Cambridge International Examinations
Cambridge Pre-U Certificate

PHYSICS (PRINCIPAL) **9792/01**

Paper 1 Multiple Choice **May/June 2017**

1 hour 30 minutes

8443279561

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the one you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any working should be done in this booklet.
Electronic calculators may be used.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 3 Pre-U Certificate.

This document consists of **16** printed pages.

IB17 06_9792_01/3RP

Data

gravitational field strength close to Earth's surface	$g = 9.81\,\mathrm{N\,kg^{-1}}$
elementary charge	$e = 1.60 \times 10^{-19}\,\mathrm{C}$
speed of light in vacuum	$c = 3.00 \times 10^{8}\,\mathrm{m\,s^{-1}}$
Planck constant	$h = 6.63 \times 10^{-34}\,\mathrm{J\,s}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\,\mathrm{F\,m^{-1}}$
gravitational constant	$G = 6.67 \times 10^{-11}\,\mathrm{N\,m^2\,kg^{-2}}$
electron mass	$m_e = 9.11 \times 10^{-31}\,\mathrm{kg}$
proton mass	$m_p = 1.67 \times 10^{-27}\,\mathrm{kg}$
unified atomic mass constant	$u = 1.66 \times 10^{-27}\,\mathrm{kg}$
molar gas constant	$R = 8.31\,\mathrm{J\,K^{-1}\,mol^{-1}}$
Avogadro constant	$N_A = 6.02 \times 10^{23}\,\mathrm{mol^{-1}}$
Boltzmann constant	$k = 1.38 \times 10^{-23}\,\mathrm{J\,K^{-1}}$
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8}\,\mathrm{W\,m^{-2}\,K^{-4}}$

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
	$s = \left(\frac{u+v}{2}\right)t$
heating	$\Delta E = mc\Delta\theta$
change of state	$\Delta E = mL$
refraction	$n = \frac{\sin\theta_1}{\sin\theta_2}$
	$n = \frac{v_1}{v_2}$

