Diploma Programme
Programme du diplôme
Programa del Diploma

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]**.

8819 – 6504

1. Which quantity has the fundamental SI units of $\text{kg m}^{-1}\text{ s}^{-2}$?

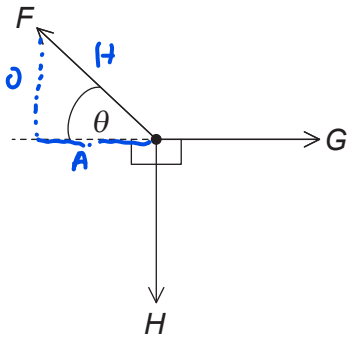
A. Energy

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.

starts moving, reaches a maximum, then is in equilibrium

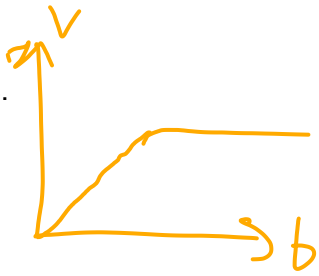
What is correct about the motion of the object?

A. The acceleration increases from zero to a maximum.

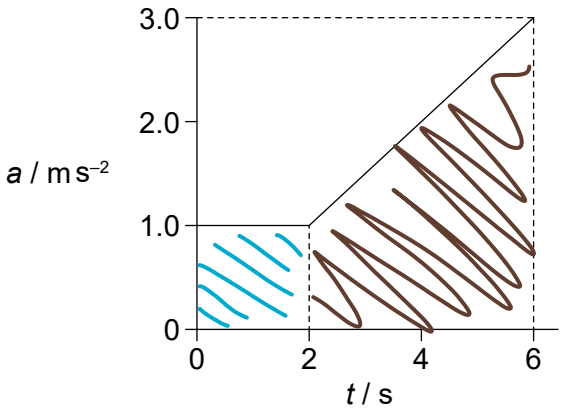
B. The acceleration increases from zero to a maximum and then decreases.

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 $t = 6$ s?

A. $6\,m\,s^{-1}$

B. $8\,m\,s^{-1}$

C. $10\,m\,s^{-1}$

D. $14\,m\,s^{-1}$

$\Delta v = (1 \times 2)$ $\Delta v = \frac{1}{2} \times 4 \times (3+1)$

$\Delta v = 2 \times 4$

$\Delta v = 8$

$\Delta v = 2 + 8 = 10\,m\,s^{-1}$

total

NOTE: official markscheme incorrectly had 'B' as the answer.

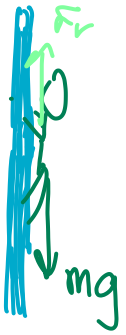
5. A climber of mass m slides down a vertical rope with an average acceleration a. What is the average frictional force exerted by the rope on the climber?

A. mg

B. $m(g + a)$

C. $m(g - a)$

D. ma



$ma = mg - Fr$

$Fr = mg - ma$

$Fr = m(g - a)$

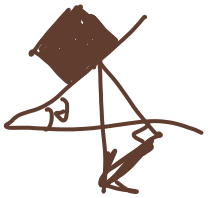
6. A cube slides down the surface of a ramp at a constant velocity. What is the magnitude of the frictional force that acts on the cube due to the surface?

A. The weight of the cube

B. The component of weight of the cube parallel to the plane

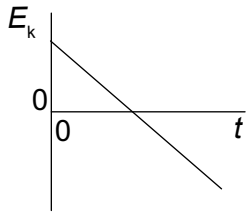
C. The component of weight of the cube perpendicular to the plane

D. The component of the normal reaction at the surface parallel to the plane

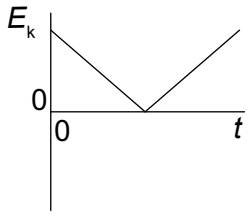


7. A ball is thrown vertically upwards. Air resistance is negligible. What is the variation with time t of the kinetic energy E_k of the ball?

A.



B.



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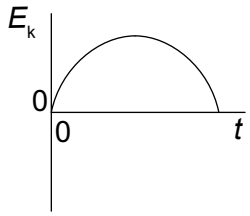
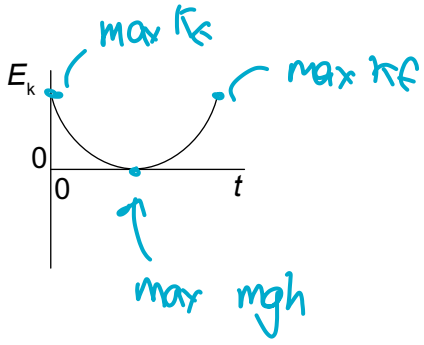


D.



