新灯塔国际教育

AS 物理逆袭宝典

A-Level Physics • AS Level

Pearson Edexcel IAL Physics • Units 1-2

答案手册 Answers

新灯塔国际教育

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1 Mechanics（力学）

Basic Drill

1. 20 s

2. Scalar; kg m^2 s^{-2}

3. 48 m

4. 24 m s^{-1}

5. 4.5 N m

6. 30 m

7. 240 N

8. 4.5 m s^{-2}

9. The downward normal contact force exerted by the book on the table.

10. 4.0 kg m s^{-1}

11. 2.0 m s^{-1}

12. 6.0 N m

13. 3.0 N

14. 200 J

15. 2240 J

16. 590 J

17. 9.9 m s^{-1}

18. 150 W

19. 0.65 (or 65%)

20. 1.6 m s^{-2}

21. Change in velocity

22. 9.80 m s^{-2}

23. The point where the entire weight of an object may be considered to act.

24. 29 N

25. 1.4 $\times 10^4$ W (or 14 kW)

26. 3.0 m s^{-2}

27. 91 m

28. 1.7 m s^{-1}

29. 23 N

30. 0.49 s

31. 4.5 m s^{-2}

32. 120 N

33. 15 N upwards on the Earth

34. 510 kg m s^{-1}

35. 2.0 m s^{-1}

36. 0.24 kg

37. 330 J

38. 16 m s^{-1}

39. 5.3×10^4 J

40. 5.9 m s^{-1}

41. 440 W

42. 70%

43. 9.80 m s^{-2}

44. (a) velocity (b) 8.0 m s^{-1}

45. 12 m s^{-1}

46. 13 N

47. The point at which the entire weight of the body may be considered to act.

48. (a) vector (b) scalar

49. 48 N

50. 50 m

Practice

1. (a) A vector quantity has a direction, whereas a scalar quantity has only magnitude. (b) Scalar: kinetic energy (or mass); Vector: acceleration (or momentum).

2. 6.6×10^4 N

3. 72 m

4. 89 m

5. 45 m

6. 2.6 m s^{-2}

7. An upward gravitational force of 15 N acting on the Earth.

8. 7.0 m s^{-1}

9. 1.2×10^3 J

10. 79 %

11. 98 N

12. 20 m s^{-1}

13. 27 m

14. 35 N

15. 60 N

16. (a) 9.70 m s^{-2} (b) Air resistance acts on the ball as it falls, reducing its downward acceleration.

17. 12 s

18. 380 W

19. 76 N

20. $v = p/m$; substituting this into $E_k = \frac{1}{2}mv^2$ gives $E_k = \frac{1}{2}m(p/m)^2 = \frac{p^2}{2m}$.

21. (a) 245 m s^{-1} (b) 12° West of North

22. 16 %

23. (a) Weight, normal contact force, and frictional force. (b) Zero.

24. (a) The velocity is positive but decreasing. (b) The acceleration is negative.

25. 72 m s^{-1}

Advanced Practice

1. 1.41 s

2. 118 m s^{-1}

3. 584 N

4. 23.2 m s^{-1}

5. 0.32 m s^{-2}

6. 30.9 m

7. 0.51 s

8. 15 N

9. 72%

10. 135 N

11. The gradient represents the acceleration of free fall g. Using $s = ut + \frac{1}{2}at^2$ with $u = 0$ and $a = g$, rearranging gives $2h = gt^2$, which matches the form $y = mx$ where $m = g$.

12. 0.46 m s^{-1} in the opposite direction to the ball

13. 5.2 N

14. 16 kJ

15. 46 N

16. 1800 J

17. An upward gravitational force of 12 N exerted by the book on the Earth.

18. 290 W

19. 1.7 m

20. 75%

2 Materials（材料）

Basic Drill

1. 8950 kg m^{-3} (or 9.0×10^3 kg m^{-3})

2. 120 N m^{-1}

3. 2.5 N

4. Deformation in which the material returns to its original length or shape when the deforming force is removed.

5. 3.0×10^8 Pa

6. 2.5×10^{-3}

7. 1.4×10^{-3} N

8. 0.10 m

9. 0.54 J

10. kg $m^{-1}s^{-2}$

11. 2.0×10^{11} Pa

12. P

13. Viscosity decreases.

14. 0.36 J

15. So that the velocity is constant and the viscous drag force balances the weight minus upthrust.

16. 4.0×10^8 Pa

17. 2.0×10^{-5} m^3

18. 0.25 J

19. 0.036 N

20. Permanent deformation where the material does not return to its original shape or dimensions when the deforming force is removed.

