Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Higher level
Paper 1A

Specimen paper

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]**.

0000 – 6501

1. A car has an initial speed of $16\,m\,s^{-1}$. It decelerates at $4.0\,m\,s^{-2}$ until it stops.

What is the distance travelled by the car?

A. 4 m

B. 16 m

C. 32 m

D. 64 m

2. A block of mass 2.0 kg accelerates from a speed of $15\,m\,s^{-1}$ to a speed of $20\,m\,s^{-1}$ without changing its direction.

What impulse acts on the block?

A. 2.5 N s

B. 5.0 N s

C. 10 N s

D. 17.5 N s

3. A net force of 8.0 N accelerates a 4.0 kg body from rest to a speed of $5.0\,m\,s^{-1}$.

What is the work done by the force?

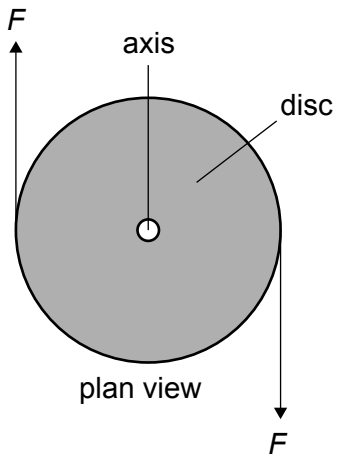
A. 50 J

B. 40 J

C. 32 J

D. 20 J

4. A disc of mass M and radius R is on a horizontal frictionless table. Two equal and opposite forces, each of magnitude F, act on the disc. The moment of inertia of the disc about its axis is $\frac{1}{2}MR^2$.



What is the angular acceleration of the disc?

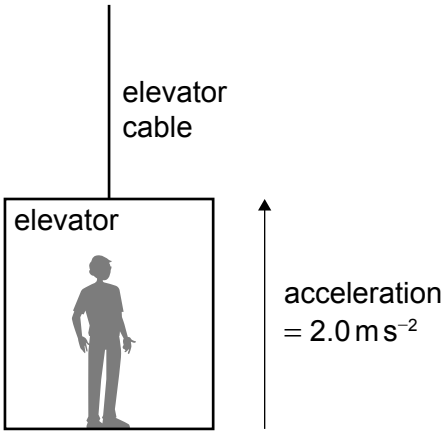
A. 0

B. $\frac{F}{MR}$

C. $\frac{2F}{MR}$

D. $\frac{4F}{MR}$

5. A person stands in an elevator (lift). The total mass of the person and the elevator is 800 kg. The elevator accelerates upward at $2.0\,\text{m}\,\text{s}^{-2}$.



What is the tension in the cable?

A. 1.6 kN

B. 6.4 kN

C. 8.0 kN

D. 9.6 kN

6. An object is released from rest in a vacuum at a height H above the Earth's surface.

As the object falls it passes a point at a height of $0.75H$ above the surface.

What is $\dfrac{\text{kinetic energy of the object at a height of } 0.75H}{\text{gravitational potential energy of the object at a height of } H}$?

A. $\dfrac{1}{16}$

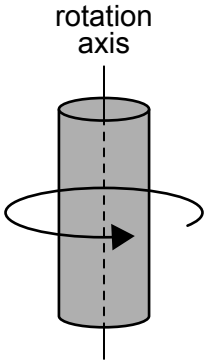
B. $\dfrac{1}{4}$

C. $\dfrac{9}{16}$

D. $\dfrac{3}{4}$

7. A cylinder of mass *M* and radius *R* rotates at constant angular speed ω about an axis through its centre. The rotational kinetic energy of the cylinder is *K*.

The moment of inertia of the cylinder is $\frac{1}{2}MR^2$.



A second cylinder has mass 2*M*, radius 2*R* and rotates with angular speed 2ω.

What is the rotational kinetic energy of the second cylinder?

