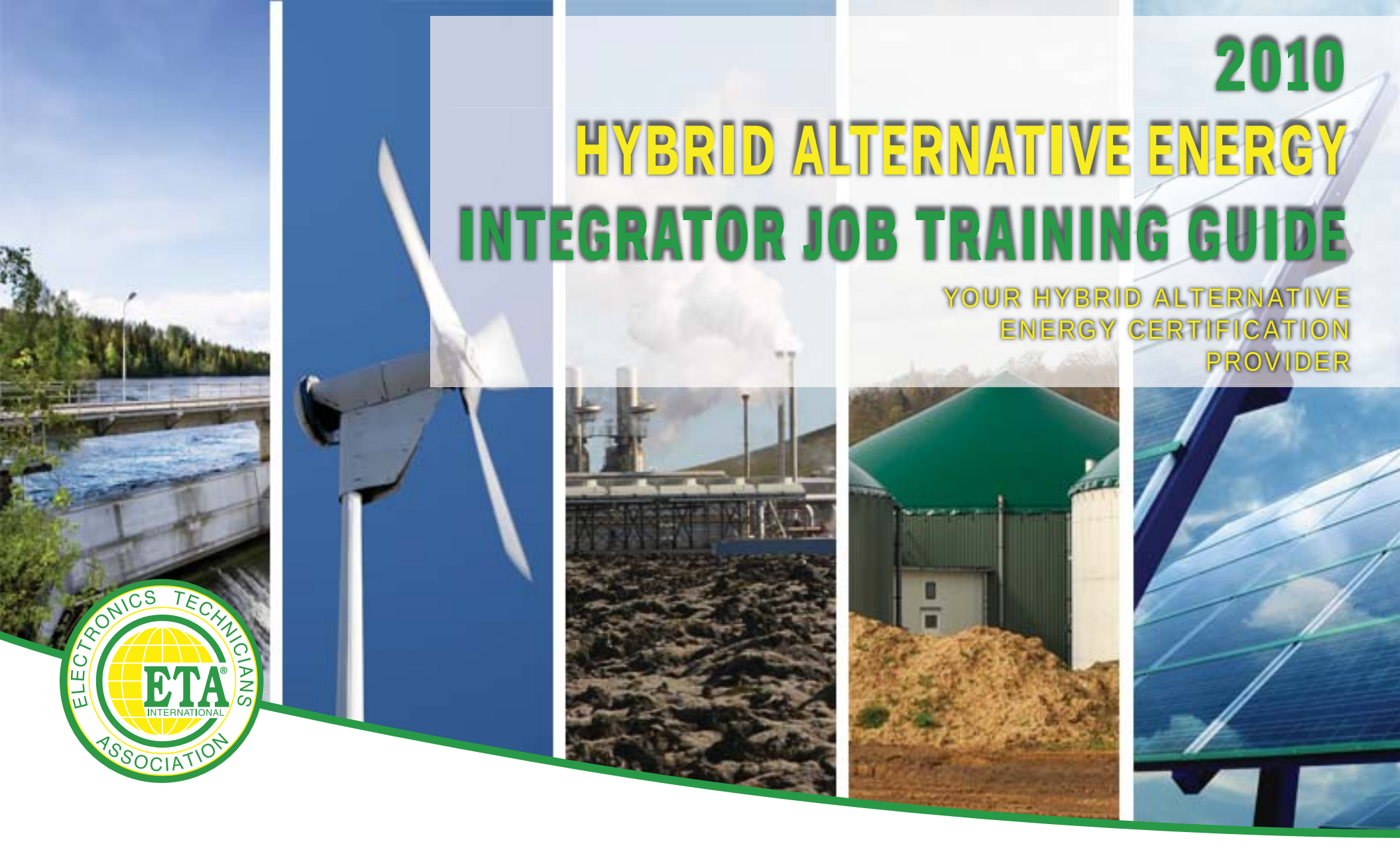

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	SCALE VALUE	PROFICIENCY CODE KEY
TASK PERFORMANCE LEVELS	**1**	Can do simple parts of the task. Needs to be told or shown how to do most of the task. **(EXTREMELY LIMITED)**
	2	Can do most parts of the task. Needs help only on hardest parts. **(PARTIALLY PROFICIENT)**
	3	Can do all parts of the task. Needs only a spot check of completed work. **(COMPETENT)**
	4	Can do the complete task completely and accurately. Can tell or show others how to do the task. **(HIGHLY PROFICIENT)**
TASK KNOWLEDGE LEVELS	**a**	Can name parts, tools, and simple facts about the task. **(NOMENCLATURE)**
	b	Can determine step-by-step procedures for doing the task. **(PROCEDURES)**
	c	Can Identify why and when the task must be done and why each step is needed. **(OPERATING PRINCIPLES)**
	d	Can predict, isolate, and resolve problems about the task. **(ADVANCED THEORY)**
SUBJECT KNOWLEDGE LEVELS	**A**	Can identify basic facts and terms about the subject **(FACTS)**
	B	Can identify relationship of basic facts and state general principles about the subject. **(PRINCIPLES)**
	C	Can analyze facts and principles and draw conclusions about the subject. **(ANALYSIS)**
	D	Can evaluate conditions and make proper decisions about the subject. **(EVALUATION)**

***** A task knowledge scale value may be used alone or with a task performance scale value to define a level of knowledge for a specific task. (**Examples: b and 1b**)

****** A subject knowledge scale value is used alone to define a level of knowledge for a subject not directly related to any specific task, or for a subject common to several tasks.

— Not required for this Level.

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2009 ALTERNATIVE ENERGY INTEGRATOR

MAJOR CATEGORIES

1.0 APPLIED PHYSICAL SCIENCE

2.0 MATH

3.0 CODES AND STANDARDS

4.0 ALTERNATIVE ENERGY POWER INCENTIVES, ECONOMICS AND FEASIBILITY STUDY

5.0 ESTIMATING HOME ENERGY NEEDS

6.0 PHOTOVOLTAICS

7.0 RESIDENTIAL FUEL CELLS

8.0 WIND ENERGY

9.0 MICRO-HYDRO

10.0 SOLAR THERMO

11.0 GEOTHERMAL HEATING AND COOLING

12.0 SOFTWARE

13.0 DEVELOPING THE SYSTEM DESIGN AND PROPOSAL

14.0 STIRLING TECHNOLOGY

1.0 APPLIED PHYSICAL SCIENCE	Level 1	Level 2	Level 3
1.1 Key Elements of Force, Work, and Motion	B	C	C
1.1.1 Define the following key terms of force, energy, work, and motion:	B	C	C
1.1.1.1 Force	B	C	C
1.1.1.1.1 Contact force	B	C	C
1.1.1.1.2 Normal force	B	C	C
1.1.1.1.3 Net force	B	C	C
1.1.1.1.4 Dissipative forces	B	C	C
1.1.1.1.5 Restoring force	B	C	C
1.1.1.1.6 Conservative force	B	C	C
1.1.1.1.7 Neoconservative force	B	C	C
1.1.1.1.8 Centrifugal	B	C	C
1.1.1.2 Energy	C	C	C
1.1.1.2.1 Kinetic energy	C	C	C
1.1.1.2.1.1 Translational kinetic energy	C	C	C
1.1.1.2.1.2 Rotational kinetic energy	C	C	C
1.1.1.2.2 Potential energy	C	C	C
1.1.1.2.2.1 Gravitational potential energy	C	C	C
1.1.1.2.2.2 Elastic potential energy	C	C	C
1.1.1.2.3 Mechanical energy	C	C	C
1.1.1.2.4 Chemical energy	C	C	C
1.1.1.2.5 Thermal energy	C	C	C
1.1.1.2.6 Electrical	C	C	D
1.1.1.2.7 Nuclear	A	A	A
1.1.1.3 Speed	B	C	C
1.1.1.3.1 Average speed	B	C	C
1.1.1.3.2 Instantaneous speed	B	C	C
1.1.1.4 Velocity	B	C	C
1.1.1.4.1 Average linear velocity	B	C	C
1.1.1.4.2 Instantaneous linear velocity	B	C	C
1.1.1.4.3 Relative velocity	B	C	C
1.1.1.4.4 Average angular velocity	B	C	C
1.1.1.4.5 Instantaneous angular velocity	B	C	C

