

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY  
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2024

## 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.

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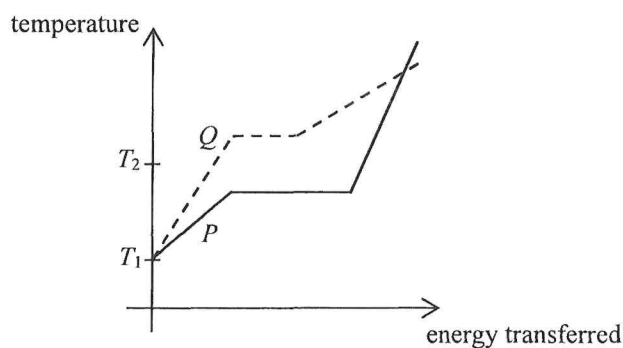
### INSTRUCTIONS FOR SECTION A (MULTIPLE-CHOICE QUESTIONS)

- (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.

## Section A

There are 33 questions. Questions marked with \* involve knowledge of the extension component.  
Take  $g = 9.81 \text{ m s}^{-2}$ .

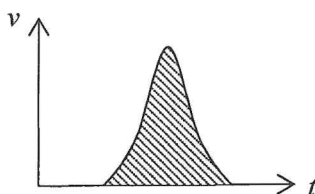
1. Substance  $P$  and  $Q$  are of the same mass and both are solids at temperature  $T_1$ . The graph below shows the variation of temperature of the substances with energy transferred.



Which statement below is correct ?

- A.  $P$  has a higher melting point than  $Q$ .
  - B. The specific latent heat of fusion of  $P$  is smaller than that of  $Q$ .
  - C. The specific heat capacity of solid  $P$  is greater than that of solid  $Q$ .
  - D. At temperature  $T_2$ ,  $P$  is gas while  $Q$  is solid.
2. If 0.5 kg of water at  $50^\circ\text{C}$  is mixed with 2.0 kg of ice at  $0^\circ\text{C}$ , what is the final temperature of the mixture ?  
Given: specific heat capacity of water =  $4200 \text{ J kg}^{-1}^\circ\text{C}^{-1}$   
specific latent heat of fusion of ice =  $3.34 \times 10^5 \text{ J kg}^{-1}$
- A.  $-54^\circ\text{C}$
  - B.  $0^\circ\text{C}$
  - C.  $10^\circ\text{C}$
  - D.  $25^\circ\text{C}$
- \*3. The best vacuum attained in the laboratory has a pressure of about  $10^{-8} \text{ Pa}$ . Estimate the order of magnitude of the number of air molecules in  $1 \text{ cm}^3$  of such 'vacuum' at room temperature.
- A.  $10^4$
  - B.  $10^6$
  - C.  $10^8$
  - D.  $10^{12}$

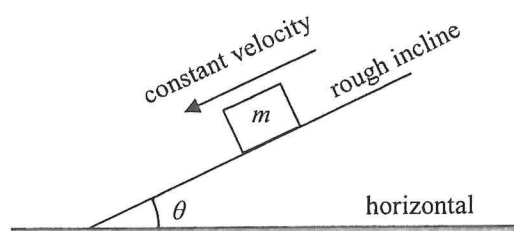
4.



What physical quantity does the shaded area represent in the above velocity-time ( $v$ - $t$ ) graph ?

- A. acceleration
- B. change of velocity
- C. momentum
- D. displacement

5.



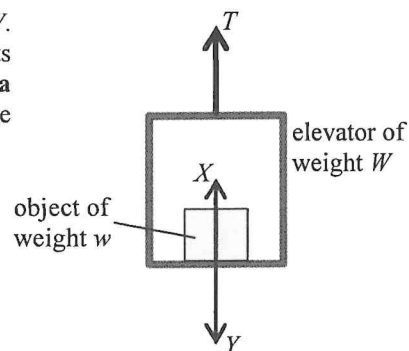
A block of mass  $m$  slides down along a fixed rough incline with constant velocity as shown. The incline makes an angle  $\theta$  with the horizontal. What is the magnitude of the force exerted on the incline by the block ?

- A. zero
- B.  $mg$
- C.  $mg \sin \theta$
- D.  $mg \cos \theta$

6.

An object of weight  $w$  is placed inside an elevator of weight  $W$ . A force  $T$  pulls the elevator upward. A **supporting force  $X$**  acts on the object while the **floor of the elevator experiences a force  $Y$**  due to the presence of the object. Which of the following is an action and reaction pair ?

