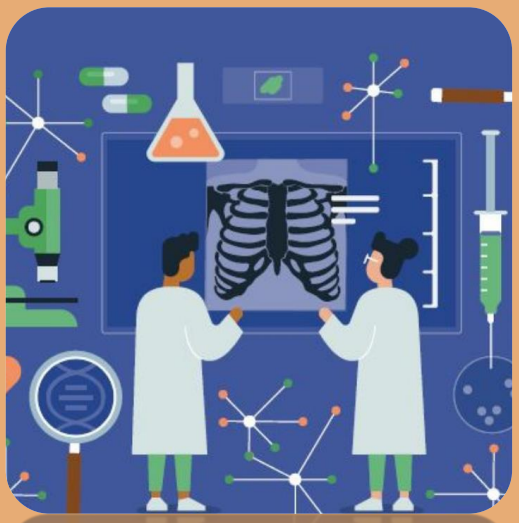


Medical Physics

Medical Physics 100- Final Exam- Athar Batch

لجنة الطب والجراحة

$g = 10\ m/s^2$

$1\ atm = 1.013 \times 10^5\ Pa$

$k = 9 \times 10^9\ Nm^2/C^2$

$c = 3 \times 10^8\ m/s$

$\rho_{water} = 1 \times 10^3\ kg/m^3$

$\rho_{blood} = 1.06 \times 10^3\ kg/m^3$

1. Vector $\vec{A}$ has a magnitude of 6.0 m and is directed along the positive x-axis. Vector $\vec{B}$ has a magnitude of 7.0 m and makes an angle of 120° with the positive x-axis. What is the magnitude of $\vec{A} - \vec{B}$?

   a. 8.0 m

   b. 9.8 m

   c. 11.3 m

   d. 5.0 m

$|\vec{A}| = 6 \quad \theta = 0$

$Ax = |\vec{A}|\cos(0)$

$Ay = |\vec{A}|\sin(0)$

$\vec{A} = (6\hat{x}, 0\hat{y})$

$|\vec{B}| = 7 \quad \theta = 120$

$Bx = 7\cos 120$

$By = 7\sin 120$

$B = (-3.5\hat{x}, 6.1\hat{y})$

$C = A - B = (6\hat{x}, 0\hat{y}) - (-3.5\hat{x}, 6.1\hat{y})$

$= (9.5\hat{x}, -6.1\hat{y})$

$|\vec{C}| = \sqrt{(9.5)^2 + (6.1)^2} = 11.3$

Answer: c. 11.3 m

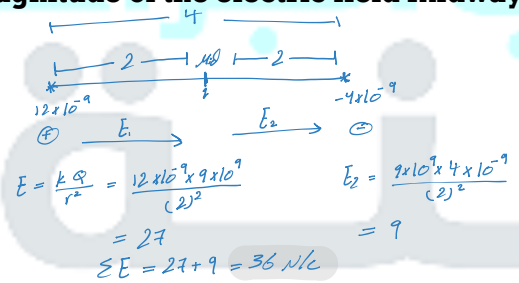
2. Two-point particles, one with charge 12 nC and the other with -4 nC, are separated by 4 m. The magnitude of the electric field midway between them is:

   a. 10 N/C

   b. 18 N/C

   c. 36 N/C

   d. 12 N/C



$E = \frac{kq}{r^2} = \frac{12 \times 10^{-9} \times 9 \times 10^9}{(2)^2} = 27$

$E_2 = \frac{9 \times 10^9 \times 4 \times 10^{-9}}{(2)^2} = 9$

$\Sigma E = 27 + 9 = 36\ N/C$

Answer: c. 36 N/C

3. The velocity of a particle moving along the x axis is given by $v(t)=(4+12t-3t^2)$ m/s. What is the average acceleration of the particle between t=0 and t=1.0 s?

