福建中學

FUKIEN SECONDARY SCHOOL

S5 Final Examination (2020-2021)

Physics Paper 1

(2 hours 30 minutes)

Section A: Multiple-Choice Questions

Date: 15th June 2021 Name: _____

Time: 8:30a.m. – 11:00a.m. Class: _____ No.: _____

Instructions to students:

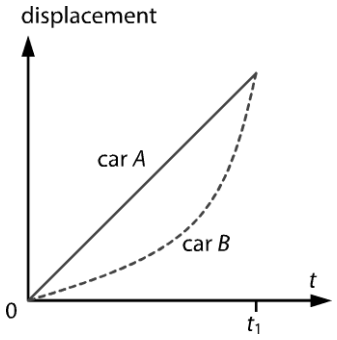
1. There are **TWO** sections, A and B, in this Paper. You are advised to finish Section A in about 50 minutes.
2. Section A consists of multiple-choice questions in this question paper, while Section B contains conventional questions printed separately in Question-Answer Book.
3. Answers to Section A should be marked on the Multiple-choice Answer Sheet while answers to Section B should be written in the spaces provided on Question-Answer Book. **The Answer Sheet for Section A and the Question-Answer Book for Section B must be handed in 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 the instructions on the Answer Sheet carefully. Insert the information required in the spaces provided.
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 should use an **HB** pencil to mark all your answers on the Answer Sheet. Wrong marks must be completely erased.
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.

There are 33 questions. The last two pages of this question paper contain a list of data, formulae and relationships which you may find useful.

1. Two cars *A* and *B* are travelling on a straight road. Their motion graphs are shown as below. Which of the following statements is **incorrect**?



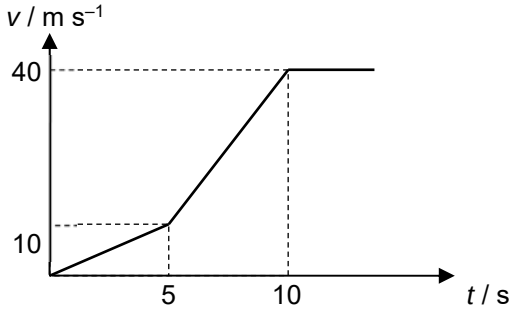
A. From time $t = 0$ to t_1, the distances travelled by the cars are the same.

B. From time $t = 0$ to t_1, the average speeds of the cars are the same.

C. From time $t = 0$ to t_1, the instantaneous speed of car *A* is always higher.

D. From time $t = 0$ to t_1, the direction of travel of the cars are always the same.

2. A car travels on a straight road. The figure below shows its velocity–time graph.



Find the maximum acceleration of the car and the distance travelled by the car during the period in which its acceleration is maximum.

	Maximum acceleration	**Distance travelled during maximum acceleration**
A.	2 m s^{-1}	25 m
B.	4 m s^{-1}	100 m
C.	6 m s^{-1}	100 m
D.	6 m s^{-1}	125 m

3. A car accelerates uniformly from rest at *a*. After a certain time, its acceleration becomes $-a$. It continues to travel and stops finally. If the total displacement of the car is *L*, what is the total time of travel?

A. $\sqrt{\frac{4L}{a}}$ B. $\sqrt{\frac{2L}{a}}$ C. $\sqrt{aL}$ D. $\sqrt{\frac{aL}{2}}$

4. A diver jumps upwards and then falls into the swimming pool as shown in Figure (a). She finally stops in the water. The springboard is at height h above the water surface. Figure (b) shows her velocity–time graph in the above process.

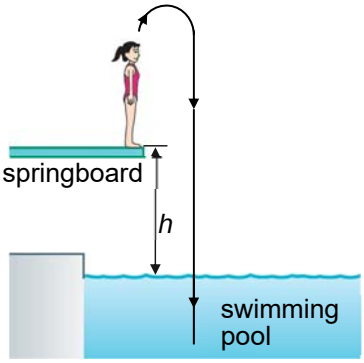


Figure (a)

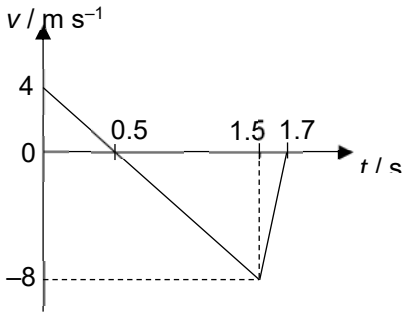


Figure (b)

Find the height h.

