Kuwait University Physics Department

Physics 101
First Examination

March 25, 2003

Name: ..... الحل النموذجي ..... Student No. .....

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Solution.

For use by Instructors only

Prob.	1	2	3	4	5	6	7	8	9	10	11	12	Total
Marks													

1. Answer all the questions.
2. The solution should be given explicitly for each problem.
3. No solution = no grade.
4. Check the correct answer for each question.
5. Take g = 10 m/s^2.

NOTE: IT IS STRICTLY FORBIDDEN TO BRING ANY MOBILE COMMUNICATION DEVICES (MOBILE PHONES, PAGERS, ETC.), INTO THE EXAMINATION HALL.

1. A car travels from city A to city B, and covers 1/3 of the distance with a speed of 50 km/h and 2/3 of the distance with a speed of 80 km/h. What is its average speed (in m/s) during the trip?

a) 22.5 b) 33.2 c) 18.5 d) 12.4 e) 8.8 f) Other

$$\bar{s} = \frac{\text{total distance}}{\text{total time}}$$

$$\bar{s} = \frac{d}{\frac{1}{3}\frac{d}{v_1} + \frac{2}{3}\frac{d}{v_2}} = \frac{1}{\frac{1}{3}\frac{3.6}{50} + \frac{2}{3}\frac{3.6}{80}}$$

$$\bar{s} = 32.2 \text{ m/s}$$

2. Carl Louis runs 200 m in 19 s. He starts from rest and accelerates at 6.7 m/s^2 for the first 1.6 s but after that he maintains a constant speed to the finish line. Find that speed.

a) 22 b) 14 c) 6 (d) 11 e) 18 f) Other

$$v = v_0 + at$$

$$v = 0 + 6.7(1.6) = 10.72 \approx 11 \text{ m/s}$$

3. The velocity of an object moving in the positive x-direction varies with time as shown in the figure. If the position of the object at t = 1 s is x_0 = 2 m, find its position at t = 4 s.

a) 2 b) –2 c) 0 d) 4 e) 3 f) Other

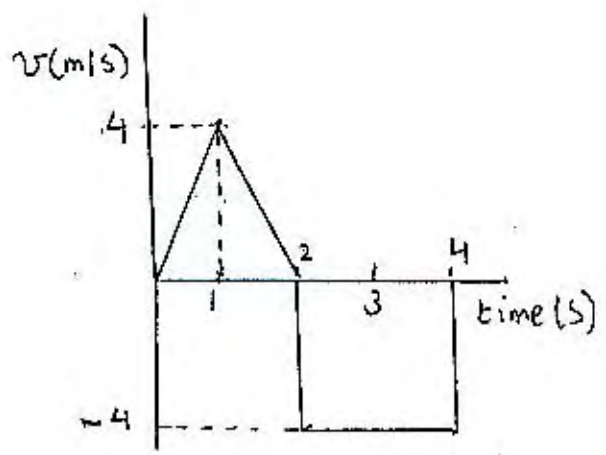
$$\Delta x = \frac{1}{2}(1)4 + 2(-4)$$

$$= -6$$

$$\Delta x = x - x_0$$

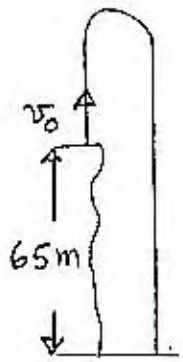
$$-6 = x - 2$$

$$\therefore x = -4 \text{ m}$$



4. A stone is thrown vertically upward with a speed of 10 m/s from the edge of a cliff 65 m high. What is its speed (in m/s) just before hitting the ground?

a) 35 b) 37 c) 32 d) 40 e) 26 f) Other



Known v_0, Δy, g

wanted v

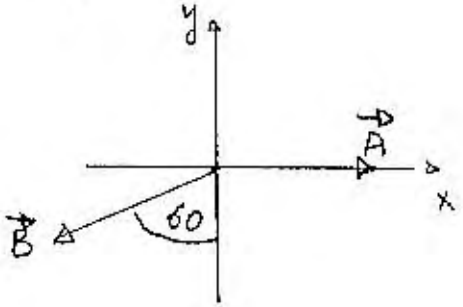
$$v^2 = v_0^2 - 2g\Delta y$$

$$v^2 = (10)^2 - 2(10)(-65)$$

$$v = -37.4 \qquad |\vec{v}| \simeq 37 \text{ m/s.}$$

5. If A = 2 m and B = 5 m and $\vec{C} = \vec{B} - \vec{A}$, find the angle that the vector $\vec{C}$ makes with the positive x-axis.

a) 32 b) 45 c) 47 d) 277 e) 225 f) Other



$A_x = 2$, $A_y = 0$

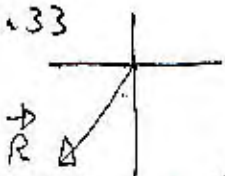
$B_x = B\cos 210$ $\quad B_y = B\sin 210$

$= -5(0.866)$ $\quad = -5(0.5)$

$= -4.33$ $\quad = -2.5$

$C_x = B_x - A_x \Rightarrow C_x = -4.33 - 2 = -6.33$

$C_y = B_y - A_y \Rightarrow C_y = -2.5$



$\theta = \tan^{-1}\frac{-2.5}{-6.33} = 21.6 \quad +180 = 201.6 = 202^\circ$

6. Let $\vec{S} = \hat{i} + 2\hat{j} + 2\hat{k}$ and $\vec{T} = 3\hat{i} + 4\hat{k}$

Find $\vec{S} \cdot (\vec{S} \times \vec{T})$.

