BIRZEIT UNIVERSITY

# Physics 141
First Hour Exam

First Semester 2017-2018

Time: 80 minutes

*Student Name:* ______________________ *Student No:* ______________ Section (   )

*Please read these instructions and remarks before starting the exam:*

- Write your name and student number and section number in the box above.
- The exam consists of 20 multiple choice problems, answer all of them.
- Mark the correct answer of each problem on the answer sheet below.
- Turn in all the exam sheets.

***Use $g = 9.8\ m/s^2$ or as specified in the problem***

*Kinematics with a = constant*

1. $v = v_0 + at$

$x = x_0 + v_0 t + \frac{1}{2}at^2$

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

$\bar{v} = \frac{1}{2}(v_1 + v_2)$

Uniform **Circular motion**

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

Kinematics with a ≠ constant:

$v = v_0 + \int_0^t a(t)dt$

$x = x_0 + \int_0^t v(t)dt$

*Relative motion* .2

5. $\vec{v}_{AB} = \vec{v}_{AC} + \vec{v}_{CB}$

*Newton's Second Law: Net force* $= m\vec{a}$

**Answer Sheet:**

| Q | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | | | | | | | | ✓ | | | ✓ | | | | ✓ | | | | | |
| B | ✓ | | | | | | | | | ✓ | | ✓ | | | | ✓ | | | ✓ | |
| C | | | ✓ | | | | | | | | | | ✓ | | | | ✓ | ✓ | | |
| D | | | | | ✓ | | ✓ | | ✓ | | | | | ✓ | | | | | | |
| E | | ✓ | | ✓ | | ✓ | | | | | | | | | | | | | | ✓ |

1. A cube مكعب with an edge ضلع of exactly 1 cm has a volume of:

A) $10^{-9}$ m³
B) $10^{-6}$ m³
C) $10^{-3}$ m³
D). $10^{3}$ m³
E) $10^{6}$ m³

$1\,cm = 10^{-2}\,m$

$1\,cm^3 = (10^{-2}\,m)^3 = 10^{-6}\,m$

2. A car travels East at constant velocity. The net force on the car is:

A) east
B) west
C) up
D) down
E) zero

$\vec{v} = \text{constant}$

$\vec{a} = \frac{d\vec{v}}{dt} = 0$

3. A block is suspended معلقة from the ceiling السقف by a string حبل . The reaction to the force of gravity on the block is the force exerted by the:

A) string on the block
B) block on the string
C) block on the Earth
D) ceiling on the string
E) string on the ceiling

4. The speed of a car is given by $v = bt^4$, where $v$ is in m/s and $t$ is in seconds. The units of $b$ are:

A) m·s⁵
B) s⁴/m
C) m.s⁴
D) m/s⁴
E) m/s⁵

$b = \frac{v}{t^4} = \frac{m/s}{s^4} = m/s^5$

5. A car travels 40 kilometers at an average speed of 80 km/h and then travels 40 kilometers at an average speed of 40 km/h. The average speed of the car for the whole trip is:

A) 40 km/h
B) 45 km/h
C) 48 km/h
D) 53 km/h
E) 80 km/h

$\text{average speed} = \frac{\text{total distance}}{\text{total time}} = \frac{40+40\ km}{(0.5h)+(1h)}$

$= \frac{80}{1.5}\ km/h = 53\ km/h$

6. Rain is falling vertically downwards with a speed of 10 m/s as seen by an observer fixed on the ground. What is the rain velocity as seen by the driver of a car travelling towards the West at 36 km/h?

R = Rain , C = Car , G = Ground

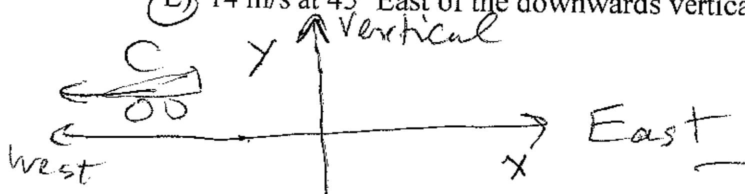
$36\ km/h = 36\ \frac{km}{h} \times \frac{1000\,m}{1\,km} \times \frac{1h}{3600\,s} = 10\ m/s$

A) 37 m/s at 75° East of the downwards vertical
B) 37 m/s at 75° West of the downwards vertical
C) 10 m/s vertically downwards
D) 14 m/s at 45° West of the downwards vertical
E) 14 m/s at 45° East of the downwards vertical

