FUKIEN SECONDARY SCHOOL
S5 Final Examination (2020-2021)
Physics Paper 2
(1 hour)

Date: 15th June 2021 Name:____________________

Time: 11:30 a.m. – 12:30 p.m. Class: ________ No.: _______

INSTRUCTIONS

(1) Insert the information required in the spaces provided on the question paper and answer sheet.

(2) This paper consists of **TWO** sections, Sections A and B. Each section contains eight multiple-choice questions (10 marks) and one structured question (10 marks). The total mark of the paper is 40. Attempt **ALL** questions.

(3) Write your answers in the spaces provided in the answer sheet.

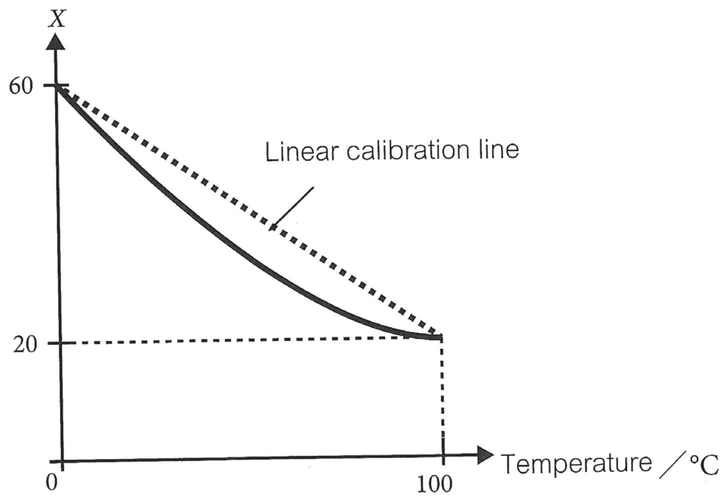
(4) The diagrams in this paper are **NOT** necessarily drawn to scale.

(5) The last two pages of the answer sheet contain a list of data, formulae and relationships which you may find useful.

(6) No extra time will be given to students for inserting any information or filling in the question number boxes after the 'Time is up' announcement.

Section A: Heat and Gases (20 marks)

1.1 The solid line in the figure below shows how a thermometric property X varies with the temperature while the dotted line is the linear calibration line. Assume X varies linearly with the temperature as shown in the calibration line. Find the expected temperature when $X = 35$.



A. 37.5 °C

B. 58.2 °C

C. 62.5 °C

D. 87.5 °C

1.2 When an object P is in contact with another object Q, heat flows from P to Q. P MUST have a higher

(1) temperature.

(2) internal energy.

(3) specific heat capacity.

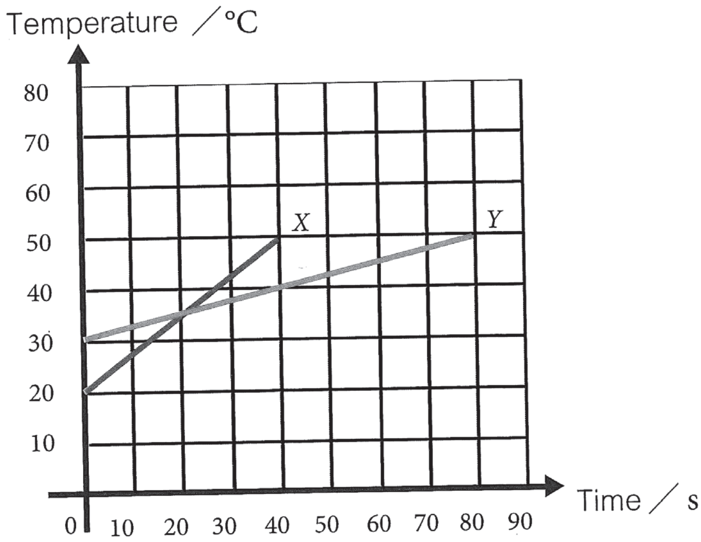
A. (1) only

B. (2) only

C. (1) and (3) only

D. (2) and (3) only

1.3 The graph below shows the temperature variation of objects X and Y with time when they are heated separately by heaters of the same power. Given that the ratio of mass of object X to that of object Y is 1:2. Find the ratio of specific heat capacity of object X to that of object Y. Assume that there is no heat loss to the surroundings.