- A.  $T$  and  $(W + w)$
- B.  $w$  and  $X$
- C.  $X$  and  $Y$
- D. It cannot be determined as the direction of acceleration of the elevator is unknown.



7. In an experiment, a horizontal force  $F$  acts on a block placed on a rough horizontal surface as shown in Figure (a). Figure (b) shows the variation of the block's kinetic energy  $E_k$  with the distance  $s$  it travelled. Neglect air resistance and assume frictional force unchanged.

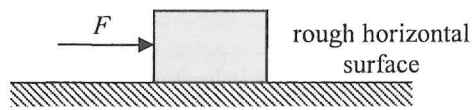


Figure (a)

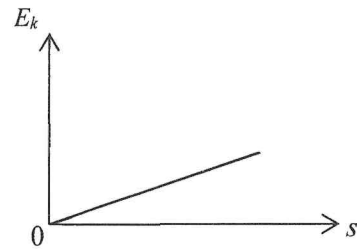
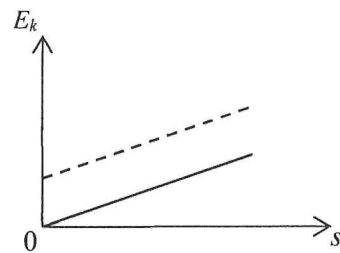


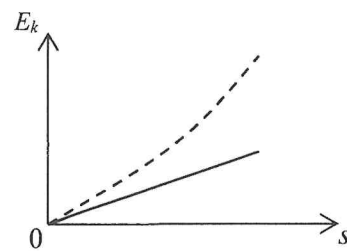
Figure (b)

If the experiment is repeated with force  $F$  doubled, which of the following graphs represents the expected result (in dotted line)?

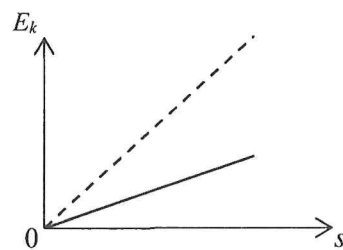
A.



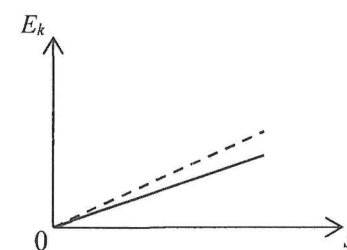
B.



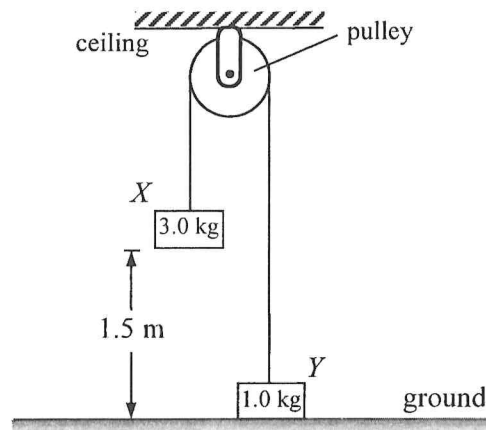
C.



D.

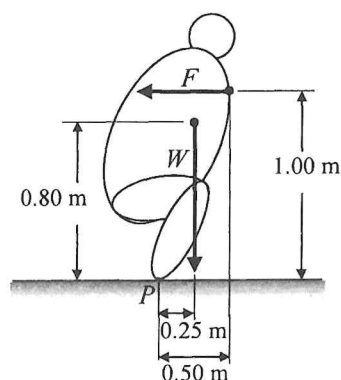
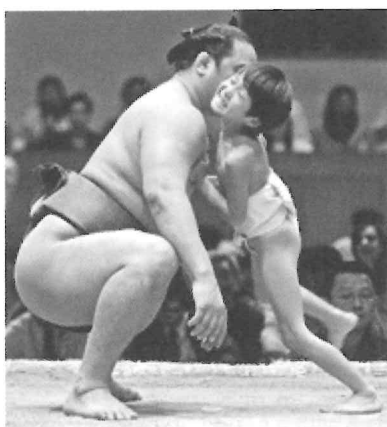


8. Block  $X$  and  $Y$  of mass  $3.0\text{ kg}$  and  $1.0\text{ kg}$  respectively are connected by a light inextensible string passing over a smooth light pulley fixed to the ceiling as shown. The blocks are released from rest. Find the time taken for block  $X$  to reach the ground. Neglect air resistance.



