2017-S6MK

PHY

PAPER 1A

SACRED HEART CANOSSIAN COLLEGE

16 – 17 S6 MOCK EXAMINATION

PHYSICS PAPER 1

Time allowed: 2 hours 30 minutes

This paper must be answered in English

GENERAL INSTRUCTIONS

1. There are **TWO** sections, A and B, in this Paper. You are advised to finish Section A in about 50 minutes.
2. Section A consists of multiple-choice questions in this question paper, while Section B contains conventional questions printed separately in Question-Answer Book **B**.
3. Answers to Section A should be marked on the Multiple-choice Answer Sheet while answers to Section B should be written in the spaces provided in the Question-Answer Book **B**. **The Answer Sheet for Section A and the Question-Answer Book for Section B will be collected separately at the end of the examination.**
4. The diagrams in this paper are **NOT** necessarily drawn to scale.
5. The last two pages of this question paper contain a list of data, formulae and relationships which you may find useful.

INSTRUCTIONS FOR SECTION A (MULTIPLE-CHOICE QUESTIONS)

1. Read carefully the instructions on the Answer Sheet. After the announcement of the start of the examination, you should write your name and insert the information required in the spaces provided. No extra time will be given for writing the information after the 'Time is up' announcement.
2. When told to open this book, you should check that all questions are there. Look for the words **'END OF SECTION A'** after the last question.
3. All questions carry equal marks.
4. **ANSWER ALL QUESTIONS.** You are advised to use an HB pencil to mark all the answers on the Answer Sheet, so that wrong marks can be completely erased with a clean rubber. You must mark the answers clearly; otherwise you will lose marks if the answers cannot be captured.
5. You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.
6. No marks will be deducted for wrong answers.

Not to be taken away before the end of the examination session

Section A

There are 33 questions. Questions marked with * involve knowledge of the extension component.

1. Two objects are of different temperatures. Which of the following statements is/are correct?

   (1) There is heat transfer between the two objects when they are put in contact.

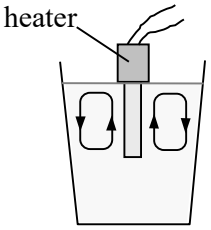
   (2) The cooler object may have more internal energy.

   (3) The average kinetic energy of the particles in the two objects can be the same.

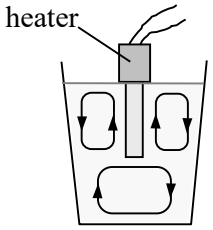
   A. (1) only
   B. (1) and (2) only
   C. (2) and (3) only
   D. (1), (2) and (3)

2. An immersion heater is put in a glass of water. Which of the following diagrams best shows the convection current in the water?

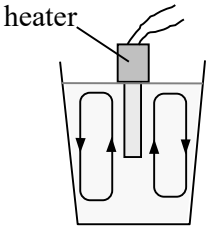
   A.



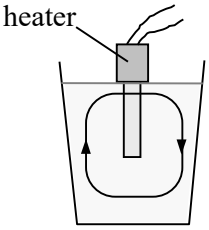
   B.



   C.



   D.



3. Which of the following actions would increase the rate of heat loss by radiation of a hot object?

(1) Increase its temperature.
(2) Increase its surface area.
(3) Paint its surface silvery.

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

*4. A boy is going to fill more air in a basketball. Initially, there are 2.4 moles of gas inside the ball. The pressure of the gas in the ball is 100 kPa at 25 °C. After pumping, the pressure of the gas in the ball is 150 kPa and its temperature is 40 °C. If the volume of the ball remains unchanged, find the number of moles of gas in the ball after pumping.

A. 2.25 mol
B. 3.05 mol
C. 3.30 mol
D. 3.43 mol

*5. Two moles of an ideal gas is heated from 50 °C to 90 °C. What is the increase in the internal energy of the gas?

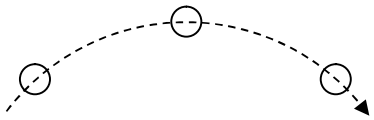
A. 332 J
B. 665 J
C. 997 J
D. 1330 J

6. Which of the following statements about mass is/are correct?

(1) Mass measures the inertia of an object.
(2) The mass of an object remains the same on planets of different gravity.
(3) A massive object will eventually come to rest if there is no force acting on it.