A. 1.0 m

B. 3.0 m

C. 3.8 m

D. 4.0 m

5. Which of the following objects have zero net force acting on them?

(1) A bob suspended by a string, and remaining at rest

(2) The moon orbiting around the Earth

(3) A box sliding down an inclined plane at a constant velocity

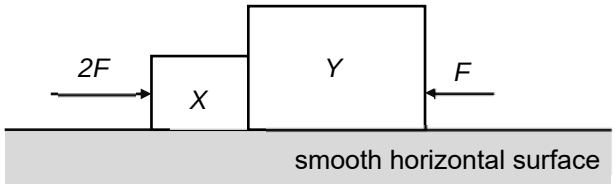
A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

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

6. Two blocks X and Y are placed on a smooth horizontal surface. The masses of X and Y are m and $5m$ respectively. Two horizontal forces F and $2F$ are applied to the blocks as shown. X and Y are in contact when they are moving.



What is the magnitude of the force acting on X by Y?

A. $\frac{F}{6}$ B. F C. $\frac{11F}{6}$ D. $\frac{13F}{6}$

7. A man of mass 75 kg is standing in a lift. Which of the following statements are correct?

   (1) When the lift falls freely, the supporting force exerted on the man by the floor is zero.

   (2) When the lift accelerates downwards, the supporting force exerted on the man by the floor is smaller than 750 N.

   (3) When the lift accelerates upwards, the weight of the man is greater than 750 N.

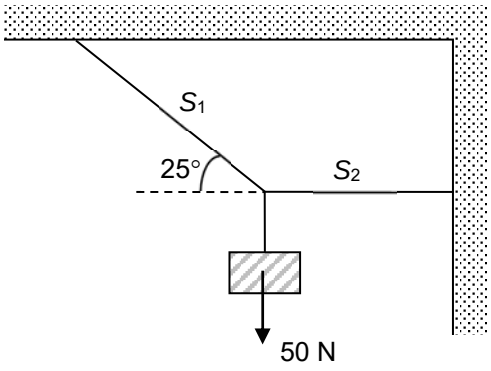
   A. (1) and (2) only

   B. (1) and (3) only

   C. (2) and (3) only

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

8. A block of weight 50 N is suspended by two threads as shown in the figure below. Thread S_1 makes an angle 25° with the horizontal and thread S_2 is horizontal. What is the tension in S_2?



   A. 23.3 N

   B. 45.3 N

   C. 107 N

   D. 118 N

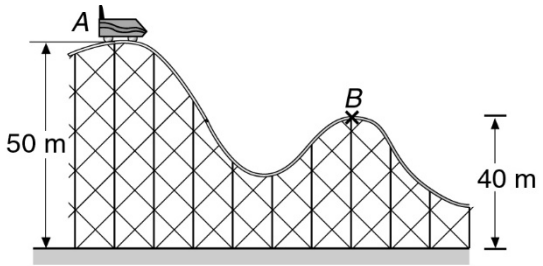
9. The figure below shows a section of a roller-coaster. When a 1500-kg cart passes A, its speed is 0.5 m s^{-1}. If the distance along the rail between A and B is 200 m and the average frictional force acting on the cart is 400 N, what is the speed of the cart at B?

   A. 5.6 m s^{-1}

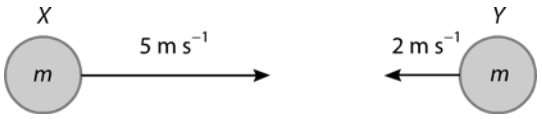
   B. 9.67 m s^{-1}

   C. 12.3 m s^{-1}

   D. 14.4 m s^{-1}



10. Two identical spheres of the same mass make a head-on collision with each other. Before the collision, sphere *X* travels at 5 m s^{-1} to the right while sphere *Y* travels at 2 m s^{-1} to the left.



