HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2016

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. Some icy cold liquid is kept cold inside a vacuum flask. Which statements are correct ?

(1) The flask's cork stopper reduces heat gain from the surroundings.
(2) The silver coating on the inner surface of the glass wall is a good reflector of infra-red.
(3) The vacuum between the double glass walls reduces heat gain by radiation.

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

2. 0.3 kg of water at temperature 50 °C is mixed with 0.2 kg of ice at temperature 0 °C in an insulated container of negligible heat capacity. What is the final temperature of the mixture ?

Given: specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$
specific latent heat of fusion of ice = 3.34×10^5 J kg^{-1}

A. −1.8 °C
B. 0 °C
C. 1.8 °C
D. 3.0 °C

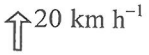
*3. When an ideal gas is heated from 25 °C to 50 °C, the average kinetic energy of the gas molecules will

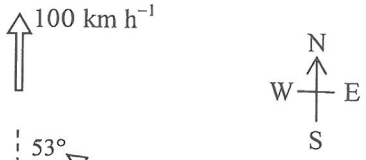
A. double.
B. increase by 41 %.
C. increase by 8.4%.
D. increase by 4.1%.

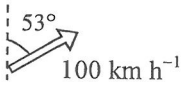
4. The speedometer of a car shown below indicates the car's

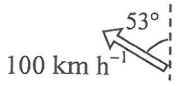
A. instantaneous speed.
B. instantaneous velocity.
C. average speed of the whole journey.
D. average velocity of the whole journey.

5. A car travelling at 80 km h^{-1} due east changes direction and travels at 60 km h^{-1} due north. Which diagram represents the change in velocity of the car ?

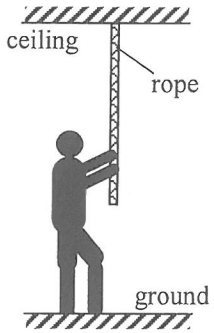
A. 

B. 

C. 

D. 

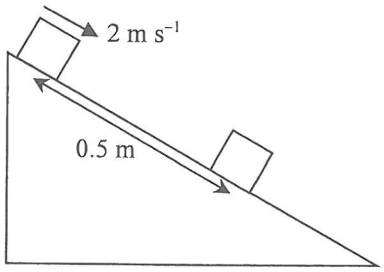
6. A boy of weight W exerts a downward pulling force F on a rope of weight G hung vertically from the ceiling. He stands still on the ground as shown. Which of the following gives the magnitude of the force exerted by



(1) the boy on the ground;
(2) the rope on the ceiling ?

	(1)	(2)
A.	W	$G - F$
B.	W	$G + F$
C.	$W - F$	$G - F$
D.	$W - F$	$G + F$

7. A block with initial speed 2 m s^{-1} slides down a rough inclined plane and stops after travelling a distance of 0.5 m. What is the deceleration of the block ?



A. 1 m s^{-2}
B. 2 m s^{-2}
C. 4 m s^{-2}
D. Answer cannot be found as the angle of inclination of the plane is not given.

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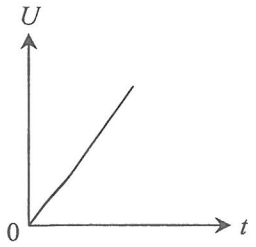
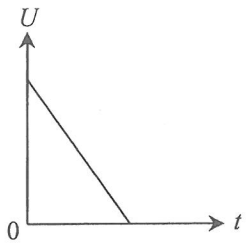
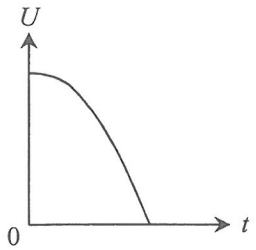
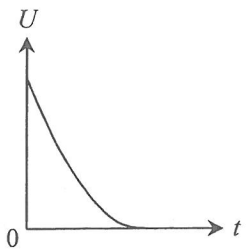
8. An object at a certain height falls freely from rest under gravity. Which graph correctly shows the variation of its gravitational potential energy U with time t ? Neglect air resistance and take $U = 0$ at the ground.

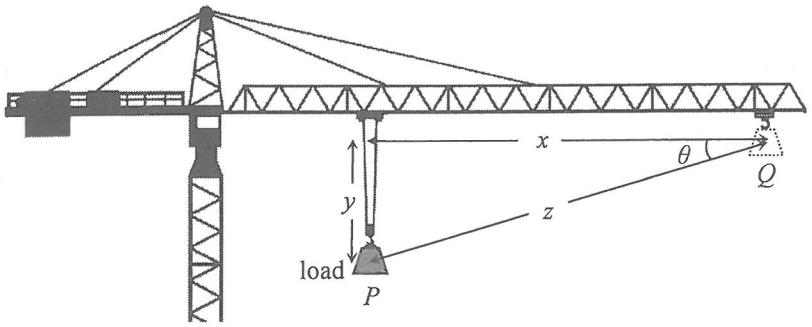
A.