A. 1:6

B. 2:1

C. 2:3

D. 3:2

1.4 40 g of ice at 0 °C is mixed with 300 g of milk at 75 °C. Find the final temperature of the mixture if there is no heat loss to the surroundings.

Given: specific heat capacity of water = 4200 J kg^{-1} °C^{-1}

specific heat capacity of milk = 3800 J kg^{-1} °C^{-1}

specific latent heat of fusion of ice = 3.34 x 10^{5} J kg^{-1}

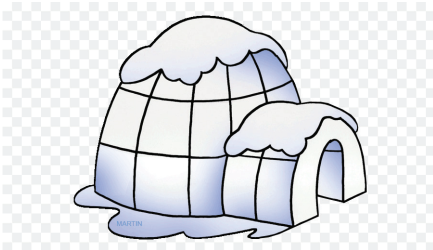
A. 55.2 °C

B. 56.8 °C

C. 63.3 °C

D. 66.2 °C

1.5 As shown in the figure below, the eskimos use ice blocks to build igloos. The inside of igloos is much warmer than the outside. Which of the following statements about igloos are correct?



(1) The ice blocks are good insulators of heat.

(2) Cold air from the outside sinks at the bottom of the entrance.

(3) The shiny white surface of the ice blocks reduces heat loss by radiation.

A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

D. (1), (2) and (3)

1.6 Which of the following statements explain(s) why we feel cool when there is a wind?

(1) The rate of evaporation of sweat is higher when it is windy.

(2) When wind blows, the warm air around us is replaced with cooler air.

(3) When wind blows, the average kinetic energy of air particles increases.

A. (1) only

B. (2) only

C. (1) and (2) only

D. (2) and (3) only

1.7 The pressure of 1 mole of an ideal gas at 273 K is 2.52×10^5 Pa. If the temperature of the ideal gas is doubled and the volume is increased by 1.31×10^3 cm^3, what is its pressure?

A. 1.73×10^5 Pa

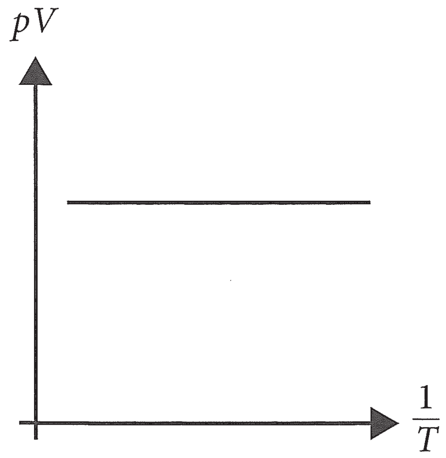
B. 2.20×10^5 Pa

C. 3.44×10^5 Pa

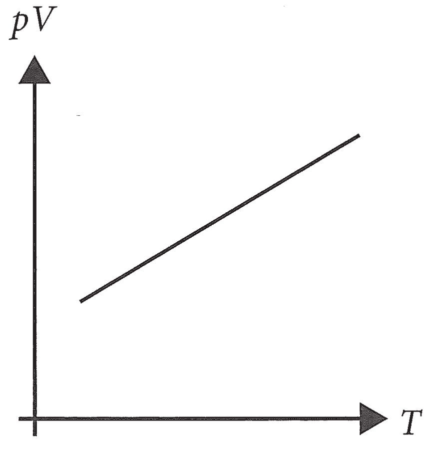
D. 4.40×10^5 Pa

1.8 Which of the following graphs correctly describes the relationship between the pressure p, volume V and temperature T (using the Kelvin temperature scale) for an ideal gas of fixed mass?