   a. 12 m/s²

   b. 4 m/s²

   c. 9 m/s²

   d. 6 m/s²

$V = 4 + 12t - 3t^2$

$v(1) = 4 + 12 - 3 = 13$

$v(0) = 4$

$\bar{a} = \frac{\Delta V}{\Delta t} = \frac{v(1) - v(0)}{1 - 0} = \frac{13 - 4}{1} = 9\ m/s^2$

Answer: c. 9 m/s²

4. A man of mass 72 kg climbs a hill of height 60 m in mutes. what is the power delivered by him?

   a. 155 W

   b. 120 W

$\Delta PE = mg\Delta h$

in 1 min

$P = \frac{\Delta w}{\Delta t} = \frac{\Delta PE}{\Delta t} = \frac{72 * 9.8 * 60}{60 * 60} = 120\ w$

c. 187 W

d. 133 W

Answer: b. 120 W

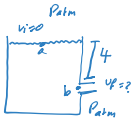
5. A large storage tank, open at the top and filled with water, if there is a small hole in its side at a point 4 m below the water level. Determine the speed at which the water leaves the hole. consider the speed of water at the top is zero.

a. 5.7 m/s

b. 8.9 m/s

c. 7.9 m/s

d. 2.5 m/s



$$P_a + \rho g y_a + \frac{1}{2}\rho v_i^2 = P_b + \rho g y_b + \frac{1}{2}\rho v_f^2$$

$$\rho g y_a - \rho g y_b = \frac{1}{2}\rho v_f^2$$

$$\rho g (y_a - y_b) = \frac{1}{2}\rho v_f^2$$

$h = 4$

$$(9.8)(4)(2) = v_f^2$$

$$v_f = 8.85$$

$$v = \sqrt{2gh}$$

Answer: b. 8.9 m/s

6. A car starts from rest at a stop sign. It accelerates at 5 m/s^2 for 5 s and then slows down at a rate of 3 m/s^2 till it stops at next stop sign. What is the distance between the two stop signs?

a. 166.7 m

b. 134.4 m

c. 148.6 m

d. 120.2 m

(A) $v_i = 0$, $a = 5$, $\Delta t = 5$, $v_f =$

(B) $v_i =$ same as v_f (A), $v_f = 0$

(A) $a = 5$ → v_f = v_i (B) $a = -3$ →

$v_f = v_i + at$

$v_f = 0 + (5)(5)$

$= 25$

$\Delta x = v_i t + \frac{1}{2} a t^2$

$= (0.5)(5)(25)$

$= 62.2$

$v_f^2 = v_i^2 + 2a\Delta x$

$0 = (25)^2 - 6\Delta x$

$\Delta x = 104.16$

Total

$= 104.16 + 62.2$

$= 166.36$ m

Answer: b. 134.4 m

7. A small artery has a length of 1.3×10^{-3} m and a radius of 2.0×10^{-5} m. If the pressure drop across the artery is 1.3 KPa, what is the flow rate through the artery? ($\eta_{blood} = 2.084 \times 10^{-3}$ m Pa.s)

a. 9×10^{-11} m^3/s

b. 6×10^{-11} m^3/s

c. 3×10^{-11} m^3/s

d. 5×10^{-11} m^3/s

$\ell = 1.3 \times 10^{-3}$, $r = 2 \times 10^{-5}$, $\Delta P = 1.3 \times 10^{3}$, $\eta = 2084 \times 10^{-3}$

$$Q = \frac{\pi \Delta P R^4}{8 \eta \ell}$$

$$= \frac{(\pi)(1300)(2 \times 10^{-5})^4}{(8)(2.084 \times 10^{-3})(1.3 \times 10^{-3})}$$

$$= 3 \times 10^{-11}$$

Answer: c. 3×10^{-11} m^3/s

8. Which of the following radiation has positive charge?

a. α- particles

b. β- particles

c. γ- rays

d. X- rays

Answer: a. α- particles

9. **A particle of charge q_1=5 nC is located on the x-axis at the point x_i=0.2 m. A second particle of charge q_2= - 3 nC is placed on the x-axis at x_2=-0.2 m. What is the total electric potential at x=0?**

