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Inquiry-Based Learning Strategies in Physics Education for Industrial Technology: Fostering Work and Life Skills among Secondary School Students

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Abstract

Inquiry-based learning has gained prominence as an effective pedagogical approach for developing practical competencies in physics education, particularly within industrial technology programmes aimed at fostering work and life skills. This study investigated the effect of inquiry-based learning strategies in physics education for industrial technology on the development of work and life skills among secondary school students. A quasi-experimental pretest-post test control-group research design was adopted. The study was conducted in Otukpo, Benue State. The target population comprised all physics students in government technical colleges in the area, from which a sample of 160 secondary school students was selected from Government Technical College, Otukpo, using multi-stage sampling techniques. Data were collected using a validated Work and Life Skills Inventory (WLSI) and a Physics Achievement Test (PAT). The instruments were validated through expert review by specialists in physics education, industrial technology, and measurement and evaluation. Reliability coefficients of 0.82 and 0.79 were obtained for the WLSI and PAT respectively using Cronbach's alpha. Students in the experimental group were exposed to inquiry-based learning strategies involving guided investigations, problem-solving tasks, and collaborative experiments in physics concepts relevant to industrial technology, while the control group received conventional instruction. Data were analysed using Analysis of Covariance (ANCOVA) at the 0.05 level of significance. Findings revealed that students taught with inquiry-based learning strategies achieved significantly higher mean scores in both work and life skills and physics achievement than those taught with the traditional method. The study concluded that inquiry-based learning strategies in physics education effectively enhance work and life skills among secondary school students in industrial technology programmes. It is recommended that physics teachers in technical colleges adopt inquiry-based instructional approaches and that curriculum planners integrate structured inquiry activities into the industrial technology physics curriculum to better prepare students for the world of work and lifelong learning.

Keywords: Inquiry-Based Learning, Physics Education, Industrial Technology, Work And Life Skills, Secondary School Students

1. INTRODUCTION

1.1 Background to the Study

The 21st century workplace demands graduates who possess not only subject-matter knowledge but also a repertoire of transferable work and life skills, including critical thinking, problem-solving, collaboration, communication, creativity, and adaptability. In technical and vocational education, these competencies are essential for bridging the gap between classroom learning and industrial practice (UNESCO, 2015; World Bank, 2019). Physics, as a foundational science in industrial technology programmes, offers unique opportunities for developing such skills when taught through active, student-centred pedagogies.

Inquiry-based learning (IBL) has emerged as a powerful instructional approach that engages learners in authentic scientific practices—posing questions, designing investigations, collecting and analysing data, and constructing explanations (Pedaste et al., 2015; Lazonder & Harmsen, 2016). Within physics education, guided and structured forms of inquiry have been shown to improve conceptual understanding, science process skills, and 21st-century competencies (Hidayatullah & Wulan, 2022; van Uum et al., 2023). When contextualised within industrial technology themes such as mechanics, electricity, energy conversion, and materials, IBL can simultaneously deepen physics knowledge and cultivate workplace-relevant dispositions.

In Nigeria, technical colleges are mandated to produce skilled manpower for industrial and technological development. Yet persistent challenges—teacher-centred instruction, limited practical exposure, and weak linkage between physics concepts and industrial applications—continue to hinder the development of work-ready graduates (Okoye & Arimonu, 2016; Uthman et al., 2024). Consequently, many secondary technical students exit with inadequate problem-solving capacity, low collaboration skills, and limited confidence in applying physics principles to real-world technical tasks.

Inquiry-based strategies that emphasise guided investigations, collaborative experiments, and industrial-context problem-solving therefore hold considerable promise for transforming physics education in technical colleges. By positioning students as active investigators rather than passive recipients of information, these strategies can foster the work and life skills required for employability and lifelong learning.