21. 3.5 cm (or 0.035 m)

22. Micrometer screw gauge; measure diameter at several different positions and orientations along the wire and calculate a mean.

23. 4.8×10^{-4} m^3

24. Young modulus

25. The point at which there is a large increase in strain for little or no increase in stress (or the material undergoes significant plastic flow).

26. 0.12 kg

27. 1.6×10^{-3} N

28. 2.5 N

29. 400 N m^{-1}

30. 3.0×10^8 Pa

31. 1.4×10^{-3}

32. 2.0×10^{11} Pa

33. 0.45 J

34. The point beyond which force is no longer directly proportional to extension.

35. 0.96 J

36. 80 N m^{-1}

37. To eliminate errors caused by temperature changes and sagging of the support.

38. 2

39. 3.2×10^5 N m^{-1}

40. Measure the time taken for the ball to fall between two fixed marks at a known distance apart after terminal velocity has been reached.

41. The maximum tensile stress a material can withstand before it fractures.

42. 6.4×10^4 J m^{-3}

43. 9.0×10^{-4} m

44. 0.080 J

45. 5.4×10^3 N

46. 1.8×10^7 N

47. Micrometer screw gauge

48. 0.051 m s^{-1}

49. 8.0×10^{-5} m^2

50. 62.5%

Practice

1. 8.0×10^3 kg m^{-3}

2. 94 N

3. 1.6×10^{-3} N

4. The object must be small, spherical, and moving at a low speed (with laminar flow).

5. (a) 2.66×10^6 Pa (b) 1.15×10^{-5} m

6. 7.5×10^7 Pa

7. 0.016

8. 240 N

9. (a) 1600 N m^{-1} (b) 0.32 J

10. (a) 8.0 N (b) 2.8×10^9 Pa

11. Breaking stress

12. Yield point

13. The viscosity of a liquid is temperature dependent; it decreases as temperature increases, which would affect the terminal velocity.

14. The diameter of the wire must be measured at several places along its length using a micrometer.

15. 88 N

16. In elastic deformation, the spring returns to its original length and shape when the force is removed; in plastic deformation, it does not return to its original length and is permanently deformed.

17. 980 kg m^{-3}

18. 1.75 J

19. $0.5e$

20. 100 N m^{-1}; halving the original length halves the extension for the same applied force, so the stiffness ($k = \frac{\Delta F}{\Delta x}$) doubles.

21. 0.80 Pa s

22. 0.15 J

23. The time taken for the sphere to fall a known distance between two fixed marker bands placed sufficiently far below the surface to ensure terminal velocity has been reached.

24. 0.030%

25. 3.8×10^3 N

Advanced Practice

1. (a) 3.08×10^{-4} m^3 (b) 3.6 N (c) 0.024 m

2. (a) Weight downwards, upthrust upwards, viscous drag upwards. (b) 1.6×10^{-3} N (c) 0.25 m s^{-1}

3. (a) 8.95×10^7 Pa (b) 2.2 mm

4. (a) 2.0×10^4 N m^{-1} (b) 0.52 J (Accept 0.50 J to 0.54 J) (c) Elastic deformation is reversible, the material returns to its original length when the force is removed. Plastic deformation causes permanent extension.

5. (a) At terminal velocity, Weight = Upthrust + Viscous Drag, so $\frac{4}{3}\pi r^3 \rho_s g = \frac{4}{3}\pi r^3 \rho_l g + 6\pi\eta r v$. Rearranging gives $v = \frac{2r^2 g(\rho_s - \rho_l)}{9\eta}$. Since g, ρ_s, ρ_l and η are constant, $v \propto r^2$. (b) The terminal velocity will increase because the viscosity of the liquid decreases at higher temperatures, reducing the viscous drag for a given speed.

