Pyuk-Volte!

**Physics 220 – Exam #1**

**January 30th, 2001**

This exam consist of 11 problems. Please check that you have them all.

Formulas and constants:

KEY

$v=v_o + at$

$x=v_o t + 0.5\ at^2$ $\quad y=v_o t + 0.5\ at^2$

$v^2=v_o^2 + 2ax$ $\quad v^2=v_o^2 + 2ay$

$x=0.5(v_o +v)t$ $\quad y=0.5(v_o +v)t$

$F = ma$

$$F_{gravity} = G\frac{m_1 m_2}{r^2}$$

$G = 6.67 \times 10^{-11}\ N\ m^2/kg^2$
Mass of the Earth = $5.98 \times 10^{24}$ kg
Radius of the Earth = $6.38 \times 10^6$ m
Mass of the Mars = $6.43 \times 10^{23}$ kg
Radius of the Mars = $3.37 \times 10^6$ m
$g = -9.8\ m/s^2$

1. Your car (m = 1000 kg) has a dead battery, and is initially at rest. You want to push it so that it reaches a velocity of 1.25 m/s in 60 seconds. What is the force that you must exert on the car? The road is horizontal.

(1) 24 N
(2) 0.024 N
(3) 9.8 N
(4) 13,000 N
(5) 48 N
(6) 0.5 N
(7) 10.0 N
(8) 0.021 N
(9) 4.9 N
(10) 21 N

$V = \overset{0}{V_0} + at$

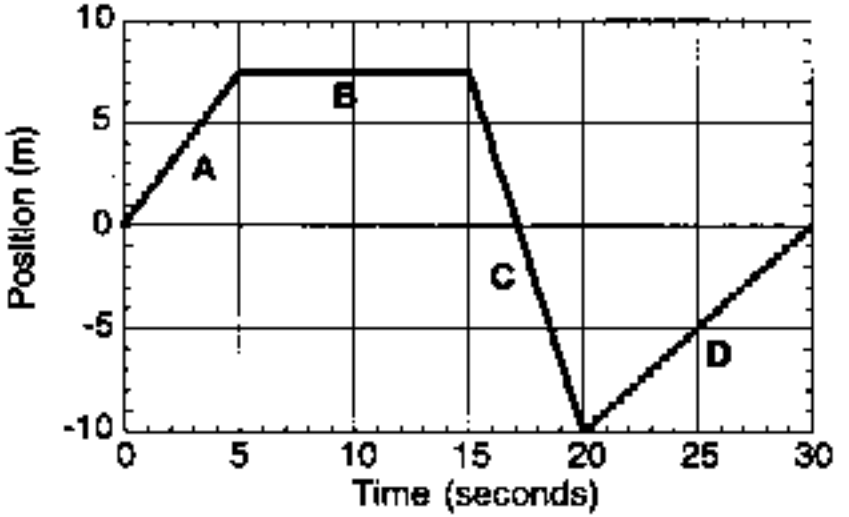
$a = \frac{v}{t} = \frac{1.25}{60} = 0.02083\ m/s^2$

$F = ma = 1000 \cdot 0.02083$

$= 20.83\ m/s^2 \sim 21$

2. A football is kicked at an angle θ with respect to the horizontal. Which one of the following statements best describes the acceleration of the football during this event if air resistance is neglected?

(1) The acceleration is zero at all times.
(2) The acceleration is 9.8 m/s² at all times.
(3) The acceleration is zero when the football has reached the highest point in its trajectory.
(4) The acceleration is positive as the football rises, and it is negative as the football falls.
(5) The acceleration starts at 9.8 m/s² and drops to some constant lower value as the ball approaches the ground.
(6) None of the above




**Questions 3, 4 and 5 pertain to the graph shown above and is described as follow:** An object is moving along the x axis. 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.

3. Which segment(s) of the graph represent(s) a constant velocity of +1.0 m/s?

(1) A
(2) B
(3) C
(4) D
(5) E
(6) A and C
(7) A and D
(8) C and D
(9) A, C and D
(10) B and D

4. What was the instantaneous velocity of the object at the end of the eighth second?

(1) -0.94 m/s
(2) 0 m/s
(3) +0.94 m/s
(4) 1.1 m/s
(5) -1.1 m/s
(6) 7.5 m/s
(7) 9.8 m/s
(8) 2.5 m/s
(9) -2.5 m/s
(10) -7.5 m/s

5. During which interval is the object moving the negative x direction?

(1) during interval A only
(2) during interval B only
(3) during interval C only
(4) during interval D only
(5) during intervals A and C
(6) during intervals B and C
(7) during intervals C and D
(8) during intervals B and D
(9) during intervals A, C and D
(10) during intervals B, C and D

6. A student is stranded on a raft (mass of man + raft = 600 kg). By paddling, he causes an average force of 17 N to be applied to the raft in the direction due East (positive x direction). The wind exerts a force of 15 N due West. At the moment the forces begin acting on the raft, the velocity of the raft is 0.18 m/s in the direction due East. Assuming the forces are maintained for 75 seconds, find the displacement of the raft. Ignore water resistance.