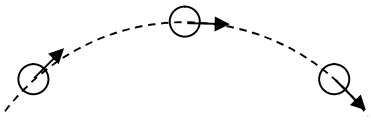
A. (2) only
B. (1) and (2) only
C. (1) and (3) only
D. (1), (2) and (3)

7.

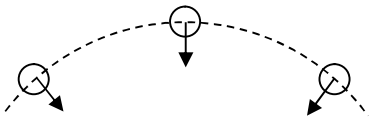


A man throws a small ball and it describes a projectile path. If air resistance is negligible, which of the following best shows the acceleration of the ball in the three positions shown in the figure?

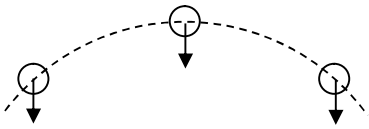
A.



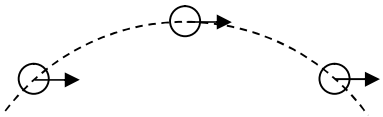
B.



C.

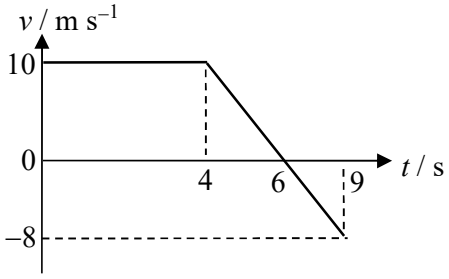


D.



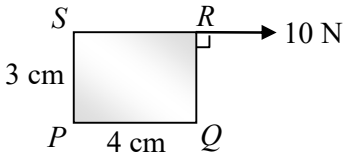
8. The figure below shows the *v*-*t* graph of an object moving along a straight line. Find the object's average velocity from 0 s – 9 s.

A. 4.22 m s^{-1}
B. 5.15 m s^{-1}
C. 6.89 m s^{-1}
D. –8 m s^{-1}



9. An external force of 10 N is applied on the corner of a rectangular block *PQRS* as shown below. Find the moment produced by the force about *P*.

A. 0.3 N m
B. 0.4 N m
C. 0.5 N m
D. 0.7 N m



10. A 65-kg girl is jumping on a trampoline as shown in Figure A. In Figure B, X is the highest position that she reaches and is 1.5 m above the flat fabric of the trampoline. After falling back onto the fabric, the fabric deforms and she falls 0.3 m to the lowest position Y. Find the average force acting on her by the fabric.

Figure A

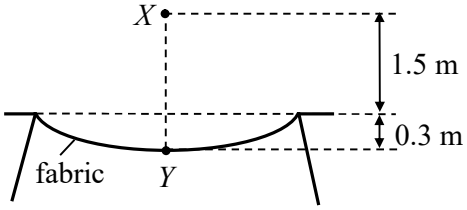
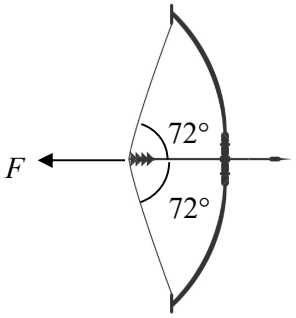


Figure B

A. 638 N
B. 2130 N
C. 3190 N
D. 3830 N

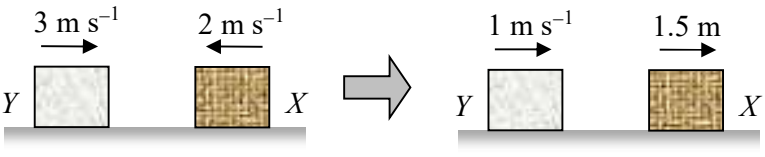
11. In the figure, an external force F is exerted on the arrow attached on the string of a bow so that the arrow remains stationary. If the tension along the string of the bow is 15 N, find the magnitude of F.

A. 4.64 N
B. 9.27 N
C. 18.5 N
D. 29.0 N



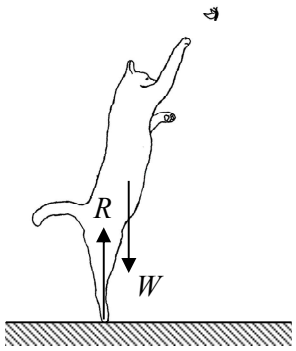
12. Object X moving at 2 m s^{-1} towards the left collides head on with object Y which is moving at 3 m s^{-1} towards the right on a smooth horizontal plane. After the collision, X moves at 1.5 m s^{-1} towards the right and Y moves at 1 m s^{-1} towards the right. If the mass of X is m_X and the mass of Y is m_Y, find $m_X : m_Y$.