6. (a) 15.6 kg (b) 0.13 m

7. (a) $F_A = \frac{E_A A_A \Delta x}{L_A}$ and $F_B = \frac{E_B A_B \Delta x}{L_B}$. Ratio $\frac{F_A}{F_B} = \frac{2.0\times10^{11}\times\pi\times(0.25\times10^{-3})^2/1.5}{1.3\times10^{11}\times\pi\times(0.40\times10^{-3})^2/1.0} = 0.40$. (b) 1.6×10^{-3} m (c) 0.12 J

8. (a) 3090 kg m^{-3} (b) 0.028 m s^{-1} (c) The flow of the liquid around the bead must be laminar (or non-turbulent).

9. (a) 6720 N (b) 25 J (c) 5.6×10^{-3} m

10. (a) Material Y has a steeper initial gradient, hence a greater Young modulus. (b) The maximum stress a material can withstand before it fractures. (c) 2.0×10^6 J m^{-3}

11. (a) 2.6×10^{11} Pa (b) 4.4% (c) A longer wire produces a larger extension for a given load, reducing the percentage uncertainty in the measurement of extension.

12. (a) Upthrust = Weight + Viscous Drag (b) 1.5×10^{-4} N (c) 0.022 m s^{-1}

13. (a) The thermal energy dissipated during one complete cycle of stretching and unloading. (b) The area under the loading curve (work done on the band) is greater than the area under the unloading curve (work recovered). The difference in energy is dissipated as heat. (c) Elastic deformation.

14. (a) Total mass $m = \rho_1 V_1 + \rho_2 V_2$. Total volume $V = V_1 + V_2$. Density $\rho = \frac{m}{V} = \frac{\rho_1 V_1 + \rho_2 V_2}{V_1 + V_2}$. (b) 8180 kg m^{-3} (c) 9.9×10^{-4} m

15. (a) 2.8×10^{-4} N (b) 0.030 m s^{-1} (c) 2900 kg m^{-3}

16. (a) Strain is the same for both materials. Since Stress = $E \times$strain, the ratio of stress is $E_{\text{steel}}/E_{\text{concrete}} = 2.0 \times 10^{11}/2.0 \times 10^{10} = 10$. (b) 3.6×10^5 N (c) 2.3×10^{-4}

17. (a) The velocity increases initially, but the acceleration decreases to zero as the viscous drag increases. The velocity eventually reaches a constant maximum value. (b) The terminal velocity will be higher. Glycerol has a lower viscosity at higher temperatures, meaning the ball must fall faster to generate the same viscous drag required to balance its weight. (c) At high speeds, the flow of fluid around the ball may become turbulent rather than laminar, which is a required condition for Stokes' law.

18. (a) Parallel combination: $2k$. Series combination: $k/2$. (b) For parallel, total extension $x_1 = \frac{Mg}{2k}$ and energy $E_1 = \frac{1}{2}(Mg)x_1 = \frac{(Mg)^2}{4k}$. For series, total extension $x_2 = \frac{Mg}{k/2} = \frac{2Mg}{k}$ and energy $E_2 = \frac{1}{2}(Mg)x_2 = \frac{(Mg)^2}{k}$. Hence $E_2/E_1 = 4$.

19. (a) The maximum stress (or force) that can be applied to a material such that it returns to its original length when the load is removed. (b) The point at which a large increase in strain occurs for a small or zero increase in stress. (c) 4.17×10^{-3}

20. (a) 6.1 N (b) 43 N (c) When moving upwards, there is an additional downward force of viscous drag acting on the block, so a greater upward tension is required to maintain equilibrium.

3 Waves and Particle Nature of Light（波与光的粒子性）

Basic Drill

1. 340 m s^{-1}

2. Higher than atmospheric pressure

3. 2.5×10^{14} Hz

4. 30 m s^{-1}

5. 0.50 m

6. 2.0×10^{3} W m^{-2}

7. 1.60

8. 42°

9. The wave must travel from a medium of higher refractive index to one of lower refractive index, and the angle of incidence must be greater than the critical angle.

10. The oscillations of the wave occur in a single plane perpendicular to the direction of wave propagation.

11. $\frac{\pi}{2}$ rad (or 90°)

12. Sources that emit waves with a constant phase difference and the same frequency.

13. 28.9°

14. 0.062 m (or 6.2 cm)

15. Shorter pulses prevent the reflected pulses from overlapping, allowing distinct boundaries to be distinguished.

16. The degree of diffraction increases.

17. 30°

18. 2.5×10^{-6} m

19. 9.9×10^{-19} J

20. 3.68×10^{-19} J

21. 1.04×10^{15} Hz

22. 2.10 eV

23. 3.64×10^{-10} m

24. 4.59×10^{14} Hz

25. Electron diffraction

26. 0.40 m

27. In transverse waves, oscillations are perpendicular to energy transfer; in longitudinal waves, oscillations are parallel to energy transfer.