B.


C.


D.


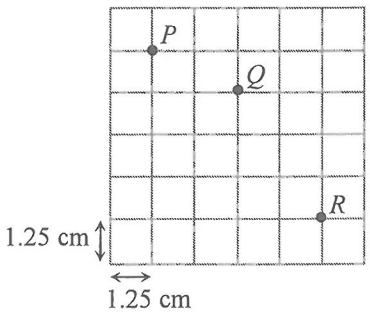
9. A crane moves a load of weight W steadily from point P to point Q as shown.



The work done on the load by the crane is

A. Wy.
B. $W(x + y)$.
C. Wz.
D. $Wz \cos \theta$.

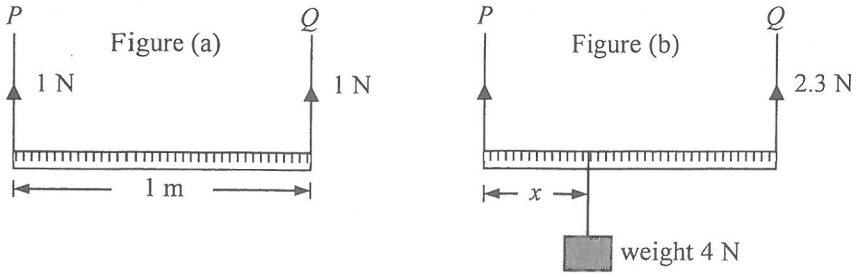
*10.



The above stroboscopic picture shows a particle projected horizontally at position P into the air in a vertical plane. Subsequently the particle reaches positions Q and R such that the time interval between P and Q is equal to that between Q and R. Each square of the grid measures 1.25 cm × 1.25 cm. Find the particle's speed of projection at P. Neglect air resistance. ($g = 9.81$ m s^{-2})

A. 0.3 m s^{-1}
B. 0.4 m s^{-1}
C. 0.5 m s^{-1}
D. 0.6 m s^{-1}

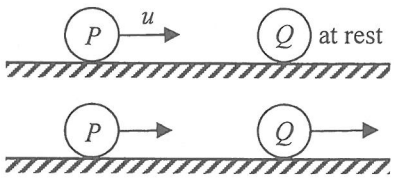
11.



A uniform metre rule is supported by vertical wires P and Q and remains at rest horizontally as shown in Figure (a). The tension in each wire is 1 N. When a weight of 4 N is hung from the metre rule at a certain position as shown in Figure (b), the tension in Q becomes 2.3 N while the metre rule remains horizontal. Find the distance x shown.

A. 32.5 cm
B. 57.5 cm
C. 67.5 cm
D. Answer cannot be found as the tension in P is not known.

12. On a smooth horizontal surface, a marble P moving with speed u collides head-on with another marble Q, which is at rest. After collision, P and Q move with different speeds as shown.

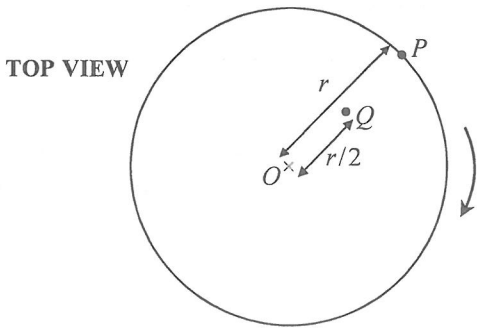


Which of the following statements about this collision is/are correct ?

(1) During collision, the force acting on Q by P is equal and opposite to that acting on P by Q.
(2) The total momentum of the two marbles is conserved only when the collision is perfectly elastic.
(3) The kinetic energy lost by P must be equal to that gained by Q.

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

*13. Particles P and Q are fixed at distances r and $r/2$ respectively from the centre O of a horizontal circular platform which is rotating uniformly as shown.



The ratio of the acceleration of P to that of Q is

A. 1 : 2.
B. 2 : 1.
C. 1 : 4.
D. 4 : 1.

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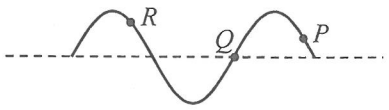
*14. A satellite orbits the Earth in a circular path of radius 7.2×10^6 m. What is the period of the satellite ?
Given : mass of the Earth = 6.0×10^{24} kg

A. 1.4 hours
B. 1.7 hours
C. 1 day
D. Answer cannot be found as the mass of the satellite is not known.

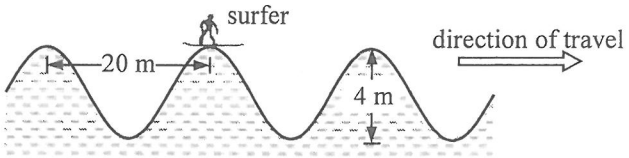
15.