(1) 48 m
(2) 23 m
(3) 53 m
(4) 0.0033 m
(5) 8400 m
(6) 0.5 m
(7) 1.5 m
(8) 220 m
(9) 9.8 m
(10) 33 m

$\Sigma F_x = m a_x$

$17 - 15 = 600 a$

$a_x = 0.003333$

$x = v_0 t + \frac{1}{2} a_x t^2$

$x = 0.18(75) + \frac{1}{2}(0.003333)(75)^2$

$x = 22.87 \sim 23 \text{ m}$

7. A space probe weighs 5390 N on Earth and 2079 N on Mars. What is the acceleration due to gravity on Mars in m/s$^2$?

$g_E = 9.8$

(1) 0
(2) 0.265
(3) 1.61
(4) 2.73
(5) 3.78
(6) 4.9
(7) 5.70
(8) 7.63
(9) 9.8
(10) 25.4

$m = \frac{W_E}{g_E}$ $\quad$ $m = \frac{W_m}{g_m}$

$g_m = \frac{W_m}{W_E} g_E = 3.78 \text{ m/s}^2$

8. A football player kicks a football at an angle of 30° from the horizontal. The initial speed of the ball is 20 m/s. Ignore air resistance. Find the maximum height that the ball attains in meters.

(1) 0
(2) 10
(3) 2.2
(4) 9.8
(5) 49
(6) 0.033
(7) 7.5
(8) 2.5
(9) 0.19
(10) 5.1

$V_0 = 20\ m/s$

$\theta = 30^\circ$

$V_y^2 = V_{0y}^2 + 2 a_y y$

$y = \frac{V_y^2 - V_{0y}^2}{2 a_y} = \frac{-(V_0 \sin 30)^2}{2(-9.8)} = 5.1\ m$

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

9. A communications satellite has a mass of 12,600 kg and orbits the Earth 600 km above the Earth's surface. Determine the weight (in Newtons) of the satellite in its orbit above the Earth's surface.

(1) $0.951 \times 10^5$
(2) 0
(3) $1.23 \times 10^5$
(4) $2.65 \times 10^5$
(5) $0.0226 \times 10^5$
(6) $5.65 \times 10^5$
(7) $12.8 \times 10^5$
(8) $0.84 \times 10^5$
(9) $1.18 \times 10^5$
(10) $1.03 \times 10^5$

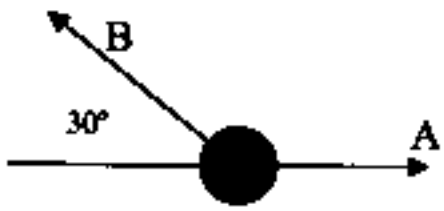
$W = \frac{G M_E m_s}{(r_E + orbit)^2}$

$W = \frac{6.67 \times 10^{-11} * 5.98 \times 10^{24} * 12{,}600}{(6.38 \times 10^6 + 600 \times 10^3)^2}$

$W = 1.03 \times 10^5$

10. The only two forces acting on a 5.00 kg mass are indicated in the figure below as A and B. The magnitude of force A is 50 N. The magnitude of force B is 200 N. The directions of forces A and B are given in the figure. Determine the magnitude of the acceleration of the mass.

(1) 40.0 m/s²
(2) 24.6 m/s²
(3) 41.2 m/s²
(4) 48.8 m/s²
(5) 31.7 m/s²
(6) 20.0 m/s²
(7) 44.7 m/s²
(8) 30.0 m/s²
(9) 9.8 m/s²
(10) 12.2 m/s²




$\vec{A} = 50\,\hat{i}$

$\vec{B} = (200\cos 30)\,\hat{i} + (200\sin 30)\,\hat{j}$

$= -173.3\,\hat{i} + 100\,\hat{j}$

$\Sigma F_x = 50 - 173 = m a_x = 5 a_x$

$a_x = -24.6$

$\Sigma F_y = 100 = m a_y = 5 a_y$

$a_y = 20$

$a = \sqrt{a_x^2 + a_y^2} = 31.7\ m/s^2$

11. You kick a soccer ball at a speed of 10.0 m/s off a 100 m high cliff. The initial velocity vector is 30° above the horizontal direction as the ball leaves your foot. Determine the time of flight of the ball.

(1) 0 s
(2) 4.03 s
(3) 2.53 s
(4) 2.01 s
(5) 5.05 s
(6) 0.065 s
(7) 7.52 s
(8) 10.2 s
(9) 20.4 s
(10) 9.69 s

$v_0 = 10.0\ m/s \qquad \theta = 30°$

$y = -100\ m$

$y = v_0 t + \frac{1}{2} a t^2$

$\frac{1}{2} a_y t^2 + v_{0y} t - y = 0$

$\frac{1}{2}(-9.8)t^2 + v_0(\sin 30)\,t + 100 = 0$

$t = 5.05\ s$

The other solution $t = -4.03$ occurs prior to kick off. so it doesn't apply.