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.1.1.5 Acceleration	B	C	C
1.1.1.5.1 Average linear acceleration	B	C	C
1.1.1.5.2 Instantaneous linear acceleration	B	C	C
1.1.1.5.3 Radial acceleration	B	C	C
1.1.1.5.4 Centripetal acceleration	B	C	C
1.1.1.5.5 Acceleration due to gravity	B	C	C
1.1.1.5.6 Average angular acceleration	B	C	C
1.1.1.5.7 Instantaneous angular acceleration	B	C	C
1.1.1.5.8 Constant angular acceleration	B	C	C
1.1.1.5.9 Tangential acceleration	B	C	C
1.1.1.6 Momentum	B	C	C
1.1.1.6.1 Linear momentum	B	C	C
1.1.1.6.2 Angular momentum	B	C	C
1.1.1.7 Vector	B	C	C
1.1.1.8 Scalar	B	C	C
1.1.1.9 Power	B	C	C
1.1.1.10 Work	B	C	C
1.1.1.11 Impulse	B	C	C
1.1.1.12 Elastic collision	B	C	C
1.1.1.13 Inelastic collision	B	C	C
1.1.1.14 Mass	B	C	C
1.1.1.14.1 Center of mass	B	C	C
1.1.1.15 Gravity	B	C	C
1.1.1.15.1 Center of gravity	B	C	C
1.1.1.16 Displacement	B	C	C
1.1.1.16.1 Resultant displacement	B	C	C
1.1.1.17 Frame of reference	B	C	C
1.1.1.17.1 Inertial reference frames	B	C	C
1.1.1.18 Motion	B	C	C
1.1.1.18.1 Uniform circular motion	B	C	C
1.1.1.18.2 Accelerated motion	B	C	C
	B	C	C

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.1.1.19 Inertia	B	C	C
1.1.1.19.1 Rotational inertia	B	C	C
1.1.1.19.2 Moment of inertia	B	C	C
1.1.1.20 Resultant	B	C	C
1.1.1.21 Free-body diagram	B	C	C
1.1.1.22 Friction	B	C	C
1.1.1.22.1 Rolling friction	B	C	C
1.1.1.22.2 Static friction	B	C	C
1.1.1.22.3 Kinetic friction	B	C	C
1.1.1.23 Rigid body	B	C	C
1.1.1.24 Tension	B	C	C
1.1.1.25 Weight	B	C	C
1.1.1.26 Centrifugation	B	C	C
1.1.2 Explain the appropriate use of the following standard units of measurements used with force, energy, work, and motion:	B	C	C
1.1.2.1 m/s	B	C	C
1.1.2.2 miles per hour	B	C	C
1.1.2.3 knot	B	C	C
1.1.2.4 m/s^2	B	C	C
1.1.2.5 meter	B	C	C
1.1.2.6 foot	B	C	C
1.1.2.7 mile	B	C	C
1.1.2.8 degree	B	C	C
1.1.2.9 radian	B	C	C
1.1.2.10 gram	B	C	C
1.1.2.11 kilogram	B	C	C
1.1.2.12 Newton	B	C	C
1.1.2.13 pound	B	C	C
1.1.2.14 ft lb	B	C	C
1.1.2.15 kcal	B	C	C
1.1.2.16 kWh	B	C	C
1.1.2.17 Watt	B	C	C

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.1.2.18 horse power	B	C	C
1.1.2.19 Hertz	B	C	C
1.1.3 Explain the following key principles, constants, and rules used with force, energy, work, and motion:	C	C	C
1.1.3.1 Resolving a vector into it's components	C	C	C
1.1.3.2 Work energy principle	C	C	C
1.1.3.3 Spring constant	C	C	C
1.1.3.4 Principle of conservation of mechanical energy	C	C	C
1.1.4 Explain the following key theorems, theories, and hypothesis used with force, energy, work, and motion:	C	C	C
1.1.4.1 Galileo's Hypothesis of free-falling bodies	C	C	C
1.1.5 Explain the following key laws used with force, energy, work, and motion:	C	C	C
1.1.5.1 Newton's First Law of Motion or law of inertia	C	C	C
1.1.5.2 Newton's Second Law of Motion	C	C	C
1.1.5.3 Newton's Third Law of Motion	C	C	C
1.1.5.4 Newton's Law of Universal Gravitation	C	C	C
1.1.5.5 Law of conservation of energy	C	D	D
1.1.5.6 Law of conservation of momentum	C	D	D
1.1.5.6.1 Two bodies colliding	C	D	D
1.1.5.6.2 Linear momentum	C	D	D
1.1.6 Explain the following key equations used with force, energy, work, and motion:	C	C	C
1.1.6.1 Kinematic equations for constant acceleration	C	C	C
1.1.6.2 Spring equation	C	C	C
1.2 Key Elements of Heat and Thermodynamics	C	C	C
1.2.1 Define the following key terms used in the technology of heat and thermodynamics:	C	C	C
1.2.1.1 Macroscopic	C	C	C
1.2.1.2 Microscopic	C	C	C
1.2.1.3 Temperature	C	C	C
1.2.1.4 Thermal stress	C	C	C
1.2.1.5 Critical temperature	C	C	C
1.2.1.6 Vapor	C	C	C
1.2.1.7 Dew point	C	C	C
1.2.1.8 Supersaturated	C	C	C

1.0 APPLIED PHYSICAL SCIENCE Cont'd		Level 1	Level 2	Level 3
1.2.1.9	Saturated vapor pressure	C	C	C
1.2.1.10	Partial pressure	C	C	C
1.2.1.11	Relative humidity	C	C	C
1.2.1.12	Concentration gradient	C	C	C
1.2.1.13	Molecular mass	C	C	C
1.2.1.14	Atomic number	C	C	C
1.2.1.15	Heat	C	C	C
1.2.1.16	Thermal energy	C	C	C
1.2.1.17	Internal energy	C	C	C
1.2.1.18	Specific heat	C	C	C
1.2.1.19	Calorimetry	C	C	C
1.2.1.20	Latent heat	C	C	C
1.2.1.21	Heat of fusion	C	C	C
1.2.1.22	Heat of vaporization	C	C	C
1.2.1.23	R-values	C	C	C
1.2.1.24	Heat reservoir	C	C	C
1.2.1.25	Isotherms	C	C	C
1.2.1.26	Operating temperatures	C	C	C
1.2.1.27	Thermal pollution	A	A	A
1.2.2	Explain the appropriate use of the following standard units of measurement used in the technology of heat and thermodynamics:	C	C	C
1.2.2.1	Degrees Celsius/centigrade	C	C	C
1.2.2.2	Degrees Fahrenheit	C	C	C
1.2.2.3	Degrees Kelvin	C	C	C
1.2.2.4	Convert units of measurement between degrees Celsius, Fahrenheit, and Kelvin	3c	3c	3c
1.2.2.5	Mole	C	C	C
1.2.2.6	Calorie	C	C	C
1.2.2.7	Kilocalorie	C	C	C
1.2.2.8	Btu	C	C	C
1.2.2.9	Joule	C	C	C
1.2.3	Explain the following key principles used in the technology of heat and thermodynamics:	C	C	C
1.2.3.1	Heat transfer	C	C	C

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.2.3.2 Work done by a gas	C	C	C
1.2.3.3 Conservation of energy	C	C	C
1.2.3.4 Enthalpy	C	C	C
1.2.3.5 Entropy	C	C	C
1.2.3.5.1 Entropy of an isolated system	C	C	C
1.2.3.6 Brownian movement	C	C	C
1.2.3.7 Thermal equilibrium	C	C	C
1.2.3.8 Universal gas constant	C	C	C
1.2.3.9 Avogadro's number	A	A	A
1.2.3.10 Boltzmann's constant	A	A	A
1.2.3.11 Maxwell distribution of speeds	B	B	B
1.2.3.12 Sublimation	A	A	A
1.2.3.13 Evaporation	A	A	A
1.2.3.14 Diffusion	A	A	A
1.2.3.15 Diffusion constant	A	A	A
1.2.3.16 Mechanical equivalent of heat	C	C	C
1.2.3.17 Change of phase	C	C	C
1.2.3.18 Heat transfer	C	C	C
1.2.3.18.1 Conduction	C	C	C
1.2.3.18.2 Convection	C	C	C
1.2.3.18.3 Radiation	C	C	C
1.2.3.19 Thermal conductivity constant	C	C	C
1.2.3.20 Proportionality constant	C	C	C
1.2.3.21 Cooling by radiation	C	C	C
1.2.3.22 Solar constant	C	C	C
1.2.3.23 Closed system	C	C	C
1.2.3.24 Open system	C	C	C
1.2.3.25 Isolated system	C	C	C
1.2.3.26 Isothermal process	C	C	C
1.2.3.27 Adiabatic process	C	C	C
1.2.3.28 Isobaric process	C	C	C
1.2.3.29 Isochoric process	C	C	C

