Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Higher level
Paper 1A

5 November 2025

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

2 hours [Paper 1A and Paper 1B]

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A calculator is required for this paper.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for paper 1A is **[40 marks]**.
- The maximum mark for paper 1A and paper 1B is **[60 marks]**.

23 pages

8825–6707
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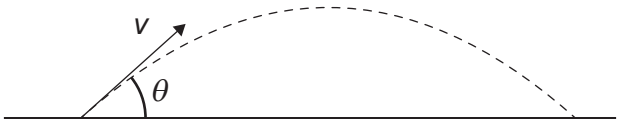
1. A projectile is launched with an initial velocity v at an angle θ above the horizontal. The projectile lands at the same height from which it was released. Air resistance is negligible.



What is the time of flight of the projectile?

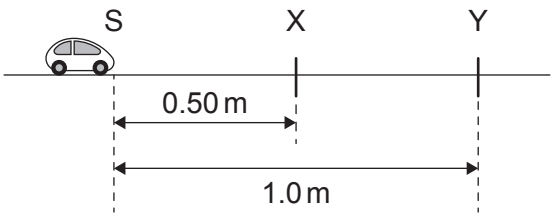
A. $\dfrac{v\sin\theta}{g}$

B. $\dfrac{2v\sin\theta}{g}$

C. $\dfrac{2v\cos\theta}{g}$

D. $\dfrac{2v\sin\theta\cos\theta}{g}$

2. A cart starts from rest at point S and moves in a straight line with a constant acceleration. Two points X and Y are 0.50 m and 1.0 m from S.



The cart passes X with speed v_X and passes Y with speed v_Y. What is $\dfrac{v_Y}{v_X}$?

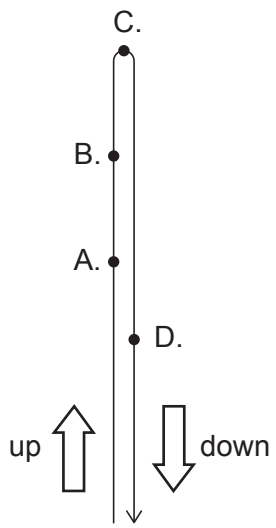
A. $\sqrt{2}$

B. 2

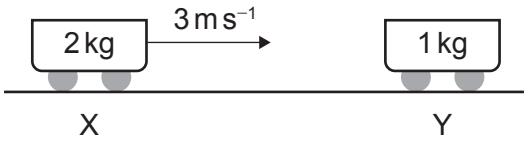
C. $2\sqrt{2}$

D. 4

3. A ball is thrown vertically upwards. Air resistance is **not** negligible. Four positions of the ball are shown: A and B on the way up, C at the maximum height, and D on the way down. At which position does the acceleration of the ball have its greatest magnitude?



4. Cart X, of mass 2 kg, is moving at a speed of $3\,m\,s^{-1}$ to the right and collides on a horizontal track with cart Y of mass 1 kg. Y is initially stationary.



The velocity of Y immediately after the collision is $4\,m\,s^{-1}$ to the right. What is the velocity of X immediately after the collision?

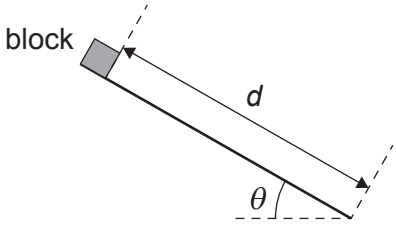
A. $1\,m\,s^{-1}$ to the right

B. $1\,m\,s^{-1}$ to the left

C. $2\,m\,s^{-1}$ to the right

D. $2\,m\,s^{-1}$ to the left

5. A block of mass m is released from rest and slides down a ramp of length d that makes an angle θ with the horizontal. A constant frictional force F acts on the block.



What is the kinetic energy of the block at the bottom of the ramp?

A. $mgd - Fd\cos\theta$

B. $mgd - Fd$

C. $mgd\sin\theta - Fd\cos\theta$

D. $mgd\sin\theta - Fd$

6. An electric motor of efficiency 75 % raises a mass of 120 kg at a constant speed of $0.50\,\mathrm{m\,s^{-1}}$. What is the power input to the motor?

