PHYSICS 211——PRACTICE EXAM 1

NAME (printed) FOR WED RECITATION

SIGNATURE _____

Student Number (SSN) _____

SECTION _____

INSTRUCTIONS

1) Wait for oral instructions before starting the test.

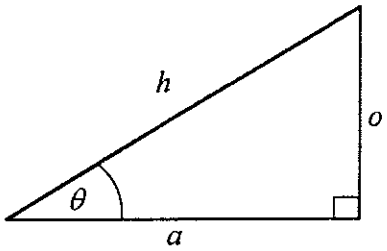
2) Remember to justify (in English) as many steps as possible for partial credit.

3) **No calculators or other aids permitted.**

For the graders:

1. _____
2. _____
3. _____
4. _____

TOTAL _____



$$\sin\theta = o/h$$
$$\cos\theta = a/h$$
$$\tan\theta = o/a$$

$$\sin(90^\circ - \theta) = \cos\theta \qquad \cos(90^\circ - \theta) = \sin\theta$$

$$\begin{aligned} \sin 0 &= 0 & \cos 0 &= 1 \\ \sin 90^\circ &= 1 & \cos 90^\circ &= 0 \\ \sin 30^\circ &= 1/2 & \cos 60^\circ &= 1/2 \end{aligned}$$

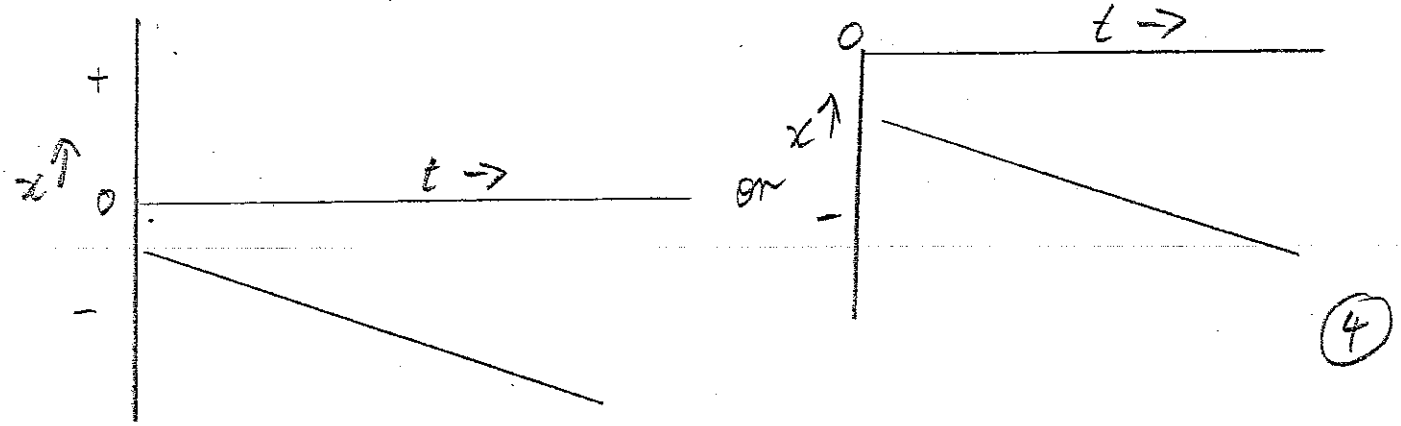
$$2\sin\theta\cos\theta = \sin 2\theta$$

1. a) Write down the SI (i.e., the metric system) units of position (x), time (t), velocity (v), and acceleration (a). *[1 point each]*

x m or meters
t s or seconds
v m/s or ms^{-1}
a m/s^2 or ms^{-2}

(4)

b) Draw a single position versus time graph (i.e., an $x - t$ graph) for an object whose position is negative, whose velocity is negative, and whose acceleration is zero. Label your axes and the origin clearly. (You may draw any graph that meets these requirements.) *[4 points]*



(4)

c) An object travels in a straight line from point A to point B at non-constant speed. It can definitely be stated that *[4 points]*

