2022-23
S6 PHY
MOCK EXAM
PAPER 1A

Belilios Public School
Mock Examination, 2022-2023

PHYSICS PAPER 1

Secondary 6 **Time allowed: 2 hours 30 minutes**

Name: _____ Class: _____ Class no: _____

GENERAL INSTRUCTIONS

1. This paper must be answered in English.
2. This paper consists of **TWO** sections: Section A and Section B.
3. For Section A, put all answers on the M.C. answer sheet provided.
4. For Section B, answer all questions and write your answers in the spaces provided in this question-answer book.
5. The diagrams in this paper are NOT necessarily drawn to scale.
6. 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

1. 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.
2. There are 33 questions in this section. All questions carry equal marks.
3. **Answer all questions**. Write your answers on the M.C. answer sheet provided.
4. You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.
5. No marks will be deducted for wrong answers.

Section A
There are 33 questions. Questions marked with * involve knowledge of the extension components

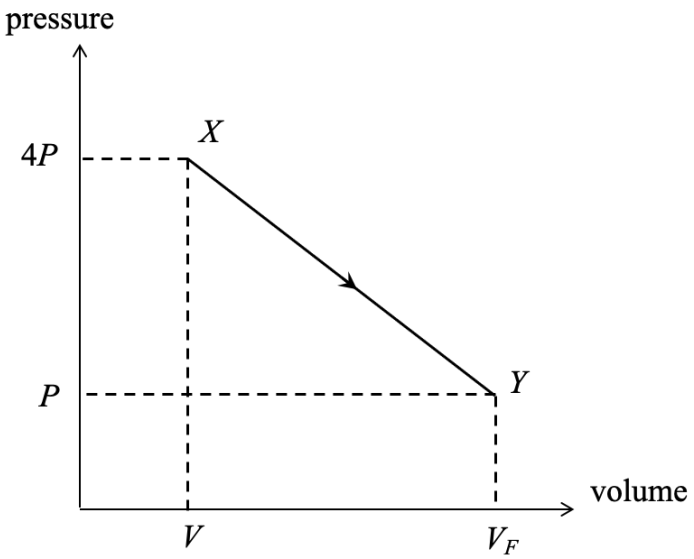
1. Liquid *P* of temperature 90 °C is mixed with liquid *Q* of temperature of 10 °C. The equilibrium temperature of the mixture is 30 °C. Assume that there is no heat lost to or gained from the surroundings. Which of the following deduction must be correct?

   A. The internal energy of *P* equals that of *Q* at 30 °C.
   B. The mass of *P* is less than that of *Q*.
   C. The specific heat capacity of *P* is larger than that of *Q*.
   D. The heat capacity of *P* is less than that of *Q*.

2. A paper cup contains some hot water. Which of the following can help retaining the warmth of the water?
   (1) Wrap the paper cup with shiny aluminium foil.
   (2) Add a lid to the paper cup.
   (3) Stir the water.

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

*3. A fixed mass of an ideal gas expands from state *X* to state *Y* through a process as represented in the pressure-volume graph below.



   If the temperature at *X* equals that at *Y*, which of the following deductions are correct?
   (1) $V_F = 4V$
   (2) The temperature of the gas remains constant throughout the process.
   (3) The average molecular kinetic energy of the gas at state *X* equals that at state *Y*.

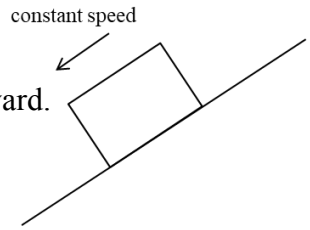
   A. (1) and (2) only
   B. (1) and (3) only
   C. (2) and (3) only
   D. (1), (2) and (3)

4. Initially, four uniform blocks, each of thickness h are spread on a table. Their masses are m, $2m$, $3m$ ad $4m$.

At least how much work is done on the blocks in stacking them on top of one another?

