CNEC Christian College
MOCK Examination (2021-2022)
Form Six
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 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.**

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

(4) 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.

(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.

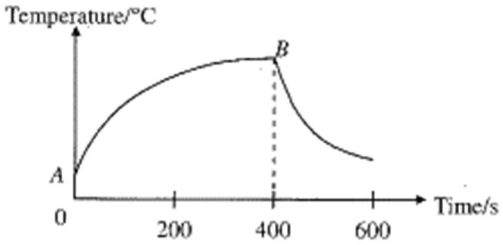
(5) You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.

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

Section A: Multiple-Choice Questions

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

1.



The graph above shows the time variation of temperature of a cup of water, which is put on a table at room temperature. An immersion heater is immersed into the water. It is switched on for a while and is switched off later. Which of the following statements is/are correct?

(1) The heater is switched off at t = 400 s.

(2) If the power of the heater increases, the slope of the part of the graph AB increases.

(3) After t = 400 s, the temperature keeps on decreasing until all the internal energy in the water is released.

A. (2) only

B. (3) only

C. (1) and (2) only

D. (1) and (3) only

2. A liquid X at 90 °C is mixed with a liquid Y at 30 °C. The final mixture has a temperature of 70 °C. Neglecting any heat exchange with the surroundings, which of the following statements is correct?

A. At the final temperature, X and Y has the same internal energy.

B. The heat lost by X is less than the heat gained by Y.

C. X has a higher specific heat capacity than Y.

D. X has a higher heat capacity than Y.

***3.** A hydrogen gas jar of pressure 140×10^5 Pa and volume 10×10^{-3} m^3 is used to fill hydrogen balloons of volume 4×10^{-3} m^3 each at 1.1×10^5 Pa. Assume all hydrogen gas is used to fill up the balloons and the temperature of the gas remains unchaged. The number of balloons that can be filled is

A. 300.

B. 318.

C. 336.

D. 354.

4. In a training session, an athlete completes 2 laps along a track around a football field. In the first lap, his average speed is v. What should be his average speed in the second lap such that his overall average speed is 1.5v?

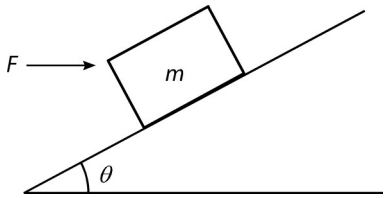
A. 2v

B. 2.5v

C. 3v

D. 4v

5. A block of mass m on a smooth inclined plane is kept at rest by a horizontal force F as shown in the figure. The plane makes an angle θ with the horizontal. Find the normal reaction acting on the block by the plane.



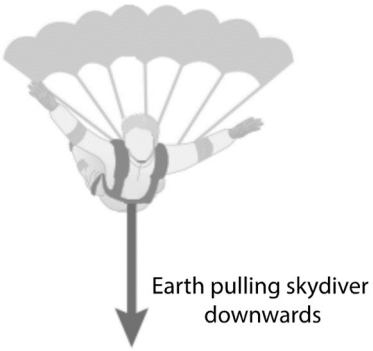
A. $mg \cos \theta$

B. $mg \sin \theta \cos \theta$

C. $\dfrac{mg}{\cos \theta}$

D. $\dfrac{mg}{\sin \theta}$

6. A skydiver is falling in air at the terminal speed. The diagram shows the force acting on him by the Earth. Which of the following forces form an action–reaction pair with this downward force?



A. the air resistance acting on the skydiver

B. the force acting on the air by the skydiver

C. the gravitational force acting on the skydiver by the Earth

D. the gravitational force pulling the Earth upwards by the skydiver

7. Trolley X moves on a horizontal smooth surface and collides head on with stationary trolley Y. Both trolleys are of the same mass.

If the collision is elastic, how will the trolleys move after the collision?