The above figure shows a snapshot of a transverse wave which travels along a string. Which statement is correct ?

A. The wave is travelling to the left if particle P is moving upwards at this instant.
B. Particles P and R are moving in the same direction at this instant.
C. Particle Q is at rest at this instant.
D. Particle R vibrates with an amplitude larger than that of particle Q.

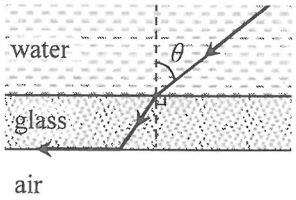
16.



The surfer in the figure reaches a crest at the moment shown. The crests of the water wave are 20 m apart and the surfer descends a vertical distance of 4 m from a crest to a trough in a time interval of 2 s. What is the speed of the wave ?

A. 1 m s^{-1}
B. 2 m s^{-1}
C. 5 m s^{-1}
D. 10 m s^{-1}

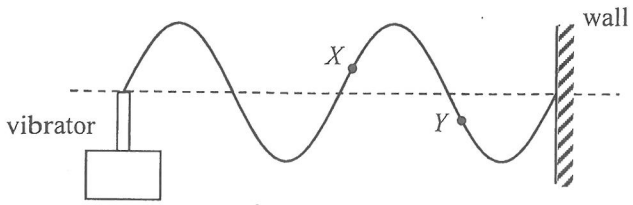
17.



A parallel-sided glass sheet separates water from air. A ray of light in water is incident at an angle θ on the glass sheet and finally emerges into air along the glass-air interface as shown. Find θ.
Given: refractive index of water is 1.33.

A. 41.2°
B. 48.8°
C. 53.1°
D. It depends on the refractive index of glass.

18. A string is tied to a vibrator while the other end is fixed to a wall. A stationary wave is formed as shown.



Which statement is correct when the frequency of the vibrator doubles ?

A. The wavelength will double.
B. The wave speed will double.
C. The amplitude will be halved.
D. Particles X and Y will become vibrating in phase.

19. Diffraction will occur when light

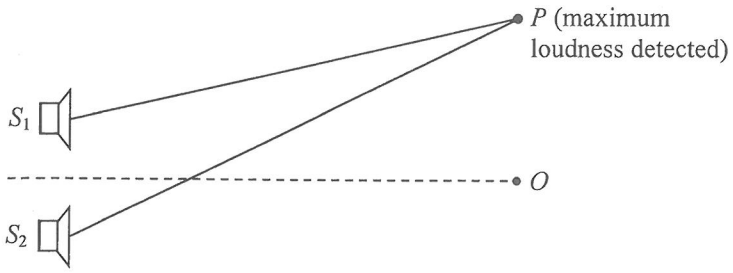
(1) passes through a pinhole.
(2) passes by a sharp edge.
(3) passes through a slit.

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

20. A beam of white light is separated into different colours after entering a glass prism because lights of different colours

A. are diffracted to different extents by the prism.
B. undergo total internal reflection at different angles inside the prism.
C. travel at different speeds in vacuum.
D. travel at different speeds in glass.

21.



Loudspeakers S_1 and S_2 connected to a signal generator emit sound waves which are in phase. Point O is equidistant from the loudspeakers while at point P maximum loudness is detected. The wavelength of the sound waves is λ. Which statement is **INCORRECT** ?

A. Both PS_1 and PS_2 must be integral multiples of wavelength λ.
B. The definite value of the path difference $PS_2 - PS_1$ cannot be determined from the information given.
C. At least one point of minimum loudness can be detected between O and P.
D. Minimum loudness will be detected at P if the sound waves from S_1 and S_2 are in antiphase.

22. An object is moving at constant speed towards a convex lens of focal length 10 cm. At the moment when it is at 100 cm from the lens, which of the following descriptions of the image is correct ?

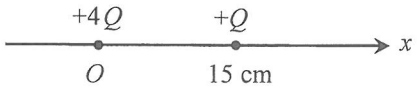
	direction of image movement	speed of the image
A.	away from the lens	faster than that of the object
B.	towards the lens	faster than that of the object
C.	away from the lens	slower than that of the object
D.	towards the lens	slower than that of the object

23. Which of the following are applications of ultrasound ?

(1) sterilizing drinking water
(2) detecting cracks in railway tracks
(3) breaking up kidney stones

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

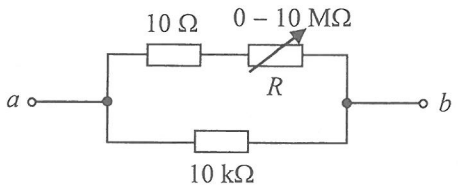
*24.