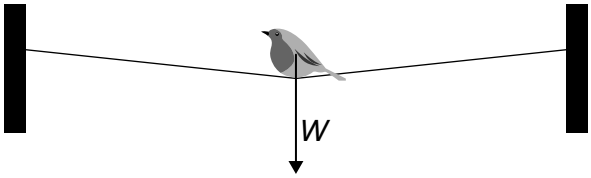
A. 8*K*

B. 16*K*

C. 32*K*

D. 64*K*

8. A bird of weight W sits on a thin rope at its midpoint. The rope is almost horizontal and has negligible mass.



The tension in the rope is

A. less than $\frac{W}{2}$

B. equal to $\frac{W}{2}$

C. between $\frac{W}{2}$ and W

D. greater than W

9. A spacecraft, moving with speed v relative to Earth, passes Earth on its way to a planet. As the spacecraft passes Earth, clocks on Earth and in the spacecraft show zero.

The planet is a distance D from Earth, according to an observer on Earth.

What are the readings on the Earth clock and on the spacecraft clock when the spacecraft arrives at the planet?

	Earth clock reading	**Spacecraft clock reading**
A.	$\frac{D}{v}$	$\frac{D}{v}\sqrt{1-\frac{v^2}{c^2}}$
B.	$\frac{D}{v}$	$\frac{D}{v\sqrt{1-\frac{v^2}{c^2}}}$
C.	$\frac{D}{v\sqrt{1-\frac{v^2}{c^2}}}$	$\frac{D}{v}$
D.	$\frac{D}{v}\sqrt{1-\frac{v^2}{c^2}}$	$\frac{D}{v}$

10. The internal energy of a real gas is

A. zero.

B. equal to the intermolecular potential energy of the particles.

C. equal to the total kinetic energy of the particles.

D. equal to the sum of the intermolecular potential energy and the total kinetic energy of the particles.

11. A gas undergoes one cycle of a cyclic process.

The net change in internal energy of the gas is

A. zero.

B. positive.

C. negative.

D. determined by the initial temperature of the gas.

12. A working refrigerator with the door open is placed in a sealed room.

The entropy of the room

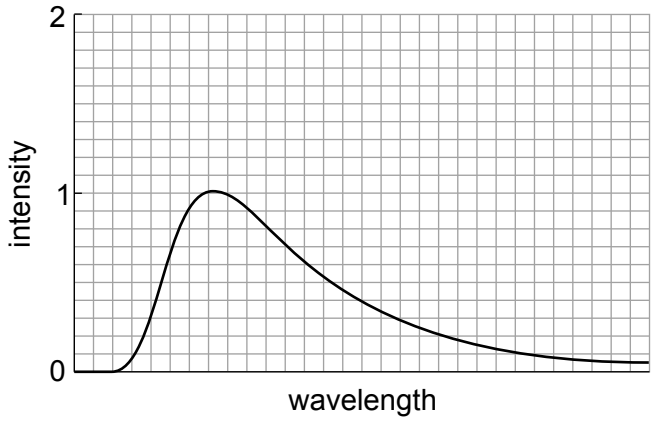
A. is zero.

B. decreases.

C. remains unchanged.

D. increases.

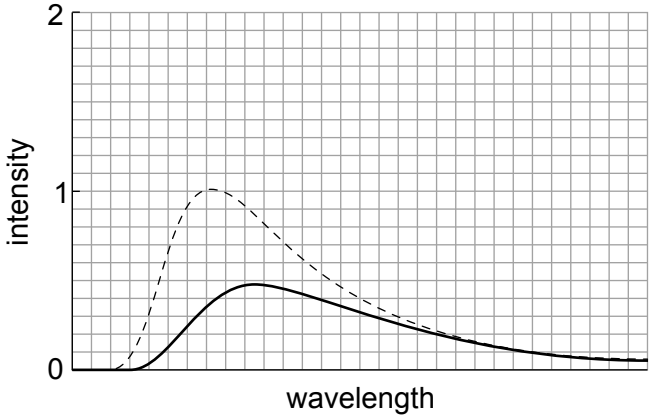
13. The black-body radiation curve of an object at 600 K is shown. The intensity units are arbitrary.