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.2.3.30 Heat engine	C	C	C
1.2.3.31 Efficiency of a heat engine	C	C	C
1.2.3.32 Carnot engine	C	C	C
1.2.3.33 Reversibility	C	C	C
1.2.3.34 Refrigerator	C	C	C
1.2.3.35 Coefficient of performance of a refrigerator	C	C	C
1.2.3.36 Heat pump	D	D	D
1.2.3.37 Coefficient of performance of a heat pump	D	D	D
1.2.3.38 Green house effect	C	C	C
1.2.4 Explain the following key theorems and theories used in the technology of heat and thermodynamics:	D	D	D
1.2.4.1 Kinetic theory	D	D	D
1.2.5 Explain the following key laws used in the technology of heat and thermodynamics:	D	D	D
1.2.5.1 Zeroth Law of Thermodynamics	D	D	D
1.2.5.2 First Law of Thermodynamics	D	D	D
1.2.5.2.1 The law of conservation of energy	D	D	D
1.2.5.3 Second Law of Thermodynamics	D	D	D
1.2.5.3.1 Lack of reversibility	D	D	D
1.2.5.3.2 Kelvin-Planck statement of the second law of thermodynamics	D	D	D
1.2.5.3.3 Clausius statement of the second law of thermodynamics	D	D	D
1.2.5.4 Order	C	C	C
1.2.5.5 Disorder	C	C	C
1.2.5.6 Randomness	C	C	C
1.2.5.7 Degradation of energy	C	C	C
1.2.5.8 Entropy and times arrow	C	C	C
1.2.5.9 Statistical interpretation of Entropy	C	C	C
1.2.5.9.1 Microstate	C	C	C
1.2.5.9.2 Macrostate	C	C	C
1.2.5.10 Third Law of Thermodynamics	D	D	D
1.2.5.11 Law of Definite Proportions	D	D	D
1.2.5.12 Gay-Lussac's Law	D	D	D
1.2.5.13 Ideal Gas Law	D	D	D
1.2.5.14 Fick's Law	D	D	D

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.2.6 Explain the following key equations used in the technology of heat and thermodynamics:	D	D	D
1.2.6.1 The equation of state for an ideal gas	D	D	D
1.2.6.2 The equation for the average translation kinetic energy of molecules in a gas	D	D	D
1.2.6.3 The diffusion equation	D	D	D
1.2.6.4 The equation for the net rate of radiant heat flow	D	D	D
1.2.6.5 The equation for entropy change	D	D	D
1.3 Key Elements of Electromagnetism	C/3c	C/3c	C/3c
1.3.1 Key terms defined			
1.3.1.1 Insulators			
1.3.1.2 Conductors			
1.3.1.3 Charge			
1.3.1.4 Electric Potential			
1.3.1.5 Potential Difference			
1.3.1.6 Electric Field			
1.3.1.7 Phase Angle			
1.3.2 Standard units of measurement			
1.3.2.1 Volt			
1.3.2.2 Amp			
1.3.2.3 Ohm			
1.3.2.4 Watt			
1.3.3 Key principles			
1.3.3.1 Kirchhoff's rules			
1.3.3.2 Induction			
1.3.3.3 Static electricity			
1.3.3.4 Circuits			
1.3.3.3.1 Series			
1.3.3.3.2 Parallel			
1.3.3.3.3 Series-Parallel			
1.3.3.5 DC			
1.3.3.6 AC			
1.3.3.7 Current Flow	▼	▼	▼

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.3.3.8 Voltage Drop	C/3c	C/3c	C/3c
1.3.3.9 Resistance			
1.3.3.10 Capacitance			
1.3.3.11 Inductance			
1.3.3.12 Magnetism			
1.3.3.13 Transformer Action			
1.3.3.14 Motors			
1.3.3.15 Generators			
1.3.3.16 Resonance			
1.3.3.17 Ferromagnetism			
1.3.3.18 Dielectric			
1.3.3.19 Hall effect			
1.3.3.20 Impedance			
1.3.4 Key theorems			
1.3.4.1 Thevenin			
1.3.4.2 Norton			
1.3.4.3 Millman's			
1.3.4.4 Superposition			
1.3.4.5 Mesh			
1.3.5 Key laws			
1.3.5.1 Ohm's Law			
1.3.5.2 Coulombs Law			
1.3.5.3 Faraday's Law of Induction			
1.3.5.4 Lenz's Law			
1.3.5.5 Ampere's Law			
1.3.6 Key equations			
1.4 Key Elements of Light	C	C	C
1.4.1 Define the following key terms of light:	C	C	C
1.4.1.1 Photon	C	C	C
1.4.1.2 Photon Energy	C	C	C
1.4.1.3 Work Function	C	C	C
1.4.1.4 Quantum of Energy	C	C	C

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.4.1.5 Least Mechanical Equivalent of Light	C	C	C
1.4.1.6 Angstrom	C	C	C
1.4.1.7 Critical Angle	C	C	C
1.4.1.8 Refraction	C	C	C
1.4.1.8.1 Index of refraction	C	C	C
1.4.1.8.2 Angle of refraction	C	C	C
1.4.1.9 Angle of incidence	C	C	C
1.4.1.10 Angle of reflection	C	C	C
1.4.1.11 Reflection	C	C	C
1.4.1.11.1 Diffuse	C	C	C
1.4.1.11.2 Specular	C	C	C
1.4.1.12 Object Distance	C	C	C
1.4.1.13 Diffraction	C	C	C
1.4.1.16.1 Diffraction pattern	C	C	C
1.4.1.14 Chromatic	C	C	C
1.4.1.14.1 Monochromatic	C	C	C
1.4.1.15 Wave-interference	C	C	C
1.4.1.15.1 Constructive	C	C	C
1.4.1.15.2 Destructive	C	C	C
1.4.1.16 Sources	C	C	C
1.4.1.16.1 Coherent	A	A	A
1.4.1.16.2 Incoherent	A	A	A
1.4.1.17 Color spectrum	C	C	C
1.4.1.18 Ultraviolet	C	C	C
1.4.1.19 Infrared	C	C	C
1.4.1.20 Dispersion	C	C	C
1.4.1.21 Intensity	C	C	C
1.4.1.22 Polarization	C	C	C
1.4.1.22.1 Polaroid	C	C	C
1.4.1.22.2 Polaroid-sheet	C	C	C
1.4.1.22.3 Plane-polarized	C	C	C
1.4.1.22.4 Polarizer	C	C	C

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.4.1.22.5 Polarizing angle	C	C	C
1.4.1.22.6 Brewster's angle	C	C	C
1.4.1.23 Convex	C	C	C
1.4.1.24 Concave	C	C	C
1.4.1.25 Focus	C	C	C
1.4.1.26 Principal axis	C	C	C
1.4.1.27 Focal point	C	C	C
1.4.1.28 Focal length	C	C	C
1.4.1.29 Focal plane	C	C	C
1.4.1.30 Lens	C	C	C
1.4.1.30.1 Converging	C	C	C
1.4.1.30.2 Diverging	C	C	C
1.4.1.30.3 Fresnel lens	C	C	C
1.4.2 Explain the appropriate use of the following standard units of measurements used with light:	C	C	C
1.4.2.1 Electron Volt	C	C	C
1.4.2.3 Lux	C	C	C
1.4.2.4 Footcandle	C	C	C
1.4.2.5 Footlambert	C	C	C
1.4.2.6 Stlb	C	C	C
1.4.2.7 Lumen	C	C	C
1.4.2.8 Erg	--	--	A
1.4.3 Explain the following key principles, constants, and rules used with light:	C	C	C
1.4.3.1 Photons Wave verses Particle theory	C	C	C
1.4.3.2 Plank's Quantum Hypothesis	C	C	C
1.4.3.3 Plank's constant	C	C	C
1.4.3.4 Black Body Radiation	C	C	C
1.4.3.5 Photoelectric Effect	D	D	D
1.4.3.5.1 Photodiode	D	D	D
1.4.3.5.2 Photocell	D	D	D
1.4.3.5.3 Light Sensitive Transistors	D	D	D
1.4.3.5.4 Photon Energy	D	D	D