diffraction

single slit, minima $n\lambda = b \sin \theta$

grating, maxima $n\lambda = d \sin \theta$

double slit interference $\lambda = \dfrac{ax}{D}$

Rayleigh criterion $\theta \approx \dfrac{\lambda}{b}$

photon energy $E = hf$

de Broglie wavelength $\lambda = \dfrac{h}{p}$

simple harmonic motion $x = A \cos \omega t$

$v = -A\omega \sin \omega t$

$a = -A\omega^2 \cos \omega t$

$F = -m\omega^2 x$

$E = \frac{1}{2} m A^2 \omega^2$

energy stored in a capacitor $W = \frac{1}{2} QV$

capacitor discharge $Q = Q_0 e^{-\frac{t}{RC}}$

electric force $F = \dfrac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$

electrostatic potential energy $W = \dfrac{Q_1 Q_2}{4\pi\varepsilon_0 r}$

gravitational force $F = -\dfrac{Gm_1 m_2}{r^2}$

gravitational potential energy $E = -\dfrac{Gm_1 m_2}{r}$

magnetic force $F = BIl \sin\theta$

$F = BQv \sin\theta$

electromagnetic induction $E = -\dfrac{\mathrm{d}(N\Phi)}{\mathrm{d}t}$

Hall effect $V = Bvd$

time dilation $t' = \dfrac{t}{\sqrt{1 - \dfrac{v^2}{c^2}}}$

length contraction $l' = l\sqrt{1 - \dfrac{v^2}{c^2}}$

kinetic theory $\frac{1}{2} m \langle c^2 \rangle = \frac{3}{2} kT$

work done on/by a gas $W = p\Delta V$

radioactive decay $\dfrac{\mathrm{d}N}{\mathrm{d}t} = -\lambda N$

$N = N_0 e^{-\lambda t}$

$t_{\frac{1}{2}} = \dfrac{\ln 2}{\lambda}$

attenuation losses $I = I_0 e^{-\mu x}$

mass-energy equivalence $\Delta E = c^2 \Delta m$

hydrogen energy levels $E_n = \dfrac{-13.6\,\text{eV}}{n^2}$

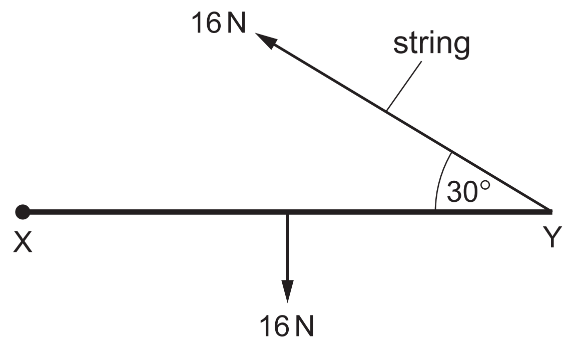
Heisenberg uncertainty principle $\Delta p \Delta x \geqslant \dfrac{h}{2\pi}$

Wien's displacement law $\lambda_{max} \propto \dfrac{1}{T}$

Stefan's law $L = 4\pi\sigma r^2 T^4$

electromagnetic radiation from a moving source $\dfrac{\Delta\lambda}{\lambda} \approx \dfrac{\Delta f}{f} \approx \dfrac{v}{c}$

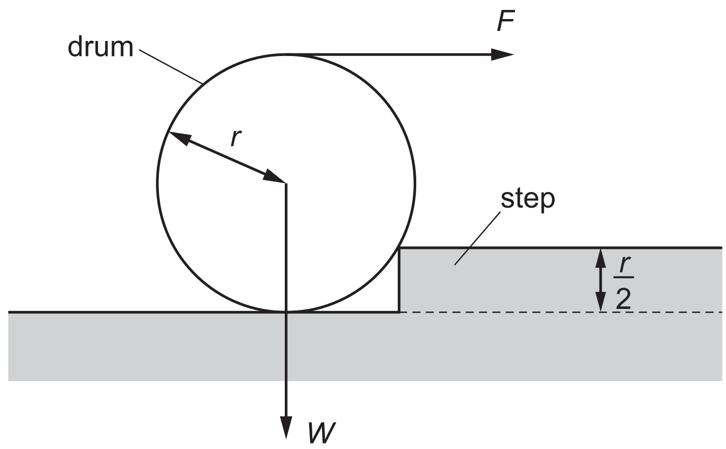
1 A rod XY of weight 16 N is hinged at X and supported by a string at Y. The string is at an angle of 30°. The tension in the string is 16 N.



What is the horizontal component of the force acting at X?

A 8.0 N **B** 9.0 N **C** 14 N **D** 16 N

2 A cylindrical drum has radius r and weight W. The drum is to be rolled over onto a step of height $\frac{r}{2}$ by a horizontal force F applied to the top of the drum.



What is the minimum force F required for the drum to start rolling on the step?

A $\frac{W}{2}$ **B** $\frac{W}{\sqrt{3}}$ **C** W **D** $\frac{\sqrt{3}}{2}W$

3 When a stationary nucleus undergoes alpha decay the resulting nucleus recoils in the opposite direction to the emitted alpha particle. The alpha particle is emitted with momentum p and kinetic energy E.

The mass of the recoiling nucleus is 50 times greater than the mass of the alpha particle.

What are the magnitudes of the momentum and kinetic energy of the recoiling nucleus?

	momentum	kinetic energy
A	p	E
B	p	$\frac{E}{50}$
C	$\frac{p}{50}$	E
D	$\frac{p}{50}$	$\frac{E}{50}$

4 On a journey from Alphatown to Betaville, a train accelerates uniformly from rest to 30.0 m s^{-1} in one minute. It then continues at constant speed for three minutes before decelerating uniformly to rest again in two minutes.

What distance does the train travel from Alphatown to Betaville?

