HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2014

PHYSICS PAPER 1

8.30 am – 11.00 am (2½ hours)

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. **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 first stick a barcode label and insert the information required in the spaces provided. No extra time will be given for sticking on the barcode label after the 'Time is up' announcement.

(2) When told to open this book, you should check that all the 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 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.

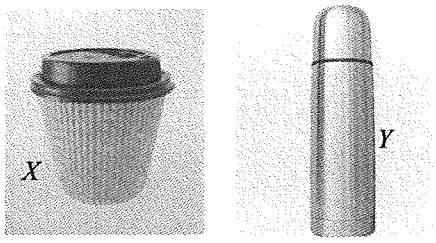
(6) No marks will be deducted for wrong answers.

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.

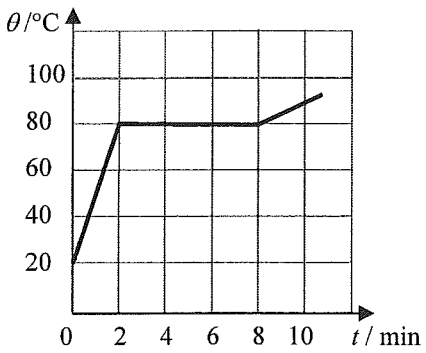
1.



Two identical scoops of ice-cream are transferred from a refrigerator into paper cup X and vacuum flask Y shown above. Under room temperature, the time required for the ice-cream in the containers to melt completely is t_X and t_Y respectively. What is the expected result and explanation ?

A. $t_X > t_Y$ as the vacuum flask reduces heat loss to the surroundings.
B. $t_X > t_Y$ as the vacuum flask retains the heat.
C. $t_Y > t_X$ as the vacuum flask keeps things cold by releasing heat into the surroundings.
D. $t_Y > t_X$ as the vacuum flask reduces the rate of heat gain from the surroundings.

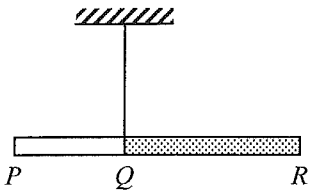
2.



An electric heater of constant power is used to heat a solid substance X which is insulated from the surroundings. The variation of its temperature θ with time t is shown above. X has a specific heat capacity of 800 J kg^{-1} $°C^{-1}$ in its solid state. What is the specific latent heat of fusion of X ?

A. 144 kJ kg^{-1}
B. 192 kJ kg^{-1}
C. 202 kJ kg^{-1}
D. Answer cannot be found as both the mass of X and the power of the heater are not known.

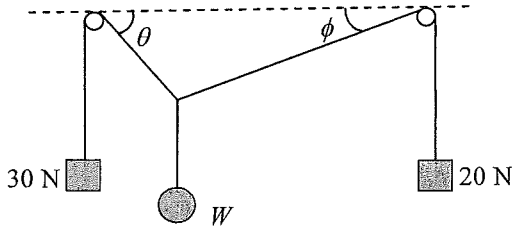
3.



PQR is a composite rod having a uniform cross-section but with portions PQ and QR made of different materials, each of uniform density. The ratio of the length of PQ to that of QR is 2 : 3. When the rod is suspended at Q, it remains horizontal as shown. What is the ratio of the mass of PQ to that of QR ?

A. 2 : 3
B. 1 : 1
C. 3 : 2
D. Answer cannot be found as the ratio of their densities is not given.

4.



The figure shows a weight W attached to two light strings which pass over two smooth pegs at the same height and with weights 30 N and 20 N attached to the respective ends of each string. The system is at equilibrium. Which deduction about W is correct ?

A. W is less than 50 N.
B. W is equal to 50 N.
C. W is greater than 50 N.
D. No information about W can be obtained as angles θ and ϕ are not known.

5. A particle is moving along a straight line with uniform acceleration. It takes 4 s to travel a distance of 36 m and then 2 s to travel the next 36 m. What is its acceleration ?

A. 2.5 m s^{-2}
B. 3.0 m s^{-2}
C. 4.0 m s^{-2}
D. 4.5 m s^{-2}

6. Two small identical blocks slide down from rest on smooth incline planes from the same height H as shown in Figure (1) and Figure (2) below. Their respective speeds at the bottom of the incline planes are denoted by v_1 and v_2 and the respective times taken to reach the bottom are t_1 and t_2. Which of the following is correct ? Neglect air resistance.