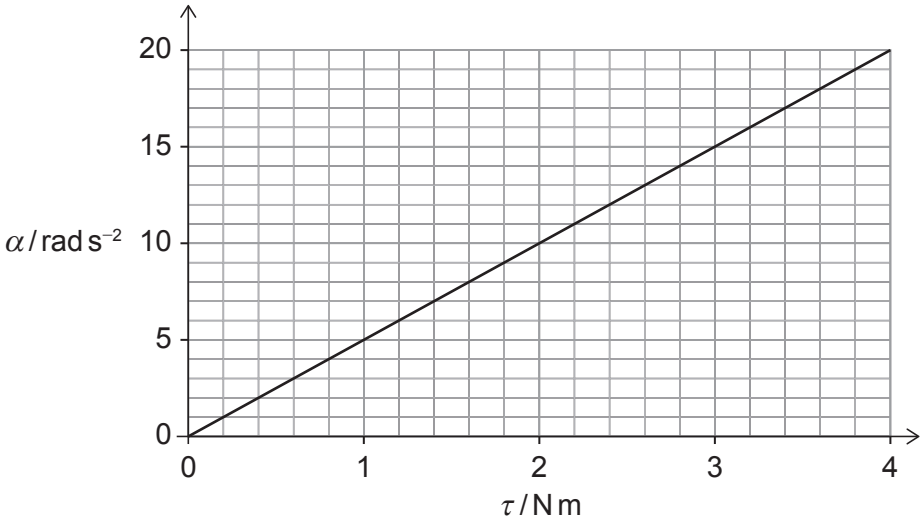
A. 20 W

B. 450 W

C. 600 W

D. 800 W

7. The graph shows how the angular acceleration α of a flywheel varies with torque τ applied to the flywheel.



What is the moment of inertia of the flywheel?

A. $0.20\,\text{kg}\,\text{m}^2$

B. $5.0\,\text{kg}\,\text{m}^2$

C. $40\,\text{kg}\,\text{m}^2$

D. $80\,\text{kg}\,\text{m}^2$

8. A muon of proper lifetime t is produced in the high atmosphere and travels towards Earth at a relativistic speed v. What is the distance travelled by the muon in the reference frame of Earth?

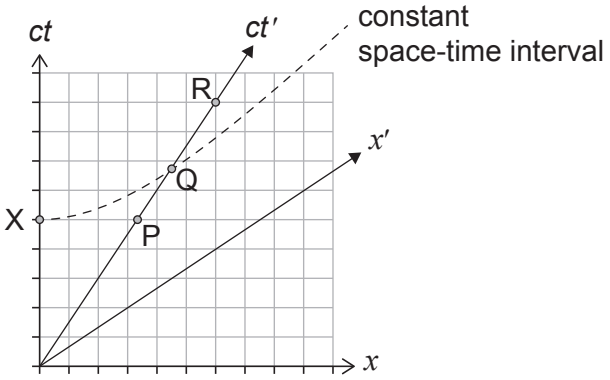
A. vt

B. $vt\left(1-\frac{v^2}{c^2}\right)$

C. $vt\sqrt{1-\frac{v^2}{c^2}}$

D. $\frac{vt}{\sqrt{1-\frac{v^2}{c^2}}}$

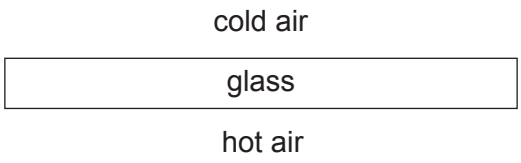
9. The space–time diagram shows coordinate axes of inertial reference frames S(x, ct) and S′(x', ct'). Event X occurs at $t = 1$ s according to the S reference frame. A line of constant space–time interval is drawn through X.



In the S′ reference frame, which event is simultaneous with X and which event has the time coordinate $t' = 1$ s?

