

CHAPTER 1: INTRODUCTION, MEASUREMENTS, UNITS

Formulas & Constants

$A = L \times W$ (Rectangle's area)	$A = \pi R^2$ (Circle's area)	Volume = Area \times Height	$c = 299,792,458 \text{ m/s}$ (speed of light in vacuum)	$1 \text{ u} = 1.6605 \times 10^{-27} \text{ kg}$ (atomic mass unit)
$1 \text{ m/s} = 3.6 \text{ km/h}$	1 giga (G) = 10^9	1 mega (M) = 10^6	1 kilo (k) = 10^3	1 centi (c) = 10^{-2}
1 milli (m) = 10^{-3}	1 micro (μ) = 10^{-6}	1 nano (n) = 10^{-9}	1 in. = 2.54 cm	1 ft = 12 in.
1 yd = 3 ft	1 mi = 5280 ft	1 mi = 1.61 km	1 L = 1000 cm ³	
	Dimension of length: L	Dimension of time: T	Dimension of mass: M	

Key Terms & Definitions

Accuracy	دقة
Analysis	تحليل
Base units	الوحدات الأساسية
Concept	مفهوم
Conversion	تحويل
Data	بيانات
Decimal place	منزلة عشرية
Detect	يكشف
Diameter	قطر دائرة
Digit	منزلة رقمية
Dimension	بعد
Equation	معادلة
Estimate	تقدير
Evidence	دليل
Experiment	تجربة

Fact	حقيقة
Guess	تخمين
Hypothesis	فرضية
Law	قانون
Measurement	قياس
Model	نموذج
Observation	ملاحظة
Order of magnitude	الترتيب المقداري
Percentage	نسبة مئوية
Phenomenon	ظاهرة
Power-of-ten	أس العشرة
Precision	ضبط
Prediction	توقع
Prefix	أداة بادئة
Principle	مبدأ

Relationship	علاقة
Rounding	تقريب
Science	علم
Scientific attitude	المنهج العلمي
Scientific method	الطريقة العلمية
Scientific notation	الترميز العلمي
SI System	نظام الوحدات العالمي
Significant figures	الأرقام المعنوية
Speculation	تأمل
Standard	معياري
Technology	تقنية
Test	اختبار
Theory	نظرية
Uncertainty	هامش الخطأ
Unit	وحدة

Science; Scientific Method; Scientific Attitude

1. ①The test of truth in science is:

A	experiment✓
B	speculation
C	hypothesis
D	facts

2. ①Good science is distinguished (يتميز) by:

A	inconsistency (عدم التوافق)
B	emotion (العاطفة)
C	imagination (الخيال)
D	measurements (القياس)✓

3. ②Our ability to measure something indicates (يشير إلى) how well we _____ that thing.

A	like
B	ignore (يجهل)
C	know✓

D misunderstand (يسيء الفهم)

4. ②The scientific method does NOT include:

A	hypothesis (فرضية)
B	speculation (تأمل)✓
C	experiment (تجربة)
D	prediction (توقع)

5. ①A scientific hypothesis is:

A	an experiment (تجربة)
B	a final conclusion (خلاصة)
C	an educated guess (تخمين مدروس)✓
D	a verified prediction (توقع محقق)

6. ②A scientific hypothesis:

A	is always true
B	is always false
C	can be tested for falsehood✓
D	is not important in science

7. ③The three main elements of a scientific method are:

A	hypothesis, prediction, conclusion
B	hypothesis, conclusion, speculation
C	speculation, hypothesis, experiment
D	hypothesis, prediction, experiment✓

8. ①Of the following, the only scientific hypothesis is:

A	souls (الأرواح) move faster than light
B	atoms are the smallest particles in the world✓
C	Einstein was the greatest scientist ever
D	space is filled with undetectable (غير مكتشف) matter

9. ①Which of these is NOT a scientific hypothesis?

A	atomic nuclei are the smallest particles in nature
B	a magnet will pick up a copper coin
C	cosmic rays cannot penetrate a physics textbook
D	sound is made of untestable waves✓

10. ①A nonscientific hypothesis is:

A	an electron is heavier than a proton
B	heavy objects fall faster than light objects
C	sunset helps poetry✓
D	the Moon is farther than the Sun

11. ①Which of these is NOT a scientific hypothesis?

A	protons carry electric charge
B	undetectable particles exist in the nucleus✓
C	charged particles bend in a magnetic field
D	electricity can travel in plastic

12. ③Characteristics (خصائص) of the scientific attitude include:

A	inquiry (استطلاع), integrity (نزاهة), humility✓
B	inquiry, integrity, pride (كبرياء)
C	submission (تسليم), integrity, humility (تواضع)
D	submission, inquiry, pride

Physics vs. Other Sciences

13. ①The physical sciences include:

A	biology (علم الأحياء)
B	botany (علم النبات)
C	entomology (علم الحشرات)
D	geology (علم طبقات الأرض) ✓

14. ①The physical sciences do NOT include:

A	chemistry
B	zoology (علم الحيوان) ✓
C	astronomy (علم الفلك)

D	geology (علم طبقات الأرض)
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15. ①The most basic science is:

A	physics✓
B	chemistry
C	biology
D	geology

16. ②Physics is considered the basic science because:

A	it is most related to our daily experience
B	all other sciences depend on it
C	it is needed for understanding other sciences
D	all of these✓

Models, Theories, and Laws

17. ②A scientific model helps in _____ some scientific phenomena (ظواهر).

A	rejecting (رفض)
B	changing
C	understanding✓
D	combining (دمج)

18. ②A scientific model relates (ينسب) a difficult-to-see scientific phenomenon (ظاهرة) to something that is:

A	unfamiliar to us
B	ambiguous (غامض)
C	not discovered (يكتشف) yet
D	familiar to us✓

19. ②The picture that a scientific model gives for a studied phenomenon (ظاهرة) is:

A	approximate (تقريبي)✓
B	exact (دقيق)
C	unclear (غير واضح)
D	reverse (معكوس)

20. ②An agreement (توافق) by competent (أكفاء) scientists is a scientific:

A	hypothesis (فرضية)
B	fact (حقيقة)✓
C	observation (ملاحظة)
D	model (نموذج)

21. ②A hypothesis that has been repeatedly (تكراراً) tested without flaws (خلل) becomes a scientific:

A	prediction (توقع)
B	observation (ملاحظة)
C	law (قانون)✓
D	experiment (تجربة)

22. ②A synthesis (تجميع) of many well-verified (محقق) hypotheses (فرضيات) is a scientific:

A	prediction (توقع)
B	theory (نظرية)✓
C	law (قانون)
D	experiment (تجربة)

23. ②In science, a theory is:

A	an educated guess
B	less correct than a fact
C	a synthesis (تجميع) of many well-tested hypotheses✓
D	unchangeable

24. ②A scientific fact is rejected (يرفض) if scientists find that it:

A	is disproved (ينقض) by evidence (أدلة)✓
B	has become more than 500 years old
C	disagrees with local politics
D	actually, a fact is always a fact

25. ①The equations $F = ma$ is an example of a physics:

A	theory
B	model
C	law✓
D	prediction

Uncertainty, Accuracy, and Precision

26. ②When are measurements absolutely (تماماً) precise?

A	usually
B	sometimes
C	always
D	never✓

27. ①There is uncertainty associated with every:

A	measurement✓
B	law
C	equation
D	principle


28. ①Main causes of uncertainty in measurements are limitations (محدودية) in:

A	instruments' accuracy and experiment time
B	instruments' (أجهزة) accuracy and human ability✓
C	experiment time and human ability
D	experiment time and lab conditions

29. ①When we use a ruler of 1 millimeter smallest divisions, the uncertainty is approximately (تقريباً) equal to:

A	0.1 mm
B	1 mm✓
C	2.5 mm
D	5 mm

30. ①Using a ruler with cm and mm divisions to measure a certain length, we get a value of 12.8 cm. Our measurement can then be written as:

A	$L = 12.8 \pm 1.0$ cm	
B	$L = 12.8 \pm 0.01$ cm	
C	$L = 12.8 \pm 0.2$ cm	
D	$L = 12.8 \pm 0.1$ cm✓	

31. ②Using a ruler with cm and mm divisions to measure a certain length, we get a value of 12.8 cm. Our measurement can then be written as:

A	$L = 12.8 \text{ cm} \pm 1\%$ ✓
B	$L = 12.8 \text{ cm} \pm 5\%$
C	$L = 12.8 \text{ cm} \pm 10\%$
D	$L = 12.8 \text{ cm} \pm 20\%$


32. ①The percent uncertainty in the measurement $L = 20.2 \pm 0.4$ cm is:

A	0.5%
B	1%
C	2%✓
D	4%

33. ②The percent uncertainty in a measurement $A = 2.03 \text{ m}^2$ is:

A	0.5%✓
B	2%
C	5%
D	10%

34. ③A scale (ميزان) has ± 0.05 g accuracy. Weighing a diamond (ماسة) on it gives 8.17 g one day and 8.09 g another day. These two measurements:

A	are unacceptable within the scale's accuracy	
B	are acceptable within the scale's accuracy✓	
C	prove that the scale's accuracy is incorrect	
D	prove that these are two different diamonds	

35. ①The ability of an instrument (جهاز) to repeatedly (تكراراً) give close (متقارب) measurements is called:

A	accuracy
B	uncertainty
C	deviation
D	precision✓

36. ①The ability of an instrument (جهاز) to give

measurements close (مقارب) to the true values is called:

A	accuracy✓
B	uncertainty
C	deviation
D	precision

Significant Figures

37. ①The number of reliably (بشكل موثوق) known digits (أرقام) in a number is its:

A	uncertainty
B	accuracy
C	significant figures✓
D	percent error

38. ①The number of significant figures in (23.20) is:

A	1
B	2
C	3
D	4✓

39. ②The number of significant figures in (0.062) is:

A	1
B	2✓
C	3
D	4

40. ①The number of decimal places in (0.062) is:

A	1
B	2
C	3✓
D	4

41. ①The area of a (10.0 cm × 6.5 cm) rectangle is correctly given as:

A	65 cm ² ✓
B	65.0 cm ²
C	65.00 cm ²
D	65.000 cm ²

42. ②The significant figures in the product of two numbers ($P = A \times B$) should be the same as the _____ significant figures of A and B.

A	most (أكثر)
B	least (أقل)✓
C	average (متوسط)
D	inverse (عكسي)

43. ③The accuracy in the sum of two numbers ($S =$

$A + B$) should be the same as the _____ accuracy of A and B.

A	most (أكثر)
B	least (أقل)✓
C	average (متوسط)
D	inverse (عكسي)

44. ②Taking accuracy into account, the difference $D = A - B$ between two numbers, $A = 3.6$ and $B = 0.57$, is correctly written as:

A	3.03
B	3.00
C	3.003
D	3.0✓

45. ②Taking accuracy into account, the sum $S = A + B$ of two numbers, $A = 3.6$ and $B = 0.40$, is correctly written as:

A	4.0✓
B	4.00
C	4
D	04.

46. ②Taking significant figures into account, the product $P = A \times B$ of two numbers, $A = 12.0$ and $B = 12$, is correctly written as:

A	144
B	140✓
C	150
D	100

47. ①Taking significant figures into account, the quotient $Q = A \div B$ of two numbers, $A = 12.0$ and $B = 12$, is correctly written as:

A	1.00
B	1
C	1.0✓
D	1.000

48. ①Dividing 2.0 by 3.0 with a calculator gives 0.66666666. Taking significant figures into account, this result should be written as:

A	0.7
B	0.6667
C	0.667
D	0.67✓

49. ①For $A = 0.01234$, $B = 0.00123$, and $C = 0.00012$, the number with the most significant figures is:

A	A only✓
B	B only

C	C only
D	they all are the same

50. ①For $A = 0.01234$, $B = 0.00123$, and $C = 0.00012$, the number with the most decimal places is:

A	A only
B	B only
C	C only
D	they all are the same✓

Scientific Notation

51. ②Scientific notation allows the number of significant figures to be:

A	clearly expressed✓
B	carefully hidden
C	neglected
D	avoided

52. ①In the scientific notation, 36900 is written as:

A	3.69×10^3
B	3.69×10^4 ✓
C	36.9×10^3
D	0.369×10^4

53. ①The scientific notation for 325 is:

A	3.25×10^2 ✓
B	3.25×10^1
C	32.5×10^0
D	32.5×10^{-1}

54. ①In the scientific notation, 0.0021 is written as:

A	21×10^{-2}
B	2.1×10^{-3} ✓
C	21×10^{-3}
D	2.1×10^{-4}

55. ①The scientific notation for 7.33 is:

A	7.33×10^2
B	7.33×10^1
C	7.33×10^0 ✓
D	7.33×10^{-1}

56. ①The number 3.69×10^2 is equivalent to:

A	369✓
B	36.9
C	3.69
D	0.369

57. ①The number 3.7×10^{-1} is equivalent to:

A	3.70
B	0.37✓
C	37.0
D	0.037

58. ①The decimal form for 7.62×10^2 is:

A	7.62
B	762✓
C	76.2
D	0.762

59. ①The decimal form for 6.150×10^{-4} is:

A	0.0615000
B	0.0061500
C	0.0006150✓
D	0.0000615

60. ②Taking significant figures into account, the product $P = A \times B$ of two numbers, $A = 2.079 \times 10^2$ and $B = 0.072 \times 10^{-1}$, is correctly written as:

A	1.49688
B	1.497
C	1.5✓
D	1.50

61. ②For $A = 3.69 \times 10^4$, $B = 3.690 \times 10^2$, and $C = 3.6900 \times 10^{-3}$, the number with the most significant figures is:

A	A only
B	B only
C	C only✓
D	they have same number of significant figures

Units & Standards

62. ②A standard is a fixed reference (مرجع) for a:

A	model
B	equation
C	law
D	unit✓

63. ①The standard of the meter is the distance traveled by light in vacuum in $1/299792458$ of a(an):

A	hour
B	second✓
C	minute
D	day

64. ①The old standard of the second was $1/86400$ of an average solar (شمسي):

A	hour
B	minute
C	day✓
D	year

65. ①The new standard of the second is defined in terms of the frequency of radiation (إشعاع) emitted by:

A	electronic devices
B	the sun
C	X-rays
D	cesium atoms✓

66. ①The standard of the kilogram, kept at the Bureau of weights and Measures in France, is a cylinder of:

A	platinum-iridium✓
B	gold-silver
C	wood-iron
D	radium-uranium

67. ①The SI unit of mass is the:

A	newton
B	kilogram✓
C	pound
D	gram

68. ①Which of the following is NOT an SI unit?

A	newton
B	kilogram
C	pound✓
D	ampere

SI Prefixes & Base Units

69. ①The SI abbreviation for 36 centimeters is:

A	36 centim
B	36 cmeter
C	36 cm✓
D	36 centimeters

70. ①1 Mm (mega-meter) equals:

A	1000 m
B	1000 km✓
C	1000000 km
D	100000 m

71. ①1 μg (microgram) equals:

A	0.0000001 g
B	0.0001 g
C	0.000001 g✓

D	0.00001 g
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72. ②Of the following SI units, the only base unit is:

A	newton
B	watt
C	gram
D	ampere✓

73. ②Of the following SI units, the only derived (مشتق) unit is:

A	volt✓
B	kilogram
C	kelvin
D	meter

74. ②A time interval of 60.0 μs is equal to:

A	0.0600 s
B	0.00600 s
C	0.000600 s
D	0.0000600 s✓

75. ②An electric current of 3×10^{-9} A is equal to:

A	3 μA
B	3 MA
C	3 nA✓
D	3 mA

Unit Conversion

76. ②Converting 215 cm to meters gives:

A	0.0215 m
B	0.215 m
C	21.5 m
D	2.15 m✓

77. ①A distance of 0.05 km is equal to:

A	5000 cm✓
B	500 cm
C	50000 cm
D	500000 cm

78. ①A length of 286.6 mm is equal to:

A	28.66 cm✓
B	286.6 cm
C	2.866 m
D	0.00286 μm

79. ②Convert 84 in. to feet:

A	5 ft
B	6 ft

C	7 ft✓
D	8 ft

80. ①Convert 15 miles to the nearest kilometers:

A	18 km
B	24 km✓
C	33 km
D	42 km

81. ①Convert 258 cm² to m²:

A	0.0258 m ² ✓
B	0.258 m ²
C	2.58 m ²
D	25.8 m ²

82. ②Convert 0.65 cm³ to mm³:

A	6500 mm ³
B	6.5 mm ³
C	65 mm ³
D	650 mm ³ ✓

83. ②A distance of 10 ft is equal to:

A	305 m
B	305 cm✓
C	30.5 cm
D	30.5 m

84. ①Express 10 in. in centimeters:

A	0.254 cm
B	254 cm
C	25.4 cm✓
D	2.54 cm

85. ②Convert 2 h 15 min to seconds:

A	8100 s✓
B	2100 s
C	5900 s
D	3500 s ³

86. ②A school speed-zone (نطاق) is 30 km/h. Three cars A, B, and C are going at speeds $v_A = 8$ m/s, $v_B = 9$ m/s, and $v_C = 10$ m/s. The cars that will receive speeding tickets are:

A	A, B, and C
B	C only
C	B and C✓
D	none

87. ②The maximum capacity in liters of a 3-m³ water tank (خزان) is:

A	30 L
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B	3000 L✓
C	300 L
D	3 L

88. ②One light year is:

A	the speed of light in vacuum
B	the time that sunlight takes to reach the Moon
C	the distance light travels in 1 year✓
D	the time that sunlight takes to reach the Earth

89. ③If there are 3×10^7 seconds in one year, a distance of one light year is equal to:

A	9×10^{15} m✓
B	9×10^{13} m
C	9×10^{11} m
D	9×10^9 m

Order of Magnitude; Estimation

90. ②Rounding (تقريب) a number to one digit multiplied by its power-of-ten gives its:

A	precision
B	accuracy
C	uncertainty
D	order of magnitude✓

91. ②The 14 highest peaks in the world are between 8000 m and 9000 m high. The order-of-magnitude of their height (ارتفاع) is:

A	1×10^4 m✓
B	0.1×10^4 m
C	2×10^4 m
D	10×10^4 m

92. ②A lake (بحيرة) is roughly (تقريباً) circular, with a 1-km diameter and 10-m average depth (عمق). Its water capacity can be estimated as:

A	1×10^6 m ³
B	1×10^7 m ³ ✓
C	1×10^8 m ³
D	1×10^9 m ³

93. ①The thickness (سمائة) of a 200-page book is 1.0 cm. The thickness of one sheet of this book can be estimated as:

A	0.001 mm
B	0.01 mm
C	0.1 mm✓
D	1 mm

94. ②If an average human lives for 70 years, and if the

heartbeat rate is 80 beats/min, the number of heartbeats in a lifetime can be estimated as:

A	3×10^6
B	3×10^7
C	3×10^8
D	3×10^9 ✓

Dimensions

95. ① The dimensions of area are:

A	$L^2 T$
B	L^2 ✓
C	L^3/T^2
D	$L^2 T^{-1}$

96. ① The dimensions of volume are:

A	L^3 ✓
B	L^2
C	L^3/T^2
D	$L^2 T^{-1}$

97. ② The dimensions of force are:

A	$L M T$
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B	$L M T^{-2}$ ✓
C	$L^3 M^2/T^2$
D	$L^2 M T^{-1}$

98. ② The dimensions of acceleration are:

A	$L T$
B	$L T^{-2}$ ✓
C	L^3/T^2
D	$L^2 T^{-1}$

99. ② The dimensions of momentum ($p = mv$) are:

A	$L M T$
B	$L M T^{-2}$
C	$L M T^{-1}$ ✓
D	$L^2 M T^{-1}$

100. ② Which of the following is dimensionally correct?

