Umm Al-Qura University
College of Applied Sciences
Physics Department

جامعة ام القرى
كلية العلوم التطبيقية
قسم الفيزياء

Final Exam

Program: Medical Physics **Course Title**: Fundamentals of Medical Physics

Course Code: 4032280 **Exam Date**: 11/4/1440 H **Exam Time**: 120 Minutes

Name:…… …….. **Student ID:**……..

Serial Number: …… **Answer Model**

Answer *FOUR* questions *ONLY*. [Exam Total Marks: 50 Marks]

(You may answer the Fifth question to supplement any midterm you were absent)

عزيزتي الطالبة يجدر بك العناية بقراءة الفقرات التالية:

- قراءة السؤال أكثر من مرة، والعناية بالكتابة الإملائية الصحيحة مطلب مهم فاعتن بذلك.
- الغش أو الشروع فيه أو محاولة ذلك، أو الإخلال بسير الاختبارات ، يعرضك لاتخاذ الإجراء النظامي .
- يمنع اصطحاب الهاتف المحمول أثناء الاختبار لأي غرض، وإخراجه أثناء الاختبار يعرضك لاتخاذ الأجراء النظامي
- يمنع استخدام أي وسيلة حسابية بدون استئذان الأستاذ المراقب.
- يمنع الخروج من الاختبار قبل مضي نصف ساعة من بداية الاختبار، وبعد إذن المراقب بذلك، ولا يحق للطالب المتأخر أكثر من نصف ساعة دخول الاختبار بأي حال من الأحوال، وفي حالة التأخر أقل من نصف ساعة فيعود تقدير دخوله من عدمه لمشرف القاعة وأستاذ المقرر.
- يترتب على خروجك أثناء الاختبار ولو لعذر منعك من إعادة الاختبار غالباً.

Question Number	Marks	Signature
Question 1 (20 Marks)		
Question 2 (10 Marks)		
Question 3 (10 Marks)		
Question 4 (10 Marks)		**Exam Committee**
Question 5 (10 Marks)		
Final Marks (50 Marks)		

د/ حنان حسين عامر

مع أطيب الامنيات بالتوفيق والنجاح

Saudi Arabia Kingdom
Ministry of Education
Umm Al-Qura University
Applied Science Faculty
Physics Department
Final Exam

Medical Physics Program
Fundamentals of Medical Physics Course
Course Code (4032280-4)
Exam Time: 120 minutes
Exam Date:11/4/1440 H
Number of Papers: 7 papers

Answer *FOUR* questions *ONLY*. QUESTION 1 is obligatory

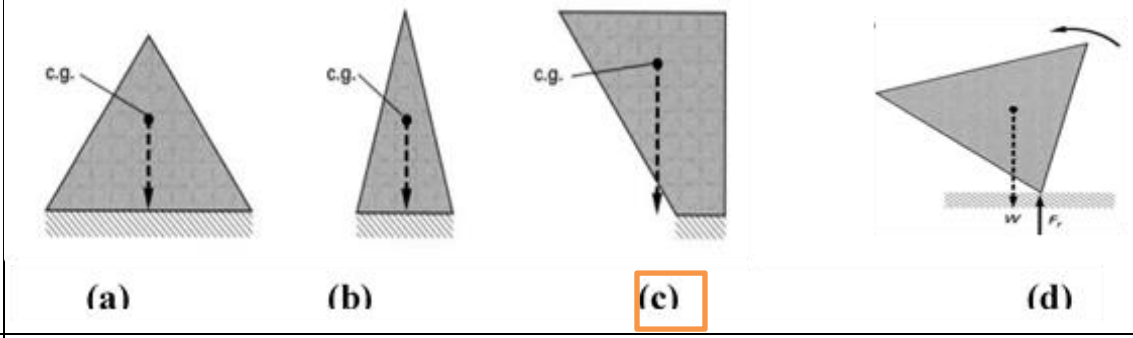
[Exam Total Marks: 50 Marks]

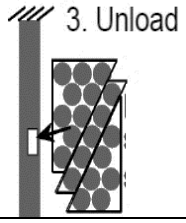
20

Answer the following Question

Question 1: Choose the correct answer for the following sentence: (20 x 1 Mark)

