ABERNATHY
X1E

Name Lindsey Lossiter
Fall, 2023

PHYS2425
Exam I

For all questions and problems involving motion, neglect air resistance.

Part 1: Multiple Choice (3 points each)

(1) A heavy object and a light object are dropped from the same height at the same time from rest in a vacuum. The heavier object reaches the ground

(a) sooner than the lighter object
(b) at the same time as the lighter object
(c) after the lighter object
(d) whichever hits first depends on the distance they drop

(2) 20 km/hr = _____ m/s:

(a) 0.833
(b) 5.56
(c) 72.0
(d) 333.3

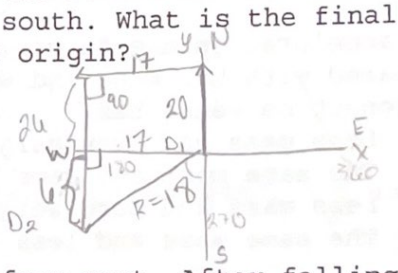
1 km = 1000 m
1 hr = 3600 s
20000/3600 = 5.56 m/s

(3) A delivery truck travels 20 blocks north, 17 blocks west, then 26 blocks south. What is the final displacement from the origin?

(a) 18.0@199.4°
(b) 18.0@250.6°
(c) 26.2@160.6°
(d) 26.2@236.8°

$\tan^{-1} = \frac{y}{x}$

$R = \sqrt{x^2 + y^2}$



$R = \sqrt{17^2 + 6^2}$
$R = 18.0$

(4) An object is dropped from rest. After falling freely for 4.5 seconds, it will have a speed of

(a) 9.8 m/s
(b) 44.1 m/s
(c) 99.2 m/s
(d) 49 m/s

gravity

$a = -9.8\ m/s^2$
$V_0 = 0$
$V_f = ?$
$t = 4.5\ s$

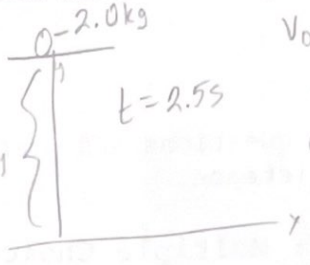
$V = V_0 + at$
$V = 0 + (-9.8)(4.5)$
$V = 44.1$

$a = -9.8$

(5) A rock with a mass of 2.0 kg is dropped from a tall building. How far has it fallen after falling for 2.50 s?

(a) 3.92 m/s
(b) 19.8 m/s
(c) 24.5 m/s
(d) 30.6 m/s

meters



$\Delta x = 0(2.5) + \frac{1}{2}(-9.8)(2.5$
$\Delta x = 0 + (4.9)(6.25)$
$\Delta x = 30.6\,m$

(6) 1 Newton is equivalent to

(a) 1 kg m/s
(b) 1 kg m/s²
(c) 1 m/s²
(d) 1 kg m·s/s

$W = mg$
$W = kg \cdot 9.8\,m/s^2$

(7) Passengers in a stopped automobile that is struck from behind by another automobile often suffer a neck injury known as whiplash. Which statement best describes this situation:

(a) the head goes forward faster than the car
(b) the head and car move forward at the same speed
(c) the head moves toward the rear of the car
(d) the head stays at the same place while the car moves forward

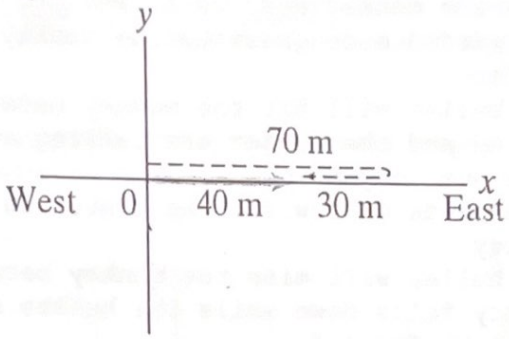
(8) The acceleration due to gravity on Venus is 8.8m/s². Compared with her mass and weight on Earth, an astronaut on Venus has

(a) Less mass and less weight
(b) The same mass and same weight
(c) Less mass and more weight
(d) The same mass and less weight

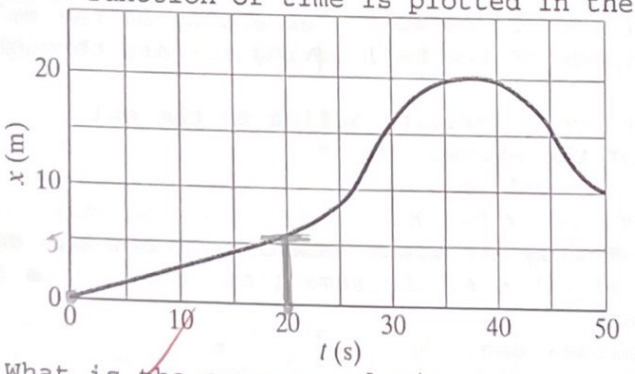
mass = constant
wt = changes

(9) A person walks 70 m east, then 30 m west as shown in the figure below. If it takes him 50 seconds to do this, what is his average velocity?