28. 130 m s^{-1}

29. 1.9×10^{4} W m^{-2}

30. $\frac{\pi}{2}$ rad

31. 0.36 m

32. 150 Hz

33. 25°

34. 44.0°

35. 2.26×10^{8} m s^{-1}

36. A transverse wave in which oscillations occur in only one single plane containing the direction of wave propagation.

37. 25.2°

38. 400 mm^{-1}

39. 2.65×10^{-24} kg m s^{-1}

40. 0.031 m

41. To prevent overlap between emitted and reflected pulses and improve depth resolution.

42. 2.92×10^{-19} J

43. 2.30 eV

44. 5.55×10^{14} Hz

45. 6.86×10^{-19} J

46. 1.50 eV

47. 5.13×10^{5} m s^{-1}

48. 9.53×10^{14} Hz

49. 1.22×10^{-7} m

50. 342 m s^{-1}

Practice

1. (a) The maximum displacement of a particle in the wave from its equilibrium position. (b) 25000 Hz

2. (a) Amplitude = 4.0 cm, Wavelength = 10 cm. (b) 0.42 s

3. (a) The air molecules oscillate parallel to the direction of energy transfer, creating regions of compression and rarefaction. (b) 340 m s^{-1}

4. 100 m s^{-1}

5. 2400 W m^{-2}

6. (a) 29° (b) 1.97×10^8 m s^{-1}

7. (a) 37.3° (b) The angle of incidence (40°) is greater than the critical angle (37.3°), so total internal reflection will occur.

8. (a) 0.75 m (b) 5.0π rad (or 16 rad)

9. Plane polarisation means the oscillations of the wave are confined to a single plane that includes the direction of energy transfer. Sound waves cannot be polarised because they are longitudinal waves, meaning their oscillations are already restricted to the direction of energy transfer.

10. (a) 4.8×10^7 W m^{-2} (b) 6.63×10^{-19} J (c) 4.5×10^{15}

11. 512 lines per mm

12. 3.11 eV

13. 2.4×10^{-19} J

14. (a) The minimum frequency of incident electromagnetic radiation required to remove a photoelectron from the surface of a metal. (b) 4.77 eV

15. 1.2×10^{-10} m

16. (a) 3.02×10^{-19} J (b) 4.56×10^{14} Hz

17. According to Huygens' construction, every point on the wavefront as it passes through a slit acts as a source of secondary spherical wavelets. These wavelets spread out and superpose, causing the wave to diffract.

18. (a) 0.041 m (b) If the pulse duration is too long, the emitted pulse may overlap with the reflected echo from a shallow boundary, preventing the detection of the flaw.

19. The student must measure the angle of incidence in air and the corresponding angle of refraction in the block. The refractive index is determined using the equation $n = \frac{\sin\theta_1}{\sin\theta_2}$, where θ_1 is the angle of incidence and θ_2 is the angle of refraction.

20. In the photoelectric effect, emission occurs instantaneously and only if the incident frequency is above a threshold frequency, regardless of intensity. This shows that light energy is transferred in discrete packets (photons) rather than accumulating continuously as a wave would suggest.

21. (a) 3 (b) 36 m s^{-1}

22. (a) Sources that emit waves with a constant phase difference. (b) 325 nm (or $\frac{\lambda}{2}$)

23. 3.8×10^{26} W

24. The frequency remains constant, and the wavelength increases.

25. (a) 6.5×10^{-19} J (b) 1.3×10^{-9} m

Advanced Practice

1. (a) 1.4×10^{-19} J (b) 1.3×10^{-9} m

2. (a) 64 Hz (b) 80 N

3. (a) 72° (b) 27°

4. (a) 32° (b) 550 W m^{-2}

5. (a) 1.5 mm (b) 3.5 cm

6. (a) 3.1×10^{15} Hz (b) 6.5×10^{-7} m

7. (a) 0.14 m (b) 340 m s^{-1}

8. (a) 5.6×10^{-7} m (b) 9

9. (a) 4.6×10^{-19} J (b) 4.3 eV

10. (a) 3.6×10^{-23} kg m s^{-1} (b) $\lambda = h/p = (6.63 \times 10^{-34})/(3.62 \times 10^{-23}) = 1.83 \times 10^{-11}$ m

11. (a) 5π rad (b) Minimum, because the path difference is an odd multiple of half a wavelength ($(n + 0.5)\lambda$), resulting in destructive interference.

