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 Response Form provided. Using an HB pencil, completely fill in the circle that has the letter corresponding to your answer.

1. Which of the following correctly applies to a projectile in the absence of friction?

   A. The vertical velocity is changing.
   B. The horizontal velocity is changing.
   C. The vertical acceleration is changing.
   D. The horizontal acceleration is changing.

   } all constant

2. An 1800 kg car initially travelling at 15 m/s brakes to avoid hitting another car. The car accelerates at $-1.9\ m/s^2$ while braking to a stop. How far does the car travel during its acceleration?

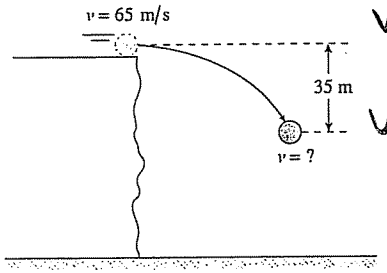
   $v_f^2 = v_0^2 + 2ad$

   $0^2 = 15^2 + 2(-1.9)d$

   $d = 59.2\ m$

   A. 29 m
   B. 59 m
   C. 120 m
   D. 180 m

3. A 15 kg rock is projected horizontally from a very high cliff at a speed of 65 m/s as shown.



$v_f^2 = v_0^2 + 2ad$

$= 0 + 2(9.8)(35)$

$v_f = 26.2\ m/s$

65 m/s + 26.2 m/s → 70 m/s

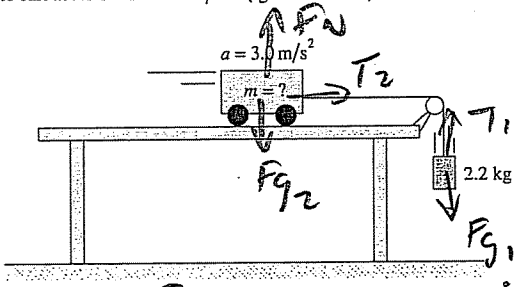
What is the speed of the rock after it has fallen a vertical distance of 35 m?

   A. 26 m/s
   B. 59 m/s
   C. 65 m/s
   D. 70 m/s

4. Which of the following is equal to the gravitational field strength?

   A. F_g N/kg
   B. $\frac{m}{F_g}$
   C. $\frac{F_g}{m}$
   D. $F_g \times m$

5. A cart of unknown mass is attached to a 2.2 kg mass hanging over the edge of a table as shown. The cart accelerates at $3.0\ m/s^2$. (Ignore friction.)



$F_{net} = F_{g1} - T_1 + T_2$

$(m + 2.2)(3.0) = 2.2(9.8)$

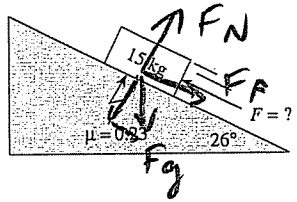
$3m + 6.6 = 21.6$

$3m = 15$

What is the mass of the cart?

   A. 1.2 kg
   B. 5.0 kg
   C. 6.6 kg
   D. 7.2 kg

6. What force F applied parallel to the incline would make the 15 kg block shown below move at a constant speed up the incline?



$F_{net} = 0$

$F_{net} = F - F_f - F_{gx}$

$0 = F - \mu F_N - F_{gx}$

$0 = F - \mu mg\cos 26 - mg\sin 26$

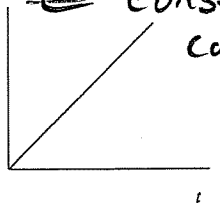
$0 = F - 30.4 - 64.4$

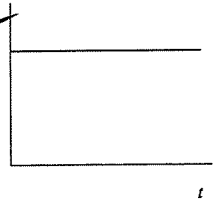
$F = 95\,N$

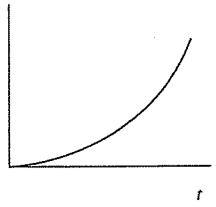
A. 30 N
B. 34 N
C. 64 N
D. 95 N

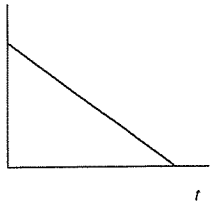
7. A ball is dropped from a tree and falls to the ground. Which of the following best represents the ball's total energy, E_T, as it falls?

conserved
constant

A.