Which of the following velocities of sphere *X* just after the collision is/are possible? Take the direction to the right as positive.

(1) 2 m s^{-1} to the left

(2) 3 m s^{-1} to the right

(3) 5 m s^{-1} to the right

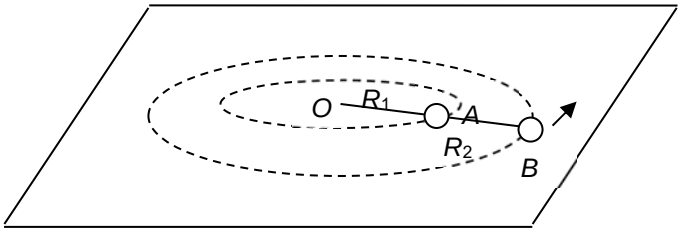
A. (1) only

B. (2) only

C. (1) and (2) only

D. (2) and (3) only

11. In the following figure, *A* and *B* are two identical balls. They are fixed on a rod and rotating with it. The distances of the balls *A* and *B* from centre *O* are R_1 and R_2 respectively. What is the ratio of the acceleration of *A* to that of *B*?



A. 1 : 1

B. 2 : 1

C. $R_2 : R_1$

D. $R_1 : R_2$

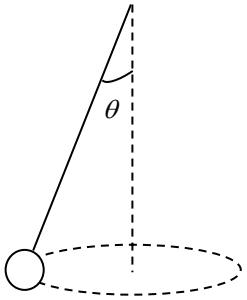
12. As shown in the figure below, a metal sphere of weight *W* is hung by a string and moves in a circle. The string makes an angle θ to the vertical. The tension of the string is *T*. Which of the following gives the centripetal force on the metal sphere?

A. *T*

B. $T \sin \theta$

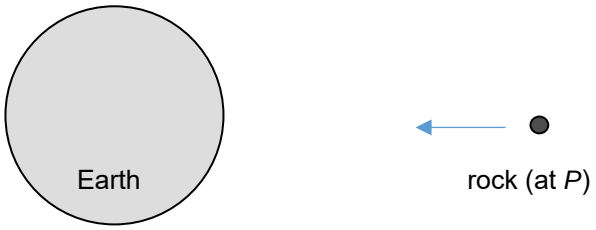
C. $(T - W) \times \sin \theta$

D. $(T - W \cos \theta) \times \sin \theta$

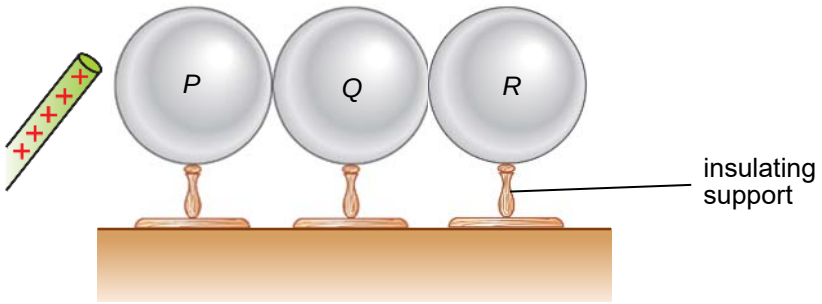


13. A rock moves towards the Earth's centre in space. When it is at position P, its speed is 2594 m s^{-1}. 10 minutes later, its speed becomes 2619 m s^{-1}. The distance travelled by the rock in this time interval is negligible compared to its distance from the Earth. If the radius of the Earth is R_E, the distance of P from the Earth's centre is approximately

A. $2R_E$.
B. $4R_E$.
C. $15R_E$.
D. $235R_E$.



14. The figure below shows three insulated uncharged sphere P, Q and R in contact. A positively charged rod is brought near P without touching it. After earthing Q momentarily, R is isolated from Q. Afterwards, the charged rod is removed.



What are the charges on P, Q and R after the charged rod is removed?

	P	***Q***	***R***
A.	zero	zero	zero
B.	negative	zero	positive
C.	negative	zero	zero
D.	negative	negative	zero

15. Two conducting spheres are separated by a distance d. One carries a charge of $8Q$ and the other carries a charge of $-2Q$. The electric force between them is F. The spheres are brought to touch and returned to their original positions. What is the electric force between them now?