1.2 Statement of the Problem

Despite the recognised importance of physics in industrial technology programmes, conventional lecture-demonstration methods dominate classrooms in many Nigerian technical colleges. These methods often prioritise content coverage over the development of transferable skills. Students rarely engage in authentic inquiry, design their own investigations, or collaborate on industrial-relevant problems. As a result, achievement in physics remains modest, and graduates frequently lack the critical thinking, teamwork, communication, and problem-solving competencies demanded by employers (National Board for Technical Education [NBTE], 2018; Adeyele & Ramnarain, 2024).

Although international and regional studies have documented the benefits of inquiry-based learning for conceptual understanding and science process skills (Minner et al., 2010; Hidayatullah & Wulan, 2022), empirical evidence specific to the development of work and life skills among secondary technical college students in Nigeria remains scarce. In particular, little is known about the differential impact of inquiry-based versus conventional instruction on both physics achievement and a comprehensive set of work and life skills within the industrial technology context. This gap necessitates rigorous investigation.

1.3 Purpose of the Study

The purpose of this study was to investigate the effect of inquiry-based learning strategies in physics education for industrial technology on the development of work and life skills among secondary school students in Otukpo, Benue State. Specifically, the study sought to:

1. Determine the effect of inquiry-based learning strategies on students' work and life skills.
2. Determine the effect of inquiry-based learning strategies on students' achievement in physics concepts relevant to industrial technology.
3. Examine whether any differential effects exist across dimensions of work and life skills (critical thinking/problem-solving, collaboration, communication, creativity/innovation, and self-management).

1.4 Research Questions

4. What is the effect of inquiry-based learning strategies on the mean work and life skills scores of secondary technical college students?
5. What is the effect of inquiry-based learning strategies on the mean physics achievement scores of secondary technical college students?
6. Are there significant differences in the dimensions of work and life skills between students taught with inquiry-based strategies and those taught with conventional methods?

1.5 Hypotheses

The following null hypotheses were tested at the 0.05 level of significance:

***H0*1:** There is no significant difference in the mean post-test work and life skills scores of students taught physics using inquiry-based learning strategies and those taught using the conventional method, after controlling for pre-test scores.

***H0*2:** There is no significant difference in the mean post-test physics achievement scores of students taught using inquiry-based learning strategies and those taught using the conventional method, after controlling for pre-test scores.

***H0*3:** There is no significant difference in the mean scores on the dimensions of work and life skills between the experimental and control groups after the intervention.

1.6 Significance of the Study

The findings of this study are expected to provide empirical evidence on the efficacy of inquiry-based learning for fostering work and life skills in technical college physics. Curriculum developers and the National Board for Technical Education may use the results to justify the integration of structured inquiry activities into industrial technology physics curricula. Physics teachers in technical colleges will gain practical guidance on implementing guided investigations and collaborative experiments. Students stand to benefit from improved conceptual understanding and enhanced employability skills. Finally, the study contributes to the growing body of African research on learner-centred pedagogies in vocational science education.

1.7 Scope and Delimitations

The study was delimited to National Technical Certificate (NTC) II physics students in Government Technical College, Otukpo, Benue State. The inquiry-based intervention focused on selected physics topics with clear industrial technology applications: forces and machines, electricity and electrical circuits, energy conversion and efficiency, and properties of materials. Work and life skills were operationalised through five dimensions measured by the WLSI. The intervention lasted six weeks. Generalisation is therefore limited to similar technical college contexts in Nigeria.

1.8 Operational Definitions

Inquiry-based learning strategies: Instructional approaches in which students, under teacher guidance, formulate questions, design and conduct investigations, analyse data, and construct evidence-based explanations related to physics concepts in industrial contexts.

Work and life skills: Transferable competencies comprising critical thinking and problem-solving, collaboration, communication, creativity and innovation, and self-management/responsibility, as measured by the Work and Life Skills Inventory (WLSI).

Industrial technology physics: Physics content and applications relevant to technical trades, including mechanics, electricity, energy systems, and materials science.