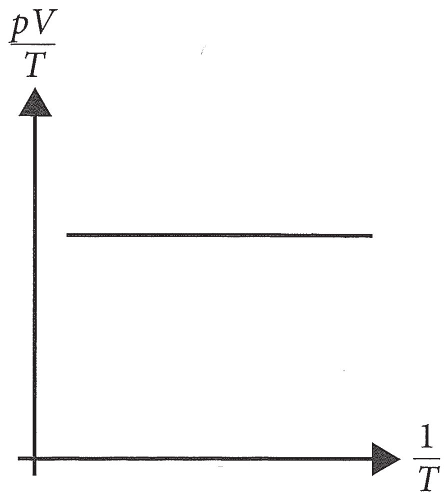
A.



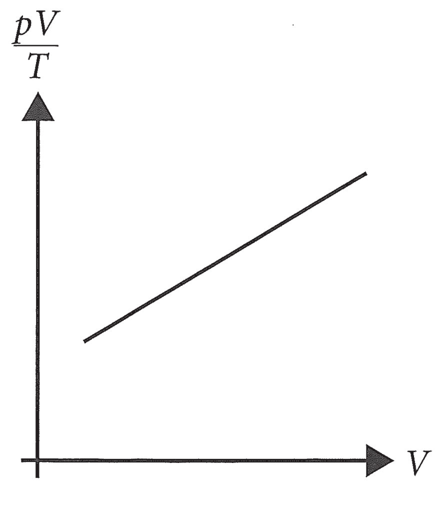
B.



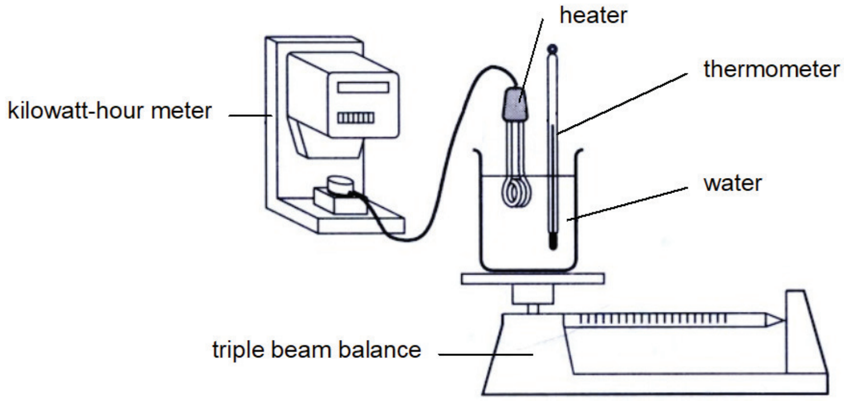
C.



D.



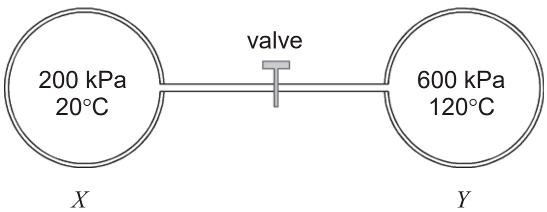
1.9 (a) The following set-up is used to determine the specific latent heat of vaporization of water.



(i) Describe the experimental procedures for finding the specific latent heat of vaporization of water. (4 marks)

(ii) Suggest two improvements on the set-up to increase the accuracy of the experiment. (2 marks)

(b) As shown in the figure below, *X* and *Y* are two identical insulated containers connected by tube with a valve which is initially closed. *X* contains an ideal gas at 200 kPa at 20°C. *Y* contains the same gas at 600 kPa at 120°C.