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.4.3.6 Compton Effect	C	C	C
1.4.3.7 Effects of wavelength on a photon's energy	D	D	D
1.4.3.8 Huygens' principle	C	C	C
1.4.4 Explain the following key theorems, theories, and hypothesis used with light:	C	C	C
1.4.4.1 The Ray Model	C	C	C
1.4.5 Explain the following key laws used with light:	C	C	C
1.4.5.1 Law of Conservation of Momentum	C	C	C
1.4.5.2 Law of Conservation of Energy	C	C	C
1.4.5.3 Law of reflection	C	C	C
1.4.5.4 Snell's law	C	C	C
1.4.5.5 Law of refraction	C	C	C
1.4.5.6 Brewster's law	C	C	C
1.4.6 Explain the following key equations used with light:	C	C	C
1.4.6.1 Mirror equation	C	C	C
1.4.6.2 Lens equation	C	C	C
1.4.6.3 Lens maker's equation	C	C	C
1.4.6.4 Diffraction equation	C	C	C
1.5 Key Elements of Fluid Statics and Dynamics	C	C	D
1.5.1 Define and apply the following key terms:	C	C	D
1.5.1.1 Pressure	C	C	D
1.5.1.1.1 Dynamic pressure	C	C	D
1.5.1.1.2 Static pressure	C	C	D
1.5.1.1.3 Pressure head	C	C	D
1.5.1.1.4 Gauge pressure	C	C	D
1.5.1.1.5 Absolute pressure	C	C	D
1.5.1.1.6 Differential pressure	C	C	D
1.5.1.2 Density	B	B	B
1.5.1.3 Specific Gravity	B	B	B
1.5.1.4 Viscosity	D	D	D
1.5.1.4.1 Coefficient of viscosity	D	D	D
1.5.1.5 Laminar Flow	D	D	D
1.5.1.6 Turbulent Flow	D	D	D

1.0 APPLIED PHYSICAL SCIENCE Cont'd		Level 1	Level 2	Level 3
1.5.1.7	Aneroid Gauge	B	B	B
1.5.1.8	Barometer	B	B	B
1.5.1.9	Eddy currents in fluids	D	D	D
1.5.1.10	Dynamic Lift	D	D	D
1.5.1.11	Surface Tension	B	B	B
1.5.1.12	Surfactants	B	B	B
1.5.1.13	Cohesion	B	B	B
1.5.1.14	Adhesion	B	B	B
1.5.1.15	Capillarity	B	B	B
1.5.1.16	Plasma	B	B	B
1.5.1.17	Open tube manometer	B	B	B
1.5.1.18	Buoyancy	B	B	B
1.5.1.19	Apparent weight	B	B	B
1.5.1.20	Hydrometer	B	B	B
1.5.1.21	Venturi meter	B	B	B
1.5.1.22	Velocity gradient	B	B	B
1.5.1.23	Surface energy	B	B	B
1.5.2	Define and apply the following units of measurement, and convert between SI (International Standard) and English:	C	C	C
1.5.2.1	kg/m^3	C	C	C
1.5.2.2	N/m^2	C	C	C
1.5.2.3	psi	C	C	C
1.5.2.4	pascal	C	C	C
1.5.2.5	GPM	C	C	C
1.5.2.6	atm.	C	C	C
1.5.2.7	bar	C	C	C
1.5.2.8	mm-HG	C	C	C
1.5.2.9	torr	C	C	C
1.5.2.10	$N.s/m^2$	C	C	C
1.5.2.11	poise	C	C	C
1.5.3	Explain and apply the following key principles and constants:			
1.5.3.1	Bernoulli's principle	D	D	D
1.5.3.2	Pascal's principle	D	D	D

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.5.3.3 Archimedes' principle	A	A	A
1.5.3.4 Venturi Effect	D	D	D
1.5.3.5 Boltzmann's constant	A	A	A
1.5.4 Explain and apply the following key theorems and theories:	D	D	D
1.5.4.1 Bernoulli's theorem	D	D	D
1.5.4.2 Torricell's theorem	D	D	D
1.5.5 Explain and apply the following key laws:	D	D	D
1.5.5.1 Charles's Law	D	D	D
1.5.5.2 Boyle's Law	D	D	D
1.5.5.3 Pascal's Law	D	D	D
1.5.6 Explain and apply the following key equations and their use:	D	D	D
1.5.6.1 Bernoulli's Equation	D	D	D
1.5.6.2 Continuity Equation	D	D	D
1.5.6.3 Poiseuille's Equation	D	D	D
1.6 Key Concepts of Chemistry	C	C	D
1.6.1 Explain the following key principles, effects and constants used in chemistry.	C	C	D
1.6.1.1 Chemistry of Acids, Bases and Salts	C	C	D
1.6.1.2 Electrochemistry	C	C	D
1.6.1.3 Chemistry of Oxidation and Reduction	C	C	D
1.6.1.4 Chemical Bonding	C	C	D
1.6.1.5 Chemistry of the Battery	C	C	D
1.6.1.5.1 Lead Acid	C	C	D
1.6.1.5.2 NiCad	C	C	D
1.6.1.5.3 Lithium	C	C	D
1.6.1.5.4 Gel battery	C	C	D
1.6.1.6 Organic Compounds	C	C	D
1.6.1.7 The Periodic Table	C	C	D
1.6.1.8 Sub-concepts in Chemistry	C	C	D
1.6.1.8.1 Radioactivity	C	C	D
1.6.1.8.2 Mole Concept	C	C	D
1.6.1.8.3 Law of Conservation	C	C	D
1.6.1.8.4 Alkali Metals and Earths	C	C	D

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.6.1.8.5 Halogens	C	C	D
1.6.1.8.6 Concentration and Solubility	C	C	D
1.6.1.8.7 Freezing and Boiling Points	C	C	D
1.6.1.8.8 Equilibrium Constant	C	C	D
1.6.1.8.9 Le Châtelier's Principle	C	C	D
1.6.1.8.10 Catalytic Processes	C	C	D
1.7 Key Elements of Mechanics and Equilibrium	D	D	D
1.7.1 Define and apply the following key terms used with mechanics and equilibrium:	D	D	D
1.7.1.1 Torque	D	D	D
1.7.1.2 Lever arm	D	D	D
1.7.1.3 Moment arm	D	D	D
1.7.1.4 Axis of rotation	D	D	D
1.7.1.5 Moment of force	D	D	D
1.7.1.6 Equilibrium	D	D	D
1.7.1.6.1 Stable equilibrium	D	D	D
1.7.1.6.2 Unstable equilibrium	D	D	D
1.7.1.6.3 Neutral equilibrium	D	D	D
1.7.1.7 Elastic region	D	D	D
1.7.1.8 Plastic region	D	D	D
1.7.1.9 Elasticity	C	C	C
1.7.1.10 Stress	C	C	C
1.7.1.10.1 Compressive	C	C	C
1.7.1.10.2 Shear	C	C	C
1.7.1.11 Strain	C	C	C
1.7.1.12 Elastic modulus (Elastic modulus)	C	C	C
1.7.1.13 Young's modulus (Share modulus)	C	C	C
1.7.1.14 Bulk modulus (Bulk modulus)	C	C	C
1.7.2 Define the following standard units of measurements used in mechanics and equilibrium:	A	A	A
1.7.2.1 E (N/m2)	A	A	A
1.7.2.2 G (N/m2)	A	A	A
1.7.2.3 B (N/m2)	A	A	A