A. $F/16$
B. $4F/16$
C. $9F/16$
D. $25F/16$

16. A microwave oven draws a current of 5.5 A from the mains supply. How much charge flows through the oven for two minutes?

A. 0.183 C

B. 2.75 C

C. 11 C

D. 660 C

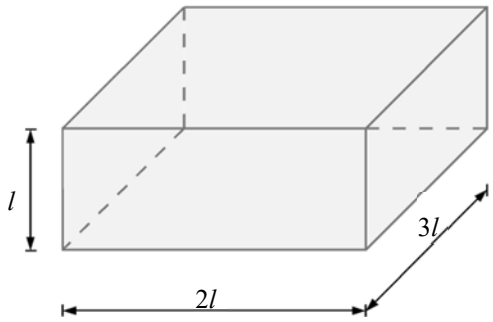
17. A rectangular metal block has dimensions $l \times 2l \times 3l$ as shown below. The resistivity of the metal is ρ. Find the maximum resistance across any two opposite faces of the block.

A. $\frac{2\rho}{3l}$

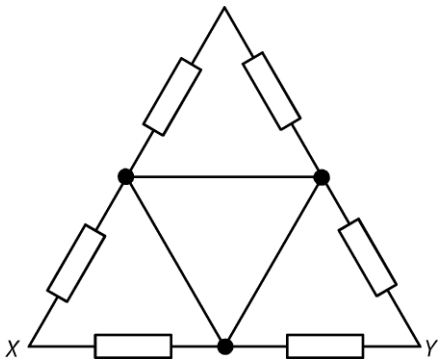
B. $\frac{\rho}{l}$

C. $\frac{3\rho}{2l}$

D. $\frac{6\rho}{l}$



18. Six identical 3 Ω resistors are connected as shown below.



What is the equivalent resistance between X and Y?

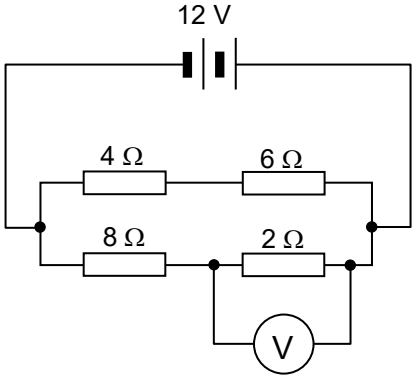
A. 1.5 Ω

B. 2 Ω

C. 2.5 Ω

D. 3 Ω

19. In the circuit on the right, the battery has an internal resistance of 1 Ω. What is the reading of the voltmeter?



A. 2 V

B. 2.4 V

C. 3 V

D. 8 V

20. Wilson used the following electrical appliances last month:

Electrical appliance	Rating	Duration
Rice cooker	220 V, 700 W	60 hours
Washing machine	220 V, 1000 W	30 hours
Air-conditioner	220 V, 1300 W	240 hours

Calculate the cost of electricity used in last month. Note: 1 kW h of electricity costs $0.86.

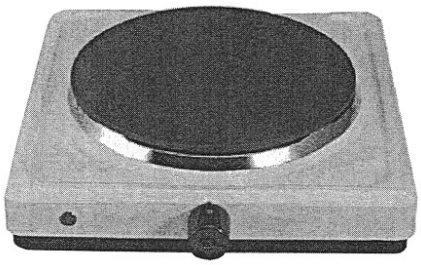
A. $72.6

B. $330

C. $384

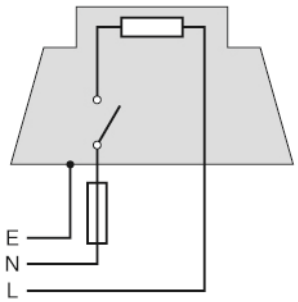
D. $851

21. The photo below shows an electric hot plate.

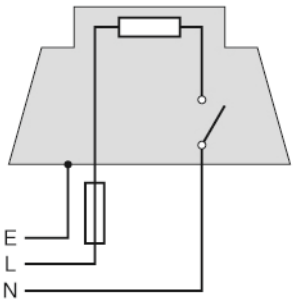


Which of the following diagrams correctly shows the connections of the wires of the electric hot plate to the mains supply? (Live: L, Neutral: N, Earth: E)

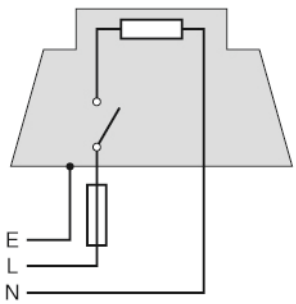
A.