	Simultaneous with X in the S′frame	**$t' = 1$ s in the S′frame**
A.	P	R
B.	Q	R
C.	R	P
D.	R	Q

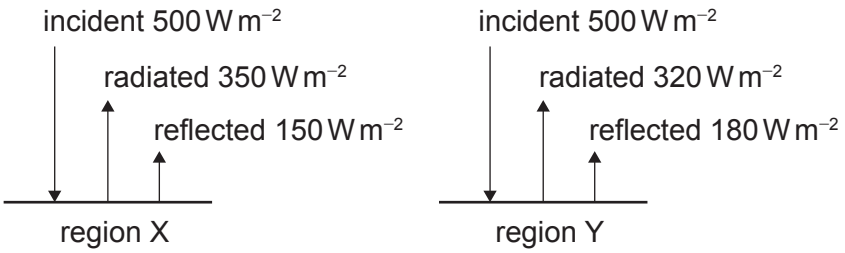
10. A layer of glass separates cold air from hot air. The temperature gradient across the glass is H, and the rate of thermal energy transfer through a unit surface area of the glass is P.



The thickness of the glass layer is doubled. What are the temperature gradient and the rate of thermal energy transfer through the glass after this change?

	Temperature gradient	**Rate of thermal energy transfer**
A.	$2H$	$2P$
B.	$2H$	$\frac{P}{2}$
C.	$\frac{H}{2}$	$2P$
D.	$\frac{H}{2}$	$\frac{P}{2}$

11. The diagram shows the incident, radiated and reflected intensities of the solar radiation for two regions X and Y on the surface of Earth. X and Y have the same surface temperature.



Which region has a greater albedo, and which region has a greater emissivity?

	Greater albedo	**Greater emissivity**
A.	X	X
B.	Y	X
C.	X	Y
D.	Y	Y

12. Which process involving gas molecules in the Earth's atmosphere is the main cause of the greenhouse effect?

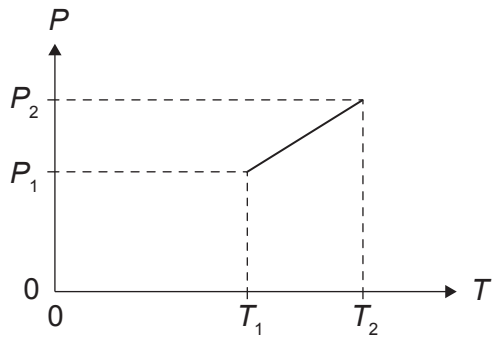
A. Reflection of incoming solar radiation

B. Absorption and re-radiation of incoming solar radiation

C. Reflection of outgoing infrared radiation

D. Absorption and re-radiation of outgoing infrared radiation

13. A sample of *n* moles of an ideal gas is kept at a constant volume. The graph shows how the pressure *P* of the gas varies with absolute temperature *T*.



What is the volume of the gas?

A. $nR\dfrac{T_2 - T_1}{P_2 - P_1}$

B. $nR\dfrac{P_2 - P_1}{T_2 - T_1}$

C. $nR\left(\dfrac{T_2}{P_2} - \dfrac{T_1}{P_1}\right)$

D. $nR\left(\dfrac{P_2}{T_2} - \dfrac{P_1}{T_1}\right)$

14. Two containers are filled with monatomic gas of equal mass at the same temperature. One container holds helium and the other neon.

The mass of a neon atom is five times the mass of a helium atom.

What is $\frac{\text{internal energy of the helium gas}}{\text{internal energy of the neon gas}}$?

A. $\frac{1}{5}$

B. 1

C. $\sqrt{5}$

D. 5

15. A thermal energy of 7.0 J is removed from an ideal gas, and a work of 2.0 J is done by the gas. What is the change in the internal energy of the gas?

A. –9.0 J

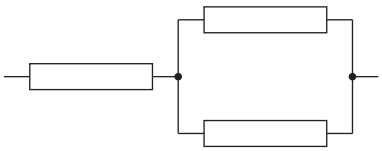
B. –5.0 J

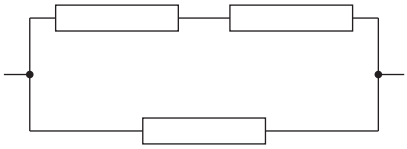
C. +5.0 J

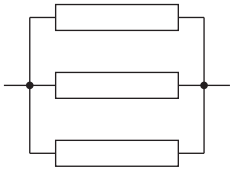
D. +9.0 J

16. Three identical resistors are arranged in four different networks. The same potential difference is applied across each network. Which network dissipates the greatest electrical power?

