

No part of this product may be reproduced in any form or by any electronic or mechanical means, including information storage and retrieval systems, without written permission from the IB.

Additionally, the license tied with this product prohibits commercial use of any selected files or extracts from this product. Use by third parties, including but not limited to publishers, private teachers, tutoring or study services, preparatory schools, vendors operating curriculum mapping services or teacher resource digital platforms and app developers, is not permitted and is subject to the IB's prior written consent via a license. More information on how to request a license can be obtained from <http://www.ibo.org/contact-the-ib/media-inquiries/for-publishers/guidance-for-third-party-publishers-and-providers/how-to-apply-for-a-license>.

Aucune partie de ce produit ne peut être reproduite sous quelque forme ni par quelque moyen que ce soit, électronique ou mécanique, y compris des systèmes de stockage et de récupération d'informations, sans l'autorisation écrite de l'IB.

De plus, la licence associée à ce produit interdit toute utilisation commerciale de tout fichier ou extrait sélectionné dans ce produit. L'utilisation par des tiers, y compris, sans toutefois s'y limiter, des éditeurs, des professeurs particuliers, des services de tutorat ou d'aide aux études, des établissements de préparation à l'enseignement supérieur, des fournisseurs de services de planification des programmes d'études, des gestionnaires de plateformes pédagogiques en ligne, et des développeurs d'applications, n'est pas autorisée et est soumise au consentement écrit préalable de l'IB par l'intermédiaire d'une licence. Pour plus d'informations sur la procédure à suivre pour demander une licence, rendez-vous à l'adresse <http://www.ibo.org/fr/contact-the-ib/media-inquiries/for-publishers/guidance-for-third-party-publishers-and-providers/how-to-apply-for-a-license>.

No se podrá reproducir ninguna parte de este producto de ninguna forma ni por ningún medio electrónico o mecánico, incluidos los sistemas de almacenamiento y recuperación de información, sin que medie la autorización escrita del IB.

Además, la licencia vinculada a este producto prohíbe el uso con fines comerciales de todo archivo o fragmento seleccionado de este producto. El uso por parte de terceros —lo que incluye, a título enunciativo, editoriales, profesores particulares, servicios de apoyo académico o ayuda para el estudio, colegios preparatorios, desarrolladores de aplicaciones y entidades que presten servicios de planificación curricular u ofrezcan recursos para docentes mediante plataformas digitales— no está permitido y estará sujeto al otorgamiento previo de una licencia escrita por parte del IB. En este enlace encontrará más información sobre cómo solicitar una licencia: <http://www.ibo.org/es/contact-the-ib/media-inquiries/for-publishers/guidance-for-third-party-publishers-and-providers/how-to-apply-for-a-license>.

Physics
Standard level
Paper 1

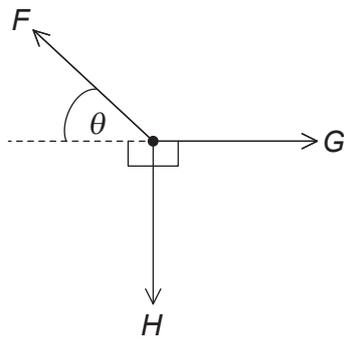
Tuesday 5 November 2019 (afternoon)

45 minutes

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for this examination paper is **[30 marks]**.

1. Which quantity has the fundamental SI units of $\text{kg m}^{-1} \text{s}^{-2}$?
- A. Energy
 - B. Force
 - C. Momentum
 - D. Pressure
2. An object is held in equilibrium by three forces of magnitude F , G and H that act at a point in the same plane.



Three equations for these forces are

- I. $F \cos \theta = G$
- II. $F = G \cos \theta + H \sin \theta$
- III. $F = G + H$

Which equations are correct?

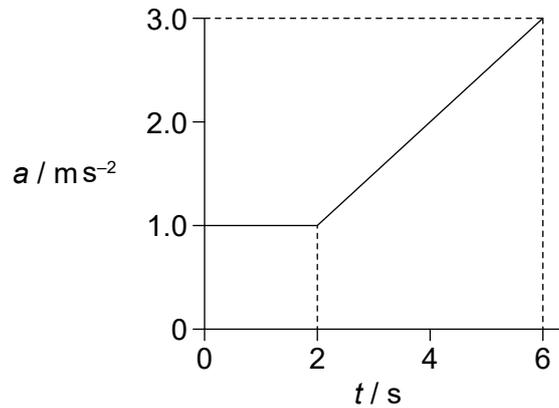
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

3. Two forces act along a straight line on an object that is initially at rest. One force is constant; the second force is in the opposite direction and proportional to the velocity of the object.



