X1.18a **1070**

PHYS-1070(18) (Kaldon-20592) **Name** _____ **S O L U T I O N** _____

WMU - Summer I 2006 **Book Title** _____

Exam 1 - 100,000 points

Rev. 05/17/06 We.5

State Any Assumptions You Need To Make – Show All Work – Circle Any Final Answers
Use Your Time Wisely – Work on What You Can – Be Sure to Write Down Equations
Short Answers Should Be Short! – Feel Free to Ask Any Questions

EXAM 1 [FORM - A]

PHYS-1070 (KALDON-18)

SUMMER I 2006

WMU

The New Vespa!

Now Pay Attention – You Can Do This (30,000 points) *Multiple-Guess-Fill-In-The-Bubbles*

mph	sec
25	144.0
30	120.0
35	102.9
40	90.0
45	80.0
50	72.0
55	65.5
60	60.0
65	55.4
70	51.4
75	48.0
80	45.0
85	42.4
90	40.0
95	37.9
100	36.0
105	34.3
110	32.7
115	31.3
120	30.0
125	28.8
130	27.7
135	26.7
225	16.0

1.)(a) Sam drives his car for 2.00 miles at 40.0 mph. How many minutes does it take to travel this distance? *The handy chart at left may be useful.* *90.0 sec/mile × 2 miles = 180 sec = 3 min.*
A = 1.00 min B = 2.00 min C = 3.00 min D = 4.00 min
E = 5.00 min F = None of these
Ⓐ Ⓑ **Ⓒ** Ⓓ Ⓔ Ⓕ

(b) Sarah drives her car for 2.00 miles accelerating from rest to 80.0 mph. How many minutes does it take to travel this distance? *Average speed = 40 mph, so 2 miles in 3 min.*
A = 1.00 min B = 2.00 min C = 3.00 min D = 4.00 min
E = 5.00 min F = None of these
Ⓐ Ⓑ **Ⓒ** Ⓓ Ⓔ Ⓕ

(c) Stuart drove 2.00 miles accelerating from rest to 80.0 mph and then 2.00 miles decelerating from 80.0 mph back down to zero. How many minutes does it take? *Twice (b).*
A = 1.00 min B = 2.00 min C = 3.00 min D = 4.00 min
E = 5.00 min F = None of these
Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ **Ⓕ**

(d) Susan drives 0.500 mile at 40.0 mph, 0.500 mile at 45.0 mph, 0.500 mile at 90.0 mph and 0.500 mile at 120. mph How many minutes does it take? *½ × (90.0 sec + 80.0 sec + 40.0 sec + 30.0 sec) = ½ × (240 sec) = 120 sec = 2.00 min.*
A = 1.00 min B = 2.00 min C = 3.00 min D = 4.00 min
E = 5.00 min F = None of these
Ⓐ **Ⓑ** Ⓒ Ⓓ Ⓔ Ⓕ

For each of the following, select the answer A-D that BEST represents the motion.
(e) John is climbing a tree, making a steady pace. This is an example of _____ Motion.
A = No B = Uniform C = Constant Acceleration
D = None of these
Ⓐ **Ⓑ** Ⓒ Ⓓ

(f) John is falling out of the tree. This is an example of _____ Motion.
A = No B = Uniform C = Constant Acceleration
D = None of these
Ⓐ Ⓑ **Ⓒ** Ⓓ

(g) John is lying on the ground under the tree, resting. This is an example of _____ Motion.
A = No B = Uniform C = Constant Acceleration
D = None of these
Ⓐ Ⓑ Ⓒ Ⓓ

For each of the following, select the answer A-F that BEST represents the quantity.
(h) An object in free fall from rest is moving with a speed of _____ after 1.00 seconds.
A = +9.81 m B = -9.81 m C = +9.81 m/s
D = -9.81 m/s E = +9.81 m/s²F = -9.81 m/s²
Ⓐ Ⓑ **Ⓒ** **Ⓓ** Ⓔ Ⓕ

(i) The acceleration in the y-direction of an object in free-fall is _____.
A = +9.81 m B = -9.81 m C = +9.81 m/s
D = -9.81 m/s E = +9.81 m/s²F = -9.81 m/s²
Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ **Ⓕ**

(j) An object moving with an acceleration in the x-direction of 2g will travel _____ after 1.00 seconds.
A = +9.81 m B = -9.81 m C = +9.81 m/s
D = -9.81 m/s E = +9.81 m/s²F = -9.81 m/s²
d = ½ a t² = ½ (2g) t² = g t² = 9.81m/s² × (1.00sec)²
Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ Ⓕ

***"Magnifico!"* (35,000 points)**

2.) (a) The Vespa Granturismo 200 is a new scooter from the famous Italian maker. The company's specifications give the maximum speed as 74.0 mph (119 km/h = 33.1 m/s). If the Vespa accelerates from rest to 33.1 m/s in 16.6 seconds, find the acceleration, *a*.

$$v = v_0 + a\,t = a\,t \quad or \quad a = \frac{\Delta v}{\Delta t}$$
$$a = \frac{v}{t} = \frac{33.1 m/s}{16.6\,\text{sec}} = 1.994 m/s^2$$

(b) How far does the Vespa travel in this time? *This can be found with or without the answer to (a).*

$$x = x_0 + v_0 t + \tfrac{1}{2} a\,t^2$$
$$x = \tfrac{1}{2} a\,t^2 = \tfrac{1}{2}\left(1.994 m/s^2\right)\left(16.6\,\text{sec}\right)^2$$
$$= 274.7 m$$