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.7.3 Define the following principles and constants used in mechanics and equilibrium:	D	D	D
1.7.3.1 Mechanical advantage	D	D	D
1.7.3.2 Levers	D	D	D
1.7.3.2.1 1st Class Lever	D	D	D
1.7.3.2.2 2nd Class Lever	D	D	D
1.7.3.2.3 3rd Class Lever	D	D	D
1.7.3.3 Pulleys	D	D	D
1.7.3.4 Gears	D	D	D
1.7.3.5 Inclined plane	D	D	D
1.7.3.6 Screw	D	D	D
1.7.3.7 Principle of equilibrium	D	D	D
1.7.3.7.1 First condition of equilibrium	D	D	D
1.7.3.7.2 Second condition of equilibrium	D	D	D
1.7.3.8 Cantilever	D	D	D
1.7.3.9 Beam and wire support	D	D	D
1.7.3.10 Elastic limit	D	D	D
1.7.3.11 Proportional limit	D	D	D
1.7.4 Define the following theorems and theories used in mechanics and equilibrium:	+	+	+
1.7.5 Define and apply the following key laws used in mechanics and equilibrium:	D	D	D
1.7.5.1 Hooke's law	D	D	D
1.7.6 Define the following equations used in mechanics and equilibrium:	+	+	+
1.8 Key Elements of Meteorology			
1.8.1 Explain the appropriate use of the following key terms used with meteorology.	+	+	+
1.8.2 Explain the appropriate use of the following standard units of measurements used with meteorology:			
1.8.2.1 Barometric Pressure	--	A	A
1.8.2.1.1 Inches of Mercury (Hg)	--	A	A
1.8.2.1.2 MilliBar (mB)	--	A	A
1.8.2.1.3 hectoPascal (hPa)	--	A	A
1.8.2.2 Wind Speed	--	A	A
1.8.2.2.1 MPH	A	A	A
1.8.2.2.2 m/s	A	A	A
1.8.2.2.3 Beaufort Scale	A	A	A

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.8.2.2.4 Saffir-Simpson Scale	A	A	A
1.8.2.2.5 Fujita Scale	A	A	A
1.8.3 Explain how to research and interpret information from the following:			
1.8.3.1 NOAA (National Oceanic and Atmospheric Administration)	2c	2c	3c
1.8.3.1.1 Basic Meteorological Reports	2c	2c	3c
1.8.3.1.2 Weather Maps and Charts	2c	2c	3c
1.8.3.2 National Meteorological Databases			
1.8.3.2.1 Earth Axial Tilt Angle	3c	3c	3c
1.8.3.2.2 Solar Irradiation	3c	3c	3c
1.8.3 Explain the following key principles, effects and constants used in meteorology.			
1.8.3.1 Solar Time	B	B	B
1.8.3.2 Longitude	B	B	B
1.8.3.3 Latitude	B	B	B
1.8.3.4 Coriolis Effect	A	A	A
1.8.3.5 Wind patterns	B	B	B
1.8.3.6 Temperature ranges	--	A	A
1.8.3.6.1 El Niño	--	A	A
1.8.3.6.2 La Niña	--	A	A
1.8.3.7 Weather patterns	--	A	A
1.8.3.8 Climate	--	A	A
1.8.3.9 Ocean currents	--	A	A
1.8.3.10 Wind speed and direction	A	C	C
1.8.3.11 Updraft and downdraft	B	B	B
1.8.3.12 Airflow around a pressure system	A	C	C
1.8.3.13 Use of rain and snow gauges	--	--	A
1.8.4 Explain the following key theorems, theories, and hypothesis used with meteorology.	+	+	+
1.8.5 Explain the following key laws used with meteorology.	+	+	+
1.8.6 Explain the following key equations used with meteorology			
1.8.6.1 Celsius to Fahrenheit	B	B	B
1.8.6.2 Fahrenheit to Celsius	B	B	B
1.8.6.3 Heat index and wind chill factors	--	--	A
1.8.6.4 Dew point and frost point	--	--	A

1.0 APPLIED PHYSICAL SCIENCE Cont'd	Level 1	Level 2	Level 3
1.8.6.5 Humidity:	--	--	A
1.8.6.5.1 Absolute	--	--	A
1.8.6.5.2 Relative	--	--	A
1.8.6.5.3 Specific	--	--	A
- END OF 1.0 APPLIED PHYSICAL SCIENCE -			

2.0 MATH	Level 1	Level 2	Level 3
2.1 Explain how to make the key arithmetic and algebraic calculations required in the alternative energy field	B	C	D
2.1.1 Explain how to do calculations using decimals	B	C	D
2.1.2 Define “percent”, “base”, and “rate” and explain their use	B	C	D
2.1.3 Explain how to solve equations with one unknown	B	C	D
2.1.4 Explain how to solve equations with two unknowns	B	C	D
2.1.5 Explain how to solve inequalities	B	C	D
2.1.6 Explain how to solve equations with logarithmic expressions	B	C	D
2.1.6.1 Define the following logarithmic terms	B	C	D
2.1.6.1.1 Logarithm	B	C	D
2.1.6.1.2 Antilogarithm	B	C	D
2.1.6.1.3 Co-logarithm	B	C	D
2.1.6.1.4 Natural logarithm	B	C	D
2.1.6.1.5 Base	B	C	D
2.1.6.1.6 Characteristic	B	C	D
2.1.6.1.7 Mantissa	B	C	D
2.1.7 Explain how to solve equations with differential expressions	--	C	D
2.2 Explain how to make the key trigonometric calculations required in the alternative energy field	B	C	D
2.2.1 Explain how to do calculations using sines	B	C	D
2.2.2 Explain how to do calculations using cosines	B	C	D
2.2.3 Explain how to do calculations using tangents	B	C	D
2.3 Explain how to make the key trigonometric calculations required in the alternative energy field	B	C	D
2.3.1 Define the following terms:	--	C	D
2.3.1.1 Mean	--	C	D
2.3.1.2 Median	--	C	D
2.3.1.3 Mode	--	C	D
2.3.1.4 Z Distribution	--	C	D
2.3.1.5 Standard deviation	--	C	D
2.3.1.6 Sigma level	--	C	D
2.3.2 Explain how to calculate the following:	--	C	D
2.3.2.1 Mean	--	C	D
2.3.2.2 Standard deviation	--	C	D
2.3.2.3 Probability	--	C	D

3.0 CODES AND STANDARDS	Level 1	Level 2	Level 3
3.1 Municipal Codes	+	+	D
3.2 National Electrical Code	+	+	D
3.2.1 Article 300 – Wiring Methods	+	+	D
3.2.3 Article 445 – Generators	+	+	D
3.2.1 Article 685 – Integrated Electrical Systems	+	+	D
3.2.2 Article 690 – Solar Photovoltaic Systems	+	+	D
3.2.3 Article 692 – Fuel Cell Systems	+	+	D
3.2.4 Article 700 – Emergency Systems	+	+	D
3.3 ANSI/TIA/EIA-570A	+	+	D
3.4 NFPA 5000	+	+	D
3.5 NFPA 9000	+	+	D
3.6 International Residential Code (IRC)	+	+	D
3.7 ANSI/ASHRAE/IESNA Standard 100-1995	+	+	D
3.8 ANSI/ASHRAE/IESNA Standard 90.1-1989	+	+	D
3.9 ANSI/ASHRAE Standard 90.2-2001	+	+	D
3.10 ANSI/ASHRAE Standard 105-1984	+	+	D
3.12 IEEE 1547	+	+	D
3.13 IEEE 929	+	+	D
3.14 UL 1703, Standard for Flat-plate Photovoltaic Modules and Panels	+	+	D
3.15 UL 1741, Standard for Static Inverters, Converters, & Controllers for use in Independent Power Systems	+	+	D