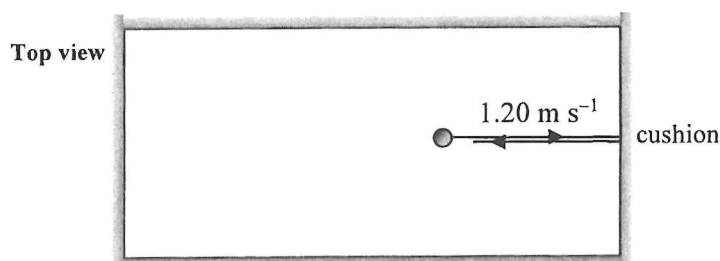
- A.  $0.55\text{ s}$   
 B.  $0.64\text{ s}$   
 C.  $0.68\text{ s}$   
 D.  $0.78\text{ s}$

9. A person thought that when he pulls his hair with a large enough force, eventually he will be able to pull himself off the ground. This is a misconception because
- the pulling force is acting internally within that person but it is not an external force acting on the person.
  - it is impossible to generate a pulling force larger than a person's weight.
  - the pulling force is balanced by the person's weight.
  - it is impossible for the pulling force to overcome the force due to atmospheric pressure.
10. A child tries to push a 150 kg (sumo) wrestler in order to topple him backwards in a game. The simplified diagram indicates the weight  $W$  of the wrestler and the horizontal pushing force  $F$  acting on the wrestler by the child.  $P$  is the wrestler's contact point on the ground.



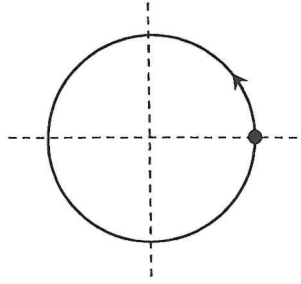
Find the minimum value of  $F$  required.

- 368 N
  - 736 N
  - 1177 N
  - 2354 N
11. On a billiard table, a billiard ball of mass 0.16 kg and moving with a uniform speed of  $1.20 \text{ m s}^{-1}$  collides elastically with the cushion. It rebounds with the same speed normal to the cushion as shown. If the impact time is 0.0003 s, find the average force acting on the ball by the cushion during collision.



- 0 N
- 640 N
- 1280 N
- 2560 N

\*12.



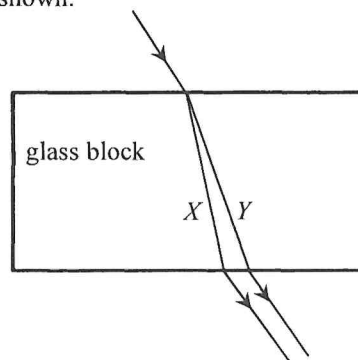
The figure shows a particle performing uniform circular motion. Which of the following correctly indicates the directions of its velocity and acceleration at the instant shown ?

- |    | velocity | acceleration |
|----|----------|--------------|
| A. | ↑        | ←            |
| B. | ↖        | ←            |
| C. | ↖        | →            |
| D. | ↑        | →            |

\*13. A satellite orbits the Earth in a circular orbit of radius  $r$  with a period of 24 hours. The period of another satellite which orbits the Earth in a circular orbit of radius  $2r$  is

- A. less than 24 hours.
- B. 24 hours.
- C. between 24 hours and 48 hours.
- D. more than 48 hours.

14. A light beam consisting of monochromatic light beam  $X$  and  $Y$  is incident on a rectangular glass block. It splits into two beams as shown.

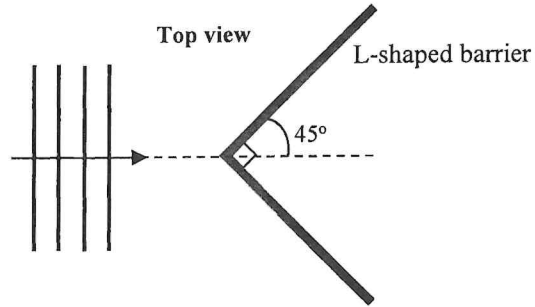


Which of the following comparisons of beam  $X$  and  $Y$  is/are correct ?