A	speed = acceleration / time
B	distance = speed / time
C	force = mass × acceleration ✓
D	density = mass × volume

CHAPTER 2 : MOTION & ENERGY

Formulas & Constants

Average speed: $\bar{v} = \frac{d}{t} = \frac{v_f + v_i}{2}$	$a = \frac{v_f - v_i}{t}$	$v_f^2 - v_i^2 = 2 a \cdot d$	$v_f = v_i + g \cdot t$ $v = g \cdot t$ ($v_i = 0$)	$d = \frac{1}{2} a \cdot t^2 + v_i \cdot t$ $d = \frac{1}{2} g \cdot t^2$ ($v_i = 0$)	$\Sigma E = \text{constant}$ (energy consrv.)
$F = m \cdot a$	$w = m \cdot g$	$P = W / t$	$W = F \cdot d \cdot \cos \theta$	$PE = m \cdot g \cdot h$ $KE = \frac{1}{2} m \cdot v^2$	$V_f = \sqrt{2 g \cdot h}$
$F_{A \text{ on } B} = F_{B \text{ on } A}$	$R^2 = X^2 + Y^2$	$\tan \theta = Y / X$	1 m/s = 3.6 km/h	$g = 10 \text{ m/s}^2$	1 hp = $\frac{3}{4}$ kW

Key Terms & Definitions

Acceleration	تسارع	Horizontal	أفقي	Resultant	محصلة
Action	فعل	Inertia	القصور الذاتي	Reaction	ردة فعل
Air resistance	مقاومة الهواء	Instantaneous	لحظي	Resolution	تحليل
Average	متوسط	Interaction	تفاعل	Speed	السرعة القياسية
Component	عنصر / مُكوِّن / مُركَّب	Kinetic energy	الطاقة الحركية	Static	سكوني
Direction	اتجاه	Mass	كتلة	Support force	قوة الدعم
Displacement	إزاحة	Magnitude	مقدار	Tension	توتر
Distance	مسافة	Mechanical	ميكانيكي	Terminal speed	السرعة الحدية
Dynamic	حركي	Motion	حركة	Vector	كمية متجهة
Energy	طاقة	Net force	قوة إجمالية / صافية	Velocity	السرعة المتجهة
Equilibrium	اتزان	Normal force	القوة العمودية	Vertical	رأسي أو عمودي
Force	قوة	Potential energy	طاقة الوضع	Volume	حجم
Free fall	سقوط حر	Power	قدرة	Weight	وزن
Friction	احتكاك	Projectile	قذيفة أو مقذوف	Work	تغل
Gravity	جاذبية	Projection	إسقاط		

Vectors

1. **Scalar** is a **quantity** that does **not** need:

- A value
- B magnitude
- C direction** ✓
- D unit

2. **Vector** is a **quantity** that **needs**:

- A direction only
- B magnitude only
- C unit only
- D magnitude and direction** ✓

3. **Example** of a **scalar** is:

- A velocity
- B distance** ✓
- C acceleration
- D force

4. **Example** of a **vector** is:

- A velocity** ✓
- B distance
- C speed
- D time

5. For **linear motion**, the **angle** between the **velocity** and **acceleration** vectors is:

- A always 0°
- B always 180°
- C 0° or 180°** ✓
- D always 90°

6. Adding **two perpendicular** vectors (\vec{A}) and (\vec{B}) gives a resultant (\vec{R}) with **magnitude**:

$$A-R = \sqrt{A^2 + B^2} \sqrt{}$$

$$B-R = A^2 + B^2$$

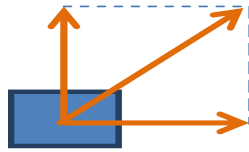
$$C-R = \sqrt{A + B}$$

$$D-R = 1 / \sqrt{A^2 + B^2}$$

محصلة أي متجهين
متعامدين تحسب
مقدارها من نظرية
فيثاغورس

7. Two perpendicular forces, $F_1 = 40 \text{ N}$ and $F_2 = 30 \text{ N}$, act on a brick. The magnitude of the net force (F_{net}) on the brick is:

- A 70 N
- B 50 N ✓
- C 0 N
- D 10 N

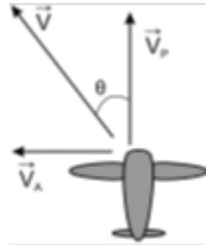


$$R = \sqrt{(F_1^2 + F_2^2)} = \sqrt{(40^2 + 30^2)}$$

$$= \sqrt{2500} = 50 \text{ N}$$

8. If an airplane heading north with speed $v_p = 400 \text{ km/h}$ faces a westbound wind (رياح نحو الغرب) of speed $v_A = 300 \text{ km/h}$, the resultant velocity of the plane (\vec{V}) is:

- A 500 km/h, north-west ✓
- B 700 km/h, north-east
- C 500 km/h, north-east
- D 700 km/h, north-west



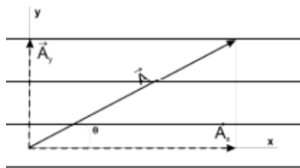
$$R = \sqrt{(v_p^2 + v_A^2)}$$

$$= \sqrt{(400^2 + 300^2)}$$

$$= \sqrt{250000} = 500 \text{ N}$$

9. Decomposing (or resolving) a vector (\vec{A}) into two components in perpendicular directions (A_x and A_y) gives :

- A $-A_x + A_y = A$
- B $A_x + A_y = A^2$
- C $A_x^2 + A_y^2 = A$
- D $A_x^2 + A_y^2 = A^2$ ✓



Linear Motion, Velocity, Acceleration

10. To calculate an object's average speed we need to know the:

- A acceleration and time
- B velocity and time
- C distance and time ✓
- D velocity and distance

11. A horse gallops (يجري) a distance of 10 kilometers in 30 minutes. Its average speed is:

- A 15 km/h
- B 20 km/h ✓
- C 30 km/h
- D 40 km/h

$$\bar{v} = \frac{d}{t} = \frac{10 \text{ km}}{\frac{1}{2} \text{ h}} = \frac{2 \times 10}{1} = 20 \text{ km/h}$$

12. A car maintains a constant velocity of 100 km/h for 10 seconds. During this interval its acceleration is:

- A 0 km/h² ✓
- B 1 km/h²
- C 10 km/h²
- D 100 km/h²

بما ان الجسم خلال حركته كانت سرعته ثابتة واتجاه ثابت (خط مستقيم) فذلك يعني ان التسارع يساوي الصفر .

13. While an object near Earth's surface is in free fall, its _____ increases:

- A velocity ✓
- B acceleration
- C mass
- D height

14. The speed at a specific moment is called _____ speed:

- A average
- B instantaneous ✓
- C initial
- D final

15. Acceleration is the rate of change in:

- A force
- B distance
- C speed
- D velocity ✓

16. If the speed is constant, the acceleration must be:

- A constant
- B zero
- C negative
- D unknown ✓

لان التسارع كمية متجهة فلكي يكون صفر فلا بد ان تكون السرعة والاتجاه ثابت (أي خط مستقيم)

17. A car moves along a **straight road** with **constant acceleration**. If its initial and final speeds are $v_i = 10$ m/s, $v_f = 20$ m/s, its **average speed** is:

- A 12 m/s
- B 15 m/s** ✓
- C 10 m/s
- D 20 m/s

$$\bar{v} = \frac{v_i + v_f}{2} = \frac{10 + 20}{2} = \frac{30}{2} = 15 \text{ m/s}$$

18. If an object in **linear motion** moves a **distance** of **20m** in **5 seconds**, its **average speed** is:

- A 4 m/s** ✓
- B 5 m/s
- C 10 m/s
- D 20 m/s

$$\bar{v} = \frac{d}{t} = \frac{20}{5} = 4 \text{ m/s}$$

19. If an object is in **linear motion**, and its **speed** changes from **10 m/s** to **20 m/s** in **10 seconds**, its **acceleration** is:

- A 20 m/s²
- B 10 m/s²
- C 5 m/s²
- D 1 m/s²** ✓

$$a = \frac{\Delta v}{t} = \frac{v_f - v_i}{t} = \frac{20 - 10}{10} = \frac{10}{10} = 1 \text{ m/s}^2$$

20. If your **average speed** is **80 km/h** on a **4-hour** trip, the **total distance** you cover is:

- A 40 km
- B 80 km
- C 120 km
- D 320 km** ✓

$$d = \bar{v} \times t = 80 \times 4 = 320 \text{ km}$$

21. If you travel **300 km** in **4 hours**, your **average speed** is:

- A 50 km/h
- B 75 km/h** ✓
- C 80 km/h
- D 100 km/h

$$\bar{v} = \frac{d}{t} = \frac{300}{4} = 75 \text{ km/h}$$

Free Fall

22. If **air resistance** on a **falling rock** can be **neglected**, we say that **this rock** is in:

- A outer space
- B terminal speed
- C free fall** ✓
- D slow motion

بما أن مقاومة الهواء مهملة فإن أي جسم ساقط يعتبر في حالة سقوط حر

23. If a **stone** drops in a **free fall** from the edge of a high cliff, its **speed** after **5 seconds** is:

- A 10 m/s
- B 40 m/s
- C 50 m/s** ✓
- D 100 m/s

سرعة الجسم الساقط سقوط حر في أي لحظة من سقوطه من بدء السقوط

$$v = gt = 10 \times 5 = 50 \text{ m/s}$$

24. If a **stone** drops in a **free fall** from the edge of a high cliff, the **distance** it covers after **4 seconds** is:

- A 40 m
- B 80 m** ✓
- C 120 m
- D 160 m

المسافة التي يقطعها جسم يسقط سقوط حر في أي لحظة من بدء السقوط

$$d = \frac{1}{2}gt^2 = \frac{1}{2} \times 10 \times t^2 = 5 \times t^2 = 5 \times 4^2 = 5 \times 16 = 80 \text{ m}$$

25. If an object in **free fall** has an **initial speed** of **10 m/s**, its **speed** after **10 seconds** is:

- A 80 m/s
- B 90 m/s
- C 100 m/s
- D 110 m/s** ✓

سرعة الجسم الساقط سقوط حر بعد مرور 10 ثواني من اكتسابه سرعة ابتدائية

$$v_f = v_i + gt = 10 + (10 \times 10) = 10 + 100 = 110 \text{ m/s}$$

26. **Neglecting air resistance**, if a player **throws a ball** straight up with a **speed** of **30 m/s**, the **ball** will reach its **maximum height** after:

- A 6 seconds
- B 5 seconds
- C 4 seconds
- D 3 seconds** ✓

حركة الاجسام المقذوفة الى اعلى ويخط مستقيم عند اهمال مقاومة الهواء تتبع قوانين السقوط الحر ولكن تختلف عنها في ان السرعة ستقل كل ثانية عن التي تليها بمعدل 10 م/ث

$$v = gt \rightarrow t = \frac{v}{g} = \frac{30}{10} = 3 \text{ s}$$

27. If an object is in **free fall**, the **distance** it travels **every seconds** is:

- A the same as the previous (السابق) second
- B more than the previous second** ✓
- C less than the previous second
- D undefined

المسافة التي يقطعها جسم ساقط سقوط حر تزداد كل ثانية عن الثانية التي تسبقها

28. If an **object** is in **free fall**, its **speed every seconds** is:

A the same as the previous (السابق) second

B more than the previous second ✓

C less than the previous second

D undefined

سرعة الجسم الساقط سقوط حر تزداد كل ثانية عن الثانية التي تسبقها بمعدل ١٠ م / ث

33. If **two equal forces** act on a **moving cart** in **opposite directions**, we can say about it that:

A it has acceleration

B it is in static equilibrium

C it is in dynamic equilibrium ✓

D nonzero net force acts on it

إذا اثرت قوتان متساوية في المقدار ومتعاكسة في الاتجاه على جسم متحرك فإنها ستلغي بعضها البعض أي ان مجموعها يساوي الصفر ويكون الجسم في حالة انزان ديناميكي

Newton's 1st Law of Motion; Inertia; Equilibrium

29. If **no external forces** act on a **moving** object, it will:

A continue moving at the same speed

B continue moving at the same velocity ✓

C move slower and slower until it finally stops

D make a sudden stop

30. If an object is in **mechanical equilibrium**, we can say that:

A a nonzero net force acts on it

B it has constant velocity ✓

C it has small acceleration

D it has large acceleration

عندما يكون الجسم في حالة اتزان ميكانيكي فانه سوف يتحرك بسرعة ثابتة وبخط مستقيم وذلك لان مجموع القوى المؤثرة عليه تساوي الصفر

34. If **two equal forces** act on a **stationary** (ساكن) book in **opposite directions**, we can say about it that:

A it has acceleration

B it is in static equilibrium ✓

C it is in dynamic equilibrium

D a nonzero net force acts on it

إذا اثرت قوتان متساوية في المقدار ومتعاكسة في الاتجاه على جسم ساكن فإنها ستلغي بعضها البعض أي ان مجموعها يساوي الصفر ويكون الجسم في حالة انزان ديناميكي

35. If you stand at rest on a **pair of identical bathroom scales**, the readings on the two scales will always be:

A each equal to your weight

B each equal to half your weight ✓

C each equal to double your weight

D different from each other

عند الوقوف على زوج من المقاييس في حالة سكون فان الوزن سينقسم بالتساوي حيث تكون قراءة كل مقياس نصف الوزن

31. **Inertia** means that:

A an object at rest tries to remain at rest, and a moving object tries to stop

B an object at rest tries to move, and a moving object tries to stop

C an object at rest tries to move, and a moving object tries to keep moving

D an object at rest tries to remain at rest, and a moving object tries to keep moving ✓

حيث ان قانون نيوتن الاول يسمى بقانون القصور الذاتي

32. The **SI unit of inertia** is the:

A kilogram

B newton

C joule

D none of these ✓

لان القصور الذاتي ليس كمية فيزيائية قابلة للقياس

36. A man weighing **800 N** stands at **rest** on **two bathroom scales** so that his weight is **distributed evenly between them**. The reading on each scale is:

A 400 N ✓

B 200 N

C 1600 N

D 800 N

بما ان وزن الرجل 800 N فكل ميزان ستكون قراءته نصف الوزن أي 400 N

37. A **80-kg painter** stands on a **20-kg painting staging** (سقالة دهان) that **hangs on two ropes**. If the staging is **at rest** and both ropes have the **same tension**, the **tension in each rope** is:

- A 200 N
B 500 N✓
 C 800 N
 D 1000 N

بما ان النظام في حالة سكون أي في حالة اتزان أي لا بد ان تكون محصلة القوى تساوي الصفر

$$\Sigma F = 0$$

$$\Sigma T + \Sigma W = 0$$

$$\Sigma T = \Sigma W \rightarrow \Sigma T = w_p + w_s = (80 \times 10) + (20 \times 10) = 1000 \text{ N} \rightarrow$$

$$T_1 = T_2 = \frac{\Sigma T}{2} = \frac{1000}{2} = 500 \text{ N}$$

Force; Support Force; Friction

38. The **support force** is on an object **results** from the _____ of atoms in the surface:

- A compression**✓
 B speed
 C acceleration
 D energy

39. The **support force** on a **2-kg book** lying on a level table is:

- A 1 N
 B 2 N
 C 10 N
D 20 N✓

$$F_N = W = 2 \times 10 = 20 \text{ N}$$

40. In the following, check the correct statement:

- A force is a vector, mass is a scalar**✓
 B force is a vector, weight is a scalar
 C mass is a vector, weight is a scalar
 D force is a vector, mass is a vector

41. **Two forces** act on an object: $\vec{F}_1 = (6 \text{ N, east})$; $\vec{F}_2 = (8 \text{ N, west})$. The net force ($\Sigma \vec{F}$) on it is:

- A (14 N, east)
 B (14 N, west)
C (2 N, west)✓
 D (-2 N, west)

مقدار محصلة القوى يكون حاصل طرح مقادير القوتين وذلك اذا كانت متعاكسة في الاتجاه . اما اتجاه المحصلة فيكون في اتجاه القوة الاكبر وذلك اذا كانت مختلفة ايضا في المقدار ومتعاكسة في الاتجاه

42. **Two forces** act on an object: $\vec{F}_1 = (10 \text{ N, up})$; $\vec{F}_2 = (10 \text{ N, down})$. The net force ($\Sigma \vec{F}$) on it is:

- A (20 N, up)
 B (20 N, down)
 C (10 N, up)
D zero✓

محصلة قوتين متساوية في المقدار ومتعاكسة في الاتجاه تساوي الصفر

43. **Two forces** act on a crate and the crate is in **equilibrium**. These two forces are:

- A (100 N, right), (100 N, left)**✓
 B (100 N, right), (50 N, left)
 C (50 N, right), (100 N, left)
 D (100 N, right), (100 N, right)

بما ان الجسم في حالة اتزان أي ان محصلة القوى تساوي الصفر فلا بد ان تكون القوتين متساوية في المقدار ومتعاكسة في الاتجاه

44. If the **force of friction** on a **moving object** is **10N**, the **force** needed to keep it at **constant velocity** is:

- A 0 N
 B 5 N
C 10 N✓
 D more than 10 N

لكي يكمل الجسم المتحرك حركته بسرعة متجهة ثابتة فلا بد ان تكون قوة الحركة المعاكسة للاحتكاك مساوية لها في المقدار وذلك حتى تكون محصلة القوة تساوي الصفر

45. When an object **falling** through **air stops gaining speed**, we say that it has reached its _____ speed:

- A average
 B instantaneous
 C final
D terminal✓

عندما يسقط الجسم في الهواء فلا يعتبر سقوطه سقوط حر واثناء سقوطه تزداد سرعته حتى تصل الى حد معين تسمى بالسرعة الحدية وذلك عندما يتساوى وزن الجسم الساقط مع قوة مقاومة الهواء

46. **Air drag** depends on a falling object's:

- A size and speed**✓
 B size and density
 C density and speed
 D none of these

العوامل المؤثرة على مقاومة الهواء هي سرعة الجسم الساقط والمساحة السطحية المواجهة للهواء اثناء السقوط

Mass; Weight

47. **Mass** is a **measure** of an object's:

- A inertia✓
- B volume
- C density
- D speed

48. **Mass** is an object's **quantity** of:

- A energy
- B matter✓
- C dimensions
- D momentum

49. The **SI unit** for **weight** is the:

- A newton✓
- B kilogram
- C gram
- D pound

50. **Two identical barrels** (برميل), one filled with **oil** and one with **cotton**, should have:

- A same mass and different inertia
- B same inertia and different weight
- C same volume and different mass✓
- D same weight and different density

51. If the **Earth's gravitational pull** is **6 times** that of the **Moon**, an object taken to the Moon will have:

- A same mass and less weight✓
- B same weight and less mass
- C same mass and same weight
- D less mass and less weight