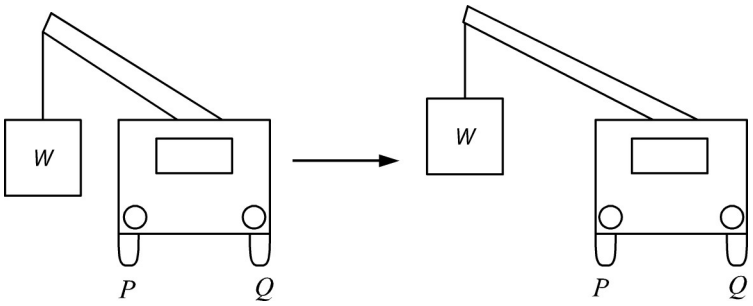
A. The trolleys will move in opposite direction at the same speed.

B. The trolleys will move in opposite direction at different speeds.

C. X will stop and Y will move away from X.

D. Y will remain stationary and X will move away from Y.

8. A crane lorry is holding a load W at rest. The normal reaction at wheels P and Q are R_P and R_Q respectively. The arm of the crane is now prolonged as shown. How do R_P and R_Q change?



A. R_P increases and R_Q decreases.

B. R_P decreases and R_Q increases.

C. Both R_P and R_Q increase.

D. Both R_P and R_Q decrease.

9. A car of mass 1000 kg increases its speed uniformly from 0 to 15 m s^{-1} in 3 s. If the average resistance force of the road is 500 N, find the average power developed by the car.

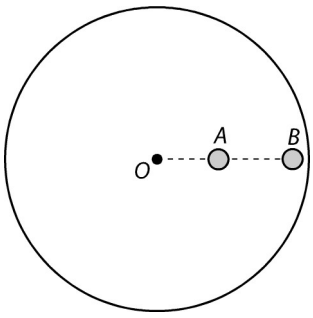
A. 41.25 kW

B. 82.5 kW

C. 123.75 kW

D. 165 kW

***10.** Two small identical coins A and B are put on a rough horizontal turntable which is rotating at a uniform angular speed about its centre O. Given that $OB = 2 \times OA$. If the coins do not slip, which of the following statements is/are correct?



(1) The kinetic energy of B is twice that of A.

(2) The friction acting on B is twice that on A.

(3) The period of B is twice that of A.

A. (1) only

B. (2) only

C. (1) and (3) only

D. (2) and (3) only

11. At $t = 0$, a particle is released from rest by a helicopter at a height of 800 m above the ground. At $t = 10$ s, the particle falls steadily with a certain velocity. Which of the following statements about the particle after $t = 10$ s is/are correct before striking the ground?

(1) The gravitational potential energy of the particle decreases.

(2) The kinetic energy of the particle increases.

(3) The air resistance keeps increasing.

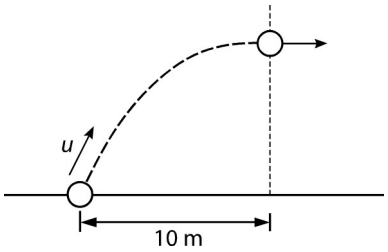
A. (1) only

B. (1) and (2) only

C. (2) and (3) only

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

***12.** A ball is projected with a speed u from the ground. After 1 s, its horizontal displacement is 10 m and its velocity becomes horizontal. Find u.



A. 9.81 m s^{-1}

B. 12.0 m s^{-1}

C. 14.0 m s^{-1}

D. 19.6 m s^{-1}

13. A particle of mass 2 kg is released from rest at height of 18.0 m from a building. It strikes the ground without rebounding and becomes at rest on the ground in 0.04 s. What is the average reaction force acting on the particle by the ground? Neglect air resistance.

A. 470 N

B. 900 N

C. 960 N

D. 1880 N

14. Which of the following surfaces produce diffuse reflection when parallel light rays fall on them?

(1) a blackboard in the classroom

(2) a plane mirror

(3) a page in this question paper

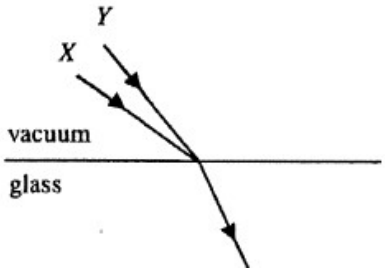
A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

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

15.