What is the radiation curve of the same object at 450 K?

The original curve is shown with a dashed line.

A.



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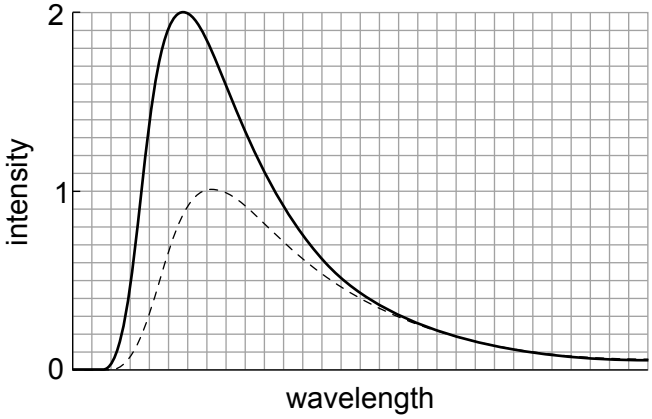
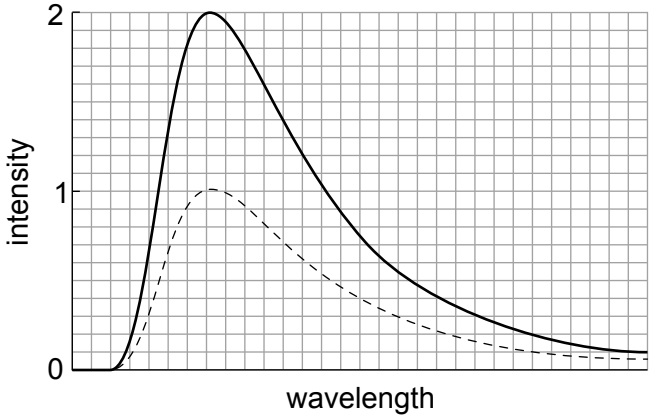
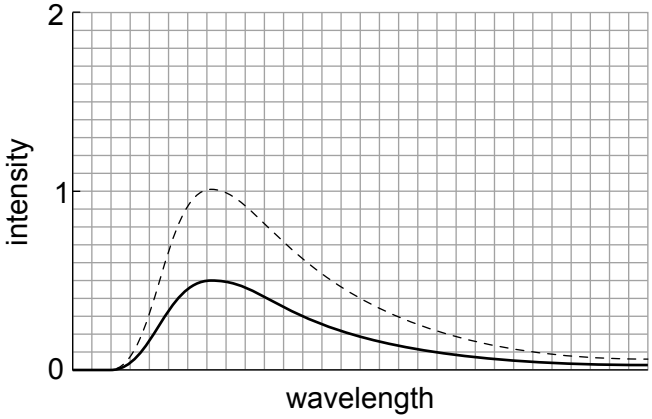


C.



D.



14. Star X has a luminosity L and an apparent brightness b. Star X is at a distance d from Earth.

Star Y has the same apparent brightness as X but is four times more luminous.

What is the distance of Star Y from Earth?

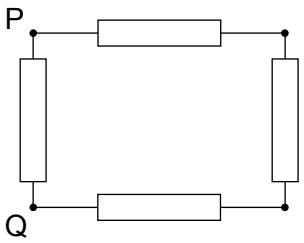
A. $4d$

B. $2d$

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

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

15. Four identical resistors, each of resistance R, are connected as shown.



What is the effective resistance between P and Q?