B.


C.


D.


8. A 45 kg steel ball is projected vertically with an initial speed of 280 m/s. While the ball is rising, 8.5×10^5 J of heat energy are produced due to air friction. What is the maximum height reached by the ball?

$E_b = E_a$

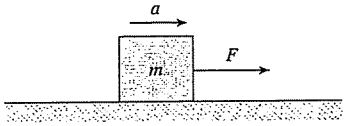
$E_K = E_P + E_{Fi}$

$\frac{1}{2}(45)(280)^2 = (45)(9.8)h + 8.5\times10^5\,J$

$1.76\times10^6 = 441h + 8.5\times10^5\,J$, $h = 2072$

A. 1900 m
B. 2100 m
C. 4000 m
D. 5900 m

9. The force F shown below is pulling the mass m over a frictionless surface with an acceleration of a.



Which of the following is equal to the mass's rate of change of momentum?

A. F
B. $\frac{F}{a}$
C. $\frac{F}{m}$
D. $F \cdot a$

$\frac{\Delta p}{\Delta t} = \frac{m\Delta v}{\Delta t}$

$= ma$

10. A 5.0 kg ice block is sliding along a smooth floor at 1.0 m/s west when a 0.20 N force directed east acts on it for 4.0 s. What is the magnitude of the block's final momentum?

A. 0.80 kg m/s
B. 4.2 kg m/s
C. 5.0 kg m/s
D. 5.8 kg m/s

$I = F\Delta t = \Delta p$

$= (.2)(4)$

$= .8\,N{\cdot}s$ east

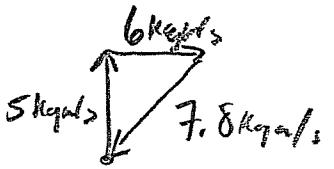
$\Delta p = p_f - p_0$

$-.8 = p_f - 5$ kg m/s

$p_f = -4.2$ kg m/s

$P_b = P_a$

$0 = 0$



11. A 1.0 kg physics puck is at rest when a small explosion breaks it into three pieces. A 0.50 kg piece goes north at 10 m/s and a 0.30 kg piece goes east at 20 m/s. What is the magnitude of the momentum of the third piece?

A. 1.0 kg m/s
B. 3.3 kg m/s
C. 7.8 kg m/s
D. 11 kg m/s

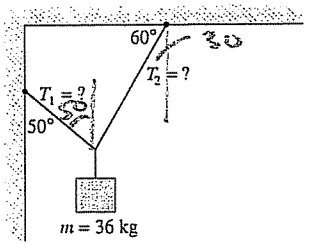
12. Which of the following demonstrates the application of torque?

A. Pulling a block across a floor
B. Pushing a block up an incline
C. Using a screwdriver to turn a screw
D. Stopping a block from sliding down an incline

13. What are the tensions T_1 and T_2 in the two ropes holding the 36 kg mass as shown?

$\sum F_x = 0$

$\sum F_y = 0$

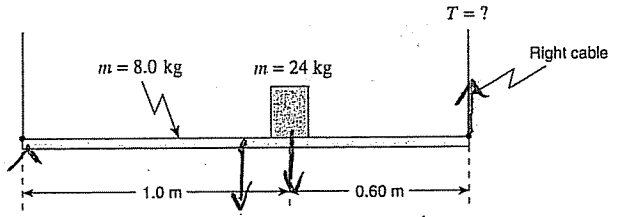


$F_g = 352.8$

$\frac{F_g}{\sin 100} = \frac{T_1}{\sin 30} = \frac{T_2}{\sin 50}$

	Tension T_1	Tension T_2
A.	180 N	180 N
B.	180 N	270 N
C.	350 N	180 N
D.	350 N	350 N

14. Two cables are used to support a 24 kg mass on a 1.6 m long 8.0 kg uniform horizontal beam as shown.



C_g F_g

What is the tension T in the right cable?