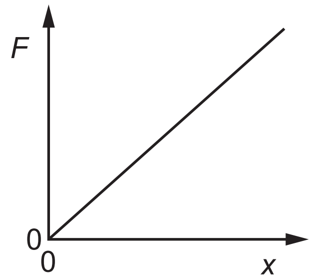
A 135 m **B** 180 m **C** 8.10 km **D** 10.8 km

5 A mass m is situated in a uniform gravitational field of strength g.

Which row describes the force on the mass due to the gravitational field?

	magnitude of force	direction of force
A	g	in direction of field
B	g	in opposite direction to field
C	mg	in direction of field
D	mg	in opposite direction to field

6 The graph shows how the extension x of a wire fixed at its upper end varies with the force F applied at the lower end.



The wire is of unstretched length L, cross-sectional area A, and made of material of Young modulus E.

Which expression is equal to the gradient of the graph?

A $\dfrac{EA}{L}$ **B** $\dfrac{EL}{A}$ **C** $\dfrac{A}{EL}$ **D** $\dfrac{L}{EA}$

7 A scale model of a table is made so that all its linear dimensions are one tenth of those of the real table (scale 1 : 10). The model is made from the same wood as the table.

What is the value of $\dfrac{\text{stress in the legs of the model}}{\text{stress in the legs of the real table}}$?

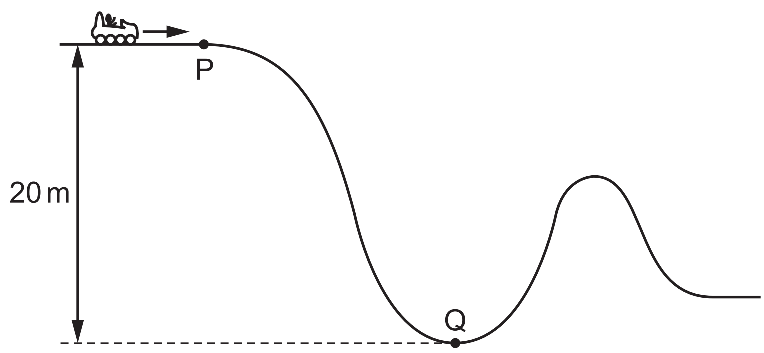
A 0.001 **B** 0.01 **C** 0.1 **D** 1

8 An electric motor is 40% efficient. When operating at full power, it has a useful power output of 2.0 kW.

How much electrical energy is transferred at full power in one minute?

A 0.80 kJ **B** 5.0 kJ **C** 48 kJ **D** 300 kJ

9 On the rollercoaster section shown, a car and passenger of total mass 400 kg travels at a speed of 10 m s^{-1} as it passes through point P.



At which speed will the car and passengers pass through point Q?

Assume that frictional forces are negligible.

A 20 m s^{-1} **B** 22 m s^{-1} **C** 24 m s^{-1} **D** 30 m s^{-1}

10 In a refrigerator, freon is evaporated at a rate of $4.0\,\text{kg}\,\text{h}^{-1}$. The thermal energy required to achieve this comes from a tray of water at 0 °C in the refrigerator that is changed to become ice.

substance	specific latent heat of fusion / $\text{kJ}\,\text{kg}^{-1}$	specific latent heat of vaporisation / $\text{kJ}\,\text{kg}^{-1}$
freon	50	150
water	330	2300

What is the minimum time required to freeze 400 g of water?

