

Physics 180 Term Test #1
October 11, 2007

Aids permitted: *Writing/drawing aids and non-programmable calculators.*

Do all 4 questions. Provide appropriate reasoning for your answers.

PUT YOUR NAME, TUTORIAL SECTION AND STUDENT NUMBER ON ALL BOOKS

S.I. (m-k-s) units are used throughout with $g = 10 \text{ m/s}^2$.

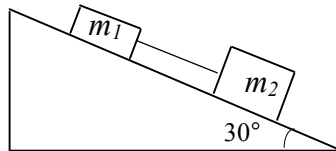
1) In 3 sentences or less, explain or discuss each of the following (without symbols, equations or graphs).

- i) What is the difference between distance and displacement in kinematics?
- ii) If Newton's laws of motion are valid in a certain frame of reference, explain if they are also valid in another frame moving with constant acceleration relative to the first frame.
- iii) If an object moves completely around a circle is it possible for the magnitude of its total (linear) acceleration ever to be zero?
- iv) If a mass on a spring oscillates in a horizontal plane at the surface of the earth, how will its period of oscillation change when it is hung vertically?
- v) What is meant by phase angle in simple harmonic motion?

[5 marks for each part]

2) In the figure, a box of ant aunts ($m_1 = 1.65 \text{ kg}$) and a box of ant uncles ($m_2 = 3.3 \text{ kg}$) slide down an inclined plane while attached by a massless rod parallel to the plane. The angle of the incline is 30° . The coefficient of kinetic friction between the aunt box and the incline is $\mu_1 = 0.23$; that between the uncle box and the incline is $\mu_2 = 0.11$. Compute:

- i) The tension in the rod and *[10 marks]*
- ii) the magnitude of the common acceleration of the two boxes. *[10 marks]*
- iii) How would answers to "i" and "ii" change if the uncles and aunts reverse positions? *[5 marks]*



3) A particle moves on a circle of radius R with constant period T , starting from the angular position $\theta = 0$. Derive expressions for:

- i) Its tangential velocity at any time, t , in terms of symbols given. *[10 marks]*
- ii) Its total acceleration, in terms of symbols given. *[10 marks]*
- iii) If the object is not restricted to move in a circle, *i.e.*, it moves freely in a plane with position vector $\vec{r} = r\hat{r}$, derive a general expression for the radial component of its acceleration. *[5 marks]*

Hint: $\frac{d\hat{r}}{d\theta} = \hat{\theta}$, $\frac{d\hat{\theta}}{dt} = -\frac{d\theta}{dt}\hat{r}$

[Please turn over for Q4]

4) An object is launched from the surface of the Earth at 60° relative to the horizontal with a speed of 100 m/s .

i) What is its horizontal displacement when it reaches its maximum vertical displacement, and what is the maximum vertical displacement? *[10 marks]*

ii) How long after launch does the object's velocity vector make an angle of 45° relative to the horizontal? *[10 marks]*

iii) At its maximum height the object explodes, sending fragments in all directions with a speed of 100 m/s relative to the unexploded object. One of the fragments initially moves purely vertically upward relative to the unexploded object. What angle does its velocity vector make relative to the horizontal when it hits the ground?

[5 marks]

Total marks: 100