Secondary school students: In this study, National Technical Certificate (NTC) II students enrolled in government technical colleges.

2. LITERATURE REVIEW

2.1 Conceptual Framework

2.1.1 Inquiry-Based Learning in Physics Education

Inquiry-based learning encompasses a continuum of pedagogical approaches ranging from confirmation and structured inquiry to guided and open inquiry (Banchi & Bell, 2008; Pedaste et al., 2015). In secondary physics, guided inquiry—where the teacher provides the question and materials but students design procedures and interpret results—has been found particularly effective for developing both conceptual understanding and process skills (Lazonder & Harmsen, 2016; van Uum et al., 2023). Meta-analyses confirm that guided inquiry produces significant gains in 21st-century skills among high-school physics learners (Hidayatullah & Wulan, 2022).

When physics inquiry is contextualised within industrial technology themes, students encounter authentic problems such as diagnosing mechanical efficiency losses, designing simple electrical circuits for workshop use, or investigating material strength under load. Such contextualisation enhances relevance and supports the transfer of learning to workplace settings (Okoye & Arimonu, 2016; Uthman et al., 2024).

2.1.2 Work and Life Skills in Technical Education

Work and life skills, often subsumed under the broader label of 21st-century skills or soft skills, include critical thinking, problem-solving, collaboration, communication, creativity, and self-regulation (UNESCO, 2015; UNICEF MENA, 2017). In technical and vocational education and training (TVET), these skills are recognised as critical for employability and lifelong learning (World Bank, 2019). Physics laboratories and workshops provide natural settings for practising these competencies when instruction shifts from teacher demonstration to student investigation and collaborative problem-solving.

Empirical studies in Nigerian technical colleges have shown that inquiry-oriented and project-based approaches improve both cognitive achievement and soft skills in auto-mechanics, metalwork, and electrical installation (Uthman et al., 2024; Joseph, 2025). Similar findings have been reported for STEM integration in secondary schools across Africa (Ekine et al., 2023).

2.1.3 Hands-on and Active Learning in Industrial Technology

Hands-on, active learning is a cornerstone of effective technical education. When students manipulate apparatus, collect data, and troubleshoot real devices, they construct deeper conceptual models and develop procedural fluency (Elizar, 2023; Rahman et al., 2025). Inquiry-based strategies systematise this hands-on engagement by embedding it within a scientific investigation cycle, thereby linking practical skill development with higher-order cognitive processes.

2.2 Theoretical Framework

2.2.1 Constructivism

Constructivist theory posits that learners actively construct knowledge through experience and social interaction rather than passively receiving information (Piaget, 1970; Vygotsky, 1978). Inquiry-based learning is a direct pedagogical expression of constructivism: students build understanding by investigating phenomena, testing ideas, and negotiating meaning with peers. In the industrial technology context, constructivist inquiry allows students to connect abstract physics principles with concrete technical applications.

2.2.2 Experiential Learning Theory

Kolb's (1984) experiential learning cycle—concrete experience, reflective observation, abstract conceptualisation, and active experimentation—provides a complementary framework. Inquiry activities in physics laboratories supply the concrete experience; subsequent group discussion and report writing support reflection and conceptualisation; and application of findings to new industrial problems constitutes active experimentation. The six-week intervention in the present study was designed to cycle repeatedly through these stages.

2.2.3 Socio-Scientific and Socio-Technical Issues

Engaging students with socio-technical issues—such as energy efficiency in workshops, safety in electrical installations, or sustainable material selection—adds authentic purpose to inquiry (Zeidler et al., 2019). Although the present study focused primarily on skill development rather than citizenship outcomes, the industrial contexts chosen for investigations inherently contained socio-technical dimensions that enriched student engagement.

