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]**.

8825–6719
20 pages

1. A stone is released from rest and falls vertically. Air resistance is negligible. What is correct about the stone during each consecutive second of its motion?

A. The change in velocity is constant.

B. The change in displacement is constant.

C. The change in acceleration decreases.

D. The change in speed increases.

2. A projectile is launched horizontally from the top of a cliff with a speed of $10\,m\,s^{-1}$. The projectile hits the ground at a distance of 30 m from the base of the cliff. Air resistance is negligible.

What is the height of the cliff?

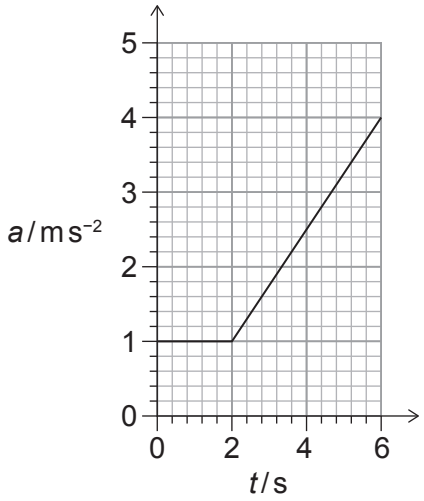
A. 15 m

B. 30 m

C. 45 m

D. 90 m

3. A force is applied to a mass of 3 kg. The graph shows the variation with time t of the acceleration a of the mass.



What is the average force acting on the mass?

A. 5 N

B. 6 N

C. 12 N

D. 24 N

4. An object of mass m, moving with a speed v, collides with a stationary object of mass m. The objects stick together.

What is the change in kinetic energy in the collision?

A. Zero

B. $\frac{mv^2}{8}$

C. $\frac{mv^2}{4}$

D. $\frac{3mv^2}{8}$

5. A mass m is attached to a string and moves in a vertical circle of constant radius R. At the top of the circle, the tension in the string is T. Air resistance is negligible.

What is the kinetic energy of m at the top of the circle?

A. $\frac{R(T-mg)}{2}$

B. $\frac{R(T+mg)}{2}$

C. $R(T-mg)$

D. $R(T+mg)$

6. A pump has efficiency η when raising water from a well of depth d. The mass of water raised per second is R. Changes in kinetic energy of the water are considered negligible.

What is the input power to the pump required to raise the water?

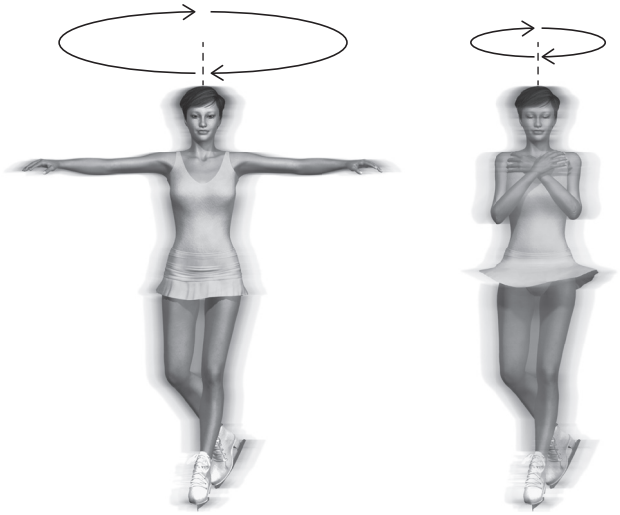
A. $\frac{Rd}{\eta g}$

B. $\frac{\eta R}{gd}$

C. ηRgd

D. $\frac{Rdg}{\eta}$

7. An ice skater is spinning with their arms extended in a fixed position at a constant angular velocity. The ice skater then quickly pulls their arms closer to their body. Frictional effects are negligible.



Three statements are made about the ice skater's motion.

I. The angular momentum of the ice skater remains constant.

II. The rotational kinetic energy of the ice skater remains constant.

III. The net torque acting on the ice skater is zero.

Which of the statements are correct?

