UNIT 2: Linear Motion & Waves
Linear Motion:

Science as a Human Endeavour:

Safety for motorists and other road users has been substantially increased through application of Newton's laws and conservation of momentum by the development and use of devices, including:

- helmets
- seatbelts
- crumple zones
- airbags
- safety barriers

Pearson Physics 11 pp. 283-285

Science Understanding:

- Distinguish between scalar and vector quantities, and *add and subtract vectors in one dimension*
  Pearson Physics 11 Sections 6.1-6.3
  WACE Study Guide pp. 89-92
- uniformly accelerated motion is described in terms of relationships between measurable scalar and vector quantities, including displacement, speed, velocity and acceleration —this includes *applying the relationships*:

$$v_{av} = \frac{s}{t}, \qquad a = \frac{v - u}{t}, \qquad v = u + at, \qquad s = ut + \tfrac{1}{2}at^2, \qquad v^2 = u^2 + 2as$$

  Pearson Physics 11 Sections 7.1-7.4
  WACE Study Guide pp. 93-95
  Exploring Physics p. 141; Set 14: 14.2, 14.4, 14.6, 14.8; Set 15: 15.1; 15.4, 15.8, 15.10, 15.11, 15.14, 15.16
- representations, including graphs, vectors, and equations of motion, can be used qualitatively and quantitatively to describe and predict linear motion

  Pearson Physics 11 Section 7.3
  WACE Study Guide pp. 84-97
- vertical motion is analysed by assuming the acceleration due to gravity is constant near Earth's surface

  Pearson Physics 11 Section 7.5
  WACE Study Guide pp. 99-100
- Newton's three Laws of Motion describe the relationship between the force or forces acting on an object, modelled as a point mass, and the motion of the object due to the application of the force or forces

  Pearson Physics Sections 8.3-8.5
  WACE Study Guide pp. 103-108, 112-113
  Exploring Physics p. 149-150; Set 16: 16.6, 16.8, 16.10, 16.12, 16.14
- free body diagrams show the forces and net force acting on objects, from descriptions of real-life situations involving forces acting in one or two dimensions

  This includes applying the relationships

$$\text{resultant} \quad F = ma, \qquad F_{weight} = mg$$

  Pearson Physics 11 Section 8.7
  WACE Study Guide p. 116-117 (not good on free body diagrams)
  Exploring Physics Set 16: 16.1, 16.3, 16.5
- momentum is a property of moving objects; it is conserved in a closed system and may be transferred from one object to another when a force acts over a time interval

  This includes applying the relationships

$$p = mv, \qquad \sum mv_{before} = \sum mv_{after}, \qquad mv - mu = \Delta p = F\,\Delta t$$

  Pearson Physics Sections 8.1, 8.2, 8.7
  WACE Study Guide pp. 106-111,114-116
  Exploring Physics pp. 160-161; Set 17: 17.1, 17.3, 17.5, 17.8, 17.9, 17.10, 17.12, 17.15, 17.19, 17.22
- energy is conserved in isolated systems and is transferred from one object to another when a force is applied over a distance; this causes work to be done and changes the kinetic (E_k) and/or potential (E_p) energy of objects

  This includes applying the relationships

$$E_k = \tfrac{1}{2}mv^2, \qquad E_p = mg\,\Delta h, \qquad W = Fs, \qquad W = \Delta E$$

  Pearson Physics 11 Section 9.1, 9.2, 9.4, 9.5

- collisions may be elastic and inelastic; kinetic energy is conserved in elastic collisions

    This includes applying the relationship

    $$\sum \tfrac{1}{2} m\, v^2{}_{before} = \sum \tfrac{1}{2} m\, v^2{}_{after}$$

    Pearson Physics 11 Section 9.3
    WACE Study Guide p. 120
    Exploring Physics Set 18: 18.1, 18.2, 18.3

- power is the rate of doing work or transferring energy

    This includes applying the relationship

    $$P = \frac{W}{t} = \frac{\Delta E}{t} = F\, v_{av}$$

    Pearson Physics Section 9.6
    WACE Study Guide pp. 121-123
    Exploring Physics pp. 167-168; Set 18: 18.6, 18.8, 18.12, 18.13, 18.15, 18.19, 18.21

General:
WACE Study Guide has Linear Motion Review Questions pp. 124-128 and a Trial Test pp. 175-181

