By Anan Elayan

جامعة بيرزيت
BIRZEIT UNIVERSITY

Physics 141

Fall 2021-2022 | First Hour Exam | Time: 80 minutes

Student Name: Solution *Student No.:* _____

هام: يرجى قراءة هذه التعليمات بتمعن قبل بدء الامتحان

يمنع منعاً باتاً استخدام الهاتف النقال ووضع سماعات أذن أثناء الامتحان، ويجب إطفاء الهاتف ووضعه داخل الحقيبة، علماً أن عدم الالتزام بذلك يعتبر غشاً أكاديمياً ويتعرض فاعله للعقوبة الأكاديمية حسب أنظمة وقوانين الجامعة.

1. أكتب اسمك ورقمك الجامعي في المكانين المخصصين لذلك أعلاه.
2. ضع دائرة حول رقم المحاضرة المسجل بها في جدول المحاضرات (وليس حصة النقاش) أسفل الصفحة.
3. يتكون الامتحان من قسمين، القسم الأول يحتوي 12 سؤال اختيار من متعدد، والقسم الثاني يحتوي سؤالين موضوعيين، يحل السؤالان على ورقة الامتحان في المكان المخصص لهما.
4. أنقل أجوبة القسم الأول في الجدول التالي وذلك بوضع إشارة (X) بقلم الحبر في الخانة المناسبة.
5. عند انتهاء الامتحان، سلم جميع أوراق الامتحان كاملة إلى المراقب.
6. لا يسمح باستخدام أوراق خارجية للحل، ويوجد ورقة إضافية في آخر الامتحان لهذا الغرض.

Answer Sheet (Part A: Multiple Choice)

A /Q #	1	2	3	4	5	6	7	8	9	10	11	12
(a)			X								X	
(b)				X			X		X	X		
(c)												
(d)								X				X
(e)	X	X			X	X						

ضع دائرة حول رقم شعبة المحاضرة المسجل بها

Lecture #	Instructor	Day	Time
1	Abdalaziz Shawabka	T, R	14:15 - 15:30
2	Isma'El Badran	T, R	10:00 - 11:15
3	Ghassan Abbas	T, R	12:50 - 14:05
4	Abdallah Sayyed	T, R	11:25 - 12:40
5	Zafer Hawash	T, R	10:00 - 11:15
6	Wael Karain	T, R	11:25 - 12:40
7	Rula Bakeer	T, R	14:15 - 15:30

لاستخدام المصحح

M. Choice	/12	
Problem 1	/4	
Problem 2	/4	
Total	/20	

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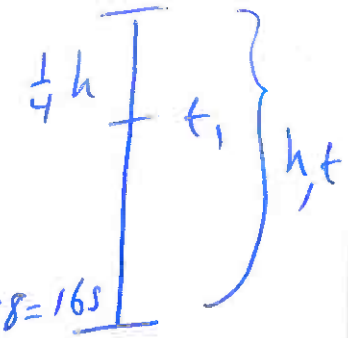
1. A stone is released (أسقط) from a high building. If the stone covers (قطع) the first quarter (الربع الأول) (i.e. 0.25) of the building height in 8 seconds, then the total time it takes the stone to reach ground is
   a) 20 second
   b) 18 second
   c) 24 second
   d) 12 second
   e) 16 second

$\frac{1}{4}h = \frac{1}{2}gt_1^2$

$h = \frac{1}{2}gt^2$

$\frac{h}{\frac{1}{4}h} = \frac{t^2}{t_1^2} \Rightarrow 4 = \frac{t^2}{t_1^2}$

$t = 2t_1 = 2 \times 8 = 16s$



2. A 1000 kg racing car (سيارة سباق) can accelerate from rest to 108 km/h in 7.5 seconds. Assuming constant acceleration, the force needed to achieve (يحصل على) such speed in this time interval (فترة زمنية) is?
   a) 5000 N
   b) 3750 N
   c) 3000 N
   d) 2500 N
   e) 4000 N

$v = 108\ km/h = 30\ m/s$

$v = v_0 + at \Rightarrow 30 = 0 + a \times 7.5$

$a = 4\ m/s^2$, $F = ma = 1000 \times 4 = 4000\ N$

3. A cheetah (فهد) with a speed of 90 km/hr is chasing (يركض خلف) a ghazel (غزال) running at 20 m/s in a straight line. If the distance between them is 40 m when the chasing started, in how many seconds will the cheetah catch the ghazel?
   a) 8.0 s
   b) 7.0 s
   c) 4.0 s
   d) 6.0 s
   e) 5.0 s

$v_c = 90\ km/hr = 25\ m/s$

$v_r = v_c - v_g = 25 - 20 = 5\ m/s$

$t = \frac{d}{v_r} = \frac{40}{5} = 8.0\ s$

4. A car travels from Birzeit to Ramallah at an average speed of 70 km/h and then back to Birzeit at an average speed of 50 km/h. The average speed of the car for the whole trip is:
   a) 60 km/hr
   b) 58 km/hr
   c) 53 km/hr
   d) 75 km/hr
   e) 72 km/hr