A. 130 N
B. 150 N
C. 190 N
D. 300 N

$\Sigma \tau = 0$ cw τ = ccw τ

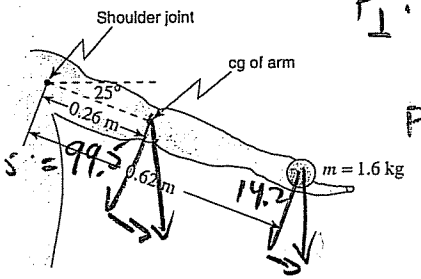
$C_g(.8) + F_g(1.0) = T(1.6)$

$8(9.8)(.8) + 24(9.8)(1.0) = T(1.6)$

$298 = 1.6T$

15. A 1.6 kg ball is held in the hand of a fully extended 11.2 kg arm as shown. (cg = centre of gravity)

$F_\perp \cdot d$



$F_g \cos 25 = 14.2$

$C_g \cos 25 = 99.5$

What is the total torque about the shoulder joint due to the ball and to this arm?

A. 17 N·m
B. 19 N·m
C. 35 N·m
D. 38 N·m

$(99.5N)(.26m) + 14.2N(.62m)$

$25.9 + 8.8$

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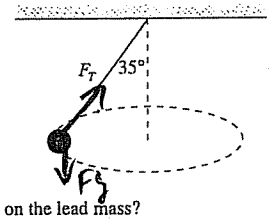
16. A small spider is accidentally taking a ride on a CD rotating with a period T. Its centripetal acceleration is 10 m/s^2. The CD player is turned off and the disc slows down. What is the spider's centripetal acceleration when the disc has slowed so the period is 2T?

$a_c = \frac{4\pi^2 r}{T^2}$ since T^2 $(2T)^2 = 4T^2$ so $\frac{1}{4}$

A. 2.5 m/s^2
B. 5.0 m/s^2
C. 20 m/s^2
D. 40 m/s^2

17. The 2.5 kg lead mass shown below is moving in a horizontal circle. The tension in the line is 30 N.

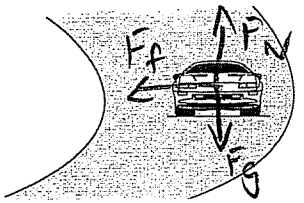


$F_T = 30N$, $F_g = 24.5N$, $F_c = 17.3N$

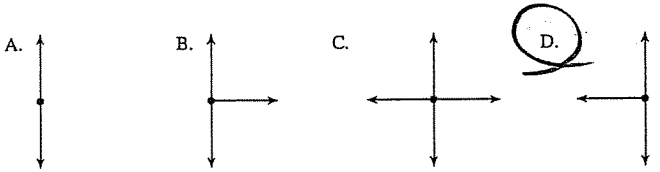
What is the centripetal force on the lead mass?

A. 17 N
B. 25 N
C. 30 N
D. 55 N

18. A car is going around a curve at constant speed on a level road as shown in the diagram below.



Which of the following free body diagrams shows the forces acting on the car?



19. A satellite is in a circular orbit around a planet. Which of the following describes the magnitude of the force due to gravity on the satellite as it moves around the planet?

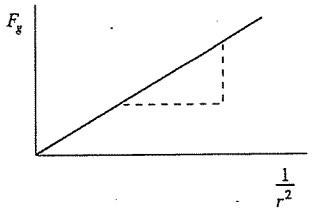
A. constant
B. increasing
C. decreasing
D. increasing then decreasing

20. A planet has a larger gravitational field strength on its surface than does the earth. Which of the following is a possible comparison of this planet's mass and radius with Earth's?

$g = \frac{GM_P}{r^2}$

	MASS	RADIUS
A.	larger ✓	equal
B.	equal	larger ✗
C.	smaller ↖	equal
D.	smaller ↘	larger

21. The force due to gravity between two masses (m_1 and m_2) is determined for several separation distances. This data is then used to create the graph below. What is the slope of this graph?