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. $\frac{15E}{16}$

Before $E = \frac{1}{2}kx^2$

After $E = \frac{1}{2}k\left(\frac{x}{4}\right)^2$

$E = \frac{1}{2}kx^2 \times \frac{1}{16}$

Spring lost $\frac{15}{16}E$

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. $\frac{290mL}{c}$

$Q_{lost} = mc_{water}\Delta T$ $\quad Q_{gained} = m_{ice}L$

$Q_{lost} = 17mc_{water}$

$Q_{lost} = Q_{gained}$

$17m_{water}c = m_{ice}L$

$\frac{17mc}{L} = m_{ice}$

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

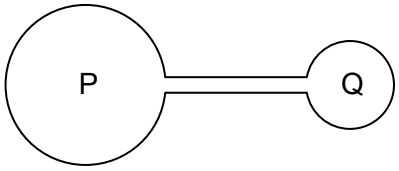
$pV = nRT$

$p = \frac{nRT}{V}$

$\downarrow p \propto T \downarrow$

$\checkmark \uparrow$

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

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

$pV = nRT$

$\frac{pV}{RT} = n$

$\frac{n_P}{n_Q} = \frac{\frac{pV_P}{RT_P}}{\frac{pV_Q}{RT_Q}} = \frac{\frac{V_P}{T_P}}{\frac{V_Q}{T_Q}} = \frac{V_P}{T_P} \times \frac{T_Q}{V_Q}$

this would be the same as mass ratio

$= \frac{2V_Q}{200} \times \frac{400}{V_Q}$

$= \frac{2 \times 400}{200} = 4$

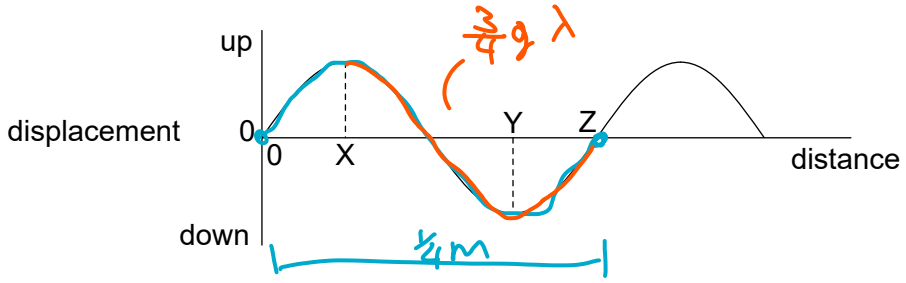
12. The motion of an object is described by the equation

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

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 m s^{-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 m s^{-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?

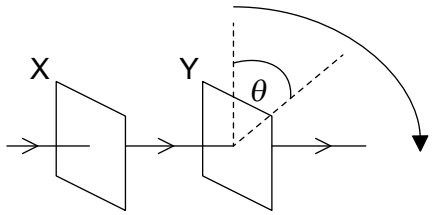
A. $\frac{y}{4}$

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°, 180°, 270°

B. 90°, 270°, 450°

C. 180°, 360°, 540° multiple of 180°

D. 180°, 540°, 720°

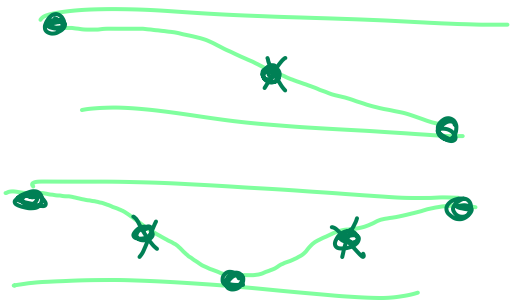
16. A pipe is open at both ends. What is correct about a standing wave formed in the air of the pipe?

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.

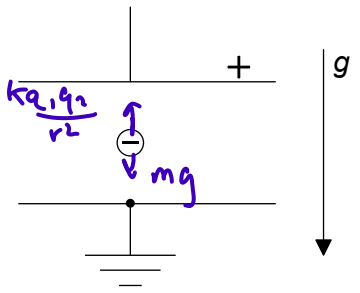
D. There is always a central antinode.



nodes = 1
antinodes = 2

nodes = 2
antinodes = 3

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

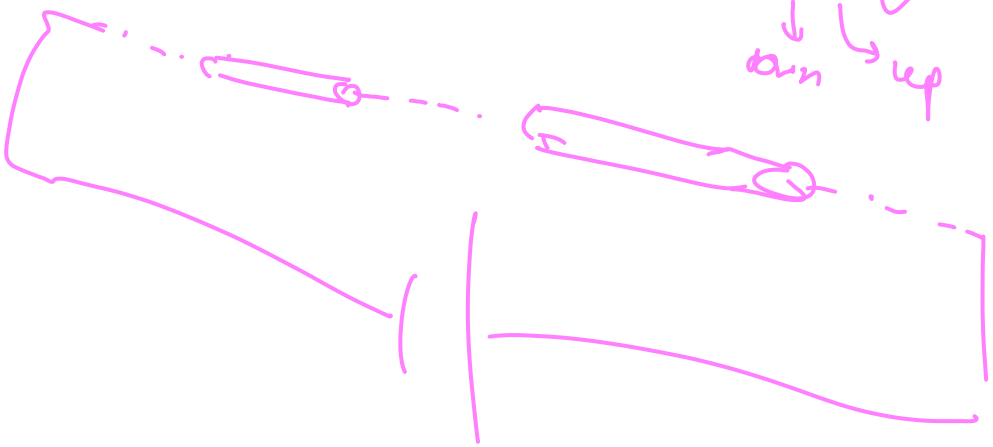
18. A thin copper wire and a thick copper wire are connected in series to an electric cell. Which quantity will be greater in the thin wire?

