Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Standard level
Paper 1

25 October 2023

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]**.

8823 – 6510

14 pages

1. The resistive force F that acts on an object moving through a fluid at speed v is given by $F = kv$ where k is a constant. What is the unit of k?

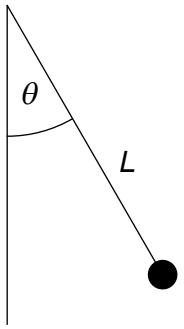
A. $\mathrm{N\,s^{-1}}$

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

C. $\mathrm{kg\,m^{2}\,s^{-3}}$

D. $\mathrm{kg\,s^{-1}}$

2. A pendulum is displaced by angle θ and released from rest.



What is the initial acceleration of the pendulum?

A. zero

B. $g \sin \theta$

C. $g \cos \theta$

D. g

3. Particle X moves in a circle with a constant speed v. The net force on X is F_X. Particle Y moves with a constant **velocity**, the magnitude of the **velocity** is v. The net force on Y is F_Y. Which of the following is correct?

A. $F_X > F_Y$

B. $F_X = F_Y \neq 0$

C. $F_X < F_Y$

D. $F_X = F_Y = 0$

4. A projectile is launched with an initial kinetic energy E. The initial horizontal and vertical components of velocity are equal. Air resistance is negligible. What is the kinetic energy of the projectile at the highest point of the motion?

A. zero

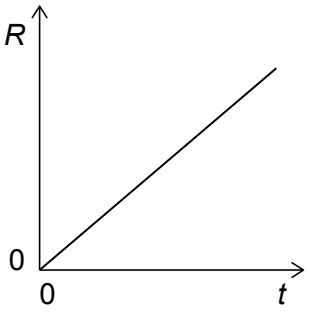
B. $\frac{E}{4}$

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

D. E

5. An object falls from rest in vacuum. R is the **rate of the change** of kinetic energy with time t. How does R vary with t?

A.



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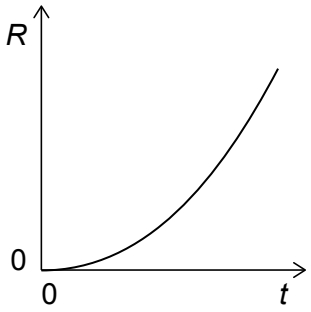

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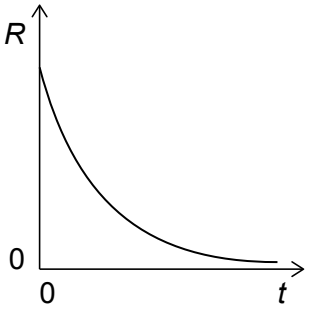
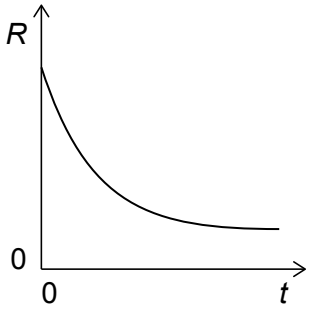


D.



6. The velocity of an object changes from $+2\,\text{m s}^{-1}$ to v. What is the value of v for which the magnitude of the impulse acting on the object is greatest?

A. $-4\,\text{m s}^{-1}$

B. $-2\,\text{m s}^{-1}$

C. $+2\,\text{m s}^{-1}$

D. $+4\,\text{m s}^{-1}$

7. X has a mass that is twice the mass of Y. The kinetic energy of X is four times that of Y.

What is the value of $\dfrac{\text{momentum of X}}{\text{momentum of Y}}$?