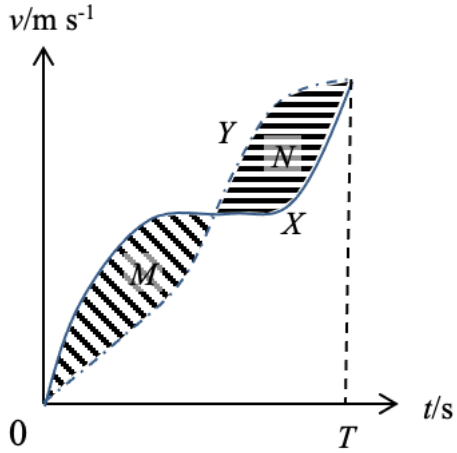
A. 3 *mgh*
B. 8 *mgh*
C. 10 *mgh*
D. 20 *mgh*

5. A block is sliding down a rough incline with constant velocity. Which of the following statement is correct?



A. No work is done on the block by the gravitational force on it.
B. The resultant force acting on the block by the incline is vertically upward.
C. The net force acting on the block is pointing down the incline.
D. The momentum of the block is decreasing.

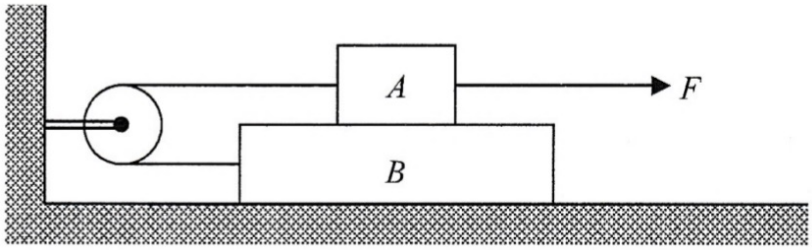
6. The figure shows the velocity-time graphs of two cars X and Y racing on a straight road. They start at the same position.



Which of the following correctly describes the situation about X and Y at time $t = T$ s?

A. If area $M >$ area N, X has a higher velocity than Y at $t = T$ s.
B. If area $M >$ area N, X is ahead of Y at $t = T$ s.
C. If area $M >$ area N, Y has a higher velocity than X at $t = T$ s.
D. If area $M >$ area N, Y is ahead of Y at $t = T$ s.

7. Block A is placed on top of another block B, which rests on a horizontal surface. The friction between A and B is 3 N and that between B and the surface is 8 N. Find the minimum value of F to move the blocks.



A. 8 N
B. 11 N
C. 12 N
D. 14 N

8. Figure (a) shows a uniform rod of length 1 m supported by two spring balances P and Q. The reading of the balance is 0.48 N. If the balance P is shifted to a new position as shown in Figure (b), what would be the new reading of balance Q?

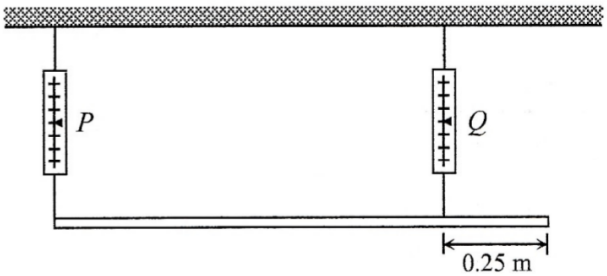


Figure (a)

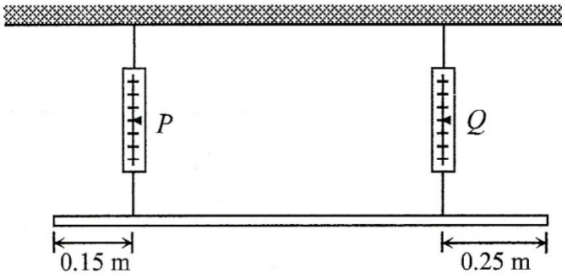
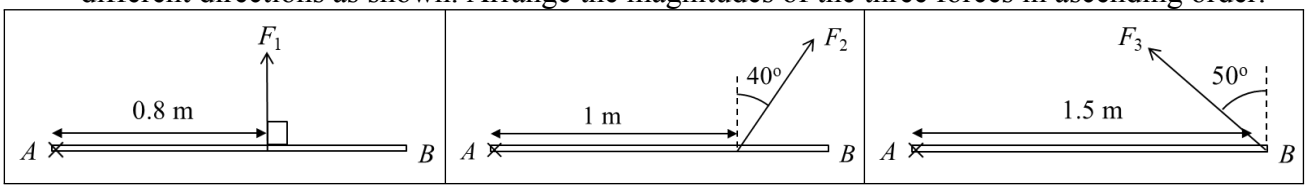