إذا كانت قوة سحب الجاذبية الأرضية تزيد ٦ مرات عن قوة سحب الجاذبية للقمر فإن الجسم إذا انتقل من الأرض إلى القمر سيكون له نفس الكتلة ولكن وزنه سيقبل

Newton's 2nd Law

52. An **object's acceleration** is **directly proportional** to the:

- A net force✓
- B average speed
- C mass
- D inertia

وذلك من قانون نيوتن الثاني

$$a = \frac{F_{net}}{m}$$

53. If an **object's mass decreases** while a **constant force** is applied to it, its **acceleration**:

- A decreases
- B increases✓
- C remains constant
- D changes according to volume

لان العلاقة عكسية بين الكتلة والتسارع عند ثبوت القوة

54. If the **net force** acting on an object **decreases**, its **acceleration**:

- A decreases✓
- B increases
- C remains constant
- D changes direction

لان العلاقة طرية بين القوة المحصلة والتسارع عند ثبوت الكتلة

55. The **net force** on an **50-kg** crate is **100 N**, its **acceleration** is:

- A 0.5 m/s²
- B 1 m/s²
- C 2 m/s²✓
- D 5 m/s²

$$a = \frac{F_{net}}{m} = \frac{100}{50} = 2 \text{ m/s}^2$$

56. A **1-kg** falling ball encounters **10 N** of **air resistance**. The **net force** on the ball is:

- A 0 N✓
- B 4 N
- C 6 N
- D 10 N

$$F_{net} = w - R = mg - R = (1 \times 10) - 10 = 10 - 10 = 0 \text{ N}$$

Newton's 3rd Law

57. The **number of forces** involved (الداخلة) in an **interaction** between **two objects** is:

- A 0
- B 1
- C 2✓
- D 3

58. A **force** is defined (تعريفها) as:

- A part of an interaction between two objects✓
- B a push from an object on itself
- C a pull from an object on itself
- D a push and a pull on the same object

59. **Newton's 3rd law** states that, for **two objects X and Y**, whenever **X exerts a force on Y**, then:

- A Y exerts double that force on X
- B Y moves in the opposite direction
- C Y exerts half that force on X

D Y exerts an equal but opposite force on X✓

60. In an **interaction** between **two objects**, the **action and reaction forces**:

- A are perpendicular
- B do not cancel each other**✓
- C add up to zero
- D are on the same object

61. When a **man pushes on a wall with force F**, the **wall pushes back on him with force of magnitude**:

- A zero
- B F/2
- C F**✓
- D 2 F

حسب قانون نيوتن الثالث فان قوتا الفعل ورد الفعل تكون متساوية في المقدار ومتعاكسة في

62. When a **cannon shoots a cannonball with acceleration a_b** , the **cannon recoils (يرتد) with acceleration a_c** such that:

- A $a_c = a_b$
- B a_c is much larger than a_b
- C a_c is much smaller than a_b** ✓
- D $a_c = 0$

عند اطلاق المدفع فان ارتداد الدفع للخلف اقل من تسارع كرة المدفع الى الامام وذلك بسبب اختلاف كتلة كل منهما

63. When a **cannon shoots a cannonball with force F_b** , the **cannon recoils (يرتد) with force F_c** such that:

- A $F_c = F_b$** ✓
- B F_c is much larger than F_b
- C F_c is much smaller than F_b
- D $F_c = 0$

في تفاعل القوى بين المدفع وكرة المدفع فان القوتين متساوية في المقدار وذلك حسب قانون نيوتن الثالث

64. When a **cannon shoots a cannonball**, the **cannon's recoil (يرتد) is much slower than the cannonball** because:

- A the force on the cannon is much less
- B the mass of the cannon is much greater**✓
- C the cannon's mass is more distributed (موزع)
- D there is more air resistance

62. When a **man stretches a spring with a 100-N force** (within its elasticity range), the **spring pulls him back with**:

- A 0 N
- B 50 N
- C 100 N**✓
- D 200 N

Work; Energy

66. **Work is produced only if there is:**

- A force and motion**✓
- B force and elevation (ارتفاع)
- C force and time
- D time and elevation

ينتج الشغل اذا وجد فقط قوة في اتجاه الحركة وحركة للجسم

67. **Work is proportional to:**

- A (force) and (1/distance)
- B (force) and (distance)**✓
- C (1/force) and (distance)
- D (force) and (distance)²

الشغل يتناسب طرديا مع كل من القوة والمسافة

68. The **SI unit of work** is:

- A Newton
- B watt
- C joule**✓
- D ampere

$$work = F \times S = N \cdot m = joule$$

69. **A joule is equivalent to:**

- A N/m²
- B m/N
- C N/m
- D N.m**✓

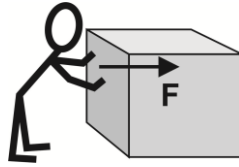
70. A **cart moves 10 m in the same direction** as a **20-N force** acting on it. The **work** done by this force is:

- A 200 J**✓
- B 2 J
- C 0.5 J
- D 20 J

$$work = F \times S = 20 \times 10 = 200 J$$

71. A man does **2000-J work** in pushing a crate a **distance of 10 m** on a **frictionless floor**. The **force** applied by the man is:

- A 20 N
- B 200 N**✓
- C 2000 N
- D 20000 N



$$work = F \times S \rightarrow F = \frac{work}{s} = \frac{2000}{10} = 200 N$$

Power

72. An engine (محرك) can do **100,000-J work** in **10 s**. The **power** of this engine is:

- A 1 MW
- B 100 kW
- C 1000 W
- D 10 kW**✓

$$power = \frac{work}{time} = \frac{100000}{10} = 10000 \text{ Watt} = 10 \text{ Kw}$$

73. An engine (محرك) can do **75-kJ work** in **10 s**. The **power** of this engine in **horsepower** is:

- A 10 hp**✓
- B 1 hp
- C 0.1 hp
- D 100 hp

$$power = \frac{work}{time} = \frac{75 \text{ kJ}}{10} = \frac{75 \times 10^3}{10} = 7500 \text{ watt} = \frac{7500}{750} = 10 \text{ hp}$$

74. The **SI unit** of power is:

- A Newton
- B watt**✓
- C joule
- D ampere

$$power = \frac{work}{time} = \frac{J}{s} = \text{watt}$$

75. A **watt** is equivalent to:

- A $\text{kg} \cdot \text{m}^3/\text{s}^2$
- B $\text{kg}^2 \cdot \text{m}^2/\text{s}^3$
- C $\text{kg} \cdot \text{m}^2/\text{s}^3$** ✓
- D $\text{kg}^2 \cdot \text{m}^2/\text{s}$

$$power = \frac{work}{time} = \frac{F \times S}{t} = \frac{\text{m} \cdot \text{g} \cdot \text{s}}{\text{t}} = \frac{\text{kg} \cdot \frac{\text{m}}{\text{s}^2} \cdot \text{m}}{\text{s}} = \text{kg} \cdot \frac{\text{m}^2}{\text{s}^3}$$

76. Of the following quantities, **the ones that have the same unit are:**

- A work and energy**✓
- B work and power
- C energy and power
- D work and pressure

Mechanical Energy

77. **Mechanical energy** results from an object's:

- A position only
- B position and/or motion**✓
- C motion only
- D neither position nor motion

78. **Mechanical energy** consists of:

- A kinetic energy and power
- B potential energy and power
- C potential and kinetic energy**✓
- D power and work

Potential Energy

79. Of the following, **the form of energy that is NOT potential** is the energy of:

- A a moving car**✓
- B a stretched bow (مشدود قوس)
- C a compressed spring (مضغوط زنبرك)
- D water in a high reservoir (خزان)

80. **Potential energy** is the energy stored in an object because of its:

- A speed
- B position**✓
- C charge
- D mass

81. A **20-kg** box rests on a **2-m** high shelf. Its **potential energy** relative to the ground is:

- A 100 J
- B 200 J
- C 400 J**✓
- D 800 J

$$PE = m \cdot g \cdot h = 20 \times 10 \times 2 = 400 J$$

82. The **mass** of a box of **200-J** potential energy when resting on a **2-m**-high shelf is:

- A 10 kg✓
- B 20 kg
- C 40 kg
- D 80 kg

$$PE = m \cdot g \cdot h$$

$$m = \frac{PE}{g \cdot h} = \frac{200}{10 \times 2} = \frac{200}{20} = 10 \text{ kg}$$

87. The mass of a bicycle of **4000-J** kinetic energy traveling at **10 m/s** is:

- A 40 kg
- B 50 kg
- C 60 kg
- D 80 kg✓

$$KE = \frac{1}{2} m v^2 \rightarrow m = \frac{2 KE}{v^2} =$$

$$\frac{2 \times 4000}{10^2} = \frac{8000}{100} = 80 \text{ kg}$$

83. If a **5-kg** box sitting on a shelf of height (h) has **100-J** potential energy relative to the ground, h equals:

- A 1 m
- B 2 m✓
- C 4 m
- D 8 m

$$PE = m \cdot g \cdot h \rightarrow h = \frac{PE}{m \cdot g} = \frac{100}{5 \times 10}$$

$$= \frac{100}{50} = 2 \text{ m}$$

88. The **speed** of a **40-kg** bicycle of **1620-J** kinetic energy is:

- A 9 m/s✓
- B 3 m/s
- C 27 m/s
- D 90 m/s

$$KE = \frac{1}{2} m v^2 \rightarrow v = \sqrt{\frac{2 KE}{m}}$$

$$v = \sqrt{\frac{2 \times 1620}{40}} = \sqrt{\frac{3240}{40}}$$

$$v = \sqrt{81} = 9 \text{ m/s}$$

84. **Three 5-kg rocks** are raised to a **height of 5 m**, with Rock1 raised with a rope, Rock2 raised on a ramp (منحدر), and Rock3 raised with an lift (مصعد). The rock that attains the most potential energy is:

- A Rock1
- B Rock2
- C Rock3
- D all the same✓

بما ان لها نفس الكتلة ونفس الارتفاع
فإنها ستمتلك نفس طاقة الوضع

Kinetic Energy

85. **Kinetic energy** is the energy stored in an object because of its:

- A motion✓
- B position
- C charge
- D mass

86. The kinetic energy of a **1000-kg** car traveling at a speed of **20 m/s** is:

- A 50 kJ
- B 100 kJ
- C 200 kJ✓
- D 400 kJ

$$KE = \frac{1}{2} m v^2 = \frac{1}{2} \times 1000 \times 20^2$$

$$= 200000 \text{ J}$$

$$= 200 \text{ kJ}$$

89. If an object's **speed doubles**, its **kinetic energy**:

- A remains the same
- B doubles
- C triples
- D quadruples✓

$$KE_1 = \frac{1}{2} m v_1^2$$

if $v_2 = 2v_1$

$$KE_2 = \frac{1}{2} m v_2^2 = \frac{1}{2} m (2 v_1)^2$$

$$= \frac{1}{2} m \times 4 v_1^2$$

$$= 4 \times \frac{1}{2} m v_1^2$$

$$KE_2 = 4KE_1$$

90. If an object's **mass doubles** while moving at a **constant speed**, its **kinetic energy**:

- A remains the same
- B doubles✓
- C triples
- D quadruples

$$KE_1 = \frac{1}{2} m_1 v^2$$

if $m_2 = 2m_1$

$$KE_2 = \frac{1}{2} m_2 v^2 = \frac{1}{2} \times 2m_1 v^2$$

$$= 2 \times \frac{1}{2} m_1 v^2$$

$$KE_2 = 2KE_1$$

91. The kinetic energy of a car traveling at 20 m/s is 500 kJ. If it travels at 40 m/s, its kinetic energy becomes:

- A 500 kJ
- B 1000 kJ
- C 2000 kJ ✓
- D 4000 kJ

$$\text{if } v_2 = 2v_1 \rightarrow KE_2 = 4KE_1$$

$$40 = 2 \times 20 \rightarrow KE_2 = 4 \times 500 \text{ kJ}$$

$$KE_2 = 2000 \text{ kJ}$$

92. The work done by the engine of a 1000-kg car to move it from rest to a speed of 20 m/s is:

- A 50 kJ
- B 100 kJ
- C 200 kJ ✓
- D 400 kJ

$$\text{work} = KE = \frac{1}{2} m v^2$$

$$\text{work} = \frac{1}{2} \times 1000 \times (20)^2$$

$$\text{work} = 200000 \text{ J} = 200 \text{ kJ}$$

93. The force exerted by the engine of a 1000-kg car to move it from rest to a speed of 20 m/s within 100 m is:

- A 1000 N
- B 2000 N ✓
- C 4000 N
- D 5000 N

$$\text{work} = KE \rightarrow F \times S = \frac{1}{2} m v^2$$

$$F = \frac{KE}{S} = \frac{\frac{1}{2} m v^2}{S} = \frac{\frac{1}{2} \times 1000 \times 20^2}{100}$$

$$= \frac{200000}{100} = 2000 \text{ N}$$

Conservation of Energy

94. The total energy of an object of mass (m), falling at height (h) with speed (v) can be written as:

- A $E = \frac{1}{2} m v^2 + 2 mgh$
- B $E = \frac{1}{2} m v^2 + mgh$ ✓
- C $E = m v^2 + \frac{1}{2} mgh$
- D $E = \frac{1}{2} m v^2 + \frac{1}{2} mgh$

الطاقة الكلية لجسم على له كتلة m ويسقط من ارتفاع h تساوي مجموع طاقة الوضع والطاقة الحركية له

95. As an object falls, its potential energy _____ and its kinetic energy _____.

- A increases, decreases
- B decreases, decreases
- C decreases, increases ✓
- D increases, increases

عندما يسقط جسم ما فإنه طاقة الوضع له تتناقص بينما تزداد طاقته الحركية

96. The ram of pile-driver (مدك) falls from a height of 20 m. Its speed just before touching ground is:

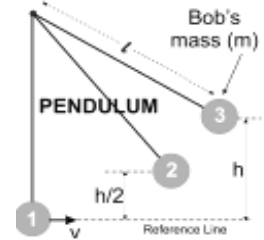
- A 2 m/s
- B 5 m/s
- C 10 m/s
- D 20 m/s ✓

$$v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} =$$

$$v = \sqrt{400} = 20 \text{ m/s}$$

97. A simple pendulum's bob has speed (v) at its lowest point (1); its highest point (3) has height (h). If h = 20 cm, v equals:

- A 2 m/s ✓
- B 5 m/s
- C 10 m/s
- D 20 m/s



$$PE_3 = KE_1 \rightarrow v = \sqrt{2gh}$$

$$= \sqrt{2 \times 10 \times 0.20} = \sqrt{4}$$

$$= 2 \text{ m/s}$$

98. When a simple pendulum's bob of mass m = 0.5 kg is at its highest point (3), its height is h = 40 cm. Its kinetic energy at its lowest point (1) is:

- A 0 J
- B 2 J ✓
- C 5 J
- D 10 J

$$KE_1 = PE_3 = mgh = 0.5 \times 10 \times 0.4 = 2 \text{ J}$$

99. When a simple pendulum's bob of mass m = 0.5 kg is at its highest point (3), its height is h = 40 cm. Its kinetic energy at point (2) of height 1/2 h is:

- A 5 J
- B 2 J
- C 1 J ✓
- D 0 J

$$KE_2 = PE_2 = mg \frac{h}{2} = 0.5 \times 10 \times \frac{0.4}{2} = 1 \text{ J}$$

100. When a simple pendulum's bob of mass $m = 0.5 \text{ kg}$ is at its highest point (3), its height is $h = 40\text{cm}$. Its total energy at point (2) of height $\frac{1}{2} h$ is:

A 5 J

B 2 J ✓

C 1 J

D 0 J

$$E_{\text{TOTAL}} = PE_2 + KE_2 = 1\text{J} + 1\text{J} = 2\text{J}$$

CHAPTER 3: HEAT & MATTER

Formulas & Constants

mass density = $\frac{m}{V}$	weight density = $\frac{mg}{V}$	stress (S) = $\frac{F}{A}$	$T_C = \frac{5}{9} (T_F - 32^\circ)$	$T_F = \frac{9}{5} (T_C) + 32^\circ$
$T_K = T_C + 273$	1 cal = 4.19 J	$Q = c.m.\Delta T$	melting: $Q = m.L_f$ vaporization: $Q = m.L_v$	$F = k.\Delta l$ (Hooke's Law)

Key Terms & Definitions

Absolute zero	الصفر المطلق	Evaporation	تبخير	Neutral	متعادل
Absorption	امتصاص	Expansion	تمدد	Nucleus	نواة
Atom	ذرة	Fluid	مائع	Particle	جسيم
Boiling	غليان	Freezing	تجمد	Phase	طور
Bonding	ترابط	Fusion	انصهار	Pressure	ضغط
Charge	شحنة	Gas	غاز	Saturated	مشبع
Compound	مركب	Heat	حرارة	Solid	صلب
Compression	ضغط	Heat transfer	انتقال الحرارة	Solidification	تصلب
Condensation	تكثف	Humidity	رطوبة	Specific Heat	الحرارة النوعية
Deform	يشوه	Inelastic	غير مرن	Strain	انفعال
Density	كثافة	Liquid	سائل	State	حالة
Dew	ندى	Latent Heat	الحرارة الكامنة	Stress	إجهاد
Diffusion	انتشار	Matter	مادة	Substance	صنف
Elastic limit	حد المرونة	Melting	ذوبان	Temperature	درجة الحرارة
Elastic range	حيز المرونة	Metal	معدن؛ فلز	Tension	توتر
Elasticity	مرونة	Mixture	خليط أو مزيج	Vaporization	تبخير
Element	عنصر	Molecule	جزيء	Volume	حجم

Temperature

1. Converting **77 degrees F** to **Celsius** gives:

A 25 degrees C ✓

B 55 degrees C

C 75 degrees C

D 95 degrees C

$$T_C = \frac{5}{9} (T_F - 32^\circ)$$

$$T_C = \frac{5}{9} (77 - 32^\circ) = 25^\circ C$$

3. Converting **257 degrees F** to **Celsius** gives:

A 55 degrees C

B 220 degrees C

C 125 degrees C ✓

D 335 degrees C

$$T_C = \frac{5}{9} (T_F - 32^\circ)$$

$$T_C = \frac{5}{9} (257 - 32^\circ) = 125^\circ C$$

2. Converting **113 degrees F** to **Celsius** gives:

A 35 degrees C

B 45 degrees C ✓

C 110 degrees C

D 165 degrees C

$$T_C = \frac{5}{9} (T_F - 32^\circ)$$

$$T_C = \frac{5}{9} (113 - 32^\circ) = 45^\circ C$$

4. Converting **10 degrees F** to **Celsius** gives:

A 25 degrees C

B 5 degrees C

C 0 degrees C

D -12 degrees C ✓

$$T_C = \frac{5}{9} (T_F - 32^\circ)$$

$$T_C = \frac{5}{9} (10 - 32^\circ) = -12^\circ C$$

5. Converting **20 degrees F** to Celsius gives:

- A -7 degrees C ✓
- B 30 degrees C
- C 42 degrees C
- D -12 degrees C

$$T_C = \frac{5}{9}(T_F - 32^{\circ})$$
$$T_C = \frac{5}{9}(20 - 32^{\circ}) = -7^{\circ}\text{C}$$

