Physics 111 Common Exam 1, Spring 2013, Version A

Name (Print): _____ **4 Digit ID:**_____ **Section:** _____

Honors Code Pledge: For ethical and fairness reasons all students are pledged to comply with the provisions of the NJIT Academic Honor Code. You must answer the exam questions entirely by yourself. **Turn off all cell phones, pagers, or other communication devices**. Use only your own calculator.

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Instructions:

- First, write your name and section number on **both** the Scantron card and this exam sheet.
- Use the formula sheet (last exam booklet page) and no other materials.
- Budget your time. There are 10 multiple choice problems and 2 long problems.
- **For the long workout problems, you must show how you got your answers on this set of exam sheets.** Use the backs of pages if necessary. For most, if not all, of the multiple choice problems, it will be difficult to arrive at the correct answer without showing your work. However, while partial credit will be awarded for the long workout problems, partial credit will not be awarded on the multiple choice problems.
- Answer each question on the Scantron card using #2 pencil. Also circle your answers on question papers.
- Do not hesitate to ask for clarification of any exam question, if needed, from your proctor or Professor.

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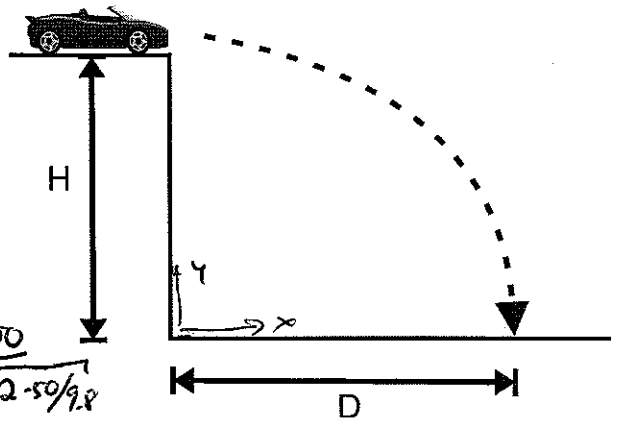
1. A car drives off a cliff which is H=50m high. The car strikes the ground D=100m from the base of the cliff as shown in the illustration. What was the velocity of the car as it leaves the cliff?



A) none of the other answers
B) 11 m/s
C) 4.5 m/s
D) 23 m/s
E) 31 m/s

$y = y_0 + v_{0y}t - \frac{1}{2}gt^2$

$0 = H - \frac{1}{2}gt^2$

$t = \sqrt{\frac{2h}{g}}$ $\quad D = v_0 t$ $\quad v_0 = \frac{D}{\sqrt{2h/g}} = \frac{100}{\sqrt{2 \cdot 50/9.8}}$

$v_0 = 31.3$ m/s

2. The position of a particle as a function of time is given by $x(t) = At^4 + Be^{-t/C} + Dt + E$ for which A, B, C, D, and E are constants. What are the units of the constant A?

A) m/s^2
B) m/s^4
C) m/s
D) m
E) none of the above

$x : At^4$

$A : \frac{x}{t^4} \Rightarrow \frac{m}{s^4}$

3. The position of a particle as a function of time is given by $\vec{r}(t) = 15\hat{i} + 5\hat{j} + 20t\,\hat{i} + 4t^3\hat{j}$. What is the magnitude of the velocity at t=2s?

A) 33 m/s
B) 20 m/s
C) 8 m/s
D) 52 m/s
E) 68 m/s

$\vec{v} = \frac{d\vec{r}(t)}{dt} = 20\hat{i} + 12t^2\hat{j}$

$\vec{v}(t=2) = 20\hat{i} + 48\hat{j}$

$|\vec{v}| = \sqrt{20^2 + 48^2} = 52$

4. Vector $\vec{A}$ has a magnitude of 10 and directed 50° **counterclockwise** from the positive x axis. Vector $\vec{B}$ has a magnitude of 15 and directed 110° **clockwise** from the positive x axis. What is the resultant vector of $\vec{A}+\vec{B}$?

A) $1.3\hat{i}-21.8\hat{j}$
B) $1.3\hat{i}+21.8\hat{j}$
C) $1.3\hat{i}-6.4\hat{j}$
D) $1.3\hat{i}+6.4\hat{j}$
E) None of the other answers

$\vec{A} = 10\cos 50\,\hat{i} + 10\sin 50\,\hat{j}$

$\vec{B} = 15\cos(-110)\,\hat{i} + 15\sin(-110)\,\hat{j}$

$\vec{A}+\vec{B} = 1.3\hat{i} - 6.4\hat{j} = (A_x+B_x)\hat{i} + (A_y+B_y)\hat{j}$

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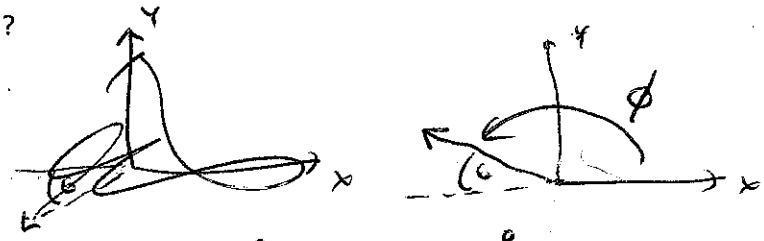
5. What is the direction of the vector $\vec{C} = -3\hat{i}+2\hat{j}$?