OR

$$v^2 = v_0^2 + 2a(x - x_0)$$
$$v^2 = 2ax$$
$$x = \frac{v^2}{2a} = \frac{\left(33.1 m/s\right)^2}{2\left(1.994 m/s^2\right)} = 274.7 m$$

(c) What is the average speed of the Vespa while it is accelerating?

$$v = \frac{d}{t} = \frac{274.7 m}{16.6\,\text{sec}}$$
$$= 16.55 m/s$$

OR

$$v_{ave} = \frac{v_0 + v}{2} = \frac{v}{2} = \frac{33.1 m/s}{2}$$
$$= 16.55 m/s$$

(d) Unfortunately, having too much fun, Vincent runs his brand new Vespa straight off a cliff with $v_{0x} = 33.1$ *m/s*, where it falls 18.0 feet (5.49 meters) to the ravine below. Find the *y*-component of the velocity, v_y, just before it impacts the ground.

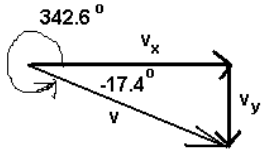
$$v_y^2 = v_{0y}^2 - 2g(y - y_0)$$
$$= -2g(0 - y_0) = 2gy_0$$
$$v_y = \sqrt{2gy_0} = \sqrt{2\left(9.81 m/s^2\right)(5.49 m)}$$
$$= \pm 10.38 m/s = -10.38 m/s$$

(e) Find the final velocity, $\vec{v}$, just before it impacts the ground. Give the answer in Standard Form. *If you did not get an answer to (d), use a vertical speed of 13.4 m/s.*

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{\left(33.1 m/s\right)^2 + \left(-10.38 m/s\right)^2}$$
$$= 34.69 m/s$$

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right) = \tan^{-1}\left(\frac{-10.38 m/s}{33.1 m/s}\right)$$
$$= -17.4° = 342.6°$$

$$\vec{v} = 34.69 m/s @ 342.6$$



Soviet Space Secrets (35,000 points)

3.) (a) During a "normal" launch into space (as if *any* launch into space is "normal"!!), the payload has to be accelerated from rest to an orbital speed of 7880 m/s (about 17,600 mph) in 8.00 minutes. Find the average acceleration of this launch.

$$v = v_0 + a\,t = a\,t \quad or \quad a = \frac{\Delta v}{\Delta t}$$
$$a = \frac{v}{t} = \frac{7880 m/s}{480.\,\text{sec}} = 16.42 m/s^2$$

(b) Find the distance that the rocket traveled, if it spent 8.00 minutes at this average acceleration. *If you did not get an answer to (a), use a = 20.0 m/s².*

$$x = x_0 + v_0 t + \tfrac{1}{2} a\,t^2$$
$$x = \tfrac{1}{2} a\,t^2 = \tfrac{1}{2}\left(16.42 m/s^2\right)\left(480.\,\text{sec}\right)^2$$
$$= 1{,}892{,}000 m$$

OR

$$v^2 = v_0^2 + 2a(x - x_0)$$
$$v^2 = 2ax$$
$$x = \frac{v^2}{2a} = \frac{\left(7880 m/s\right)^2}{2\left(16.42 m/s^2\right)}$$
$$= 1{,}891{,}000 m$$

(c) In 1983, the Soviet Soyuz T-10A was all set to be launched, when a fire broke out on the launch pad ten minutes before launch. An emergency escape rocket finally blasted the Soyuz and the cosmonauts on board two thousand feet into the air (610. meters) just six seconds before the main booster blew up. Ignoring air resistance and parachutes, as usual, find the time it takes to fall to the ground from rest at a height of 610. meters.

$$y = y_0 + v_{0y}t - \tfrac{1}{2}gt^2$$
$$0 = y_0 - \tfrac{1}{2}gt^2$$
$$y_0 = \tfrac{1}{2}gt^2$$
$$t^2 = \frac{2y_0}{g}$$
$$t = \sqrt{\frac{2y_0}{g}} = \sqrt{\frac{2(610.m)}{9.81m/s^2}} = 11.15\,\text{sec}$$

(d) At what speed would an object in free-fall from rest at 610. meters hit the ground? *This can be found even if you don't have the answer to (c).*

$$v_y = v_0 - gt = -gt$$
$$= -(9.81m/s^2)(11.15\,\text{sec})$$
$$= -109.4m/s$$

OR

$$v_y^2 = v_{0y}^2 - 2g(y - y_0)$$
$$= -2g(0 - y_0) = 2gy_0$$
$$v_y = \sqrt{2gy_0} = \sqrt{2(9.81m/s^2)(610.m)}$$
$$= \pm 109.4m/s = -109.4m/s$$

a speed of 109.4 m/s is acceptable

(e) On another mission, the booster rocket taking the Soyuz 18A capsule into space failed on the way up. Again the capsule was safely jettisoned in time, but the emergency maneuver had a peak deceleration at a brutal 20.6 *gee*'s. At this rate, how long (time) would it take for them to slow down from 8000 mph (3580 m/s) to where the parachutes can open at 340 mph (152 m/s)?

$$a = -20.6g = -20.6(9.81m/s^2) = -196.2m/s^2$$
$$v = v_0 + at = at \quad or \quad a = \frac{\Delta v}{\Delta t}$$
$$a = \frac{v - v_0}{t}$$
$$t = \frac{v - v_0}{a} = \frac{152m/s - 3580m/s}{-196.2m/s^2} = 17.47\,\text{sec}$$