Point charges $+4Q$ and $+Q$ are fixed on the x-axis with $+4Q$ at the origin O and $+Q$ at x = 15 cm as shown. The respective electric fields due to the two charges are equal at

A. x = 10 cm.
B. x = 12 cm.
C. x = 20 cm.
D. x = 30 cm.

25.



In the above circuit, the variable resistor R can be adjusted over its full range from 0 to 10 MΩ. What is the approximate range of resistance between a and b ?

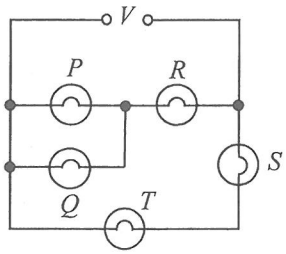
A. 0 to 10 kΩ
B. 10 Ω to 10 kΩ
C. 10 Ω to 10 MΩ
D. 10 kΩ to 10 MΩ

26. Two filament light bulbs X and Y are connected in parallel to a dry cell. X is brighter than Y. Which statements are correct ?

(1) In 1 s, the number of charges flowing through X is greater than that flowing through Y.
(2) In 1 s, the electrical energy dissipated by X is greater than that dissipated by Y.
(3) For every unit charge passing, the electrical energy dissipated by X is equal to that dissipated by Y.

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

27.



In the above circuit, all the bulbs are identical. If the voltage V gradually increases, which bulb(s) will burn out first ?

A. P and Q
B. R
C. S
D. T

28. A television set in stand-by mode consumes 1.5 W. If it is in this mode for 16 hours a day, estimate the carbon dioxide (CO_2) emission due to the electricity consumed in stand-by mode in a 30-day month. Given: 1 kW h of electricity consumed corresponds to 0.8 kg CO_2 emission from the power station.

A. 0.576 kg
B. 0.720 kg
C. 576 kg
D. 720 kg

*29. A student uses a search coil to study the strength of the magnetic field inside a long solenoid which is connected to an a.c. signal generator set at a certain frequency. Which of the following can improve the accuracy of this experiment ?

(1) Ensure the plane of the search coil is perpendicular to the field lines.
(2) Increase the signal generator's frequency and use the same current as before.
(3) Set the axis of the solenoid along an east-west direction to avoid the effects of the Earth's magnetic field.

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

Go on to the next page

*30. A sinusoidal a.c. of a certain frequency delivers a r.m.s. voltage $V_{r.m.s.}$. If its frequency is doubled and its peak voltage is halved, what would be the r.m.s. voltage ?

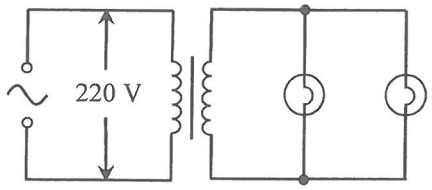
A. $\frac{1}{2} V_{r.m.s.}$

B. $\frac{1}{\sqrt{2}} V_{r.m.s.}$

C. $\frac{1}{2\sqrt{2}} V_{r.m.s.}$

D. $V_{r.m.s.}$

*31.



In the above circuit, each light bulb works at its rated value '22 W, 11 V'. The current in the primary coil is 0.25 A. Find the efficiency of the transformer.

A. 20%
B. 40%
C. 64%
D. 80%

32. Which of the following statements about ionizing radiations is/are correct ?

(1) The ionizing power of α-particles is much stronger than that of β-particles.
(2) γ-radiation can be completely shielded by a 10 cm thick concrete wall.
(3) Ionizing radiations α, β and γ all undergo deflection in an electric field.

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

33. Two radionuclides X and Y are of half-lives 3 hours and 4 hours respectively and initially there are N_X and N_Y undecayed nuclei respectively. After 24 hours, the number of undecayed nuclei of both nuclides becomes the same. Find $N_X : N_Y$.

A. 8 : 1
B. 4 : 3
C. 4 : 1
D. 2 : 1

END OF SECTION A

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 = 1.661×10^{-27} kg (1 u is equivalent to 931 MeV)
astronomical unit	AU = 1.50×10^{11} m
light year	ly = 9.46×10^{15} m
parsec	pc = 3.09×10^{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
$P = \frac{1}{2}\rho A v^3$	maximum power by wind turbine

Atomic World

$\frac{1}{2}m_e v_{max}{}^2 = hf - \phi$	Einstein's photoelectric equation
$E_n = -\frac{1}{n^2}\left\{\frac{m_e e^4}{8h^2\varepsilon_0^2}\right\} = -\frac{13.6}{n^2}$ 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.	$E = \frac{V}{d}$	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