12. (a) 33° (b) 2.0 cm

13. (a) 1.1×10^{19} s^{-1} (b) 2.3×10^{17} m^{-2} s^{-1}

14. (a) 0.54 m (b) 60 Hz

15. (a) 3.18×10^{3} W m^{-2} (b) 4.00×10^{-7} m (c) 11π rad (or 34.6 rad) (d) Destructive interference; the phase difference is an odd integer multiple of π radians, so the waves arrive in antiphase. (e) 41.8°

16. (a) 0.75 mm (b) 1.9 mm

17. (a) 4.5×10^{-7} m (b) 2.8 eV

18. (a) The critical angle is $\sin^{-1}(1/1.60) = 38.7°$. The angle of incidence is 45°, which is greater than the critical angle, so total internal reflection occurs. (b) 1.13

19. (a) 130 Hz (b) The closed end is a pressure antinode (maximum pressure variation) and the open end is a pressure node (zero pressure variation).

20. (a) The wave model predicts energy accumulates over time regardless of frequency, whereas the particulate model explains that a single photon must have sufficient discrete energy ($E = hf$) to instantly overcome the work function. (b) 6.3×10^{11}

4 Electric Circuits（电学与电路）

Basic Drill

1. 600 C

2. 4.5×10^{19}

3. Energy transferred per unit charge from non-electrical forms into electrical energy (or work done per unit charge in driving charge through a complete circuit).

4. 420 J

5. The current through a conductor is directly proportional to the potential difference across it, provided temperature and other physical conditions remain constant.

6. 0.20 A

7. 0.27 Ω

8. 0.60 V

9. 4.2 A

10. 60 Ω

11. 12 Ω

12. 240 W

13. 2.2×10^6 J

14. 8.0 V

15. Current increases temperature of the filament, increasing the amplitude of lattice vibrations and collision rate with conduction electrons.

16. Resistance decreases because higher temperature releases more conduction electrons, significantly increasing the charge carrier density.

17. Incident photons release valence electrons, increasing the number density of conduction electrons.

18. 1.40 V

19. 1.05 V

20. 1.95×10^{-2} A (or 19.5 mA)

21. 8.0 Ω

22. Energy transferred (or work done) per unit charge from electrical energy to other forms when charge moves between the two points ($V = \frac{W}{Q}$).

23. 3.0 Ω

24. 0.25

25. 24 Ω

26. 9.0×10^{20}

27. 12 V

28. Current through a conductor is directly proportional to the potential difference across it, provided temperature and other physical conditions remain constant.

29. 3.5 A away from the junction

30. Conservation of energy

31. 6.0 Ω

32. 16 W

33. 1200 W

34. 4.3×10^5 J

35. Larger current increases the filament temperature, causing lattice ions to vibrate with greater amplitude, which increases the rate of collisions between conduction electrons and ions.

36. 0.6 V to 0.7 V

37. 5.0 m

38. $4R$

39. 5.7×10^{-7} Ω m

40. 1.5×10^{-4} m s^{-1}

41. Number density of conduction electrons (charge carrier density), n

42. 0.70 m

43. 1.0 kΩ

44. The output voltage increases; higher temperature decreases thermistor resistance, so the fixed resistor takes a greater share of the total potential difference.

45. 1.5 V

46. 0.40 Ω

47. 6.0 A

48. (a) Electromotive force (e.m.f.) $\mathcal{E}$ (b) Internal resistance r

49. The resistance decreases.

50. The number density n increases.

Practice

1. (a) 900 C (b) 5.6×10^{21}

2. (a) Potential difference is the work done (or energy transferred) per unit charge. (b) 16 V

3. 1.4×10^{-4} m s^{-1}

4. 1.1×10^{-6} Ω m

5. (a) 1.0 Ω (b) 4.8 V

6. 16 Ω

7. (a) 35 Ω (b) 2.7×10^{6} J

8. The graph is a curve through the origin with a decreasing gradient. As current increases, the temperature of the filament increases, causing greater lattice vibrations which increases the resistance.