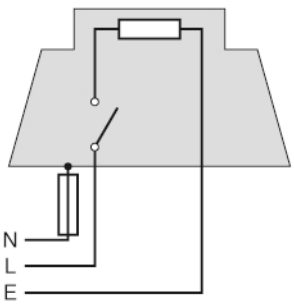
B.



C.



D.



22. Which of the following statements about magnetic field lines is/are correct?

(1) They must start from an N-pole and end at a S-pole.

(2) They never cross each other.

(3) They show the direction of the magnetic force acting on the N-pole of a magnet inside the field.

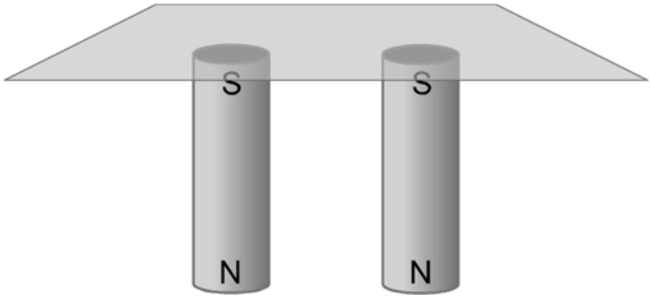
A. (1) only

B. (3) only

C. (1) and (3) only

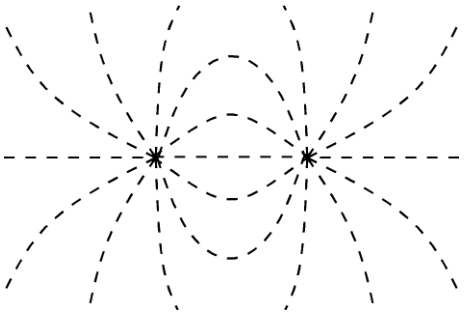
D. (2) and (3) only

23. Two identical bar magnets are placed just beneath a horizontal plastic sheet as shown below.

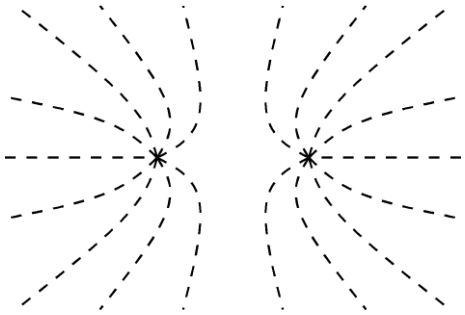


Iron filings are sprinkled on the plastic sheet. Which of the following best shows the pattern formed by the iron filings as seen above?

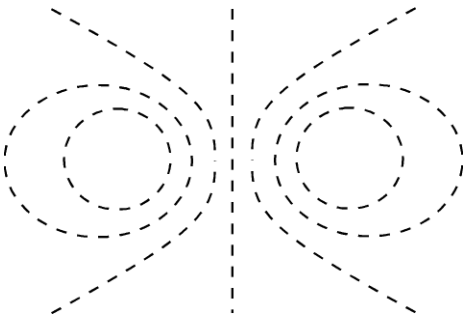
A.



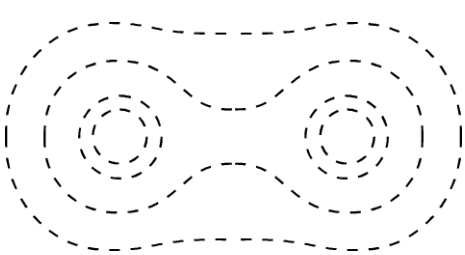
B.



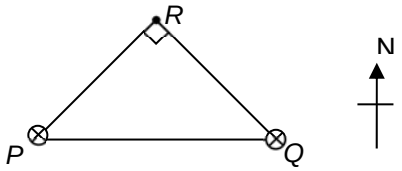
C.