Two colured light, *X* and *Y*, travel from vacuum to glass. They undergo refraction and travel along the same path in glass. Which of the following descriptions about the two coloured lights is correct?

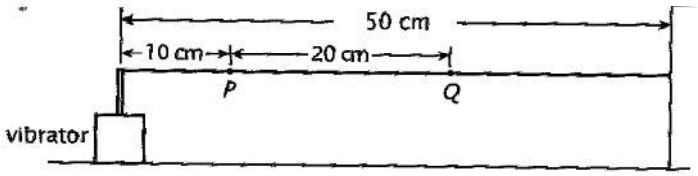
A. Glass has a greater refractive index for *X* and *X* travels with the same speed as *Y* in vacuum.

B. Glass has a greater refractive index for *X* and *X* travels slower than *Y* in vacuum.

C. Glass has a smaller refractive index for *X* and *X* travels with the same speed as *Y* in vacuum.

D. Glass has a smalller refractive index for *X* and *X* travels faster than *Y* in vacuum.

16.



A string with one end fixed and the other end connected to a vibrator. The frequency of the vibrator is set at 30 Hz and a stationary wave of two vibrating loops is produced. *P* and *Q* are two particles on the string.

Which of the following statemnts is/are correct?

(1) The speed of the wave along the string is 6 m s^{-1}.

(2) *P* and *Q* are vibrating with the same amplitude.

(3) When the frequency of the vibrator is doubled, *P* and *Q* are vibrating in phase.

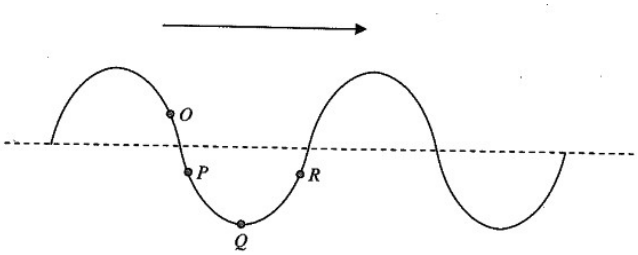
A. (1) only

B. (3) only

C. (1) and (2) only

D. (2) and (3) only

17.



The figure shows the instantaneous position of a wave, which is advancing to the right. Which particle will reach its equilibrium position first?

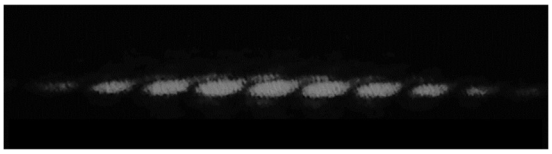
A. *O*

B. *R*

C. *Q*

D. *P*

18. The figure shows the interference pattern formed on a screen by passing a beam of monochromatic light through a double slit. Which of the following can increase the separation of the fringes?



(1) Use a beam of light of higher frequency.

(2) Use a diffraction grating with more lines per mm.

(3) Increase the distance between the light source and the double slit.

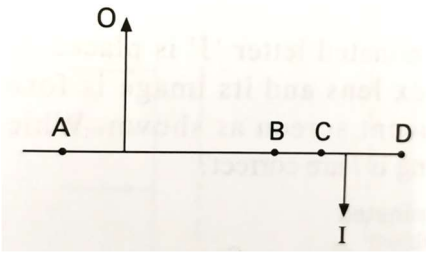
A. (2) only

B. (3) only

C. (1) and (2) only

D. (1) and (3) only

19. The diagram shows the positions of an object and its image formed by a lens. What type of lens is it and which point is the principal focus of the lens?



A. concave, point *B*

B. concave, point *D*

C. convex, point *A*

D. convex, point *C*

20. When a beam of light is directed from medium *A* to medium *B* at an angle of incidence of 40°, the angle of refraction is 30° (Fig. a). When a beam of light is directed from medium *B* to medium *C* at the same angle of incidence, the angle of refraction is 50° (Fig. b). When a beam of light is directed from medium *C* to medium *A* at the same angle of incidence, what will be the angle or refraction (Fig. c)?