a) 0 b) 24 c) $4\hat{i} + 6\hat{k}$ d) $2\hat{i} + 2\hat{j} + 8\hat{k}$ e) 12 f) Other

$$\vec{P} = \vec{S} \times \vec{T} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & 2 \\ 3 & 0 & 4 \end{vmatrix} = (8-0)\hat{i} - (4-6)\hat{j} + (0-6)\hat{k}$$

$$= 8\hat{i} + 2\hat{j} - 6\hat{k}$$

$$\vec{S} \cdot \vec{P} = S_x P_x + S_y P_y + S_z P_z = 1(8) + 2(2) - 2(6)$$

$$= 0$$

7. The components of vectors $\vec{A}$ and $\vec{B}$ add up as follows:

$$A_x + B_x = 2A_x$$
$$A_y + B_y = 2A_y$$

If A = 3, find the magnitude of the vector $(\vec{A} + \vec{B})$.

a) 8 b) 6 c) 4 d) 2 e) 10 f) Other

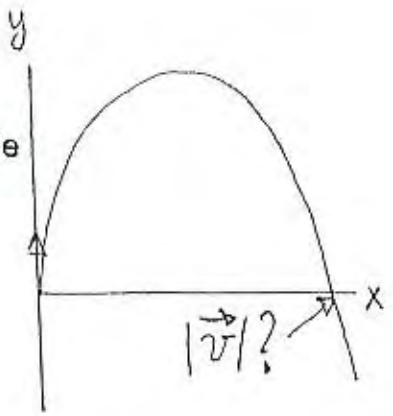
$\vec{R} = \vec{A} + \vec{B}$

$R_x = A_x + B_x = 2A_x$, $R_y = A_y + B_y = 2A_y$

$R^2 = R_x^2 + R_y^2 = 4A_x^2 + 4A_y^2 = 4A^2$

$R = 2A = 2(3) = 6$

8. At t = 0, a particle leaves the origin with a velocity of 12 m/s in the positive y-direction and moves in the x-y plane with a constant acceleration of $(2\hat{i} - 4\hat{j})$ m/s^2. At the instant the particle crosses the x-axis (y = 0) on its way back, what is the speed of the particle (in m/s).



a) 16 b) 17 c) 18 d) 14 e) 22 f) Other

x-direction

$v_{0x} = 0$, $a_x = 2$ m/s^2

$t = 6$ s

$v_x = v_{0x} + at$

$v_x = 0 + 2(6) = 12$ m/s

y-direction.

$\Delta y = 0$, $a = -4$ m/s^2

$v_{0y} = 12$ m/s

$\Delta y = v_{0y}t + \frac{1}{2}at^2 \Rightarrow 0 = 12t + \frac{1}{2}(-4)t^2$

$0 = t(12 - 2t) \Rightarrow t = 0$ or $t = 6$ s

$v_y = v_{0y} + at \Rightarrow v_y = 12 - 4(6) = -12$ m/s

$v = \sqrt{12^2 + 12^2} = 17$ m/s

9. A plane continues flying horizontally at a constant speed of 300 m/s and 4 km above ground level after it drops a small package. The package falls without air resistance till it hits the ground. What is the distance (in m) between the plane and the package when the latter hits the ground?

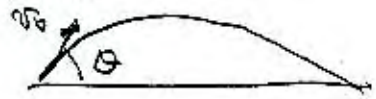
a) 120 b) 300 c) 4000 d) 12000 e) Cannot estimate f) Other

Since v_x for the plane = v_x of the package

The plane will be 4 km vertically above the package when it hits the ground.

10. A projectile is thrown with initial velocity v_0 having x-component 12 m/s and y-component 20 m/s. Find the range (in m) of the projectile.

a) 34 b) 48 c) 62 d) 54 e) 27 f) Other



$$v_0^2 = v_{0x}^2 + v_{0y}^2$$

$$v_0^2 = (12)^2 + (20)^2 = 544$$

$$\theta = \tan^{-1}\frac{v_{0y}}{v_{0x}} = \tan^{-1}\frac{20}{12} = 59^0$$

$$R = \frac{v_0^2 \sin 2\theta}{g} = \frac{544 \sin 118}{10} = 48$$

11. A carnival merry-go-round has a 10 m radius and rotates about a vertical axis at a constant rate. If a passenger standing on the edge of the merry-go-round experiences an acceleration of 12 m/s^2 towards the center of the merry-go-round, find the period (in s) of the circular motion.

a) 6.2 b) 4.6 c) 5.7 d) 6.6 e) 2.8 f) Other

$r = 10$ m , $a = 12$ m/s^2

$$a = \frac{v^2}{r} \Rightarrow v^2 = 12(10) = 120$$

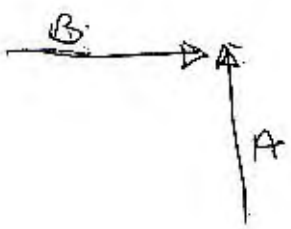
$$v = \sqrt{120} = 10.95 \text{ m/s}$$

$$T = \frac{2\pi r}{v} = \frac{2(3.14)(10)}{10.95} = 5.7 \text{ s}$$

12. Two motor-cyclists A and B each travelling at 20 m/s approach the same right angle intersection. Cyclist a is moving from south to north while cyclist B is moving from west to east. What is the magnitude of their relative velocity in m/s?

a) zero (not in the same direction), b) 40 c) 20
d) 28 e) It depends on their separation f) Other

$$v_{AG} = v_{BG} = 20 \text{ m/s}$$



$$\vec{v}_{AB} = \vec{v}_{AG} + \vec{v}_{GB}$$

$$= \vec{v}_{AG} - \vec{v}_{GB}$$

$$= 20\hat{j} - 20\hat{i}$$

$$v_{AB} = \sqrt{(20)^2 + (20)^2} = 28.2 \simeq 28 \text{ m/s}$$