Past Stage 2 Physics WACE Exam Questions:

Year	Questions
2010	6, 15, 18, 19, 22, 23
2011	3, 8, 10, 11, 14,15, 18, 19, 20
2012	1,2,4,7,11,12,13,14,17,19,22,23
2013	3,4,7,8,13,17,18,22
2014	1,8,12,13,17,23,24,25

Waves:

Science as a Human Endeavour:
- Application of the wave model has enabled the visualisation of imaging techniques. These can include:
- medical applications, such as ultrasound
    Pearson Physics 11 pp. 383-384
- geophysical exploration, such as seismology.
    Pearson Physics 11 p. 355
    WACE Study Guide pp. 141-142
- Noise pollution comes from a variety of sources and is often amplified by walls, buildings and other built structures. Acoustic engineering, based on an understanding of the behaviour of sound waves, is used to reduce noise pollution. It focuses on absorbing sound waves or planning structures so that reflection and amplification do not occur.
    Pearson Physics 11 pp. 384-386

Science Understanding:
- waves are periodic oscillations that transfer energy from one point to another
    WACE Study Guide pp. 130
    Pearson Physics 11 Section 10.1
    Exploring Physics Problem Set 19
- mechanical waves transfer energy through a medium; longitudinal and transverse waves are distinguished by the relationship between the directions of oscillation of particles relative to the direction of the wave velocity
    WACE Study Guide pp. 130-131
    Pearson Physics 11 Section 10.1
    Exploring Physics Problem Set 19
- waves may be represented by displacement/time and displacement/distance wave diagrams and described in terms of relationships between measurable quantities, including period, amplitude, wavelength, frequency and velocity
    This includes applying the relationships

    $$v = f\, \lambda\,, \qquad T = \frac{1}{f}$$

    WACE Study Guide pp. 131-134
    Pearson Physics 11 Section 10.2
    Exploring Physics p. 180; Problem Set 19
- the mechanical wave model can be used to explain phenomena related to reflection and refraction, including echoes and seismic phenomena
    WACE Study Guide pp. 137-142
    Pearson Physics 11 Section 10.3
    Exploring Physics p. 188-189; Problem Set 20

- the superposition of waves in a medium may lead to the formation of standing waves and interference phenomena, including standing waves in pipes and on stretched strings
  This includes applying the relationships for
    strings attached at both ends and pipes open at both ends

$$\lambda = \frac{2\ell}{n}$$

  pipes closed at one end

$$\lambda = \frac{4\ell}{(2n-1)}$$

  WACE Study Guide pp. 143-149
  Pearson Physics 11 Sections 10.4, 10.5
  Exploring Physics Problem Set 20
- a mechanical system resonates when it is driven at one of its natural frequencies of oscillation; energy is transferred efficiently into systems under these conditions
  WACE Study Guide pp. 146
  Pearson Physics 11 pp. 364-365
  Exploring Physics Problem Set 20
- the intensity of a wave decreases in an inverse square relationship with distance from a point source
  This includes applying the relationship

$$I \; \alpha \; \frac{1}{r^2}$$

  WACE Study Guide pp. 135-137
  Pearson Physics 11 pp. 380-382

  General:
  WACE Study Guide has Waves Review Questions pp. 150-156 and a Trial Test pp. 182-189

UNIT 1: Ionising Radiation & Nuclear Reactions, Electrical Circuits & Heating Processes

Ionising Radiation & Nuclear Reactions:
Science as a Human Endeavour:
Qualitative and quantitative analyses of relative risk (including half-life, absorbed dose, dose equivalence) are used to inform community debates about the use of radioactive materials and nuclear reactions for a range of applications and purposes, including:

- radioisotopes are used as diagnostic tools and for tumour treatment in medicine
  Pearson Physics 11 pp. 82-83
  WACE Study Guide pp. 44-45
  Exploring Physics pp. 68-69
- nuclear power stations employ a variety of safety mechanisms to prevent nuclear accidents, including shielding, moderators, cooling systems and radiation monitors
  WACE Study Guide pp. 55-57
  Exploring Physics pp. 86-87
  Pearson Physics 11 Section 4.2
- the management of nuclear waste is based on the knowledge of the behaviour of radiation.
  Pearson Physics 11 pp. 101-102
  WACE Study Guide pp. 49, 57
Science Understanding:
- the nuclear model of the atom describes the atom as consisting of an extremely small nucleus which contains most of the atom's mass, and is made up of positively charged protons and uncharged neutrons surrounded by negatively charged electrons
  WACE Study Guide pp. 33-34
  Pearson Physics 11 Section 3.1
  Exploring Physics p. 50 Set 5: 5.1, 5.2
- nuclear stability is the result of the strong nuclear force which operates between nucleons over a very short distance and opposes the electrostatic repulsion between protons in the nucleus
  WACE Study Guide pp. 33,36
  Pearson Physics 11 pp. 51-52
  Exploring Physics p.50
- some nuclides are unstable and spontaneously decay, emitting alpha, beta (+/-) and/or gamma radiation over time until they become stable nuclides
  WACE Study Guide pp. 31-37
  Pearson Physics 11 Sections 3.2, 3.3
  Exploring Physics Set 5: 5.5, 5.7, 5.9, 5.11, 5.13, 5.15, 5.17
- each species of radionuclide has a half-life which indicates the rate of decay
  This includes applying the relationship

$$N = N_0 \left(\frac{1}{2} \right)^n$$

WACE Study Guide pp. 39-42
Pearson Physics 11 Section 3.4
Exploring Physics p. 61 Set 6: 6.1, 6.3, 6.5, 6.7, 6.9, 6.11, 6.13, 6.15, 6.17

- alpha, beta and gamma radiation have different natures, properties and effects
  WACE Study Guide p. 34-35
  Pearson Physics 11 Section 3.3
- the measurement of absorbed dose and dose equivalence enables the analysis of health and environmental risks
  This includes applying the relationships

$$\text{absorbed dose} = \frac{E}{m}, \qquad \text{dose equivalent} = \text{absorbed dose} \times \text{quality factor}$$

  Pearson Physics 11 Section 3.5
  WACE Study Guide pp. 47-48
  Exploring Physics p. 70 Set 7: 7.1, 7.3, 7.5, 7.7, 7.9, 7.11, 7.13, 7.15, 7.17
- Einstein's mass/energy relationship relates the binding energy of a nucleus to its mass defect
  This includes applying the relationship

$$\Delta E = \Delta m \, c^2$$

  WACE Study Guide pp. 51-53
  Pearson Physics 11 pp. 107-108
  Exploring Physics pp. 79-80 Set 8: 8.1, 8.3, 8.5, 8.7
- Einstein's mass/energy relationship also applies to all energy changes and enables the energy released in nuclear reactions to be determined from the mass change in the reaction
  This includes applying the relationship

$$\Delta E = \Delta m \, c^2$$

  WACE Study Guide pp. 51-53
  Pearson Physics 11 pp. 91-93, 104-105
  Exploring Physics pp. 79-80 Set 8: 8.9, 8.11, 8.13, 8.15, 8.17, 8.19
- alpha and beta decay are examples of spontaneous transmutation reactions, while artificial transmutation is a managed process that changes one nuclide into another
  WACE Study Guide p. 44, 53
  Pearson Physics 11 pp. 49-50
- neutron-induced nuclear fission is a reaction in which a heavy nuclide captures a neutron and then splits into smaller radioactive nuclides with the release of energy
  WACE Study Guide pp. 51-54
  Pearson Physics 11 Section 4.1
- a fission chain reaction is a self-sustaining process that may be controlled to produce thermal energy, or uncontrolled to release energy explosively if its critical mass is exceeded
  WACE Study Guide p. 53-55
  Pearson Physics 11 Section 4.1
- nuclear fusion is a reaction in which light nuclides combine to form a heavier nuclide, with the release of energy
  WACE Study Guide pp. 56-57
  Pearson Physics 11 Section 4.3
- more energy is released per nucleon in nuclear fusion than in nuclear fission because a greater percentage of the mass is transformed into energy
  Pearson Physics 11 Sections 4.1, 4.3
  WACE Study Guide pp. 56-57

  WACE Study Guide – Chapter 2 Review Questions pp. 58-61
  WACE Study Guide – Trial Test 2 pp. 163-168
  Pearson Physics 11 Chapter 3 & 4 Review Questions (pp. 85-86 & 111)

  Past Stage 2 Physics WACE Exam Questions:

Year	Questions
2010	2,4,9,10,13,14,21
2011	1,13,16,21,23
2012	3,5,21,24
2013	1,6,10,15,16,20
2014	2,4,6,10,11,16,21

Electrical Circuits:

<u>Science as a Human Endeavour</u>
The supply of electricity to homes has had an enormous impact on society and the environment. An understanding of electrical circuits informs the design of effective safety devices for the safe operation of:

- lighting
- power points
- stoves
- other household electrical devices.