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

B. R

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

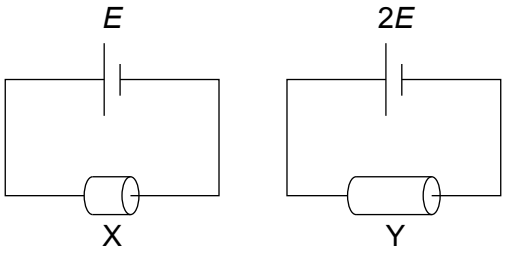
D. $4R$

16. Conductor X is connected to a cell of emf E. A power of 16 W is dissipated in X.

Conductor Y is made from the same material with the same diameter as X but is twice as long. A cell of emf $2E$ is connected to Y.

Both cells have negligible internal resistance.

What power is dissipated in Y?



A. 8.0 W

B. 16 W

C. 32 W

D. 64 W

17. Two containers, X and Y, are filled with an ideal gas at the same pressure.

The volume of X is four times the volume of Y. The temperature of X is 327 °C and the temperature of Y is 27 °C.

What is $\frac{\text{amount of substance in X}}{\text{amount of substance in Y}}$?

A. $\frac{1}{8}$

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

C. 2

D. 8

18. An electromagnetic wave has a wavelength that is about the size of the diameter of an atom.

What region of the electromagnetic spectrum does the wave belong to?

A. Infrared

B. Visible light

C. Ultraviolet

D. X-ray

19. A particle undergoes simple harmonic motion of period T. At time $t = 0$ the particle is at its equilibrium position.

What is t when the particle is at its greatest distance from the equilibrium position?

A. $\frac{T}{8}$

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

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

D. T

20. Diagram 1 shows the variation with position of the displacement of a standing wave formed on a string.

Diagram 2 shows the variation with position of the displacement of a travelling wave moving to the right along a string.

Diagram 1

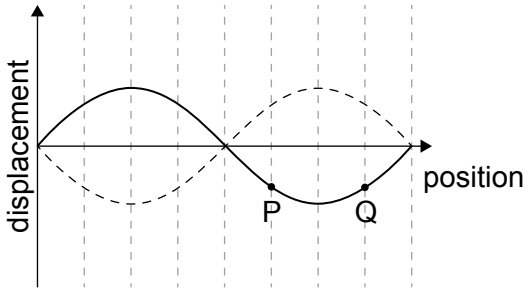
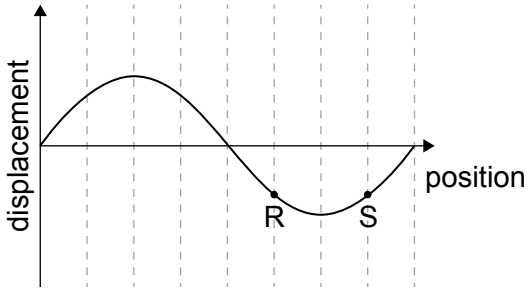


Diagram 2



Points P, Q, R and S are points on the string.

What is the phase difference between P and Q and the phase difference between R and S?

	Phase difference between P and Q	**Phase difference between R and S**
A.	0	0
B.	$\frac{\pi}{2}$	0
C.	0	$\frac{\pi}{2}$
D.	$\frac{\pi}{2}$	$\frac{\pi}{2}$

21. A mass of 0.25 kg hangs from a spring of spring constant 4.0 N m^{-1}.

What is the natural frequency of oscillation for this system?