A) 34° counterclockwise from the positive x-axis
B) 34° clockwise from the positive x-axis
C) 56° counterclockwise from the positive x-axis
D) 146° counterclockwise from the positive x-axis
E) 124° counterclockwise from the positive x-axis



$\tan\theta = \frac{2}{3}$ $\quad \theta = 34°$

$180 - 34 = 146°$

6. An object moving with constant acceleration has a velocity of 12 cm/s on the positive x direction when its x coordinate is 3.00 cm. If the x coordinate 2.00 s later is -5.00 cm, what is its acceleration (assumed constant)?

A) 15.2 cm/s^2
B) -6.4 cm/s^2
C) -16.0 cm/s^2
D) 0 cm/s^2
E) 29.0 cm/s^2

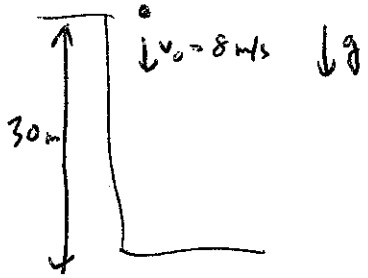
$x = x_0 + v_0 t + \frac{1}{2}at^2$

$-5 = 3 + 12\cdot 2 + \frac{1}{2}a\,2^2$

$a =$

7. A ball is thrown directly downward with an initial speed of 8 m/s from a height if 30 m. After what time interval does it strike the ground?

A) 3.46 s
B) 0.12 s
C) 1.79 s
D) 57.1 s
E) 9.8 s



$Y = Y_0 + v_{0y}t - \frac{1}{2}gt^2$

$0 = 30 - 8t - \frac{1}{2}9.8t^2$

take + root

$t = \dfrac{8 \pm \sqrt{(-8)^2 + 4\cdot 30\cdot \frac{9.8}{2}}}{-9.8}$ $\Rightarrow t = 1.79$

8. A 3.00 kg object hung from a string in an elevator. What is the tension in the string if the elevator is moving downward with acceleration $3m/s^2$?

A) 9 N

B) 29.4 N

C) 20.4 N

D) 38.4 N

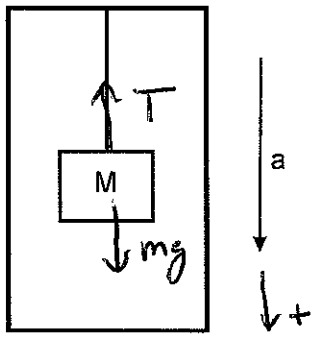
E) none of the other answers

$mg - T = ma$

$T = mg - ma$

$= m(g-a) = 3(9.8-3)$

$= 20.4$



9. A block slides down a frictionless plane having an inclination of $\theta = 15^0$. The block starts from rest at the top and the length of the incline is 2.00m. Find the acceleration of the block.

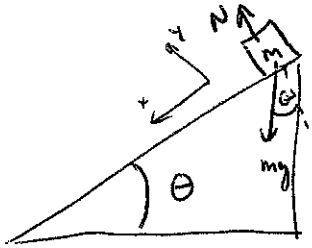
A) 3.65 m/s^2

B) 65.22 m/s^2

C) 2.54 m/s^2

D) 0 m/s^2

E) 0.61 m/s^2



$N - mg\cos\theta = 0$

$mg\sin\theta = ma$

$a = 9.8 \sin 15$

$a = 2.54$

10. The distance between two telephone poles is 50 m. When a 1 kg bird lands on the telephone wire midway (ie. 25m from each) between the poles, the wire sags 0.2m. How much tension does the bird produces in the wire? Ignore the weight of the wire.

