PHYSICS 1111K, Spring 2005
Computer Numbers 12052, 12053, 12054
9:30AM~10:45AM / TR
First Exam

1. CLOSED BOOK exam. Please answer all the problems including all the sections. Be sure to show your work to determine how you got the answer and include any reasons.

2. Please **print your name** as it appears in your registration record. Leave the exam sheets stapled. **DO NOT SEPARATE** them. **SHOW ALL STEPS**. Partial credit may be given for incomplete answers if the steps leading to the final answer are correct.

3. Each of the 10 problems are worth 10 points. Some problems have more than one part in which case the 10 points are divided among the parts.

4. If you have questions, please raise your hand, DO NOT LEAVE your seat or talk to OTHERS. If any of the questions seem ambiguous, ASK.

5. Duration of the exam: 75 Minutes. Good Luck!

NAME: ……………………………………………………………..

1 meter (m) = 100 centimeters (cm) = 1000 millimeters (mm), 1000 meters = 1 kilometer
3.281 feet = 1 meter, 5280 feet = 1 mile, 3600 seconds = 1 hour
acceleration of gravity = -9.8 m/s^2
Distance - [L], Mass - [M], Time - [T]

Sin θ = Opposite/Hypotenuse
Cos θ = Adajacent/Hypotenuse

1. Linear Motion

$\Delta t = t - t_o$
$\Delta x = x - x_o$
$\Delta v = v - v_o$
$\Delta x = v \, \Delta t$

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x - x_0}{t - t_0}$$

$F_{net} = m\,a$ (m –mass, a- acceleration)

$V_{AB} = V_{AC} + V_{CB}$

Constant Acceleration

$v = v_o + \mathbf{a}t$

$x = x_o + v_o t + (½)\,\mathbf{a}t^2$

$x = x_o + ½(v + v_o)t$

$v^2 = v^2_o + 2\mathbf{a}(x - x_o)$

$(t_0 = 0)$

1.) (a) Which one of the following choices is equivalent to 5.0 m^2?

(a) 5.0×10^{-4} cm^2 (c) 5.0×10^{-2} cm^2 (e) 25.0×10^{4} cm^2

(b) 5.0×10^{4} cm^2 (d) 5.0×10^{2} cm^2

$$5\ m^2 = 5 \times (10^2\ cm)^2$$
$$= 5 \times 10^4\ cm^2$$

1) (b) The distance d that a certain particle moves may be calculated from the expression $d = at + bt^2$ where a and b are constants; and t is the elapsed time. What are the dimensions of the quantity b ?

(a) $[L][T]^{-1}$ (b) $[T]^{-2}$ (c) $[L][T]^{-2}$ (d) $[L]^{-1}[T]^2$ (e) No Dimensions

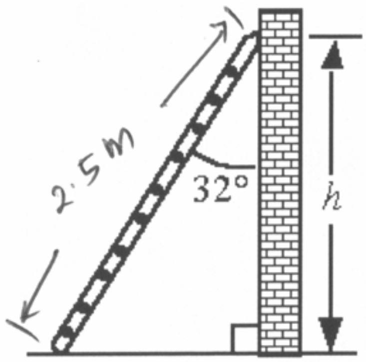
$$d = at + bt^2$$

$$\therefore \quad b = \frac{d - at}{t^2}.$$

d and at should have same dimensions.

$$\therefore \text{dimensions of } b = \frac{[L]}{[T]^2}$$
$$= [L][T]^{-2}$$

2) (a) A 2.5-m ladder leans against a wall and makes an angle with the wall of 32 ° as shown in the figure. What is the height h above the floor where the ladder makes contact with the wall?



