Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Standard level
Paper 1

7 November 2024

Zone A afternoon | **Zone B** afternoon | **Zone C** 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]**.

8824 – 9593

16 pages

1. The radius of a sphere is R. The absolute uncertainty in R is ΔR.

What is the fractional uncertainty in the volume of the sphere?

A. $\frac{3\Delta R}{R}$

B. $\left(\frac{\Delta R}{R}\right)^3$

C. $\frac{4\pi\Delta R}{3R}$

D. $4\pi\left(\frac{\Delta R}{R}\right)^3$

2. Which quantity has the fundamental SI units of $\text{kg}\,\text{s}^{-3}$?

A. Power

B. Intensity

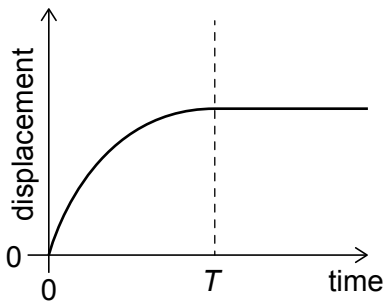
C. Momentum

D. Energy

3. A runner accelerates from rest and reaches a constant speed at time *T*.

What is the variation of displacement with time?

A.



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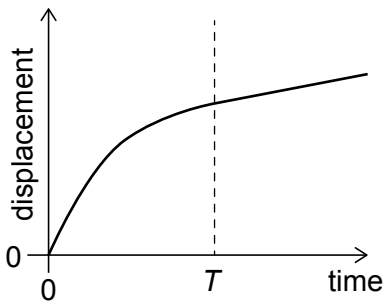

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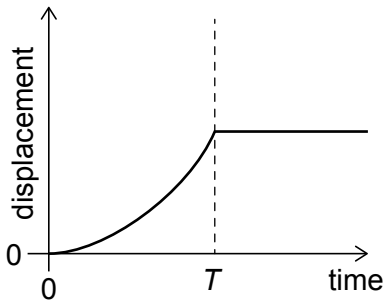

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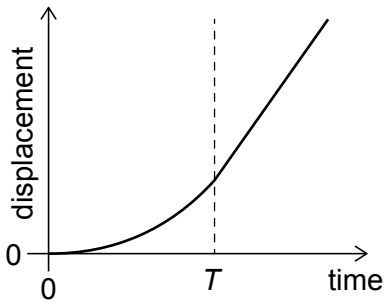


4. A balloon rises at a steady vertical velocity of $10\,m\,s^{-1}$. An object is released at rest relative to the balloon when the object is at a height 120 m above the ground. Air resistance is negligible.

What time, to the nearest second, does the object take to hit the ground?

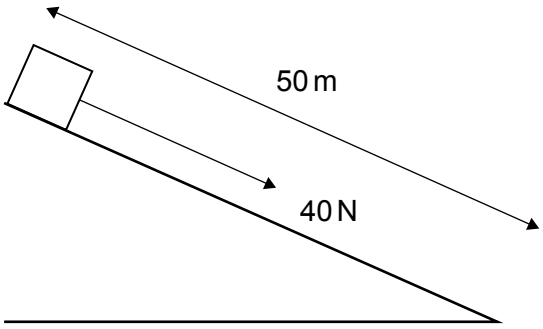
A. 4 s

B. 5 s

C. 6 s

D. 12 s

5. An object of mass 10 kg is initially at rest at the top of a slope of length 50 m. A constant **net** force of 40 N acts on the object down the slope.



What is the speed of the object at the bottom of the slope?

A. $20\,\text{m s}^{-1}$

B. $40\,\text{m s}^{-1}$

C. $200\,\text{m s}^{-1}$

D. $400\,\text{m s}^{-1}$

6. When a horizontal spring is extended by a distance x, the force acting on the spring is F. The extension of the spring is directly proportional to the force.

What is the energy stored in the spring?

A. $\frac{F}{2x}$

B. Fx

C. $\frac{Fx}{2}$

D. $\frac{Fx^2}{2}$

7. An object of mass 6.0 kg is accelerated horizontally from rest in 4.0 s to reach a speed of 10 m s^{-1}.

What is the average power delivered to the object?

A. 7.5 W

B. 15 W

C. 75 W

D. 150 W

8. An athlete of mass *M* jumps vertically upward, lifting their centre of mass a distance *h* after losing contact with the ground.

What is the impulse that acts on the athlete during contact with the ground?