A. 4 : 7
B. 1 : 4
C. 4 : 1
D. 7 : 4



13. A cat is jumping up as shown. The weight of the cat is W and the normal force exerted on the cat by the floor is R. Which of the following statements is/are correct?

(1) R and W form an action-and-reaction pair.
(2) R and W are always equal in magnitude.
(3) W remains unchanged during the jump.



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

*14. An object on a horizontal plane moves in a uniform circular motion. Which of the following statements is/are correct?

(1) The velocity of the object is unchanged.
(2) The total energy of the object is unchanged.
(3) The net force on the object is zero.

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

*15. A ball is projected at an angle of 35° above the horizontal from the top of a cliff with a speed of 20 m s^{-1}. If air resistance is negligible, find the ball's horizontal displacement 5 s later.

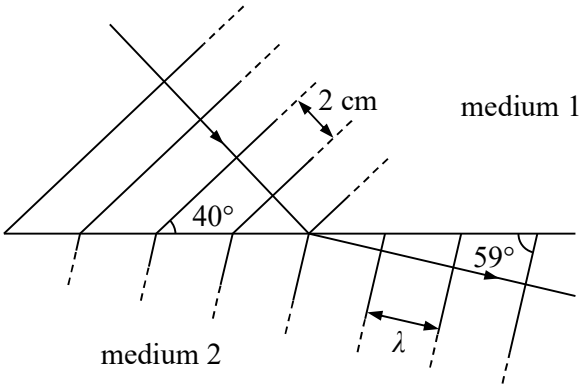
A. 36.0 m
B. 57.4 m
C. 72.6 m
D. 81.9 m

*16. Jupiter's diameter is 1.40×10^{8} m and the acceleration due to gravity on its surface is about 2.5 times that on the Earth's surface. Estimate the mass of Jupiter.

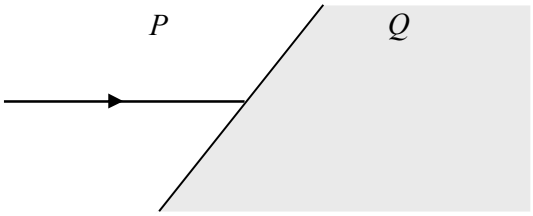
A. 4.9×10^{17} kg
B. 1.2×10^{27} kg
C. 1.8×10^{27} kg
D. 2.1×10^{28} kg

17. A plane wave travels from medium 1 to medium 2 as shown in the figure below. Find λ, the wavelength of the wave in medium 2.

A. 2 cm
B. 2.21 cm
C. 2.67 cm
D. 2.97 cm

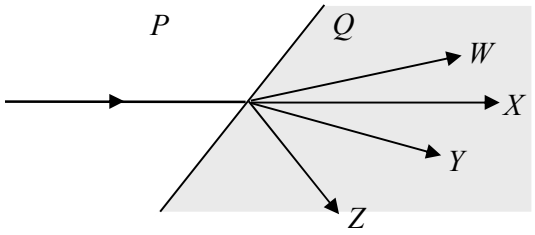


18. A light ray is directed from medium P to medium Q as shown. The refractive index of medium Q is higher than that of medium P.



Which of the following best shows the path of the refracted light ray?

A. W
B. X
C. Y
D. Z

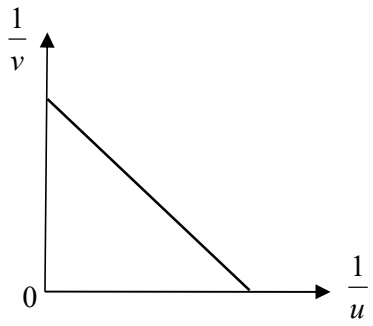


19. When water waves passes through a narrow slit, which of the following wave properties remain(s) unchanged?

(1) Direction of propagation
(2) Speed
(3) Wavelength

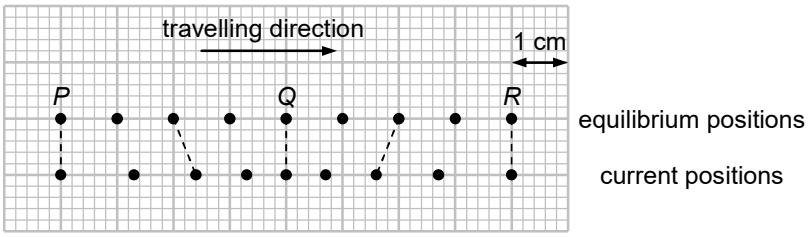
A. (1) only
B. (2) only
C. (2) and (3) only
D. (1), (2) and (3)