A.

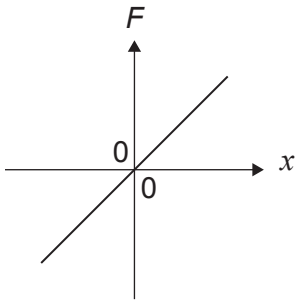
B. 

C. 

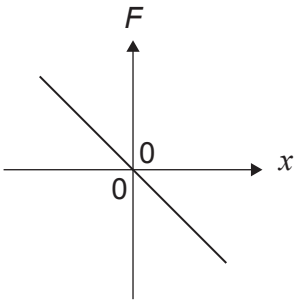
D. 

17. A force *F* acts on a particle. The displacement of the particle is x. Which variation of *F* with x results in simple harmonic motion?

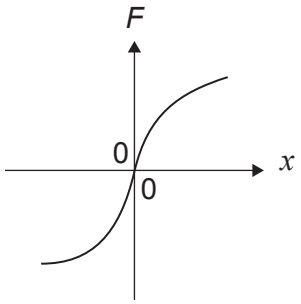
A.



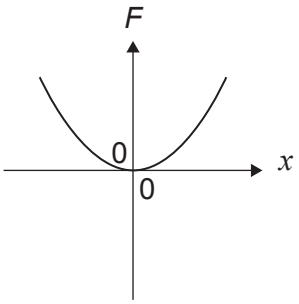
B.



C.

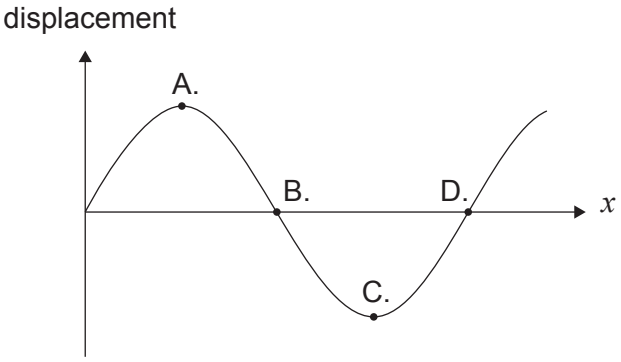


D.



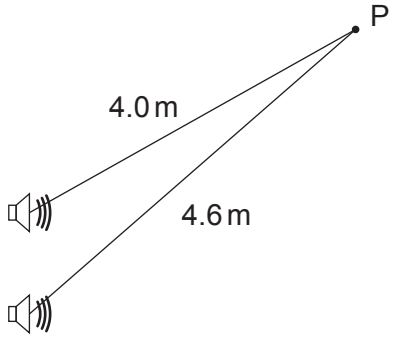
18. The graph shows how the displacement of a wave varies with the position x along the wave. The wave travels towards positive x.

At the instant shown, which point along the wave has the maximum positive velocity?



19. Two loudspeakers are driven in phase and emit sound of the same frequency. A minimum intensity of sound is detected at point P.

P is 4.0 m from one loudspeaker and 4.6 m from the other.



What is a possible wavelength of the sound?

A. 20 cm

B. 30 cm

C. 40 cm

D. 60 cm

20. Monochromatic light of wavelength λ is incident normally on a diffraction grating. The adjacent lines of the diffraction grating are separated by a distance of 2.8λ. How many diffraction maxima are present in the transmitted light?

A. 2

B. 3

C. 5

D. 7

21. A standing sound wave is formed in a pipe of length L that is open at both ends. The standing wave has two nodes. What is the wavelength of the standing wave?

A. $\frac{L}{2}$

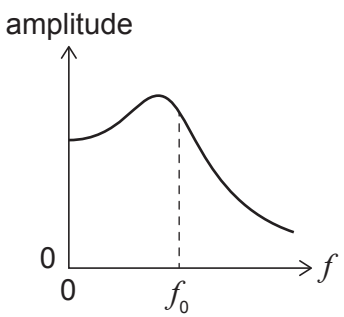
B. $\frac{2L}{3}$

C. L

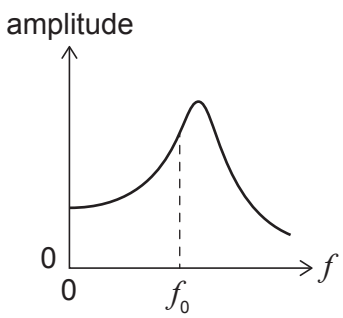
D. $2L$

22. A heavily damped oscillator of natural frequency f_0 is driven by a periodic force of frequency f. Which graph shows how the amplitude of the oscillations varies with f?