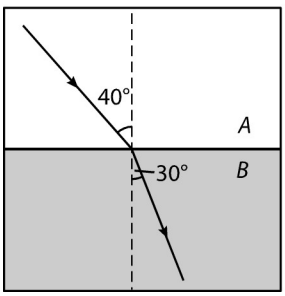


Fig. a

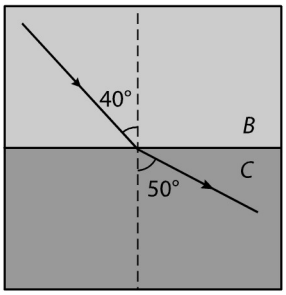


Fig. b

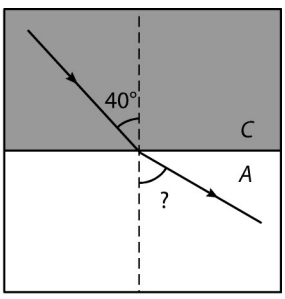


Fig. c

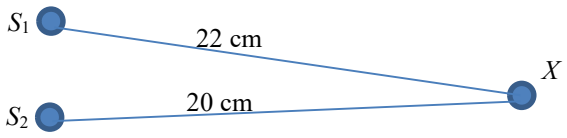
A. 24.8°

B. 36.6°

C. 43.9°

D. 80.0°

21. Two coherent sources S_1 and S_2, give out waves. Constructive interference is found at X. What is/are the possible wavelengh of the waves?



(1) 1 cm

(2) 2 cm

(3) 4 cm

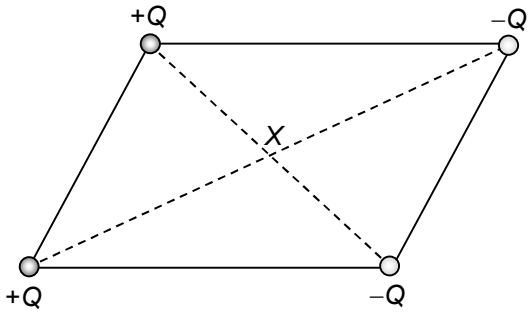
A. (1) only

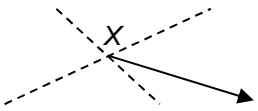
B. (2) only

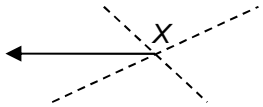
C. (3) only

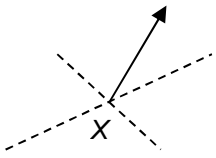
D. (1) and (2) only

22. Four point charges are placed at the four vertices of a parallelogram as shown. What is the direction of electric field strength at point X?



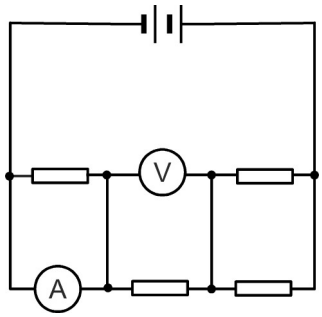
A. 

B. 

C. 

D. No electric field at X

23. In the circuit shown, the four resistors are identical. Both the ammeter and the voltmeter are ideal and the internal resistance of the battery is zero. If the voltage of the battery is 6 V, what is the reading of the voltmeter?



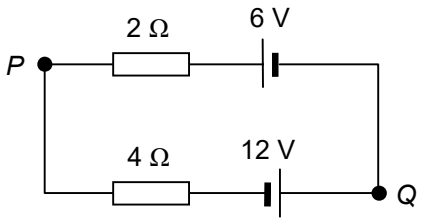
A. 2 V

B. 3 V

C. 3.5 V

D. 4 V

24. A 6-V battery and a 12-V battery, both of negligible internal resistance, are connected in series with two resistors of 2 Ω and 4 Ω as shown in the following figure.



What is the voltage across *PQ*?