D.



24. Two long straight parallel wires *P* and *Q* carry currents of equal magnitude directed into the page. The wires are put at the vertices of a right-angled isosceles triangle as shown below.



Which direction does the resultant magnetic field at *R* point to?

A. East

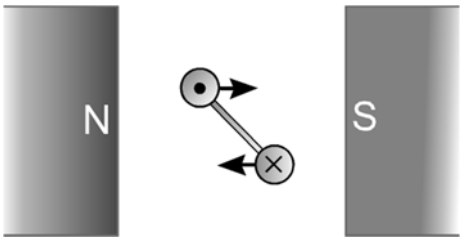
B. South

C. West

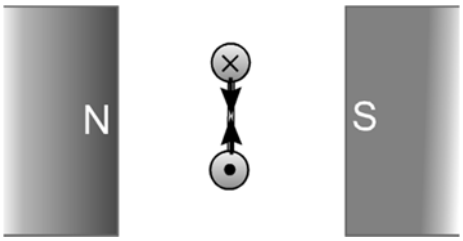
D. North

25. Which of the following figures correctly shows the magnetic forces acting on a rectangular current-carrying loop in a uniform magnetic field?

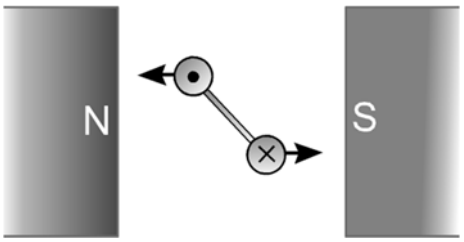
A.



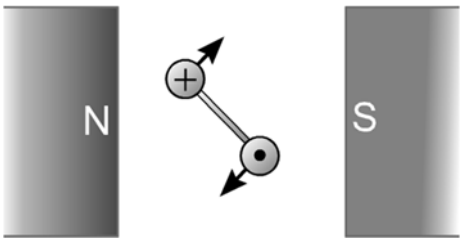
B.



C.



D.



26. In the figure below, current is induced in solenoid *B*

(1) when the resistance of rheostat R_1 decreases.

(2) when the resistance of rheostat R_2 decreases.

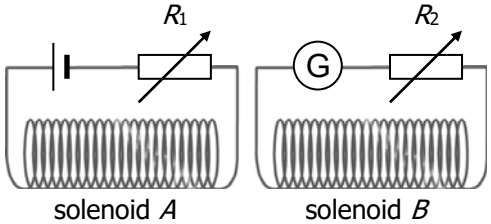
(3) at the instant the cell is disconnected from solenoid *A*.

A. (1) and (2) only

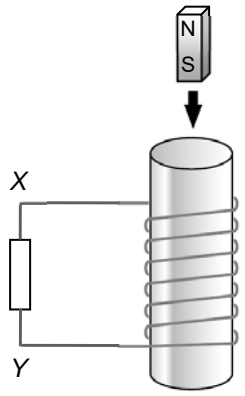
B. (1) and (3) only

C. (2) and (3) only

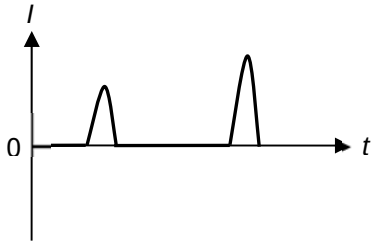
D. (1), (2) and (3)

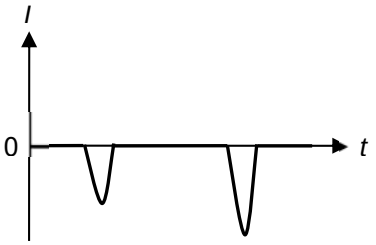


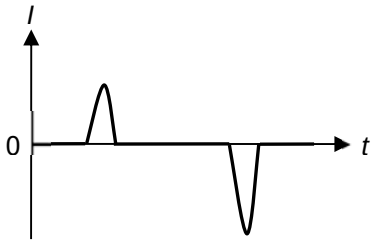
27. A bar magnet is released from rest and drops through a solenoid.