4.0 ALTERNATIVE ENERGY POWER INCENTIVES, ECONOMICS AND FEASIBILITY STUDY	Level 1	Level 2	Level 3
4.1 Explain the economics of residential alternative energy production	C	C	D
4.1.1 Interpret a payback analysis for indicated sources of alternative energy, both singularly and in hybridized combinations	C	3c	4d
4.2 Explain the Energy Policy Act and its effects on the residential use of alternative energy	B	C	D
4.3 Calculate the value of any rebates indicated for residential alternative energy use	3b	3c	3c
4.4 Calculate tax incentives indicated for residential alternative energy use:	3b	3c	3c
4.4.1 Federal	3b	3c	3c
4.4.2 State	3b	3c	3c
4.4.3 Local	3b	3c	3c
4.5 Explain the various methods of selling excess power	C	C	C
4.6 Explain what Renewable Energy Credits are and the various methods of deriving revenue from them	C	C	D
4.7 Identify the laws that affect the installation and means of alternative energy production	D	D	D
4.8 Determine the feasibility of using alternative energy on the site under consideration	D	D	D
4.8.1 Explain how to research legal restrictions and codes for the following:	D	D	D
4.8.1.1 Local energy producer policies on grid-tied systems	D	D	D
4.8.1.2 Homeowners association covenants	D	D	D
4.8.1.3 Local codes	D	D	D
4.8.1.4 State laws	D	D	D
4.8.1.5 Federal laws	D	D	D
4.8.2 Research information on the following:	3c	3c	4d
4.8.2.1 Local energy producers pricing	3c	3c	4d
4.8.2.2 Local energy producers buy-back rates	3c	3c	4d
4.8.2.3 Local energy producers purchase rate on Green Credits	3c	3c	4d
4.8.3 Calculate the following expected energy requirements for:	4d	4d	4d
4.8.3.1 Monthly average	4d	4d	4d
4.8.3.2 Peak projected consumption	4d	4d	4d
4.8.3.3 Projected Increases in consumption	4d	4d	4d
4.8.3.4 Total recommended installed capacity	4d	4d	4d
4.8.4 Determine geographical feasibility of the site	D	D	D
4.8.4.1 Determine geographical feasibility for deriving alternative energy from:	D	D	D
4.8.4.1.1 Geothermal	--	D	D
4.8.4.1.2 Solar Passive Thermal	--	D	D

4.0 ALTERNATIVE ENERGY POWER INCENTIVES, ECONOMICS AND FEASIBILITY STUDY Cont'd	Level 1	Level 2	Level 3
4.8.4.1.3 Micro Hydro	D	D	D
4.8.4.1.4 Wind	D	D	D
4.8.4.1.5 Photovoltaic	D	D	D
4.8.4.1.6 Residential Fuel Cells	D	D	D
4.8.4.2 Discuss aesthetic considerations for each of the alternative energy sources indicated by the geographical study	B	C	D
4.8.4.3 Inspect the local site for physical restraints and determine if the restraints can be mitigated	D	D	D
4.8.5 Discuss cost of production of all indicated alternative energy sources	D	D	D
4.8.6 Discuss cost of purchase and installation of all indicated alternative energy sources	C	D	D
4.8.7 Determine which, if any, alternative energy sources can be recommended (either singularly or in a hybridized combination)	C	D	D
4.8.8 Create the Site Feasibility Study report for the site under construction	--	3c	4d
- END OF 4.0 ALTERNATIVE ENERGY POWER INCENTIVES, ECONOMICS AND FEASIBILITY STUDY -			

5.0 ESTIMATING HOME ENERGY NEEDS	Level 1	Level 2	Level 3
5.1 Analyze whole-home electrical loads for opportunities to improve energy efficiency and develop an efficient energy use plan	3b	3c	3d
5.1.1 Identify electrical loads that may be shifted to a more appropriate energy source	3b	3c	3d
5.1.2 Identify electrical appliances that may be replaced by more energy efficient ones	3b	3c	3d
5.1.2.1 Explain the appliance Energy Star rating system and how to use it in improving the efficient use of energy in the home	C	C	C
5.2 Calculate electrical load requirements for the following:	3b	3c	3d
5.2.1 Lighting	3b	3c	3d
5.2.2 Heating	3b	3c	3d
5.2.3 Air-conditioning and ventilation	3b	3c	3d
5.2.4 Refrigeration	3b	3c	3d
5.2.5 Hot water	3b	3c	3d
5.2.6 Home entertainment	3b	3c	3d
5.2.7 Data (computing and networking)	3b	3c	3d
5.2.8 Communications	3b	3c	3d
5.2.9 Security	3b	3c	3d
5.2.10 Integration and management	3b	3c	3d
5.2.11 Electric motors and actuators	3b	3c	3d
5.2.12 Phantom loads	3b	3c	3d
5.3 Calculate load estimates and prepare a load summary worksheet to prepare a load summary for:	3b	3c	3d
5.3.1 Existing structures	3b	3c	3d
5.3.2 Proposed new structures	3b	3c	3d
	3b	3c	3d
5.4 Identify peak consumption periods and their levels of energy consumption	3b	3c	3d
5.5 Identify the maximum projected load and its projected duration	3b	3c	3d
5.6 Explain an appliance's duty cycle and its use in calculating the appliance's load requirements	C	C	C
5.7 Explain an appliance's projected surge load and its use in calculating the appliance's load requirements	C	C	C
5.8 Calculate the whole home monthly and yearly projected load	3b	3c	3d

6.0 PHOTOVOLTAICS	Level 1	Level 2	Level 3
6.1 Describe photovoltaic system types	C	C	D
6.2 Describe required components for a photovoltaic system	B	B	D
6.3 Demonstrate knowledge of solar radiation fundamentals	B	C	D
6.3.1 Explain the following terms and units of measurements and their use in photovoltaics:	C	C	C
6.3.1.1 Insolation	C	C	D
6.3.1.2 Peak Sun hours	C	C	D
6.3.1.3 Orientation	C	C	D
6.3.1.4 Azimuth	C	C	D
6.3.1.5 Magnetic declination	C	C	D
6.3.1.6 Kilowatt-hours per square meter	D	D	D
6.3.1.7 Tilt angle	D	D	D
6.3.1.7.1 Winter loads	D	D	D
6.3.1.7.2 Summer loads	D	D	D
6.3.1.8 Solar Noon	C	C	C
6.3.1.9 Altitude	C	C	C
6.3.1.10 Latitude	C	C	C
6.4 Research and compile site data for the proposed site of a photovoltaic system	3c	3c	4d
6.5 Conduct a site analysis for the proposed site of a photovoltaic system	3c	3c	4d
6.6 Describe the modules necessary to create a photovoltaic system	C	C	D
6.6.1 List the types of modules	C	C	D
6.6.2 List the characteristics of various modules and the function of each	C	C	D
6.6.2.1 Define standard test conditions	C	C	D
6.6.2.1.1 Define the following terms as they relate to a photovoltaic module's Standard test conditions:	C	C	D
6.6.2.1.1.1 PTC (PV USA test condition) ratings	C	C	D
6.6.2.1.1.2 STC (Standard test condition) ratings	C	C	D
6.6.3 Describe a photovoltaic module's performance	C	C	C
6.6.3.1 Describe external factors and how they affect a photovoltaic module's performance	C	C	C
6.6.3.1.1 Temperature	C	C	C
6.6.3.1.2 Dirt	C	C	C
6.6.3.1.3 Solar intensity	C	C	C
6.6.3.2 Explain the use of a module's I-V Curve (current-voltage)	C	C	C