*20. A student puts an object in front of a convex lens. He varies the object distance u and records the corresponding image distance v. The relation between $\frac{1}{v}$ against $\frac{1}{u}$ is shown in the graph below. Which of the following quantities of the graph can determine the focal length of the lens?



A. x-intercept
B. area under the line
C. slope of the line
D. reciprocal of the slope of the line

21. The figure below shows the displacements of some particles from their equilibrium positions when a longitudinal wave is travelling in a medium.



Which of the following statements are correct?
(1) Particles P, Q and R are stationary at the instance shown.
(2) The wavelength of the wave is 8 cm.
(3) P and R are in phase.

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

22. Which of the following is **NOT** a use of ultraviolet radiation?

A. Detection of fake money notes
B. Production of vitamin D
C. Sterilization of drinking water
D. Security check for luggage

*23. When a monochromatic light of wavelength 4×10^{-5} cm is directed perpendicularly to a plane transmission grating, the second order bright fringe is formed at an angle of 30° to the normal of the grating. What is the number of lines per cm of the grating?

A. 3125
B. 6250
C. 13 000
D. 25 000

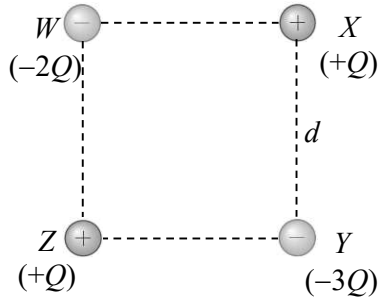
24. Two identical metal spheres carry different charges Q_1 and Q_2 respectively. When they are separated by a certain distance, the electrostatic force between them is F. When they are brought to touch each other and returned to their original positions, the electrostatic force between them becomes F'. Which of the following statements must be correct?

(1) Both spheres contain equal amount of charges after touch.
(2) F' is repulsive.
(3) magnitude of $F' \leq$ magnitude of F

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

*25. Four point charges W, X, Y and Z are placed at the vertices of a square of side length d as shown. Find the electric field strength at the centre of the square.

A. $\dfrac{Q}{16\pi\varepsilon_0 d^2}$
B. $\dfrac{Q}{8\pi\varepsilon_0 d^2}$
C. $\dfrac{Q}{4\pi\varepsilon_0 d^2}$
D. $\dfrac{Q}{2\pi\varepsilon_0 d^2}$

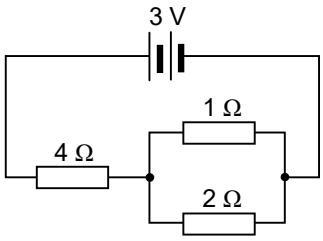


26. A kettle takes 15 minutes to boil 3 kg of water from 25°C. If it costs \$1.1 per kW h, estimate the cost of boiling 3-kg water by this kettle. Take the specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$.

A. \$0.263
B. \$0.289
C. \$0.571
D. \$0.592

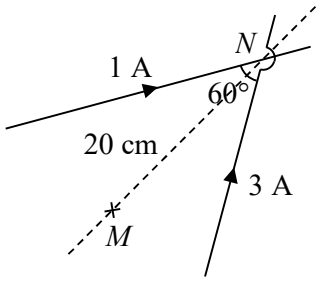
27. Consider the following circuit. Find the current flowing through the 1-Ω resistor.