A. I and II only

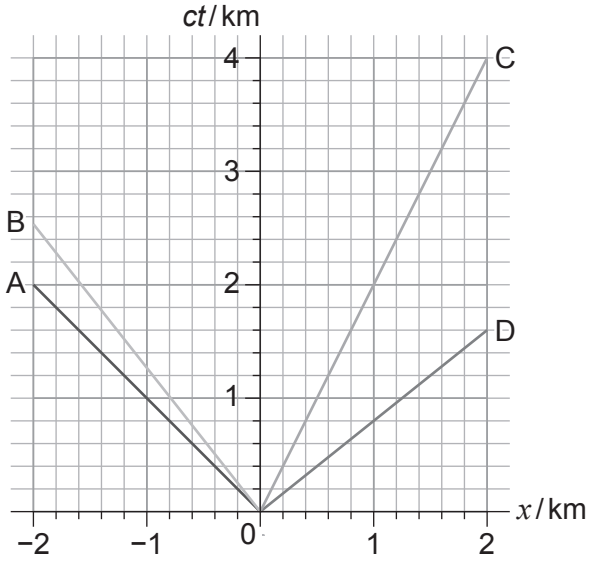
B. I and III only

C. II and III only

D. I, II and III

8. Rocket R travels away from an observer on Earth at a speed of 0.80*c*. A space–time diagram shows four world lines.

What is the correct world line of R in the reference frame of Earth?



9. The fixed distance between Earth and a star measured in Earth's reference frame is d_E. A spaceship travels from Earth to the star at a constant speed of 0.8*c* relative to Earth. The distance between Earth and the star as measured by the spaceship is d_s.

What is $\frac{d_s}{d_E}$?

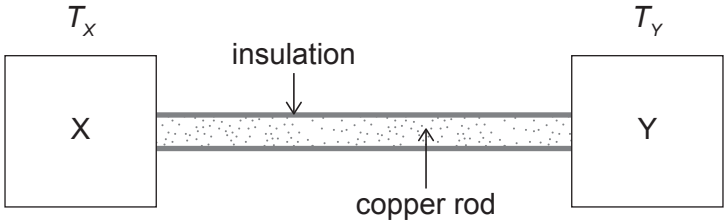
A. $\frac{3}{5}$

B. $\frac{4}{5}$

C. $\frac{5}{4}$

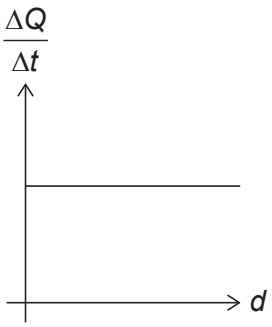
D. $\frac{5}{3}$

10. Insulated solid copper rods of different diameters and fixed length are placed in thermal contact with two objects X and Y, maintained at different temperatures T_X and T_Y respectively. The diagram shows the setup with one such rod.



Which graph shows the variation with rod diameter d of the rate of thermal energy transfer $\frac{\Delta Q}{\Delta t}$ along the rod?

A.



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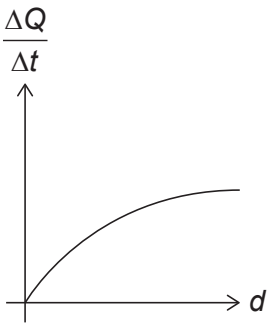

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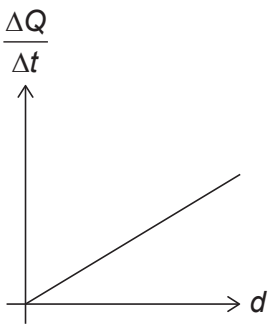

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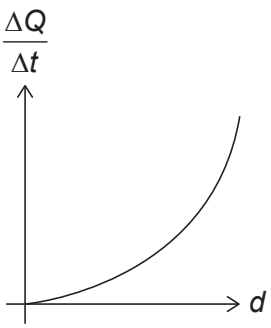


11. 80 g of a liquid are heated with a constant power output of 100 W. All the power goes into the liquid. After 60 s, the rise in temperature is 50 K.

What is the specific heat capacity of the liquid in $J\,kg^{-1}\,K^{-1}$?