A. Mgh

B. $\frac{M}{gh}$

C. $M\sqrt{2gh}$

D. $\frac{M}{\sqrt{2}}\sqrt{gh}$

9. A toy car collides with an identical toy car at rest. The cars stick together. The surface is frictionless.

Three statements about this collision are:

I. The speed of one car decreases and the speed of the other car increases.

II. Total momentum is conserved.

III. Kinetic energy is conserved.

Which statements are true?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

10. A heater of power P provides energy to a liquid at its boiling point. A mass m of the liquid vaporizes in time t. The specific latent heat of vaporization is L. How much energy is transferred to the surroundings in time t?

A. $Pt + mL$

B. $Pt - mL$

C. $\frac{mL}{Pt}$

D. $\frac{Pt}{mL}$

11. The molar mass of helium is $4.0\,\text{g mol}^{-1}$. A sample of helium has mass $0.50\,\text{g}$.

How many molecules of helium are there in the sample?

A. 3.0×10^{22}

B. 7.5×10^{22}

C. 3.0×10^{23}

D. 7.5×10^{23}

12. An ideal gas is in a container with a movable piston. The piston compresses the gas rapidly.

The temperature of the gas increases because

A. molecules bounce off the piston with increased speed.

B. molecules collide with the piston more frequently.

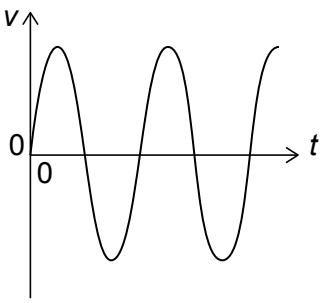
C. molecules exert a greater force on the piston.

D. the number of molecules per cubic metre has increased.

13. A particle is displaced in the negative direction and released from rest at time $t = 0$. It performs simple harmonic motion (shm).

Which graph shows the variation with time t of the velocity v of the particle?

A.



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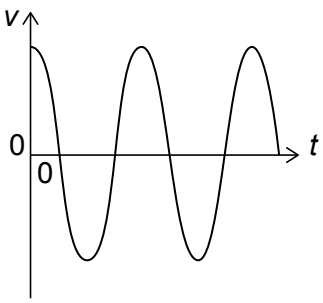

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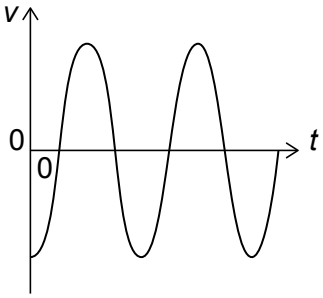

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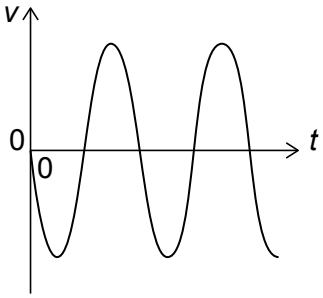
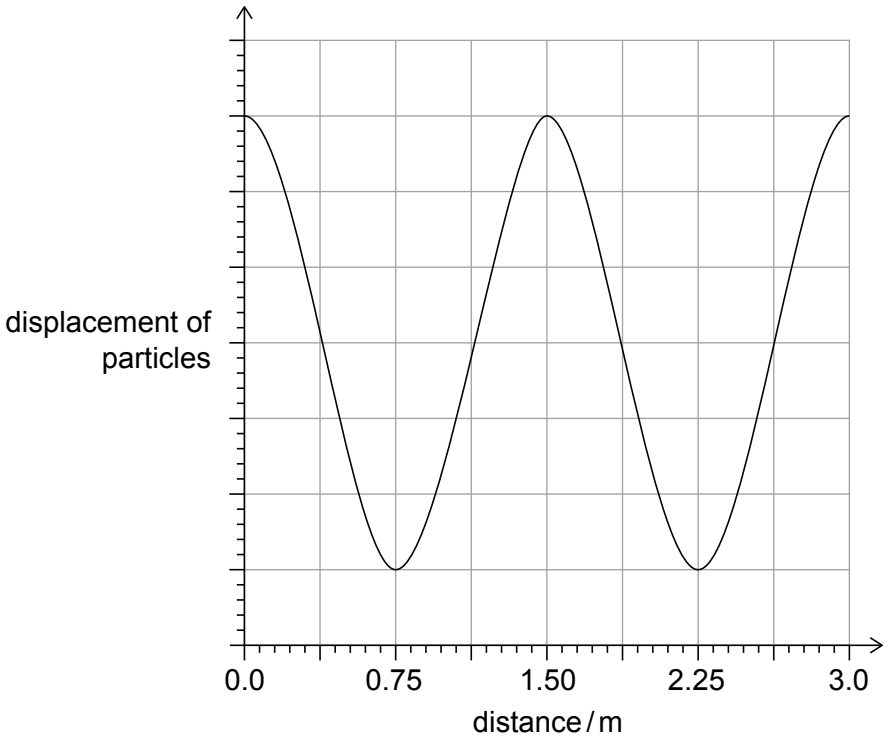


14. A travelling wave of time period 2.0 s is moving through a medium. The graph shows, for one instant, the variation with distance of the displacement of particles in the medium.