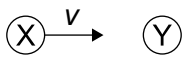
A. $\sqrt{2}$

B. 2

C. $2\sqrt{2}$

D. 4

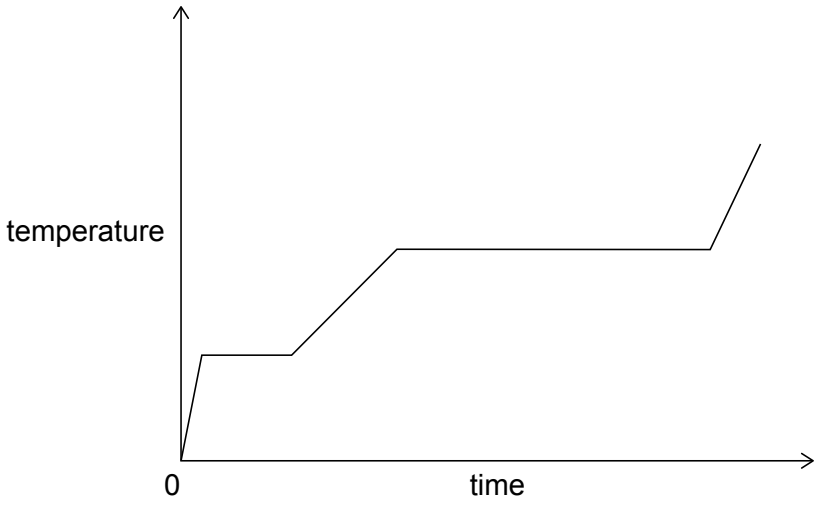
8. A ball X moving with speed v collides with an identical ball Y that is initially at rest. The collision is perfectly elastic.



Which of the following are correct for the speed of X and the speed of Y after the collision?

	Speed of X	Speed of Y
A.	X $v = 0$	Y → v
B.	X → $\frac{v}{2}$	Y → $\frac{v}{2}$
C.	X $v = 0$	Y → $\frac{v}{2}$
D.	v ← X	Y → v

9. Energy is supplied at a constant rate to a fixed mass of a substance. The graph shows the variation of the temperature of the substance with time.



Which statement about the substance is correct?

A. Specific latent heat of vaporization > specific latent heat of fusion

B. Specific latent heat of fusion > specific latent heat of vaporization

C. Specific heat capacity of solid > specific heat capacity of liquid

D. Specific heat capacity of vapour > specific heat capacity of liquid

10. Scientists observe that materials that are good conductors of electricity are also good conductors of thermal energy. What is the most reasonable conclusion that scientists can reach about the nature of the conduction mechanism in both cases and the nature of electricity and thermal energy?

	Nature of conduction mechanism	**Nature of electricity and thermal energy**
A.	same	same
B.	same	different
C.	different	same
D.	different	different

11. For a fixed mass of an ideal gas the pressure is proportional to…

A. density and volume.

B. density and absolute temperature.

C. absolute temperature and volume.

D. absolute temperature only.

12. What is the $\frac{\text{number of atoms in 20 g of Neon-20}}{\text{number of atoms in 40 g of Krypton-80}}$?

A. $\frac{1}{4}$

B. $\frac{1}{2}$

C. 2

D. 4

13. A particle executes simple harmonic oscillations. What is the phase difference between the displacement and the acceleration?

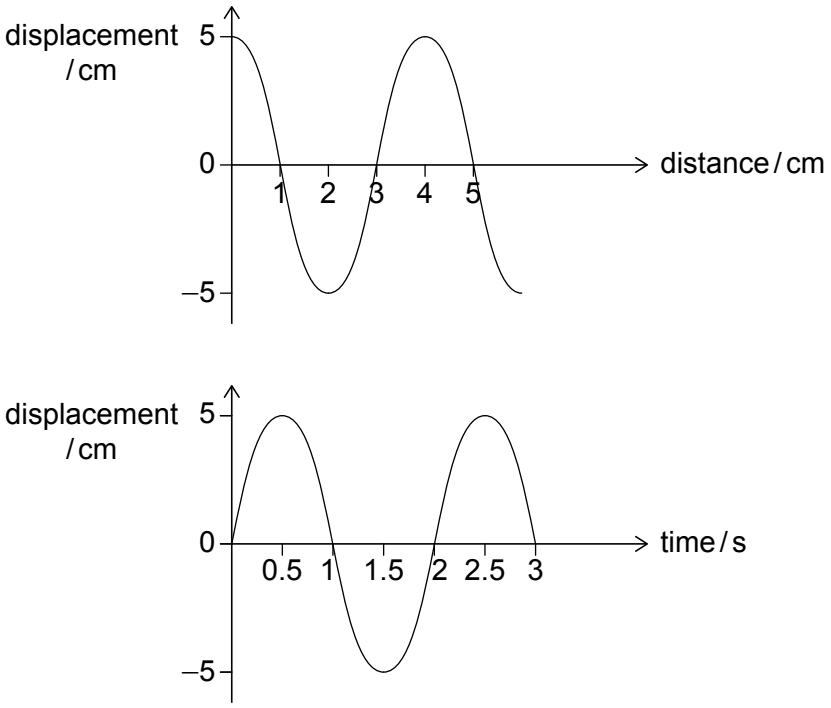
A. zero

B. $\frac{\pi}{4}$

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

D. π

14. A wave is travelling on a string. The graphs show the variation of the displacement of the string with distance and the variation of the displacement of a particle on the string with time.