   a. **90 V**

   b. **360 V**

   c. **-360 V**

   d. **-90 V**

$V_{(+)} = \frac{kQ}{r} = \frac{9\times10^9 \times 5\times10^{-9}}{0.2}$

$V_+ = 225$

$V_{(-)} = \frac{9\times10^9 \times (-3)\times10^{-9}}{0.2}$

$V_- = -135$

Total $V = 225 - 135$

$= 90V$

Answer: a. 90 V

10. **The speed of light in an unknown medium is measured to be 2 × 10^8 m/s. What is the index of refraction of the medium?**

   a. **1.6**

   b. **1.8**

   c. **1.5**

   d. **1.3**

$V = 2\times10^8$

$n = ??$

$C = nV$

$n = \frac{3\times10^8}{2\times10^8} = 1.5$

Answer: c. 1.5

11. **If *a* is acceleration, *v* is velocity, *x* is position, and *t* is time, then which equation is not dimensionally correct?**

   a. $t^2 = 2x/a$

   b. $x = vt$

   c. $a = v^2/2x$

   d. $t = av$

a) $t^2 = \frac{2x}{a}$

$t^2 = \frac{2x}{\frac{v}{t}}$

$t^2 = \frac{2x \cdot t}{v}$

$t^2 = \frac{2x \cdot t^2}{x}$

$t^2 = 2t^2$

$[T]^2 = 2[T]^2$ ✓

Value

d) $t = av$

$t = \frac{v}{t} \cdot v$

$t = \frac{v^2}{t}$

$t = \frac{x^2}{t^3}$ ✗

$[T] \neq \frac{[L]^2}{[T]^3}$

Answer: d. $t = av$

12. **Calculate the volume of the displaced water to keep a person weight 500 N floating in a swimming pool?**

   a. **0.03 m^3**

   b. **0.08 m^3**

   c. **0.04 m^3**

   d. **0.05 m^3**

$F_B = F_g$

$\rho g V = 500$

$V = \frac{500}{(1000)(9.8)}$

$= 0.05$

Answer: d. 0.05 m^3

13. **A convex lens has focal length 20 cm. Calculate at what distance from the lens should the object be placed so that it forms an image at 30 cm on the other side of the lens.**

   a. **60 cm**

   b. **-40 cm**

$f = 20\times10^{-2}$

$s = ?$

$s' = 30\times10^{-2}$

$\frac{1}{f} = \frac{1}{s'} + \frac{1}{s}$

$\frac{1}{0.2} - \frac{1}{0.3} = \frac{1}{s'}$

$s' = 0.6\,m$

$= 60\,cm$

Object distance s is positive when the object is on the same side as the incident light.
Image distance s'
is negative when the image is on the same side as the incident light and positive when on the opposite side.

c. -60 cm

d. 40 cm

Answer: a. 60 cm

14. A cube of Aluminum has a cubical hole through its center. If the cube is heated from 60° F to 130° F. What is the fractional increase of the volume of the hole if the coefficient of linear expansion for Aluminum is $2.4 \times 10^{-5}\ K^{-1}$?

a. 4.8×10^{-3}

b. 5×10^{-3}

c. 1.7×10^{-3}

d. 2.8×10^{-3}

$T_i = 60\ F = \frac{5}{9}(60-32)\ C = 15.56$

$T_f = 130\ F = \frac{5}{9}(130-32) = 54.44$

$\Delta T = 38.88$

$\Delta V = 3\alpha V_0 \Delta T$

$\frac{\Delta V}{V_0} = 3\alpha \Delta T = (3)(2.4\times10^{-5})(38.88) = 2.79\times10^{-3}$

Answer: d. 2.8×10^{-3}

15. A ray of light travels through air (n = 1.0) and approaching the boundary with water (n = 1.33). The angle of incidence is 30°. Determine the angle of refraction.