6.0 PHOTOVOLTAICS Cont'd	Level 1	Level 2	Level 3
6.6.3.3 Define the following terms as they relate to a photovoltaic module's performance:	C	C	C
6.6.3.3.1 Maximum Power Point (Vmp) and (Imp)	C	C	C
6.6.3.3.2 Short Circuit Current (Isc)	C	C	C
6.6.3.3.3 Open Circuit Voltage (Voc)	C	C	C
6.6.3.3.4 Load Resistance	C	C	C
6.6.4 Explain the theory of operation of a photovoltaic module:	C	C	C
6.6.4.1 Describe photovoltaic module cell types	C	C	C
6.6.4.2 Explain how a photovoltaic module operates in series with another module	C	C	C
6.6.4.3 Explain how a photovoltaic module operates in parallel with another module	C	C	C
6.6.4.4 Explain how a photovoltaic module operates when connected in a series-parallel array	C	C	C
6.6.5 List safety considerations when working with photovoltaic modules	D	D	D
6.7 Identify the various array mounting techniques	D	D	D
6.7.1 Explain the procedures for roof mounting of photovoltaic arrays	D	D	D
6.7.1.1 Explain wind loading as it applies to roof mounted photovoltaic arrays	D	D	D
6.7.1.2 Identify structural issues that may affect roof mounted photovoltaic arrays	D	D	D
6.7.2 Explain the procedures for ground mounted photovoltaic arrays	D	D	D
6.7.3 Explain the procedures for pole mounted photovoltaic arrays	D	D	D
6.7.3.1 Explain the tracking system used to track pole-mounted photovoltaic arrays	D	D	D
6.8 Explain the battery's role in both an on-grid and off-grid configuration	D	D	D
6.8.1 Identify the various types of batteries used in a photovoltaic system	B	B	B
6.8.2 List the specifications for batteries used in a photovoltaic system	B	B	D
6.8.3 State the optional configurations available to organize a battery bank	C	C	D
6.8.3.1 Explain how batteries are hooked up in series and their expected performance in this configuration	C	C	C
6.8.3.2 Explain how batteries are hooked up in parallel and their expected performance in this configuration	C	C	C
6.8.4 Explain the theory of operation of the various types of batteries used with photovoltaic systems	C	C	C
6.8.4.1 Explain charging stages	C	C	C
6.8.5 List the safety issues relating to batteries used with photovoltaic systems	D	D	D
6.9 Explain the use of photovoltaic controllers	C	C	D
6.9.1 List the various types of controllers used with photovoltaic systems:	C	C	D

6.9.1.1	Shunt controllers	C	C	D
6.9.1.2	Single-stage series controllers	C	C	D
6.9.1.3	Diversion controllers	C	C	D
6.9.1.4	Pulse-width modulation	C	C	D
6.9.1.5	Maximum power point tracking controllers	C	C	D
6.9.1.6	Voltage step down controllers	C	C	D
6.9.2	Explain the characteristics of the various types of controllers used with photovoltaic systems	C	C	D
6.9.3	Explain the theory of operation of the various types of controllers used with photovoltaic systems	C	C	D
6.9.4	List the safety issues relating to controllers used with photovoltaic systems	D	D	D
6.10	Explain the use of inverters with photovoltaic systems	C	C	C
6.10.1	List the various types of inverters used with photovoltaic systems:	C	C	D
6.10.1.1	Waveform types	C	C	D
6.10.1.1.1	Square wave	C	C	D
6.10.1.1.2	Modified	C	C	D
6.10.1.1.3	Sine wave	C	C	D
6.10.1.2	Grid-tied	D	D	D
6.10.1.3	Stand-alone	D	D	D
6.10.1.4	Grid-tied with battery backup	D	D	D
6.10.1.5	AC coupled	D	D	D
6.10.1.6	Micro inverters	C	C	C
6.10.2	Explain the theory of operation of inverters	C	C	C
6.10.3	List the safety issues relating to inverters used with photovoltaic systems	D	D	D
6.11	Explain the organization of photovoltaic systems wiring	D	D	D
6.11.1	Describe the wire sizes used with photovoltaic systems	C	C	C
6.11.1.1	Explain the expected voltage drop with the various wire sizes and currents carried	D	D	D
6.11.2	Describe the over-current and over-voltage protection used with of photovoltaic systems wiring	D	D	D
6.11.3	Explain conduit fill adjustments and how they relate to photovoltaic system wiring	D	D	D
6.11.4	Explain the use of disconnects and how they relate to photovoltaic system wiring	D	D	D
6.11.5	Explain the use of grounding how it relates to photovoltaic systems wiring	D	D	D
6.11.6	List the safety issues relating to wiring used with photovoltaic systems	D	D	D

6.0 PHOTOVOLTAICS Cont'd	Level 1	Level 2	Level 3
6.12 Describe stand-alone photovoltaic systems	C	C	D
6.12.1 Design a stand-alone photovoltaic system	3c	3c	4d
6.12.2 Explain how stand-alone photovoltaic systems are sized	C	C	D
6.12.3 Explain how stand-alone photovoltaic systems are hybridized with a generator	C	C	C
6.12.4 Explain the theory of operation of stand-alone photovoltaic systems	C	C	C
6.12.5 List the safety issues relating to stand-alone photovoltaic systems	D	D	D
6.13 Describe grid-tied photolytic systems	C	C	D
6.13.1 Design a grid-tied photolytic system	3c	3c	4d
6.13.2 Explain how grid-tied photolytic systems are sized	C	C	D
6.13.3 Explain how grid-tied photolytic systems are hybridized with a generator	C	C	C
6.13.4 Explain Net-metering	C	C	C
6.13.5 Explain the theory of operation of grid-tied photolytic systems	C	C	C
6.13.6 List the safety issues relating to grid-tied photolytic systems	D	D	D
6.14 Explain the following aspects of photovoltaic systems installation:	C	C	D
6.14.1 Conduct a site evaluation	3c	3c	4d
6.14.2 Photovoltaic array installation	C	C	D
6.14.3 Battery installation	C	C	D
6.14.4 Controller installation	C	C	D
6.14.5 Inverter installation	C	C	D
6.14.6 System wiring installation	C	C	D
6.14.7 Hook up, operational check, and commissioning	C	C	D
6.14.8 Documentation	C	C	D
6.14.9 Safety issues of installation	D	D	D
6.14.10 Cost analysis	C	C	D
6.15 Explain maintenance and troubleshooting principles used with installed photovoltaic systems	D	D	D
- END OF 6.0 PHOTOVOLTAICS -			

7.0 RESIDENTIAL FUEL CELLS		Level 1	Level 2	Level 3
7.1	List the system components necessary for a residential fuel cell	C	C	D
7.2	List the various types of fuels cells that could be used to provide electricity to the home	C	C	D
7.3	Explain the fundamentals of producing energy with fuel cells	C	C	D
7.4	Explain the procedure for collecting site data needed to conduct a site analysis before installing a residential fuel cell	D	D	D
7.5	Explain the procedure for conducting a site analysis before installing a residential fuel cell	D	D	D
7.6	Describe the following attributes concerning residential fuel cells:	C	C	C
7.6.1	Types	C	C	C
7.6.2	Characteristics	C	C	C
7.6.3	Performance	C	C	C
7.6.4	Theory of operation	C	C	C
7.6.5	Safety	D	D	D
7.7	Describe the following steps in fuel cell installation:	D	D	D
7.7.1	Site evaluation	D	D	D
7.7.2	Fuel cell installation	D	D	D
7.7.3	Battery installation	D	D	D
7.7.4	Controller installation	D	D	D
7.7.5	Inverter installation	D	D	D
7.7.6	System wiring installation	D	D	D
7.7.7	Hook up and operational check	D	D	D
7.7.8	Documentation	D	D	D
7.7.9	Safety issues of installation	D	D	D
7.7.10	Cost analysis	D	D	D
7.8	Explain maintenance and troubleshooting principles used with installed residential fuel cells	D	D	D

8.0 WIND ENERGY		Level 1	Level 2	Level 3
8.1	List the system components necessary for wind energy systems	C	C	C
8.2	List the various types of wind energy systems that could be used to provide electricity to the home	C	C	C
8.3	Explain the fundamentals of producing energy with wind energy systems	C	C	D
8.4	Explain the procedure for collecting site data needed to conduct a site analysis before installing a residential wind energy system	D	D	D
8.5	Explain the procedure for conducting a site analysis before installing a residential wind energy system	C	C	D
8.6	Describe the following attributes concerning residential wind energy system:	C	C	C
8.6.1	Types	C	C	C
8.6.2	Characteristics	C	C	C
8.6.3	Performance	C	C	C
8.6.4	Theory of operation	C	C	C
8.6.5	Safety	D	D	D
8.7	Describe the following steps in residential wind energy system installation:	C	C	C
8.7.1	Site evaluation	D	D	D
8.7.2	Wind energy generator installation	C	C	D
8.7.3	Battery installation	C	C	D
8.7.4	Controller installation	C	C	D
8.7.5	Inverter installation	C	C	D
8.7.6	System wiring installation	C	C	D
8.7.7	Hook up, operational check, commissioning	C	C	D
8.7.8	Documentation	C	C	D
8.7.9	Safety issues of installation	D	D	D
8.7.10	Cost analysis	D	D	D
8.8	Explain maintenance and troubleshooting principles used with installed residential wind energy systems	D	D	D