What is the speed of the wave?

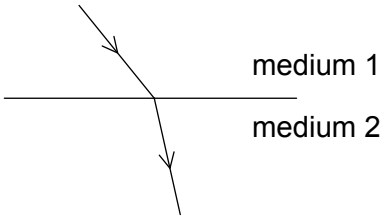
A. $2.0\,cm\,s^{-1}$

B. $2.5\,cm\,s^{-1}$

C. $8.0\,cm\,s^{-1}$

D. $10\,cm\,s^{-1}$

15. A wave is travelling from medium 1 to medium 2.



Medium 1 has a refractive index n_1 and medium 2 has a refractive index n_2. The wavelength of the wave in medium 1 is λ_1 and in medium 2 is λ_2. What is correct for the comparison of the refractive indices and wavelengths?

	Refractive indices	Wavelengths
A.	$n_1 > n_2$	$\lambda_1 > \lambda_2$
B.	$n_1 > n_2$	$\lambda_1 < \lambda_2$
C.	$n_1 < n_2$	$\lambda_1 > \lambda_2$
D.	$n_1 < n_2$	$\lambda_1 < \lambda_2$

16. A double-slit interference pattern is produced using monochromatic light. What colour of light produces an interference pattern with the largest fringe separation?

A. Blue

B. Green

C. Yellow

D. Red

17. The first harmonic of a standing sound wave is established in a tube with one end open and one end closed. When the length of the tube is increased by 0.10 m the next harmonic is formed. What is the wavelength of the sound?

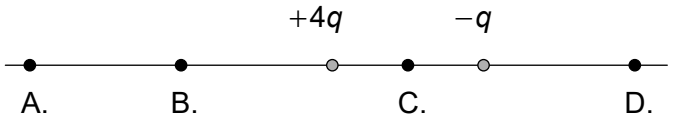
A. 0.10 m

B. 0.13 m

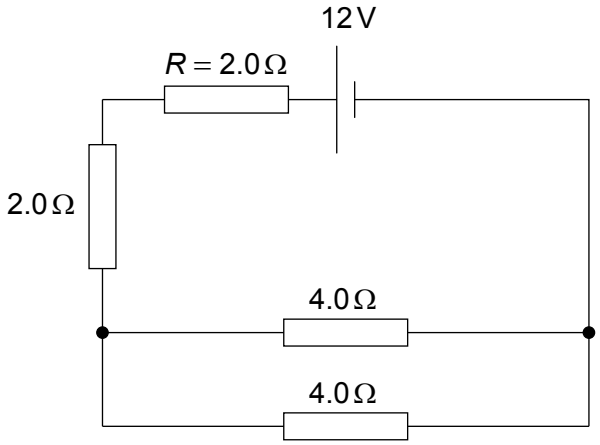
C. 0.20 m

D. 0.40 m

18. Two point charges of $+4q$ and $-q$ are placed a fixed distance apart. Where is the electric field strength equal to zero?



19. A network of three resistors is connected to a cell of emf 12 V and internal resistance R of $2.0\,\Omega$ as shown.



What is the current in one of the $4.0\,\Omega$ resistors?

A. 0.5 A

B. 1.0 A

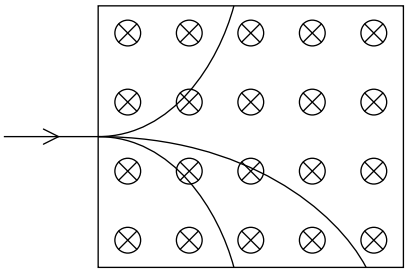
C. 1.2 A

D. 2.0 A

20. What is the resistance of an ideal voltmeter and the resistance of an ideal ammeter?

	Resistance of an ideal voltmeter	**Resistance of an ideal ammeter**
A.	zero	infinite
B.	zero	zero
C.	infinite	infinite
D.	infinite	zero

21. The path of three particles with identical magnitude of charge but different mass is shown as they enter a region of uniform magnetic field. The particles have the same initial velocity. The magnetic field is directed into the plane of the paper.