A. G

B. m_1m_2

C. $\frac{m_1m_2}{G}$

D. Gm_1m_2

$F_g = \frac{GMm_2}{r^2}$

$F_g = GM_1m_2\left(\frac{1}{r^2}\right)$

$y = mx$

22. What is the speed of a 500 kg satellite orbiting the moon at distance of 2.5×10^6 m from the moon's centre?

A. 0.89 m/s

B. 20 m/s

C. 1.4×10^3 m/s

D. 3.1×10^4 m/s

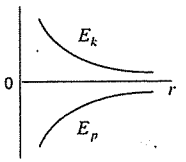
$F_g = F_c$

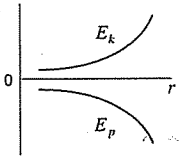
$\frac{GM_1m_2}{r^2} = \frac{m_2v^2}{r}$

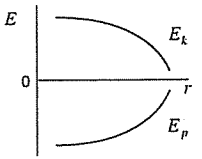
$v^2 = \frac{GM_1}{r} = \frac{(6.67\times10^{-11})(7.35\times10^{22}\,kg)}{2.5\times10^6 m}$

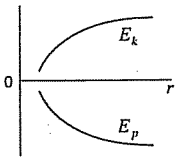
$v = 1400$

23. A mass is launched from the surface of a large moon at high speed. Which of the following graphs shows the potential and kinetic energies of the mass as it moves away from the moon?

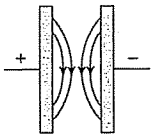
A.


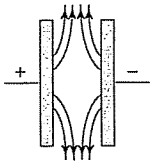
B.


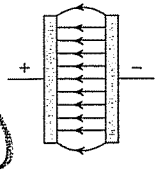
C.


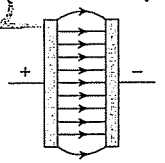
D.


24. Which diagram best illustrates the electric field between oppositely charged parallel plates?

A.


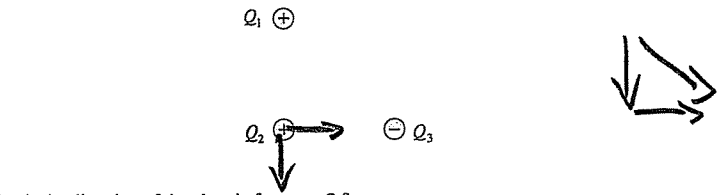
B.


C.


D.


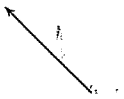
+ proton travel

25. Three charges of identical magnitude are arranged as shown.



What is the direction of the electric force on Q_2?

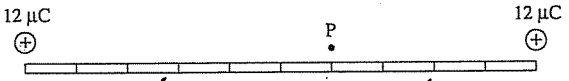
A. 

B. 

C. 

D. 

26. Identical 12 μC charges are placed at the ends of a metre stick.



What is the electric potential at point P at the 60 cm mark on the metre stick?

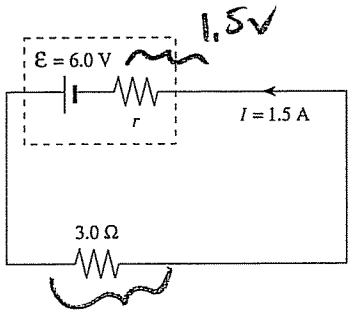
A. 9.0×10^4 V
B. 3.8×10^5 V
C. 4.5×10^5 V
D. 9.8×10^5 V

$V = \frac{kQ}{r}$ $\frac{9\times10^9(12\mu C)}{.6} + \frac{(9\times10^9)(12\mu C)}{.4}$

180 000 + 270 000

4.5×10^5

27. What is the internal resistance of the battery if it delivers 1.5 A when connected to a 3.0 Ω external load?



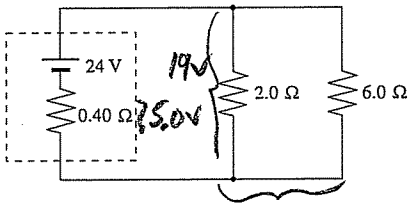
1.5V

V = 4.5V

r = 1.0Ω

A. 1.0 Ω
B. 3.0 Ω
C. 4.0 Ω
D. 7.0 Ω

28. In the circuit below, what is the current through the 2.0 Ω resistor?



A. 9.5 A
B. 10 A
C. 12 A
D. 13 A

$\frac{19V}{2} = 9.5A$

$\frac{1}{2} + \frac{1}{6}$

$\frac{3}{6} + \frac{1}{6} = \frac{4}{6}$

$\frac{6}{4} = 1.5\Omega$

$R_T = 1.9\Omega$

$I_T = \frac{24}{1.9} = 12.6A$

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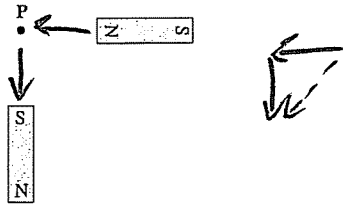
29. Which set groups the three common household electrical appliances in increasing order of rate of energy consumption while operating?