10. Converting **145 degrees C** to Fahrenheit gives:

- A 177 degrees F
- B 293 degrees F ✓
- C 112 degrees F
- D 217 degrees F

$$T_F = \frac{9}{5}(T_C) + 32^{\circ}$$
$$T_F = \frac{9}{5}(145) + 32^{\circ} = 293^{\circ}\text{F}$$

6. Converting **-50 degrees F** to Celsius gives:

- A -46 degrees C ✓
- B -32 degrees C
- C -23 degrees C
- D -18 degrees C

$$T_C = \frac{5}{9}(T_F - 32^{\circ})$$
$$T_C = \frac{5}{9}(-50 - 32^{\circ}) = -45.5^{\circ}\text{C} =$$
$$T_C = -46^{\circ}\text{C}$$

11. Converting **35 degrees C** to Fahrenheit gives:

- A 59 degrees F
- B 77 degrees F
- C 95 degrees F ✓
- D 3 degrees F

$$T_F = \frac{9}{5}(T_C) + 32^{\circ}$$
$$T_F = \frac{9}{5}(35) + 32^{\circ} = 95^{\circ}\text{F}$$

7. Converting **-40 degrees F** to Celsius gives:

- A -20 degrees C
- B -30 degrees C
- C -40 degrees C ✓
- D -50 degrees C

$$T_C = \frac{5}{9}(T_F - 32^{\circ})$$
$$T_C = \frac{5}{9}(-40 - 32^{\circ}) = -40^{\circ}\text{C}$$

12. Converting **95 degrees C** to Fahrenheit gives:

- A 63 degrees F
- B 127 degrees F
- C 275 degrees F
- D 203 degrees F ✓

$$T_F = \frac{9}{5}(T_C) + 32^{\circ}$$
$$T_F = \frac{9}{5}(95) + 32^{\circ} = 203^{\circ}\text{F}$$

8. The **Fahrenheit** and **Celsius** temperature scales **have the same reading** at:

- A 32 degrees
- B 0 degrees
- C -32 degrees
- D -40 degrees ✓

$$T_C = T_F \rightarrow T_C = \frac{5}{9}(T_F - 32^{\circ})$$
$$T = \frac{5}{9}(T - 32^{\circ}) \rightarrow T = \frac{5}{9}T - \frac{5}{9} \times -32$$
$$T - \frac{5}{9}T = \frac{5}{9} \times -32 \rightarrow \frac{9-5}{9}T = \frac{5}{9} \times -32$$
$$\frac{4}{9}T = \frac{5}{9} \times -32 \rightarrow T = \frac{5}{9} \times -32 \times \frac{9}{4}$$
$$T = -40^{\circ}\text{C}$$

13. Converting **75 degrees C** to Kelvin gives:

- A 348 K ✓
- B 198 K
- C 32 K
- D 212 K

$$T_K = T_C + 273$$
$$T_K = 75 + 273 = 348 \text{ K}$$

14. Converting **25 degrees C** to Kelvin gives:

- A 248 K
- B 298 K ✓
- C 47 K
- D 237 K

$$T_K = T_C + 273$$
$$T_K = 25 + 273 = 298 \text{ K}$$

9. Converting **15 degrees C** to Fahrenheit gives:

- A 59 degrees F ✓
- B 47 degrees F
- C 21 degrees F
- D -12 degrees F

$$T_F = \frac{9}{5}(T_C) + 32^{\circ}$$
$$T_F = \frac{9}{5}(15) + 32^{\circ}$$
$$T_F = 59^{\circ}\text{F}$$

15. Converting **-50 degrees C** to Kelvin gives:

- A -40 K
- B 323 K
- C 223 K ✓
- D -273 K

$$T_K = T_C + 273$$
$$T_K = -50 + 273 = 223 \text{ K}$$

16. Converting **406 degrees K** to **Celsius** gives:

- A 337 degrees C
- B 276 degrees C
- C 579 degrees C
- D 133 degrees C✓

$$T_K = T_C + 273 \rightarrow T_C = T_K - 273$$

$$T_C = 406 - 273 = 133^{\circ}\text{C}$$

17. Converting **175 degrees K** to **Celsius** gives:

- A -98 degrees C✓
- B 112 degrees C
- C -213 degrees C
- D 45 degrees C

$$T_K = T_C + 273 \rightarrow T_C = T_K - 273$$

$$T_C = 175 - 273 = -98^{\circ}\text{C}$$

18. Converting **6000 degrees K** to **Celsius** gives:

- A 6273 degrees C
- B 5727 degrees C✓
- C 5911 degrees C
- D 6196 degrees C

$$T_K = T_C + 273 \rightarrow T_C = T_K - 273$$

$$T_C = 6000 - 273 = 5727^{\circ}\text{C}$$

19. The melting point of pure iron is **1505 degrees C**. What **Fahrenheit temperature** is this?

- A 1689 degrees F
- B 3563 degrees F
- C 2741 degrees F✓
- D 4112 degrees F

$$T_F = \frac{9}{5}(T_C) + 32^{\circ}$$

$$T_F = \frac{9}{5}(1505) + 32^{\circ}$$

$$T_F = 2741^{\circ}\text{F}$$

20. The melting point of mercury is **-38.0 degrees F**. What **Celsius temperature** is this?

- A -36 degrees C
- B -37 degrees C
- C -38 degrees C
- D -39 degrees C✓

$$T_C = \frac{5}{9}(T_F - 32^{\circ})$$

$$T_C = \frac{5}{9}(-38.0 - 32^{\circ})$$

$$T_C = -38.8^{\circ}\text{C} = -39^{\circ}\text{C}$$

21. Find the **amount of heat in cal** generated by **95 J** of work.

- A 23 cal✓
- B 25 cal
- C 27 cal
- D 24 cal

$$Q = \frac{95\text{ J}}{4.19} = 22.6 = 23\text{ cal}$$

22. Find the **amount of heat in kcal** generated by **7150 J** of work.

- A 1.43 kcal
- B 1.79 kcal✓
- C 8.11 kcal
- D 31.7 kcal

$$Q = \frac{7150\text{ J}}{4190} = 1.79\text{ kcal}$$

23. Find the **amount of work in MJ** that is equivalent to **3850 kcal**.

- A 3.17 MJ
- B 0.918 MJ
- C 16.1 MJ✓
- D 8.23 MJ

$$\text{work} = 3850\text{ kcal} \times 4190 \frac{\text{joule}}{\text{kcal}}$$

$$\text{work} = 16.1 \times 10^6\text{ J} = 16.1\text{ MJ}$$

24. Find the **amount of work in kJ** that is equivalent to **7.65 kcal** of heat.

- A 17.7 kJ
- B 9.18 kJ
- C 1.83 kJ
- D 32.1 kJ✓

$$\text{work} = 7.65\text{ kcal} \times 4190 \frac{\text{joule}}{\text{kcal}}$$

$$\text{work} = 32.01 \times 10^3\text{ J} = 32.1\text{ kJ}$$

25. Find the **mechanical work equivalent (in kJ)** of **8550 cal** of heat.

- A 35.8 kJ✓
- B 2.04 kJ
- C 15.3 kJ
- D 23.1 kJ

$$\text{work} = 8550\text{ cal} \times 4.19 \frac{\text{joule}}{\text{cal}}$$

$$\text{work} = 35.8 \times 10^3\text{ J} = 35.8\text{ kJ}$$

26. Find the **heat equivalent (in kcal)** of **763 kJ** of work.

- A 17.5 kcal
- B 182 kcal✓
- C 1232 kcal
- D 3200 kcal

$$Q = 763\text{ kJ} = \frac{763 \times 10^3\text{ J}}{4190} = 182\text{ kcal}$$

27. How much work must a person do to offset eating a piece of cake containing **625 Cal**?

- A 39.2 kJ
- B 92.4 kJ
- C 2.62 MJ✓
- D 13.3 MJ

$$\text{work} = 625\text{ Cal} \times 4190 \frac{\text{joule}}{\text{Cal}}$$

$$\text{work} = 2.61 \times 10^6\text{ J} = 2.61\text{ MJ}$$

Heat

28. How much work must a person do to offset eating a 200-g bag of potato chips if 28 g of chips contain 150 Cal?

- A 320 kJ
- B 610 kJ
- C 1.2 MJ
- D 4.5 MJ ✓

$$28 \text{ g} \rightarrow 150 \text{ Cal}$$

$$200 \text{ g} \rightarrow ? \text{ Cal}$$

$$Q = \frac{200 \times 150}{28} = 1071.4 \text{ Cal}$$

$$\text{Work} = 1071.4 \text{ Cal} \times 4190 \frac{\text{Joule}}{\text{Cal}}$$

$$\text{Work} = 4.5 \times 10^6 \text{ J} = 4.5 \text{ MJ}$$

32. An industrial engine produces 38,000 kcal of heat. What is the mechanical work equivalent of the heat produced?

- A 33 MJ
- B 85 MJ
- C 120 MJ
- D 160 MJ ✓

$$\text{work} = 38000 \text{ kcal} \times 4190 \frac{\text{Joule}}{\text{Kcal}}$$

$$\text{work} = 159 \times 10^6 \text{ J} \approx 160 \times 10^6 \text{ J}$$

$$\text{work} = 160 \text{ MJ}$$

29. A fuel yields 11.5 kcal/g when burned. How many joules of work are obtained by burning 1 kg of the fuel?

- A 48 MJ ✓
- B 36 MJ
- C 24 MJ
- D 12 MJ

$$\text{work} = 11.5 \frac{\text{Kcal}}{\text{g}} \times 1000 \text{ g} \times 4190 \frac{\text{Joule}}{\text{Kcal}}$$

$$\text{work} = 48 \times 10^6 \text{ J} = 48 \text{ MJ}$$

30. A fuel produces 16 kcal/g when burned. If 500 g of the fuel is burned, how many joules of work are produced?

- A 22 MJ
- B 34 MJ ✓
- C 47 MJ
- D 65 MJ

$$\text{work} = 16 \frac{\text{Kcal}}{\text{g}} \times 500 \text{ g} \times 4190 \frac{\text{Joule}}{\text{Kcal}}$$

$$\text{work} = 33.5 \times 10^6 \text{ J} = 34 \text{ MJ}$$

31. Natural gas burned in a gas turbine has a heating value of 110 kcal/g. If the turbine is 25% efficient and 2.5 g of gas is burned each second, find the power output in kilowatts.

- A 35 kW
- B 160 kW
- C 290 kW ✓
- D 1900 kW

$$\text{work} = 110 \frac{\text{Kcal}}{\text{g}} \times 2.5 \text{ g} \times 4190 \frac{\text{Joule}}{\text{Kcal}} \times 0.25$$

$$\text{work} = 288 \times 10^3 \text{ J} = 288 \text{ kJ}$$

$$\text{power} = \frac{\text{work}}{\text{time}} = \frac{288 \text{ kJ}}{1 \text{ s}} = 288 \text{ kW} \approx 290 \text{ kW}$$

Heat; Change of Phase

33. What heat is needed to change the temperature of 100 kg of copper (c = 0.092 kcal/kg degree-C) from 100 to 200 degrees-C?

- A 920 kcal ✓
- B 9.2 kcal
- C 92 kcal
- D 9200 kcal

$$Q = mc\Delta T$$

$$Q = 100 \times 0.092 \times (200 - 100)$$

$$Q = 100 \times 0.092 \times 100 = 920 \text{ kcal}$$

34. What heat is needed to change the temperature of 10 kg of water (c = 1.00 kcal/kg degree-C) from 10 to 20 degrees-C?

- A 10 kcal
- B 100 kcal ✓
- C 200 kcal
- D 419 kcal

$$Q = mc\Delta T$$

$$Q = 10 \times 1.00 \times (20 - 10)$$

$$Q = 10 \times 1.00 \times 10 = 100 \text{ kcal}$$

35. What heat is needed to change the temperature of 100 kg of steel (c = 0.115 kcal/kg degree-C) from 1000 to 1100 degrees-K?

- A 100 kcal
- B 300 kcal
- C 1150 kcal ✓
- D 4600 kcal

$$Q = mc\Delta T$$

$$Q = 100 \times 0.115 \times (1100 - 1000)$$

$$Q = 100 \times 0.115 \times 100 = 1150 \text{ kcal}$$

36. What heat should be given off by 10 kg of aluminum ($c = 0.22 \text{ kcal/kg degree-C}$) to change their temperature from 200 to 100 degrees-C?

- A 51 kcal
- B 430 kcal
- C 910 kcal
- D 220 kcal✓

$$Q = mc\Delta T$$

$$Q = 10 \times 0.22 \times (100 - 200)$$

$$Q = 10 \times 0.22 \times -100 = -220 \text{ kcal}$$

والإشارة السالبة للدلالة على انها مفقودة

37. How many calories of heat are required to melt 7 g of ice at 0 degrees C? ($L\text{-fusion} = 80 \text{ cal/g}$)

- A 560 cal✓
- B 135 cal
- C 2300 cal
- D 1500 cal

$$Q = mL_f$$

$$Q = 7 \times 80 = 560 \text{ cal}$$

38. How many calories of heat are given off by 10 g of steam at 100 degrees C to condense to water at 100 degrees C? ($L\text{-vaporization} = 540 \text{ cal/g}$)

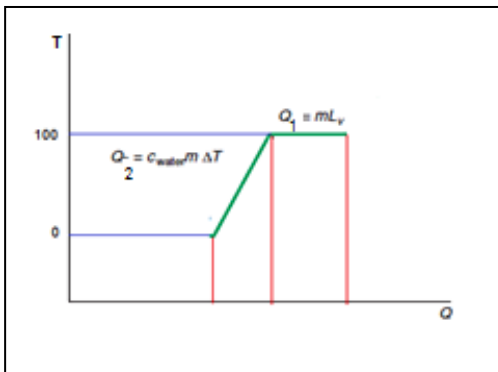
- A 540 cal
- B 5400 cal✓
- C 54000 cal
- D 540000 cal

$$Q = mL_v$$

$$Q = 10 \times 540 = 5400 \text{ cal}$$

39. How many calories of heat are given off by 10 g of steam at 100 degrees C to condense to water at 0 degrees C? ($c\text{-water} = 1 \text{ cal/g degree C}$, $L\text{-vaporization} = 540 \text{ cal/g}$)

- A 640000 cal
- B 64000 cal
- C 6400 cal✓
- D 640 cal



$$Q = Q_1 + Q_2$$

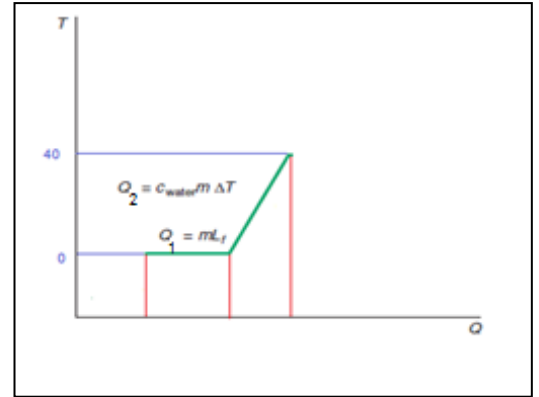
$$Q = mL_v + m c \Delta T$$

$$Q = (10 \times 540) + (10 \times 1 \times (0 - 100))$$

$$Q = 5400 + 1000 = 6400 \text{ cal}$$

40. How many calories of heat are required by 50 g of ice at 0 degrees C to melt to water at 40 degrees C? ($c\text{-water} = 1 \text{ cal/g degree C}$, $L\text{-fusion} = 80 \text{ cal/g}$)

- A 2000 cal
- B 4000 cal
- C 5000 cal
- D 6000 cal✓



$$Q = Q_1 + Q_2$$

$$Q = mL_f + m c \Delta T$$

$$Q = (50 \times 80) + (50 \times 1 \times (40 - 0))$$

$$Q = 4000 + 2000 = 6000 \text{ cal}$$

Elasticity; Stress; Hooke's Law

41. When a **deforming** (مشوه) force acts on an **elastic** object, the object is:

- A never deformed
- B permanently (بشكل دائم) deformed
- C temporarily (وقتيا) deformed✓
- D broken into pieces

عندما تؤثر قوة على جسم مرن فان التشوه الحادث به يكون مؤقتا بحيث يعود الجسم لوضعه الطبيعي بعد زوال القوة المؤثرة عليه .

42. An **elastic material** can be:

- A dough (عجين)
- B clay (طين)
- C lead (رصاص)
- D rubber (مطاط)✓

43. When a **10-N force** is applied on a **20-cm spring**, it extends to **25 cm**. What would be its length when a **30-N force** is applied to it within its elastic range?

- A 35 cm✓
 B 15 cm
 C 30 cm
 D 20 cm

$$L_0 = 20 \text{ cm} \rightarrow L_1 = 25 \text{ cm} \rightarrow \Delta L_1 = 25 - 20 = 5 \text{ cm}$$

$$F_1 = 10 \text{ N} \rightarrow \Delta L_1 = 5 \text{ cm}$$

$$F_2 = 30 \text{ N} \rightarrow \Delta L_2 = ?$$

$$\Delta L_2 = \frac{F_2 \Delta L_1}{F_1} = \frac{30 \times 5}{10} = 15 \text{ cm}$$

$$L_2 = L_0 + \Delta L_2 = 20 + 15 = 35 \text{ cm}$$

44. When a **100-N force** is applied on a **20-cm spring**, it extends to **21 cm**. What would be its length when a **1000-N force** is applied to it within its elastic range?

- A 25 cm
 B 30 cm✓
 C 35 cm
 D 5 cm

$$L_0 = 20 \text{ cm} \rightarrow L_1 = 21 \text{ cm} \rightarrow \Delta L_1 = 21 - 20 = 1 \text{ cm}$$

$$F_1 = 100 \text{ N} \rightarrow \Delta L_1 = 1 \text{ cm}$$

$$F_2 = 1000 \text{ N} \rightarrow \Delta L_2 = ?$$

$$\Delta L_2 = \frac{F_2 \Delta L_1}{F_1} = \frac{1000 \times 1}{100} = 10 \text{ cm}$$

$$L_2 = L_0 + \Delta L_2 = 20 + 10 = 30 \text{ cm}$$

45. When a **50-N force** is applied on a **20-cm spring**, it extends to **22 cm**. What would be its length when a **75-N force** is applied to it within its elastic range?

- A 3 cm
 B 21 cm
 C 23 cm✓
 D 30 cm

$$L_0 = 20 \text{ cm} \rightarrow L_1 = 22 \text{ cm} \rightarrow \Delta L_1 = 22 - 20 = 2 \text{ cm}$$

$$F_1 = 50 \text{ N} \rightarrow \Delta L_1 = 2 \text{ cm}$$

$$F_2 = 75 \text{ N} \rightarrow \Delta L_2 = ?$$

$$\Delta L_2 = \frac{F_2 \Delta L_1}{F_1} = \frac{75 \times 2}{50} = 3 \text{ cm}$$

$$L_2 = L_0 + \Delta L_2 = 20 + 3 = 23 \text{ cm}$$

46. When a **10-N force** is applied on a **20-cm spring**, it is compressed to **18 cm**. What would be its length when a **30-N compressing force** is applied to it within its elastic range?