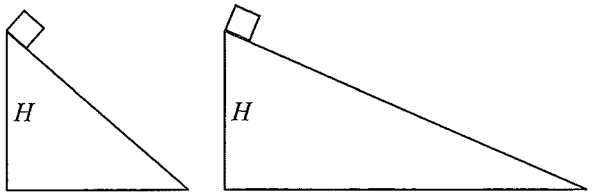
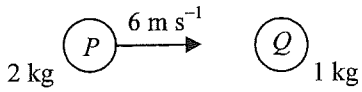


Figure (1) Figure (2)

A. $v_1 > v_2$ and $t_1 = t_2$
B. $v_1 > v_2$ and $t_1 < t_2$
C. $v_1 = v_2$ and $t_1 = t_2$
D. $v_1 = v_2$ and $t_1 < t_2$

7.



A sphere P of mass 2 kg makes a head-on collision with another sphere Q of mass 1 kg which is initially at rest. The speed of P just before collision is 6 m s^{-1}. If the two spheres move in the same direction after collision, which of the following could be the speed(s) of Q just after collision ?

(1) 2 m s^{-1}
(2) 4 m s^{-1}
(3) 6 m s^{-1}

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

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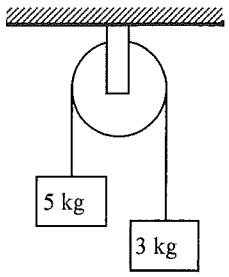
8. Two blocks of masses 5 kg and 3 kg respectively are connected by a light string passing through a frictionless fixed light pulley. Find the magnitude of the acceleration of the blocks in terms of the acceleration due to gravity g when they are released. Neglect air resistance.



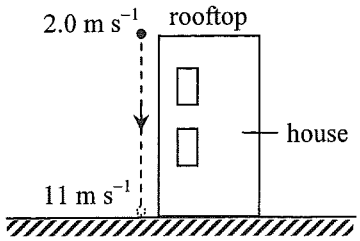
A. g

B. $\frac{g}{2}$

C. $\frac{g}{4}$

D. $\frac{g}{8}$

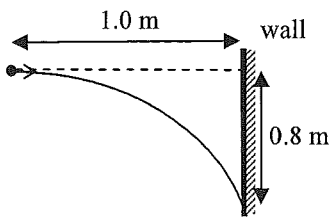
9.



A particle is projected vertically downward with an initial speed of 2.0 m s^{-1} from the rooftop of a house. The particle reaches the ground with a speed of 11 m s^{-1} as shown. Estimate the height of the house. Neglect air resistance. (g = 9.81 m s^{-2})

A. 3.3 m
B. 6.0 m
C. 6.5 m
D. 12 m

*10.



A particle is projected horizontally towards a vertical wall 1.0 m away. It hits the wall at a position 0.8 m vertically below its point of projection. At what speed is it projected ? Neglect air resistance. (g = 9.81 m s^{-2})

A. 2.0 m s^{-1}
B. 2.5 m s^{-1}
C. 5.0 m s^{-1}
D. 6.3 m s^{-1}

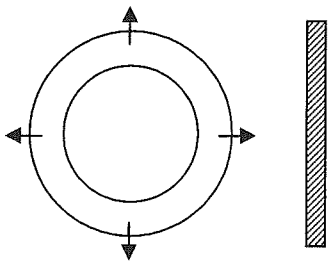
*11. An astronaut inside a spacecraft moving in a circular orbit around the Earth is apparently weightless because

A. the astronaut is too far from the Earth to feel the Earth's gravitational force.
B. the astronaut and the spacecraft are both moving with the same acceleration towards the Earth.
C. the Earth's gravitational force on the astronaut is balanced by the reaction force of the spacecraft's floor.
D. the Earth's gravitational force on the astronaut is balanced by the centripetal force.

*12. An artificial satellite revolves in a circular orbit above the Earth's surface at a height equal to the radius of the Earth. Find the acceleration of the satellite in terms of the acceleration due to gravity g on the Earth's surface.