	INCREASING RATE OF ENERGY CONSUMPTION →		
A.	desktop computer	toaster	oven
B.	desktop computer	oven	toaster
C.	toaster	oven	desktop computer
D.	toaster	desktop computer	oven

30. In a step-down transformer, which of the following is greater in the secondary than in the primary?

A. power
B. current
C. voltage
D. number of turns

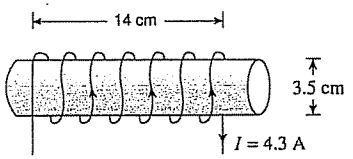
31. Two identical bar magnets are placed as shown.



What is the direction of the magnetic field at P?

A. ↙ B. ↗ C. ↖ D. ↘

32. A current of 4.3 A flows through a solenoid. The 620-turn solenoid is 14 cm long and has a 3.5 cm diameter.



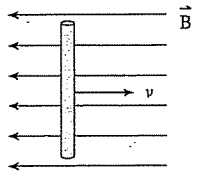
$B = \frac{\mu_0 N I}{\ell} = \frac{4\pi \times 10^{-7}(620)(4.3A)}{.14m}$

What are the direction and magnitude of the magnetic field inside the solenoid?

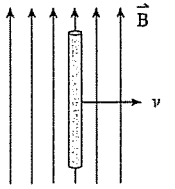
	DIRECTION OF FIELD	MAGNETIC FIELD STRENGTH (T)
A.	left	2.4×10^{-2}
B.	left	9.6×10^{-2}
C.	right	2.4×10^{-2}
D.	right	9.6×10^{-2}

33. A conductor is moved to the right through four magnetic fields as shown below. In which case will the largest emf be generated?

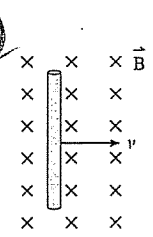
A.



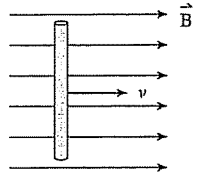
B.

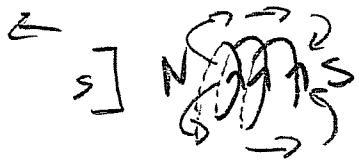


C.



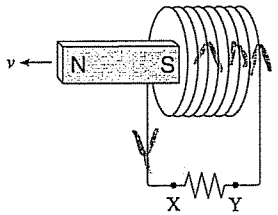
D.





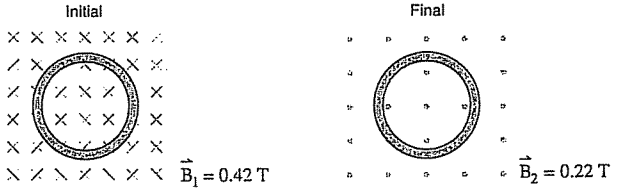
I is up at front

34. A bar magnet is moved away from a coil as shown. What is the direction of the current through the resistor and the polarity of the left end of the coil?



	Direction of Current Through the Resistor	Polarity of Left End of Coil
A.	X to Y ✓	North ✓
B.	X to Y	South
C.	Y to X	North ✓
D.	Y to X	South

35. A 200-turn coil has a 15.2 V potential difference induced in it when the magnetic field changes from 0.42 T to 0.22 T in the opposite direction in 3.2×10^{-2} s. What is the radius of this coil?



