# Final Exam Formulæ & Constants



$$\vec{v} = \frac{d\vec{r}}{dt}$$
$$\vec{\omega} = \frac{d\vec{\theta}}{dt}$$
$$\vec{a} = \frac{d\vec{v}}{dt}$$
$$\vec{\alpha} = \frac{d\vec{\omega}}{dt}$$
$$v_{\text{sf}} = v_{\text{si}} + a_{\text{s}}\,\Delta t$$
$$\omega_{\text{f}} = \omega_{\text{i}} + \alpha\,\Delta t$$
$$s_{\text{f}} = s_{\text{i}} + v_{\text{si}}\,\Delta t + \tfrac{1}{2}a_{\text{s}}\,(\Delta t)^2$$
$$\theta_{\text{f}} = \theta_{\text{i}} + \omega_{\text{si}}\,\Delta t + \tfrac{1}{2}\alpha\,(\Delta t)^2$$
$$s = r\theta$$
$$v = r\omega$$
$$a_{\text{t}} = r\alpha$$

$$\sum \vec{F} = m\vec{a} = \frac{d\vec{p}}{dt}$$
$$\sum \vec{F}_{\text{ext}} = M\vec{a}_{\text{cm}} = \frac{d\vec{P}}{dt}$$
$$\sum \vec{\tau}_{\text{ext}} = I\vec{\alpha} = \frac{d\vec{L}}{dt}$$
$$f_{\text{s,max}} = \mu_{\text{s}} n$$
$$f_{\text{k}} = \mu_{\text{k}} n$$
$$a_{\text{r}} = \frac{v^2}{r}$$
$$\vec{w} = m\vec{g}$$
$$|\vec{F}_{\text{G}}| = \frac{Gm_1m_2}{|\vec{r}|^2}$$
$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$W = \int \vec{F} \cdot d\vec{s}$$
$$W_{\text{ext}} = \Delta K + \Delta U + \Delta E_{\text{th}}$$
$$K = \tfrac{1}{2}mv^2$$
$$K = \tfrac{1}{2}I\omega^2$$
$$U_{\text{g}} = mgy$$
$$U_{\text{s}} = \tfrac{1}{2}k\,(\Delta s)^2$$
$$U_{\text{G}} = -\frac{Gm_1m_2}{r}$$
$$P = \frac{dE_{\text{sys}}}{dt}$$
$$P = \vec{F} \cdot \vec{v}$$
$$\vec{J} = \int \vec{F}\,dt = \Delta\vec{p}$$
$$\vec{p} = m\vec{v}$$

$$\vec{r}_{\text{cm}} = \frac{\sum \vec{r}_i m_i}{\sum m_i}$$
$$\vec{r}_{\text{cm}} = \frac{\int \vec{r}\,dm}{\int dm}$$
$$I = \sum m_i r_i^2$$
$$I = \int r^2\,dm$$
$$I = I_{\text{cm}} + Md^2$$
$$\vec{L} = \vec{r} \times \vec{p}$$
$$\vec{L} = I\vec{\omega}$$
$$x = A\cos(\omega t + \phi_0)$$
$$\vec{a}_{\text{x}} = -\omega^2\vec{x}$$
$$\omega = \sqrt{k/m}$$
$$\omega = 2\pi f = \frac{2\pi}{T}$$

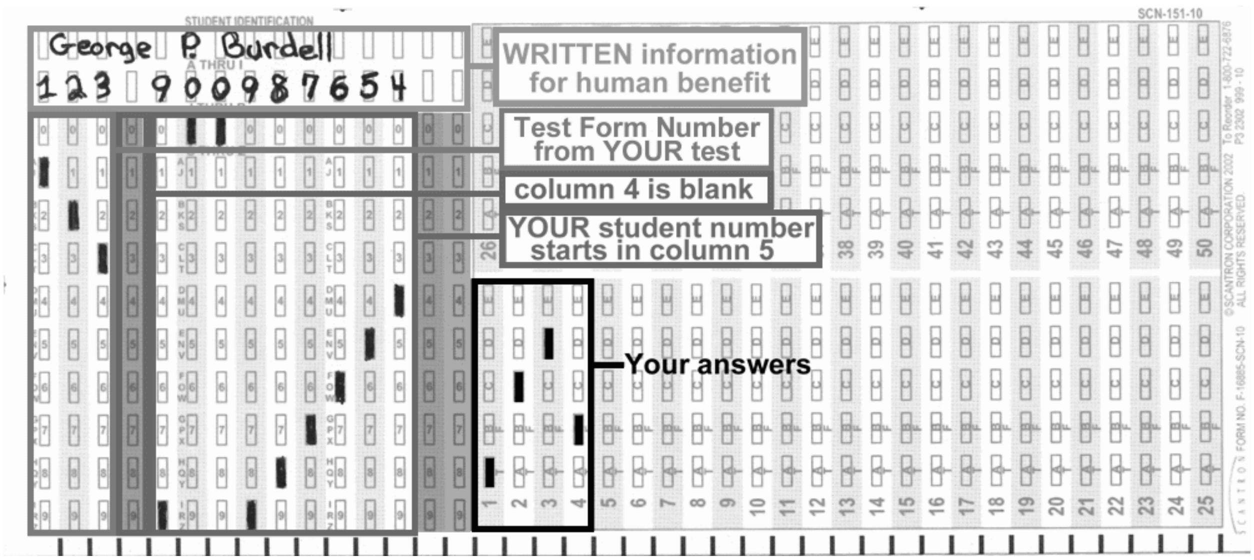
Physical Constants:

Gravitational Acceleration at Earth's Surface $g = 9.8\,\text{m/s}^2$

*Unless otherwise directed, all problems take place on Earth, and drag is to be neglected.*

A

*Please remove this sheet from your Quiz or Exam*




YOUR form number is **211**

# Recitation Sections

| | Clough 123 | Clough 125 | Clough 127 | Clough 131 | Clough 325 |
|---|---|---|---|---|---|
| **Wednesday** | | | | | |
| 1:05 – 1:55 pm | | | | | B01 Roberts, Kelli |
| 2:05 – 2:55 pm | | A01 Roberts, Kelli | | | |
| 3:05 – 3:55 pm | | | | A06/B05 Gaire, Vinod | |
| 4:05 – 4:55 pm | A02 Tregoning, Brett | A07 Whitley, Lee | B08 Biewer, John | B02 Gaire, Vinod | |
| 5:05 – 5:55 pm | | | | A05 Gaire, Vinod | B06 Ibnamasud, Shadman |
| **Thursday** | | | | | |
| 1:05 – 1:55 pm | | | | | |
| 2:05 – 2:55 pm | | | | | A03 Gaire, Vinod |
| 3:05 – 3:55 pm | | B07 Gaire, Vinod | B03 Tregoning, Brett | | |
| 4:05 – 4:55 pm | A04 Walia, Saumya | B04 Gaire, Vinod | A09 Tregoning, Brett | | |
| 5:05 – 5:55 pm | A08 Walia, Saumya | | | | |

| Version | Quiz #1 Form #211 | Name:____________________ |
|---|---|---|
| A | Physics 2211 A & B Fall 2016 | Recitation Section:____________ |

- Print your name, quiz form number (3 digits at the top of this form), and student number (9 digit Georgia Tech ID number) in the section of the answer card labeled "Student Identification."
- Bubble the Quiz Form Number in columns 1–3, skip column 4, then bubble your Student Number in columns 5–13.
- Free-response questions are numbered I–III. For each, make no marks and leave no space on your card. Show all your work clearly, including all steps and logic. Box your answer.
- Multiple-choice questions are numbered 1–7. For each, select the answer most nearly correct, circle this answer on your quiz, and bubble it on your answer card. Do not put any extra marks on the card.
- Turn in your quiz and answer card as you leave. Your score will be posted when your quiz has been graded. Quiz grades become final when the next quiz is given.
- You may use a calculator that cannot store letters, but no other aids or electronic devices.

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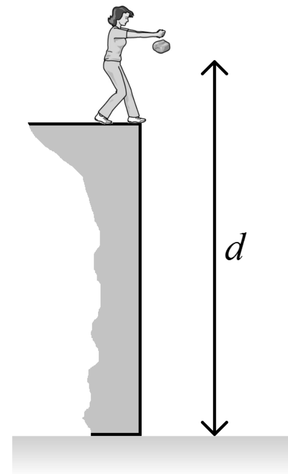
*I*. (16 points) The acceleration $\vec{a}$ of a particle moving in one dimension is depends on time $t$ and is given by

$$\vec{a} = -\left(3.0\,\mathrm{m/s^4}\right)t^2 + \left(18.0\,\mathrm{m/s^3}\right)t$$