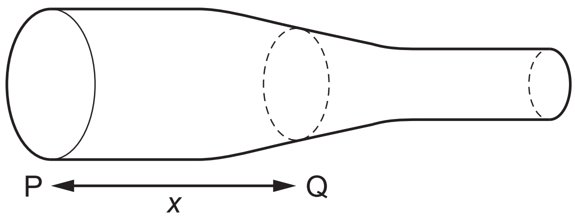
A 13 minutes

B 40 minutes

C 92 minutes

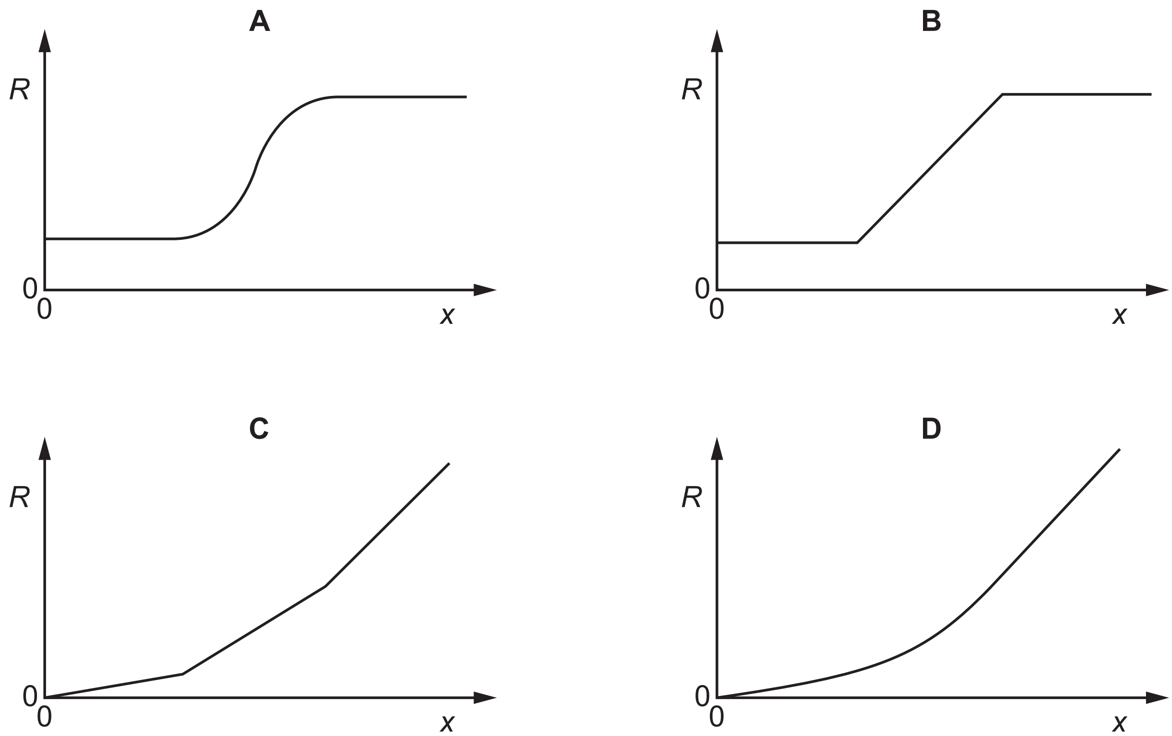
D 280 minutes

11 A metal wire is moulded so that its circular cross-section decreases.

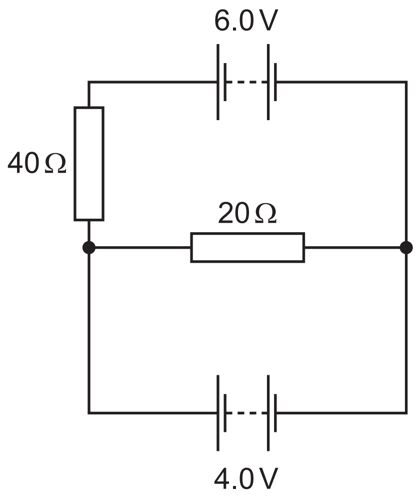


The resistance R of the wire is measured between end P and Q, a distance x from P.

Which graph shows the variation of R with x as Q is moved from end P to the other end of the wire?



12 The diagram shows two batteries of electromotive force (emf) 6.0 V and 4.0 V connected in a circuit.



The internal resistance of each battery is negligible.

What is the current in the battery of emf 4.0 V?

A 0.05 A **B** 0.15 A **C** 0.20 A **D** 0.25 A

13 The batteries in an electric car can be recharged by connecting them to an electrical supply operating at 230 V and supplying 8.0 A for 10 hours.