A. 3.5×10^{-2} m
B. 5.1×10^{-2} m
C. 5.9×10^{-2} m
D. 6.2×10^{-2} m

$\Delta B = .64$ T

$\mathcal{E} = -\frac{N\Delta B \cdot A}{\Delta t}$

$15.2\text{V} = \frac{200(.64)\pi r^2}{.032}$

$r^2 = .0012$

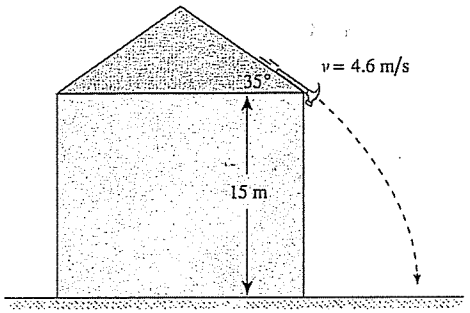
$r = .0347$m

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

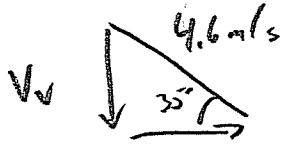
Answers

1) A
2) B
3) D
4) C
5) B
6) D
7) B
8) B
9) A
10) B
11) C
12) C
13) B
14) C
15) C
16) A
17) A
18) D
19) A
20) A
21) D
22) C
23) A
24) D
25) D
26) C
27) A
28) A
29) A
30) B
31) A
32) A
33) C
34) A
35) A

1. A hammer slides down a roof sloped at 35° reaching a speed of 4.6 m/s before falling off.



How much time does it take to fall the 15 m to the ground? **(5 marks)**



$V_V = 4.6\ m/s\ (\sin 35°)$

$= 2.64\ m/s$

$V_0 = 2.64\ m/s$

$a = 9.8\ m/s^2$

$d = 15\ m$

$t = ?$

$V_f^2 = V_0^2 + 2ad$

$V_f = 17.35\ m/s$

$V_f = V_0 + at$

$17.35 = 2.64 + (9.8)t$

$t = 1.5\ s$

ANSWER:

time: _____

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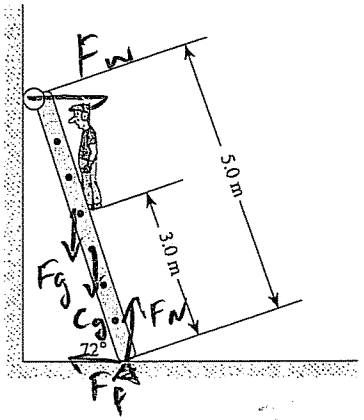
2. A 65 kg man is 3.0 m up a 5.0 m, 16 kg ladder leaning against a smooth wall at an angle of 72° as shown below.



What minimum force of friction between the ladder and the floor is required to keep the ladder from sliding? **(5 marks)**

$\sum F_x = 0 \quad F_f = F_W$

$\sum \tau = 0 \quad C_{g\perp}(2.5\text{m}) + F_{g\perp}(3.0\text{m}) = F_{W\perp}(5.0)$

CWT = CCWT $\quad 48.4(2.5) + (197)(3.0) = F_{W\perp}(5.0)$

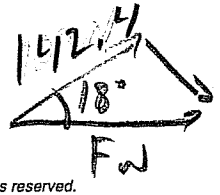
$C_{g\perp} = (16\text{kg})(9.8)\cos 72°$

$= 48.4\text{N}$

$F_{g\perp} = (65\text{kg})(9.8)\cos 72°$

$= 197\text{N}$

$F_{W\perp} = 142.4\text{N}$



$\cos 18° = \frac{142}{F_W}$

$F_W = \frac{142}{\cos 18} = 150\text{N}$

ANSWER:

minimum force: _____

3. Alpha particles with a mass of 6.6×10^{-27} kg and a charge of 3.2×10^{-19} C are fired towards each other from a great distance.

a) If they each have a speed of 2.5×10^{6} m/s to start with, what will be their minimum separation distance? **(4 marks)**

$E_b = E_a$

$E_{K_1} + E_{K_2} = E_p$

$2\left[\frac{1}{2}(6.6\times10^{-27})(2.5\times10^{6})^2\right] = \frac{K(3.2\times10^{-19})(3.2\times10^{-19})}{r}$