- (1)  $X$  has a higher frequency.
- (2)  $X$  has a larger speed in glass.
- (3) In the glass block, the critical angle for  $X$  is greater.

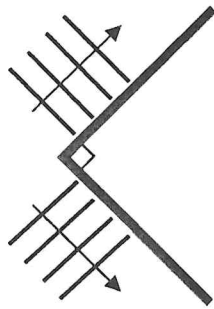
- A. (1) only
- B. (3) only
- C. (1) and (2) only
- D. (2) and (3) only

15.

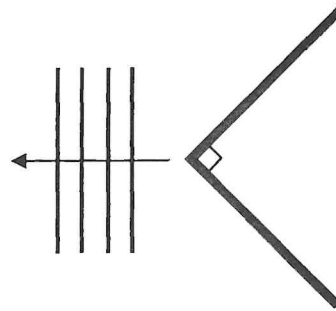


In a ripple tank, a series of plane water waves approach an L-shaped barrier as shown above. Which diagram below best shows the wave pattern reflected from the barrier?

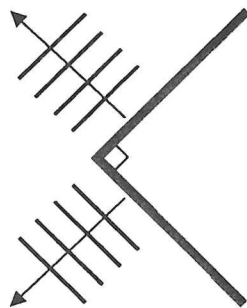
A.



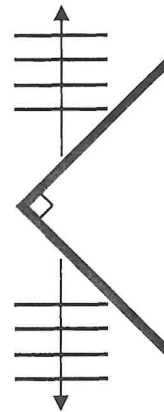
B.



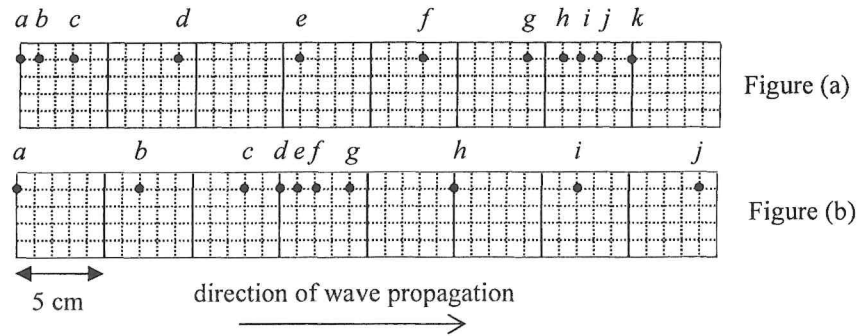
C.



D.



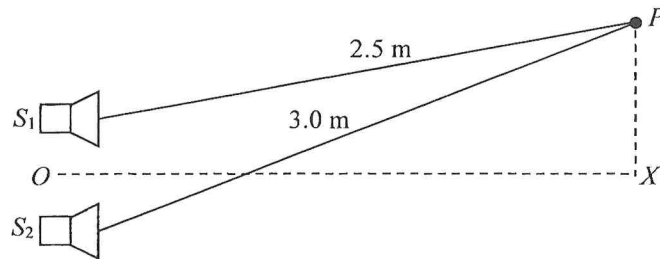
16.



A series of particles is uniformly distributed along a slinky spring initially. Figure (a) and (b) show their positions at two instants when a travelling wave of frequency 10 Hz propagates along the spring from left to right. Which statement below is correct?

- A. Particle *a* is always stationary.
- B. Particle *b* and *c* vibrate with different amplitudes.
- C. The wavelength of the wave is 16 cm.
- D. The smallest time interval for obtaining these two figures is 0.05 s.

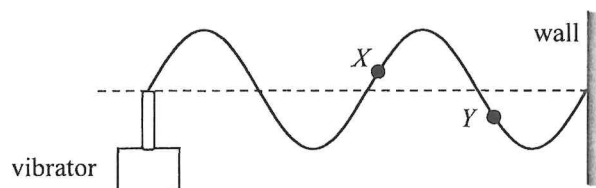
17. Two identical loudspeakers  $S_1$  and  $S_2$  connected to a signal generator produce sounds of wavelength 0.10 m which are in **anti-phase**.



$OX$  is the perpendicular bisector of the line joining  $S_1$  and  $S_2$ . What type of interference occurs at  $X$  and  $P$  respectively?