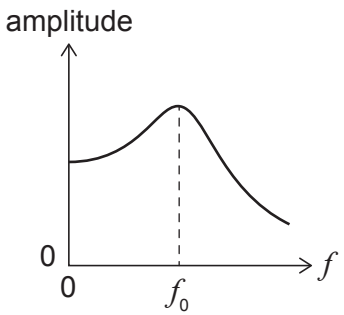
A.



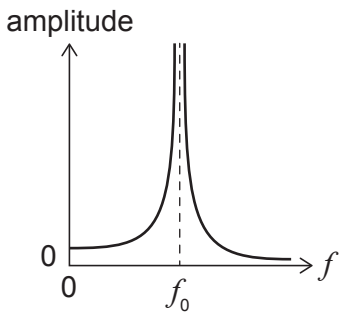
B.



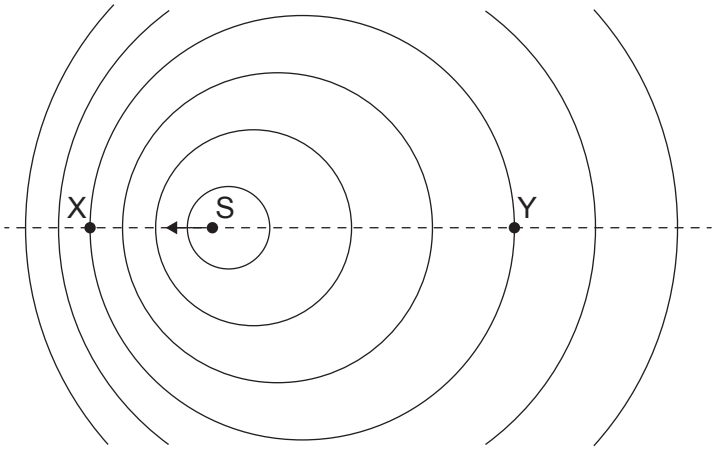
C.



D.



23. A source S of a sound wave is moving at a constant velocity along a line joining stationary observers X and Y. The diagram shows consecutive wavefronts of the sound.



Consider the following statements:

I. More wavefronts pass X in a unit time than Y.

II. The speed of the wavefronts is greater at X than at Y.

III. The wavelength of the sound at X is less than the wavelength at Y.

Which statements are correct?

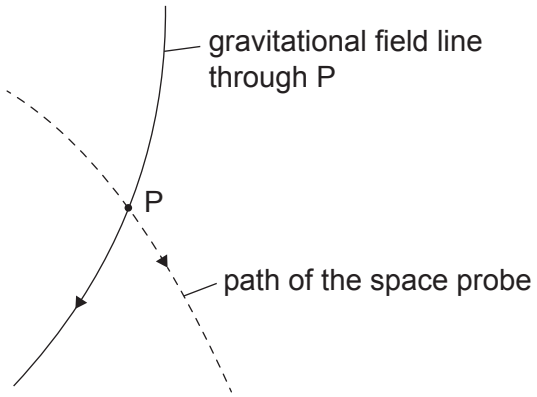
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

24. A space probe moves in a gravitational field. No other forces than the gravitational force act on the probe. At one instant, the probe is at point P. The diagram shows the path of the probe and the gravitational field line through P.



What is the direction of the acceleration of the probe at P?