What is correct about the motion of the object?

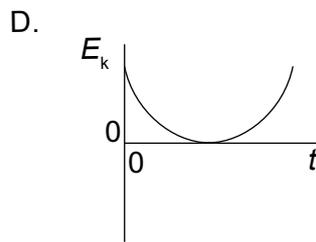
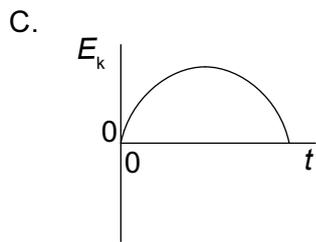
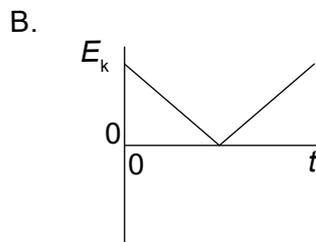
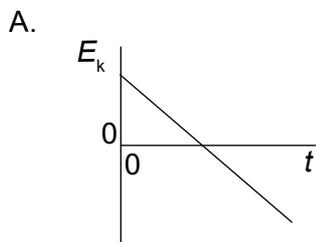
- A. The acceleration increases from zero to a maximum.
 - B. The acceleration increases from zero to a maximum and then decreases.
 - C. The velocity increases from zero to a maximum.
 - D. The velocity increases from zero to a maximum and then decreases.
4. The variation with time t of the acceleration a of an object is shown.



What is the change in velocity of the object from $t = 0$ to $t = 6 \text{ s}$?

- A. 6 ms^{-1}
- B. 8 ms^{-1}
- C. 10 ms^{-1}
- D. 14 ms^{-1}

5. A climber of mass m slides down a vertical rope with an average acceleration a . What is the average frictional force exerted by the rope on the climber?
- A. mg
 - B. $m(g + a)$
 - C. $m(g - a)$
 - D. ma
6. A cube slides down the surface of a ramp at a constant velocity. What is the magnitude of the frictional force that acts on the cube due to the surface?
- A. The weight of the cube
 - B. The component of weight of the cube parallel to the plane
 - C. The component of weight of the cube perpendicular to the plane
 - D. The component of the normal reaction at the surface parallel to the plane
7. A ball is thrown vertically upwards. Air resistance is negligible. What is the variation with time t of the kinetic energy E_k of the ball?



8. The tension in a horizontal spring is directly proportional to the extension of the spring. The energy stored in the spring at extension x is E . What is the work done by the spring when its extension changes from x to $\frac{x}{4}$?

- A. $\frac{E}{16}$
- B. $\frac{E}{4}$
- C. $\frac{3E}{4}$
- D. $\frac{15E}{16}$

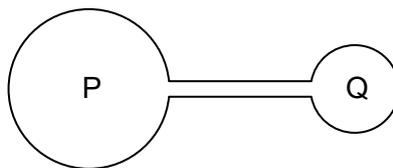
9. A mass m of water is at a temperature of 290 K. The specific heat capacity of water is c . Ice, at its melting point, is added to the water to reduce the water temperature to the freezing point. The specific latent heat of fusion for ice is L . What is the minimum mass of ice that is required?

- A. $\frac{17mc}{L}$
- B. $\frac{290mc}{L}$
- C. $\frac{17mL}{c}$
- D. $\frac{290mL}{c}$

10. An ideal gas is in a closed container. Which changes to its volume and temperature when taken together must cause a decrease in the gas pressure?

| | Volume | Temperature |
|----|----------|-------------|
| A. | decrease | increase |
| B. | decrease | decrease |
| C. | increase | increase |
| D. | increase | decrease |

11. Two flasks P and Q contain an ideal gas and are connected with a tube of negligible volume compared to that of the flasks. The volume of P is twice the volume of Q.



P is held at a temperature of 200K and Q is held at a temperature of 400K.

What is $\frac{\text{mass of gas in P}}{\text{mass of gas in Q}}$?

