**

A proton at rest 1.0 m from a fixed 5.0 μC charge is released as illustrated.



Calculate the speed of the proton when it is 3.0 m from the fixed charge.

$$E_{ki} + E_{pi} = E_{pf} + E_{kf}$$

$$\frac{KQQ}{1m} = \frac{KQQ}{3m} + \frac{1}{2}mv^2$$

$$v^2 = \frac{2}{m}\left(KQQ - \frac{KQQ}{3}\right)$$

$$v = \sqrt{\frac{2}{1.67\times10^{-27}}(9\times10^9)(1.6\times10^{-19})(5\times10^{-6})\left(1-\frac{1}{3}\right)}$$

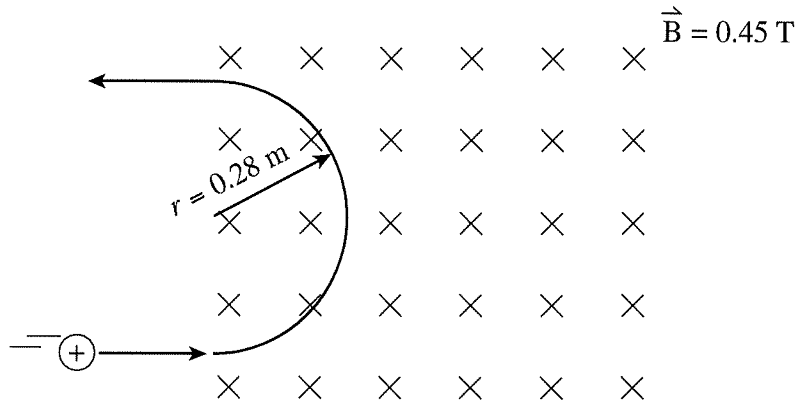
$$= 2.4\times10^6\ m/s$$ ✓

A deuteron (charge $+e$, mass $2m_p$) is placed at the same starting position as the proton. Explain why the speed of the deuteron at the 3.0 m mark is different than that of the proton.

deuteron is heavier so same charge but dividing by a larger # yeilding a smaller v

4. **(5 marks)**

A proton travelling at a high velocity enters a 0.45 T magnetic field and travels in a circular path of radius 0.28 m as shown.



What is the kinetic energy of the proton?