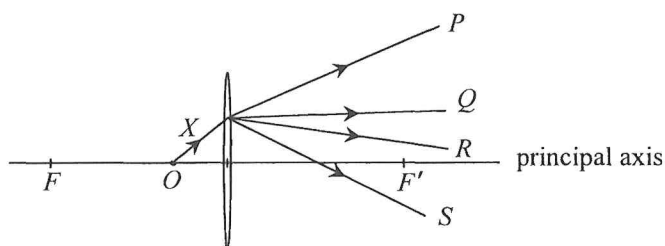
- |    | $X$          | $P$          |
|----|--------------|--------------|
| A. | destructive  | constructive |
| B. | constructive | constructive |
| C. | destructive  | destructive  |
| D. | constructive | destructive  |

18. A string is tied to a vibrator at one end while the other end is fixed to a wall. The figure shows the stationary wave formed at a certain frequency of the vibrator.



Which statement is correct when the frequency is doubled ?

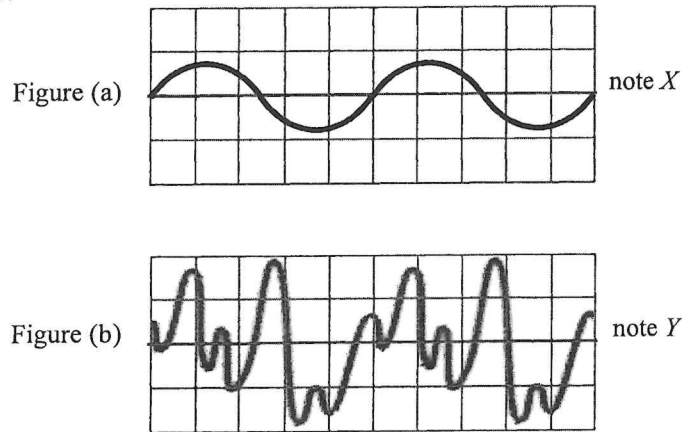
- A. The amplitude of the wave will double.
  - B. The wavelength will double.
  - C. The speed of the wave will double.
  - D. Particle  $X$  and  $Y$  will become in phase.
19.  $X$  is a light ray from an object  $O$  placed on the principal axis of a convex lens as shown.  $F$  and  $F'$  are the foci of the lens. Which light ray best represents the emergent ray ?



- A.  $P$
  - B.  $Q$
  - C.  $R$
  - D.  $S$
- \*20. An object of height 10 cm placed at 20 cm in front of a concave lens forms an image of height 8 cm. Find the focal length of the concave lens.

- A. 4.4 cm
  - B. 8.9 cm
  - C. 40 cm
  - D. 80 cm
21. Which description below is **INCORRECT** ?
- A. Microwaves are a kind of electromagnetic waves.
  - B. Microwaves can be observed with the naked eye.
  - C. Microwaves propagate with the speed of light in a vacuum.
  - D. Microwaves are used in radar to detect the position of an aeroplane.

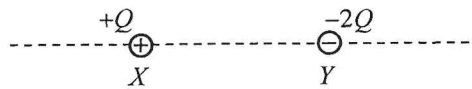
22. Figure (a) and (b) are the CRO displays of musical note  $X$  and  $Y$  using the same time axis and intensity axis.



Which comparison of these two notes must be correct ?

|    | pitch          | loudness     |
|----|----------------|--------------|
| A. | the same       | the same     |
| B. | the same       | not the same |
| C. | higher for $Y$ | the same     |
| D. | higher for $Y$ | not the same |

23. Charges  $+Q$  and  $-2Q$  are fixed at  $X$  and  $Y$  as shown.

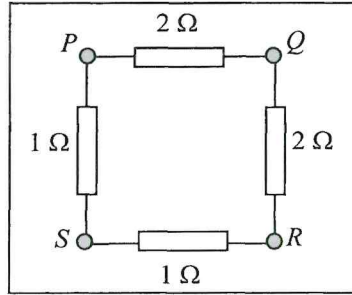


Which description(s) about the electric field along the dotted line is/are correct ?

- (1) Between  $X$  and  $Y$ , the respective electric fields due to the two charges are in the same direction.
- (2) To the right of  $Y$ , the resultant electric field is always directed to the left.
- (3) On the dotted line, there exist two points where the resultant electric field is zero.