$$\cos 32^\circ = \frac{h}{2.5\text{ m}}$$

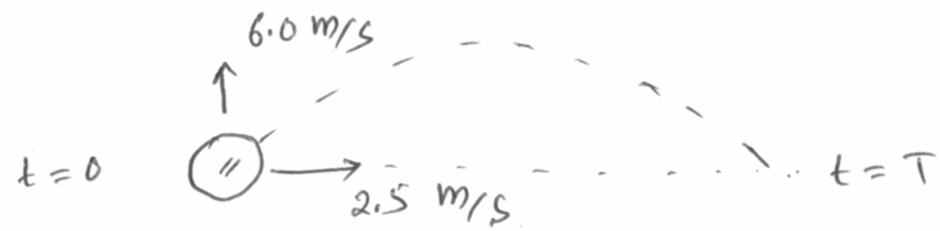
$$\therefore h = 2.5\text{ m} \cos 32^\circ$$

$$= \underline{\underline{2.12\text{ m}}}$$

2.) (b) Two vectors **A** and **B** are added together to form a vector **C**. The relationship between the magnitudes of the vectors is given by $A + B = C$. Which one of the following statements concerning these vectors is true?

(a) **A** and **B** must be displacements.
(b) **A** and **B** must have equal lengths.
(c) **A** and **B** must point in opposite directions.
(d) **A** and **B** must point in the same direction.
(e) **A** and **B** must be at right angles to each other.

3) A basketball player is running at a constant velocity of 2.5 m/s when he tosses a basketball upward with a speed of 6.0 m/s. The player continues running with the same constant velocity. (a) Could he catch the ball – explain your answer ? (b) If he can catch the ball, ignoring air resistance find the time elapsed (t) before the player catches the ball.



(a) Yes.

Both the player and the basketball have the same horizontal velocity. i.e the same horizontal displacement with the time.

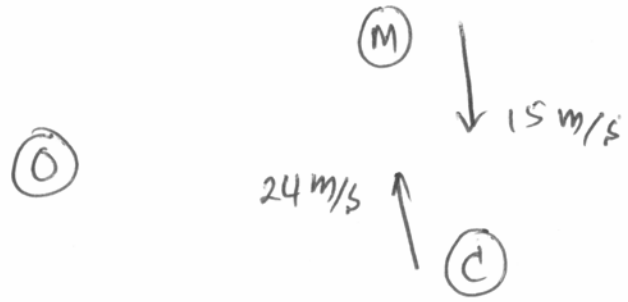
(b) Applying ↑ $x = x_0 + v_0 t + \frac{1}{2} \cdot at^2$

$$0 = 0 + 6.0\,\text{m/s}\ T + \frac{1}{2}\left(-9.8\,\frac{\text{m}}{\text{s}^2}\right)T^2$$

$$\therefore\ T = \frac{2 \times 6.0\,\text{m/s}}{9.8\,\text{m/s}^2}$$

$$= 1.22\,\text{s}$$

4) A motorcycle has a velocity of 15 m/s, due south (observed by a police officer standing on the side of the road) as it passes a car with a velocity of 24 m/s, due north. The same officer observes the velocity of the car. What is the magnitude and direction of the velocity of the motorcycle as seen by the driver of the car?



$V_{MO} = \downarrow 15\ m/s$

$V_{CO} = \uparrow 24\ m/s$

$\therefore V_{OC} = \downarrow 24\ m/s$

$$V_{MC} = V_{MO} + V_{OC}$$

$$= \downarrow 15\ m/s + \downarrow 24\ m/s$$

$$= \downarrow 39\ m/s$$

5) A student adds two displacement vectors with magnitudes of 3.0 m and 4.0 m, respectively. Which one of the following could ***not*** be a possible choice for the magnitude of the resultant vector? (Hint: the two vectors could be in any direction)