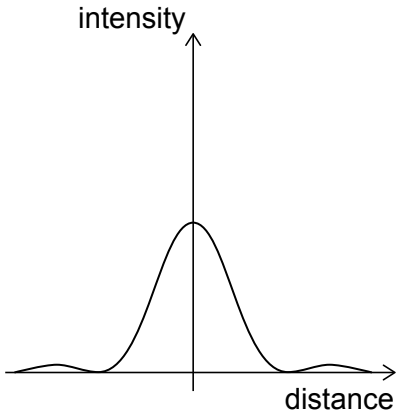
A. 0.50 Hz

B. 0.64 Hz

C. 1.6 Hz

D. 2.0 Hz

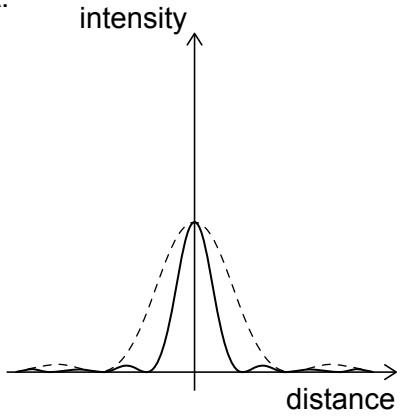
22. Light from a monochromatic source is incident on a single slit and the resulting diffraction pattern is viewed on a screen. The graph shows the variation of intensity with distance on the screen.



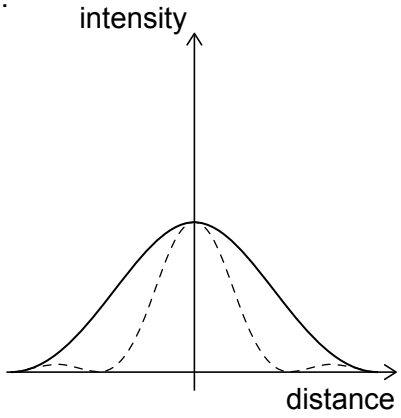
The intensity of the source remains the same. The width of the slit is increased.

Which graph correctly shows the variation of intensity after the change? The original curve is shown with a dashed line.

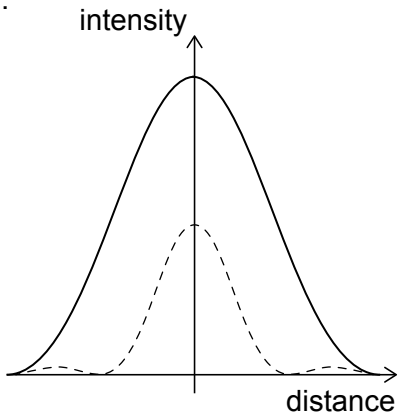
A.



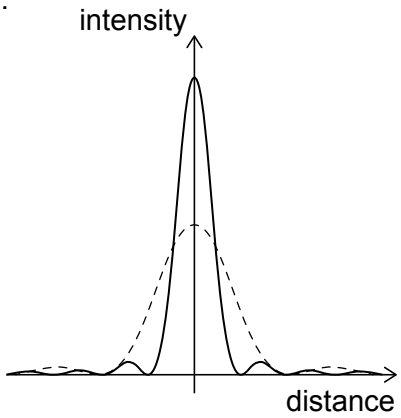
B.



C.



D.



23. Monochromatic light is incident on a diffraction grating. The diffraction pattern from the diffraction grating is then formed on a screen.

Only the central maximum and the first-order maxima can be observed on the screen.

What change will allow the second-order maxima to be observed on the screen?

A. Decrease the distance between the diffraction grating and the source of light

B. Increase the distance between the diffraction grating and the screen

C. Increase the wavelength of the monochromatic light

D. Reduce the number of lines per unit length of the diffraction grating

24. A solid metallic sphere is positively charged and isolated from all other charges.

The electric potential due to the sphere

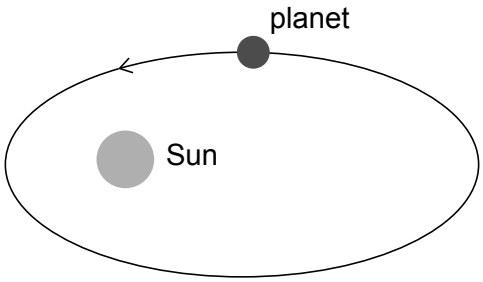
A. is constant inside the sphere.