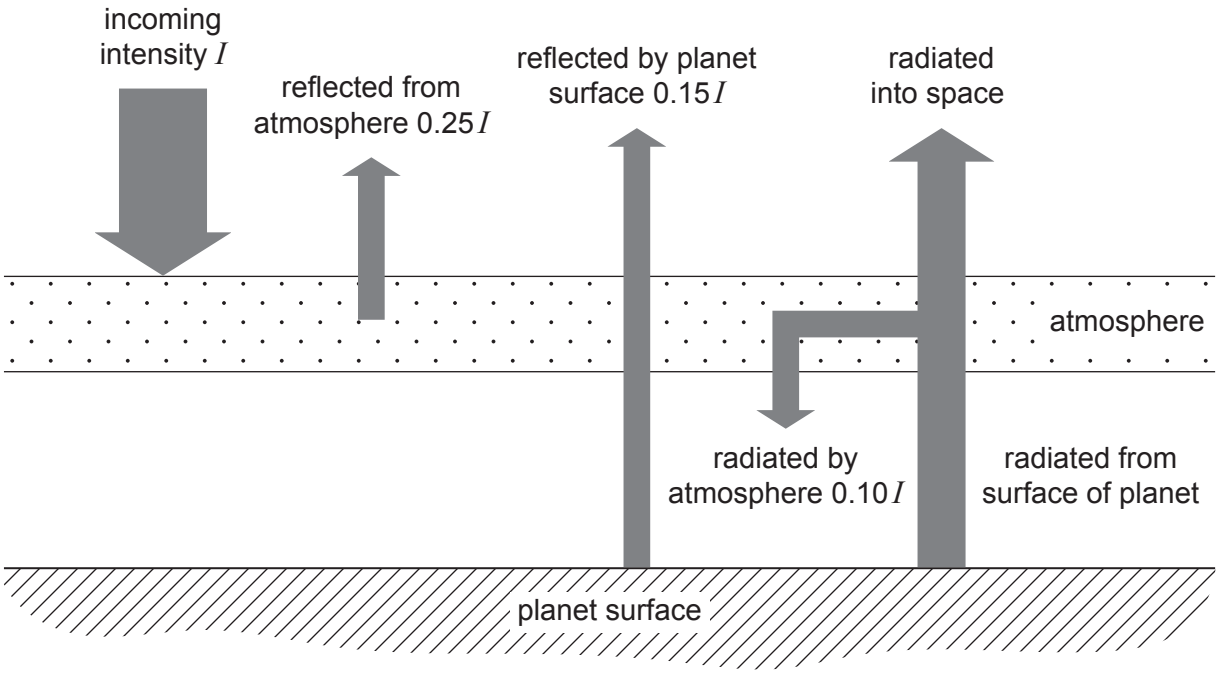
A. 120

B. 960

C. 1200

D. 1500

12. The energy balance model of a planet's climate is shown. The reflected and radiated intensities are given in terms of the incident incoming intensity I.



What is the radiated intensity from the surface of the planet?

A. 0.40 I

B. 0.50 I

C. 0.70 I

D. 1.10 I

13. A rigid vessel of volume V contains N molecules of an ideal monatomic gas. The average kinetic energy of the molecules is E_k. What is the pressure in the vessel?

A. $\frac{2N}{3VE_k}$

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

C. $\frac{3N}{2VE_k}$

D. $\frac{3NE_k}{2V}$

14. A substance changes from a liquid into a solid without a change in temperature.

What is true about the internal energy of the substance and the total intermolecular potential energy of the substance when this phase change occurs?

	Internal energy of the substance	**Total intermolecular potential energy of the substance**
A.	decrease	decrease
B.	no change	decrease
C.	decrease	no change
D.	no change	no change

15. The entropy of a system is S, and the number of possible microstates is Ω. What is the number of possible microstates for a system of entropy $\frac{S}{2}$?

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

B. $\frac{\sqrt{\Omega}}{2}$

C. $\sqrt{\Omega}$

D. Ω^2

16. The Carnot efficiency of a heat engine is 0.4 when the cold reservoir temperature is T_c. The hot reservoir is held at a constant temperature. What is the Carnot efficiency when the cold reservoir temperature is $\frac{T_c}{2}$?

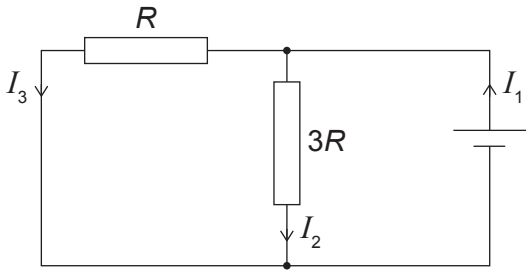
A. 0.2

B. 0.3

C. 0.7

D. 0.8

17. In the circuit shown, the cell has negligible internal resistance.



Which equation is correct?