Figure (b)

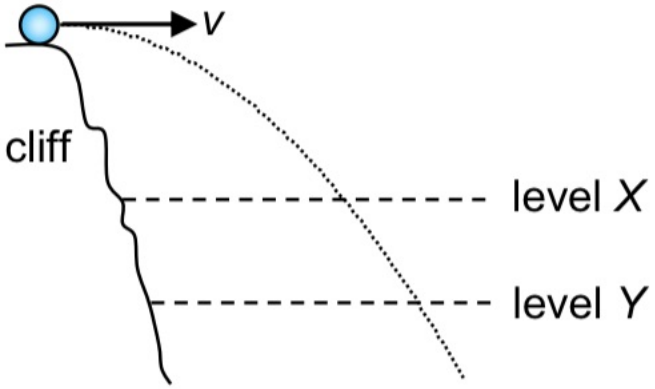
A. 0.32 N
B. 0.36 N
C. 0.42 N
D. 0.48 N

9. A uniform rod AB is hinged at A. It can be supported in equilibrium by a force applied in three different directions as shown. Arrange the magnitudes of the three forces in ascending order.



A. $F_1 < F_2 < F_3$
B. $F_1 < F_3 < F_2$
C. $F_2 < F_1 < F_3$
D. $F_3 < F_1 < F_2$

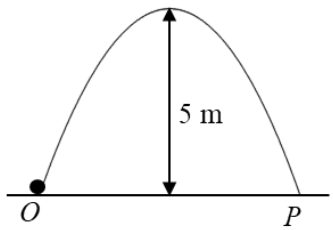
*10. An object of mass m is projected horizontally with a speed v from a cliff as shown.



Which of the following statements is/are correct?
(1) If v is doubled, the time for the object to travel from level X to level Y will be halved.
(2) If v is doubled, the horizontal distance travelled by the object within level X and level Y will be doubled.
(3) If m is doubled, the time for the object to travel from level X to level Y will be halved.

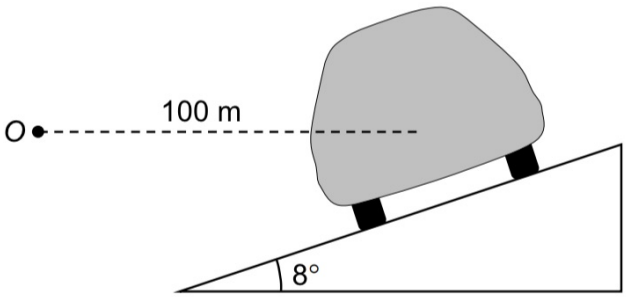
A. (2) only
B. (3) only
C. (1) and (2) only
D. (1) and (3) only

*11. A small ball of mass 0.3 kg is projected from a point O on the ground with a certain initial velocity. It reaches a maximum height of 5 m, and then returns to the ground at the point P. If air resistance is neglected, find the magnitude of the change in momentum of the ball from O to P.



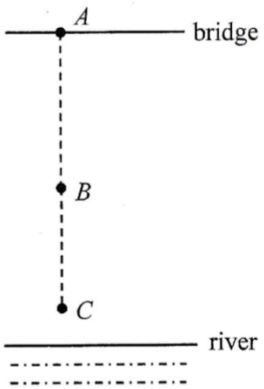
A. 2.97 N s
B. 4.46 N s
C. 5.94 N s
D. Cannot be determined since the initial velocity is not given.

*12. A 500-kg car is moving around a circular path with a banking angle of 8^{o} at uniform speed. The radius of curvature is 100 m. Suppose no friction acts on the car when its speed is v. Find the value of v.



A. 11.7 m s^{-1}
B. 20.3 m s^{-1}
C. 31.2 m s^{-1}
D. 42.1 m s^{-1}

13. A boy performs a bungee jump from a bridge above a river. He is tied to the bridge at *A* with an elastic cord. He falls from rest at *A*. When he reaches *B*, the elastic cord starts to stretch. He is momentarily at rest at *C*. Neglect air resistance. Which of the following descriptions about the motion of the boy is correct?