No.	Question
1	**The elastic property of the material is defined by --------.**
	(a) stress **(b) young's modulus** **(c)** strain **(d)** no correct answer.
2	**For a given momentum, the magnitude of the impulsive force is ---- with the collision time.**
	(a) not related **(b)** directly proportional **(c) inversely proportional** **(d)** no correct answer
3	**At large stimulus, the reflex action of ----- neurons are stimulated.**
	(a) sensory **(b) motor** **(c)** both a&b **(d)** no correct answer
4	**The stored energy (ΔU) within the body increases when the heat flow (Q) from the body ---- and the work done (W) by the body ------.**
	(a) decreases, increases **(b) increases, decreases** **(c)** decreases, decreases **(d)** increases, increases
5	**A body is said to be in a static equilibrium, if .....**
	(a) $\Sigma F=0$ & $\Sigma G=0$ **(b)** $\Sigma F=0$ & $\Sigma \tau=0$ **(c)** $\Sigma \tau=0$ & $\Sigma K=0$ **(d)** $\Sigma F=0$ & $\Sigma M=0$
6	**The measurement of human blood pressure depends on the ------- flow of the blood.**
	(a) laminar **(b) turbulent** **(c)** orygen rate **(d)** no correct answer

7	**The center of gravity (c.g) of an erect person with arms at the side is at approximately ..... of the person height measure from the soles of the feet.**
	(a) 90% **(b)** 65% **(c) 56%** **(d)** 40%
8	**Beta particles emitted from a radioactive isotope can be stopped using -----.**
	(a) air **(b)** paper **(c) aluminum** **(d)** no correct answer
9	**-------- neurons transmit impulse to the brain or spinal cord.**
	(a) sensory **(b)** motor **(c)** both a&b **(d)** no correct answer
10	**In a vessel, as the area (A) of the vessel increases, the velocity (v) of blood flow ----, the flow rate (Q) of the blood -----**
	(a) increases, decreases **(b)** decreases, decreases **(c)** decreases, is constant **(d) increases, is constant**
11	**Which one of the following figures will express unstable position.....?**
	
12	**If $^{222}_{86}$Rn emits alpha (α) particle, the resultant isotope is ----.**
	(a) $^{226}_{88}$Rn **(b)** $^{218}_{85}$Rn **(c)** $^{218}_{84}$**Po** **(d)** no correct answer
13	**An 80 cm strip of rubber is stretched to 105 cm. What is the tensile strain?**
	(a) 0.31 **(b)** 3.1 **(c)** 31 **(d)** no correct answer
14	**The time, required for half of radioactive atoms to decay, is called--------.**

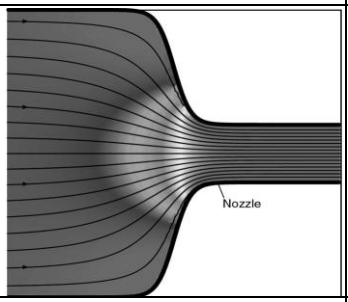
	(a) half-life **(b)** tenth-life **(c)** decay constant **(d)** no correct answer
15	**The mechanical advantage (M) is ------ to the excursion and velocity (v) of the load.**
	(a) directly proportional **(b) inversely proportional** **(c)** not related **(d)** no correct answer
16	**The stiffer the material, the ---- this material has.**
	(a) less stress **(b) less compliance** **(c)** more compliance **(d)** more strain
17	**If the distance between two stimuli is 20 cm and the latency period between the first response and the second response is 3 msec. What is the nerve conduction velocity?**
	(a) 62.5 m/s **(b) 66.7 m/s** **(c)** 120 m/s **(d)** no correct answer
18	**The electrodes for recording the EEG signals are often ------ of silver choride.**
	(a) needle **(b) small discs** **(c)** cones **(d)** no correct answer
19	**When unloading tensile stress, the molecules arranged as shown in the given figure. What is the type of deformation?** 
	(a) elastic **(b) plastic** **(c)** both a&b **(d)** no correct answer
20	**When dry friction acts between two surfaces that are not moving relative to each other, what is this type of friction?**
	(a) static **(b)** dynamic **(c)** fluid **(d)** no correct answer

Answer *ONLY* THREE questions of the following:

10

QUESTION (2): Mark RIGHT (R) or WRONG (W) and CORRECT the false one:

(10 Marks)

No.	Sentence	R or W	Correction
1	If the half-life of a radioactive element is 5730 years, it will reach to 25% of its radioactivity after 11,460 years.	R	
2	Makkah city climate is characterized by a high temperature. This means the basal metabolic rate (BMR) given the body, to stabilize body temperature, is **high**	W	low
3	Frictional force dissipates kinetic energy into **electric** energy and eventually **moves** the object	W	Heat - stops
4	**ERG** is the recording of the potentials from muscles during movement.	W	EMG
5	The black lines are the path that the fluid takes as it flows. Wider spacing indicates low speed flow. 	R	
6	A strip of rubber with a cross section of 10 cm x 0.23 cm is pulled with a force of 2.3 N. The tensile stress in the rubber is 10^4 N **(2.5 Marks)**	R	Stress = force/area

QUESTION (3): Answer the following questions

10

[A] Give reason(s) of the following: (2 x 2 Marks)

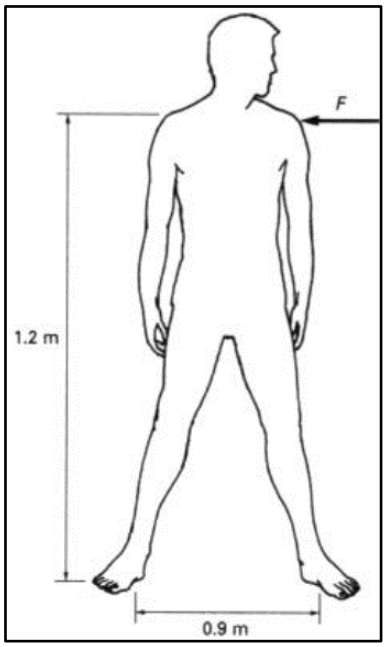
1) Myelinated neurons conduct impulses much faster than those without myelin.

Answer: -For myelinated axons both the capacitance Cand the resistance Rare small and thus very short time is needed for the axon to depolarize and repolarize. Accordingly, the speed in myelinated neurons is extremely high.

2) Persons can jump safely from a height considerably greater than 56 cm without any fracture.

Answer: -If, on landing, the joints of the body bend and the energy of the fall is redistributed to reduce the chance of fracture-

[B] In the given figure, what is the required force to topple this person? **(4 Marks)**



Answer: $T_a = F_a \times 1.2$

$T_w = w \times 0.45$

$F_a \times 1.2 = w \times 0.45$

$F_a = 0.375\ W$ N

[C] For a person with $A_r = 1.3\ m^2$ with a skin and an environmental temperatures 34°C and 25 °C respectively, what is the radiative heat loss rate? [Stefan Boltzman constant is 6.0 Cal/m^2-hr-°C and the emissivity of the skin is 0.98] **(2 Marks)**

Answer: - - $Q = A\varepsilon\sigma(T_{skin}^{\ 4} - T_{env}^{\ 4})$

$Q = 7.22 \times 10^6$ Cal

QUESTION (4): Answer the following questions

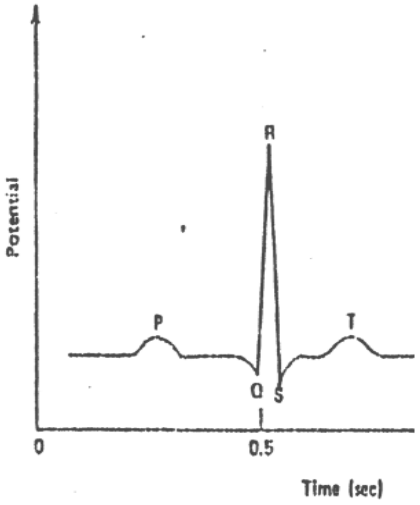
10

[A] Your colleagues obtained the given ECG in the figure but cannot explain it. Can you help her and interpret the recorded peaks in the ECG?