B. is constant outside the sphere.

C. is smallest at the surface of the sphere.

D. increases with distance from the sphere.

25. A planet orbits the Sun in an elliptical orbit moving in the direction shown.



At the position shown, which quantity is decreasing for the planet?

A. Acceleration

B. Angular momentum

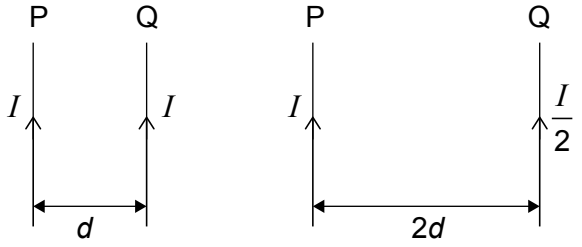
C. Kinetic energy

D. Gravitational potential energy

26. Two long parallel wires P and Q are a distance *d* apart. They each carry a current.

A magnetic force per unit length *F* acts on P due to Q.

The distance between the wires is increased to 2*d* and the current in Q is decreased to $\frac{I}{2}$.



What is the magnetic force per unit length that acts on P due to Q after the changes?

A. $\frac{F}{8}$

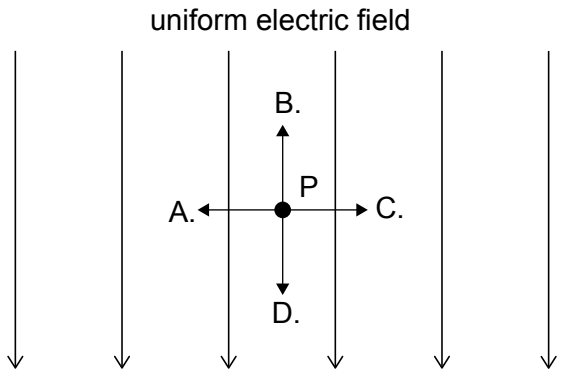
B. $\frac{F}{4}$

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

D. F

27. P is a point in a uniform electric field.

What is the direction in which the electric potential increases at P?



28. Planets X and Y orbit the same star.

The average distance between planet X and the star is five times greater than the average distance between planet Y and the star.

What is $\frac{\text{orbital period of planet X}}{\text{orbital period of planet Y}}$?

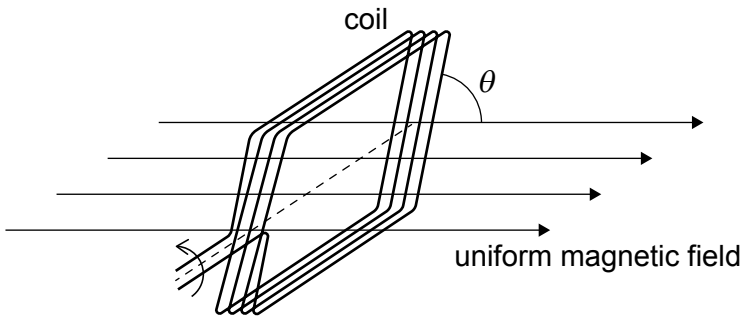
A. $\sqrt[3]{5}$

B. $\sqrt{5}$

C. $\sqrt[3]{5^2}$

D. $\sqrt{5^3}$

29. A rectangular conducting coil rotates at a constant angular velocity in a uniform magnetic field. The rotation axis of the coil is perpendicular to the field.



At one instant the plane of the coil is at an angle θ to the direction of the field.