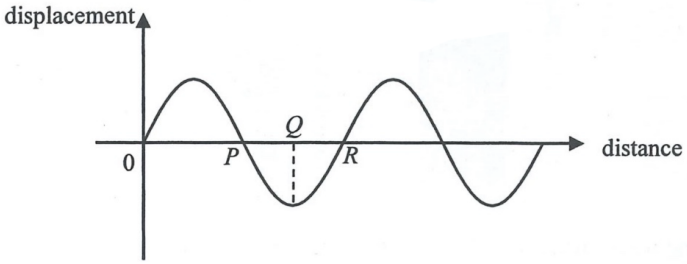


A. The acceleration of the boy increases from *A* to *B*.
B. The boy starts to decelerate at *B*.
C. At a point between *B* and *C*, the acceleration of the boy changes direction.
D. At point *C*, the acceleration of the boy is zero.

*14. The geostationary orbit is around 35786 km above the ground. Which of the following about the motion of a satellite in the geostationary orbit is/are correct?
(1) The satellite is right above a point on the equator.
(2) The satellite experiences no weight.
(3) The acceleration due to gravity of the satellite can be estimated by $35786\text{ km}\times\left(\frac{2\pi}{24\text{ hours}}\right)^2$.

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

15. The figure shows the displacement-distance graph at a certain instant of a wave. Particle at position *Q* is at its maximum displacement.



Which of the following statements concerning the instant shown is correct?

A. If the wave is a stationary longitudinal wave, *PR* is one wavelength apart.
B. If the wave is a transverse travelling wave, particle at *Q* has zero acceleration.
C. If the wave is a longitudinal travelling wave, *Q* is a centre of rarefaction.

D. If the wave is a stationary transverse wave, P and R are positions of nodes.

16. Which of the following statements describing the nature of visible light is NOT correct?

A. Light is a type of electromagnetic wave.
B. All frequencies of light have the same speed in glass.
C. Total internal reflection may occur when light travels from glass to air.
D. Interference of light proves light is a wave.

17. In a double-slit experiment to find out the wavelength of monochromatic light, a ray of light is incident on a double slit and the alternate fringes are observed on a screen placed D m away from the double slit. The slit separation is a m. Which of the following are correct?
(1) a should be large enough to observe more number of bright fringe.
(2) D should be much larger than a for an observable fringe pattern.
(3) The ray should incident on the double slit normally.

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

*18. A monochromatic light is incident normally on a diffraction grating with 300 lines per mm. It is found that the angular separation of the two 3rd maxima is 78.1°. Find the wavelength of the monochromatic light and the maximum number of maxima that can be observed.

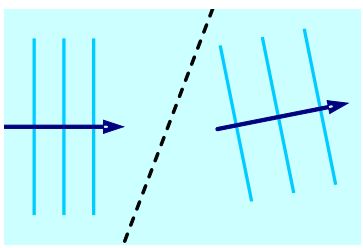
	Wavelength	Maximum number of maxima
A.	700 nm	9
B.	700 nm	7
C.	400 nm	9
D.	400 nm	7

19. A convex lens projects the image of a distant object on a screen 15 cm away. What is the range of object distance u if the image formed is to be erected and at least 2 times magnified?

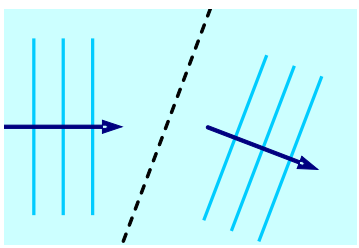
A. $u \geq 30$ cm
B. $7.5 \text{ cm} \leq u \leq 22.5$ cm
C. $7.5 \text{ cm} \leq u < 15$ cm
D. $0 \text{ cm} < u \leq 7.5$ cm

20. A wave travels through an interface as shown. Which of the following statements is correct?

(1)

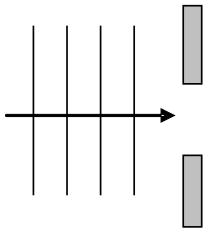


(2)



A. (1) is possible when light travels from air to water.
B. (2) is possible when sound travels from air to water.
C. (1) is impossible for all waves.
D. (2) is impossible for all waves.