WACE Study Guide pp. 77-78
Pearson Physics 11 Section 5.6
Exploring Physics pp. 132-133

Science Understanding

- there are two types of charge that exert forces on each other

  Pearson Physics 11 Section 5.1
  WACE Study Guide pp. 63-65
  Exploring Physics p. 90 Set 9: 9.1, 9.3, 9.5, 9.9

- electric current is carried by discrete charge carriers; charge is conserved at all points in an electrical circuit

  This includes applying the relationship

  $$I = \frac{q}{t}$$

  Pearson Physics 11 pp. 128-129
  WACE Study Guide p. 66-67
  Exploring Physics pp. 91 Set 9: 9.7, 913

- energy is conserved in the energy transfers and transformations that occur in an electrical circuit

  Pearson Physics 11 Section 5.5
- the energy available to charges moving in an electrical circuit is measured using electric potential difference, which is defined as the change in potential energy per unit charge between two defined points in the circuit

  This includes applying the relationship

  $$V = \frac{W}{q}$$

  WACE Study Guide pp. 65-66
  Pearson Physics 11 Section 5.2
  Exploring Physics pp. 91
- energy is required to separate positive and negative charge carriers; charge separation produces an electrical potential difference that drives current in circuits

  WACE Study Guide p. 65-66
  Pearson Physics 11 Section 5.2
- power is the rate at which energy is transformed by a circuit component; power enables quantitative analysis of energy transformations in the circuit

  This includes applying the relationship

  $$P = \frac{W}{t} = V I$$

  Pearson Physics 11 p. 129
  WACE Study Guide p. 67-68
  Exploring Physics pp. 97 Set 10: 10.1, 10.3, 10.5, 10.7, 10.9, 10.11, 10.13

- resistance depends upon the nature and dimensions of a conductor

  Pearson Physics 11 Section 5.4
  WACE Study Guide pp. 71
- resistance for ohmic and non-ohmic components is defined as the ratio of potential difference across the component to the current in the component

  This includes applying the relationship

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

  Pearson Physics 11 Section 5.4
  WACE Study Guide pp. 70, 76-79
  Exploring Physics pp. 105; Set 11: 11.1, 11.3, 11.5, 11.7, 11.9

- circuit analysis and design involve calculation of the potential difference across the current in, and the power supplied to, components in series, parallel, and series/parallel circuits

  This includes applying the relationships

$$\text{series components,} \quad I = \text{constant,} \quad V_t = V_1 + V_2 + V_3 \; ....$$
$$R_t = R_1 + R_2 + R_3 \; ....$$

$$\text{parallel components,} \quad V = \text{constant,} \quad I_t = I_1 + I_2 + I_3 \; ....$$
$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \; ...$$

WACE Study Guide pp. 73-76
Pearson Physics 11 Section 5.5
Exploring Physics pp. 115; Set 12: 12.1, 12.3, 12.5, 12.7, 12.9, 12.11, 12.13

- there is an inherent danger involved with the use of electricity that can be reduced by using various safety devices, including fuses, residual current devices (RCD), circuit breakers, earth wires and double insulation

Pearson Physics 11 Section 5.6
WACE Study Guide pp. 76-78
Exploring Physics pp. 125-126, 132-133 Set 13: 13.1, 13.3, 13.5, 13.7, 13.9, 13.10, 13.12, 13.14

- electrical circuits enable electrical energy to be transferred and transformed into a range of other useful forms of energy, including thermal and kinetic energy, and light

WACE Study Guide p. 69
Pearson Physics 11 pp. 129-121
Exploring Physics pp. 125-126

WACE Study Guide – Chapter 3 Review Questions pp. 79-81
WACE Study Guide – Trial Test 3 pp. 169-174
Pearson Physics 11 Chapter 5 Review questions pp. 164-166

Past Stage 2 Physics WACE Exam Questions:

Year	Questions
2010	1,3,5,7,12,17,20
2011	9,12,17,22
2012	6,8,15,16,18,20
2013	2,5,12,21,23
2014	3,7,9,15,18,19,22