(4 Marks)

Answer: -

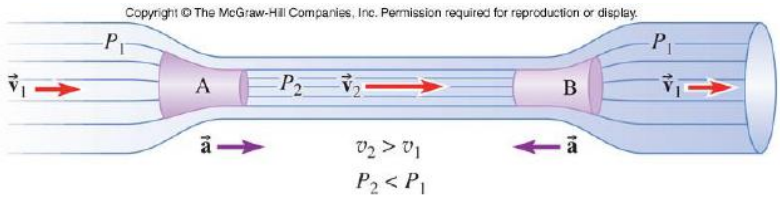
- **Atrial Depolarization;**
  which produces the P-wave.
- **Atrial Repolarization;**
  which is rarely seen and unlabeled.
- **Ventricular Depolarization;**
  which produces the **QRS** complex which is very important signal in determining the heart state.
- **Ventricular Repolarization;**
  which produces the T-wave.



[B] Write Bernoulli equation of the fluid flow in the streamline of vessel. Which pressure is higher than the other, point 1 or point 2? Give reason for answer

(3 Marks)

Answer: -



This is the most general equation

$$P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$$

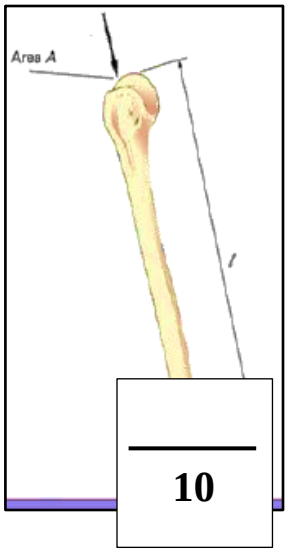
Work per unit volume done by the fluid

Potential energy per unit volume

Kinetic energy per unit volume

Points 1 and 2 must be on the same streamline

[C] Consider the fracture of two leg bones that have a combined length of about 90 cm and an average area of 6 cm^2. If the breaking stress is 10^9 N/m^2, and the young's modulus of the bone is 1.4 x 10^{14} N/m^2. What is the total energy absorbed by the bones of two legs at the point of fracture?



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(3 Marks)

Answer: - - $E = \frac{1}{2} (A\, l\, S_B^2)/ Y$

E = 385.7 J

QUESTION (5): Answer the following questions

[A] Mention factors affect **(2 x 2 Marks)**

1) The basal metabolic rate (BMR) of person (five only)

2) the impulse speed of conduction along neurons

Answer:

1) **Factors affect BMR**

- **Body Size**: The larger the body the greater the BMR
- **Body-Fat**: Fatty tissues have a lower BMR than muscle tissue.
- **Hormones:** People with an overactive thyroid have a higher BMR.
- **Illness:** Increased BMR as the body works harder to fight infection
- **Fasting**: Reduces BMR, because the body conserves energy to keep vital organs functioning.
- **Drugs:** Caffeine and nicotine increase BMR
- **Exercise :** BMR increases during exercise.
- **Gender:** Males have an elevated BMR than females
- **Climate:** Cold temperatures increase BMR given the body uses energy to stabilize body temperature.
- **Age:** BMR Decreases with age due to less activity and reduce lean tissue

2)

Impulses typically travel along neurons at a speed of 1 to 120 m/sec. The speed of conduction can be influenced by;

- The diameter of a fiber.
- The temperature.
- The presence or absence of myelin

[B] If the duration of a collision is 4 msec and the change in momentum is 2 Kg.m/sec. What is the average force that acted during this collision? **(2 Marks)**

Answer: - $F_{av} = \frac{2\ Kg.m/sec}{6\ x\ 10^{-3} sec} = 3.3\ x\ 10^{7}\ N$

[C] A garden hose of inner radius 3.0 cm carries water at 6.0 m/s. The nozzle at the end has radius 1 cm. How fast does the water move through the constriction**? (1.5 Marks)**

Answer: - $A_1v_1 = A_2v_2$

$v_2 = 54$ **m/sec-**

[D] Female 70 kg consuming 10,000 KJ who jogged for 30 minutes (200 Kcalories) and cycled for 1.5 hours (500 Kcalories). Is there an energy balance? Explain your answer

(2.5 Marks)

Answer: -

BMR = 6350.4 KJ

Thermic Effect = 1000 KJ

Energy Expenditure = 10290.4 KJ

Energy Balance = -290.4 Kj