- A 6 cm
 B 16 cm
 C 26 cm
 D 14 cm✓

$$L_0 = 20 \text{ cm} \rightarrow L_1 = 18 \text{ cm} \rightarrow \Delta L_1 = 20 - 18 = 2 \text{ cm}$$

$$F_1 = 10 \text{ N} \rightarrow \Delta L_1 = 2 \text{ cm}$$

$$F_2 = 30 \text{ N} \rightarrow \Delta L_2 = ?$$

$$\Delta L_2 = \frac{F_2 \Delta L_1}{F_1} = \frac{30 \times 2}{10} = 6 \text{ cm}$$

$$L_2 = L_0 - \Delta L_2 = 20 - 6 = 14 \text{ cm}$$

وعملية الطرح لان الزنبرك (النابض) يحدث له تقلص عند الضغط عليه

47. A block of lead with dimensions (**10 cm × 5 cm × 4 cm**) has a mass of **2.3 kg**. It exerts the **greatest stress** on a flat surface when it lies on the side with dimensions:

- A 5 cm × 10 cm
 B 5 cm × 4 cm✓
 C 10 cm × 4 cm
 D same stress on all sides

$$S = \frac{F}{A}$$

بما ان العلاقة عكسية بين الاجهاد والمساحة بالتالي يكون الاجهاد اكبر ما يمكن عندما يوضع الجسم على الوجه الاصغر مساحة

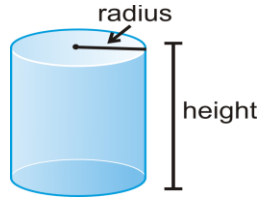
48. A cube (مكعب) of iron of **10-cm sides** weighs **80 N**. The **stress** it exerts on a flat surface is:

- A 80 Pa
 B 800 Pa
 C 8000 Pa✓
 D 80,000 Pa

$$S = \frac{F}{A} = \frac{80}{(0.1)^2} = 8000 \text{ Pa}$$

49. A cylinder of lead is of **5.64-cm** radius, 20-cm height, and **23-kg** mass. The **stress** it exerts on a flat surface when it lies on its flat side is:

- A 23 Pa
- B 230 Pa
- C 2.3 k Pa
- D 23 k Pa ✓



$$S = \frac{F}{A} = \frac{m g}{\pi r^2} = \frac{23 \times 10}{\pi(0.0564)^2}$$

$$S = 23 \times 10^3 Pa = 23 k Pa$$

52. A **500-g** block of wood with dimensions (**10 cm × 5 cm × 4 cm**) has density of:

- A 2500 kg/m³ ✓
- B 2.5 kg/m³
- C 0.8 kg/m³
- D 800 kg/m³

$$D_m = \frac{m}{v} = \frac{500}{10 \times 5 \times 4} = \frac{500g}{200cm^3}$$

$$D_m = \frac{500g}{200cm^3} = \frac{500 \times 10^{-3}}{200 \times 10^{-6}}$$

$$D_m = 2.5 \times 10^3 = 2500kg/m^3$$

Density

50. **Density** of a substance (صنف) depends on the _____ and _____ of its atoms.

- A mass, charge (شحنة)
- B mass, spacing ✓
- C spacing (تباعد), charge
- D mass, color

تعتمد كثافة المادة على كتلة الذرات والمسافات التي تفصل بينها

51. A **500-g** block of wood with dimensions (**10 cm × 5 cm × 4 cm**) has **density** of:

- A 0.5 g/cm³
- B 1.5 g/cm³
- C 2.5 g/cm³ ✓
- D 3.5 g/cm³

$$D_m = \frac{m}{v} = \frac{500}{10 \times 5 \times 4} = \frac{500}{200} = 2.5 g/cm^3$$

53. A **500-g** block of wood with dimensions (**10 cm × 5 cm × 4 cm**) has **weight density** of:

- A 2.5 kN/m³
- B 5 kN/m³
- C 10 kN/m³
- D 25 kN/m³ ✓


$$D_m = 2500kg/m^3$$

$$D_w = 2500 \times 10 = 25000 \frac{N}{m^3}$$

$$D_w = 25 \times 10^3 N/m^3 = 25kN/m^3$$

CHAPTER 4: ELECTRICITY

Formulas & Constants

$e = 1.6 \times 10^{-19} \text{ C}$ $1/e = 6.25 \times 10^{18}$	$q_{\text{proton}} = +e$ $q_{\text{electron}} = -e$	$F = k \frac{q_1 \cdot q_2}{d^2}$	$k = 9 \times 10^9 \text{ N.m}^2/\text{C}^2$	Electric field: $\mathcal{E} = \frac{F}{q}$
Elec. potential energy: E_p	$E_p = k \frac{Q \cdot q}{d}$; $V = \frac{E_p}{q}$	$I = \frac{\Delta Q}{\Delta t}$	$R = \rho \frac{l}{A}$; $A = \pi \cdot r^2$	
$V = I.R$		$P = V.I = \frac{V^2}{R} = I^2.R$	$R_{\text{series}} = R_1 + R_2 + \dots$	$\frac{1}{R_{\text{parallel}}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$

Key Terms & Definitions

Alternating current	تيار متردد	Electric field	المجال الكهربائي	Potential difference	فرق الجهد
Capacitor	مكثف	Electric potential	الجهد الكهربائي	Power	قدرة
Charge	شحنة	Electricity	كهرباء	Resistance	مقاومة
Conductor	موصل	Electrostatics	الكهرباء الساكنة	Resistivity	مقاومية
Current	تيار	Insulator	عازل	Semiconductor	شبه موصل
Direct current	تيار مباشر	Parallel circuit	دائرة متوازية	Series circuit	دائرة متتالية أو متسلسلة

Electric Charges; Coulomb's Law

1. **Normally**, an **atom's net charge** is:

- A negative
- B positive
- C zero** ✓
- D a vector

4. A **negatively** charged object is an object with:

- A extra electrons** ✓
- B extra protons
- C extra neutrons
- D lack of (نقص) electrons

negative object

$$N_e > N_p$$

2. The **number of electrons** needed to make up **one coulomb** of charge is:

- A 1.6×10^{-19}
- B $1.6 \times 10^{+19}$
- C 6.25×10^{-18}
- D 6.25×10^{18}** ✓

$$q = n \times e \rightarrow n = \frac{q}{e}$$

$$= \frac{1 \text{ C}}{1.6 \times 10^{-19}}$$

$$= 6.25 \times 10^{18} \text{ electron}$$

5. The **electrostatic force** equation for two charged objects, q_1 and q_2 , gives a **positive result** if:

- A q_1 is positive and q_2 is negative
- B q_1 is negative and q_2 is positive
- C q_1 and q_2 have the same sign** ✓
- D q_1 and q_2 are neutral

كون القوة الكهروستاتيكية موجبة إذا كانت قوة تنافر أي ان الجسمان لهما نفس الإشارة

3. A **positively** charged object is an object with:

- A extra electrons
- B lack (نقص) of protons
- C extra neutrons
- D lack of electrons** ✓

Positive object

$$N_p > N_e$$

6. The **electrostatic force** equation for two charged objects, q_1 and q_2 , gives a **negative result** if:

- A q_1 repels q_2
- B $q_2 = q_1$
- C $q_1 = \frac{1}{2} q_2$
- D q_1 attracts q_2** ✓

تكون القوة الكهروستاتيكية سالبة
إذا كانت قوة تجاذب أي ان
الجسمان يختلفان في الإشارة

11. A group of charges (**Q**) exert a net force **$F = 10 \text{ N}$** on a charge **$q = 0.2 \text{ C}$** located at point (X). This means that the **magnitude** of the **electric field** resulting from **Q** at **X** equals:

- A 0.2 N/C
- B 5 N/C
- C 10 N/C
- D 50 N/C**✓

$$E = \frac{F}{q} = \frac{10}{0.2} = 50 \text{ N/C}$$

7. The **electrostatic force** between two charged objects, q_1 and q_2 , is **located at**:

- A q_1
- B q_2
- C q_1 for force from q_2 , and q_2 for force from q_1** ✓
- D halfway between q_1 and q_2

12. The **electric field** around a **negative point-charge (Q)** **points** (يتجه):

- A radially away from Q
- B radially toward Q**✓
- C in circles around Q
- D in ellipsoids (مجسم بيضوي) around Q

8. The **attractive force** between two charges $q_1 = \frac{1}{3} \text{ C}$ and $q_2 = -\frac{1}{3} \text{ C}$ separated by **1 km** is:

- A 1000 N**✓
- B 100 N
- C 10 N
- D 1 N

$$F_{elec} = k \frac{q_1 q_2}{d^2} = 9 \times 10^9 \frac{\frac{1}{3} \times \frac{-1}{3}}{(1 \times 1000)^2} = 9 \times 10^9 \frac{-1}{10^6} = \frac{10^9}{10^6} = -10^3 \text{ N}$$

13. The **electric field** around a **positive point-charge (Q)** **points** (يتجه):

- A radially away from Q**✓
- B radially toward Q
- C in circles around Q
- D in ellipsoids (مجسم بيضوي) around Q

9. The **repulsive force** between **two identical 1-C** charges separated by **300 m** is:

- A 100 N
- B 1 kN
- C 10 kN
- D 100 kN**✓

$$F_{elec} = k \frac{q_1 q_2}{d^2} = 9 \times 10^9 \frac{1 \times 1}{(300)^2} = \frac{9 \times 10^9}{9 \times 10^4} = 1 \times 10^5 \text{ N} = 100 \text{ kN}$$

14. The **electric field** between **two point charges (+Q) and (-Q)** separated by a distance (**d**) **points** (يتجه):

- A on a straight line from +Q to -Q**✓
- B radially toward Q
- C radially toward -Q
- D on a straight line from -Q to +Q

15. The **electric field** around **two point charges (+Q) and (-Q)** separated by a distance (**d**) is:

- A concentric (متداخل) cubes
- B radially toward Q
- C radially toward -Q
- D concentric ellipsoids (مجسم بيضوي)**✓

Electric Field; Electric Potential

10. The following quantities are all **scalar**, **except** for:

- A electric current
- B electric field**✓
- C electric charge
- D electric potential

16. The **SI unit** for the **electric potential energy** is the:

- A ampere
- B watt
- C volt
- D joule**✓

17. The **SI unit** for the **electric potential** is the:

- A ampere
- B watt
- C volt**✓
- D joule

18. **One volt** is equal to:

- A 1 joule/second
- B 1 joule/coulomb**✓
- C ampere/second
- D ampere/coulomb

19. A charge $q = 0.5 \text{ C}$ located at point (X) has electric potential energy $PE = 10 \text{ J}$ caused by a group of charges (Q). This means that the **electric potential** resulting from Q at X equals:

- A 0.5 V
- B 5 V
- C 10 V
- D 20 V**✓

$$V = \frac{\text{Electric P.E}}{q} = \frac{10}{0.5} = 20V$$

Capacitor; Resistance

20. **Electric energy** can be **stored** in a:

- A resistance
- B capacitor**✓
- C switch
- D light bulb

21. A **capacitor** consists of:

- A a conductor between two insulating plates
- B an insulator between two conducting plates**✓
- C two insulating plates in vacuum
- D two conducting plates in vacuum

22. When a **capacitor** is **connected** to a **battery**, the **plate** connected to the _____ terminal becomes _____:

- A positive, positive**✓
- B negative, positive
- C positive, negative
- D positive, neutral

23. If a **capacitor** is connected to a **battery** of potential difference **V**, the capacitor becomes **fully charged** when the potential difference between its plates equals:

- A 0
- B V**✓
- C V/2
- D 2V

24. A **10-km** copper wire (**resistivity** = $1.7 \times 10^{-8} \Omega \cdot \text{m}$) has cross-sectional **area** = 1 mm^2 . Its **resistance** is:

- A 1.7Ω
- B 17Ω
- C 170Ω** ✓
- D 1700Ω

$$\begin{aligned} R &= \rho \frac{L}{A} = 1.7 \times 10^{-8} \times \frac{10 \text{ km}}{1 \text{ mm}^2} \\ &= 1.7 \times 10^{-8} \times \frac{10 \times 10^3 \text{ m}}{1 \times 10^{-6} \text{ m}^2} \\ &= 1.7 \times 10^{-8} \times \frac{10^4}{10^{-6}} \\ &= 1.7 \times 10^{-8} \times 10^{10} \\ &= 1.7 \times 10^2 = 170 \Omega \end{aligned}$$

Ohm's Law; Electric Power; Electric Circuits

25. An **electric circuit** consists of a **24-** **Resistance** connected across the terminals of a **12-V** battery. The **electric current** in this circuit is:

- A 24 amperes
- B 12 amperes
- C 2 amperes
- D 0.5 amperes**✓

$$V = I.R \rightarrow I = \frac{V}{R} = \frac{12}{24} = 0.5 \text{ A}$$

26. An **electric circuit** consists of a **light bulb** connected across the terminals of a **12-V battery**. If the **electric current** in this circuit is **6 mA**, the **resistance** of the light bulb is:

- A 0.5 kΩ
- B 2 kΩ** ✓
- C 20 Ω
- D 2 Ω

$$V = I.R \rightarrow R = \frac{V}{I} = \frac{12}{6 \times 10^{-3}} = 2000\Omega = 2K\Omega$$

27. If the **power rating** of a vacuum cleaner is **550 W**, the **current** it draws in a **220-V** electric circuit is:

- A 0.4 amperes
- B 1.5 amperes
- C 2.5 amperes** ✓
- D 5 amperes

$$P = I.V \rightarrow I = \frac{P}{V} = \frac{550}{220} = 2.5 A$$

28. If a light bulb in a **220-V** electric circuit draws **0.5 amperes**, its **power rating** is:

- A 110 W** ✓
- B 440 W
- C 40 W
- D 75 W

$$P = I.V = 0.5 \times 220 = 110 W$$

29. A classroom has **ten 25-W** compact fluorescent lamps (CFL). If these lamps are turned on for **10 hours_ every day**, their **energy consumption** (استهلاك) in **20 days** is:

- A 1 kWh
- B 5 kWh
- C 10 kWh
- D 50 kWh** ✓

$$E = P \times t = (10 \times 25 \times 10^{-3}) \times (10 \times 20) = 50 kWh$$

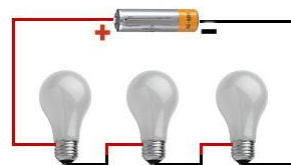
30. In electricity, the **kilowatt-hour** is a **unit** of:

- A electric current
- B electric power
- C electric potential
- D electric energy** ✓

$$E = P \times t = Kw.h$$

31. **Three identical light bulbs**, each of **resistance 12Ω**, are connected in **series** to a **12-V battery**. Their **equivalent resistance** is:

- A 4 Ω
- B 12 Ω
- C 24 Ω
- D 36Ω** ✓



$$R_{series} = R_1 + R_2 + R_3 = 12 + 12 + 12 = 36\Omega$$

32. **Three identical light bulbs**, each of **resistance 12Ω**, are connected in **series** to a **12-V battery**. The **potential difference** across **each light bulb** is:

- A 0 V
- B 4 V** ✓
- C 8 V
- D 12 V

$$V_1 = V_2 = V_3 \rightarrow V_1 = I_{TOTAL} \cdot R_1$$

$$V_1 = \frac{V_{TOTAL}}{R_{TOTAL}} \cdot R_1 = \frac{12}{(12 + 12 + 12)} \times 12 = \frac{144}{36} = 4 V$$

او حل آخر: بما ان المقاومات متماثلة في قيمها والتيار له قيمة ثابتة في التوصيل على التوالي فان فروق الجهد بين اطراف المقاومات ستكون ايضا متماثلة حيث ان:

$$V_1 = V_2 = V_3 \rightarrow V_1 = \frac{V_{TOTAL}}{3} = \frac{12}{3} = 4 V$$

33. **Three identical light bulbs**, each of **resistance 12 Ω**, are connected in **series** to a **12-V battery**. The **current** passing through **each light bulb** is:

- A $\frac{1}{3}$ A** ✓
- B $\frac{2}{3}$ A
- C 1 A
- D 3 A

$$I_1 = I_2 = I_3 = I_{TOTAL} = \frac{V_{TOTAL}}{R_{TOTAL}}$$

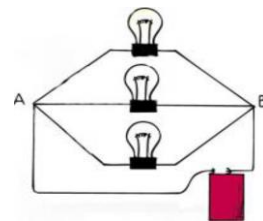
$$I_{TOTAL} = \frac{12}{(12 + 12 + 12)} = \frac{12}{36} = \frac{1}{3} A$$

34. Three identical light bulbs, each of resistance $12\ \Omega$, are connected in parallel to a 12-V battery. Their equivalent resistance is:

- A $4\ \Omega$ ✓
- B $12\ \Omega$
- C $24\ \Omega$
- D $36\ \Omega$

$$\frac{1}{R_{parallel}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \rightarrow \frac{1}{R_{parallel}} = \frac{1}{12} + \frac{1}{12} + \frac{1}{12} = \frac{3}{12}$$

$$\rightarrow \frac{1}{R_{parallel}} = \frac{3}{12} \rightarrow R_{parallel} = \frac{12}{3} = 4\ \Omega$$



35. Three identical light bulbs, each of resistance $12\ \Omega$, are connected in parallel to a 12-V battery. The potential difference across each light bulb is:

- A 0 V
- B 4 V
- C 8 V
- D $12\ V$ ✓

$$V_1 = V_2 = V_3 = V_{TOTAL} = 12\ V$$

وذلك لان التوصيل على التوازي

36. Three identical light bulbs, each of resistance $12\ \Omega$, are connected in parallel to a 12-V battery. The current passing through each light bulb is:

- A $\frac{1}{3}\ A$
- B $\frac{2}{3}\ A$
- C $1\ A$ ✓
- D 3 A

بما ان التوصيل على التوازي فان قيمة التيار الكلي ستقسم الى تيارات فرعية وكل تيار فرعي ستكون قيمته مماثلة لبقية قيم التيارات الفرعية الاخرى وذلك لان كل منها بها نفس مقدار المقاومة وعلى هذا فان:

$$I_1 = I_2 = I_3 \rightarrow I_1 = \frac{V_{TOTAL}}{R_1} = \frac{12}{12} = 1\ A$$



37. In an electric circuit consisting of two resistances ($10\ \Omega$ and $5\ \Omega$) connected in series, if the current through the $10\ \Omega$ resistance is 1 A, the current through other resistance is:

- A 0 A
- B 0.5 A
- C $1\ A$ ✓
- D 2 A

بما ان التوصيل على التوصيل على التوالي فان قيمة التيار ستكون ثابتة في جميع نقاط الدائرة وعلى هذا فان:

$$I_1 = I_2 = I_{TOTAL} \rightarrow I_2 = 1\ A$$

38. In an electric circuit consisting of **two resistances** (10Ω and 5Ω) connected in **parallel**, if the **current** through the 10Ω . resistance is $1 A$, the **current** through **other resistance** is:

- A $0 A$
B $0.5 A$
C $1 A$
D $2 A$ ✓

بما ان التوصيل على التوازي فان قيمة فرق الجهد ستكون ثابتة بين اطراف جميع المسارات الفرعية والتي ستكون هي نفس قيمة فرق الجهد بين طرفي البطارية. وبما ان قيمة التيار في المقاومة الاولى 10Ω هي $1 A$ وحيث ان قيمة المقاومة الثانية 5Ω تقل عن قيمة المقاومة الاولى بمقدار **النصف** فان قيمة التيار في المقاومة الثانية ستزيد عن قيمة التيار المار في المقاومة الاولى بمقدار **الضعف** وذلك لان العلاقة بين التيار والمقاومة عكسية حسب قانون اوم :

$$R_1 = 10\Omega \rightarrow I_1 = 1A \rightarrow V_1 = I_1 \cdot R_1 = 1 \times 10 = 10V$$

$$R_2 = 5 \Omega \rightarrow I_2 = \frac{V_{TOTAL}}{R_2} = \frac{10}{5} = 2 A$$

وذلك لان فرق الجهد في التوصيل على التوازي :

$$V_1 = V_2 = V_{TOTAL} = 10 V$$

CHAPTER 5: OPTICS

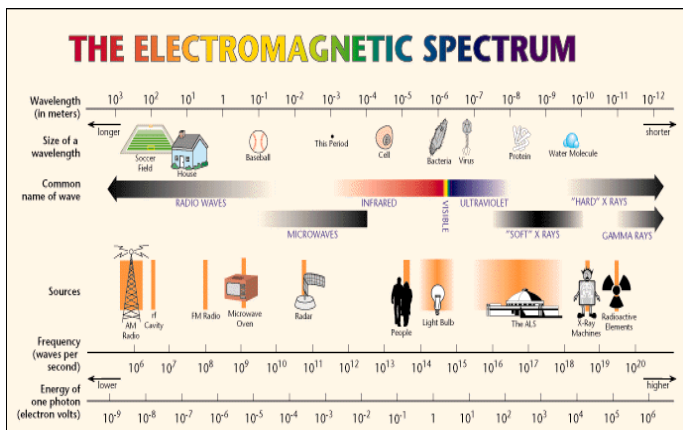
Formulas & Constants

$f = c / \lambda$ or: $c = f \cdot \lambda$ f = frequency; λ = wavelength	$f = 1 / T$ (frequency = 1/(time of 1 cycle))	$E = h \cdot f$ (photon energy = constant \times wave frequency)	$c = 3 \times 10^8$ m/s $h = 6.6 \times 10^{-34}$ J.s
10^0 to 10^{14} Hz (frequencies in the e-m spectrum)	4×10^{14} to 8×10^{14} Hz (frequency range of visible light)	$\theta_i = \theta_r$ (law of reflection)	$1 \text{ Hz} = 1 \text{ s}^{-1}$
Snell's law: $n_i \sin \theta_i = n_r \sin \theta_r$ (i = incidence; r = refraction)	Index of refraction: $n = \frac{c}{v}$ (v = speed of light in medium)	$\frac{1}{f} = \frac{1}{s_o} + \frac{1}{s_i}$ or: $s_i = \frac{s_o \cdot f}{s_o - f}$ (o = object; i = image)	$M = \frac{h_i}{h_o} = -\frac{s_i}{s_o}$ $= \frac{1}{1 - s_o/f}$

Key Terms & Definitions

Aberration	زيج	Focal point	البؤرة	Prism	منشور
Absorption	امتصاص	Frequency	تردد	Rainbow	قوس المطر
Amplitude	ارتفاع الموجة	Electromagnetic	كهرومغناطيسي	Ray	شعاع
Astigmatism	انحراف في القرنية	Incidence	سقوط	Real image	صورة حقيقية
Beam	حزمة	Infrared	تحت الحمراء	Reflection	انعكاس
Chromatic	لوني	Inverted image	صورة مقلوبة	Refraction	انكسار
Concave	مقعر	Least time principle	قاعدة الزمن الأقصر	Resonance	رنين
Converge	يركز	Lens	عدسة	Source	مصدر
Convex	محدب	Magnify	يكبر	Spectrum	طيف
Cornea	القرنية	Medium	وسط	Specular	مرئي؛ بصري
Critical angle	الزاوية الحرجة	Microwaves	الموجات شديدة القصر	Transparent	شفاف
Defect	خلل	Mirage	سراب	Ultraviolet	فوق البنفسجي
Deformation	تشوه	Mirror	مرآة	Upright image	صورة قائمة
Diffuse	مبعثر أو منتشر	Oscillation	ارتجاج أو اهتزاز	Violet	بنفسجي
Dispersion	انتشار	Period	فترة الموجة	Virtual image	صورة وهمية
Diverge	يوزع	Photon	فوتون	Visible light	الضوء المرئي
Fiber optics	تألياف البصرية	Plane	مسطح	Wave	موجة
Focal distance	البعد البؤري	Polished	مصقول	Wavelength	طول الموجة

Electromagnetic Waves & Spectrum



1. Light is the **oscillation** of:

- A electric & sound fields
- B electric & magnetic fields** ✓
- C sound & magnetic fields
- D electric & gravitational fields

الضوء هو عبارة عن
تذبذب المجال الكهربائي
والمجال المغناطيسي

2. **Shaking** an **electrically** charged rod to-and-fro in empty space **produces**:

- A air waves
- B sound waves
- C electromagnetic waves** ✓
- D vacuum waves

3. **Electromagnetic** waves **start from a vibrating**:

- A fork (شوكة)
- B string (وتر)
- C spring (زنبرك)
- D charge✓

تنشأ الموجة الكهرومغناطيسية
من تذبذب شحنة كهربائية

4. In an electromagnetic wave, the electric and magnetic fields are:

- A perpendicular to each other and to the direction of motion✓
- B parallel to each other and to the direction of motion
- C perpendicular to each other and parallel to the direction of motion
- D parallel to each other and perpendicular to the direction of motion

5. A wave's **frequency** is:

- A the number of waves repeating (تكرر) every second✓
- B the time duration for one complete wave
- C the maximum value of a wave
- D the length of a single wave

تردد الموجة هو عدد الموجات التي تتكرر
في الثانية الواحدة

6. A wave's **wavelength** is:

- A the number of waves repeating every second
- B the time duration for one complete wave
- C its maximum value
- D the length of a single wave✓

الطول الموجي للموجة
هو طول موجة واحدة

7. Going from **left to right** in the **electromagnetic spectrum**, the following happens:

- A both wavelength and frequency increase
- B both wavelength and frequency decrease
- C wavelength increases and frequency decreases
- D wavelength decreases and frequency increases✓

8. In the **electromagnetic spectrum**, the **narrowest range** is that of:

- A radio waves
- B x-ray waves
- C visible light waves✓
- D ultraviolet waves

في الطيف الكهرومغناطيسي فإن
أضيق مدى سيكون لموجات
الضوء المرئي

9. **Electromagnetic** waves that **travel in vacuum slower than light** are:

- A gamma-ray waves
- B x-ray waves
- C ultraviolet waves
- D none of these✓

لأنه في الفراغ تنتقل جميع
الموجات الكهرومغناطيسية بنفس
السرعة

10. In the **electromagnetic spectrum**, the **highest energy** is that of:

- A gamma-ray waves✓
- B x-ray waves
- C visible light waves
- D ultraviolet waves

في الطيف الكهرومغناطيسي
فإن الموجات التي لها أعلى
طاقة هي أشعة جاما

11. In the **electromagnetic spectrum**, the **lowest frequency** is that of:

- A ultraviolet waves
- B x-ray waves
- C red light waves
- D radio waves✓

في الطيف الكهرومغناطيسي فإن
الموجات التي لها أقل تردد هي
موجات الراديو

12. Among the following **electromagnetic waves**, the **longest wavelength** is for:

- A infrared waves
- B microwave✓
- C visible light waves
- D ultraviolet waves

من الموجات الكهرومغناطيسية
التالية فإن التي لها أعلى طول
موجي هي موجات الميكروويف

13. The **wavelength** of **300-MHz** microwave is:

- A 1 μm
- B 1 mm
- C 1 cm
- D 1 m✓

$$f = \frac{c}{\lambda} \rightarrow \lambda = \frac{c}{f} = \frac{3 \times 10^8}{300 \text{ MHz}}$$
$$\lambda = \frac{3 \times 10^8}{300 \times 10^6} = \frac{3 \times 10^8}{3 \times 10^8} = 1 \text{ m}$$

14. The **frequency** of **0.5- μm** green light is:

- A $2 \times 10^{14} \text{ Hz}$
- B $4 \times 10^{14} \text{ Hz}$
- C $6 \times 10^{14} \text{ Hz}$ ✓
- D $8 \times 10^{14} \text{ Hz}$

$$f = \frac{c}{\lambda} = \frac{3 \times 10^8}{0.5 \mu\text{m}} =$$
$$f = \frac{3 \times 10^8}{0.5 \times 10^{-6}} = 6 \times 10^{14} \text{ Hz}$$

Reflection

15. **Wave reflection** means that it **always**:

A enters into a new medium (وسط)

B returns to the medium from which it came√

C returns along the same line where it came

D slides along the border between two media

معنى انعكاس الموجات بانها دائما
تعود الى الوسط الذي قدمت منه

16. We **see** most **things** around us **because**:

A they are primary sources of light

B they are secondary sources of light

C they reflect light√

D they absorb light

نستطيع رؤية الاشياء من حولنا
لانها تعكس الضوء

17. If light beam (X) falls **obliquely** on a **mirror** and **reflects** into beam (Y), we can say that:

A X is always perpendicular to the mirror

B Y is always perpendicular to the mirror

C X and Y make equal angles with the mirror√

D X and Y are perpendicular to each other

عند سقوط الشعاع الضوئي على المرآة فانه دائما
تكون زاوية السقوط مساوية لزاوية الانعكاس

18. When a light beam is **reflected**, it keeps a **constant**:

A speed

B frequency

C wavelength

D all of these√

عند انعكاس الشعاع الضوئي فان
الشعاع المنعكس لا تتغير سرعته او
تردده او طول الموجه فقط الذي يتغير
اتجاهه .

19. The **angle** of **reflection** is always:

A equal to the angle of incidence√

B smaller than the angle of incidence

C larger than the angle of incidence

D equal to the angle of refraction

20. An object placed in **front** of a **plane mirror** forms an image that is of _____ **size** and _____ **distance** to the mirror.

A same; same√

B larger; same

C same; nearer

D same; farther

اذا وضع الجسم امام مرآة مستوية فانه دائما
تكون صورة خيالية (خلف المرآة) لها نفس
حجم الجسم ولها نفس بعد الجسم عن المرآة

21. An object placed **between** a **concave** (مقعر) mirror and its **focus** forms an image that is of _____ **size** and _____ **distance** to the mirror.

A smaller; farther

B larger; nearer

C smaller; nearer

D larger; farther√

اذا وضع جسم بين مرآة مقعرة وبؤرتها (أي
انه يكون داخل نطاق البؤرة) بالتالي يكون
 $S_0 < f$
فتكون له صورة خيالية (خلف المرآة)
معتدلة مكبرة وبعيدة

22. An object placed in **front** of a **convex** (محدب) mirror forms an image that is of _____ **size** and _____ **distance** to the mirror.

A smaller; farther

B larger; nearer

C smaller; nearer√

D larger; farther

اذا وضع الجسم امام مرآة محدبة فانه
تكون صورة للجسم تكون خيالية (خلف
المرآة) ومصغرة وقريبة من المرآة

23. An **image** formed **behind** a **mirror** is **virtual** for:

A plane, convex and concave√

B plane and concave, and real for convex

C plane and convex, and real for concave

D convex and concave, and real for plane

الصورة المتكونة خلف المرآة هي صورة خيالية وتنتج عن جميع انواع
المرايا سواء كانت مستوية او منحنية بنوعها (مقعرة ومحدبة)

24. **Diffuse reflection** occurs when **light** is **incident** on a **surface** that is:

A smooth (أملس)

B polished (مصقول)

C transparent (شفاف)

D rough (خشن)√

الانعكاس المشتت (الغير منتظم)
يحدث عند سقوط الشعاع الضوئي
على اسطح خشنة .

25. **Specular** (بصري) reflection occurs when **light** is **incident** on a:

A lens

B mirror√

C painted wall

D page of a book

الانعكاس البصري (منتظم) يحدث عند
سقوط الشعاع الضوئي على اسطح
مصقولة مثل المرآة .

26. **After diffuse reflection**, **light** goes in:

A one direction

B two opposite directions

C no direction

D all directions√

بعد حدوث الانعكاس المشتت فان
الضوء المنعكس ينتشر في جميع
الاتجاهات .

27. You can see the road ahead of your car at night because of:

- A specular reflection
- B absorption
- C diffuse reflection ✓
- D refraction

نستطيع رؤية الطريق امام السيارة ليلا بسبب حدوث الانعكاس المشتت للاشعة الضوئية .

28. If a convex mirror of 2-m focal length is placed 8 m away from a 2.5-m-high door, the image of the door will appear in the mirror at a distance of:

- A 1.6 m ✓
- B 2.4 m
- C 0.8 m
- D 3.2 m

$$s_i = \frac{s_o \cdot f}{s_o - f} = \frac{8 \times -2}{8 - (-2)} = \frac{-16}{10} = -1.6 \text{ m}$$

ملاحظة: البعد البؤري للمراة المفرقة (المحدبة) يكون دائما سالبا. والاشارة السالبة في بعد الصورة لانها خيالية

29. If a convex mirror of 2-m focal length is placed 8 m away from a 2.5-m-high door, the height of the door's image will be:

- A 0.1 m
- B 0.5 m ✓
- C 1 m
- D 1.25 m

$$\frac{h_i}{h_o} = \frac{-s_i}{s_o} \rightarrow \frac{h_i}{2.5} = \frac{-(-1.6)}{8}$$

$$h_i = \frac{2.5 \times 1.6}{8} = 0.5 \text{ m}$$

30. If a convex mirror of 2-m focal length is placed 8 m away from a 2.5-m-high door, the magnification of the door in the mirror will be:

- A 5
- B 2
- C 0.5
- D 0.2 ✓

$$M = \frac{h_i}{h_o} = \frac{0.5 \text{ m}}{2.5 \text{ m}} = 0.2$$

او حل آخر :

$$M = \frac{-s_i}{s_o} = \frac{-(-1.6) \text{ m}}{8 \text{ m}} = 0.2$$

31. If a convex mirror of 2-m focal length is placed 8 m away from a 2.5-m-high door, the image of the door will be:

- A upright and reduced ✓
- B upright and enlarged
- C inverted and reduced
- D inverted and enlarged

صفات الصورة المتكونة عن المراة المحدبة تكون دائما خيالية (خلف المراة) معتدلة ومصغرة

32. If a concave mirror of 2-m focal length is placed 7 m away from a 2.5-m-high door, the image of the door will appear in the mirror at a distance of:

- A 1.4 m
- B 2.8 m ✓
- C 0.7 m
- D 5.6 m

$$s_i = \frac{s_o \cdot f}{s_o - f} = \frac{7 \times 2}{7 - 2} = \frac{14}{5} = 2.8 \text{ m}$$

33. If a concave mirror of 2-m focal length is placed 7 m away from a 2.5-m-high door, the height of the door's image will be:

- A 0.1 m
- B 0.5 m
- C 1 m ✓
- D 1.25 m

$$\frac{h_i}{h_o} = \frac{-s_i}{s_o} \rightarrow \frac{h_i}{2.5} = \frac{-2.8}{7}$$

$$h_i = \frac{2.5 \times -2.8}{7} = -1 \text{ m}$$

والاشارة السالبة للدلالة على ان الصورة مقلوبة

34. If a concave mirror of 2-m focal length is placed 7 m away from a 2.5-m-high door, the magnification of the door in the mirror will be:

- A -2
- B +2
- C -0.4 ✓
- D +0.4

$$M = \frac{h_i}{h_o} = \frac{-1 \text{ m}}{2.5 \text{ m}} = -0.4$$

او حل آخر :

$$M = \frac{-s_i}{s_o} = \frac{-2.8 \text{ m}}{7 \text{ m}} = -0.4$$

35. If a concave mirror of 2-m focal length is placed 7 m away from a 2.5-m-high door, the image of the door will be:

- A upright and reduced
- B upright and enlarged
- C inverted and reduced ✓
- D inverted and enlarged

بما ان بعد الجسم اكبر من البعد البؤري للمراة المقعرة أي ان

$$s_o > f$$

بالتالي فان الصورة المتكونة تكون حقيقية ومقلوبة اما بالنسبة لحجمها فيحسب كالتالي :

$$s_i = \frac{s_o \cdot f}{s_o - f} = \frac{7 \times 2}{7 - 2} = \frac{14}{5} = 2.8 \text{ m}$$

$$\frac{h_i}{h_o} = \frac{-s_i}{s_o} \rightarrow \frac{h_i}{2.5} = \frac{-2.8}{7}$$

$$h_i = \frac{2.5 \times -2.8}{7} = -1 \text{ m}$$

حيث ان ارتفاع الصورة اقل من ارتفاع الجسم والاشارة السالبة تدل على الصورة مقلوبة

Refraction

36. The process of light bending when passing obliquely from one medium into another is called:

- A specular reflection
- B absorption
- C diffuse reflection
- D refraction ✓

عملية انحراف الضوء عن مساره عند انتقاله من وسط الى اخر تسمى بالانكسار .