2.3 Related Empirical Studies

A growing body of research supports the efficacy of inquiry-based approaches in physics and technical education. Hidayatullah and Wulan (2022) conducted a meta-analysis of 30 studies and concluded that guided inquiry significantly enhances 21st-century skills among high-school physics students. Van Uum et al. (2023) found that guided inquiry practicals on ionising radiation produced significant gains in intrinsic motivation compared with step-by-step instruction.

In the Nigerian technical college context, studies on inquiry and related active strategies have reported positive effects on achievement and retention in auto-mechanics (Effects of Inquiry-Based Instructional Strategy, 2025), metalwork (Uthman et al., 2024), and electronics works (Joseph, 2025). Project-based and problem-based variants have similarly improved practical skills and soft skills in electrical/electronic technology education (Efficacy of problem-based intervention, 2025). Internationally, inquiry activities have been shown to raise levels of inquiry skills themselves (Impact of inquiry activities, 2018) and to support the gradual development of control-of-variables reasoning (Investigating the Evolution of CVS Sub-Skills, 2026).

Despite this evidence, few studies have simultaneously measured both physics achievement and a multi-dimensional work-and-life-skills construct within an industrial-technology physics course at the secondary technical level in Nigeria. The present study addresses that gap.

3. METHODOLOGY

3.1 Research Design

A quasi-experimental pretest-posttest control-group design was adopted. Intact classes were assigned to experimental and control conditions to avoid disruption of the school timetable. The design controlled for pre-existing differences through analysis of covariance (ANCOVA), with pre-test scores as covariates.

3.2 Population and Sample

The target population comprised all NTC II physics students in government technical colleges in Otukpo Local Government Area, Benue State. A multi-stage sampling procedure was used. First, Government Technical College, Otukpo was purposively selected because it offers industrial technology programmes with a substantial physics enrolment. Second, four intact NTC II classes were randomly assigned—two to the experimental group ($n = 82$) and two to the control group ($n = 78$)—yielding a total sample of 160 students. The sample size was considered adequate for detecting medium effect sizes with power ≥ .80 at $\alpha = .05$.

3.3 Instruments

3.3.1 Work and Life Skills Inventory (WLSI)

The WLSI is a 40-item Likert-type instrument developed by the researcher to measure five dimensions of work and life skills: (1) Critical Thinking and Problem-Solving (8 items), (2) Collaboration (8 items), (3) Communication (8 items), (4) Creativity and Innovation (8 items), and (5) Self-Management and Responsibility (8 items). Response options ranged from 1 (Strongly Disagree) to 5 (Strongly Agree). Content and face validity were established by a panel of three experts in physics education, industrial technology, and measurement and evaluation. Cronbach's alpha reliability coefficient for the overall scale was 0.82; subscale alphas ranged from 0.74 to 0.81.

3.3.2 Physics Achievement Test (PAT)

The PAT is a 40-item multiple-choice test covering the four industrial-technology-relevant physics topics taught during the intervention. Items were generated from the NBTE curriculum and validated by the same expert panel. A pilot test with 40 students yielded a Cronbach's alpha of 0.79 and a mean item difficulty index of 0.48. The test was scored dichotomously (1 = correct, 0 = incorrect), giving a maximum score of 40.

3.4 Intervention

The experimental group received a six-week inquiry-based instructional programme organised around four modules:

- Module 1 – Forces, Machines and Mechanical Advantage (Week 1–1.5)
- Module 2 – Electricity, Circuits and Electrical Safety in Workshops (Week 1.5–3)
- Module 3 – Energy Conversion, Efficiency and Conservation (Week 3–4.5)
- Module 4 – Properties of Materials and Simple Strength Testing (Week 4.5–6)

Each module followed a guided-inquiry sequence: (a) presentation of an industrial-context problem or question; (b) small-group formulation of hypotheses and experimental design; (c) hands-on investigation using available workshop and laboratory equipment; (d) data analysis and construction of explanations; and (e) whole-class sharing and reflection. Teachers received a two-day orientation workshop and a detailed lesson guide. The control group was taught the same content using conventional lecture-demonstration methods.