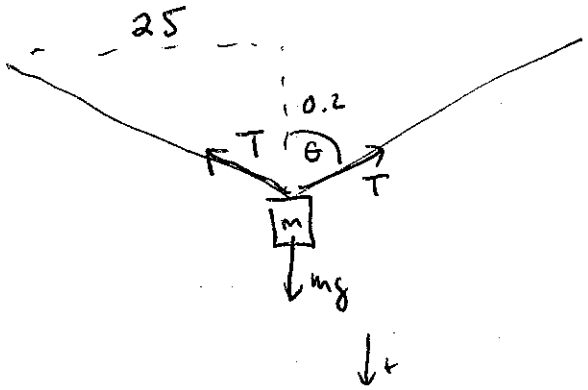
A) 920N

B) 0.5N

C) 613N

D) 12N

E) 105N



$mg - 2T\cos\theta = 0$

$T = \frac{mg}{2\cos\theta}$

$\tan\theta = \frac{25}{.2} \Rightarrow \theta = 89.54^\circ$

$T = \frac{1 \cdot 9.8}{2\cos(89.54)} = 613$

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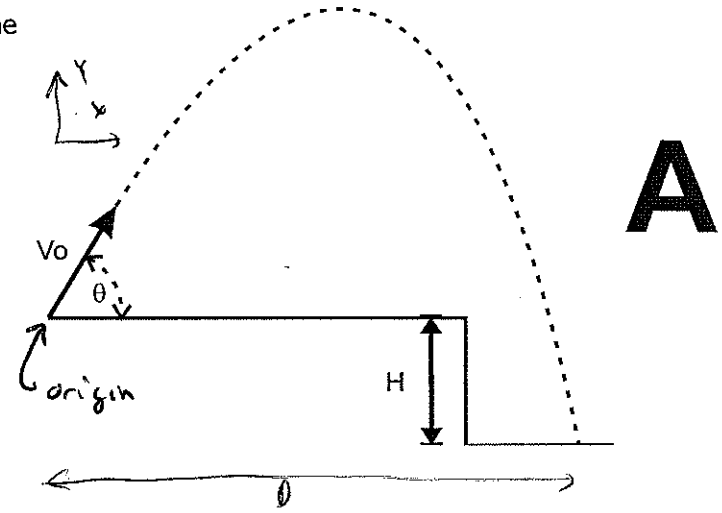
11. A projectile is launched with an initial speed V_o = 50m/s and an initial angle of 60 degrees from the ground. The projectile reaches a maximum height and then hits the bottom of a hole which is H=30m deep.

a) What is the horizontal component of the velocity of the projectile when it strikes the bottom of the hole?

(2)

$V_{ox} = V_o \cos\theta$

$= 50 \cos 60 = 25$ m/s



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(b) How long is the projectile in flight before it strikes the bottom of the hole?

(3)

$Y = Y_i + V_{oy}t - \frac{1}{2}gt^2$

$-H = 0 + V_o \sin\theta\, t - \frac{1}{2}gt^2$

$0 = \frac{1}{2}gt^2 - V_o \sin\theta\, t - H$

$t = \dfrac{V_o \sin\theta \pm \sqrt{V_o^2 \sin^2\theta + 4H\frac{1}{2}g}}{g}$

$t = \dfrac{50\sin 60 \pm \sqrt{50^2 \sin^2 60 + 2(30)9.8}}{9.8}$

choose + root so $t > 0$ $\quad t = 9.483$ sec.

(c) What is the final vertical component of the velocity when the projectile strikes the bottom of the hole?

(3)

$V_y^2 = V_{iy}^2 - 2g(Y - Y_i)$

$V_y = -\sqrt{V_{iy}^2 - 2g(Y - Y_i)}$

↑ negative root since $V_y < 0$

$V_y = -\sqrt{50^2 \sin^2 60 - 2(9.8)(-H - 0)}$

$V_y = -49.6$ m/s

(d) What is the total horizontal distance travelled by the projectile from launch to striking the bottom of the hole?

(2)

$x = x_i + V_{ox}t$

$D = 0 + 25 \cdot 9.483$

$D = 237$ m

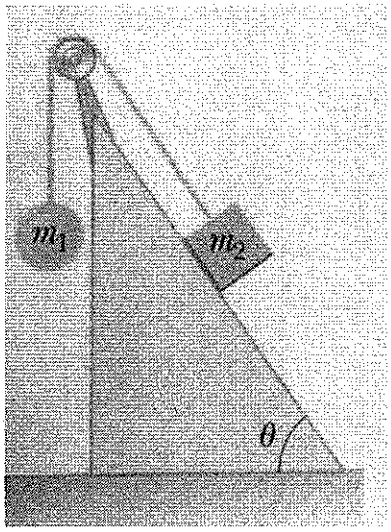
12. Two objects are connected by a light string that passes over a frictionless pulley as shown. Assume that the incline is frictionless and take m_1=2.00 kg, m_2=6.00 kg and θ =55^0.

a) Draw the free body diagram for each mass.

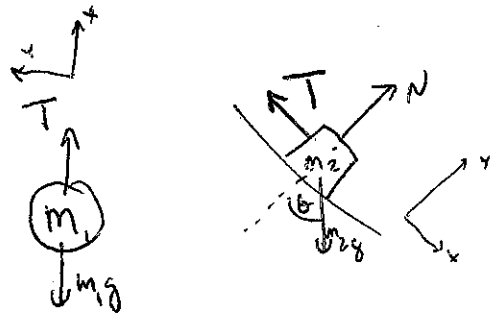
b) Find the magnitude of the acceleration of the objects.

c) In which direction does mass m_1 accelerate? Up or Down?

d) Find the tension in the string.



a)



b) $T - m_1 g = m_1 a$ $\quad (\sin\theta) m_2 g - T = m_2 a$

Combine

$$\sin\theta\, m_2 g - m_1 g = (m_1 + m_2) a$$

$$a = \frac{\sin\theta\, m_2 g - m_1 g}{m_1 + m_2} = \frac{\sin 55 \cdot 6 \cdot 9.8 - 2 \cdot 9.8}{2 + 6}$$

c) $a = (+)3.57\ m/s^2$

moves in + x direction or up

d) $T = m_1 a + m_1 g$

$= m_1(a+g) = 2 \cdot (3.57 + 9.8)$

$= 26.74$