$\bar{v} = \frac{d_{total}}{t_{total}} = \frac{2d}{\frac{d}{v_1} + \frac{d}{v_2}}$

$= \frac{2v_1v_2}{v_1 + v_2} = \frac{2 \times 70 \times 50}{120} = 58\ km/hr$

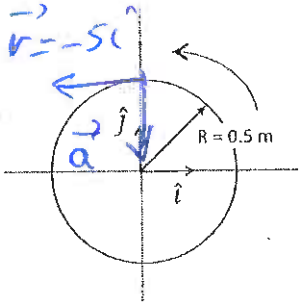
5. A small stone is tied to a string (خيط) of length 0.5 meter. The stone is set into a counterclockwise (عكس عقارب الساعة) horizontal uniform circular motion on a smooth (ناعم) table. The velocity of the stone at one point is $-5\hat{\imath}$ m/s. The acceleration of the stone (in m/s^2) at this moment is

a) $200\hat{\jmath}$
b) $-200\hat{\imath}$
c) $10\hat{\imath}$
d) $10\hat{\imath} + 10\hat{\jmath}$
e) $-50\hat{\jmath}$

$\vec{v} \perp \vec{a}$

$|\vec{a}| = \frac{v^2}{r} = \frac{5^2}{0.5} = 50 \text{ m/s}^2$

$\vec{a} = -50\hat{\jmath}$



6. Let $\vec{A} = 3\hat{\imath} + 2\hat{\jmath}$ and $\vec{B} = 3\hat{\imath} - 3\hat{\jmath}$. $\vec{A} \times \vec{B}$ is

a) $\hat{\jmath}$
b) $2\hat{\imath} + 3\hat{\jmath}$
c) $4\hat{\imath} - 2\hat{\jmath} + 2\hat{k}$
d) $-\hat{k}$
e) $-15\hat{k}$

$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 3 & 2 & 0 \\ 3 & -3 & 0 \end{vmatrix} = \hat{k}(-9-6) = -15\hat{k}$

7. A car traveling along a straight road increases its speed from v_1 = 10 m/s to v_2 = 30 m/s in 25 seconds. If the car's acceleration is constant, what is the distance traveled by the car?

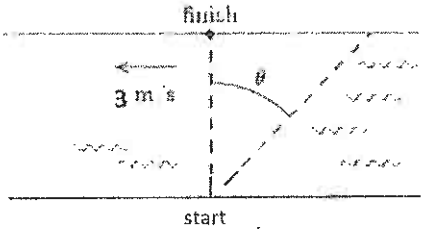
a) 400 m
b) 500 m
c) 300 m
d) 250 m
e) 600 m

$\bar{v} = \frac{v_1 + v_2}{2} = \frac{10+30}{2} = 20 \text{ m/s}$

$\Delta x = \bar{v}\,\Delta t = 20 \times 25 = 500 \text{ m}$

8. A girl wishes to swim across a river to a point directly opposite as shown. She can swim at 6m/s relative to water, and the river is flowing at 3 m/s relative to ground. At what angle θ (in degrees) with respect to the line joining the starting and finishing points should she swim?

a) 37
b) 53
c) 49
d) 30
e) 75



$\vec{v}_{we}$, $\vec{v}_{ge}$, θ, $\vec{v}_{gw}$

$\sin\theta = \frac{|\vec{v}_{we}|}{|\vec{v}_{gw}|} = \frac{3}{6} = 0.5$

$\theta = 30^\circ$

9. A moving object has a position vector $\vec{r} = (2.0 + 3.0t)\hat{\imath} + (3.0 - 1.0t^2)\hat{\jmath}$, where quantities are in SI units. What is the speed of the object at t = 2 seconds?

a) 10 m/s
b) 5 m/s
c) 12 m/s
d) 8 m/s
e) 15 m/s

$\vec{v} = \frac{d\vec{r}}{dt} = 3\hat{i} - 2t\hat{j}$

at $t = 2$, $\vec{v}(2) = 3\hat{i} - 4\hat{j}$

$|\vec{v}| = \sqrt{3^2 + 4^2} = 5$ m/s

10. The angle (in degrees) between the vector $\vec{A} = 2\hat{\imath} + \sqrt{3}\hat{\jmath} + 3\hat{k}$ and the y- axis is

a) 60
b) 64
c) 120
d) 45
e) 41

$\cos\theta = \frac{A_y}{|\vec{A}|} = \frac{\sqrt{3}}{\sqrt{2^2 + \sqrt{3}^2 + 3}^2} = \frac{\sqrt{3}}{4}$

