Physics 218—Exam 01

- Name: ____________________
- Section number ____________________
- Assigned ID: ____________________

**IMPORTANT**
Read these directions carefully

- There are 4 problems totalling 75 points. Check your exam to make sure you have all the pages. Work each problem on the page the problem is on. You may use the back.

- **Indicate what you are doing!** We cannot give full credit for merely writing down the answer. **Neatness counts!** I shall give generous partial credit if I can tell that you are on the right track. This means you must be neat and organised.

- Each problem with its associated figure is self explanatory. If you must ask a question, then come to the front, being as discreet as possible so as not to disturb others.

- Put your name on each page it is asked for. You will lose credit if you fail to print your name on each page it is asked for.
(I) Multiple-choice questions: [10pts]

(1) The velocity of an object is given by $v = At^3$. If the units for time $t$ and the velocity $v$ are $s$ and $m/s$ respectively, what is the unit for the constant $A$? (3pts)

- (a) $m/s$
- (b) $m^3/s^3$
- (c) $m/s^4$
- (d) $s^4/m$
- (e) Not enough information

(2) It is well-known that the gravitational acceleration on the surface of the moon is $\frac{1}{6}$ of that on the surface of the earth. If a person can jump to a height $h$ on the earth, how high can he jump on the moon? (4pts)

- (a) $6h$
- (b) $3h$
- (c) $\frac{1}{3}h$
- (d) $\frac{1}{6}h$
- (e) Not enough information

(3) An object moving at a constant speed around a circle has a centripetal acceleration $a$. If both the speed and circle radius are doubled, the acceleration becomes (3pts)

- (a) $a$
- (b) $2a$
- (c) $4a$
- (d) $\frac{1}{2}a$
- (e) $\frac{1}{4}a$
(II) [20pts] The velocity of a particle moving in a two-dimensional plane is given by
\[ \vec{v} = (4 - 2t \hat{i} + (2t^3 - 2t) \hat{j} . \]
(a) What is its instantaneous acceleration \( \vec{a} \)? (5pts)

(b) What is the average acceleration between \( t = 0 \) and \( t = 2 \), expressed as a vector? What is its magnitude and direction? (5pts)

(c) If at \( t = 0, \vec{r} = \vec{r}_0 = -3 \hat{j} \), what is the position vector \( \vec{r} \), as a function of \( t \)? (5pts)

(d) What is the average velocity between time \( t = 0 \) and \( t = 2 \), expressed as a vector? What is its magnitude and direction? (5pts)
(III) [20pts] A ball is thrown straight up from the ground with speed $v_0$. At the same instant, a second ball is dropped from rest from a height $H$ directly above the point where the first ball was thrown upward. There is no air resistance.

(a) Find the time interval until the two balls collide.

(b) Find the value of $H$ in terms of $v_0$ and $g$ such that at the instant when the balls collide, the first ball is at the highest point of its motion.
(IV) [25pts]
A rock is thrown from the roof of a building with a velocity $v_0 = 20\text{m/s}$ at an angle of $\alpha_0 = 37^\circ$ from the horizontal. The building has a height $h = 9\text{m}$. (You can ignore the air resistance.) (For those with no calculators, $\sin(37^\circ) \approx \frac{3}{5}$, $\cos(37^\circ) \approx \frac{4}{5}$ and $g \approx 10\text{m/s}^2$.)

(a) What is the speed of the rock when it reaches the highest point of the trajectory? (5pts)
(b) How long will the rock stay in the air? (5pts)
(c) How far will the rock travel horizontally from the building before it hits the ground? (5pts)

(d) What is the speed of the rock just before it hits the ground? (5pts)
(e) Show that the answer of (d) is independent of $\alpha_0$. (5pts)