37. When light is **refracted**, it keeps a **constant**:

A speed

B frequency ✓

C wavelength

D all of these

عند انكسار الضوء فإن التردد يبقى ثابتا

38. When **light is refracted** in passing from **air into water**, its **angle of refraction** is:

A equal to the angle of incidence

B more than the angle of incidence

C less than the angle of incidence ✓

D zero

عند انتقال الضوء من وسط قليل الكثافة الضوئية الى وسط عالي الكثافة الضوئية مثل انتقاله من الهواء الى الماء فإنه ينكسر مقتربا من العمود المقام فتصبح زاوية الانكسار اقل من زاوية السقوط

39. **Mirage** (السراب) happens on **hot days** because **light rays coming toward us from the sky**:

A bend toward the ground ✓

B bend away from the ground

C bounce (يرتد) off the ground

D stick to the ground

يحدث السراب في الايام الحارة بسبب ان الشعاع الضوئي القادم من السماء يحدث له انحناء بالقرب من الارض

40. What we **actually** see in a **mirage** (سراب):

A water vapor collecting above the road

B water that evaporates very fast

C sky light that appears like water ✓

D only an imaginary image

في السراب تتعكس صورة السماء لتبدو وكأنها ماء على الطريق

41. If the **speed of light in water is 0.75 c**, the **index of refraction** of water is:

A 1.33 ✓

B 0.75

C 2.25

D 0.25

$$n = \frac{c}{v} = \frac{c}{0.75 c} = \frac{1}{0.75} = 1.33$$

42. The **index of refraction of water is 4/3**. A beam of light incident from **air into water** at 30° ($\sin 30^\circ = \frac{1}{2}$) **refracts** at an **angle** of:

A 13°

B 9°

C 49°

D 22° ✓

الشعاع الضوئي ينتقل من الهواء الى الماء وبالتالي فإن وسط السقوط الهواء والوسط الذي حدث فيه انكسار الماء

$$n_1 \sin i = n_2 \sin r$$

$$1 \times \sin 30 = \frac{4}{3} \sin r$$

$$\sin r = \frac{1}{2} \times \frac{3}{4}$$

$$r = \sin^{-1} \left(\frac{1}{2} \times \frac{3}{4} \right) \rightarrow r = \sin^{-1} \left(\frac{3}{8} \right)$$

$$r = \sin^{-1}(0.375) = 22^\circ$$

43. The **index of refraction of water is 4/3**. A beam of light incident from **water into air** at 30° ($\sin 30^\circ = \frac{1}{2}$) **refracts** at an **angle** of:

A 42° ✓

B 90°

C 49°

D 22°

الشعاع الضوئي انتقل من الماء الى الهواء وبالتالي فإن وسط السقوط الماء والوسط الذي حدث فيه انكسار الهواء

$$n_1 \sin i = n_2 \sin r$$

$$\frac{4}{3} \times \sin 30 = 1 \times \sin r$$

$$\sin r = \frac{4}{3} \times \frac{1}{2}$$

$$r = \sin^{-1} \left(\frac{4}{3} \times \frac{1}{2} \right) \rightarrow r = \sin^{-1} \left(\frac{4}{6} \right)$$

$$r = \sin^{-1}(0.666) = 41.8 \approx 42^\circ$$

44. The **index of refraction of water is 4/3**. This means that the **critical angle of water (into air)** is:

A 42°

B 90°

C 49° ✓

D 22°

الزاوية الحرجة هي زاوية سقوط وبما ان المطلوب الزاوية الحرجة للماء أي ان المطلوب زاوية السقوط للشعاع الضوئي من الماء الى الهواء والزاوية الحرجة هي زاوية سقوط دائما تقابلها زاوية انكسار مقدارها 90°

$$n_1 \sin i = n_2 \sin r$$

$$\frac{4}{3} \times \sin i_c = 1 \times \sin 90$$

$$\sin i_c = \frac{3}{4} \times 1$$

$$i_c = \sin^{-1} \left(\frac{3}{4} \right) = \sin^{-1}(0.75) = 48.5 \approx 49^\circ$$

45. If a **beam of light is incident from water into air** at the **critical angle**, its **angle of refraction** in air is:

A 0°

B 90° ✓

C 60°

D 30°

إذا انتقل شعاع ضوئي من وسط عالي الكثافة الضوئية الى وسط اقل منه في الكثافة الضوئية مثل الانتقال من الماء الى الهواء وكان الانتقال أي السقوط بزواوية حرجة فإنه ينكسر بزواوية مقدارها 90° درجة

46. A beam of **light** is directed **from the bottom of a swimming pool** so as to **hit the top surface** at a 60° -angle. This beam will then **undergo** (يخضع) a **total** :

A dispersion

B diffuse reflection

C internal reflection ✓

D refraction

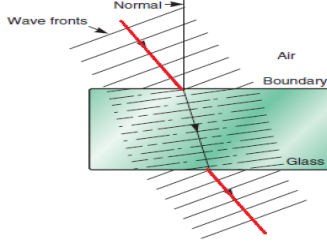
إذا سلط شعاع ضوئي من اسفل حوض للسباحة ليصطدم بالسطح (أي ان الشعاع انتقل من الماء الى الهواء اي من وسط عالي الكثافة الضوئية الى وسط اقل منه في الكثافة الضوئية) وكانت زاوية السقوط مقدارها 60° وهي اكبر من الزاوية الحرجة للماء التي تعادل 49° فسيخضع هذا الشعاع الى انعكاس كلي داخلي

$$\theta_i > \theta_c \rightarrow TIR$$

47. A **beam of light falling** obliquely on a **pane (لوح) of glass leaves** the pane such that **it is:**

- A parallel to the pane
- B perpendicular to the pane
- C perpendicular to its original direction
- D parallel to its original (أصلي) direction✓**

إذا سقط شعاع ضوئي على لوح زجاجي بشكل مائل فإن اتجاه الشعاع الخارج من اللوح يكون موازيا لاتجاه الشعاع الساقط (أي اتجاهه الأصلي)



48. A **fish under water appears nearer** because of:

- A refraction✓**
- B aberration
- C reflection
- D dispersion

تبدو الاجسام المغمورة في الماء كالمسكة اقرب مما هي عليه في الواقع بسبب الانكسار

49. **Light travels through an optical fiber by:**

- A dispersion
- B diffuse reflection
- C total internal reflection✓**
- D total refraction

ينقل الضوء عبر الالياف البصرية بواسطة الانعكاس الكلي الداخلي

Dispersion; Rainbow



50. In the **visible light spectrum, red** appears at the:

- A right
- B left✓**
- C middle
- D outside

في الطيف المرئي فان اللون الاحمر يبدو على اليسار

51. In the **visible light spectrum, the longest-wavelength light** is:

- A red✓**
- B blue
- C green
- D violet

في طيف الضوء المرئي فانه عند الانتقال من اليسار الى اليمين يقل الطول الموجي ويزداد التردد والطاقة ولذلك فان اللون الاحمر له اكبر طول موجي من الالوان الاخرى في الطيف المرئي .

52. In the **visible light spectrum, the highest frequency light** is:

- A red
- B blue
- C green
- D violet✓**

في طيف الضوء المرئي فانه عند الانتقال من اليسار الى اليمين يقل الطول الموجي ويزداد التردد والطاقة ولذلك فان اللون البنفسجي له اكبر تردد من الالوان الاخرى في الطيف المرئي .

53. The **light component that travels the fastest through glass or water** is:

- A blue light
- B red light✓**
- C violet light
- D green light

الترددات المنخفضة من الطيف المرئي تنتقل بسرعة عالية في المواد الشفافة (مثل الماء والزجاج) بينما تنتقل الترددات العالية من الطيف المرئي بسرعة بطيئة في المواد الشفافة لذلك ينتقل اللون الاحمر بأعلى سرعة في المواد الشفافة من الالوان الاخرى في الطيف المرئي .

54. **Separation of light falling on a prism into colors** is called:

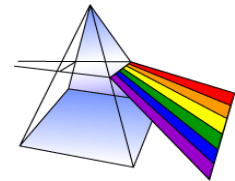
- A dispersion✓**
- B reflection
- C absorption
- D mirage

عملية فصل اللون الابيض المرئي الى مجموعة من الالوان مرتبة حسب ترددها تسمى التفرق او التشتت .

55. When **white light falls on a prism (as shown), its color components separate** so that the **highest (from base)** is:

- A blue light
- B green light
- C violet light
- D red light✓**

عند سقوط الضوء الابيض على منشور فانه يتحلل الى مكوناته من للطيف المرئي بحيث يكون اعلاها من القاعدة اللون الاحمر.



56. You can **see a rainbow on a humid day only if the sunlight** is coming from:

- A above
- B nowhere
- C behind you✓**
- D in front of you

لكي نستطيع رؤية قوس المطر فلا بد ان تكون قطرات المطر في الجهة المقابلة لأشعة الشمس لذلك فإذا كان قوس المطر امامنا فلا بد ان تكون الاشعة الضوئية قادمة من خلفنا

57. **Rainbow results from that:**

- A raindrops make the shape of prisms in the air
- B light disperses inside raindrops✓**
- C raindrops form water ponds on the ground
- D raindrops reflect light at different angles

ينشأ قوس المطر نتيجة تفرق اشعة الشمس في قطرات الماء

58. **Rainbow** is formed in the following **sequence**

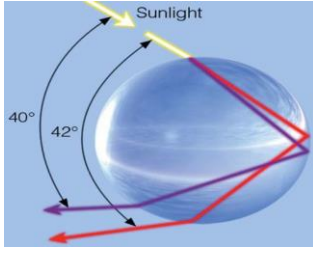
A **refraction _ reflection _ refraction** ✓

B reflection _ refraction _ reflection

C refraction _ refraction _ reflection

D reflection _ reflection _ refraction

يتكون قوس المطر نتيجة لحدوث العمليات التالية بالترتيب
: انكسار - انعكاس - انكسار



Lenses

59. A **converging** lens has _____ **surfaces** and is _____ at its **center** than its edges:

A **convex** (محدبة); thinner

B **concave** (مقعرة); thinner

C **concave**; thicker

D **convex**; thicker ✓

العدسة الممجة لها اسطح محدبة وتكون
سميكة في الوسط اكثر من الاطراف

60. A **diverging** lens has _____ **surfaces** and is _____ at its **center** than its edges:

A **convex** (محدبة); thinner

B **concave** (مقعرة); thinner ✓

C **concave**; thicker

D **convex**; thicker

العدسة المفرقة لها اسطح مقعرة
وتكون رقيقة في الوسط اكثر من
الاطراف

61. A **converging** lens **converges** a beam of light that is **parallel** to its **principal axis** into:

A **the focal point on the other side** ✓

B the focal point on the same side

C the center of curvature on the same side

D the center of curvature on the other side

العدسة الممجة (المحدبة) تجمع الاشعة الضوئية الساقطة بشكل موازي
للمحور الرئيسي في البؤرة الموجودة في الجهة الاخرى من العدسة

62. A **diverging** lens **diverges** a beam of light that is **parallel** to its **principal axis** so as to **appear** coming from:

A the focal point on the other side

B **the focal point on the same side** ✓

C the center of curvature on the same side

D the center of curvature on the other side

العدسة المفرقة (المقعرة) تفرق الاشعة الضوئية الساقطة بشكل موازي
للمحور الرئيسي بحيث تبدو بعد تفرقها وكأنها قدمت من البؤرة الموجودة
فم، جهة السقوط

63. **Light** passing through the **center** of a lens:

A bends up for a diverging lens

B bends up for a converging lens

C **passes without deviation for both types** ✓

D gets reflected for both types

الشعاع الضوئي الذي يمر من مركز العدسة (بنوعيه المحدبة
والمقعرة) لا يحدث له أي انحراف عن مساره

64. When an **object** is placed **inside** the **focal point** of a **converging** lens, its image is:

A **real and farther**

B **real and nearer**

C **virtual and nearer**

D **virtual and farther** ✓

اذا وضع جسم داخل نطاق البؤرة لعدسة
مجمعة (محدبة) أي أن بعد الجسم اقل
من البعد البؤري فإن الصورة تكون
خيالية (أي تتواجد في نفس جهة الجسم
ومكبرة وبعيدة ومعتدلة .

65. When an **object** is placed **outside** the **focal point** of a **converging** lens, its image is:

A **real and inverted** (مقلوبة) ✓

B **real and upright** (قائمة)

C **virtual and upright**

D **virtual and inverted**

اذا وضع جسم خارج نطاق
البؤرة لعدسة مجمعة (محدبة)
أي ان بعد الجسم اكبر من البعد
البؤري فإن الصورة تكون
حقيقية (أي في الجهة الاخرى
من العدسة) ومقلوبة .

66. **Distortion** (تشويه) in the **image** of a lens is called:

A **conversion**

B **aberration** ✓

C **dispersion**

D **refraction**

التشويه الحادث في الصورة الناتجة
عن العدسة يسمى الزيغ

67. **Distortion** (تشويه) in the **image** of a lens caused by **different speeds** of the **color** components (مكونات) of light is called:

A spherical aberration

B linear aberration

C astigmatic aberration

D **chromatic aberration** ✓

التشويه الحادث في الصورة الناتجة عن
العدسة بسبب اختلاف سرعات مكونات
الضوء (الوان الطيف المرئي) عند
عبورها العدسة يسمى بالزيغ اللوني

68. An **eye defect** (خلل) where the **cornea** (القرنية) is **curved unevenly** (تقوس بشكل غير مستوي) is called:

A **conversion**

B **dispersion**

C **astigmatism** ✓

D **refraction**

الخلل في العين الذي يحدث نتيجة
انحناء القرنية بشكل غير متساوي
يسمى الإستجماتزم .

69. If a **converging lens** of **2-m focal length** is placed **7 m** away from a **2.5-m-high door**, the **distance** of the door's **image** from the lens will be:

- A 1.4 m
B 2.8 m✓
 C 0.7 m
 D 5.6 m

$$s_i = \frac{s_o \cdot f}{s_o - f} = \frac{7 \times 2}{7 - 2} = \frac{14}{5} = 2.8 \text{ m}$$

70. If a **converging lens** of **2-m focal length** is placed **7 m** away from a **2.5-m-high door**, the **height** of the door's **image** will be:

- A 0.1 m
 B 0.5 m
C 1 m✓
 D 1.25 m

$$\frac{h_i}{h_o} = \frac{-s_i}{s_o} \rightarrow \frac{h_i}{2.5} = \frac{-2.8}{7}$$

$$h_i = \frac{2.5 \times -2.8}{7} = -1 \text{ m}$$

والاشارة السالبة للدلالة على ان الصورة مقلوبة

71. If a **converging lens** of **2-m focal length** is placed **7 m** away from a **2.5-m-high door**, the **magnification** of the door in the lens will be:

- A -2
 B +2
C -0.4✓
 D +0.4

$$M = \frac{h_i}{h_o} = \frac{-1 \text{ m}}{2.5 \text{ m}} = -0.4$$

او حل آخر :

$$M = \frac{-s_i}{s_o} = \frac{-2.8 \text{ m}}{7 \text{ m}} = -0.4$$

72. If a **converging lens** of **2-m focal length** is placed **7 m** away from a **2.5-m-high door**, the **image** of the door will be:

- A upright and virtual
 B inverted and virtual
 C upright and real
D inverted and real✓

بما ان بعد الجسم اكبر من البعد البؤري
 للمرأة المقعرة أي ان
 $s_o > f$
 بالتالي فان الصورة المتكونة تكون حقيقية
 ومقلوبة

73. If a **diverging lens** of **2-m focal length** is placed **8 m** away from a **2.5-m-high door**, the **distance** of the door's **image** from the lens will be:

- A 1.6 m**✓
 B 2.4 m
 C 0.8 m
 D 3.2 m

$$s_i = \frac{s_o \cdot f}{s_o - f} = \frac{8 \times -2}{8 - (-2)} = \frac{-16}{10} = -1.6 \text{ m}$$

ملاحظة : البعد البؤري للعدسة المفرقة (المقعرة) دائما
 سالب. والاشارة السالبة في بعد الصورة تدل على ان
 الصورة خيالية

74. If a **diverging lens** of **2-m focal length** is placed **8 m** away from a **2.5-m-high door**, the **height** of the door's **image** will be:

- A 0.2 m
B 0.5 m✓
 C 1 m
 D 2 m

$$\frac{h_i}{h_o} = \frac{-s_i}{s_o} \rightarrow \frac{h_i}{2.5} = \frac{-(-1.6)}{8}$$

$$h_i = \frac{2.5 \times 1.6}{8} = 0.5 \text{ m}$$

ملاحظة : بعد الصورة بالسالب لان العدسة المفرقة
 (المقعرة) تكون دائما صور خيالية لكن طولها يكون
 بالموجب لأنها معتدلة

75. If a **diverging lens** of **2-m focal length** is placed **8 m** away from a **2.5-m-high door**, the **magnification** of the door in the lens will be:

- A -0.4
 B +0.4
 C -0.2
D +0.2✓

$$M = \frac{h_i}{h_o} = \frac{0.5 \text{ m}}{2.5 \text{ m}} = 0.2$$

او حل آخر :

$$M = \frac{-s_i}{s_o} = \frac{-(-1.6) \text{ m}}{8 \text{ m}} = 0.2$$

76. If a **diverging lens** of **2-m focal length** is placed **8 m** away from a **2.5-m-high door**, the **image** of the door will be:

- A upright and virtual**✓
 B inverted and virtual
 C upright and real
 D inverted and real

صفات الصورة المتكونة عن
 العدسة المفرقة (المقعرة)
 تكون دائما خيالية (في نفس
 جهة الجسم) ومعتدلة

Extra Question On Chapter 5

77- The **frequency** of a radio wave that repeats **5000 times every second** is:

- A 0.0002 Hz
- B 20000 Hz
- C. 150000 Hz,
- D 5000 Hz**✓

$$f = \frac{5000}{1} = 5000 \text{ Hz}$$

78. The **only** waves that we **cannot see** are:

- A red light
- B green light
- C blue light
- D. ultraviolet light**✓

موجات الضوء الابيض هي المرئية فقط
اما الموجات التي ترددها اعلى او اقل من
تردد الضوء الابيض فهي غير مرئية

79. The **speed of light in glass** is:

- A. 3/2 C
- B. 2/3 C** ✓
- C. 4/3
- D. 3/4 C

$$n = \frac{c}{v} \rightarrow \frac{3}{2} = \frac{c}{v} \rightarrow v = \frac{2}{3} c$$

81. **total internal reflection** is possible for a beam of light incident from

- A .glass into water**✓
- B .water into glass
- C. air into glass
- D. air into water

يحدث الانعكاس الكلي الداخلي:
١- عند انتقال الشعاع الضوئي من وسط مرتفع في الكثافة الضوئية الى وسط اقل منه في الكثافة الضوئية.
٢- تكون زاوية السقوط اثناء هذا الانتقال اكبر من الزاوية الحرجة.
وذلك حتى يحدث انعكاس كلي للشعاع

80. A beam of light incident at **30°** from air into glass refracts at an angle of light.

- A . 45°
- B. 30°
- C . 60°
- D. < 30°**✓

اذا انتقل الشعاع الضوئي من وسط منخفض في الكثافة الضوئية الى وسط اكبر منه في الكثافة الضوئية كما في حالة عند انتقال الشعاع الضوئي من الهواء الى الزجاج فان الشعاع الضوئي سوف ينكسر مقتربا من العمود المقام وبالتالي فان زاوية الانكسار تكون اقل من زاوية السقوط

83. The **image** produced by a **converging** lens **cannot be**

- A real and enlarged
- B. virtual and inverted**✓
- C real and inverted
- D virtual and enlarged

82. **Rainbow** appears on a :

- A. sunny and dry day
- B. sunny and humid day**✓
- C. dark and humid day
- D. dark and dry day

3. **Electromagnetic** waves **start from a vibrating**:

- A fork (شوكة)
- B string (وتر)
- C spring (زنبرك)
- D charge✓

تنشأ الموجة الكهرومغناطيسية
من تذبذب شحنة كهربائية

4. In an electromagnetic wave, the electric and magnetic fields are:

- A perpendicular to each other and to the direction of motion✓
- B parallel to each other and to the direction of motion
- C perpendicular to each other and parallel to the direction of motion
- D parallel to each other and perpendicular to the direction of motion

5. A wave's **frequency** is:

- A the number of waves repeating (تكرر) every second✓
- B the time duration for one complete wave
- C the maximum value of a wave
- D the length of a single wave

تردد الموجة هو عدد الموجات التي تتكرر
في الثانية الواحدة

6. A wave's **wavelength** is:

- A the number of waves repeating every second
- B the time duration for one complete wave
- C its maximum value
- D the length of a single wave✓

الطول الموجي للموجة
هو طول موجة واحدة

7. Going from **left to right** in the **electromagnetic spectrum**, the following happens:

- A both wavelength and frequency increase
- B both wavelength and frequency decrease
- C wavelength increases and frequency decreases
- D wavelength decreases and frequency increases✓

8. In the **electromagnetic spectrum**, the **narrowest range** is that of:

- A radio waves
- B x-ray waves
- C visible light waves✓
- D ultraviolet waves

في الطيف الكهرومغناطيسي فإن
أضيق مدى سيكون لموجات
الضوء المرئي

9. **Electromagnetic** waves that **travel in vacuum slower than light** are:

- A gamma-ray waves
- B x-ray waves
- C ultraviolet waves
- D none of these✓

لأنه في الفراغ تنتقل جميع
الموجات الكهرومغناطيسية بنفس
السرعة

10. In the **electromagnetic spectrum**, the **highest energy** is that of:

- A gamma-ray waves✓
- B x-ray waves
- C visible light waves
- D ultraviolet waves

في الطيف الكهرومغناطيسي
فإن الموجات التي لها أعلى
طاقة هي أشعة جاما

11. In the **electromagnetic spectrum**, the **lowest frequency** is that of:

- A ultraviolet waves
- B x-ray waves
- C red light waves
- D radio waves✓

في الطيف الكهرومغناطيسي فإن
الموجات التي لها أقل تردد هي
موجات الراديو

12. Among the following **electromagnetic waves**, the **longest wavelength** is for:

- A infrared waves
- B microwave✓
- C visible light waves
- D ultraviolet waves

من الموجات الكهرومغناطيسية
التالية فإن التي لها أعلى طول
موجي هي موجات الميكروويف

13. The **wavelength** of **300-MHz** microwave is:

- A 1 μm
- B 1 mm
- C 1 cm
- D 1 m✓

$$f = \frac{c}{\lambda} \rightarrow \lambda = \frac{c}{f} = \frac{3 \times 10^8}{300 \text{ MHz}}$$
$$\lambda = \frac{3 \times 10^8}{300 \times 10^6} = \frac{3 \times 10^8}{3 \times 10^8} = 1 \text{ m}$$

14. The **frequency** of **0.5- μm** green light is:

- A $2 \times 10^{14} \text{ Hz}$
- B $4 \times 10^{14} \text{ Hz}$
- C $6 \times 10^{14} \text{ Hz}$ ✓
- D $8 \times 10^{14} \text{ Hz}$

$$f = \frac{c}{\lambda} = \frac{3 \times 10^8}{0.5 \mu\text{m}} =$$
$$f = \frac{3 \times 10^8}{0.5 \times 10^{-6}} = 6 \times 10^{14} \text{ Hz}$$

Reflection

15. **Wave reflection** means that it **always**:

- A enters into a new medium (وسط)
 B returns to the medium from which it came√
 C returns along the same line where it came
 D slides along the border between two media

معنى انعكاس الموجات بانها دائما
 تعود الى الوسط الذي قدمت منه

16. We **see** most **things** around us **because**:

- A they are primary sources of light
 B they are secondary sources of light
 C they reflect light√
 D they absorb light

نستطيع رؤية الاشياء من حولنا
 لانها تعكس الضوء

17. If light beam (X) falls **obliquely** on a **mirror** and **reflects** into beam (Y), we can say that:

- A X is always perpendicular to the mirror
 B Y is always perpendicular to the mirror
 C X and Y make equal angles with the mirror√
 D X and Y are perpendicular to each other

عند سقوط الشعاع الضوئي على المرآة فانه دائما
 تكون زاوية السقوط مساوية لزاوية الانعكاس

18. When a light beam is **reflected**, it keeps a **constant**:

- A speed
 B frequency
 C wavelength
 D all of these√

عند انعكاس الشعاع الضوئي فان
 الشعاع المنعكس لا تتغير سرعته او
 تردده او طول الموجه فقط الذي يتغير
 اتجاهه .