$\theta = 64^\circ$

11. The number of beats (دقات) that your heart can make in your life time is of the order of

a) 10^9
b) 10^{11}
c) 10^7
d) 10^5
e) 10^{13}

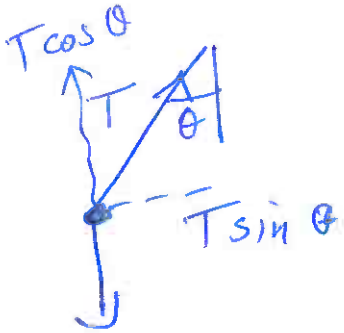
# of beats = ~~70 yr × 365 day ×~~

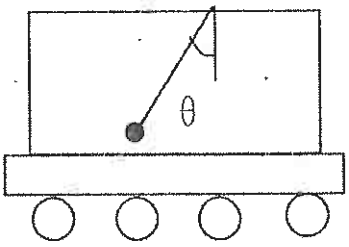
$= 70\text{ yr} \times 365\text{ day} \times 24\text{ hr} \times 60\text{ min} \times 60\text{ sec} \times 1$

$\approx 10^9$

12. You are travelling in an accelerating train and noticed a small object hanging by a string from the ceiling (سقف) of the train tilted (يميل) at an angle θ of 37 degrees from the vertical as shown. From this information, what is the acceleration (in m/s^2) of the train?

a) 2.0
b) 3.6
c) 5.8
d) 7.5
e) 1.8





$T\sin\theta = ma$

$T\cos\theta = mg$

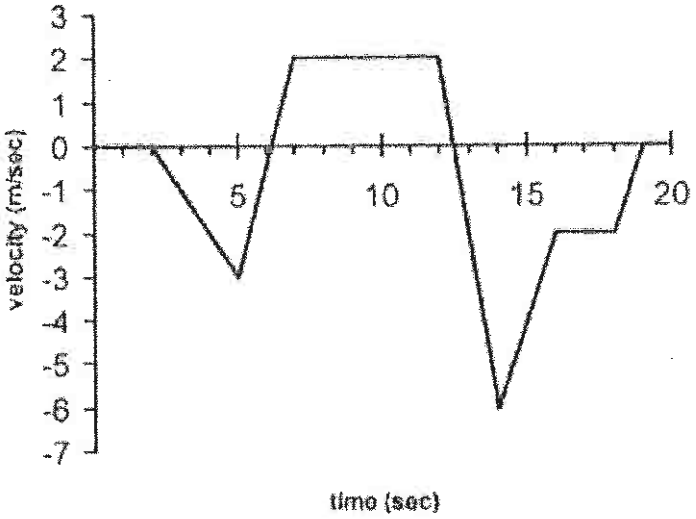
$\tan\theta = \frac{a}{g}$

$a = g\tan\theta = 10\tan 37 = 7.5\ m/s^2$

PART B

1. **(4 points):**

The adjacent graph represents the velocity of an object moving along the x-axis as a function of time. The velocity is measured in meter/second (m/s), and the time is in seconds (s). Using the graph, answer the following questions:



a. **(1 point)**: Find the net displacement from t = 7 to t =12 seconds.

Δx = area under v-t curve

$= (12-7) \times 2$

$= 10\ m$

b. **(1 point)**: Find the acceleration at t =6 seconds.

$a = \text{slope} = \frac{2-(-3)}{7-5} = \frac{5}{2} = 2.5\ m/s^2$

c. **(1 point)**: Find the average velocity during the interval t=10 to t=14 seconds.

$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{4.5-4.5}{4} = 0\ m/s$

d. **(1 point)**: At what time does the object reach maximum distance along the positive x-axis?

At $t = 12.5\ s$

2. **(4 points):**

A helicopter flying horizontally at constant velocity releases (أطلقت) a bag from a height of 500 m. The helicopter's horizontal velocity is 100 m/s. Find:

a. **(1 points):** The bag's speed when the bag is just released from the helicopter.

$v_b = v_h = 100\ m/s$ horizontally

b. **(1 points):** The bag's speed when the bag hits ground.

$v_y^2 = v_{oy}^2 - 2gy$

$= 0 - 2 \times 10 \times 500 = 10{,}000$

$v_y = 100\ m/s$

$\vec{v} = 100\hat{i} - 100\hat{j}$

$|\vec{v}| = \sqrt{100^2 + 100^2} = 141\ m/s$

c. **(1 points):** The time it takes the bag to reach ground.

$v_y = v_{oy} - gt$

$-100 = 0 - 10t \Rightarrow t = 10\ s$

or: $\Delta y = v_{oy} t - \frac{1}{2} g t^2$

$-500 = -5t^2 \Rightarrow t = 10\ s$

d. **(1 points):** The horizontal distance covered by the bag.

$x = v_{ox} t = 100 \times 10 = 1000\ m$