21. In a ripple tank experiment, a water wave is diffracted as it passes through a small gap. Which of the following changes can reduce the effect of diffraction?



A. Half the width of the gap
B. Half the amplitude of the vibrator
C. Double the frequency of the vibrator
D. Double the water depth in the ripple tank

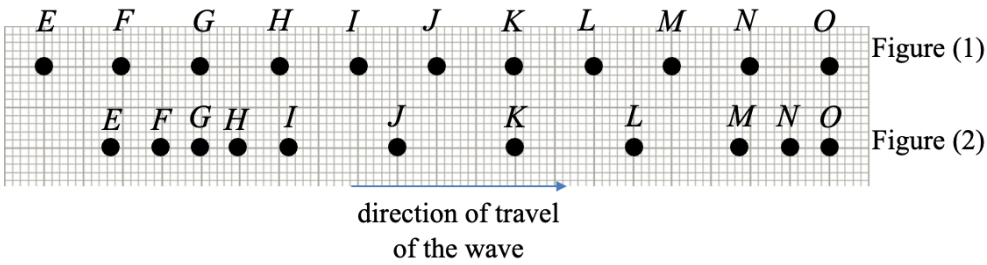
22. One end of a string is connected to a vibrator and the other end is fixed on a wall. The length of the string is 1.2 m. Stationary waves can be produced when the frequency of the vibrator is 10 Hz and 12 Hz. No stationary wave can be formed when the frequency is in between 10 Hz and 12 Hz. Which of the following statements is incorrect?

A. The stationary wave appears as 5 loops when the frequency is 10 Hz.
B. The stationary wave appears one loop more when the frequency is 12 Hz than that at 10 Hz.
C. The wave speed in the string is 4.8 m s^{-1}.
D. No interference occurs when the frequency is at 11 Hz.

23. White light can be resolved into component colours by using different tools. Which of the following tools cannot resolve white light?

A. A 45^{o}-90^{o}-45^{o} triangular plastic prism
B. A diffraction grating with 100 lines per mm
C. A double slit with slit separation 10^{-6} m
D. An optical fibre with diameter 1 mm

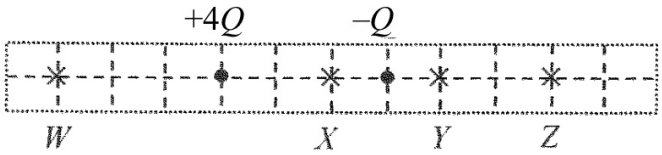
24. Figure (1) shows the equilibrium positions of particles *E* to *O* separated evenly from each other in a medium. A longitudinal wave is travelling from the left to the right. The positions of the particles at a certain instant are shown in Figure (2).



Which of the following statements is/are correct?
(1) Particle *G* is momentarily at rest in Figure (2).
(2) The separation between particle *K* and *O* is one wavelength.
(3) Particle *F* and particle *J* are in anti-phase.

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

*25. Two point charges $+4Q$ and $-Q$ are fixed as shown. At which point(s) indicated in the figure would the resultant electric field due to these two charges be zero?

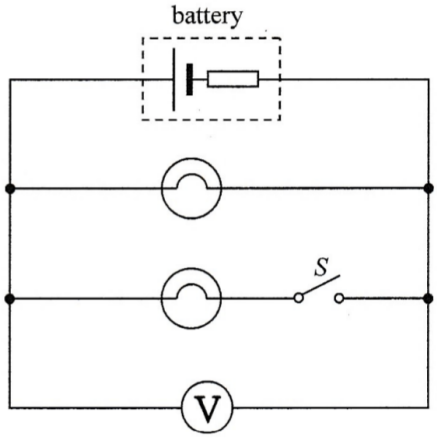


A. *X* only
B. *Z* only
C. *W* and *X* only
D. *Y* and *Z* only

26. A wall socket supplies electricity at 220 V and is fitted with a fuse of rating 13 A. In which of the following situations will the fuse melt?
(1) Two heaters rated at '220 V 2800 W' are connected in series to the socket.
(2) Four ovens rated at '220 V 800 W' are connected in parallel to the socket.
(3) A fridge rated at '220 V 1400 W' is connected to the socket and its live wire is accidentally earthed.