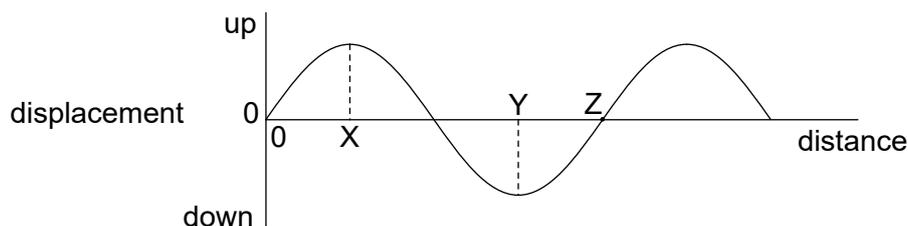
- A. $\frac{1}{8}$
- B. $\frac{1}{4}$
- C. 4
- D. 8
12. The motion of an object is described by the equation

$$\text{acceleration} \propto - \text{displacement.}$$

What is the direction of the acceleration relative to that of the displacement and what is the displacement when the speed is a maximum?

| | Direction of acceleration relative to displacement | Displacement when speed is a maximum |
|----|---|---|
| A. | same | max |
| B. | same | zero |
| C. | opposite | max |
| D. | opposite | zero |

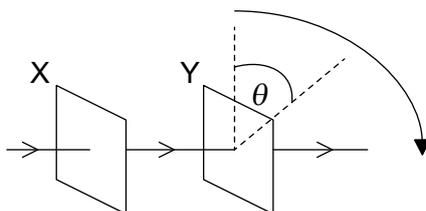
13. A transverse travelling wave is moving through a medium. The graph shows, for one instant, the variation with distance of the displacement of particles in the medium.



The frequency of the wave is 25 Hz and the speed of the wave is 100 ms^{-1} . What is correct for this wave?

- A. The particles at X and Y are in phase.
 - B. The velocity of the particle at X is a maximum.
 - C. The horizontal distance between X and Z is 3.0 m.
 - D. The velocity of the particle at Y is 100 ms^{-1} .
14. Monochromatic light is used to produce double-slit interference fringes on a screen. The fringe separation on the screen is y . The distance from the slits to the screen and the separation of the slits are both doubled, and the light source is unchanged. What is the new fringe separation on the screen?
- A. $\frac{y}{4}$
 - B. y
 - C. $2y$
 - D. $4y$

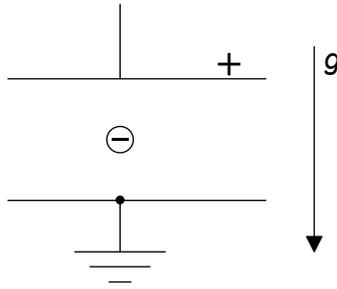
15. Unpolarized light is incident on two polarizing filters X and Y. They are arranged so that light emerging from Y has a maximum intensity. X is fixed and Y is rotated through θ about the direction of the incident beam in its own plane.



What are the first three successive values of θ for which the final transmitted intensity is a maximum?

- A. $90^\circ, 180^\circ, 270^\circ$
- B. $90^\circ, 270^\circ, 450^\circ$
- C. $180^\circ, 360^\circ, 540^\circ$
- D. $180^\circ, 540^\circ, 720^\circ$
16. A pipe is open at both ends. What is correct about a standing wave formed in the air of the pipe?
- A. The sum of the number of nodes plus the number of antinodes is an odd number.
- B. The sum of the number of nodes plus the number of antinodes is an even number.
- C. There is always a central node.
- D. There is always a central antinode.

17. A negatively charged particle in a uniform gravitational field is positioned mid-way between two charged conducting plates.

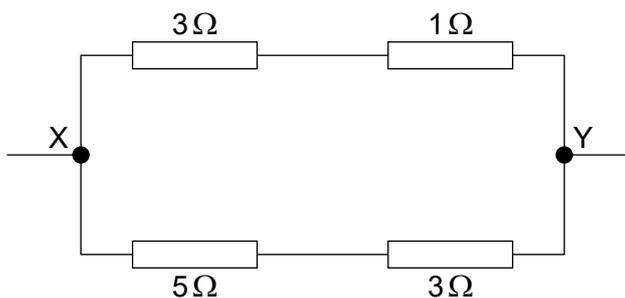


The potential difference between the plates is adjusted until the particle is held at rest relative to the plates.

What change will cause the particle to accelerate downwards relative to the plates?

- A. Decreasing the charge on the particle
 - B. Decreasing the separation of the plates
 - C. Increasing the length of the plates
 - D. Increasing the potential difference between the plates
18. A thin copper wire and a thick copper wire are connected in series to an electric cell. Which quantity will be greater in the thin wire?
- A. Current
 - B. Number of free charge carriers per unit volume
 - C. Net number of charge carriers crossing a section of a wire every second
 - D. Drift speed of the charge carriers

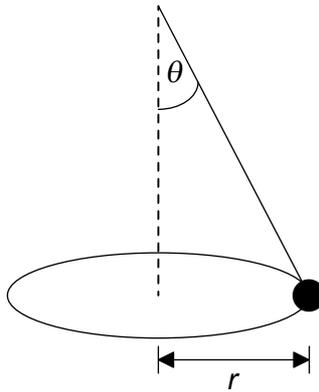
19. The diagram shows a resistor network. The potential difference between X and Y is 8.0V.