$F_c = F_m$

$\frac{mv^2}{r} = QvB$

$v = \frac{QrB}{m}$

$= \frac{1.6\times10^{-19} \times 0.28 \times 0.45}{1.67\times10^{-27}}$

$= 1.204\times10^{7}$ m/s

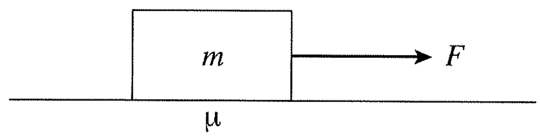
$E_k = \frac{1}{2}mv^2$

$= \frac{1}{2}(1.67\times10^{-27})(1.207\times10^{7}\text{ m/s})^2$

$= 1.2\times10^{-13}$ J ✓

5. **(5 marks)**

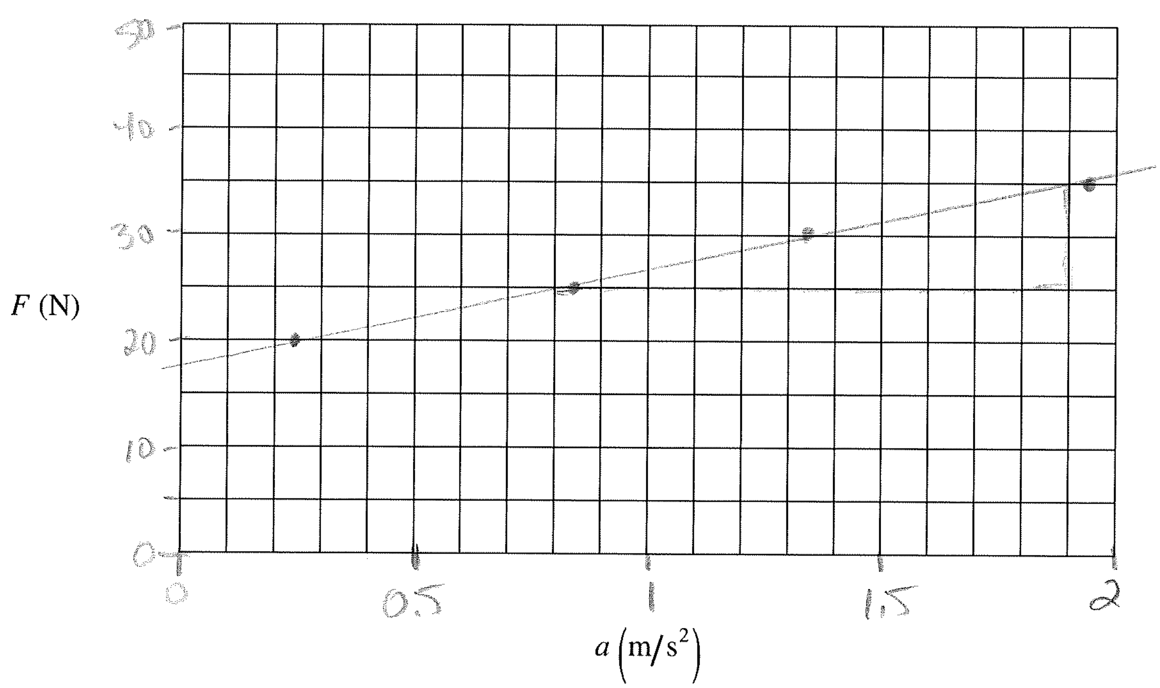
A force (F) was used to pull a wooden block across a floor as shown below.



The size of the force was varied and the data table below shows the size of the force and the block's resulting acceleration.

F (N)	$a\left(\text{m/s}^2\right)$
20	0.25
25	0.85
30	1.35
35	1.95

Plot the data on the graph below and draw a line of best fit. Extend the line back to the 'y' axis so that you have a y-intercept point and determine the slope of the line.



Using your slope value and your *y*-intercept value from the graph, determine the coefficient of friction between the block and the floor.

$F = ma$

$m = \frac{F}{a}$

Y intercept $= 17.5\,N$ ✓

Slope $= \frac{rise}{run} = \frac{(35-25)\,N}{(1.9-0.8)\,m/s^2} = 9.09\,kg$ ✓

↘

$F = (9.09\,kg)a + 17.5\,N$

$\mu = \frac{F_f}{F_N}$

Y int $= F_f$

slope $= m$

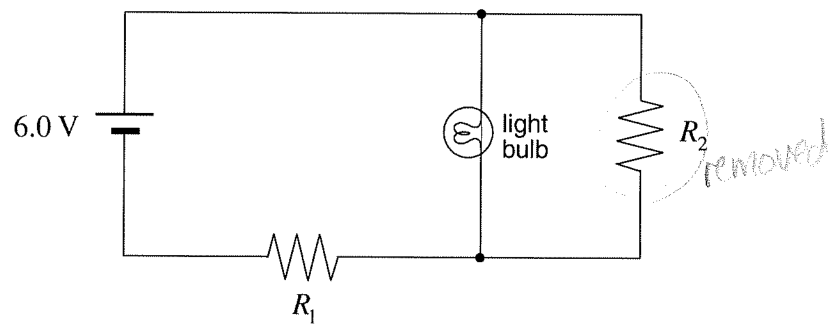
$\mu = \frac{Y_{int}}{mg} = \frac{17.5\,N}{(9.09 \times 9.8)\,N}$

$= 0.20$ ✓

6. **(4 marks)**

A student initially sets up a circuit containing two resistors and a light bulb, as shown.

$V = IR$



The student notes the brightness of the light bulb. Using principles of physics, explain what happens to the brightness of the light bulb when resistor R_2 is removed.

When R_2 removed, R_T of circuit increases
so I must drop $\left(\frac{V}{R}\right)$ but now all goes
through bulb and bulb resistance is more
than parallel was so gets more of V
so brightness increases $P = V^2/R$

END OF EXAMINATION