Heating Processes:
Science as a Human Endeavour:
- The development of heating technologies that use conduction, convection, radiation and latent heat have had, and continue to have, significant social, economic and environmental impacts. These technologies include:
  - passive solar design for heating and cooling of buildings
    Pearson Physics 11 p. 34
    WACE Study Guide p. 17
  - the development of the refrigerator over time
    Pearson Physics 11 p. 19
    WACE Study Guide pp. 13-14
  - the use of the sun for heating water
    Pearson Physics 11 p. 41
    WACE Study Guide pp. 21-22
  - engine cooling systems in cars
    Pearson Physics 11 p. 41

Science Understanding:
- the kinetic particle model describes matter as consisting of particles in constant motion, except at absolute zero
  Pearson Physics 11 pp. 4-5, 8
  WACE Study Guide pp. 2-3
  Exploring Physics pp. 12-13
- all substances have internal energy due to the motion and separation of their particles
  Pearson Physics 11 pp. 6-7
  WACE Study Guide p. 4
  Exploring Physics p.12
- temperature is a measure of the average kinetic energy of particles in a system
  Pearson Physics 11 p. 7
  WACE Study Guide p. 3-7
  Exploring Physics p 12, Set 1: 1.1
- provided a substance does not change state, its temperature change is proportional to the amount of energy added to or removed from the substance; the constant of proportionality describes the heat capacity of the substance
  This includes applying the relationship

$$Q = m c \, \Delta T$$

Pearson Physics 11 Section 1.2
WACE Study Guide pp. 8-10
Exploring Physics p. 26 Set 3: 3.3, 3.5, 3.7, 3.9, 3.11, 3.13, 3.15, 3.17, 3.19, 3.21, 3.23, 3.25

- change of state involves separating particles which exert attractive forces on each other; latent heat is the energy required to be added to or removed from a system to change the state of the system
  This includes applying the relationship

$$Q = m L$$

Pearson Physics 11 Section 1.3
WACE Study Guide pp. 10-12
Exploring Physics pp. 36-37 Set 4: 4.1, 4.3, 4.5, 4.7, 4.9, 4.11, 4.13, 4.15, 4.17, 4.19

- two systems in contact transfer energy between particles so that eventually the systems reach the same temperature; that is, they are in thermal equilibrium. This may involve changes of state as well as changes in temperature
  Pearson Physics 11 pp. 8-9, Section 1.4
  WACE Study Guide p. 9
  Exploring Physics Set 3 3.1, 3.2

- a system with thermal energy has the capacity to do mechanical work [to apply a force over a distance]; when work is done, the internal energy of the system changes
  Pearson Physics 11 pp. 9, 28
  Exploring Physics pp. 24-25

- because energy is conserved, the change in internal energy of a system is equal to the energy added by heating, or removed by cooling, plus the work done on or by the system
  Pearson Physics 11 p. 9
  Exploring Physics p.13,

- heat transfer occurs between and within systems by conduction, convection and/or radiation
  Pearson Physics 11 Sections 2.2-2.4
  WACE Study Guide pp. 15-18
  Exploring Physics p. 17, pp. 45 Set 1: 1.4, 1.11, Set 2: 2.1, 2.3, 2.5, 2.7, 2.9, 2.11, 2.13, 2.15, 2.17, 2.19

- energy transfers and transformations in mechanical systems always result in some heat loss to the environment, so that the usable energy is reduced and the system cannot be 100 percent efficient
  This includes applying the relationship

$$\text{efficiency} \quad \eta \; = \; \frac{energy \; output}{energy \; input} \; \times \; \frac{100}{1} \; \%$$

Pearson Physics 11 Section 2.1
WACE Study Guide pp. 22-23
Exploring Physics p. 13, Set 1: 1.3, 1.8

WACE Study Guide – Chapter 1 Review Questions pp. 25-28
WACE Study Guide – Trial Test 1 pp. 157-162
Pearson Physics 11 Chapter 1 & 2 Revision questions (pp. 25-26 & 43-44)

Past Stage 2 Physics WACE Exam Questions:

Year	Questions
2010	8, 11, 16, 24
2011	2, 5, 4, 6, 7
2012	9, 10
2013	9, 11, 14, 19, 24
2014	5, 14, 20