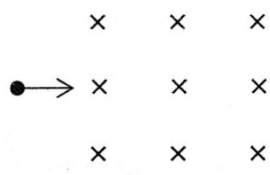
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

27. A battery of e.m.f. 3 V and internal resistance 2 Ω is connected to two identical light bulbs, each of resistance 8 Ω. An ideal voltmeter is connected across the light bulbs. What is the change in the reading of the voltmeter when the switch *S* is closed?



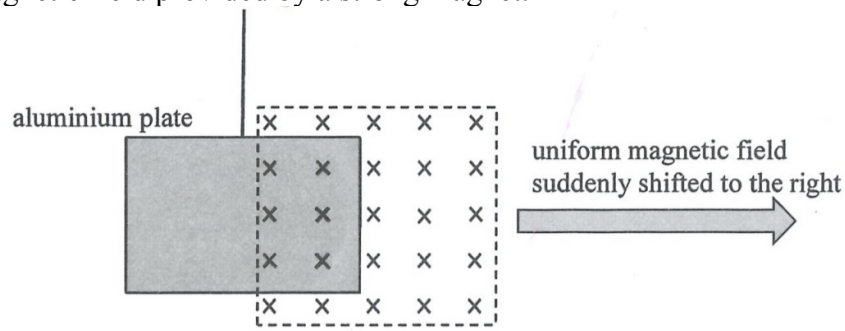
A. The reading decreases by 0.4 V.
B. The reading decreases by 0.8 V.
C. The reading increases by 0.4 V.
D. The reading increases by 0.8 V.

*28. A particle of mass of 2.4×10^{-27} kg and of charge -1.6×10^{-19} C enters a uniform into paper magnetic field of flux density 1.2 T at a speed of 2×10^{7} m s^{-1} as shown. It will



A. be deflected upward in a circular arc of radius 0.25 m.
B. be deflected upward in a circular arc of radius 0.5 m.
C. be deflected downward in a circular arc of radius 0.25 m.
D. be deflected downward in a circular arc of radius 0.5 m.

29. A thin rectangular aluminium plate suspended by a long string. The plate is partly inside a uniform magnetic field provided by a strong magnet.



The magnetic field is shifted to the right suddenly. Which of the following is NOT correct?

A. Eddy currents are induced on the aluminium plate.
B. The aluminium plate experiences a leftward magnetic force.
C. Heat is generated in the aluminium plate.
D. If the direction of magnetic field is reversed, the shifting of the field will cause the same motion of the plate.

*30. A heater of resistance 50 Ω is connected to an a.c. power with r.m.s. voltage 110 V. Which of the following statements is NOT correct?

A. The heater connected to a 110 V d.c. power supply will give the same power dissipation.
B. The peak voltage across the heater is 156 V.
C. The power dissipated by the heater is 2.2 W
D. The power dissipated by the heater will be doubled if the r.m.s. voltage of the mains supply doubles.

31. A radioactive nuclide radium-228 ($^{228}_{88}\mathrm{Ra}$) becomes a stable lead-208 isotope ($^{208}_{82}\mathrm{Pb}$) after a series of α and β decays. Find the number of β decay in the process.

A. 3
B. 4
C. 5
D. 6

32. Which of the following statements concerning nuclear reaction are correct?
(1) In all nuclear reactions, total mass of the reactants is not conserved.
(2) In nuclear fusions, the daughter nucleus generally has a larger atomic number than the mother nucleus.
(3) To start a chain reaction of nuclear fissions, an extremely high initial temperature should be attained.

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

33. The ratio of activities of two radioactive sources X and Y is 16 : 81 at $t = 0$. The ratio become 4 : 9 at $t = 1$ day. Find the value of t when the ratio become 1 : 1?

A. 5
B. 4
C. 3
D. 2

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	$u = 1.661 \times 10^{-27}\ \text{kg}$ (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
$P = \sigma AT^4$	Stefan's law
$\left\|\frac{\Delta f}{f_0}\right\| \approx \frac{v}{c} \approx \left\|\frac{\Delta\lambda}{\lambda_0}\right\|$	Doppler effect

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
$\lambda = \frac{h}{p} = \frac{h}{mv}$	dc Broglie formula
$\theta \approx \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)

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

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.	$N = N_0e^{-\lambda t}$	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