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

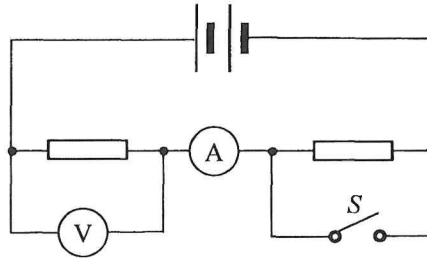
24.



Four resistors are connected to terminals  $PQRS$  of a circuit board as shown. Across which pair of terminals below is the equivalent resistance smallest?

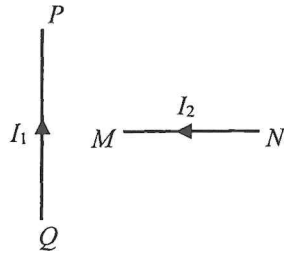
- A.  $PQ$
- B.  $PR$
- C.  $PS$
- D.  $QS$

25. In the circuit below, the two resistors are identical. When  $S$  is closed, how would the readings of the ammeter and voltmeter change?



- |    | ammeter reading | voltmeter reading |
|----|-----------------|-------------------|
| A. | increase        | increase          |
| B. | increase        | decrease          |
| C. | decrease        | increase          |
| D. | decrease        | decrease          |

26.



$PQ$  in the figure is a section of a fixed long straight wire carrying a current  $I_1$ .  $MN$  is a section of another long straight wire carrying a current  $I_2$ .  $MN$  is perpendicular to  $PQ$  and both wires are in the same plane. What is the direction of the magnetic force acting on  $MN$  due to  $PQ$ ? Neglect the effects of the Earth's magnetic field.

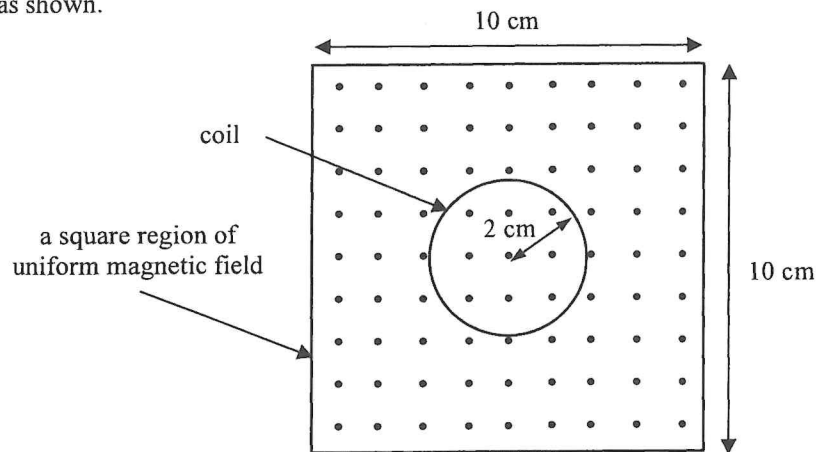
A. pointing out of the paper

B. 

C. pointing into the paper

D. 

\*27. A coil of radius 2 cm is placed inside a square region of uniform magnetic field pointing out of the paper as shown.



The magnetic field decreases uniformly from a strength of 5.0 T to 3.0 T in 0.8 s. What is the magnitude of the e.m.f. induced in the coil?