19. The **angle** of **reflection** is always:

- A equal to the angle of incidence√
 B smaller than the angle of incidence
 C larger than the angle of incidence
 D equal to the angle of refraction

20. An object placed in **front** of a **plane mirror** forms an image that is of _____ **size** and _____ **distance** to the mirror.

- A same; same√
 B larger; same
 C same; nearer
 D same; farther

اذا وضع الجسم امام مرآة مستوية فانه دائما
 تكون صورة خيالية (خلف المرآة) لها نفس
 حجم الجسم ولها نفس بعد الجسم عن المرآة

21. An object placed **between** a **concave** (مقعر) mirror and its **focus** forms an image that is of _____ **size** and _____ **distance** to the mirror.

- A smaller; farther
 B larger; nearer
 C smaller; nearer
 D larger; farther√

اذا وضع جسم بين مرآة مقعرة وبؤرتها (أي
 انه يكون داخل نطاق البؤرة) بالتالي يكون
 $S_0 < f$
 فتنكون له صورة خيالية (خلف المرآة)
 معتدلة مكبرة وبعيدة

22. An object placed in **front** of a **convex** (محدب) mirror forms an image that is of _____ **size** and _____ **distance** to the mirror.

- A smaller; farther
 B larger; nearer
 C smaller; nearer√
 D larger; farther

اذا وضع الجسم امام مرآة محدبة فانه
 تكون صورة للجسم تكون خيالية (خلف
 المرآة) ومصغرة وقريبة من المرآة

23. An **image** formed **behind** a **mirror** is **virtual** for:

- A plane, convex and concave√
 B plane and concave, and real for convex
 C plane and convex, and real for concave
 D convex and concave, and real for plane

الصورة المتكونة خلف المرآة هي صورة خيالية وتنتج عن جميع انواع
 المرايا سواء كانت مستوية او منحنية بنوعها (مقعرة ومحدبة)

24. **Diffuse reflection** occurs when **light** is **incident** on a **surface** that is:

- A smooth (أملس)
 B polished (مصقول)
 C transparent (شفاف)
 D rough (خشن)√

الانعكاس المشتت (الغير منتظم)
 يحدث عند سقوط الشعاع الضوئي
 على اسطح خشنة .

25. **Specular** (بصري) reflection occurs when **light** is **incident** on a:

- A lens
 B mirror√
 C painted wall
 D page of a book

الانعكاس البصري (منتظم) يحدث عند
 سقوط الشعاع الضوئي على اسطح
 مصقولة مثل المرآة .

26. **After diffuse reflection, light goes in:**

- A one direction
 B two opposite directions
 C no direction
 D all directions√

بعد حدوث الانعكاس المشتت فان
 الضوء المنعكس ينتشر في جميع
 الاتجاهات .

27. You can see the road ahead of your car at night because of:

- A specular reflection
- B absorption
- C diffuse reflection ✓
- D refraction

نستطيع رؤية الطريق امام السيارة ليلا بسبب حدوث الانعكاس المشتت للاشعة الضوئية .

28. If a convex mirror of 2-m focal length is placed 8 m away from a 2.5-m-high door, the image of the door will appear in the mirror at a distance of:

- A 1.6 m ✓
- B 2.4 m
- C 0.8 m
- D 3.2 m

$$s_i = \frac{s_o \cdot f}{s_o - f} = \frac{8 \times -2}{8 - (-2)} = \frac{-16}{10} = -1.6 \text{ m}$$

ملاحظة: البعد البؤري للمراة المفرقة (المحدبة) يكون دائما سالبا. والاشارة السالبة في بعد الصورة لانها خيالية

29. If a convex mirror of 2-m focal length is placed 8 m away from a 2.5-m-high door, the height of the door's image will be:

- A 0.1 m
- B 0.5 m ✓
- C 1 m
- D 1.25 m

$$\frac{h_i}{h_o} = \frac{-s_i}{s_o} \rightarrow \frac{h_i}{2.5} = \frac{-(-1.6)}{8}$$

$$h_i = \frac{2.5 \times 1.6}{8} = 0.5 \text{ m}$$

30. If a convex mirror of 2-m focal length is placed 8 m away from a 2.5-m-high door, the magnification of the door in the mirror will be:

- A 5
- B 2
- C 0.5
- D 0.2 ✓

$$M = \frac{h_i}{h_o} = \frac{0.5 \text{ m}}{2.5 \text{ m}} = 0.2$$

او حل آخر :

$$M = \frac{-s_i}{s_o} = \frac{-(-1.6) \text{ m}}{8 \text{ m}} = 0.2$$

31. If a convex mirror of 2-m focal length is placed 8 m away from a 2.5-m-high door, the image of the door will be:

- A upright and reduced ✓
- B upright and enlarged
- C inverted and reduced
- D inverted and enlarged

صفات الصورة المتكونة عن المراة المحدبة تكون دائما خيالية (خلف المراة) معتدلة ومصغرة

32. If a concave mirror of 2-m focal length is placed 7 m away from a 2.5-m-high door, the image of the door will appear in the mirror at a distance of:

- A 1.4 m
- B 2.8 m ✓
- C 0.7 m
- D 5.6 m

$$s_i = \frac{s_o \cdot f}{s_o - f} = \frac{7 \times 2}{7 - 2} = \frac{14}{5} = 2.8 \text{ m}$$

33. If a concave mirror of 2-m focal length is placed 7 m away from a 2.5-m-high door, the height of the door's image will be:

- A 0.1 m
- B 0.5 m
- C 1 m ✓
- D 1.25 m

$$\frac{h_i}{h_o} = \frac{-s_i}{s_o} \rightarrow \frac{h_i}{2.5} = \frac{-2.8}{7}$$

$$h_i = \frac{2.5 \times -2.8}{7} = -1 \text{ m}$$

والاشارة السالبة للدلالة على ان الصورة مقلوبة

34. If a concave mirror of 2-m focal length is placed 7 m away from a 2.5-m-high door, the magnification of the door in the mirror will be:

- A -2
- B +2
- C -0.4 ✓
- D +0.4

$$M = \frac{h_i}{h_o} = \frac{-1 \text{ m}}{2.5 \text{ m}} = -0.4$$

او حل آخر :

$$M = \frac{-s_i}{s_o} = \frac{-2.8 \text{ m}}{7 \text{ m}} = -0.4$$

35. If a concave mirror of 2-m focal length is placed 7 m away from a 2.5-m-high door, the image of the door will be:

- A upright and reduced
- B upright and enlarged
- C inverted and reduced ✓
- D inverted and enlarged

بما ان بعد الجسم اكبر من البعد البؤري للمراة المقعرة أي ان

$$s_o > f$$

بالتالي فان الصورة المتكونة تكون حقيقية ومقلوبة اما بالنسبة لحجمها فيحسب كالتالي :

$$s_i = \frac{s_o \cdot f}{s_o - f} = \frac{7 \times 2}{7 - 2} = \frac{14}{5} = 2.8 \text{ m}$$

$$\frac{h_i}{h_o} = \frac{-s_i}{s_o} \rightarrow \frac{h_i}{2.5} = \frac{-2.8}{7}$$

$$h_i = \frac{2.5 \times -2.8}{7} = -1 \text{ m}$$

حيث ان ارتفاع الصورة اقل من ارتفاع الجسم والاشارة السالبة تدل على الصورة مقلوبة

Refraction

36. The process of light bending when passing obliquely from one medium into another is called:

- A specular reflection
- B absorption
- C diffuse reflection
- D refraction ✓

عملية انحراف الضوء عن مساره عند انتقاله من وسط الى اخر تسمى بالانكسار .

CHAPTER 6 : MODERN PHYSICS

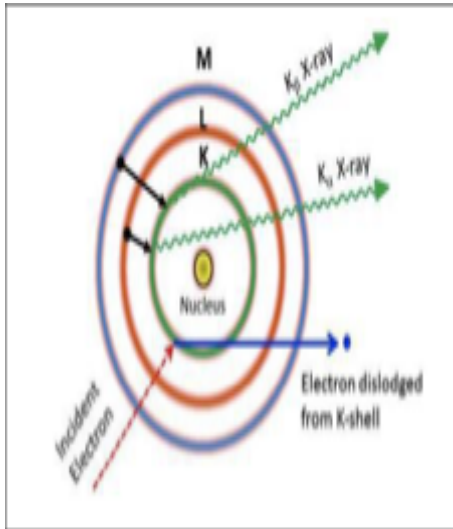
Key Terms & Definitions

Anode	مصعد؛ أنود
Beta rays	أشعة بيتا
Cathode	كاثود؛ القطب السالب
Correspondence	تناظر
Cosmic radiation	الأشعة الكونية
Electron beam	حزمة إلكترونية

Energy levels	مستويات الطاقة
Environment	البيئة
Gamma rays	أشعة غاما
Rad (Radiation Absorption Dose)	جرعة الإشعاع الممتص
Radiation-dose	جرعة إشعاعية
Radiation-therapy	المعالجة بالأشعة

Radioactivity	نشاط إشعاعي
Radon (86)	غاز الرادون (٨٦)
Relativity	النظرية النسبية
Rem (Roentgen Equivalent Man)	مكافئ رونتجن للشخص
Stable	مستقر
X-rays	أشعة أكس

X-Ray & Radioactivity



Decay Type	Radiation Emitted	Generic Equation	Model
Alpha decay	${}^4_2\alpha$	${}^A_ZX \longrightarrow {}^{A-4}_{Z-2}X + {}^4_2\alpha$	<p>Parent → Daughter + Alpha Particle</p>
Beta decay	${}^0_{-1}\beta$	${}^A_ZX \longrightarrow {}^{A}_{Z+1}X + {}^0_{-1}\beta$	<p>Parent → Daughter + Beta Particle</p>
Gamma emission	${}^0_0\gamma$	${}^A_ZX^* \xrightarrow{\text{Relaxation}} {}^A_ZX + {}^0_0\gamma$	<p>Parent (excited nuclear state) → Daughter + Gamma ray</p>

1. In 1895, **Wilhelm Roentgen** discovered:

A x-rays ✓

B radioactivity

C the element radium

D gamma-rays

4. **Before** being absorbed (تَمْتَص) or scattered (تُشْتَت), x-ray photons can penetrate (تُخْتَرِق) many layers of:

A lead

B bone

C rock

D atoms ✓

2. When a **beam of high-speed electrons strikes** (يُصَادِم) a **metal target** (هَدَف), it **dislodges** (يَقْتَلِع) the _____ of the atoms.

A inner protons

B outer protons

C inner electrons ✓

D outer electrons

5. The **energy of x-ray** photons is:

A more than gamma-ray photons

B less than microwave photons

C more than violet-light photons ✓

D less than infrared photons

3. When an **electron** is **dislodged** (تقتلع) from the **lowest energy level** of an atom, the **atom** emits **x-rays** by an:

A. outer electron falling into the lowest energy level ✓

B inner electron falling out of the lowest energy level

C inner electron falling into the nucleus

D outer electron falling into the nucleus

6. **X-rays** produce an **image** of the **bones** inside our body **by**:

A scattering (تشتت) from soft tissues and penetrating bones:

B penetrating soft tissues and getting absorbed by bones ✓

C scattering from soft tissues and getting absorbed by bone.

D penetrating both soft tissues and bone

7. **Radioactivity** started:

A in the 19th Century

B after 2nd World War

C after 1st World War

D before the human race ✓

11. All **elements** with **atomic number** greater than **82** are:

A gaseous

B artificial

C stable

D radioactive ✓

8. **Radioactivity** is a(n) _____ **phenomenon** (ظاهرة)

A natural ✓

B new

C artificial

D American

12. **Radioactive decay** results in the following **types of radiation**:

A alpha, beta, gamma ✓

B gamma, beta, x-ray

C alpha, gamma, x-ray

D alpha, beta, x-ray

9. **More** than **99.9%** of the **atoms** in our environment **are**:

A unstable

B stable ✓

C radioactive

D negative

13. Of the **radioactive radiations**, those **affected** by a **magnetic field** are:

A alpha and gamma, but not beta

B alpha and beta, but not gamma ✓

C beta and gamma, but not alpha

D alpha, beta and gamma

10. The **nucleus** of a **stable** atom:

A changes frequently

B decays in a few years

C does not change✓

D emits radiation

14. Of the **radioactive radiations**, those with an **electric charge** are:

A alpha and gamma, but not beta

B beta and gamma, but not alpha

C alpha and beta, but not gamma✓

D alpha, beta and gamma

Environmental Radiation & Radiation Doses

15. Most of our **annual exposure to radiation comes** from: السنوي للأشعة

A food and water

B medicine and diagnostics (وسائل التشخيص)

C natural background (الخلفية الطبيعية)✓

D consumer products (المنتجات الاستهلاكية)

18. The unit “**rad**” stands for :

A radiation absorbed dose (الإشعاع الممتصة)✓
(جرعة)

B roentgen equivalent man رونتجين للشخص
مكافئ

C radio frequency monitor مراقب أشعة الراديو

D real atomic mass

16. The **combustion of coal** annually **releases** into our atmosphere **13million kg** of:

A electricity

B heat

C water vapor

D radioactive elements✓

19. The unit “**rem**” stands for .

A radiation absorbed dose

B roentgen equivalent man (رونجن للشخص)✓
(مكافئ)

C radio frequency monitor

D real atomic mass

17. **Radon** is a:

A heavy inert gas✓

B transition metal

C radiation detector

D semiconductor

20. The unit “**rad**” equals:

A 0.01 J of scattered energy/ 1 kg of tissue

B 0.01 J of released energy/ 1 g of tissue

C 0.01 J of absorbed energy/ 1 kg of tissue✓

D 0.01 J of absorbed energy/ 1 g of tissue

21. The unit of **radiation dosage** based on **potential damage** is:

- A alpha
- B beta
- C ram
- D rem✓

Environmental Radiation & Radiation Doses

22. Of the following, the **most harmful** radiation **to people** is:

- A 5 rad alpha + 10 rad beta
- B 5 rad alpha + 5 rad beta
- C 5 rad alpha + 20 rad beta
- D 10 rad alpha + 5 rad beta✓

26. A **chest x-ray** exposes a **person** to a **radiation dose** (إشعاع جرعة) approximately equal to:

- A 20 k rem
- B 20 rem
- C 20 μ rem
- D 20 mrem✓

23. **Lethal doses** (قاتلة جرعات) of **radiation**, taken over a **short period of time**, begin at:

- A 500 rem✓
- B 50 rem
- C 5 rem
- D 0.5 rem

27. The **human body** contains an **amount** of **potassium** that is approximately equal to:

- A 0.2 kg✓
- B 1 kg
- C 2 kg
- D zero

24. **Radiation-therapy patients** . may receive more than **200 rems** of localized doses (مركزة جرعات) **each** _____ for **several** _____.

- A day; years
- B day; weeks✓
- C hour; days
- D month; year

28. The **human body** contains an **amount** of **radioactive potassium-40 (K-40)** that is approximately equal to:

- A 2g
- B 20 mg✓
- C 200 mg
- D zero

25. Radiation to which an **average person** in the **world is exposed per day** is approximately:

- A 1 k rem
- B 1 rem
- C 1 mrem✓
- D μ rem

29. **Between** every two heartbeats potassium-40 (**K-40**) in an average human's body **emits** approximately _____ **gamma rays**.

- A 20
- B 40 million
- C 60 thousand✓
- D zero

Environmental Radiation & Radiation Doses

30. Radiation is **harmful** to us **because**:

- A it increases our heart rate
- B it makes us too hot
- C it damages some of our cells✓
- D it burns our skin

33. Of the **radioactive radiations**, those that consist of **helium nuclei** are:

- A alpha and beta
- B only gamma
- C only beta
- D only alpha✓





31. When **cells** in our **body** are **damaged** by **radiation**, they may:

- A die
- B regenerate
- C become mutated
- D do any of these✓

34. To **absorb** (يمتص) and **collimate** (يوجه) nuclear radiation, we **use a block** of:

- A lead✓
- B aluminum
- C glass
- D brick

32. The **international symbol** of **radioactivity** is:

A	 ✓
B	
C	
D	

35. when an element **emits an alpha particle**, its atomic number :

- A. reduces by 2✓
- B. increases by 2
- C. reduces by 1
- D. increases by 1

36. when an element **emits beta particle**, its atomic number :

- A. reduces by 2
- B. increases by 2
- C. reduces by 1
- D. increases by 1✓

37. when an element **emits gamma ray** , its atomic number :

- A. reduces by 2
- B. remains constant ✓
- C. reduces by 1
- D. increases by 1