$\vec{v}_{RG} = \vec{v}_{RC} + \vec{v}_{CG}$

$\vec{v}_{RC} = \vec{v}_{RG} - \vec{v}_{CG}$

$= \underbrace{-10\ m/s\ \hat{j}}_{\text{down}} \underbrace{+10\ m/s\ \hat{i}}_{\text{East}}$




$\vec{v}_{RG} = -10\ m/s\ \hat{j}$

$\vec{v}_{CG} = -10\ m/s\ \hat{i}$

$|\vec{v}_{RC}| = \sqrt{10^2 + 10^2} = 14\ m/s$

7. A car traveling with constant acceleration increases its speed from 10 m/s to 30 m/s over a distance of 60 m? How long does this take?

A) 2.0 s
B) 4.0 s
C) 5.0 s
D) 3.0 s
E) The time cannot be calculated since the speed is not constant

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

$30^2 = 10^2 + 2a(60\,m)$

$\therefore a = 6.67\ m/s^2$

$v = v_0 + at$

$30 = 10 + (6.67)t$

$t = 3.0\ s$

8. The velocity of an object is given as a function of time by $v = 4t - 3t^2$, where $v$ is in m/s and $t$ is in seconds. Its average velocity over the interval from $t = 0$ to $t = 2$ s:

A) is 0
B) is –2 m/s
C) is 2 m/s
D) is –4 m/s
E) cannot be calculated unless the initial position is given

$x = x_0 + \int_0^t v(t)\,dt = x_0 + \int_0^t (4t - 3t^2)\,dt$

$x = x_0 + \frac{4t^2}{2} - \frac{3t^3}{3}$

$x(0) = x_0$

$x(2) = x_0 + 8 - 8 = x_0$

$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_0 - x_0}{2} = 0$

9. A car slows down with an acceleration given by $-0.50t$ m/s² for $t$ in seconds. If at time $t = 0$ it has a velocity of 16 m/s, at what time t does its velocity become 0?

A) 64 s
B) 32 s
C) 16 s
D) 8.0 s
E) 4.0 s

$v = v_0 + \int_0^t a(t)\,dt$

$= 16 - \int_0^t 0.5t\,dt$

$v(t) = 16 - \frac{1}{4}t^2$

$v(t_1) = 0 = 16 - \frac{1}{4}t_1^2$

$\therefore t_1^2 = 64\ s^2$

$t_1 = 8.0\ s$

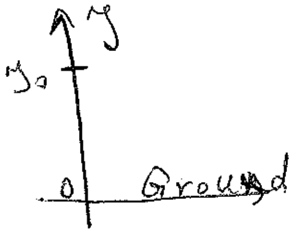
10. An object is thrown straight down with an initial speed of 4 m/s from a window which is 8 m above the ground. The time it takes the object to reach the ground is:

A) 0.80 s
B) 0.93 s
C) 1.3 s
D) 1.7 s
E) 2.0 s

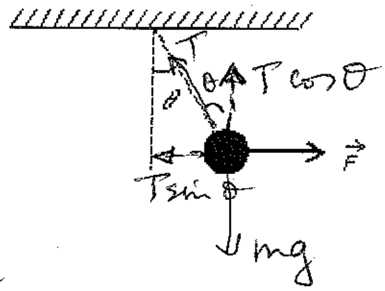
$y = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$

$0 = 8 + (-4)t_1 + \frac{1}{2}(-9.8)t_1^2$

$4.9t_1^2 + 4t_1 - 8 = 0$, $t_1 = \frac{-4 \pm \sqrt{16 + (32)(4.9)}}{(2)(4.9)}$




11. A 1-kg mass is held at rest at an angle $\theta$ from the vertical by a 20-N horizontal force $F$ as shown. The angle $\theta$ is:




A) 64°
B) 26°
C) 30°
D) 60°
E) 54°

$T\sin\theta = F$

$T\cos\theta = mg$

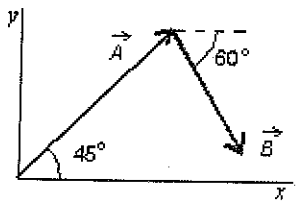
$\tan\theta = \frac{F}{mg} = \frac{20}{(1)(9.8)}$

12. Let $\vec{A} = (2\ \text{m})\hat{i} + (6\ \text{m})\hat{j} - (3\ \text{m})\hat{k}$ and $\vec{B} = (4\ \text{m})\hat{i} + (2\ \text{m})\hat{j} + (1\ \text{m})\hat{k}$. The vector difference $\vec{D} = \vec{A} - \vec{B}$ is:

A) $(6\ \text{m})\hat{i} + (8\ \text{m})\hat{j} - (2\ \text{m})\hat{k}$
B) $(-2\ \text{m})\hat{i} + (4\ \text{m})\hat{j} - (4\ \text{m})\hat{k}$
C) $(2\ \text{m})\hat{i} - (4\ \text{m})\hat{j} + (4\ \text{m})\hat{k}$
D) $(8\ \text{m})\hat{i} + (12\ \text{m})\hat{j} - (3\ \text{m})\hat{k}$
E) none of these

$D_x = A_x - B_x = 2 - 4 = -2\,m$
$D_y = A_y - B_y = 6 - 2 = 4\,m$
$D_z = A_z - B_z = -3 - 1 = -4\,m$

13. In the diagram, $\vec{A}$ has magnitude 12 m and $\vec{B}$ has magnitude 9.0 m. The $x$ component of $\vec{A} + \vec{B}$ is about:




A) 3.0 m
B) 7.6 m
C) 13 m
D) 15 m
E) 16 m

$(\vec{A}_x + \vec{B}_x) = A \cos 45^\circ + B \cos 60^\circ$
$= 8.48 + 4.5 = 13\,m$

14. Let $\vec{A} = (2\ \text{m})\hat{i} + (6\ \text{m})\hat{j} - (3\ \text{m})\hat{k}$ and $\vec{B} = (4\ \text{m})\hat{i} + (2\ \text{m})\hat{j} + (1\ \text{m})\hat{k}$.
Then the scalar product $\vec{A} \cdot \vec{B}$ equals:

A) $(8\ \text{m})\hat{i} + (12\ \text{m})\hat{j} - (3\ \text{m})\hat{k}$
B) $(12\ \text{m})\hat{i} - (14\ \text{m})\hat{j} - (20\ \text{m})\hat{k}$
C) 23 m
D) 17 m$^2$
E) 19 m$^2$

$\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y + A_z B_z$
$= (2)(4) + (6)(2) + (-3)(1)$
$= 8 + 12 - 3 = 17\,m^2$

15. Vectors $\vec{A}$ and $\vec{B}$ each have magnitude $L$. When drawn with their tails at the same point, the angle between them is 30°. The magnitude of $\vec{A} \times \vec{B}$ is:

A) $L^2/2$
B) $L^2$
C) $\sqrt{3}L^2/2$
D) $2L^2$
E) $L^2/3$

$|\vec{A} \times \vec{B}| = AB \sin 30^\circ = (L)(L)(\tfrac{1}{2}) = \frac{L^2}{2}$

16. A constant force of 8.0 N acts for 4.0 s on a 16-kg object initially at rest. The final speed of this object will be:

A) 0.5 m/s
B) 2 m/s
C) 4 m/s
D) 8 m/s
E) 32 m/s

$F = ma$

$8.0 = (16)\,a$

$\therefore a = 0.5\ m/s^2$

$v = v_0 + at$

$= 0 + (0.5)(4.0)$

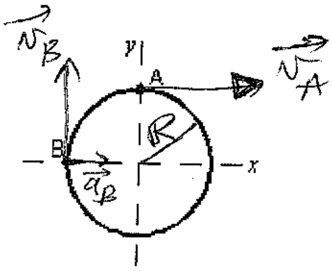
$= 2\ m/s$

17. A car moves with constant speed around the circle shown below. When it is at point A its coordinates are $x = 0$, $y = 3$m and its velocity is $(6\text{m/s})\hat{i}$. When it is at point B its velocity and acceleration are:

$\vec{r}_A = 3m\hat{j}$

$\Rightarrow R = 3m$

$|\vec{v}| = 6\ m/s = \text{constant}$

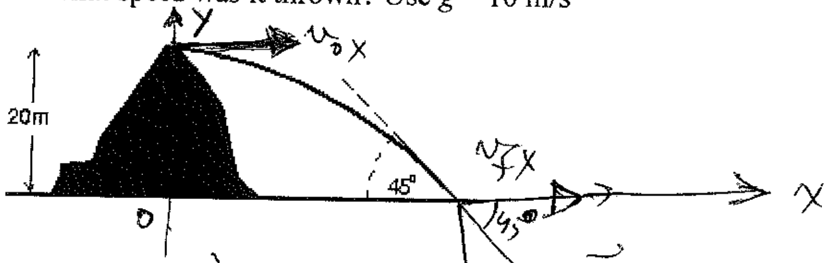


$a = \frac{v^2}{R}$

$= \frac{(6)^2}{3} = 12\ m/s^2$

A) $-(6\text{ m/s})\hat{j}$ and $(12\text{ m/s}^2)\hat{i}$, respectively
B) $(6\text{ m/s})\hat{i}$ and $-(12\text{ m/s}^2)\hat{i}$, respectively
C) $(6\text{ m/s})\hat{j}$ and $(12\text{ m/s}^2)\hat{i}$, respectively
D) $(6\text{ m/s})\hat{i}$ and $(12\text{ m/s}^2)\hat{j}$, respectively
E) $(6\text{ m/s})\hat{j}$ and 0, respectively

18. A ball is thrown horizontally بالاتجاه الأفقي from the top of a 20-m high hill. It strikes the ground at an angle of 45°. With what speed was it thrown? Use $g = 10$ m/s$^2$



A) 14 m/s
B) 28 m/s
C) 20 m/s
D) 32 m/s
E) 40 m/s

$v_{fx} = v_{fy}\ (45°)$

$v_{ox} = v_{fx}\ (a_x = 0)$

$v_{fy}^2 = v_{oy}^2 + 2a(y - y_0)$

$v_{fy}^2 = 0 + 2(-9.8)(0 - 20) = 392\ m^2/s^2$

$\therefore v_{fy} \approx 20\ m/s = v_{fx} = v_{ox}$

19. A particle goes from the point $(x_1, y_1, z_1) = (-2, 3, 1)$ m to the point $(x_2, y_2, z_2) = (3, -1, 4)$ m. Its displacement is:

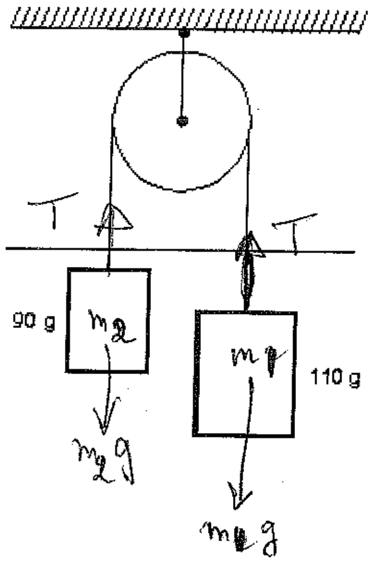
A) $(1\text{ m})\hat{i} + (2\text{ m})\hat{j} + (5\text{ m})\hat{k}$
B) $(5\text{ m})\hat{i} - (4\text{ m})\hat{j} + (3\text{ m})\hat{k}$
C) $-(5\text{ m})\hat{i} + (4\text{ m})\hat{j} - (3\text{ m})\hat{k}$
D) $-(1\text{ m})\hat{i} - (2\text{ m})\hat{j} - (5\text{ m})\hat{k}$
E) $-(5\text{ m})\hat{i} - (2\text{ m})\hat{j} = (3\text{ m})\hat{k}$

$\vec{r}_2 = 3\hat{i} - 1\hat{j} + 4\hat{k}$ m
$\vec{r}_1 = -2\hat{i} + 3\hat{j} + 1\hat{k}$ m
$\vec{d} = \vec{r}_2 - \vec{r}_1 = 5\hat{i} - 4\hat{j} + 3\hat{k}$ m

20. Two blocks are connected by a string and pulley as shown. Assuming that the string and pulley are massless and frictionless, and using $g = 9.8$ m/s², the acceleration of the 90 g block is:

$|\vec{a}_1| = |\vec{a}_2| = a$

$\vec{a}_1 \uparrow$




$\downarrow \vec{a}_2$

$y$ +

$m_1 > m_2$
$m_1$ will fall
$m_2$ will accelerate upwards

A) 0.049 m/s² downwards
B) 0.0098 m/s² downwards
C) 0.0098 m/s² upwards
D) 0.98 m/s² downwards
E) 0.98 m/s² upwards

$T - m_2 g = m_2 a \quad \ldots (1)$
$T - m_1 g = -m_1 a \quad \ldots (2)$

$(1) - (2)$: $-m_2 g + m_1 g = (m_2 + m_1) a$

$\therefore a = \dfrac{(m_1 - m_2) g}{m_1 + m_2} = 0.98\ \text{m/s}^2$