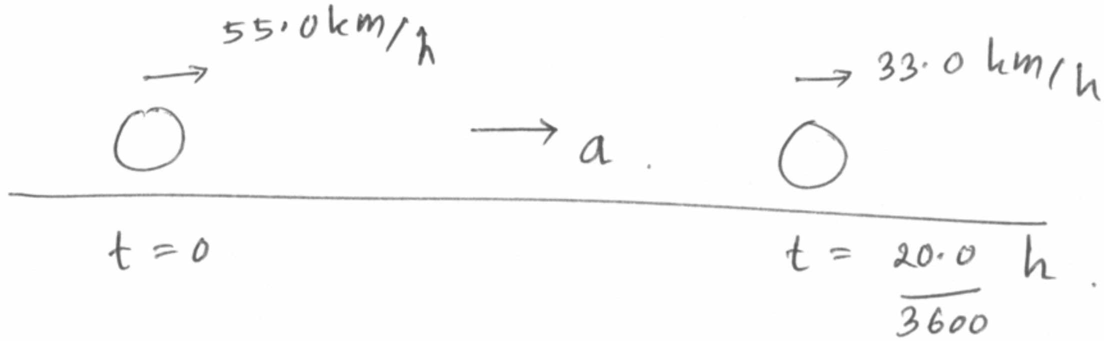
(a) 2.3 m (b) 4.0 m (c) 8.8 m (d) 3.2 m (e) 6.8 m

$R_{max} = 4.0\ m + 3.0\ m = 7.0\ m$

$R_{min} = 4.0\ m - 3.0\ m = 1.0\ m$

$\therefore\ 1.0 \leq |\vec{R}| \leq 7.0\ m$

6) A 2150-kg truck is traveling along a straight, level road at a constant speed of 55.0 km/h. Then the driver removes his foot from the accelerator. After 20.0 s, the truck's speed is 33.0 km/h. What is the magnitude of the average net force acting on the truck during the 20.0 s interval ?



Applying $\vec{v} = v_0 + at$

$$33\ \frac{km}{h} = 55.0\ \frac{km}{h} + a \cdot \frac{20}{3600}\ h$$

$$\therefore \vec{a} = \frac{(33-55)3600}{20} \cdot \frac{km}{h^2}$$

$$= -3960\ \frac{km}{h^2}.$$

Applying $\vec{F} = ma$

$$F = 2150\ kg \times \left(-3960\ \frac{km}{h^2}\right)$$

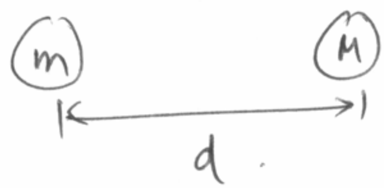
$$= -8514000\ kg\ \frac{km}{h^2}$$

$$= -8514000\ kg \cdot \frac{10^3\ m}{(3600\ s)^2}$$

$$= -656.9\ kg\ m/s^2$$

$$= -656.9\ N.$$ $\therefore \overleftarrow{F} = 656.9\ N$

7) Two point masses *m* and *M* are separated by a distance *d*. The gravitational force between them is given by $F_G = G\,mM/d^2$. Now, the masses are increased to the values 3*m* and 3*M* respectively, and the separation *d* remains fixed. How does the gravitational force between them change? (or How large is the new force compared to F_G?)



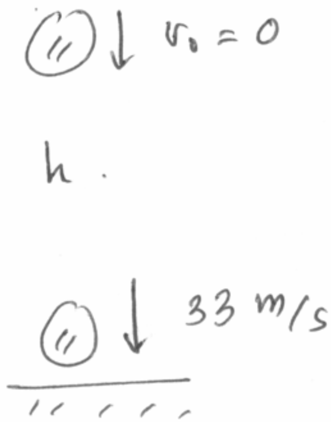
$$F_{G_2} = G \cdot \frac{3m\,3M}{d^2}$$

$$F_{G_1} = \frac{GMm}{d^2}$$

$$\therefore \frac{F_{G_2}}{F_{G_1}} = 9 \cdot \frac{GmM}{d^2} \Big/ \frac{GmM}{d^2}$$

$$= 9.$$

8) A rock is dropped from rest from a height (say *h*) above the ground. From what height (in Kilo meters) should the rock be dropped so that its speed on hitting the ground is 33 m/s? Neglect air resistance.