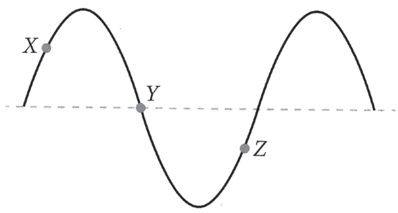


The valve is now opened. Suppose the temperatures of *X* and *Y* are kept unchanged, what is the final gas pressure when the system is steady? (4 marks)

End of Section A

Section B: Waves (20 marks)

2.1 The figure below shows a transverse wave which travels along a thread and the positions of the particles in the wave at a certain instant. Which of the following statements is/are correct?



(1) The wave is travelling to the right if particle X is moving downwards at this instant.

(2) Particles X and Z are moving in opposite directions at this instant.

(3) Particle Y is at rest at this instant.

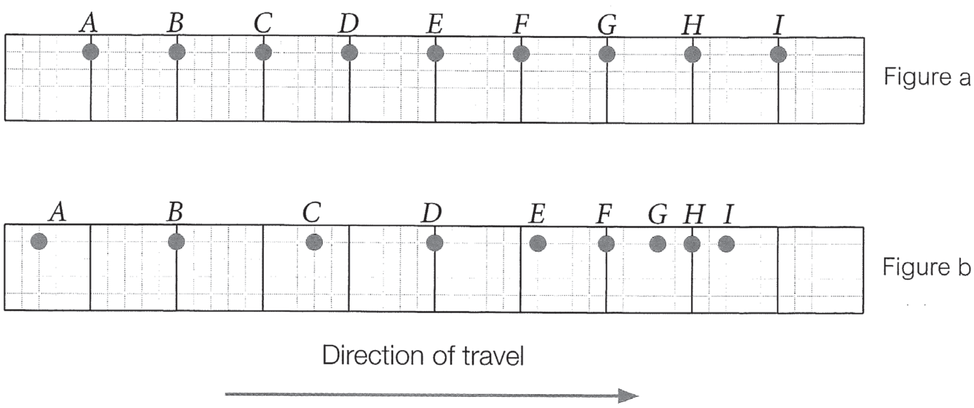
A. (1) only

B. (2) only

C. (1) and (2) only

D. (2) and (3) only

2.2 Figure a shows the even distribution of a series of particles in a string. A travelling longitudinal wave is then produced by the string. The positions of the particles at a certain instant are shown in Figure b.



Which of the following statements is correct?

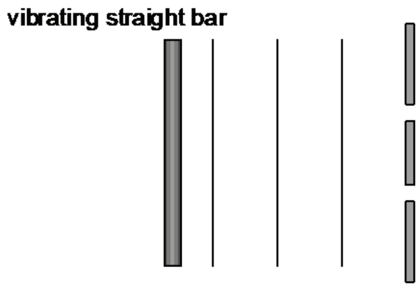
A. Particle E moves the fastest at this instant.

B. Particle C is momentarily at rest at this instant.

C. The wavelength of the wave is twice the distance between particles B and H.

D. Particle A is moving downwards at this instant.

2.3

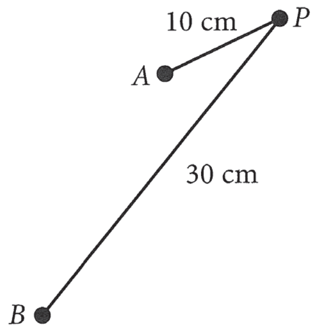


A train of straight water waves travels towards a straight barrier with small openings as shown in the figure above. Two sets of circular waves are produced on the other side of the barrier and forms an interference pattern. The separation between the antinodal lines can be increased by

(1) decreasing the distance between the two openings.
(2) increasing the wavelength of the wave.
(3) increasing the width of the opening.