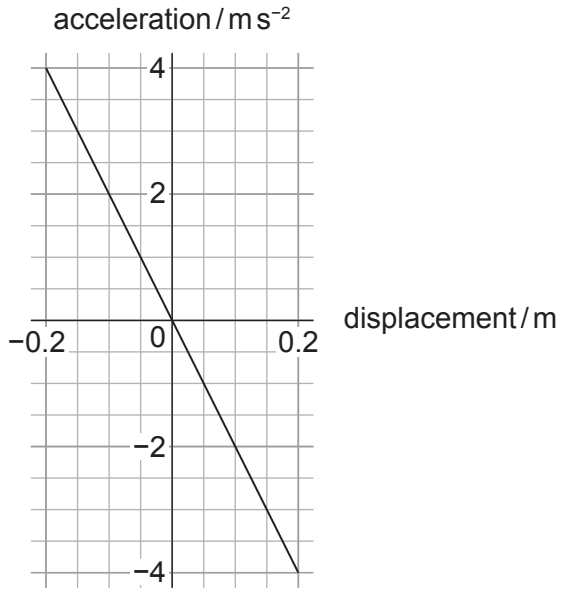
A. $I_1 = 4(I_2 + I_3)$

B. $I_1 = 4I_2$

C. $I_3 = 4I_2$

D. $I_3 = \frac{4I_1}{3}$

18. An object undergoes simple harmonic motion with frequency f. The graph shows the variation of its acceleration with displacement.



What is the value of f^2 in s^{-2}?

A. $\frac{5}{\pi^2}$

B. $\frac{5}{\pi}$

C. $\frac{100}{\pi^2}$

D. $\frac{100}{\pi}$

19. A mass oscillating vertically on a spring undergoes simple harmonic motion with amplitude X, total energy E and maximum speed v_{max}.

What is correct about the elastic potential energy E_H and speed v when the displacement is $\frac{X}{2}$?

A.	$E_H < \frac{E}{2}$	$v > \frac{v_{max}}{2}$
B.	$E_H < \frac{E}{2}$	$v < \frac{v_{max}}{2}$
C.	$E_H > \frac{E}{2}$	$v > \frac{v_{max}}{2}$
D.	$E_H > \frac{E}{2}$	$v < \frac{v_{max}}{2}$

20. A sound wave in air is directed towards a water boundary, and part of it is refracted.

Three statements are made about the refracted wave compared to the incident wave.

I. The wavelength is different.

II. The amplitude is different.

III. The frequency is different.

Which of the statements are correct?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

21. The critical angle for light passing from a medium into air is 30°.

What is the approximate value for the speed of light in the medium?

A. $0.5 \times 10^8 \,\mathrm{m\,s^{-1}}$

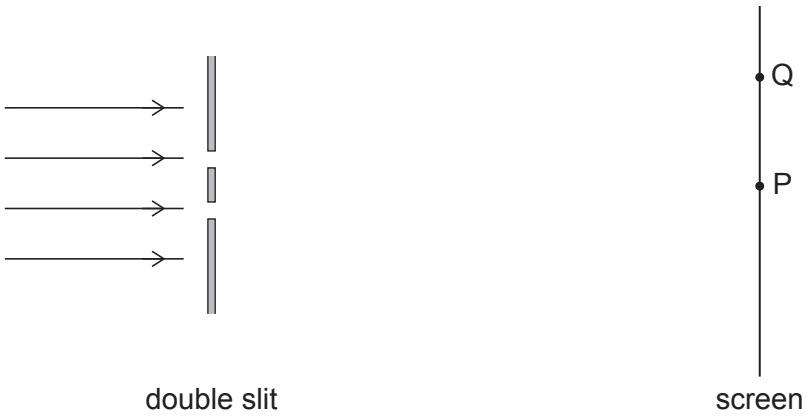
B. $1.5 \times 10^8 \,\mathrm{m\,s^{-1}}$

C. $2.0 \times 10^8 \,\mathrm{m\,s^{-1}}$

D. $2.6 \times 10^8 \,\mathrm{m\,s^{-1}}$

22. In a double-slit experiment using coherent light of wavelength λ, the central bright fringe is observed on a screen at point P. A point of destructive interference occurs at point Q. Only one point of constructive interference is observed between P and Q.

diagram not to scale



What is the path difference at Q?

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

B. λ

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

D. 2λ

23. Monochromatic coherent light is directed normally at a diffraction grating with N slits per unit length. Nine maxima in intensity are produced on a screen far away.

What change will occur to the angle between successive maxima and the number of observable maxima when the number of slits per unit length is $2N$?

	Angle between successive maxima	**Number of observable maxima**
A.	increase	decrease
B.	increase	increase
C.	decrease	decrease
D.	decrease	increase

24. A string that is fixed at both ends oscillates in the second harmonic with frequency 100 Hz. What other harmonic frequencies, in Hz, can this string oscillate at?