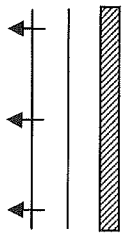
A. $\frac{g}{8}$
B. $\frac{g}{4}$
C. $\frac{g}{2}$
D. g

13.

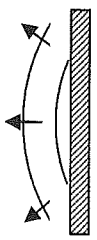


The above figure shows two circular pulses produced by drops of water falling on a ripple tank. The pulses are then reflected by a straight barrier. Which diagram best shows the reflected pulses ?

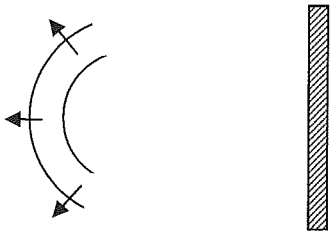
A.



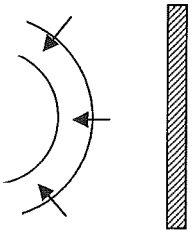
B.



C.



D.



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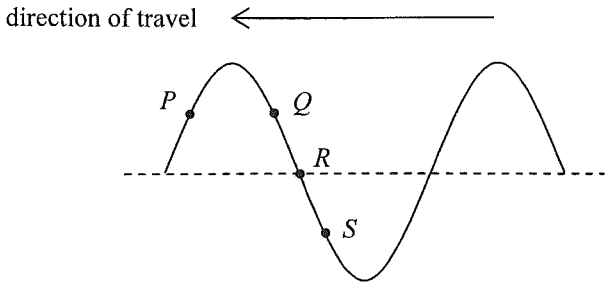
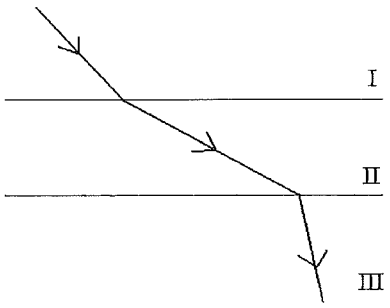
14. A transverse wave travels towards the left on a long string. P, Q, R and S are particles on the string. Which of the following statements correctly describe(s) their motions at the instant shown ?



(1) P is moving upwards.
(2) Q and S are moving in opposite directions.
(3) R is momentarily at rest.

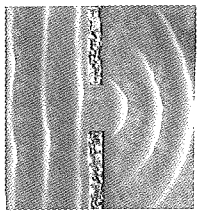
A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

15. The figure shows the path of a light ray travelling from medium I to medium III separated by parallel boundaries. Arrange in **ascending order** the speed of light in the respective media.



A. I < III < II
B. II < III < I
C. III < I < II
D. III < II < I

16.



The photograph shows a series of plane sea waves travelling through a gap in a sea wall which exhibits diffraction. Assuming that the frequency of the waves remains unchanged, which of the following will increase the degree of diffraction ?

(1) The gap in the sea wall becomes narrower.
(2) The wavelength of the waves increases.
(3) The amplitude of the waves becomes larger.

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

17.

Figure (1)

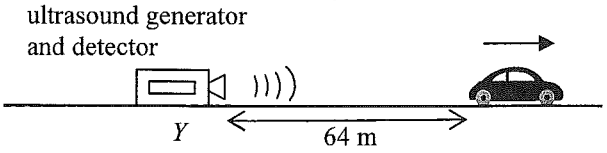


Figure (2)

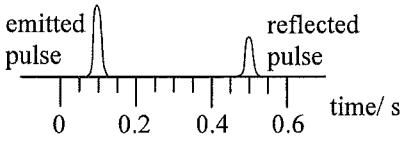
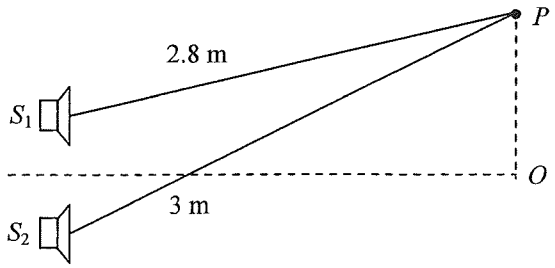


Figure (1) shows a car travelling with a uniform speed along a straight road away from a stationary ultrasound generator and detector at Y. When the car is 64 m from Y, the generator emits an ultrasound pulse towards the car. The pulse is then reflected back to the detector at Y and displayed on a CRO as shown in Figure (2). Estimate the speed of the car. Given: speed of ultrasound in air is 340 m s^{-1}

A. 16 m s^{-1}
B. 20 m s^{-1}
C. 24 m s^{-1}
D. 32 m s^{-1}

18.