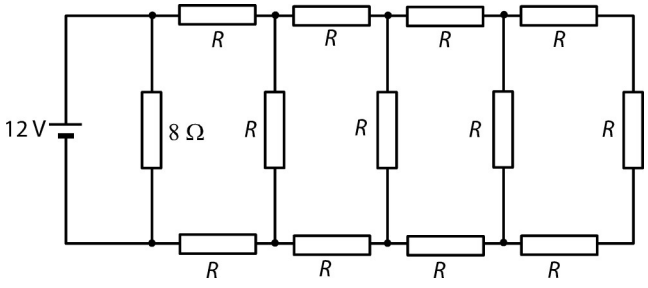
A. 0 V

B. 6 V

C. 12 V

D. 18 V

25. Twelve identical resistors *R* and an 8 Ω resistor are connected to a 12 V battery as shown. The current drawn from the battery is 2 A. If the 8 Ω resistor is replaced by a 4 Ω resistor, what is the new current drawn from the battery?



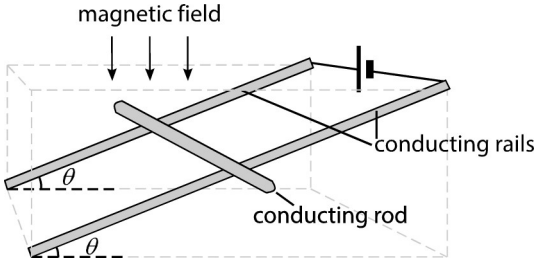
A. 4 A

B. 3.5 A

C. 3 A

D. 2.5 A

26. A conducting rod of weight W is put on a pair of smooth conducting rails inside a uniform vertically downward magnetic field. A battery is connected across the rails so that a constant current flows along the rod. When the rod is released from rest, it slides down along the rail with uniform velocity. The inclination angle of the rails to the horizontal is θ.



What is the magnitude of magnetic force acting on the rod?

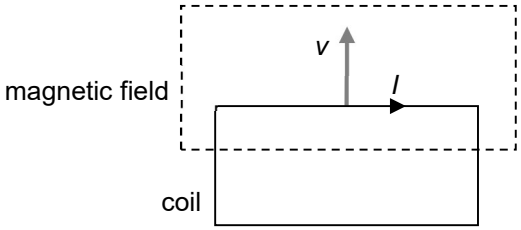
A. $W \sin \theta$

B. $W \cos \theta$

C. $W \tan \theta$

D. $\frac{W}{tan\theta}$

27. A coil is moving upwards with a velocity v and is entering a magnetic field as shown. A current I is induced in the coil.



The magnetic field must pointing

A. upwards.

B. downwards.

C. into the page.

D. out of the page.

***28.** The label on a transformer is shown below. While in normal operation, its efficiency is 70%. Estimate the current in the primary circuit of the transformer.

input a.c	220 V
output a.c	5 V, 2 A

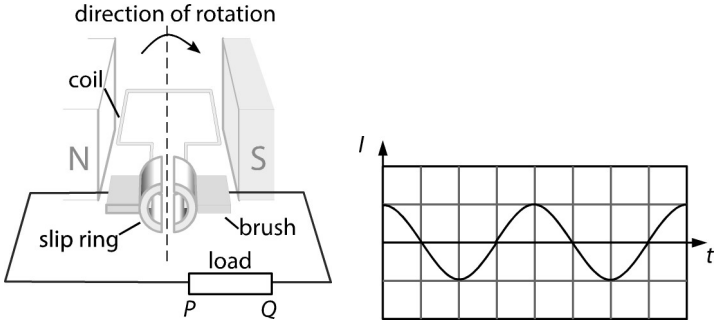
A. 32 mA

B. 45 mA

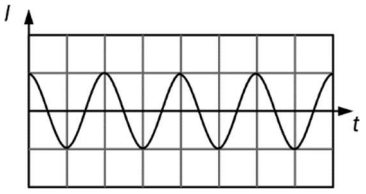
C. 65 mA

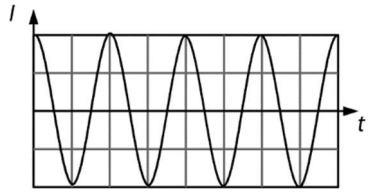
D. 93 mA

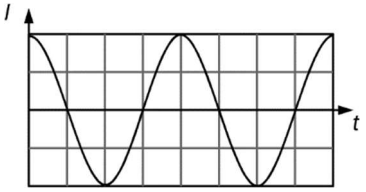
29. The coil of a generator is rotated in the direction shown. The current–time graph represents how the current through the load *PQ* changes with time.