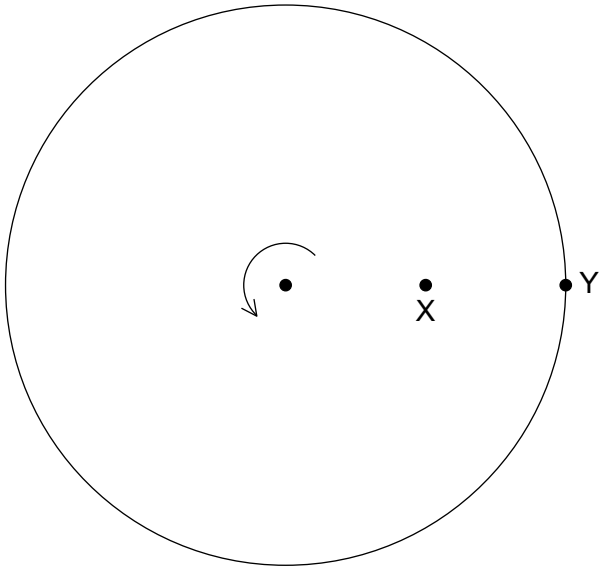


particle X

What is the mass of particle X compared to the other particles and what is the sign of the charge on particle X?

	Mass in comparison	Sign of charge
A.	larger	positive
B.	larger	negative
C.	smaller	positive
D.	smaller	negative

22. A disk of radius R rotates about its axis with angular speed ω. Point X is at a distance of $\frac{R}{2}$ from the centre and point Y is on the circumference.



What are the ratios of the linear speeds and the centripetal acceleration of X to Y.

The linear speed of X is v_X and its acceleration is a_X; the linear speed of Y is v_Y and its acceleration is a_Y.

	Linear speeds $\frac{v_X}{v_Y}$	**Acceleration** $\frac{a_X}{a_Y}$
A.	$\frac{1}{2}$	$\frac{1}{4}$
B.	$\frac{1}{2}$	$\frac{1}{2}$
C.	1	$\frac{1}{4}$
D.	1	$\frac{1}{2}$

23. The mass of a planet X is 300 times larger than the mass of the Earth and its radius is 10 times larger than the radius of the Earth. What is the gravitational field strength on the surface of planet X in terms of the gravitational field strength g on the surface of Earth?

A. $\frac{g}{30}$

B. $\frac{g}{3}$

C. $3g$

D. $30g$

24. A sample of the artificial element Seaborgium-265 (Sg-265) is created with 4.0×10^{22} atoms. Sg-265 has a half-life of 15 s. How many atoms of Sg-265 remain after one minute?

A. 2.5×10^{21}

B. 5.0×10^{21}

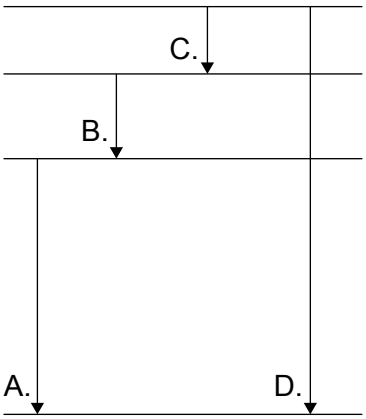
C. 1.0×10^{22}

D. 2.0×10^{22}

25. What is the number of protons and what is the number of neutrons in a nucleus of $^{214}_{82}Pb$?

	Number of protons	Number of neutrons
A.	214	82
B.	82	214
C.	82	132
D.	132	214

26. The diagram shows some of the energy levels of an atom. Which transition results in the emission of a photon with the shortest wavelength?



27. A π^+ meson can decay as shown in the equation.

$$\pi^+ \rightarrow X + \mu^+$$

Which of the following is correct for particle X and the exchange particle for this interaction?

	Particle X	Exchange particle
A.	ν_μ	W^+
B.	ν_μ	W^-
C.	$\overline{\nu}_\mu$	W^+
D.	$\overline{\nu}_\mu$	W^-

28. A wind turbine produces an output power P when the wind speed is v. At this speed the efficiency of the turbine is e. At a wind speed of $2v$ the efficiency is $\frac{3}{4}e$. What is the output power at wind speed $2v$?

A. $\frac{3}{4}P$

B. $\frac{3}{2}P$

C. $3P$

D. $6P$

29. Which of the following is **not** considered to be a greenhouse gas?

A. N_2O

B. H_2O

C. O_2

D. CH_4

30. A black body at temperature T (kelvin) has a peak wavelength λ. What is the peak wavelength when the temperature increases by 33 %?

A. $\frac{\lambda}{3}$

B. $\frac{3}{4}\lambda$

C. $\frac{4}{3}\lambda$

D. 3λ