3.5 Data Collection Procedure

After obtaining ethical clearance and informed consent, both groups completed the WLSI and PAT as pre-tests. The six-week intervention followed. Immediately after the final module, the same instruments were administered as post-tests under identical conditions. All sessions were supervised by the researcher and trained research assistants.

3.6 Data Analysis

Descriptive statistics (means, standard deviations) were computed for pre- and post-test scores. ANCOVA was used to test the hypotheses, with pre-test scores as covariates and instructional method as the independent variable. Partial eta-squared (ηp^2) was reported as a measure of effect size. Analyses were performed using SPSS version 26 at the 0.05 significance level.

3.7 Ethical Considerations

Permission was obtained from the college principal and the Benue State Science and Technical Schools Board. Students and parents/guardians provided informed consent. Participation was voluntary; students could withdraw at any time without penalty. Anonymity and confidentiality were maintained throughout. The control group received a condensed inquiry-based enrichment session after data collection to ensure equity.

4. RESULTS

4.1 Descriptive Statistics

Table 1 presents the pre-test and post-test mean scores and standard deviations for work and life skills (WLSI) and physics achievement (PAT) by group.

Table 1

Pre-test and Post-test Mean Scores and Standard Deviations for WLSI and PAT by Group

Variable / Group	N	Pre-test M	Pre-test SD	Post-test M	Post-test SD
WLSI – Experimental	82	98.42	11.67	142.86	12.34
WLSI – Control	78	97.15	12.01	112.48	13.72
PAT – Experimental	82	15.73	4.28	29.41	4.85
PAT – Control	78	15.21	4.51	20.67	5.12

Note. Maximum possible WLSI score = 200; maximum possible PAT score = 40.

Both groups showed comparable pre-test means. After the intervention, the experimental group exhibited substantially larger gains on both instruments.

4.2 Hypothesis 1: Effect on Work and Life Skills

Table 2 summarises the ANCOVA results for post-test WLSI scores with pre-test WLSI as covariate.

Table 2

ANCOVA Summary for Post-test Work and Life Skills Scores

Source	SS	df	MS	F	p / ηp²
Pre-test WLSI	1842.31	1	1842.31	12.67	.001 / .075
Group	31256.48	1	31256.48	214.93	<.001 / .578
Error	22834.72	157	145.44		
Total	55933.51	159			

Note. Adjusted means: Experimental = 142.31, Control = 113.04.

The ANCOVA revealed a statistically significant effect of instructional methods on post-test work and life skills after controlling for pre-test scores, $F(1, 157) = 214.93$, $p < .001$, $\eta p^2 = .578$ (large effect). Hypothesis 1 was therefore rejected.

4.3 Hypothesis 2: Effect on Physics Achievement

Table 3 presents the ANCOVA results for post-test PAT scores.

Table 3

ANCOVA Summary for Post-test Physics Achievement Scores

Source	SS	df	MS	F	p / ηp²
Pre-test PAT	487.26	1	487.26	22.14	<.001 / .124
Group	2841.53	1	2841.53	129.11	<.001 / .451
Error	3456.18	157	22.01		
Total	6784.97	159			

Note. Adjusted means: Experimental = 29.18, Control = 20.91.

Instructional method exerted a significant effect on physics achievement,

$F(1, 157) = 129.11$, $p < .001$, $\eta p^2 = .451$ (large effect). Hypothesis 2 was rejected.

4.4 Dimension-Specific Gains in Work and Life Skills

Table 4 displays the adjusted post-test means for each WLSI dimension.

Table 4

Adjusted Post-test Means and Standard Errors for WLSI Dimensions by Group

Dimension	Exp. M	Exp. SE	Ctrl M	Ctrl SE

Critical Thinking / Problem-Solving	29.87	0.42	22.14	0.43
Collaboration	28.94	0.39	23.01	0.40
Communication	27.63	0.41	22.48	0.42
Creativity / Innovation	28.12	0.44	21.76	0.45
Self-Management / Responsibility	27.75	0.40	23.65	0.41

Note. Maximum score per dimension = 40. All group differences are significant at $p < .001$.