(i) part of the journey was at speeds greater than the average speed

(ii) part of the journey was at speeds less than the average speed

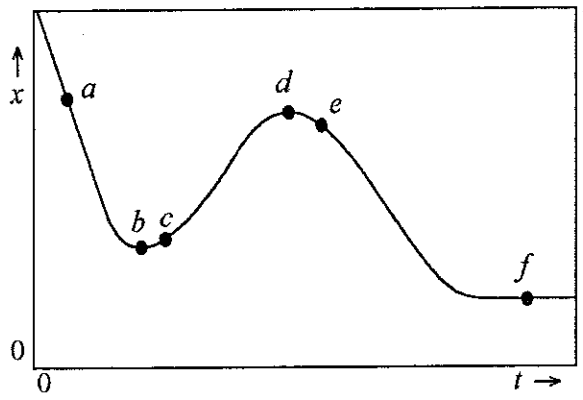
(iii) for at least one moment in time the instantaneous speed was the same as the average speed

(iv) all three of the above

(v) both (i) and (ii) but not (iii)

(4)

1. d) For each of the points labelled $a \rightarrow f$ in the position-time graph below, state whether the velocity v is positive, negative, or zero *and* whether the acceleration is zero or non-zero (sign not required). *[2 points each plus 1 bonus if all correct]*



a) $v = \ominus$ $a = 0$

b) $v = 0$ a NON-ZERO

c) $v = \oplus$ a NON-ZERO

d) $v = 0$ a NON-ZERO

e) $v = \ominus$ a NON-ZERO

f $v = 0$ $a = 0$

13

2. One Dimensional Motion

a) An object with zero initial velocity travels a distance r with constant acceleration w. If the distance travelled is $r = \frac{1}{2}wp^2$, what quantity does p represent? *[4 points]*

TIME or t

(4)

b) Write a new equation (in terms of r, k, p, w) for the distance r traveled by the above object when it has initial velocity k. *[4 points]*

$r = kp + \frac{1}{2}wp^2$

(4)

c) An object is thrown vertically upwards from the ground. If it takes 10 seconds to reach its highest point, how long does it take to return from that point to the ground? *[4 points]*

10 seconds (IE same as upward time)

(4)

2. d) A white car is traveling at the legal speed limit v_0 along an interstate highway. A blue car traveling in the same direction at twice the legal limit draws alongside the white car and (mistakenly) thinks it is a police car. The blue car slows down with constant acceleration $a = -a_b$ and the white car continues at its previous constant speed. How far apart are the cars when the blue car's speed is the legal speed limit? *[13 points]*

For the blue car $v_b = (2v_0) - a_b t$

↖ twice the limit

We need t for $v_b = v_0$.

IE $v_0 = 2v_0 - a_b t$ or $t = \frac{v_0}{a_b}$

In that time it has travelled a distance:

$$x_b = (2v_0)t - \frac{1}{2}a_b t^2$$

$$= \frac{2v_0^2}{a_b} - \frac{1}{2}a_b \frac{v_0^2}{a_b^2} = \frac{3}{2}\frac{v_0^2}{a_b}$$

In the same time the white car has travelled

$$x_w = v_0 t = v_0 \cdot \frac{v_0}{a_b} = \frac{v_0^2}{a_b}$$

∴ The distance between the cars is.

$$\boxed{x_b - x_w = \frac{3}{2}\frac{v_0^2}{a_b} - \frac{v_0^2}{a_b} = \frac{1}{2}\frac{v_0^2}{a_b}}$$

13

3. a) A vector $\vec{V}$ has a magnitude V. What is its component in a direction that makes an angle ϕ with the direction of V? *[4 points]*

$V \cos\phi$ (4)

b) A vector $\vec{V}$ has a magnitude V. What is its component (i) along a direction parallel to V, (ii) perpendicular to the direction of V? *[2 points each]*

(i) V (2)

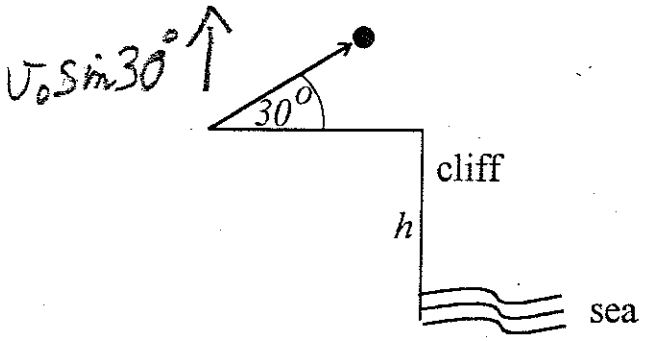
(ii) 0 (Zero) (2)

c) What can you say about the value of the horizontal acceleration component for projectile motion on the earth? *[4 points]*

It is zero (4).

("Constant" not acceptable!)