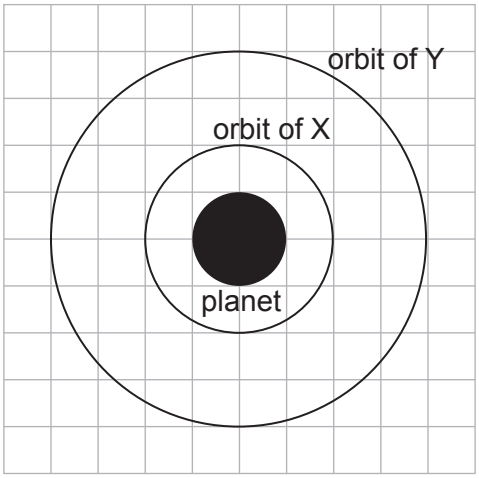
A. Tangent to the path of the probe

B. Perpendicular to the path of the probe

C. Tangent to the gravitational field line through P

D. Perpendicular to the gravitational field line through P

25. Two satellites X and Y with the same mass orbit a planet. The scaled diagram shows the orbits of the satellites.



What is $\frac{\text{kinetic energy of X}}{\text{kinetic energy of Y}}$?

A. 2

B. 3

C. 4

D. 9

26. Two point charges, $+Q$ and $-Q$, are at a distance d from each other.

What is the magnitude of the electric field strength midway between the charges?

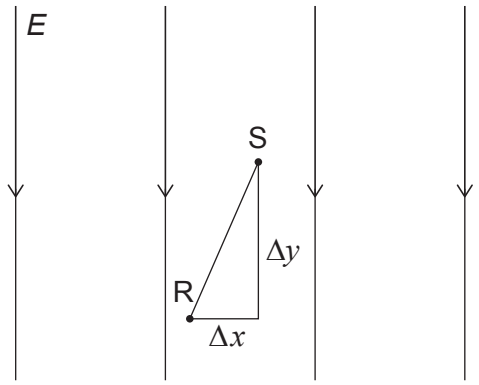
A. Zero

B. $\frac{2kQ}{d^2}$

C. $\frac{4kQ}{d^2}$

D. $\frac{8kQ}{d^2}$

27. Two points R and S are in a uniform electric field of strength E, directed vertically downwards. The horizontal distance from R to S is Δx, and the vertical distance from R to S is Δy.



The electric potential at R is zero. What is the electric potential at S?

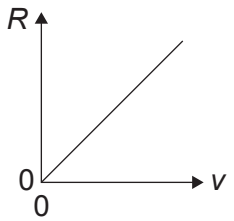
A. $E\sqrt{\Delta x^2 + \Delta y^2}$

B. $E\Delta y$

C. $-E\sqrt{\Delta x^2 + \Delta y^2}$

D. $-E\Delta y$

28. An electron moves with speed v in a region of a uniform magnetic field of strength B. The path of the electron is a circle of radius R. The graph shows how R varies with v.



What is the gradient of the graph?

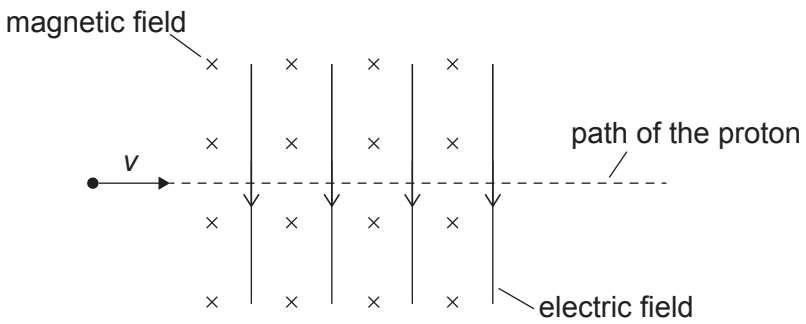
A. $\dfrac{m_e B}{e}$

B. $\dfrac{eB}{m_e}$

C. $\dfrac{m_e}{eB}$

D. $\dfrac{e}{m_e B}$

29. A proton enters a region where electric and magnetic fields are perpendicular to each other. The initial velocity v of the proton is perpendicular to both fields. The path of the proton is not deflected in the fields.



The proton is replaced by an alpha particle that is also not deflected by the fields. What is the velocity of the alpha particle?