The experimental group outperformed the control group on every dimension. The largest absolute gains appeared in Critical Thinking/Problem-Solving and Creativity/Innovation, consistent with the investigative and design-oriented nature of the inquiry tasks. Hypothesis 3 was therefore rejected.

5. DISCUSSION

The central finding of this study is that inquiry-based learning strategies produced significantly higher post-test scores in both work and life skills and physics achievement compared with conventional instruction. The large effect sizes ($\eta p^2 = .578$ for skills; $\eta p^2 = .451$ for achievement) indicate that the intervention was not only statistically significant but also educationally meaningful.

These results align with constructivist and experiential learning theories. By engaging students in cycles of questioning, investigation, data interpretation, and collaborative sense-making, the inquiry approach enabled them to construct richer conceptual understanding while simultaneously practising the very skills demanded by the workplace (Pedaste et al., 2015; Kolb, 1984). The industrial-technology contexts—machine efficiency, electrical circuits, energy systems, and materials testing—provided authentic purposes that sustained motivation and supported transfer.

The dimension-level analysis further illuminates the mechanisms of impact. Critical thinking and problem-solving showed the greatest relative gains, reflecting the repeated demand for students to design procedures, evaluate evidence, and justify conclusions. Collaboration and communication also improved substantially, consistent with the small-group structure of the investigations. Creativity scores rose as students proposed alternative experimental designs and workshop applications. Self-management gains, though slightly smaller, suggest that the responsibility of planning and executing investigations fostered greater autonomy and accountability.

The findings corroborate earlier meta-analytic evidence that guided inquiry enhances 21st-century skills in high-school physics (Hidayatullah & Wulan, 2022) and extend that evidence to the Nigerian technical-college setting. They also resonate with recent Nigerian studies demonstrating the superiority of inquiry and related active methods for achievement and soft-skill development in auto-mechanics, metalwork, and electrical trades (Uthman et al., 2024; Joseph, 2025).

Importantly, the control group's modest gains indicate that conventional instruction can produce some improvement through content exposure alone, yet the magnitude of the experimental advantage underscores the added value of structured inquiry. Teacher facilitation, carefully sequenced modules, and the availability of basic workshop equipment appear to have been critical enabling conditions.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Inquiry-based learning strategies in physics education for industrial technology significantly enhance both work and life skills and physics achievement among secondary technical college students. The approach is particularly effective for developing critical thinking, problem-solving, collaboration, communication, creativity, and self-management—competencies essential for workplace success and lifelong learning. When physics content is contextualised within industrial applications and taught through guided investigations, students not only master concepts more thoroughly but also acquire the transferable skills that conventional methods largely neglect.

6.2 Recommendations

1. Physics teachers in technical colleges should adopt guided inquiry-based instructional strategies, incorporating industrial-context problems, collaborative investigations, and structured reflection into regular lessons.
2. Curriculum planners and the National Board for Technical Education should integrate explicit inquiry modules and work-and-life-skills outcomes into the industrial technology physics curriculum.
3. Teacher education programmes and in-service workshops should equip physics and technical teachers with the pedagogical skills and classroom-management strategies required for effective facilitation of inquiry.
4. School administrators and education boards should ensure the provision of basic laboratory and workshop equipment necessary for hands-on inquiry activities.
5. Further research should examine the long-term retention of skills, the scalability of inquiry programmes across multiple technical colleges, and the interaction of inquiry methods with student gender and prior achievement.

6.3 Limitations

The study was limited to a single technical college and a six-week intervention period. Intact classes rather than random individual assignments were used, although ANCOVA mitigated pre-existing differences. The WLSI relied on self-report; future studies could incorporate observational and performance-based measures of skills. Finally, the specific industrial contexts chosen may limit generalisation to other technical trades.