Which row gives the charge that passes through the batteries and the work done by the charger during the charging process?

	charge / C	work / J
A	80	1840
B	80	6.6×10^7
C	2.9×10^5	1840
D	2.9×10^5	6.6×10^7

14 Which wave phenomenon **cannot** be exhibited by **both** light and sound?

A diffraction

B polarisation

C refraction

D superposition

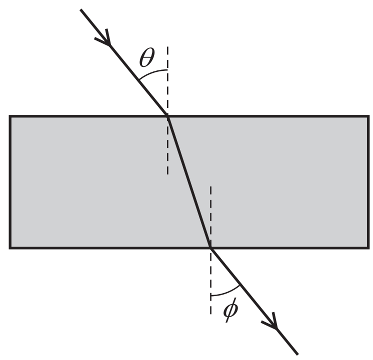
15 A wave of wavelength 2.5 m is set up on an oscillating string which completes 1200 oscillations in one minute. The amplitude of the wave is 3.0 mm.

A new wave is then set up on the same string with four times the intensity of the previous one and double the wavelength.

Which row correctly gives the amplitude and frequency of this second wave?

	amplitude / mm	frequency / Hz
A	6.0	10
B	6.0	600
C	12	10
D	12	600

16 The diagram shows a light ray passing from air into a rectangular glass block and exiting into the air on the opposite side.



Which statement is **not** correct?

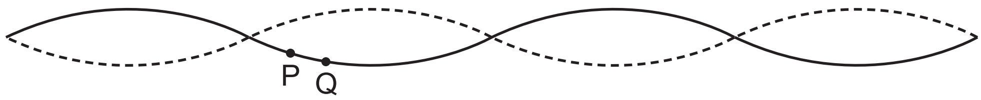
A As θ increases from 0° to 90°, ϕ also increases from 0° to 90°.

B However large θ becomes, total internal reflection cannot occur at the upper boundary.

C If the ray direction is reversed it will retrace the same path through the glass.

D When θ exceeds a certain value, total internal reflection occurs at the lower boundary.

17 A standing wave is set up on a string. Two points P and Q on the string are located, as shown.



Which row correctly describes the phase difference and maximum speed of the vibrations of the two points?

	phase difference	maximum speed
A	π rad	different
B	zero	different
C	π rad	same
D	zero	same

18 Monochromatic light of wavelength 600 nm diffracts through a single slit of width 0.01 mm.

What is the angular width of the central maximum of the diffraction pattern?

A 0.0034° **B** 0.0069° **C** 3.4° **D** 6.9°

19 The induced nuclear fission of uranium-235 can create many different pairs of daughter nuclei.

Which nuclear transformation correctly represents such an induced fission?

A ${}^{235}_{92}\mathrm{U} \rightarrow {}^{144}_{56}\mathrm{X} + {}^{90}_{36}\mathrm{Y} + 3{}^{1}_{0}\mathrm{n}$

B ${}^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{144}_{56}\mathrm{X} + {}^{90}_{36}\mathrm{Y} + {}^{1}_{0}\mathrm{n}$

C ${}^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{144}_{56}\mathrm{X} + {}^{90}_{36}\mathrm{Y} + 2{}^{1}_{0}\mathrm{n}$

D ${}^{235}_{92}\mathrm{U} \rightarrow {}^{145}_{56}\mathrm{X} + {}^{91}_{36}\mathrm{Y}$

20 Nuclide X decays to stable nuclide Y with a half-life of T years.

Geologists are sure that nuclide Y found in a particular rock sample has all come from nuclide X which was present when the rock formed.

The rock is thought to be $3T$ years old.

What is the expected ratio for this rock of $\dfrac{\text{number of atoms of X}}{\text{number of atoms of Y}}$?

A $\dfrac{1}{6}$ **B** $\dfrac{1}{7}$ **C** $\dfrac{1}{8}$ **D** $\dfrac{1}{9}$

21 The rate of rotation of a DVD during playback varies from 570 to 1600 revolutions per minute.

What is the maximum angular velocity of the DVD during playback?

A $27\,\text{rad s}^{-1}$ **B** $60\,\text{rad s}^{-1}$ **C** $170\,\text{rad s}^{-1}$ **D** $10\,000\,\text{rad s}^{-1}$

22 A simple pendulum consists of a mass of 0.200 kg on a light inextensible string of length 1.20 m. The mass is displaced sideways until it has risen 0.050 m from its equilibrium position and then it is released.