What is the current in the 5Ω resistor?

- A. 1.0A
 - B. 1.6A
 - C. 2.0A
 - D. 3.0A
20. When a wire with an electric current I is placed in a magnetic field of strength B it experiences a magnetic force F . What is the direction of F ?
- A. In a direction determined by I only
 - B. In a direction determined by B only
 - C. In the plane containing I and B
 - D. At 90° to the plane containing I and B

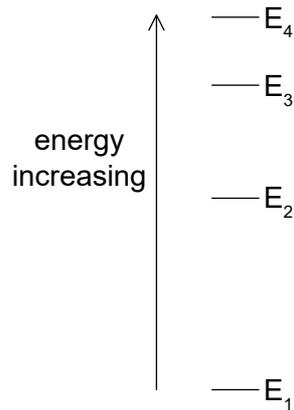
21. An object hangs from a light string and moves in a horizontal circle of radius r .



The string makes an angle θ with the vertical. The angular speed of the object is ω . What is $\tan \theta$?

- A. $\frac{\omega^2 r}{g}$
- B. $\frac{g}{\omega^2 r}$
- C. $\frac{\omega r^2}{g}$
- D. $\frac{g}{\omega r^2}$
22. An object of mass m makes n revolutions per second around a circle of radius r at a constant speed. What is the kinetic energy of the object?
- A. 0
- B. $\frac{1}{2}\pi^2 mn^2 r^2$
- C. $2\pi^2 mn^2 r^2$
- D. $4\pi^2 mn^2 r^2$
23. A satellite travels around the Earth in a circular orbit. What is true about the forces acting in this situation?
- A. The resultant force is the same direction as the satellite's acceleration.
- B. The gravitational force acting on the satellite is negligible.
- C. There is no resultant force on the satellite relative to the Earth.
- D. The satellite does not exert any force on the Earth.

24. The energy levels for an atom are shown to scale.



A photon of wavelength λ is emitted because of a transition from E₃ to E₂. Which transition leads to the emission of a photon of longer wavelength?

- A. E₄ to E₁
 - B. E₄to E₃
 - C. E₃to E₁
 - D. E₂to E₁
25. A proton, an electron and an alpha particle are at rest. Which particle has the smallest magnitude of ratio of charge to mass and which particle has the largest magnitude of ratio of charge to mass?

| | Smallest charge to mass ratio | Largest charge to mass ratio |
|----|--------------------------------------|-------------------------------------|
| A. | alpha | electron |
| B. | electron | alpha |
| C. | electron | proton |
| D. | proton | electron |

26. X is a radioactive nuclide that decays to a stable nuclide. The activity of X falls to $\frac{1}{16}$ th of its original value in 32 s.

What is the half-life of X?

- A. 2 s
 B. 4 s
 C. 8 s
 D. 16 s
27. What is correct about the nature and range of the strong interaction between nuclear particles?
- A. It is attractive at all particle separations.
 B. It is attractive for particle separations between 0.7 fm and 3 fm.
 C. It is repulsive for particle separations greater than 3 fm.
 D. It is repulsive at all particle separations.
28. What are the units of specific energy and energy density?

| | Specific energy | Energy density |
|----|------------------------|-----------------------|
| A. | J m^{-1} | J m^{-2} |
| B. | J kg^{-1} | J m^{-3} |
| C. | J kg^{-1} | J m^{-2} |
| D. | J m^{-1} | J m^{-3} |

29. What is the function of the moderator in a thermal nuclear fission reactor?
- A. To decrease the kinetic energy of neutrons emitted from fission reactions
 B. To increase the kinetic energy of neutrons emitted from fission reactions
 C. To decrease the overall number of neutrons available for fission
 D. To increase the overall number of neutrons available for fission

- 30.** What is meant by the statement that the average albedo of the Moon is 0.1?
- A. 10% of the radiation incident on the Moon is absorbed by its surface
 - B. 10% of the radiation emitted by the Moon is absorbed by its atmosphere
 - C. 10% of the radiation incident on the Moon is reflected by its surface
 - D. 10% of the radiation emitted by the Moon is at infrared wavelengths
-