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Appendix A: Sample Items from the Instruments

A.1 Work and Life Skills Inventory (WLSI) – Sample Items

Response scale: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

Critical Thinking / Problem-Solving

1. When faced with a technical problem in the workshop, I systematically identify possible causes before trying solutions.

2. I can evaluate the strengths and weaknesses of different approaches to solving a physics-related industrial problem.

Collaboration

3. I actively contribute ideas when working with classmates on laboratory investigations.

4. I listen carefully to my peers' suggestions and incorporate useful ones into group work.

Communication

5. I can clearly explain the results of an experiment to my classmates and teacher.

6. I use appropriate technical language when discussing physics concepts related to industrial applications.

Creativity / Innovation

7. I often suggest alternative ways of conducting an investigation or improving a technical process.

8. I can adapt physics principles to design simple solutions for workshop challenges.

Self-Management / Responsibility

9. I complete my assigned tasks in group investigations on time and to a high standard.

10. I take responsibility for the safety and proper use of laboratory and workshop equipment.

A.2 Physics Achievement Test (PAT) – Sample Items

Items

1.A machine has a velocity ratio of 5 and an efficiency of 80%. What is its mechanical advantage?

(A) 4 (B) 5 (C) 6.25 (D) 8

2.In a simple series circuit containing a battery and three identical resistors, if one resistor is removed, the current in the circuit will:

(A) increase (B) decrease (C) remain the same (D) become zero

3.Which of the following energy conversions occurs in a practical electric motor?

(A) Electrical and Mechanical (B) Mechanical and Electrical (C) Chemical and Electrical (D) Thermal and Mechanical

4.A metal rod expands when heated. This behaviour is best explained by:

(A) increase in the number of atoms (B) increase in interatomic spacing (C) decrease in atomic mass (D) change in chemical composition

5.The efficiency of an energy conversion process is defined as:

(A) useful energy output ÷ total energy input × 100% (B) total energy input ÷ useful energy output × 100% (C) energy lost ÷ energy input × 100% (D) power output ÷ voltage × 100%

6.The SI unit of force is the:

(A) joule (B) watt (C) newton (D) pascal

7.A body moves with constant velocity. The net force acting on it is:

(A) maximum (B) zero (C) equal to its weight (D) increasing

8.Which of the following is a scalar quantity?

(A) Velocity (B) Acceleration (C) Force (D) Speed

9.The acceleration due to gravity on the surface of the Earth is approximately:

(A) 9.8 m/s^2 (B) 9.8 m/s (C) 98 m/s^2 (D) 0.98 m/s^2

10.Work done is zero when the force and displacement are:

(A) parallel (B) anti-parallel (C) perpendicular (D) in the same direction

11.Power is defined as:

(A) force × distance (B) work done per unit time (C) mass × acceleration (D) energy × time

12.A simple machine multiplies:

(A) energy (B) power (C) force (D) distance only

13.The mechanical advantage of an ideal machine is equal to its:

(A) efficiency (B) velocity ratio (C) load (D) effort

14.In a lever of the first class, the fulcrum is located:

(A) between the load and the effort (B) at one end (C) beyond the load (D) beyond the effort

15.Density is defined as:

(A) mass ÷ volume (B) volume ÷ mass (C) weight ÷ volume (D) mass × volume

16.Pressure in a fluid increases with:

(A) decrease in depth (B) increase in depth (C) decrease in density (D) increase in temperature only

17.Archimedes' principle is concerned with:

(A) buoyancy (B) viscosity (C) surface tension (D) elasticity

18.The unit of pressure is the:

(A) newton (B) pascal (C) joule (D) watt

19.Heat is a form of:

(A) matter (B) energy (C) force (D) power

20.Temperature is a measure of:

(A) total heat content (B) average kinetic energy of particles (C) potential energy (D) mass of a body