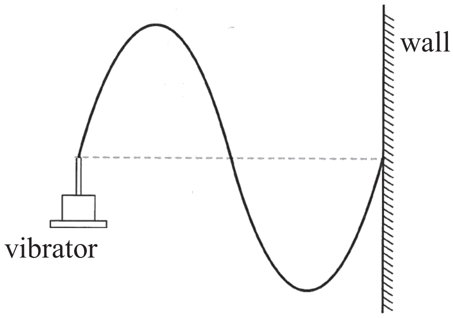
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

2.4 Two dippers *A* and *B* are vibrating in phase with the same frequency as shown in the figure below. Circular water waves of wavelength λ are produced. Consider position *P*, which of the following combinations is NOT possible?



	Type of interference that occurs at *P*	Value of λ
A.	constructive interference	10 cm
B.	constructive interference	5 cm
C.	destructive interference	8 cm
D.	destructive interference	4 cm

2.5 A vibrator produces stationary waves along a string as shown in the figure below.



Which of the following can increase the number of loops of the stationary waves?

(1) Increase the frequency of the vibrator

(2) Increase the tension of the string

(3) Increase the distance between the vibrator and the wall

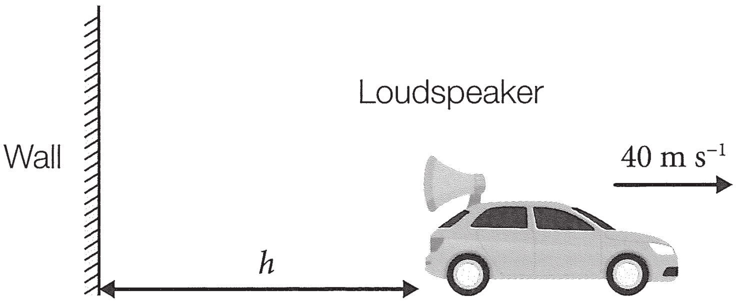
A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

D. (1), (2) and (3)

2.6 A loudspeaker is put on a car which is h m from a wall as shown below. The car travels with a uniform speed of 40 m s^{-1} along a straight road away from the wall. The loudspeaker produces a sound towards the wall and then the car receives the echo after 8 s. Estimate h. Given that the speed of sound in air is 340 m s^{-1}.



A. 360 m

B. 1200 m

C. 1360 m

D. 2720 m

2.7 Which of the following about infrared radiation is correct?

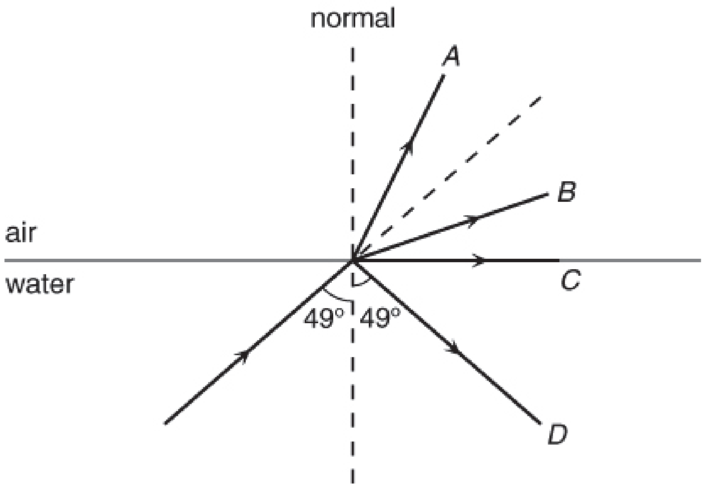
A. Infrared radiation is emitted by hot objects only.