What is the speed of the wave?

A. $0.75\,m\,s^{-1}$

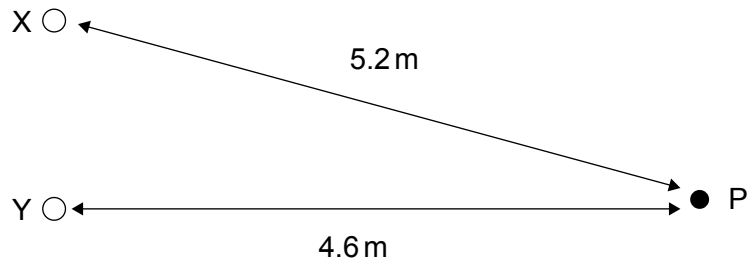
B. $1.5\,m\,s^{-1}$

C. $3.0\,m\,s^{-1}$

D. $6.0\,m\,s^{-1}$

15. Source X and source Y both emit waves of wavelength 0.40 m. There is a constant phase difference of π rad between the sources. Point P is 5.2 m from X and 4.6 m from Y. The amplitude of each wave at P is *A*.

diagram not to scale



What is the amplitude of the resultant wave at P?

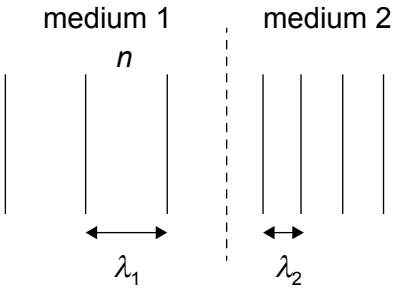
A. 0

B. *A*

C. $\frac{3}{2}A$

D. 2*A*

16. An electromagnetic wave travels from medium 1 to medium 2. The wavelength of the wave in medium 1 is λ_1. The wavelength of the wave in medium 2 is λ_2. The refractive index of medium 1 is n.



What is the refractive index of medium 2?

A. $\frac{\lambda_1 n}{\lambda_2}$

B. $\frac{\lambda_2 n}{\lambda_1}$

C. $\frac{\lambda_2}{\lambda_1}$

D. $\frac{\lambda_1}{\lambda_2}$

17. A standing wave is set up in a pipe with one closed end. One harmonic of the standing wave has a frequency 180 Hz. The next harmonic has a frequency of 300 Hz. What is the frequency of the first harmonic of the standing wave?

A. 30 Hz

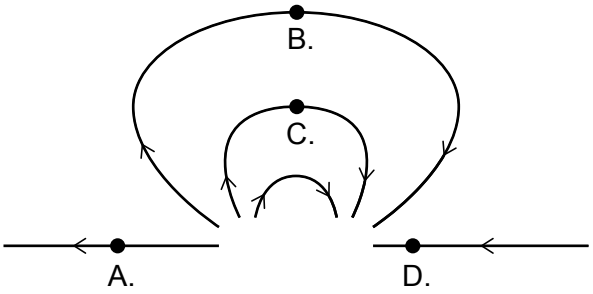
B. 60 Hz

C. 90 Hz

D. 120 Hz

18. The diagram shows electrostatic field lines. The source of the field is not shown.

At which position in the field would a negative point charge experience the greatest force to the right?



19. A conductor has a resistance of 1.0 kΩ. The length of the conductor is 20 km and the cross-sectional area is 1.0 mm^2.

What is the resistivity of this conductor?

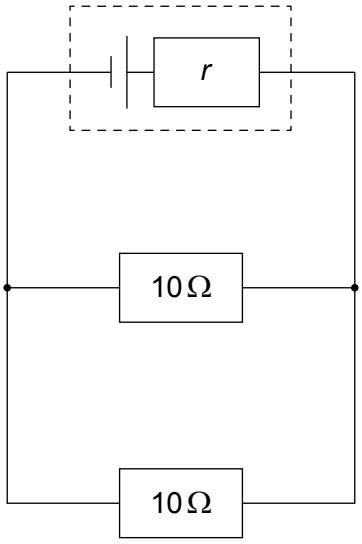
A. $2.0 \times 10^{-5}\,\Omega m$

B. $5.0 \times 10^{-5}\,\Omega m$

C. $2.0 \times 10^{-8}\,\Omega m$

D. $5.0 \times 10^{-8}\,\Omega m$

20. A cell has an emf of 17.0 V and internal resistance *r*. It is connected to two 10 Ω external resistors.



There is a current of 1.5 A in one of the external resistors.

What is the value of *r*?