A. 0.214 A
B. 0.429 A
C. 0.643 A
D. 0.857 A

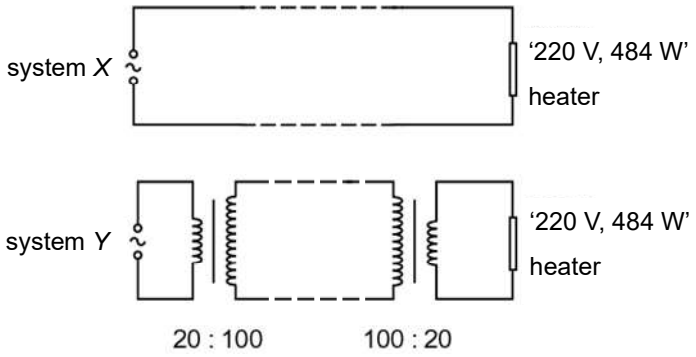


28. The following diagram shows two current-carrying wires on a plane. The two wires make an angle of 60° to each other and *MN* is the angle bisector between the two wires. If *M* is at a distance of 20 cm from *N*, find the magnetic field strength at *M*.

A. $\frac{\mu_0}{2\pi} \times 10$ T
B. $\frac{\mu_0}{2\pi} \times 20$ T
C. $\frac{\mu_0}{2\pi} \times 30$ T
D. $\frac{\mu_0}{2\pi} \times 40$ T



*29. The figure below shows two different power transmission systems, *X* and *Y*, supplying energy to a heater.

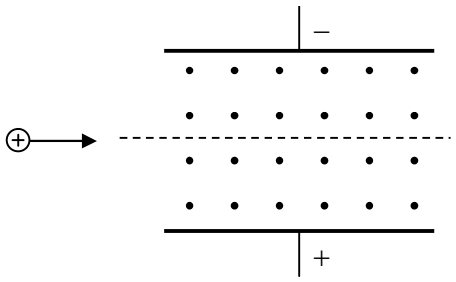


In either system, the total resistance of the transmission cables (represented by the dotted lines) is 10 Ω and the heater is working at the rated power. What is the ratio of the power loss in system *X* to that in system *Y* ? Assume the transformers are ideal.

A. 5 : 1
B. 10 : 1
C. 20 : 1
D. 25 : 1

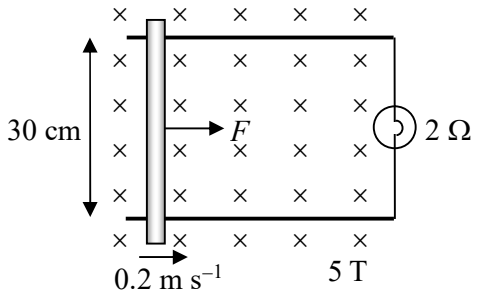
*30. A positively charged particle is flying towards a region with a uniform electric field and uniform magnetic field as shown in the figure. The electric and magnetic fields are 1000 N C^{-1} and 0.1 T respectively. If the particle passes through the region without deflection, find the speed of the particle. Neglect the effect of gravity and air resistance.

A. 10^{-3} m s^{-1}
B. 10 m s^{-1}
C. 10^{4} m s^{-1}
D. 10^{5} m s^{-1}



*31. A metal rod is pulled towards the right by a force F along two smooth parallel metal rails in a uniform magnetic field of 5 T as shown. The rod moves at a constant speed of 0.2 m s^{-1}. The rails are 30 cm apart and are connected to a light bulb of resistance 2 Ω. Find the value of F.

A. 0.225 N
B. 0.75 N
C. 1.5 N
D. 3 N



*32. The half-life of a radioisotope is 5 hours. It is found that there is 0.24 mg of that radioisotope in a milk sample. What was the amount of that radioisotope in this milk sample 1 day ago?

A. 5.65 mg
B. 5.97 mg
C. 6.21 mg
D. 6.69 mg

33. Which of the following statements about the fusion of hydrogen are correct?
(1) A high temperature is needed to initiate the reaction.
(2) A neutron is needed to trigger the reaction.
(3) This is the source of energy of the Sun.

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

END OF SECTION A

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	$\text{pc} = 3.09 \times 10^{16}\ \text{m} = 3.26\ \text{ly} = 206265\ \text{AU}$
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
$P = \sigma A T^4$	Stefan's law
$\left\|\frac{\Delta f}{f_0}\right\| \approx \frac{v}{c} \approx \left\|\frac{\Delta\lambda}{\lambda_0}\right\|$	Doppler effect

Energy and Use of Energy

$E = \frac{\Phi}{A}$	illuminance
$\frac{Q}{t} = \kappa\frac{A(T_H - T_C)}{d}$	rate of energy transfer by conduction
$U = \frac{\kappa}{d}$	thermal transmittance U-value
$P = \frac{1}{2}\rho A v^3$	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.	$N = N_0e^{-kt}$	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