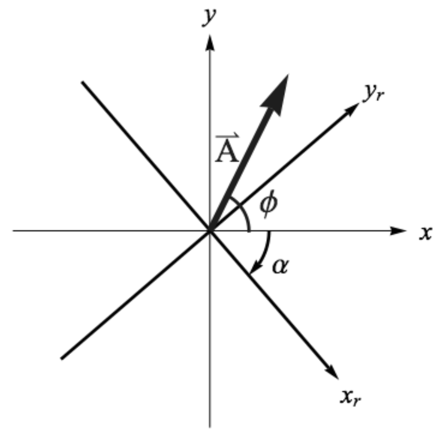
If the particle starts at position $x = 2.0\,\mathrm{m}$ at $t = 0$ with an initial velocity of $2.5\,\mathrm{m/s}$, what is its displacement after 2.0 seconds? (Hint: first find the velocity.)

*II*. (16 points) Amber stands on top of a small building, and throws a rock straight downward. It strikes the ground 2.4 s after she releases it, traveling at 25 m/s. At what distance $d$ above the ground did she release it? (*On Earth.*)




1. (6 points) In the problem above, if Amber had thrown the rock upward with the same initial speed ...
   (a) the rock would be traveling at greater than 25 m/s when it reached the ground, and it would require more than 2.4 s to reach the ground from the time it was thrown.
   (b) the rock would be traveling at greater than 25 m/s when it reached the ground, and it would require less than 2.4 s to reach the ground from the time it was thrown.
   (c) the rock would be traveling at 25 m/s when it reached the ground, and it would require 2.4 s to reach the ground from the time it was thrown.
   (d) the rock would be traveling at 25 m/s when it reached the ground, but it would require less than 2.4 s to reach the ground from the time it was thrown.
   (e) the rock would be traveling at 25 m/s when it reached the ground, but it would require more than 2.4 s to reach the ground from the time it was thrown.

2. (6 points) The figure shows two coordinate systems, the original coordinate system $(x, y)$, and $(x_r, y_r)$ which has been rotated by $\alpha$ degrees *clockwise* with respect to the original coordinate system. The vector $\vec{A}$ has magnitude and angle $(r, \theta) = (A, \phi)$ in the original coordinate system.

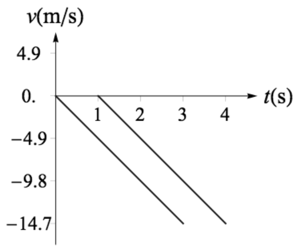


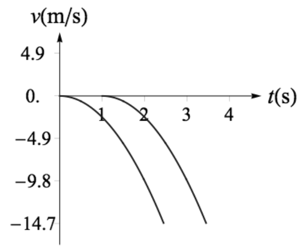

What is the angle $\theta_r$ of polar coordinate $(r_r, \theta_r)$ of $\vec{A}$ in the rotated coordinate system?

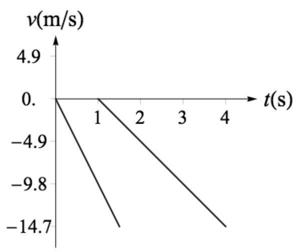
(a) $\theta_r = 90 - \phi$
(b) $\theta_r = 90 - (\alpha - \phi)$
(c) $\theta_r = \alpha + \phi$
(d) $\theta_r = \alpha - \phi$
(e) $\theta_r = 90 - \alpha$

*III*. (16 points) Write an expression for the Cartesian coordinates $(x_r, y_r)$ of $\vec{A}$ in the rotated coordinate system, in terms of parameters defined in the problem and physical or mathematical constants.

3. (8 points) I drop a stone from a tall tower at time $t = 0$, then one second later I drop another stone. Which velocity *vs.* time diagram describes this situation. ("Up" is the positive direction.)

(a)



(b)



(c)
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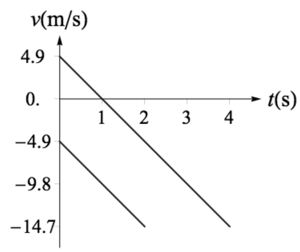
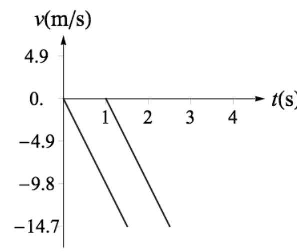
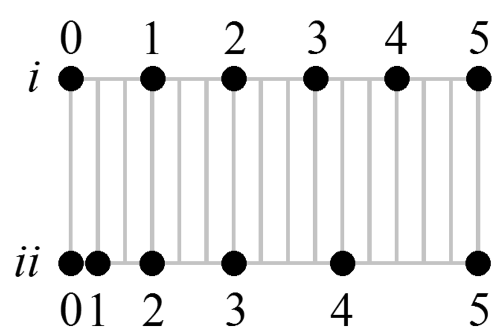