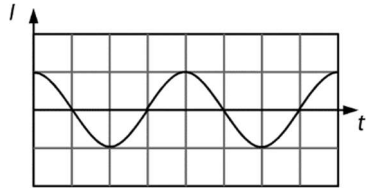


If the frequency of rotation is doubled, which of the following best shows the new current–time graph?

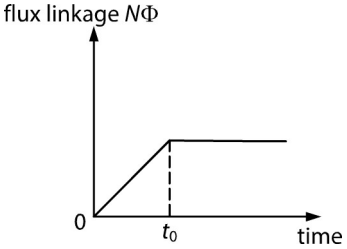
A.


B.


C.


D.


***30.** The graph shows how the flux linkage, $N\Phi$, through a coil changes with time.



The emf induced in the coil

A. increases steadily and then becomes constant after $t = t_0$.

B. is constant then becomes zero after $t = t_0$.

C. is constant then jumps to another non-zero constant after $t = t_0$.

D. decreases steadily and then becomes zero after $t = t_0$.

***31.** At time $t = 0$, the number of active nuclei of a certain radioactive sample is 8×10^{10}. The half-life of the sample is 1 hour. Find the activity of the sample at $t = 2$ hours.

A. 3.85×10^6 Bq

B. 4.82×10^6 Bq

C. 5.23×10^6 Bq

D. 7.02×10^6 Bq

32. Nuclide P undergoes a series of decay as shown and the final product is nuclide T. Among the four nuclides P, Q, S and T, which one has the largest number of neutron and which one has the largest number of proton?

$$P \xrightarrow{\beta} Q \xrightarrow{\beta} S \xrightarrow{\alpha} T$$

	Largest number of neutron	**Largest number of proton**
A.	P	P
B.	P	S
C.	S	T
D.	S	S

***33.** What is the energy given out when a helium nucleus is formed by 2 protons and 2 neutrons?

Given: mass of a proton = 1.6726×10^{-27} kg

mass of a neutron = 1.6749×10^{-27} kg

mass of helium = 6.6465×10^{-27} kg

A. 4.37 Mev

B. 6.81 Mev

C. 13.6 Mev

D. 27.2 Mev

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	$q_e = 1.60 \times 10^{-19}$ 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^{-1}

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
$\left\|\frac{\Delta f}{f_0}\right\| \approx \frac{v}{c} \approx \left\|\frac{\Delta\lambda}{\lambda}\right\|$	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
$P = \frac{1}{2}\rho A v^3$	maximum power by wind turbine

Atomic World

$\frac{1}{2}m_c {v_{max}}^2 = hf - \phi$	Einstein's photoelectric equation
$E_n = -\frac{1}{n^2}\left\{\frac{m_e e^4}{8h^2\epsilon_0^2}\right\} = -\frac{13.6}{n^2}$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.	$E = \ell \Delta m$	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.	$E_\mathrm{K} = \frac{3RT}{2N_\mathrm{A}}$	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.	$E_\mathrm{P} = mgh$	gravitational potential energy
B4.	$E_\mathrm{K} = \frac{1}{2}mv^2$	kinetic energy
B5.	$P = Fv = \frac{W}{t}$	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.	$F = \frac{Q_1Q_2}{4\pi\epsilon_0 r^2}$	Coulomb's law
D2.	$E = \frac{Q}{4\pi\epsilon_0 r^2}$	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.	$\frac{V_\mathrm{S}}{V_\mathrm{P}} \approx \frac{N_\mathrm{S}}{N_\mathrm{P}}$	ratio of secondary voltage to primary voltage in a transformer

E1.	$N = N_0 \mathrm{e}^{-kt}$	law of radioactive decay
E2.	$t_{½} = \frac{\ln 2}{k}$	half-life and decay constant
E3.	$A = kN$	activity and the number of undecayed nuclei
E4.	$E = mc^2$	mass–energy relationship