A. 0.34 Ω

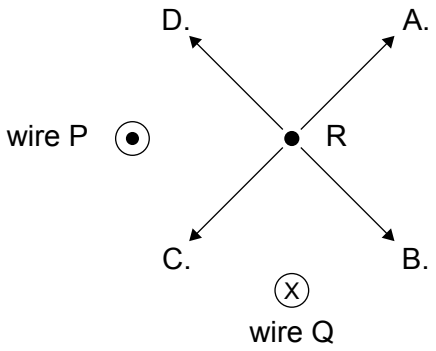
B. 0.50 Ω

C. 0.67 Ω

D. 1.3 Ω

21. P and Q are two parallel wires perpendicular to the page that carry currents of equal magnitude in opposite directions. The current in P is out of the page. R is a fixed point equidistant from P and Q.

What is the direction of the magnetic field produced at R?



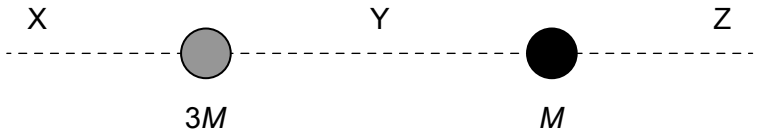
22. X and Y are two points on a disk of radius Z rotating at a constant angular speed.

X is at a distance $\frac{Z}{2}$ from the centre and Y is at a distance Z from the centre.

What is $\frac{\text{linear velocity of X}}{\text{linear velocity of Y}}$ and what is $\frac{\text{acceleration of X}}{\text{acceleration of Y}}$?

	$\frac{\text{linear velocity of X}}{\text{linear velocity of Y}}$	$\frac{\text{acceleration of X}}{\text{acceleration of Y}}$
A.	$\frac{1}{2}$	2
B.	$\frac{1}{2}$	$\frac{1}{2}$
C.	1	2
D.	1	$\frac{1}{2}$

23. The diagram shows two masses that are fixed in position. One has a mass of M and the other has a mass of $3M$. The line through the masses is divided into three segments X, Y and Z.



The net gravitational field can be directed to the left in

A. only segment Z.

B. only segment X.

C. segments Z and Y.

D. segments X and Y.

24. An unstable nuclide has too many protons.

What is the most likely decay of the nuclide?

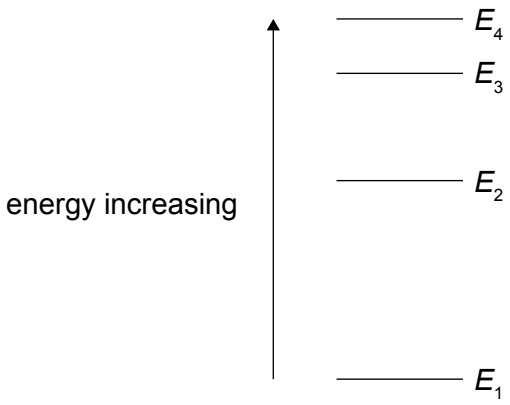
A. Alpha

B. Beta minus

C. Beta plus

D. Gamma

25. The four energy states for an atom are shown.



What is the lowest frequency of radiation that can be absorbed by the atom?

A. $\frac{E_1 - E_4}{h}$

B. $\frac{E_4 - E_1}{h}$

C. $\frac{E_3 - E_4}{h}$

D. $\frac{E_4 - E_3}{h}$

26. Which list correctly shows three fundamental forces in increasing order of range?

A. Weak nuclear, strong nuclear, electromagnetic

B. Strong nuclear, electromagnetic, weak nuclear

C. Strong nuclear, weak nuclear, electromagnetic

D. Electromagnetic, weak nuclear, strong nuclear

27. The reaction $\pi^0 + p \rightarrow p + e^- + \nu_e$ is proposed.

Three conservation laws in particle reactions are:

I. conservation of charge.

II. conservation of baryon number.

III. conservation of lepton number.

Which conservation laws are violated in the proposed reaction?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

28. Once research is completed, scientists gather support for the validity of their work by

A. using common terminology.

B. collaborating with others.

C. improving their instrumentation.

D. obtaining a review by independent scientists.

29. Three energy sources for power stations are:

I. nuclear fuel.

II. sunlight.

III. fossil fuel.

Which energy sources are primary sources?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

30. The surface of a planet absorbs an intensity of $400\,W\,m^{-2}$ and reflects $100\,W\,m^{-2}$. The surface of the planet is at equilibrium at a constant temperature.

What is the albedo of the planet surface and the radiated intensity?

	Albedo of the planet surface	**Radiated intensity / W m^{-2}**
A.	0.20	300
B.	0.20	400
C.	0.25	300
D.	0.25	400