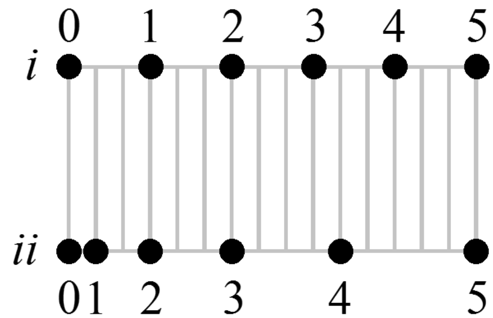

(e)



4. (8 points) Motion diagrams for two objects, *i* and *ii*, are shown. At an instant in what interval, if any, must the objects have the same velocity?

(a) In the interval from 1 to 2.
(b) In the interval from 2 to 3.
(c) There is no such instant in any time interval.
(d) In the interval from 3 to 4.
(e) In the interval from 4 to 5.

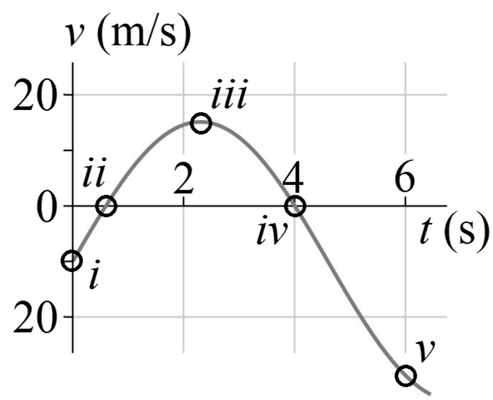


5. (8 points) Motion diagrams for two objects, $i$ and $ii$, are shown. At an instant in what interval, if any, must the objects have the same acceleration?



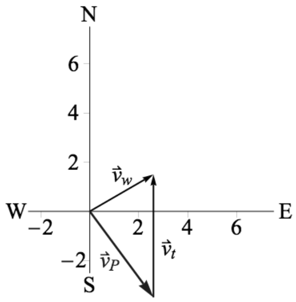

(a) In the interval from 2 to 3.
(b) In the interval from 3 to 4.
(c) There is no such instant in any time interval.
(d) In the interval from 1 to 2.
(e) In the interval from 4 to 5.

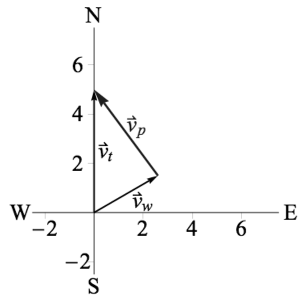
6. (8 points) The graph shows the velocity of an object moving in one dimension as a function of time. At what time in the range 0 to 6 s does the object have its greatest displacement from its position at time $t = 0\,\text{s}$?

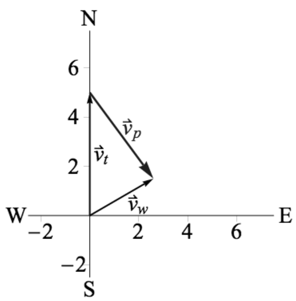


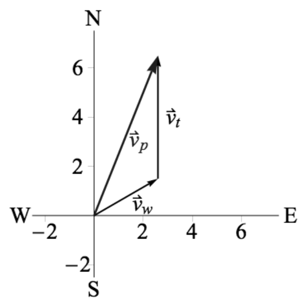

(a) About $t = 2.3\,\text{s}$, instant $iii$.
(b) At $t = 6\,\text{s}$, instant $v$.
(c) At $t = 4\,\text{s}$, instant $iv$.
(d) About $t = 0.7\,\text{s}$, instant $ii$.
(e) At $t = 0\,\text{s}$, instant $i$.

7. (8 points) I am trying to land my plane due north at 5 m/s in a 3 m/s wind 30° north of east. If my target velocity is $\vec{v}_t$, and the wind has velocity $\vec{v}_w$, the velocity I should aim my plane, $\vec{v}_p$, satisfies $\vec{v}_t = \vec{v}_w + \vec{v}_p$. Which diagram of vector addition shows the correct vector along which I should aim my plane.

(a) 


(b) 


(c) 


(d) 


(e)