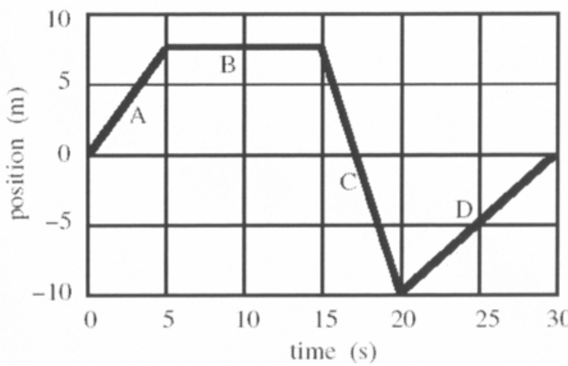


$$\downarrow \quad v^2 = v_0^2 + 2a(x - x_0)$$

$$(33\ m/s)^2 = 0 + 2\left(9.8\ \frac{m}{s^2}\right) h$$

$$\therefore h = \frac{33^2}{2 \times 9.8}\ m = \underline{\underline{55.6\ m}}$$

An object is moving along a straight line in the positive x direction. The graph shows its position from the starting point as a function of time. Various segments of the graph are identified by the letters A, B, C, and D.



9) Which segment(s) of the graph represent(s) a (i) ***constant velocity*** of +1.0 m/s? (ii) What is the velocity during the segment B ?

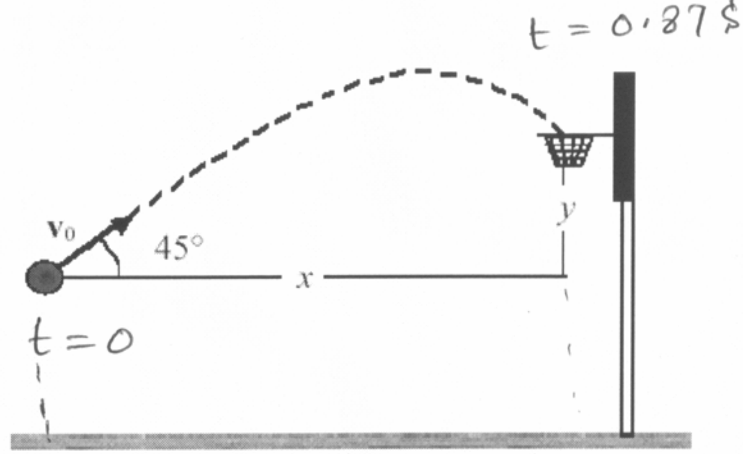
(i) D.

$$v = \frac{\Delta x}{\Delta t} = \frac{0-(-10)\ m}{(30-20)\ s} = 1\ m/s$$

(ii) zero.

$$v = \frac{\Delta x}{\Delta t} \quad \text{and} \quad \Delta x = 0.$$

10) A basketball is launched with an initial speed of 8.5 m/s and follows the trajectory shown. The ball enters the basket 0.87 s after it is launched. What are the distances *x* and *y*? **Note**: *The drawing is not to scale.*



$$v_0 = 8.5 \text{ m/s}$$

$\rightarrow$ Applying $x = x_0 + v_0 t + \frac{1}{2} a t^2$

$$x = 0 + 8.5 \frac{m}{s} \cos 45^\circ \times 0.87 s + 0$$

$$= \underline{\underline{5.23 \text{ m}}}$$

Applying $\uparrow$ $x = x_0 + v_0 t + \frac{1}{2} a t^2$

$$y = 0 + 8.5 \frac{m}{s} \sin 45^\circ \times 0.87 s + \frac{1}{2}\left(-9.8 \frac{m}{s^2}\right) 0.87 s$$

$$= \underline{\underline{0.97 \text{ m}}}$$