A. 25 and 50

B. 25 and 75

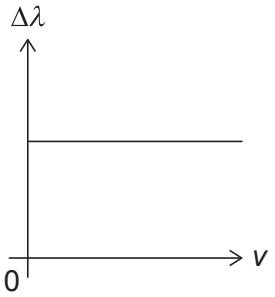
C. 50 and 150

D. 75 and 150

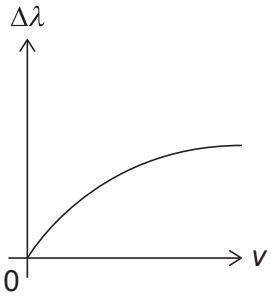
25. A source moving with speed v away from a stationary observer emits light of wavelength λ. The wavelength received by the observer is $\lambda + \Delta\lambda$. The speed v is much less than the speed of light.

Which graph gives the variation of $\Delta\lambda$ with v?

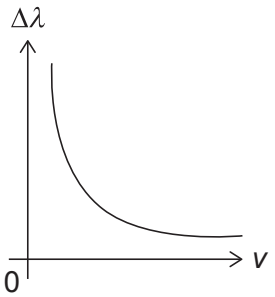
A.



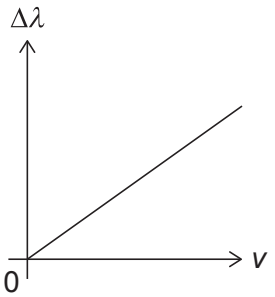
B.



C.



D.



26. Which is a statement of one of Kepler's laws of orbital motion?

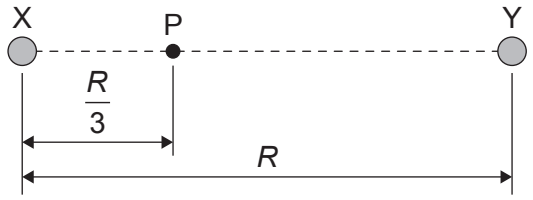
A. The square of the planet's orbital period is proportional to the cube of the length of the semi-major axis of its orbit.

B. A line segment joining a planet and the Sun sweeps out equal arc lengths during equal intervals of time.

C. A planet's orbital period is proportional to the cube of the length of the semi-major axis of its orbit.

D. The orbit of a planet is an ellipse with the Sun positioned at the centre.

27. Isolated planets X and Y have masses M_X and M_Y respectively and are separated by a distance R. A point P is located at a distance $\frac{R}{3}$ from planet X, as shown. The gravitational field strength at P is zero.



What is $\frac{M_Y}{M_X}$?

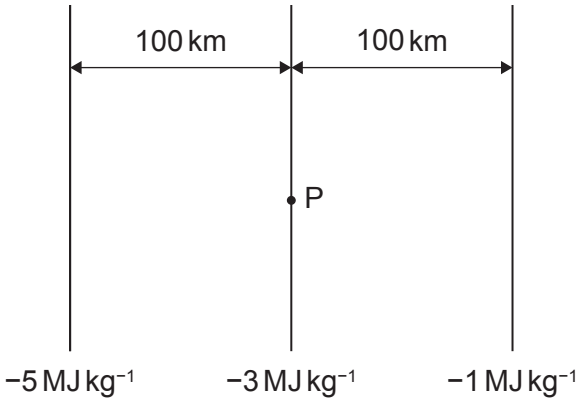
A. 2

B. 3

C. 4

D. 9

28. A point mass of 5 kg is placed at point P located on one of three gravitational equipotential lines, each separated by a distance of 100 km, as shown.



What is the initial acceleration of the point mass?

A. $4\,m\,s^{-2}$ to the left

B. $4\,m\,s^{-2}$ to the right

C. $20\,m\,s^{-2}$ to the left

D. $20\,m\,s^{-2}$ to the right

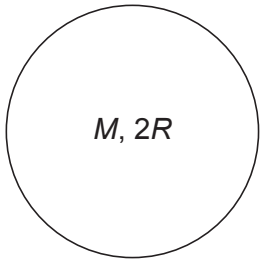
29. Four planets have masses M or $2M$ and radii R or $2R$ as shown.

Which planet has the largest escape speed?

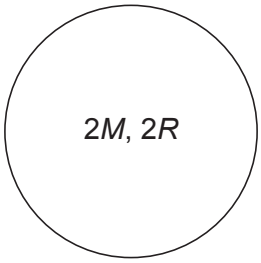
A.

B.

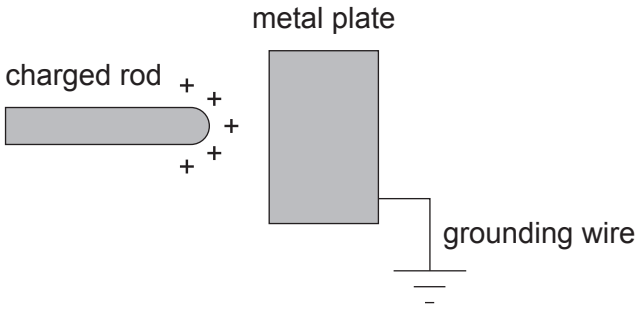
C.