B. Infrared radiation cannot penetrate smoke.

C. Infrared radiation causes the production of vitamin D in our skin.

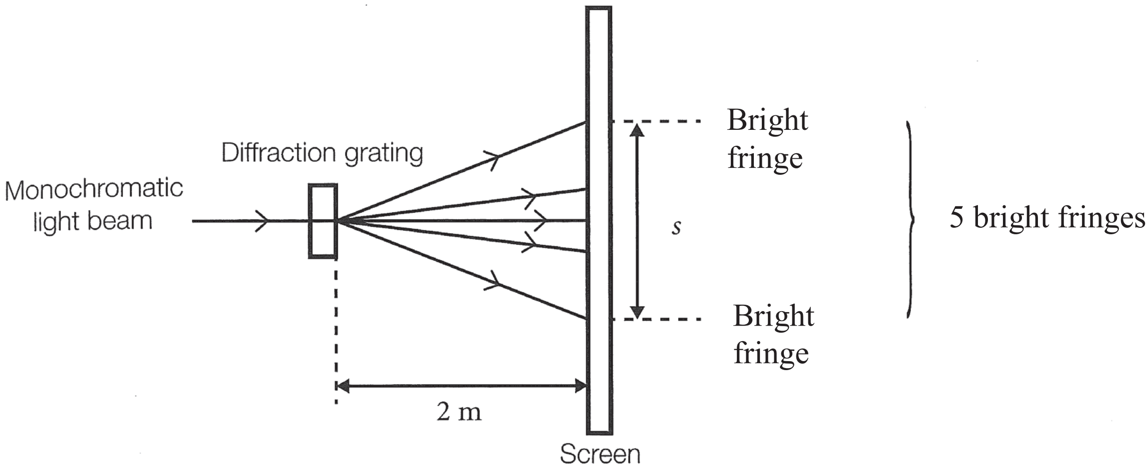
D. Infrared radiation can be used for TV remote control.

2.8 A ray of light strikes a water-air boundary at an angle of incidence of 49° as shown below. Which of the following paths best shows how the light ray travels afterwards? The refractive index of water is 1.33.



2.9

(a) As shown in the figure below, a monochromatic light beam of wavelength 650 nm is incident normally on a diffraction grating with 500 slits per mm. A screen is placed at a distance of 2 m from the diffraction grating. The separation between 5 bright fringes produced on the screen is *s*.



(i) Find *s*. (2 marks)

(ii) Theoretically, how many bright fringes can be produced on the screen in total? (2 marks)

(b) As shown in the figure on the answer sheet, an object is placed in front of a lens *L* and an image is formed. *X* and *Y* are two light rays coming from the same point of the object.

(i) What kind of lens is *L*? Explain your answer. (2 marks)

(ii) Find the focal length of the lens by using the lens formula. (2 marks)

(iii) Complete the paths of *X* and *Y* after passing through the lens and locate the focus. (2 marks)

End of Section B

END OF QUESTION PAPER

List of data, formulae and relationships

Data

molar gas constant	$R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$
Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
acceleration due to gravity	$g = 9.81 \text{ m s}^{-2}$ (close to the Earth)
universal gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
speed of light in vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
charge of electron	$e = 1.60 \times 10^{-19} \text{ C}$
electron rest mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
atomic mass unit	$\text{u} = 1.661 \times 10^{-27} \text{ kg}$ (1 u is equivalent to 931 MeV)
astronomical unit	$\text{AU} = 1.50 \times 10^{11} \text{ m}$
light year	$\text{ly} = 9.46 \times 10^{15} \text{ m}$
parsec	$\text{pc} = 3.09 \times 10^{16} \text{ m} = 3.26 \text{ ly} = 206\ 265 \text{ AU}$
Stefan constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$

Rectilinear motion

For uniformly accelerated motion:

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

Mathematics

Equation of a straight line	$y = mx + c$
Arc length	$= r\theta$
Surface area of cylinder	$= 2\pi rh + 2\pi r^2$
Volume of cylinder	$= \pi r^2 h$
Surface area of sphere	$= 4\pi r^2$
Volume of sphere	$= \frac{4}{3}\pi r^3$

For small angles, $\sin\theta \approx \tan\theta \approx \theta$ (in radians)