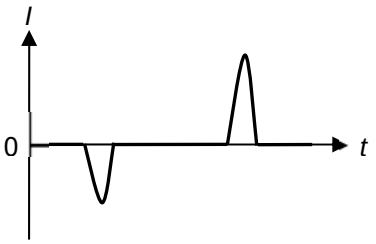


Take the current flowing from *X* to *Y* via the resistor as positive. Which of the following graphs best shows how the current *I* varies with time *t*?

A.


B.


C.


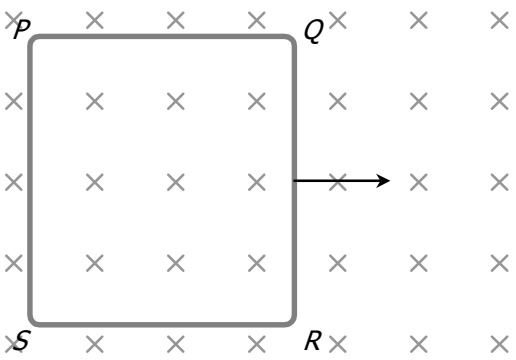
D.


28. A rectangular coil *PQRS* is moving with constant velocity in a direction perpendicular to a uniform magnetic field as shown below. Which of the following statements is/are correct?

(1) A voltage is induced across *PS* and *QR* respectively.

(2) The induced voltage becomes lower when the coil moves faster.

(3) An induced current flows along the coil in the clockwise direction *PQRS*.



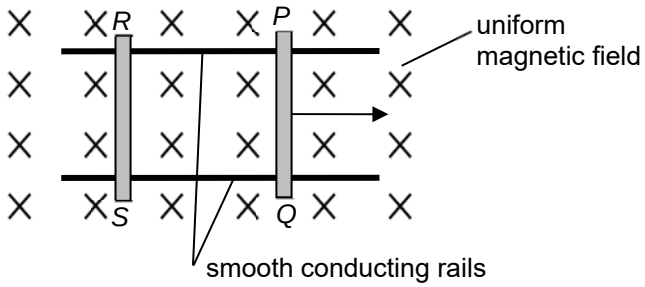
A. (1) only

B. (2) only

C. (1) and (2) only

D. (1) and (3) only

29. Two conducting rods *PQ* and *RS* are placed on two smooth conducting rails as shown below. The set-up is put in a uniform magnetic field pointing into the page.



Rod *PQ* is now pushed towards right. Which of the following statements are correct?

(1) A magnetic force acts on rod *PQ* towards the left.

(2) The induced current flows in the anti-clockwise direction.

(3) Rod *RS* starts to move towards the right.

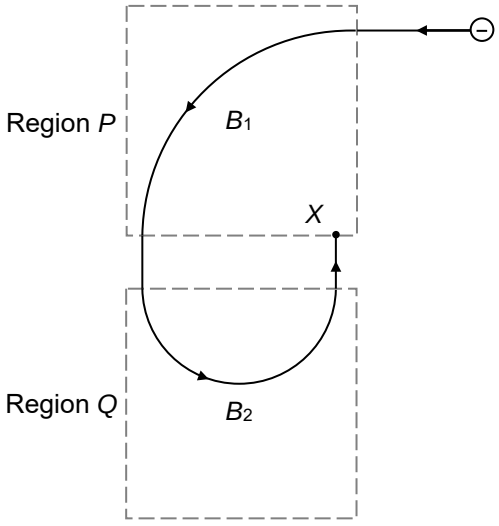
A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

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

30. Uniform magnetic fields B_1 and B_2 exist in regions *P* and *Q* respectively. An electron travels through the two regions along the path as shown on the right and reaches point *X*. Which of the following statements is/are correct?



(1) B_2 is stronger than B_1.

(2) B_1 points out of the paper.

(3) B_2 points into the paper.

A. (1) only

B. (2) only

C. (1) and (2) only

D. (1) and (3) only

31. The primary coil of a transformer is connected to the 220 V mains while its secondary coil is connected to a 2 Ω resistor. The secondary coil has 300 turns. The current drawn by the resistor is 5 A. The current drawn from the mains is 0.3 A. Which of the following statements is/are correct?