What is the tension in the string as the mass passes through its lowest position?

A 0.363 N **B** 1.80 N **C** 1.96 N **D** 2.13 N

23 An object undergoes simple harmonic motion.

Which of the following is **not** true of its motion?

A The acceleration is always towards its equilibrium position.

B The acceleration is directly proportional to its displacement from equilibrium.

C The kinetic energy is directly proportional to the amplitude of its oscillation.

D The potential energy increases with the square of its distance from equilibrium.

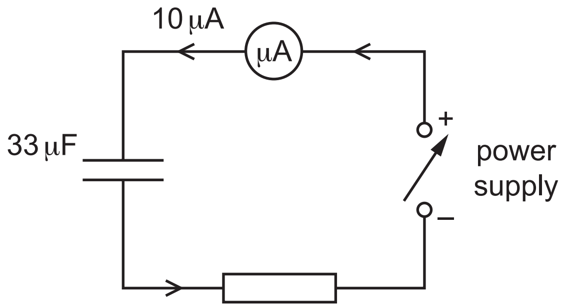
24 A small mass on a vibrating platform undergoes simple harmonic motion. The total energy of the mass is 18 mJ.

The amplitude of the oscillation is now doubled and the time period is increased to be three times as long.

What is the new total energy of the mass?

A 8 mJ **B** 12 mJ **C** 36 mJ **D** 72 mJ

25 A 33 μF capacitor is in series with a microammeter and a variable voltage power supply.



The capacitor is initially uncharged. The voltage across the power supply is then varied so that a current of 10 μA flows for 5.0 s.

By how much does the energy stored in the capacitor increase?

A 8.3×10^{-16} J **B** 3.8×10^{-5} J **C** 0.76 J **D** 38 J

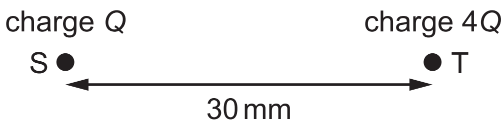
26 A charged capacitor is discharged through a resistor. A student measures the voltage V across the capacitor as a function of time t as the capacitor discharges.

He then plots a graph of the natural logarithm of V (ln$V$) against t and determines its gradient m.

Which expression is equal to the time constant for the discharge circuit?

A m **B** $-m$ **C** $\frac{1}{m}$ **D** $\frac{-1}{m}$

27 Two point charges, S and T, are separated by a distance of 30 mm. The charge on S is $+Q$ and the charge on T is $+4Q$.



How far from S will the electric fields of the two charges be equal in size and opposite in direction?

A 6 mm **B** 10 mm **C** 20 mm **D** 24 mm

28 What is the ratio $\dfrac{\text{force of gravity on Earth due to Sun}}{\text{force of gravity on Earth due to Moon}}$?

mass of Sun = 2.0×10^{30} kg

mass of Moon = 7.4×10^{22} kg

mean distance between Earth and Moon = 3.8×10^{8} m

mean distance between Earth and Sun = 1.5×10^{11} m

A 170 **B** 6.8×10^{3} **C** 1.1×10^{10} **D** 4.2×10^{12}

29 A moon orbits a planet at a radius of R. Its orbital period is T.

A second moon orbits at a radius of $\frac{2}{3}R$.

In terms of T, what is the orbital period of the second moon?

A $0.30\,T$ **B** $0.54\,T$ **C** $1.8\,T$ **D** $3.4\,T$

30 In the equation shown, what does the symbol Φ represent?

$$E = \frac{-\,\mathrm{d}(N\Phi)}{\mathrm{d}t}$$

A magnetic flux

B magnetic flux density

C magnetic flux linkage

D rate of change of magnetic flux linkage

31 Charged particles created in high energy collisions at particle accelerators such as the Large Hadron Collider at CERN are detected as they pass through strong magnetic fields. The curvature of the particle paths in the magnetic field can be used to calculate certain properties of the particles.

Two charged particles, X and Y, deflect in the same direction as they leave a collision but their paths have different curvatures. The radius of curvature for particle X is double that for Y.