3. d) A ball is projected with velocity 7 m/s upward at an angle of 30° to the horizontal from the edge of a cliff a height h above the sea. It takes 4 seconds to reach the sea. How high is the cliff? (Use $g = 10$ m/s^2) *[13 points]*



P.2

$\sin 30° = \frac{1}{2}$

We only need consider the vertical motion. (Call this y, positive upwards).

$$y = (v_0 \sin 30°)t - \frac{1}{2}gt^2 = \frac{1}{2}v_0 t - \frac{1}{2}gt^2$$

When $t = 4$ s (with $v_0 = 7$ m/s)

$$y = \frac{1}{2} \times 7 \times 4 - \frac{1}{2} \times 10 \times 16 = 14 - 80$$

$$y = -66 \text{ m}$$

$\therefore$ Height of cliff = 66 m

13

4. a) What does Newton's First Law of Motion say about objects moving with constant velocity? (One sentence) *[4 points]*

The (net) force acting on them is zero.

(4)

b) Write down Newton's Second Law of Motion *in vector equation form*, and then write down a word for each symbol. *[4 points]*

$\vec{F} = m\vec{a}$ or $\Sigma \vec{F} = m\vec{a}$

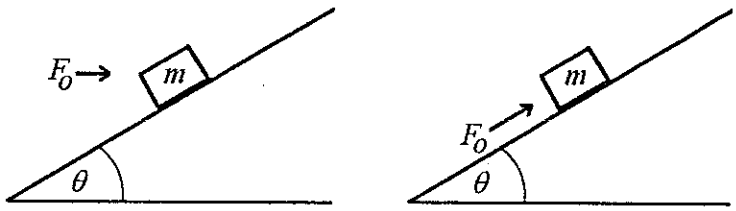
F is force m is mass a is acceleration

(4)

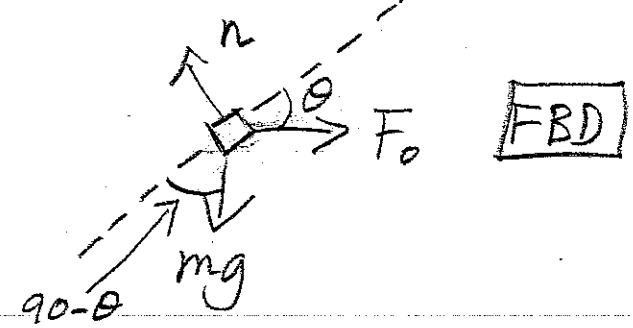
c) A mass m is hanging from the ceiling by a rope. Draw a *free body diagram* of the mass, showing the forces acting on it. *[4 points]*

T is tension

4. d) A mass m is held at rest on a (frictionless) slope by a horizontal force F_0, as shown in the left hand diagram below. The force is then removed and a force of equal magnitude F_0 is applied parallel to the slope in an upward direction as shown in the right hand diagram. Derive a formula for the acceleration of the mass. Express your answer as a formula containing g, the acceleration due to gravity, and θ, the angle of the slope. *[13 points]*



Use this as x



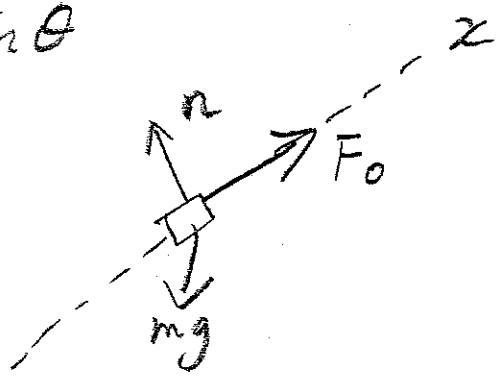
FBD

For left hand diagram:

Evaluate $\Sigma F_x = 0$;

$F_0 \cos\theta - mg\sin\theta = 0$

$\therefore F_0 = mg\frac{\sin\theta}{\cos\theta} = mg\tan\theta$



For right hand diagram:

Evaluate $\Sigma F_x = ma$;

$F_0 - mg\sin\theta = ma$

$\therefore a = \frac{F_0}{m} - \frac{mg\sin\theta}{m} = \frac{mg\tan\theta}{m} - \frac{mg\sin\theta}{m}$

UP SLOPE

$\therefore \boxed{a = g(\tan\theta - \sin\theta)}$ (13)

or $a = g\sin\theta\left(\frac{1}{\cos\theta} - 1\right)$