a. 22°

b. 30°

c. 18°

d. 26°

$n_1 = 1 \quad n_2 = 1.33$

$\theta_1 = 30 \quad \theta_2 = ?$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\frac{(1)\sin(30)}{1.33} = \sin\theta_2$

$\sin^{-1}(0.3759) = \theta_2$

$= 22$

Answer: b. 30°

16. A wire of nichrome has a radius of 1 mm and length 2 m. The resistivity of nichrome is $1.08 \times 10^{-6}\ \Omega m$. Find the current if the potential difference is 15 V?

a. 21.8 A

b. 18 A

c. 12.5 A

d. 6.8 A

$I = \frac{\Delta V}{R}$

$r = 1\times10^{-3}, \ell = 2, \rho = 1.08\times10^{-6}, \Delta V = 15\ V$

$R = \frac{\rho L}{A} = \frac{1.08\times10^{-6}\times 2}{\pi(1\times10^{-3})^2} = 0.687$

$I = \frac{15}{0.6875} = 21.8\ A$

Answer: a. 21.8 A

17. What is the length of a cube that has a mass of 256 grams and a density of 4×10^3 Kg/m^3?

a. 8 cm

b. 4 cm

c. 5 cm

d. 3 cm

$\rho = \frac{m}{V}$

$4000 = \frac{0.256}{V}$

$V = 64\times10^{-6}$

$x = \sqrt[3]{V}$

$= \sqrt{64\times10^{-6}}$

$= 0.04\ m$

$= 4\ cm$

Answer: b. 4 cm

18. **What is the height to which water will rise in a narrow tube of radius 0.5 mm, if the coefficient of the surface tension for water is 7.2×10^{-2} N/m, and the contact angle is zero degree?**

$r = 0.5 \times 10^{-3}$, $\gamma = 7.2 \times 10^{-2}$, $\theta = 0$

$h = \frac{2\gamma\cos\theta}{\rho g r}$

$= \frac{(2)(7.2\times10^{-2})(\cos 0)}{(1000)(9.8)(0.5\times10^{-3})}$

$= 0.029$

$= 2.9$ cm

a. **2.9 cm**
b. **0.98 cm**
c. **1.4 cm**
d. **3.9 cm**

Answer: a. 2.9 cm

19. **Water flows through a cylindrical pipe of varying cross- section. The velocity is 5 m/s at a point where the pipe diameter is 1 cm. At a point where the pipe diameter is 3 cm, the velocity is:**

$v_1 = 5$, $d = 1\times10^{-2}$, $r = 0.5\times10^{-2}$ | $v_2 = ?$, $d = 3\times10^{-2}$, $r = 1.5\times10^{-2}$

$Q = Q$

$v_1 A_1 = v_2 A_2$

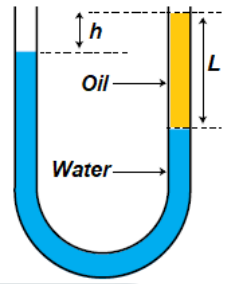
$(5)(\pi)(0.5\times10^{-2})^2 = (\pi)(1.5\times10^{-2})^2 v_2$

$v_2 = 0.55$ m/s

a. **0.44 m/s**
b. **0.25 m/s**
c. **0.55 m/s**
d. **5.0 m/s**

Answer: c. 0.55 m/s

20. **A simple U- tube that is opened at both ends is partially filled with water (ρ_{water}= 1.0 g/ cm^3). Oil (ρ_{oil}= 0.82 g/ cm^3) is then poured into one arm of the tube, forming a column 10 cm in height as shown in the figure. What is difference h in the heights of the two liquid surfaces?**



a. **0.2 cm**
b. **1.8 cm**
c. **1.0 cm**
d. **1.3 cm**

as shown previously

Answer: b. 1.8 cm

Answers on this sheet are provided by students; errors are conceivable.

Good luck.