9. (a) 4.3 V (b) 0.020 A (c) 215 Ω

10. (a) 6.0 V (b) 0.40 Ω

11. 3.0 V

12. 2.4 V

13. As temperature increases, more electrons are excited into the conduction band, significantly increasing the charge carrier density (n). This large increase outweighs the effect of increased scattering from lattice vibrations, leading to a net decrease in resistance.

14. Charge cannot be created or destroyed. Therefore, since current is the rate of flow of charge, the total current entering a junction must equal the total current leaving the junction.

15. Energy cannot be created or destroyed. In any closed loop, the total energy supplied per unit charge (sum of e.m.f.s) must equal the total energy dissipated per unit charge (sum of p.d.s).

16. 0.90 V

17. 4.9×10^{-7} Ω m

18. 4.5 W

19. 1.9 A

20. An insulator has a much lower charge carrier density (n) than a metal. For the same dimensions and potential difference, the current I is extremely small, resulting in a very high resistance and resistivity.

21. 8.0 V

22. By energy conservation, total p.d. $V = V_1 + V_2$. By charge conservation, current I is the same through both. Substituting $V = IR$ gives $IR = IR_1 + IR_2$. Dividing by I yields $R = R_1 + R_2$.

23. (a) 6.0 Ω (b) Greater than 6.0 W (c) At 6.0 V, the temperature of the filament is lower, so lattice ions vibrate with a smaller amplitude. This reduces the frequency of collisions between conduction electrons and lattice ions, causing the resistance to be less than 6.0 Ω. Since $P = V^2/R$, a lower resistance results in a greater power.

24. When illumination increases, light energy

frees more electrons into the conduction band. This increases the charge carrier density (n), which increases the current for a given potential difference, thereby decreasing the resistance.

25. 1.0 A

Advanced Practice

1. (a) Charge conservation: total current entering the parallel combination equals the sum of branch currents ($I = I_1 + I_2 + I_3$). Energy conservation: potential difference V across each parallel branch is identical. (b) Substitute $I = \frac{V}{R}$ into the current equation and divide by V to yield $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$.

2. (a) $V = 0.17$ V (b) $v = 2.9 \times 10^{-4}$ m s^{-1}

3. (a) $I = 0.50$ A (b) $V = 9.75$ V

4. $R = 8.0\ \Omega$

5. $\Delta V = 3.8$ V

6. (a) 24 Ω (b) 15 W (c) The terminal potential difference decreases. Decreasing R reduces the total equivalent resistance of the circuit, causing the total current drawn from the battery to increase. This increases the 'lost volts' across the internal resistance, thereby reducing the terminal potential difference.

7. $E = 1.1$ V

8. (a) $P' = 274$ W (b) Operating at a lower power results in a lower temperature, which reduces lattice vibrations and lowers the resistance; hence the actual power dissipated would be slightly higher than calculated.

9. (a) $E = 11.6$ V (b) $N = 5.4 \times 10^{22}$

10. (a) $E = 1.55$ V, $r = 0.50\ \Omega$ (b) $P_{\max} =$ 1.2 W

11. Ratio = 8 : 9

12. Maximum potential difference = 12.0 V; Minimum potential difference = 2.16 V

13. (a) $R = 210\ \Omega$ (b) $W = 540$ J

14. A metal has a very high number density of free electrons ($n \approx 10^{28}$ m^{-3}), whereas an insulator has virtually zero free electrons. For the same dimensions and voltage, this massive difference in n causes the 10^{20} factor difference in resistivity.

15. Total power in series = 12 W; Total power in parallel = 48 W

16. $V = 3.0$ V

17. (a) Total current = 0.95 A (b) Fraction = 0.26 (or $\frac{5}{19}$)

18. (a) Terminal potential difference = 4.5 V (b) Rate of chemical energy conversion = 8.4 W

19. (a) $\rho = 4.7 \times 10^{-7}\ \Omega$ m (b) Check the micrometer for a zero error; measure the diameter at multiple points along the wire and in different orientations.

20. As temperature increases, the NTC thermistor's resistance decreases, reducing the total circuit resistance and increasing the current. Consequently, the potential difference across the constant-resistance LDR increases.