S_1 and S_2 are two loudspeakers connected to a signal generator but the sound waves produced by them are in anti-phase. Point O is equidistant from the loudspeakers while point P is at the distances shown in the figure from the loudspeakers. What type of interference occurs at O and P if the wavelength of the sound waves is 10 cm ?

	O	***P***
A.	destructive	constructive
B.	constructive	constructive
C.	destructive	destructive
D.	constructive	destructive

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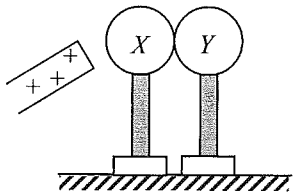
19. Which of the following statements about sound waves is/are correct ?

(1) Sound waves are electromagnetic waves.
(2) Sound waves cannot travel in a vacuum.
(3) Sound waves cannot form stationary waves.

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

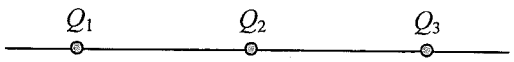
20.



Two insulated uncharged metal spheres X and Y are placed in contact. A positively-charged rod is brought near X as shown. X is then touched by a finger momentarily and the two spheres are then separated by removing Y. The charged rod is removed afterwards. Which of the following describes the charges on X and Y ?

	sphere *X*	**sphere *Y***
A.	uncharged	uncharged
B.	uncharged	positive
C.	negative	uncharged
D.	negative	negative

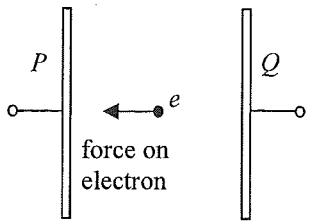
21.



Three point charges Q_1, Q_2 and Q_3 are fixed on a straight line with Q_2 at the mid-point of Q_1 and Q_3. The resultant electrostatic force on each charge is zero. Which of the following can be the sign and magnitude (in the same arbitrary units) of Q_1, Q_2 and Q_3 ?

	Q_1	Q_2	Q_3
A.	+2	+1	+2
B.	+2	−1	+2
C.	−4	+1	+4
D.	−4	+1	−4

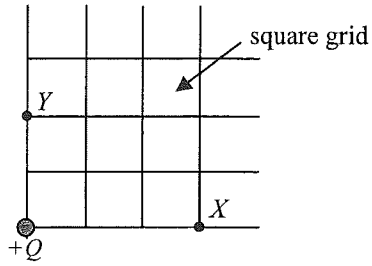
22.



Two parallel metal plates P and Q are maintained at a certain p.d. by a battery (not shown in the figure). An electron placed between the plates would experience an electrostatic force of 8.0×10^{-18} N towards P. Which of the following descriptions about the electric field E between the plates is correct ?

A. $E = 0.02$ N C^{-1} from Q to P.
B. $E = 0.02$ N C^{-1} from P to Q.
C. $E = 50$ N C^{-1} from Q to P.
D. $E = 50$ N C^{-1} from P to Q.

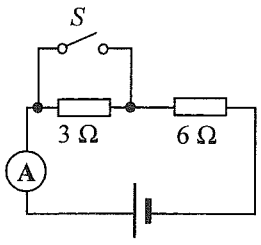
*23.



The figure shows the location of an isolated point charge $+Q$. If the electric potential at X is V, what is the electric potential at Y ?

A. $\frac{2}{3}V$
B. $\frac{3}{2}V$
C. $\frac{4}{9}V$
D. $\frac{9}{4}V$

24.



In the above circuit, the cell has constant e.m.f. and a fixed internal resistance. When S is closed, the ammeter reads 3.0 A. When S is open, which of the following is a possible reading of the ammeter ?