D.



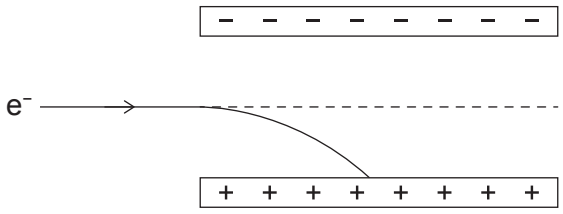
30. A positively charged rod is near a metal plate that is grounded as shown.



The grounding wire and then the rod are removed. What is correct about the overall charge on the plate before and after grounding is removed?

	Charge on plate before grounding is removed	Charge on plate after grounding is removed
A.	neutral	neutral
B.	neutral	negative
C.	negative	neutral
D.	negative	negative

31. An electron with speed v enters the region between two charged parallel plates midway between the plates, as shown. The potential difference between the plates is V.



What is the speed of the electron on impact with the plate?

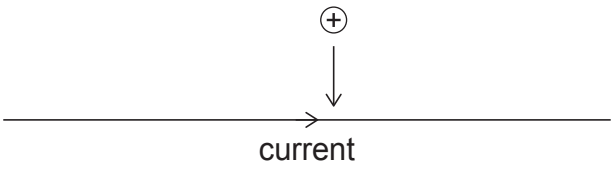
A. $\sqrt{v^2 + \frac{eV}{2m_e}}$

B. $\sqrt{v^2 + \left(\frac{eV}{2m_e}\right)^2}$

C. $\sqrt{v^2 + \frac{eV}{m_e}}$

D. $\sqrt{v^2 + \left(\frac{eV}{m_e}\right)^2}$

32. A positively charged particle is moving towards a current-carrying wire as shown.



What is the direction of the magnetic force acting on the charged particle?

A. To the right

B. To the left

C. Into the page

D. Out of the page

33. Three statements are made about emission and absorption spectra.

I. They provide information on the chemical composition of substances.

II. They provide evidence for mass-energy equivalence.

III. They arise from transitioning electrons between energy levels.

Which of the statements are correct?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

34. For which of the following atoms would the Bohr model apply, if one electron was removed from the atom?

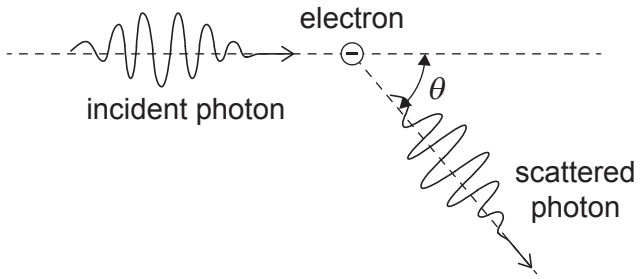
A. $^{22}_{11}\text{Na}$

B. $^{5}_{3}\text{Li}$

C. $^{235}_{92}\text{U}$

D. $^{4}_{2}\text{He}$

35. A photon scatters off an electron at an angle θ, as shown. The shift in the photon wavelength after scattering is $\frac{h}{2m_e c}$.



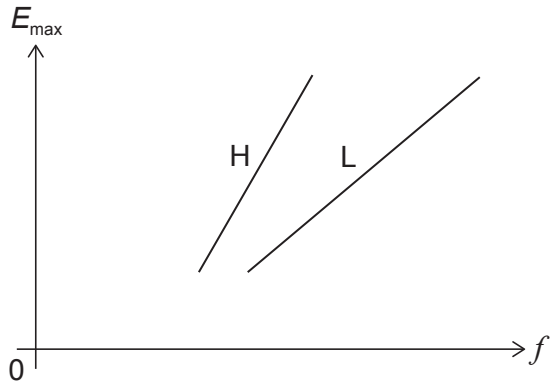
What is correct about the frequency of the photon after scattering and θ?