$r = 2.2\times10^{-14}\ m$

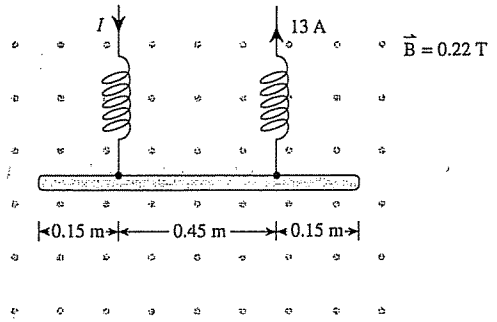
ANSWER:

a) minimum separation distance: _____

b) Using energy principles, explain why the particles do not come any closer than this minimum separation distance. **(2 marks)**

Their E_K is converted into E_P since the have similar charge & want to repel each other

4. A 0.75 m metal rod is suspended as shown. A current of 13 A then flows as indicated.



a) Is the tension in the springs increased or decreased? **(1 mark)**

increase, from R.H.R F_m is down

b) How much does the tension change? **(4 marks)**

$F_m = B \cdot I \cdot l$

$= (.22\,T)(13\,A)(.45\,m)$

$= 1.3\,N$

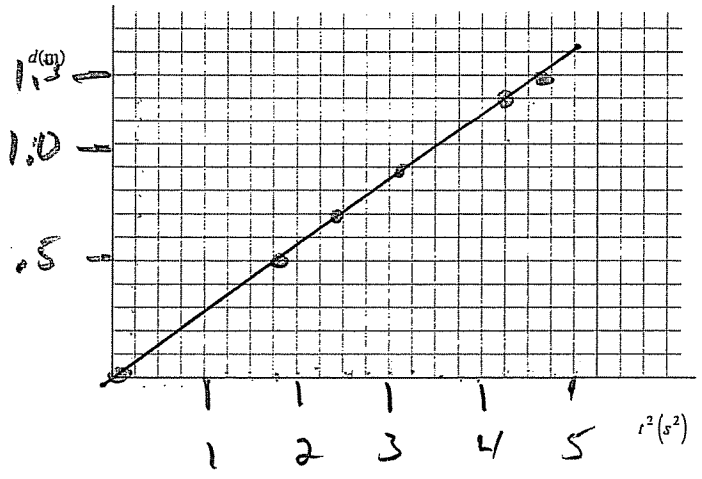
ANSWER:

b) tension change: _____

5. An experiment was performed on the surface of an asteroid. A mass was dropped from various heights and the time taken to fall was recorded.

d(m)	t(s)	$t^2(s^2)$
0	0	0
0.50	1.31	1.72
0.70	1.56	2.43
0.90	1.77	3.13
1.20	2.05	4.20
1.30	2.15	4.62

a) Plot a straight line graph of d vs. t^2. **(2 marks)**



b) From your straight line graph, determine the slope of the line. (Include units.) **(1 mark)**

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{.9 - .5}{3.13 - 1.72} = .28\ m/s^2$$

ANSWER:

b) slope of the line: _____

c) What is the acceleration due to gravity on the surface of this asteroid? **(2 marks)**

$$d = v_0 t + \frac{1}{2} a t^2$$
$$.9 = 0 + \frac{1}{2}(a)(1.77)^2$$
$$a = .57\ m/s^2$$

ANSWER:

c) acceleration due to gravity: _____

6. When checked with a voltmeter, an old 6 V lantern battery shows the expected reading of 6.0 V. However, the battery fails to light a low resistance light bulb. Identify the property of the battery that must have changed as it aged.

internal resistance has increased

Explain why this change to the property results in the bulb no longer lighting. (4 marks)

The large internal resistance produces a small current so light won't work.

END OF EXAMINATION

Answers

1) $t = 1.5\ s$

2) $F_f = 150\ N$

3) a) $r = 2.2 \times 10^{-14} m$

b) $E_K \rightarrow E_P$, so $E_{P_f} = E_{K_0}$, need more E to bring closer

4) a) increased

b) $F = 1.3\ N$

5) b) $0.28\ m/s^2$

c) $a = .156\ m/s^2$

6) R ↑, internal r ↑, $\frac{\mathcal{E}}{R_T} = I$ too small.