(a) 0.60 m/s
(b) 0.80 m/s
(c) 1.4 m/s
(d) 2.0 m/s



(10) The position of an object traveling in straight line as a function of time is plotted in the figure below.



What is the average velocity between t = 0 and t = 20s?

(a) 0.3 m/s
(b) 6.0 m/s
(c) 3.33 m/s
(d) 0.4 m/s

(11) A hunter is aiming horizontally at a monkey who is sitting in a tree. The monkey is so terrified when it sees the gun that it falls off the tree. At that instant, the hunter pulls the trigger. What will happen?

(a) The bullet will miss the monkey because although both the monkey and the bullet are falling downward due to gravity, the monkey is falling faster.

(b) The bullet will hit the monkey because both the monkey and the bullet are falling at the same rate due to gravity.

(c) It depends on how far the hunter is from the monkey.

(d) The bullet will miss the monkey because the monkey falls down while the bullet speeds straight forward.

(12) A golf ball is hit by a golf club. **While the ball is flying through the air**, what forces act on the ball? Neglect air resistance.

(a) The force of the golf club acting on the ball.

(b) The force of the ball moving forward through the air.

(c) The force of gravity acting on the ball.

(d) All of the above.

(e) Both (a) and (c).

(13) Two balls having different speeds roll off the edge of a horizontal table at the same time. Which hits the floor sooner?

(a) The slower one.

(b) The faster one.

(c) Hit at the same time.

Part 2: Problems

$x = \cos\theta$
$y = \sin\theta$

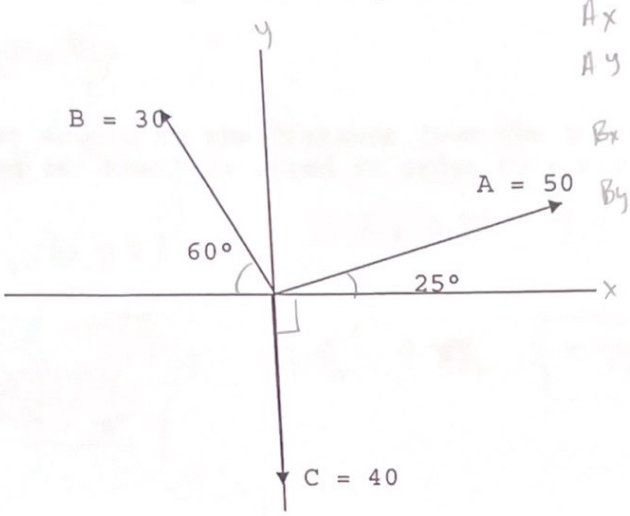
You must show your work to receive any credit.

Final answers must have correct units; otherwise, points will be deducted from that answer. Give answers correct to 3 *significant figures, angles correct to the nearest tenth of a degree.*

(1) Three vectors are shown. Their magnitudes are given in arbitrary units. (10 points).

A_x $50\cos 25 = 45.3$
A_y $50\sin 25 = 21.1$

B_x $30\cos 60 = 15$
B_y $30\sin 60 = 25.9$



(a) Complete the table of x and y values in order to determine the resultant of the three vectors:

	x	y
A	45.3	21.1
B	−15.0	25.9
C	0	−40.0
	60.3	87.1

$R = \sqrt{(60.3)^2 + (87.1)^2}$

$R = 105.9$

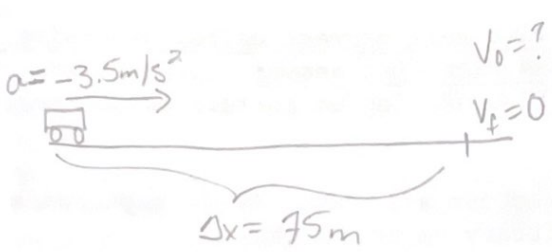
$\tan^{-1} = \frac{87.1}{60.3}$

$\theta = 55.3^\circ$

(b) Determine the resultant of the three vectors. Give both magnitude and direction:

$106 \angle 55.3^\circ$

(2) A car coming to a stop leaves skid marks 75 m long on a highway. Assuming a deceleration of 3.5 m/s², estimate the speed of the car just before braking: (10 points)



$$v_f^2 = v_0^2 + 2a\Delta x$$

$$0^2 = v_0^2 + 2(-3.5)(75)$$

$$0 = v_0^2 - 525$$

$$+525 \qquad +525$$

$$\sqrt{v_0^2} = \sqrt{525}$$

$$\boxed{v_0 = 22.9\ m/s}$$

$g = 9.8 m/s^2$ $D = vt$

(3) A gun fires a shell at an angle of 50° with a velocity of 75 m/s at a tank moving away from the gun on a horizontal field. The tank is moving at a speed of 3.0 m/s. (10 points)

(a) How much time will the shell be in the air?