	Frequency	θ
A.	increases	30°
B.	increases	60°
C.	decreases	30°
D.	decreases	60°

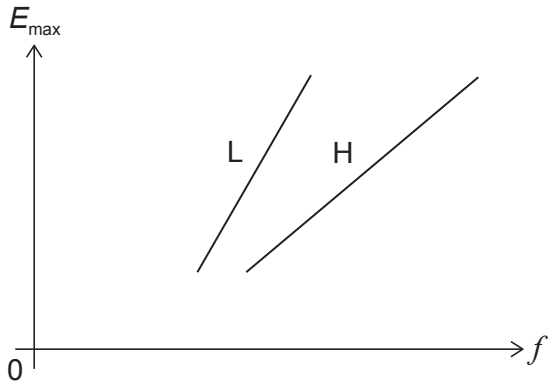
36. Light is incident on two different metal surfaces L and H. The minimum photon energy required to emit electrons from surface H is less than that from surface L.

Which graph shows the variation with light frequency f of the maximum kinetic energy E_{max} of photoelectrons emitted from both surfaces?

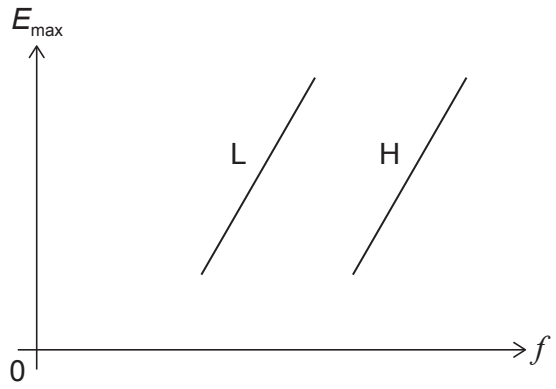
A.



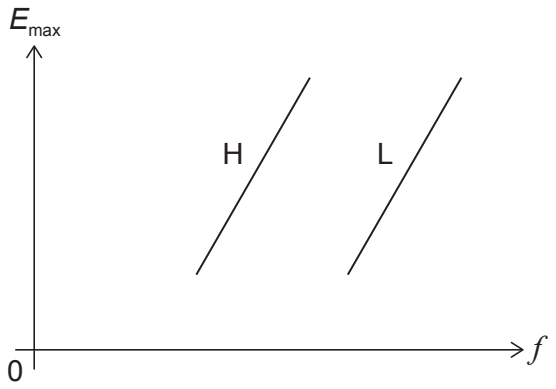
B.



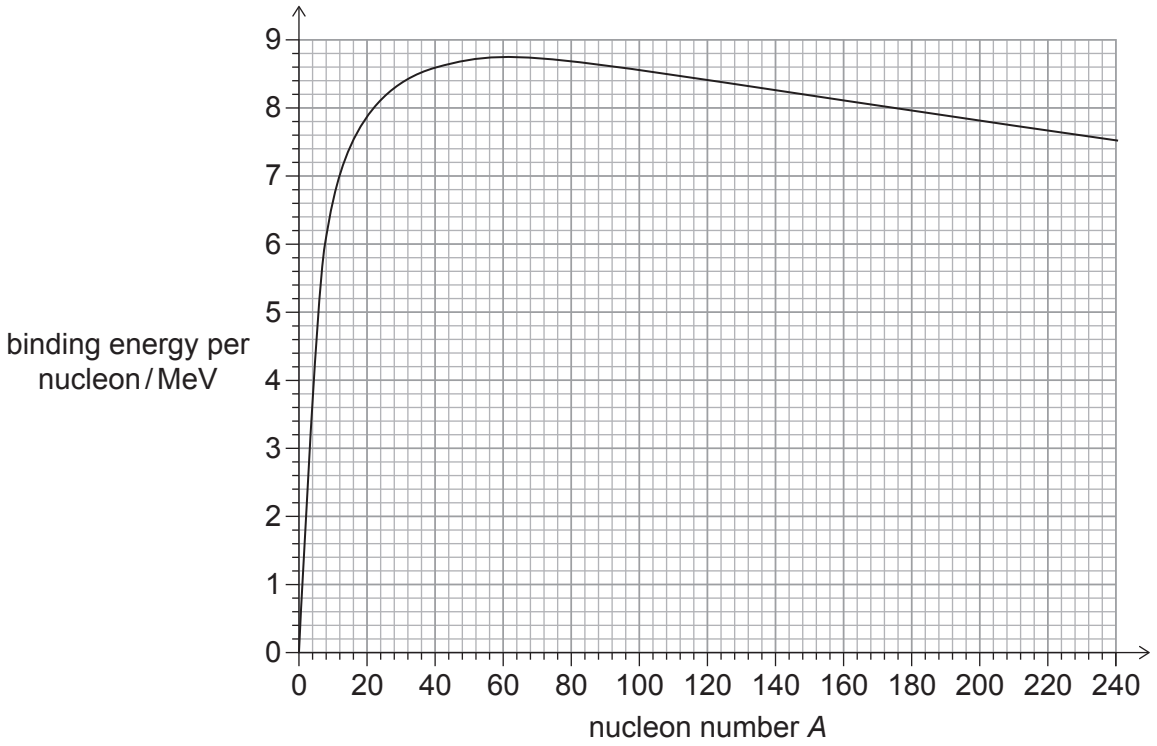
C.