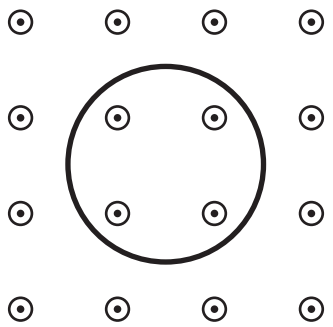
A. $\frac{v}{2}$

B. v

C. $2v$

D. $4v$

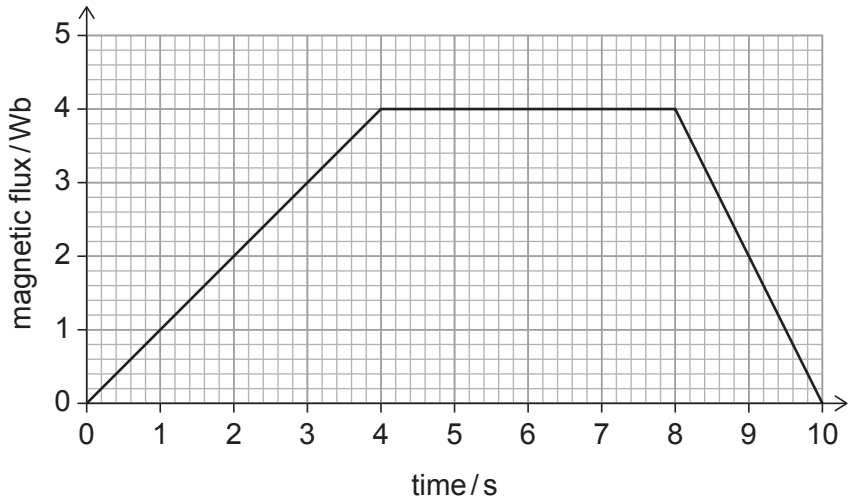
30. A conducting ring is perpendicular to a uniform magnetic field directed out of the page.



The magnitude of the magnetic field strength increases. What are the direction of the conventional current induced in the ring and the net magnetic force on the ring?

	Current induced in the ring	Magnetic force on the ring
A.	clockwise	zero
B.	counter-clockwise	zero
C.	clockwise	non-zero
D.	counter-clockwise	non-zero

31. The graph shows how the magnetic flux linked through a conducting coil varies with time. The coil has only one turn.



What is the maximum emf induced in the coil?

A. 0.40 V

B. 1.0 V

C. 2.0 V

D. 4.0 V

32. Which claim about the structure of the atom is falsified by the results of the Geiger–Marsden–Rutherford experiment?

A. The nucleus is only made up of positively charged particles.

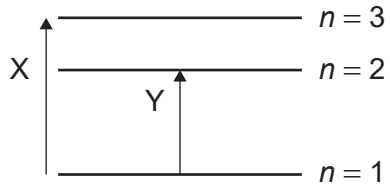
B. The electrons in the atom move in orbits of fixed radius.

C. The positive charge occupies all of the atom's volume.

D. The electrons in the atom have continuous energy.

33. Some energy levels for a hydrogen atom are shown.

diagram not to scale



What is $\frac{\text{energy absorbed in transition X}}{\text{energy absorbed in transition Y}}$?

A. $\frac{32}{27}$

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

C. 2

D. $\frac{9}{4}$

34. Monochromatic electromagnetic radiation is incident on a metal surface. Three observations about the electrons emitted from the surface are:

I. The maximum energy of the electrons does not depend on radiation intensity.

II. The number of electrons emitted in a unit time increases with radiation intensity.

III. No electrons are emitted when the frequency of radiation is less than a threshold value.

Which observations are inconsistent with the wave model of electromagnetic radiation?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

35. A photon of wavelength λ_0 scatters off an electron at rest. The shift in photon wavelength is $\Delta\lambda$. What is the kinetic energy of the scattered electron?

A. $\dfrac{hc}{\Delta\lambda}$

B. $\dfrac{hc}{\lambda_0 + \Delta\lambda}$

C. $\dfrac{hc}{\lambda_0} - \dfrac{hc}{\Delta\lambda}$

D. $\dfrac{hc}{\lambda_0} - \dfrac{hc}{\lambda_0 + \Delta\lambda}$

36. Two particles are accelerated from rest through the same electric potential difference. The particles have the same charge and different masses. Which row correctly compares the kinetic energy and the de Broglie wavelength of the particles after the acceleration?