$R = \frac{V_0^2 \sin 2\theta}{g}$

$R = \frac{(75)^2 \sin 2(50°)}{9.8 m/s^2}$

$R = \frac{5625 \sin 100}{9.8} = 565 = \Delta x$ ✓

$V_{0x} = V_0 \cos\theta$

$48.2 = 75 \cos(50)$

$\Delta x = V_{x_0} t$

$\frac{565}{48.2} = \frac{48.2 t}{48.2}$

$t = 11.7 s$

(b) What should be the distance from the gun to the tank when the shell is fired in order to score a hit?

$D = vt$ $11.7 \times 0.83 = 9.71 m$

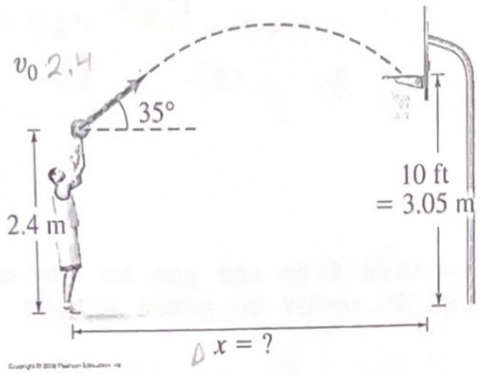
$V_y = V_{y0} - 9.8(11.7)$

0

$565 m - 9.71 m = 555.29 m$

-3

(4) A basketball is shot from an initial height of 2.4 m with an initial speed of 14 m/s as shown below. How far from the basket was the player if he made the basket? (15 points)



$t = ?$

$g = 9.8\ m/s^2$

$\theta = 35^\circ$

$\Delta x = ?$

$\Delta y = -2.4\ m$

$V_0 = 14\ m/s$

$\Delta x = V_{x0} t$

$\Delta x = V_0 \cos\theta\, t$

$\Delta x = 14\cos(35)\, t$

$\Delta x = 11.5\, t$

$\Delta x = 11.5(1.9_s)$

$\boxed{\Delta x = 21.85\ m}$ ✗

$\Delta y = V_{y0} t - \frac{1}{2} g t^2$ ✓

0.65

$-2.4\ m = V_0 \sin\theta\, t - \frac{1}{2} g t^2$ ✓

$-2.4\ m = 14\sin 35\, t - \frac{1}{2}(9.8) t^2$

$-2.4 = 8.03t - 4.9t^2$

$4.9t^2 - 8.03t - 2.4 = 0$

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

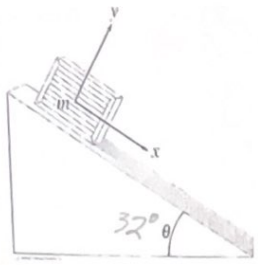
$x = \frac{-(-8.03) \pm \sqrt{(-8.03)^2 - 4(4.9)(-2.4)}}{2(4.9)}$

$x = \frac{8.03 \pm 10.56}{9.8}$

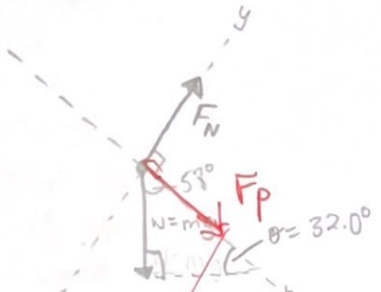
$x = 1.9_s$ or ~~$x = -0.26$~~

-4

(5) The crate shown in the figure below has a mass m and is pushed down the incline by a force F_P. It is tilted at an angle of $\theta = 32.0°$. There is no friction. (15 points)



(a) Draw the force diagram below (as was shown in class):



(b) Write the force equations as was done in class. *Include any given numerical values of the angles.*

$\Sigma F_x = w \cdot \cos 58° = ma$ $\quad$ $\Sigma F_y = F_N - w \sin 58° = 0$

(c) The crate has a mass of 15 kg. The force F_P is equal to 20 N. determine the acceleration of the crate as it slides down:

$90° + 32° = 122°$
$180 - 122 = 58°$

$= 15\,kg$

$F_P = 20N$

$20N \cos(58°) = 15kg\, a$

$\frac{10.6}{15} = \frac{15a}{15}$

$a = 0.71\,m/s$

-5

$$v = v_0 + at$$

$$\Delta x = v_0 t + \tfrac{1}{2} a t^2$$

$$v^2 = v_0^2 + 2a\Delta x$$

$$t = \sqrt{\frac{2 \cdot h}{g}}$$

$$x = R \cdot \cos\theta$$

$$y = R \cdot \sin\theta$$

$$R = \sqrt{x^2 + y^2}$$

$$\tan^{-1}\theta = \frac{y}{x}$$

$$v_x = v_{x0}$$

$$\Delta x = v_{x0} t$$

$$v_y = v_{y0} - gt$$

$$\Delta y = v_{yo} t - \tfrac{1}{2} g t^2$$

$$v_y{}^2 = v_{yo}^2 - 2g\Delta y$$

$$v_{0x} = v_0 \cos\theta$$

$$v_{0y} = v_0 \sin\theta$$

$$R = \frac{v_0{}^2 \sin 2\theta}{g}$$

$$F_{Fr} = \mu \cdot F_N$$

$$a_R = \frac{v^2}{r}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$