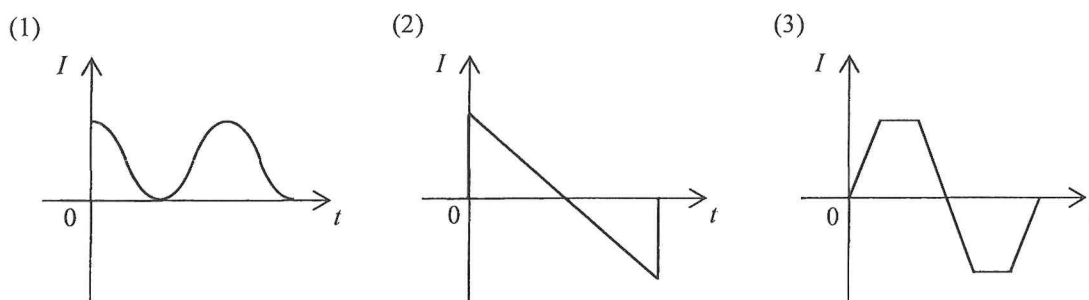
A.  $2.5 \times 10^{-2}$  V

B.  $3.1 \times 10^{-2}$  V

C.  $3.1 \times 10^{-3}$  V

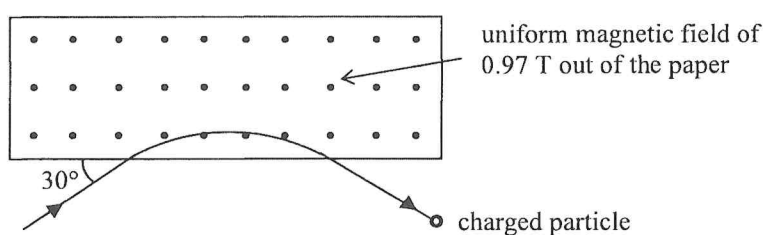
D.  $6.2 \times 10^{-3}$  V

\*28. Which of the following current against time ( $I-t$ ) graphs represent an a.c. ?



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

\*29.



A charged particle enters and leaves a magnetic field of uniform flux density  $0.97 \text{ T}$  along the path as shown. It experiences a magnetic force of  $5.9 \times 10^{-12} \text{ N}$  within the magnetic field. Given that the speed of the particle is  $1.9 \times 10^7 \text{ m s}^{-1}$ , find its charge.

- A.  $-3.2 \times 10^{-19} \text{ C}$
- B.  $+3.2 \times 10^{-19} \text{ C}$
- C.  $-6.4 \times 10^{-19} \text{ C}$
- D.  $+6.4 \times 10^{-19} \text{ C}$

\*30. A power station generates  $217 \text{ MW}$  of power for transmission to downtown under a voltage of  $132 \text{ kV}$  via a transmission cable which has an effective resistance of  $0.02 \Omega \text{ km}^{-1}$ . The power loss for a total cable length of  $40 \text{ km}$  is about

- A.  $2.16 \text{ MW}$ .
- B.  $6.49 \text{ MW}$ .
- C.  $13.0 \text{ MW}$ .
- D.  $21.6 \text{ MW}$ .

31. Which statements about domestic electricity are correct ?

- (1) All fuses should be installed in the live wire.
- (2) An electrical appliance can work even without an earth wire.
- (3) An electrical appliance having a fuse in it can protect people from getting an electric shock.

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

\*32. It takes 2.0 years for the activity of a sample containing a radioactive nuclide to drop from 800 Bq to 600 Bq. How long will it take for the activity of the sample to drop from 600 Bq to 300 Bq ?

- A. 2.0 years
- B. 2.5 years
- C. 3.0 years
- D. 4.8 years

33. In order to locate the cracks in an underground water pipe, a small amount of a radioisotope is added to the water in the pipe. The radioactive substance will leak through the crack to the soil nearby, thus radiation will be detected above ground. Which radioisotope ( $P$ ,  $Q$ ,  $R$  or  $S$ ) below is the most suitable for this purpose ?

|    | isotope | half-life  | radiation emitted |
|----|---------|------------|-------------------|
| A. | $P$     | 66 hours   | $\beta$           |
| B. | $Q$     | 36 hours   | $\gamma$          |
| C. | $R$     | 7.2 hours  | $\alpha$          |
| D. | $S$     | 45 minutes | $\alpha, \beta$   |

**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               | $q_e = 1.60 \times 10^{-19} \text{ C}$                                            |                                |
| electron rest mass               | $m_e = 9.11 \times 10^{-31} \text{ kg}$                                           |                                |
| permittivity of free space       | $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$     |                                |
| 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 :

$$\begin{aligned}
 v &= u + at \\
 s &= ut + \frac{1}{2}at^2 \\
 v^2 &= u^2 + 2as
 \end{aligned}$$