    (1) The primary coil has 5000 turns.

    (2) The transformer has an efficiency of 75.8%.

    (3) The soft-iron core inserted in the coils gets warm when the transformer operates.

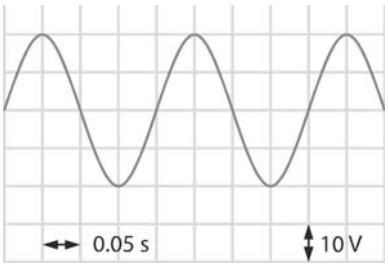
    A. (2) only

    B. (3) only

    C. (1) and (2) only

    D. (2) and (3) only

32. A sinusoidal a.c. voltage is applied across a 100 Ω resistor. The figure below shows the CRO trace of the voltage across the resistor. Find the average power dissipation by the resistor.



    A. 0.5 W

    B. 1 W

    C. 2 W

    D. 4 W

33. What are the advantages of using high voltage to transmit electricity over a long distance?

    (1) Cables can be made thinner and lighter.

    (2) The power loss during transmission can be reduced.

    (3) High voltages can be divided among various consumers easily using potential dividers.

    A. (1) and (2) only

    B. (1) and (3) only

    C. (2) and (3) only

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

END OF SECTION A

List of data, formulae and relationships

Data

molar gas constant	$R = 8.31$ 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 $= 206\,265$ 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

$\frac{Q}{t} = k\frac{A(T_H - T_C)}{d}$ 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

$\frac{1}{2}m_e v_{max}{}^2 = hf - \phi$ 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)

$\text{power} = \frac{1}{f}$ power of a lens

$L = 10\log\frac{I}{I_0}$ intensity level (dB)

$Z = \rho c$ acoustic impedance

$\alpha = \frac{I_r}{I_0} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$ intensity reflection coefficient

$I = I_0 e^{-\mu x}$ transmitted intensity through a medium

A1.	$E = mc\Delta T$	energy transfer during heating and cooling
A2.	$E = l\Delta m$	energy transfer during change of state
A3.	$pV = nRT$	equation of state for an ideal gas
A4.	$pV = \frac{1}{3}Nm\overline{c^2}$	kinetic theory equation
A5.	$E_K = \frac{3RT}{2N_A}$	molecular kinetic energy
B1.	$F = m\frac{\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t}$	force
B2.	moment = $F \times d$	moment of a force
B3.	$E_P = mgh$	gravitational potential energy
B4.	$E_K = \frac{1}{2}mv^2$	kinetic energy
B5.	$P = Fv$	mechanical power
B6.	$a = \frac{v^2}{r} = \omega^2 r$	centripetal acceleration
B7.	$F = \frac{Gm_1m_2}{r^2}$	Newton's law of gravitation
C1.	$\Delta y = \frac{\lambda D}{a}$	fringe width in double-slit interference
C2.	$d \sin\theta = n\lambda$	diffraction grating equation
C3.	$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$	equation for a single lens
D1.	$F = \frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$	Coulomb's law
D2.	$E = \frac{Q}{4\pi\varepsilon_0 r^2}$	electric field strength due to a point charge
D3.	$E = \frac{V}{d}$	electric field between parallel plates (numerically)
D4.	$R = \frac{\rho l}{A}$	resistance and resistivity
D5.	$R = R_1 + R_2$	resistors in series
D6.	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$	resistors in parallel
D7.	$P = IV = I^2R$	power in a circuit
D8.	$F = BQv \sin\theta$	force on a moving charge in a magnetic field
D9.	$F = BIl \sin\theta$	force on a current-carrying conductor in a magnetic field
D10.	$B = \frac{\mu_0 I}{2\pi r}$	magnetic field due to a long straight wire
D11.	$B = \frac{\mu_0 NI}{l}$	magnetic field inside a long solenoid
D12.	$\varepsilon = N\frac{\Delta\Phi}{\Delta t}$	induced e.m.f.
D13.	$\frac{V_s}{V_p} \approx \frac{N_s}{N_p}$	ratio of secondary voltage to primary voltage in a transformer
E1.	$N = N_0 e^{-kt}$	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