The magnitude of the emf induced in the coil is

A. never zero.

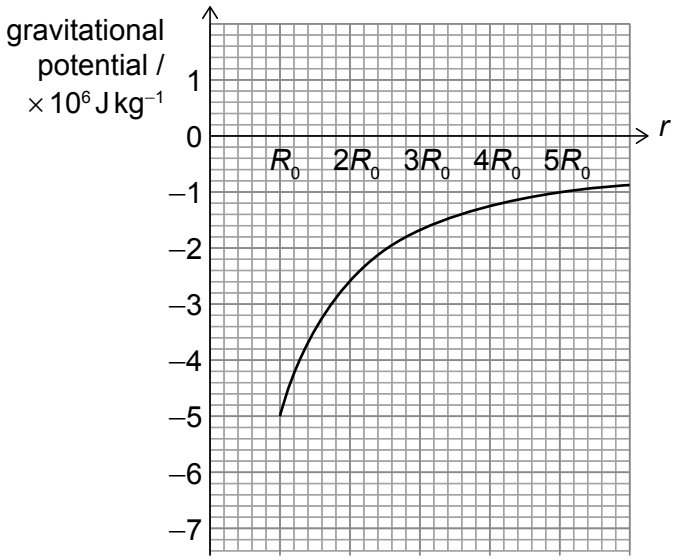
B. at a maximum when $\theta = 0°$ or 180°.

C. at a maximum when $\theta = 45°$ or 225°.

D. at a maximum when $\theta = 90°$ or 270°.

30. A spherical planet has a radius R_0.

The graph shows the variation of the gravitational potential due to the planet with distance r from the centre of the planet.



What is the escape speed from the surface of the planet?

A. $1.6 \times 10^3\,\mathrm{m\,s^{-1}}$

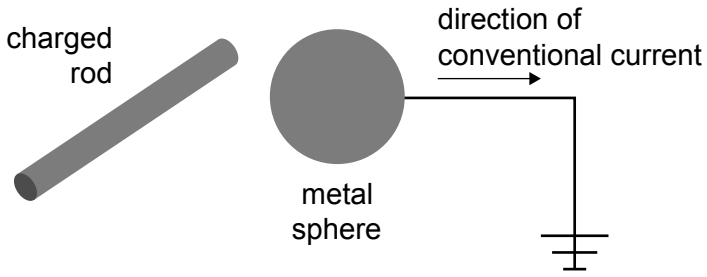
B. $2.2 \times 10^3\,\mathrm{m\,s^{-1}}$

C. $3.2 \times 10^3\,\mathrm{m\,s^{-1}}$

D. $4.5 \times 10^3\,\mathrm{m\,s^{-1}}$

31. A charged rod is brought near an initially neutral metal sphere without touching it.

When the sphere is grounded (earthed), there is an electric current for a short time from the sphere to the ground.

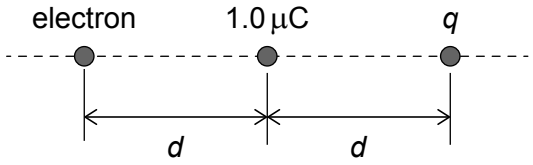


The ground connection is then removed.

What are the charge on the rod and the charge induced on the sphere when the connection is removed?

	Charge on the rod	Charge induced on the sphere
A.	negative	negative
B.	negative	positive
C.	positive	negative
D.	positive	positive

32. A positive point charge of magnitude 1.0 μC and a point charge q are separated by a distance d.



An electron is placed at a distance d from the +1.0 μC charge. The electric force on the electron is zero.

What is q?

A. −4.0 μC

B. −2.0 μC

C. 2.0 μC

D. 4.0 μC

33. What is the sequence for the evolution of a main sequence star of about 2 solar masses?

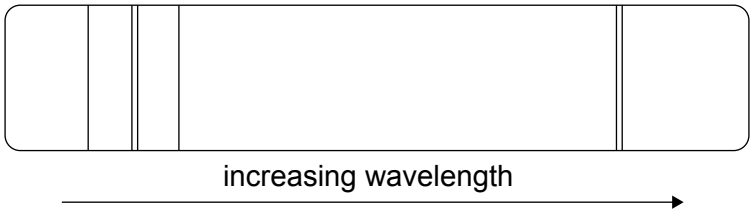
A. Red super giant → supernova → neutron star