D.



37. A graph of the variation with nucleon number A of the binding energy per nucleon is shown.



What is the approximate total energy, in MeV, needed to completely separate the nucleons of a $^{180}_{72}Hf$ nucleus?

A. 580

B. 620

C. 1440

D. 2020

38. Which two components of a nuclear power station are primarily responsible for ensuring that a controlled chain reaction is maintained?

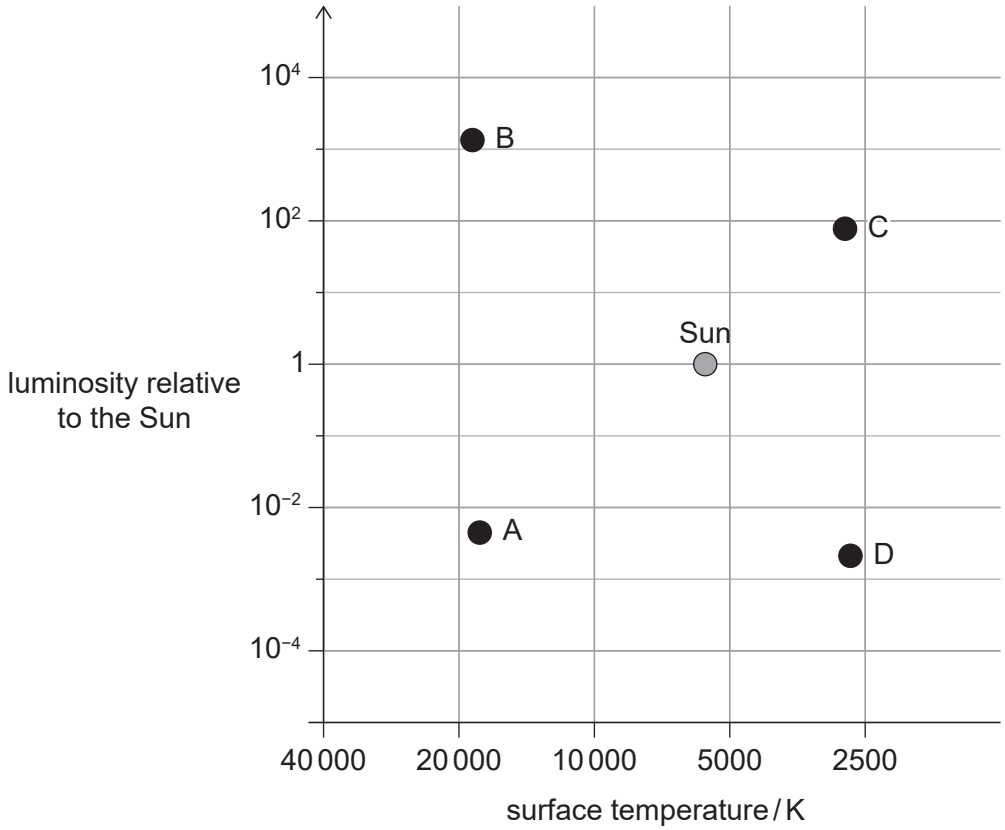
A. Control rods and heat exchangers

B. Moderators and shielding

C. Shielding and heat exchangers

D. Moderators and control rods

39. The Sun and positions of four stars A, B, C and D are plotted on the grid of a Hertzsprung–Russell (HR) diagram. Which star is a white dwarf?



40. A star is found to have a parallax angle of 0.25 arc-seconds. What is the distance to the star in light years?

A. 4.0

B. 13

C. 6.0×10^{11}

D. 38×10^{15}

Disclaimer:

Content used in IB assessments is taken from authentic, third-party sources. The views expressed within them belong to their individual authors and/or publishers and do not necessarily reflect the views of the IB.

References:

7. Dorling Kindersley, 2010. *Illustration of ice skater starting to spin*. [image online] Available at: https://www.gettyimages.co.uk/detail/illustration/illustration-of-ice-skater-starting-to-spin-royalty-free-illustration/96168836?phrase=ice+skater+spinning&searchscope=image%2Cfilm&adppopup=true [Accessed 11 December 2024]. Source adapted.