A. 1.6 A
B. 2.0 A
C. 2.4 A
D. 3.2 A

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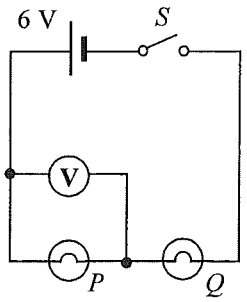
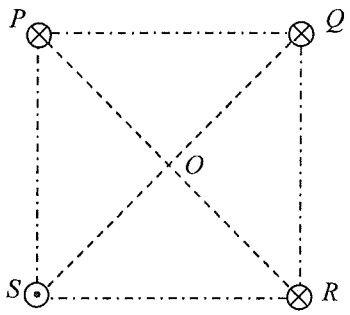
25.



The figure shows two light bulbs P and Q connected to a cell of e.m.f. 6 V and negligible internal resistance. The voltmeter reads 6 V when the switch S is closed. Which of the following is possible ?

A. Both P and Q are short-circuited.
B. Both P and Q are burnt out and become open circuit.
C. P is short-circuited or Q is burnt out and becomes open circuit.
D. P is burnt out and becomes open circuit or Q is short-circuited.

26.



Four long straight parallel wires P, Q, R and S carrying currents of equal magnitude are situated at the vertices of a square as shown. P, Q and R each carries a current directed into the paper while S carries a current directed out of the paper. The direction of the resultant magnetic field at the centre O of the square is along

A. OP.
B. OQ.
C. OR.
D. OS.

27.

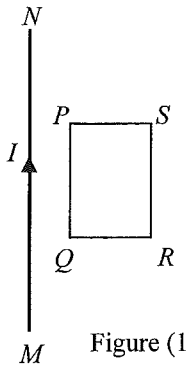


Figure (1)

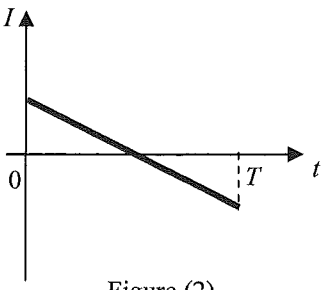
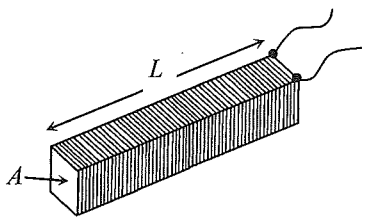


Figure (2)

A long straight current-carrying wire MN and a rectangular coil $PQRS$ are fixed in the same plane as shown in Figure (1). The current I is taken as positive when it flows from M to N and it varies with time t as shown in Figure (2). The direction of the induced current in the coil during the time interval $0 - T$ is

A. first anti-clockwise and then clockwise.
B. first clockwise and then anti-clockwise.
C. anti-clockwise throughout.
D. clockwise throughout.

28.



The figure shows a closely packed long solenoid of cross-sectional area A and length L having a total of N turns. If the solenoid carries a constant direct current throughout, which of the following changes can increase the magnetic flux density B at its central cross-section ?

	length	**cross-sectional area**	**total number of turns**
A.	$2L$	$2A$	$2N$
B.	L	$2A$	N
C.	$2L$	A	N
D.	L	A	$2N$

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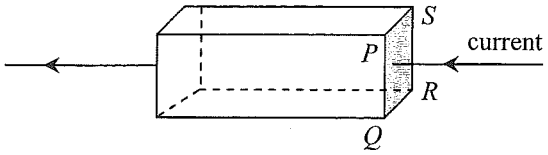
*29.



The figure shows a current flowing from right to left in a metal block with cross-section $PQRS$. When a uniform magnetic field is applied to the block, the electric potential of the side PQ is found to be higher than that of the side SR. In which direction can the magnetic field be applied ?

A. from P to Q
B. from Q to P
C. from P to S
D. from S to P

*30. When a heater is connected to a d.c. voltage of 10 V, the power dissipated is P. If the heater is connected to a sinusoidal a.c., the power dissipated becomes $\frac{1}{2}P$. What is the **r.m.s. voltage** of this a.c. source ? Assume that the resistance of the heater is constant.