B. Red giant → planetary nebula → white dwarf

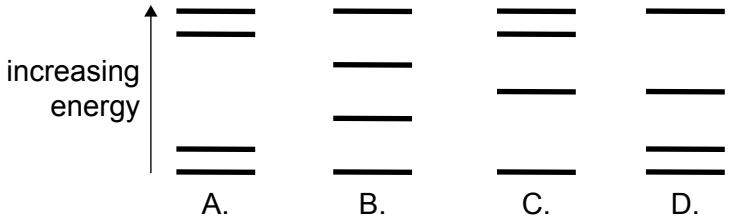
C. Red giant → supernova → white dwarf

D. Red super giant → planetary nebula → neutron star

34. The diagram shows the emission spectrum of an atom.



Which of the following atomic energy level models can produce this spectrum?



35. A photon of wavelength λ scatters off an electron at rest. The scattered photon has wavelength λ'.

What is the fraction of the incident photon energy that gets transferred to the electron?

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

B. $\frac{\lambda'}{\lambda}$

C. $\frac{\lambda' - \lambda}{\lambda}$

D. $\frac{\lambda' - \lambda}{\lambda'}$

36. Three statements about a nuclear fission reactor are:

I. The heat exchanger transfers energy from the fuel rods to the moderator.

II. The control rods must be good absorbers of neutrons.

III. The moderator must slow neutrons down.

Which statements about the reactor are correct?

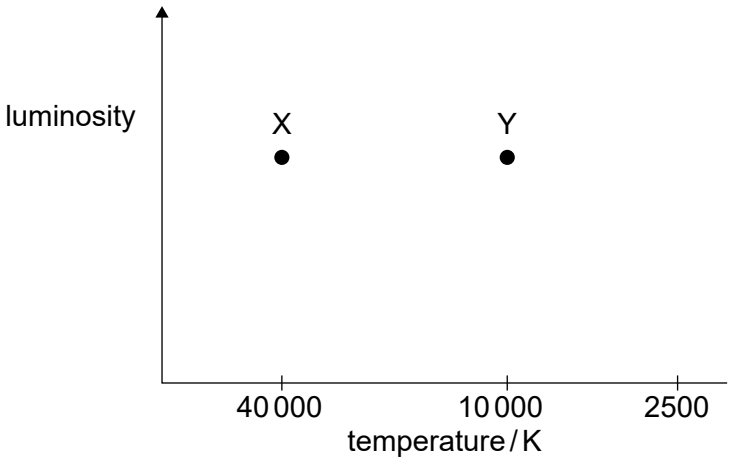
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

37. The Hertzsprung–Russell diagram shows two stars, X and Y.



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

A. $\frac{1}{16}$

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

C. 4

D. 16

38. The energy of the nth level of hydrogen is given by $-\frac{E_0}{n^2}$. What is the frequency of the photon emitted in the transition from $n = 4$ to $n = 2$?

A. $\frac{1}{16} \times \frac{E_0}{h}$

B. $\frac{3}{16} \times \frac{E_0}{h}$

C. $\frac{1}{4} \times \frac{E_0}{h}$

D. $\frac{3}{4} \times \frac{E_0}{h}$

39. Monochromatic light of frequency f_1 is incident on the surface of a metal. The stopping voltage for this light is V_1. When the frequency of the radiation is changed to f_2, the stopping voltage is V_2.

What is the quantity $\frac{V_2 - V_1}{f_2 - f_1}$ equal to?

A. h

B. $\frac{h}{e}$

C. $\frac{h}{c}$

D. $\frac{hc}{e}$

40. An alpha particle ($^4_2$He) of initial energy 5.5 MeV moves towards the centre of a nucleus of gold-197 ($^{197}_{79}$Au).

What is the distance of closest approach of the alpha particle?

A. 1.0×10^{-13} m

B. 4.1×10^{-14} m

C. 2.1×10^{-14} m

D. 6.6×10^{-33} m