Astronomy and Space Science

$U = -\frac{GMm}{r}$	gravitational potential energy
$P = \sigma AT^4$	Stefan's law
$\left\lvert\frac{\Delta f}{f_0}\right\rvert \approx \frac{v}{c} \approx \left\lvert\frac{\Delta\lambda}{\lambda_0}\right\rvert$	Doppler effect

Energy and Use of Energy

$E = \frac{\Phi}{A}$	illuminance
$\frac{Q}{t} = k\frac{A(T_H - T_C)}{d}$	rate of energy transfer by conduction
$U = \frac{k}{d}$	thermal transmittance U-value
$P = \frac{1}{2}\rho Av^3$	maximum power by wind turbine

Atomic World

$\frac{1}{2}m_e v_{max}{}^2 = hf - \phi$	Einstein's photoelectric equation
$E_n = -\frac{1}{n^2}\left\{\frac{m_e e^4}{8h^2\varepsilon_0{}^2}\right\} = -\frac{13.6}{n^2} \text{ eV}$	energy level equation for hydrogen atom
$\lambda = \frac{h}{p} = \frac{h}{mv}$	de Broglie formula
$\theta \approx \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)

Medical Physics

$\theta \approx \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)
$\text{power} = \frac{1}{f}$	power of a lens
$L = 10\log\frac{I}{I_0}$	intensity level (dB)
$Z = \rho c$	acoustic impedance
$\alpha = \frac{I_r}{I_0} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$	intensity reflection coefficient
$I = I_0 e^{-\mu x}$	transmitted intensity through a medium

A1.	$E = mc\Delta T$	energy transfer during heating and cooling
A2.	$E = l\Delta m$	energy transfer during change of state
A3.	$pV = nRT$	equation of state for an ideal gas
A4.	$pV = \frac{1}{3}Nm\overline{c^2}$	kinetic theory equation
A5.	$E_K = \frac{3RT}{2N_A}$	molecular kinetic energy
B1.	$F = m\frac{\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t}$	force
B2.	moment $= F \times d$	moment of a force
B3.	$E_P = mgh$	gravitational potential energy
B4.	$E_K = \frac{1}{2}mv^2$	kinetic energy
B5.	$P = Fv$	mechanical power
B6.	$a = \frac{v^2}{r} = \omega^2 r$	centripetal acceleration
B7.	$F = \frac{Gm_1m_2}{r^2}$	Newton's law of gravitation
C1.	$\Delta y = \frac{\lambda D}{a}$	fringe width in double-slit interference
C2.	$d \sin\theta = n\lambda$	diffraction grating equation
C3.	$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$	equation for a single lens

D1.	$F = \frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$	Coulomb's law
D2.	$E = \frac{Q}{4\pi\varepsilon_0 r^2}$	electric field strength due to a point charge
D3.	$E = \frac{V}{d}$	electric field between parallel plates (numerically)
D4.	$R = \frac{\rho l}{A}$	resistance and resistivity
D5.	$R = R_1 + R_2$	resistors in series
D6.	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$	resistors in parallel
D7.	$P = IV = I^2R$	power in a circuit
D8.	$F = BQv \sin\theta$	force on a moving charge in a magnetic field
D9.	$F = BIl \sin\theta$	force on a current-carrying conductor in a magnetic field
D10.	$B = \frac{\mu_0 I}{2\pi r}$	magnetic field due to a long straight wire
D11.	$B = \frac{\mu_0 NI}{l}$	magnetic field inside a long solenoid
D12.	$\varepsilon = N\frac{\Delta\Phi}{\Delta t}$	induced e.m.f.
D13.	$\frac{V_s}{V_p} \approx \frac{N_s}{N_p}$	ratio of secondary voltage to primary voltage in a transformer
E1.	$N = N_0 e^{-kt}$	law of radioactive decay
E2.	$t_{\frac{1}{2}} = \frac{\ln 2}{k}$	half-life and decay constant
E3.	$A = kN$	activity and the number of undecayed nuclei
E4.	$\Delta E = \Delta mc^2$	mass-energy relationship