A. 5 V
B. $5\sqrt{2}$ V
C. 10 V
D. $10\sqrt{2}$ V

31. Nucleus W decays to nucleus Z as shown below:

$$W \xrightarrow{\alpha} X \xrightarrow{\beta} Y \xrightarrow{\beta} Z$$

Which of the following statements is/are correct ?

(1) Nucleus X has 1 more proton than nucleus Y.
(2) Nucleus W has 2 more neutrons than nucleus X.
(3) W and Z are isotopes of the same element.

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

32. A GM counter is placed close to and in front of a radioactive source which emits both α and γ radiations. The count rate recorded is 450 counts per minute while the background count rate is 50 counts per minute. Three different materials are placed in turn between the source and the counter. The following results are obtained.

Material	Recorded count rate / counts per minute
(Nil)	450
cardboard	x
1 mm of aluminium	y
2 mm of lead	z

Which of the following is the most suitable set of values for x, y and z ?

	x	y	z
A.	300	300	100
B.	300	100	50
C.	100	100	0
D.	100	50	50

*33. A radium nucleus decays to a radon nucleus by emitting an α-particle. The energy released in the process is 4.9 MeV. Compared to the mass of a radium nucleus, the total mass of a radon nucleus and an α-particle is

A. 5.4×10^{-11} kg less.
B. 5.4×10^{-11} kg more.
C. 8.7×10^{-30} kg less.
D. 8.7×10^{-30} kg more.

END OF SECTION A

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List of data, formulae and relationships

Data

molar gas constant	$R = 8.31$ J mol^{-1} K^{-1}
Avogadro constant	$N_A = 6.02 \times 10^{23}$ mol^{-1}
acceleration due to gravity	$g = 9.81$ m s^{-2} (close to the Earth)
universal gravitational constant	$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}
speed of light in vacuum	$c = 3.00 \times 10^8$ m s^{-1}
charge of electron	$e = 1.60 \times 10^{-19}$ C
electron rest mass	$m_e = 9.11 \times 10^{-31}$ kg
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2 N^{-1} m^{-2}
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}$ H m^{-1}
atomic mass unit	u $= 1.661 \times 10^{-27}$ kg (1 u is equivalent to 931 MeV)
astronomical unit	AU $= 1.50 \times 10^{11}$ m
light year	ly $= 9.46 \times 10^{15}$ m
parsec	pc $= 3.09 \times 10^{16}$ m $= 3.26$ ly $= 206265$ AU
Stefan constant	$\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4}
Planck constant	$h = 6.63 \times 10^{-34}$ 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
$\left\|\frac{\Delta f}{f_0}\right\| \approx \frac{v}{c} \approx \left\|\frac{\Delta\lambda}{\lambda_0}\right\|$	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
$P = \frac{1}{2}\rho Av^3$	maximum power by wind turbine

Atomic World

$\frac{1}{2}m_e v_{max}^2 = hf - \phi$	Einstein's photoelectric equation
$E_n = -\frac{1}{n^2}\left\{\frac{m_e e^4}{8h^2\varepsilon_0^2}\right\} = -\frac{13.6}{n^2}$ 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)
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.	$V = \frac{Q}{4\pi\varepsilon_0 r}$	electric potential due to a point charge
D4.	$E = \frac{V}{d}$	electric field between parallel plates (numerically)
D5.	$I = nAvQ$	general current flow equation
D6.	$R = \frac{\rho l}{A}$	resistance and resistivity
D7.	$R = R_1 + R_2$	resistors in series
D8.	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$	resistors in parallel
D9.	$P = IV = I^2R$	power in a circuit
D10.	$F = BQv\sin\theta$	force on a moving charge in a magnetic field
D11.	$F = BIl\sin\theta$	force on a current-carrying conductor in a magnetic field
D12.	$V = \frac{BI}{nQt}$	Hall voltage
D13.	$B = \frac{\mu_0 I}{2\pi r}$	magnetic field due to a long straight wire
D14.	$B = \frac{\mu_0 NI}{l}$	magnetic field inside a long solenoid
D15.	$\varepsilon = N\frac{\Delta\Phi}{\Delta t}$	induced e.m.f.
D16.	$\frac{V_s}{V_p} \approx \frac{N_s}{N_p}$	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