## 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)

|                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Astronomy and Space Science</b><br>$U = -\frac{GMm}{r}$ gravitational potential energy<br>$P = \sigma AT^4$ Stefan's law<br>$\left  \frac{\Delta f}{f_0} \right  \approx \frac{v}{c} \approx \left  \frac{\Delta \lambda}{\lambda_0} \right $ Doppler effect                                                                                                                                     | <b>Energy and Use of Energy</b><br>$E = \frac{\Phi}{A}$ illuminance<br>$\frac{Q}{t} = \kappa \frac{A(T_H - T_C)}{d}$ rate of energy transfer by conduction<br>$U = \frac{\kappa}{d}$ thermal transmittance U-value<br>$P = \frac{1}{2} \rho A v^3$ maximum power by wind turbine                                                                                                                                 |
| <b>Atomic World</b><br>$\frac{1}{2} m_e v_{\max}^2 = hf - \phi$ Einstein's photoelectric equation<br>$E_n = -\frac{1}{n^2} \left\{ \frac{m_e q_e^4}{8h^2 \epsilon_0^2} \right\} = -\frac{13.6}{n^2} \text{ eV}$ energy level equation for hydrogen atom<br>$\lambda = \frac{h}{p} = \frac{h}{mv}$ de Broglie formula<br>$\theta \approx \frac{1.22\lambda}{d}$ Rayleigh criterion (resolving power) | <b>Medical Physics</b><br>$\theta \approx \frac{1.22\lambda}{d}$ Rayleigh criterion (resolving power)<br>$\text{power} = \frac{1}{f}$ power of a lens<br>$L = 10 \log \frac{I}{I_0}$ intensity level (dB)<br>$Z = \rho c$ acoustic impedance<br>$\alpha = \frac{I_r}{I_0} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$ intensity reflection coefficient<br>$I = I_0 e^{-\mu x}$ transmitted intensity through a medium |

|     |                                                               |                                               |      |                                                |                                                                |
|-----|---------------------------------------------------------------|-----------------------------------------------|------|------------------------------------------------|----------------------------------------------------------------|
| A1. | $E = mc \Delta T$                                             | energy transfer during heating and cooling    | D1.  | $F = \frac{Q_1 Q_2}{4\pi\epsilon_0 r^2}$       | Coulomb's law                                                  |
| A2. | $E = l \Delta m$                                              | energy transfer during change of state        | D2.  | $E = \frac{Q}{4\pi\epsilon_0 r^2}$             | electric field strength due to a point charge                  |
| A3. | $pV = nRT$                                                    | equation of state for an ideal gas            | D3.  | $E = \frac{V}{d}$                              | electric field between parallel plates (numerically)           |
| A4. | $pV = \frac{1}{3} Nmc^2$                                      | kinetic theory equation                       | D4.  | $R = \frac{\rho l}{A}$                         | resistance and resistivity                                     |
| A5. | $E_K = \frac{3RT}{2N_A}$                                      | molecular kinetic energy                      | D5.  | $R = R_1 + R_2$                                | resistors in series                                            |
|     |                                                               |                                               | D6.  | $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$  | resistors in parallel                                          |
| B1. | $F = m \frac{\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t}$ | force                                         | D7.  | $P = IV = I^2 R$                               | power in a circuit                                             |
| B2. | moment = $F \times d$                                         | moment of a force                             | D8.  | $F = BQv \sin \theta$                          | force on a moving charge in a magnetic field                   |
| B3. | $E_P = mgh$                                                   | gravitational potential energy                | D9.  | $F = BIl \sin \theta$                          | force on a current-carrying conductor in a magnetic field      |
| B4. | $E_K = \frac{1}{2} mv^2$                                      | kinetic energy                                | D10. | $B = \frac{\mu_0 I}{2\pi r}$                   | magnetic field due to a long straight wire                     |
| B5. | $P = Fv$                                                      | mechanical power                              | D11. | $B = \frac{\mu_0 NI}{l}$                       | magnetic field inside a long solenoid                          |
| B6. | $a = \frac{v^2}{r} = \omega^2 r$                              | centripetal acceleration                      | D12. | $\mathcal{E} = N \frac{\Delta \Phi}{\Delta t}$ | induced e.m.f.                                                 |
| B7. | $F = \frac{Gm_1 m_2}{r^2}$                                    | Newton's law of gravitation                   | D13. | $\frac{V_s}{V_p} \approx \frac{N_s}{N_p}$      | ratio of secondary voltage to primary voltage in a transformer |
| C1. | $\Delta y = \frac{\lambda D}{a}$                              | fringe separation in double-slit interference | E1.  | $N = N_0 e^{-kt}$                              | law of radioactive decay                                       |
| C2. | $d \sin \theta = n\lambda$                                    | diffraction grating equation                  | E2.  | $t_{\frac{1}{2}} = \frac{\ln 2}{k}$            | half-life and decay constant                                   |
| C3. | $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$                     | equation for a single lens                    | E3.  | $A = kN$                                       | activity and the number of undecayed nuclei                    |
|     |                                                               |                                               | E4.  | $\Delta E = \Delta mc^2$                       | mass-energy relationship                                       |