A. Current

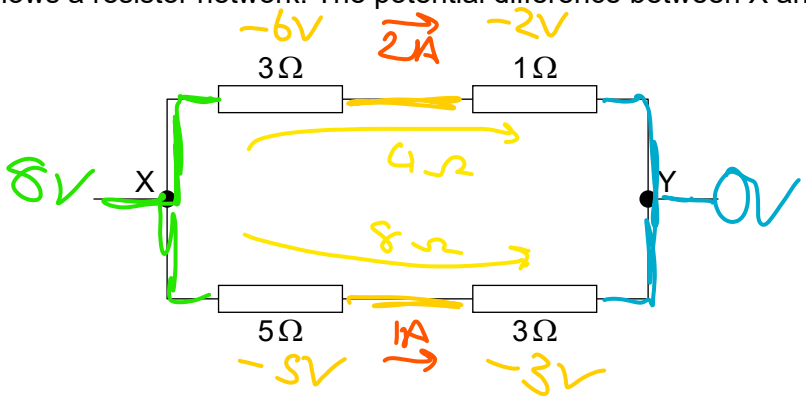
B. Number of free charge carriers per unit volume

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 8.0 V.



What is the current in the 5 Ω 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?

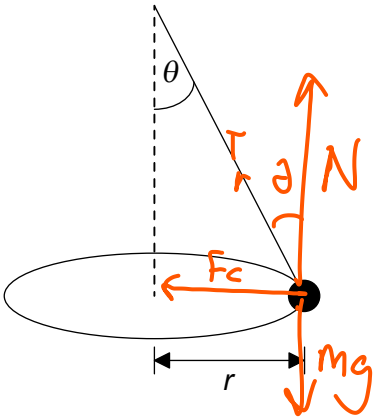
A. In a direction determined by I only

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 θ?

A. $\frac{\omega^2 r}{g}$

B. $\frac{g}{\omega^2 r}$

C. $\frac{\omega r^2}{g}$

D. $\frac{g}{\omega r^2}$

$F_c = m\omega^2 r$

$N = mg$

$\tan\theta = \frac{m\omega^2 r}{mg}$

$\tan\theta = \frac{\omega^2 r}{g}$

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. $4\pi^2 mn^2 r^2$

$KE = \frac{1}{2}mv^2$

$KE = \frac{1}{2}m(2\pi rn)^2$

$KE = 4 \times \frac{1}{2} m\pi^2 r^2 n^2$

$KE = 2\pi^2 m r^2 n^2$

$v = \frac{d}{t}$

$v = 2\pi rn$

23. A satellite travels around the Earth in a circular orbit. What is true about the forces acting in this situation?

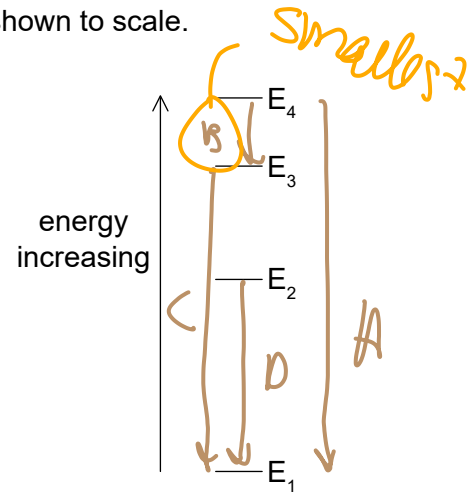
A. The resultant force is the same direction as the satellite's acceleration.

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 E_3 to E_2. Which transition leads to the emission of a photon of longer wavelength?

A. E_4 to E_1

B. E_4 to E_3

C. E_3 to E_1

D. E_2 to E_1

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.

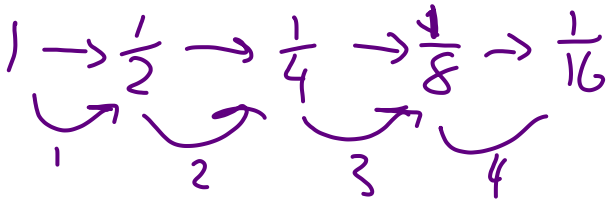
What is the half-life of X?

A. 2 s

B. 4 s

C. 8 s

D. 16 s



4 half lives

$\frac{32}{4} = 8\,s$

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?

per mass — per volume

	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?

> slow neutrons to increase reaction rate

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

Albedo = $\frac{\text{scatter power}}{\text{incident power}}$

$\frac{1}{10} = \frac{\text{scattered}}{\text{incident}}$