9.0 MICRO-HYDRO		Level 1	Level 2	Level 3
9.1	List the system components necessary for micro-hydro energy systems	C	C	C
9.2	List the various types of micro-hydro energy systems that could be used to provide electricity to the home	C	C	C
9.3	Explain the fundamentals of producing energy with micro-hydro energy systems	C	C	D
9.4	Explain the procedure for collecting site data needed to conduct a site analysis before installing a residential micro-hydro energy system	D	D	D
9.5	Explain the procedure for conducting a site analysis before installing a residential micro-hydro energy system	C	C	D
9.6	Describe the following attributes concerning residential micro-hydro energy system:	C	C	C
9.6.1	Types	C	C	C
9.6.2	Characteristics	C	C	C
9.6.3	Performance	C	C	C
9.6.4	Theory of operation	C	C	C
9.6.5	Safety	D	D	D
9.7	Describe the following steps to residential micro-hydro energy system installation:	C	C	C
9.7.1	Site evaluation	D	D	D
9.7.2	Micro-hydro energy generator installation	C	C	D
9.7.3	Battery installation	C	C	D
9.7.4	Controller installation	C	C	D
9.7.5	Inverter installation	C	C	D
9.7.6	System wiring installation	C	C	D
9.7.7	Hook up and operational check	C	C	D
9.7.8	Documentation	C	C	D
9.7.9	Safety issues of installation	D	D	D
9.7.10	Cost analysis	D	D	D
9.8	Explain maintenance and troubleshooting principles used with installed residential micro-hydro energy systems	D	D	D

10.0 SOLAR THERMO/LIGHTING	Level 1	Level 2	Level 3
10.1 Describe the concept of solar heating	--	C	D
10.1.1 State the theory of operation for the following:	--	C	D
10.1.1.1 Thermal mass	--	C	D
10.1.1.2 Thermal lag	--	C	D
10.1.1.3 Thermal cycle	--	C	D
10.1.1.4 Direct gain	--	C	D
10.1.1.5 Indirect gain	--	C	D
10.1.1.6 Trombe walls	--	C	D
10.1.1.7 Isolated solar gain	--	C	D
10.1.2 Explain how to conduct a site evaluation for the use of residential passive heating	--	D	D
10.1.3 Describe solar heating design procedures	--	C	D
10.1.4 Describe the steps to solar heating installation	--	C	D
10.1.5 Explain the safety issues relating to passive heating	--	D	D
10.2 Describe the concept of solar water heating	--	C	D
10.2.1 State the theory of operation of solar water heating	--	C	D
10.2.2 Explain how to conduct a site evaluation for the use of residential solar water heating	--	D	D
10.2.3 Design the following solar water heating systems:	--	3c	4d
10.2.3.1 Flat plate	--	3c	4d
10.2.3.2 Evacuated tube	--	3c	4d
10.2.3.3 Compact systems	--	3c	4d
10.2.3.4 Closed loop systems	--	3c	4d
10.2.3.5 Pumped systems	--	3c	4d
10.2.4 Describe the solar water heater installation procedures	--	C	C
10.2.5 Explain the safety issues relating to solar water heating	--	D	D
10.3 Describe the concept of solar pool heating	--	C	C
10.3.1 State the theory of operation of solar pool heating	--	C	C
10.3.2 Explain how to conduct a site evaluation for the use of residential solar pool heating	--	C	D
10.3.3 Describe solar pool heating designs	--	C	D
10.3.4 Describe solar pool heating installation procedures	--	C	C
10.3.5 Explain the safety issues relating to solar pool heating	--	D	D
10.4 Describe the concept of solar lighting	--	C	D
10.4.1 State the theory of daylighting for the following:	--	C	D

10.0 SOLAR THERMO Cont'd	Level 1	Level 2	Level 3
10.4.1.1 Reflected	--	C	D
10.4.1.2 Solar tubes	--	C	D
10.4.1.3 Skylights	--	C	D
10.4.1.4 Clerestory windows	--	C	D
10.5 Describe the concept of solar cooling	--	C	D
10.5.1 State the theory of solar cooling for the following:	--	C	D
10.5.1.1 Reflected	--	C	D
10.5.1.2 Convective cooling	--	C	D
10.5.1.3 Radiative cooling systems (evaporation)	--	C	D
- END OF 10.0 SOLAR THERMO -			

11.0 GEOTHERMAL HEATING AND COOLING	Level 1	Level 2	Level 3
11.1 Describe the concept of geothermal heating and cooling	--	C	D
11.2 Explain the theory of operation of the following Earth loops	--	C	C
11.2.1 Horizontal loops	--	C	C
11.2.2 Vertical loops	--	C	C
11.2.3 Pond/lake loops	--	C	C
11.2.4 Open loops (well-water systems)	--	C	C
11.3 Explain the theory of operation of heat exchangers	--	D	D
11.4 Describe codes as they affect the design and installation of geothermal heating and cooling systems	--	D	D
11.5 Site evaluation	--	D	D
11.6 Explain the procedures for installing geothermal heating and cooling systems for the following:	--	D	D
11.6.1 Installations for new structures	--	D	D
11.6.2 Retrofit installations	--	D	D
11.7 Explain the safety issues relating to geothermal heating and cooling	--	D	D
- END OF 11.0 GEOTHERMAL HEATING AND COOLING -			

12.0 SOFTWARE	Level 1	Level 2	Level 3
12.1 Use alternative energy management and residential integration software	3c	4c	4d
12.2 Use computer assisted drawing software for residential integrators	3c	4c	4c
12.3 Use alternative energy site analyses and design software for residential integrators	3c	4c	4d
12.4 Use site feasibility study software for residential integrators	3c	4c	4d
- END OF 12.0 SOFTWARE -			

13.0 DEVELOPING THE SYSTEM DESIGN AND PROPOSAL	Level 1	Level 2	Level 3
13.1 Develop a material list for a residential alternative energy project	2b	3c	4d
13.2 Develop a labor estimate for a residential alternative energy project	2b	3c	4d
13.3 Develop plans for a residential alternative energy project	2b	3c	4d
13.4 Explain the procedure for obtaining permits for a residential alternative energy project	C	C	D
13.5 Develop a work schedule for a residential alternative energy project	2b	3c	4d
13.6 Calculate the cost for a residential alternative energy project	2b	3c	4d
13.7 Calculate the price for a residential alternative energy project	2b	3c	4d
13.8 Write the contract for a residential alternative energy project	B	2b	4d
13.9 Present the proposal to a customer for a residential alternative energy project	4d	4d	4d
- END OF 13.0 DEVELOPING THE SYSTEM DESIGN AND PROPOSAL -			

14.0 STIRLING TECHNOLOGY	Level 1	Level 2	Level 3
14.1 List the system components necessary for Stirling energy systems	A	A	A
14.2 List the various types of Stirling energy systems that could be used to provide electricity to the home	A	A	A
14.3 Explain the fundamentals of producing energy with Stirling energy systems	A	A	A
14.5 Explain the procedure for collecting site data needed to conduct a site analysis before installing a residential Stirling energy system	A	A	A
14.5 Explain the procedure for conducting a site analysis before installing a residential Stirling energy system	A	A	A
14.6 Describe the following attributes concerning residential Stirling energy system:	A	A	A
14.6.1 Types	A	A	A
14.6.2 Characteristics	A	A	A
14.6.3 Performance	A	A	A
14.6.4 Theory of operation	A	A	A
14.6.5 Safety	A	A	A
14.7 Describe the following steps to residential Stirling energy system installation:	A	A	A
14.7.1 Site evaluation	A	A	A
14.7.2 Stirling generator installation	A	A	A
14.7.3 Battery installation	A	A	A
14.7.4 Controller installation	A	A	A
14.7.5 Inverter installation	A	A	A
14.7.6 System wiring installation	A	A	A
14.7.7 Hook up and operational check	A	A	A
14.7.8 Documentation	A	A	A
14.7.9 Safety issues of installation	A	A	A
14.7.10 Cost analysis	A	A	A
14.8 Explain maintenance and troubleshooting principles used with installed residential Stirling energy systems	A	A	A
- END OF 14.0 STIRLING TECHNOLOGY -			