	Kinetic energy	**De Broglie wavelength**
A.	same	same
B.	different	same
C.	same	different
D.	different	different

37. The table shows how the count rate from a sample of a radioactive nuclide varies with time *t*. The nuclide has a half-life of 50 s. The average background count rate is constant.

***t*/s**	**Count rate / s^{-1}**
0	72
50	40

What count rate will the detector measure when $t = 150$ s?

A. $8\,s^{-1}$

B. $16\,s^{-1}$

C. $24\,s^{-1}$

D. $32\,s^{-1}$

38. A nucleus of uranium-235 ($^{235}_{92}U$) absorbs a neutron and decays into two nuclides, xenon-140 ($^{140}_{54}Xe$) and strontium-94 ($^{94}_{38}Sr$).

How many neutrons are released in this reaction?

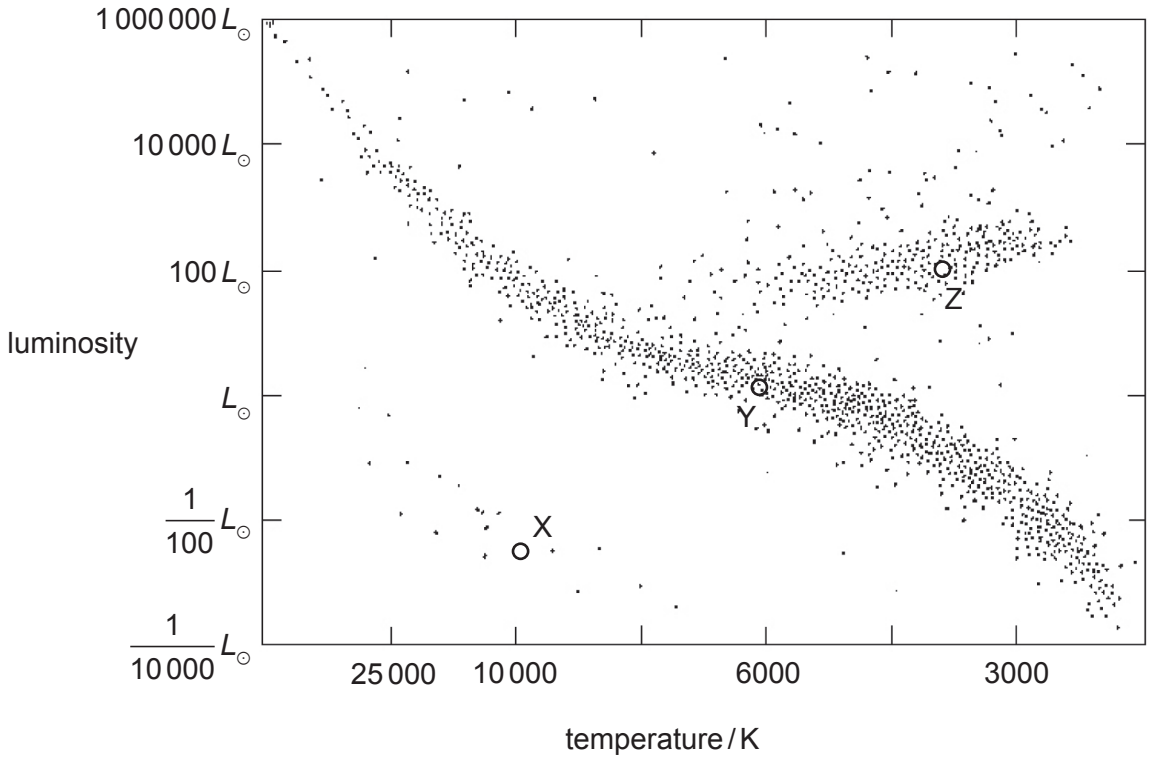
A. 1

B. 2

C. 3

D. 4

39. The Hertzsprung–Russell diagram shows three stars X, Y and Z.



Which of the following lists the stars in the order of their evolutionary stage?

A. X, Y, Z

B. Z, Y, X

C. Y, X, Z

D. Y, Z, X

40. The stellar parallax method involves a measurement of...

A. the peak wavelength of radiation from a star.

B. the frequency shift of the lines in a stellar spectrum.

C. the position of a star in the sky at different times of year.

D. the intensity of radiation from a star at different wavelengths.