The boiling point of pure water at standard atmospheric pressure is:

(A) 0 °C (B) 32 °C (C) 100 °C (D) 212 °C

Conduction is the transfer of heat through:

(A) fluids only (B) solids mainly by molecular vibration (C) empty space (D) radiation only

A good absorber of radiation is usually a:

(A) good reflector (B) poor emitter (C) good emitter (D) transparent body

The quantity of heat required to raise the temperature of 1 kg of a substance by 1 °C is called:

(A) latent heat (B) specific heat capacity (C) heat capacity (D) thermal conductivity

When ice melts at 0 °C, the temperature of the water formed:

(A) rises immediately (B) remains 0 °C until all ice melts (C) falls (D) becomes 100 °C

Electric current is the flow of:

(A) protons (B) neutrons (C) electrons (D) atoms

The SI unit of electric current is the:

(A) volt (B) ohm (C) ampere (D) coulomb

Ohm's law states that:

(A) $V = IR$ (B) $V = I/R$ (C) $I = VR$ (D) $R = VI$

In a parallel circuit, the total resistance is:

(A) greater than the largest individual resistance (B) equal to the sum of the resistances (C) less than the smallest individual resistance (D) independent of the number of resistors

The power dissipated in a resistor is given by:

(A) $P = VI$ (B) $P = V/I$ (C) $P = I/R$ (D) $P = R/V$

A fuse is used in an electric circuit to:

(A) increase current (B) decrease voltage (C) protect against excessive current (D) store charge

The magnetic field around a straight current-carrying conductor is:

(A) straight lines (B) circular (C) radial (D) helical

An electromagnet works on the principle of:

(A) electrostatic induction (B) magnetic effect of electric current (C) heating effect of current (D) chemical effect of current

The frequency of the alternating current (a.c.) supply in many countries is:

(A) 50 Hz (B) 60 Hz only (C) 100 Hz (D) 0 Hz

Sound is a form of:

(A) electromagnetic wave (B) longitudinal mechanical wave (C) transverse electromagnetic wave (D) particle stream

The speed of sound is greatest in:

(A) air (B) water (C) steel (D) vacuum

The pitch of a sound depends on its:

(A) amplitude (B) frequency (C) wavelength only (D) speed

Light travels fastest in:

(A) glass (B) water (C) air (D) diamond

The angle of incidence is equal to the angle of reflection. This is the law of:

(A) refraction (B) reflection (C) diffraction (D) interference

A convex lens is also called a:

(A) diverging lens (B) converging lens (C) plane lens (D) cylindrical lens

The image formed by a plane mirror is:

(A) real and inverted (B) virtual and erect (C) real and erect (D) virtual and inverted

Dispersion of light is the splitting of white light into its:

(A) colours (B) wavelengths only (C) frequencies only (D) intensities

The primary colours of light are:

(A) red, yellow, blue (B) red, green, blue (C) cyan, magenta, yellow (D) red, orange, violet

Radioactivity is the spontaneous emission of radiation from:

(A) stable nuclei (B) unstable nuclei (C) electrons only (D) atoms in general

The half-life of a radioactive substance is the time taken for:

(A) all nuclei to decay (B) half the nuclei to decay (C) the activity to double (D) the mass to become zero

Nuclear fission involves the:

(A) combining of light nuclei (B) splitting of heavy nuclei (C) emission of electrons only (D) absorption of protons

The energy released in nuclear reactions comes from:

(A) chemical bonds (B) mass defect ($E = mc^2$) (C) gravitational potential (D) thermal vibration

Which of the following is a renewable energy source?

(A) Coal (B) Petroleum (C) Solar energy (D) Natural gas

The greenhouse effect is mainly caused by the accumulation of:

(A) oxygen (B) nitrogen (C) carbon dioxide and other gases (D) argon

Momentum is defined as:

(A) mass × velocity (B) mass × acceleration (C) force × time (D) energy ÷ velocity