Which statement explains this?

A The particles are identical but particle X is moving at twice the velocity of Y.

B The particles are travelling at the same speed but the ratio of mass to charge for Y is double the ratio of mass to charge for X.

C The particles have the same momentum but particle X has double the charge of particle Y.

D The particles have the same velocity and charge but particle Y has double the mass of particle X.

32 A cylinder with a movable piston contains a constant mass of an ideal gas. The gas is slowly compressed at constant temperature until its volume has halved. The work done to compress the gas is W.

Which row gives the heat flow Q into the gas and the change in the internal energy ΔU of the gas?

	Q	ΔU
A	$-W$	0
B	$-W$	W
C	0	0
D	0	W

33 The number and speed of some gas molecules is given in the table.

number of molecules	molecule speed / $m s^{-1}$
1	200
1	300
3	400
2	500
1	600

What is the root mean square speed of the gas molecules?

A $400\,m\,s^{-1}$ **B** $403\,m\,s^{-1}$ **C** $413\,m\,s^{-1}$ **D** $429\,m\,s^{-1}$

34 A flask contains 0.800 moles of an ideal gas at a temperature of 300 K.

What is the total kinetic energy of the molecules of the gas?

A 5.0×10^{-21} J **B** 6.2×10^{-21} J **C** 3.0×10^{3} J **D** 3.7×10^{3} J

35 The density of air is $1.20\,kg\,m^{-3}$ at a temperature of 20 °C and standard atmospheric pressure.

What is the density of air at a temperature of 27 °C and standard atmospheric pressure?

A $0.89\,kg\,m^{-3}$ **B** $1.17\,kg\,m^{-3}$ **C** $1.23\,kg\,m^{-3}$ **D** $1.62\,kg\,m^{-3}$

36 What is meant by the term *nuclear binding energy*?

A the difference between the mass of a nucleus and the mass of its constituent nucleons

B the energy equivalent to the mass of the nucleus calculated by $\Delta E = c^2 \Delta m$

C the total energy stored in the bonds between nucleons inside a nucleus

D the work that must be done to completely separate all the nucleons inside a nucleus

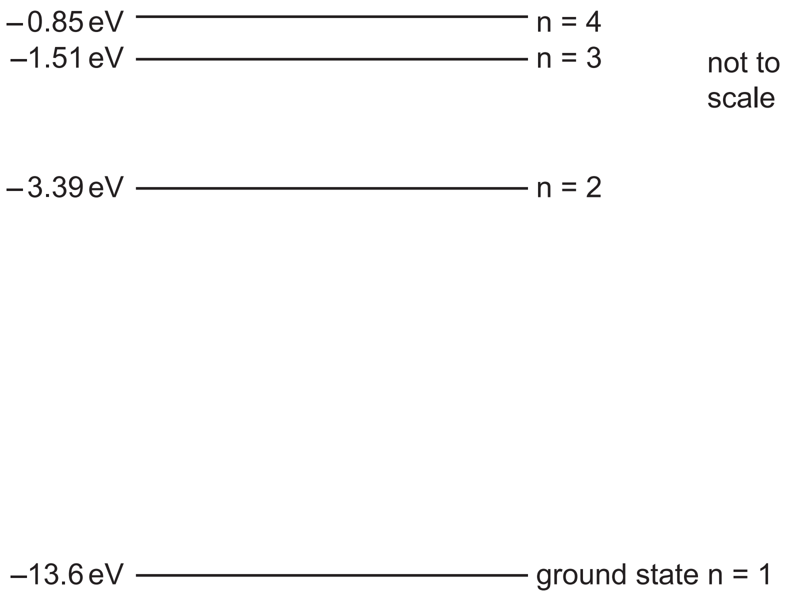
37 A source of gamma-radiation is surrounded by a protective layer of lead.

The protective layer must reduce the intensity of the gamma-radiation by 75%. The attenuation coefficient of lead for these gamma-rays is $1.13\,\text{cm}^{-1}$.

Which thickness of lead is required?

A 0.11 cm **B** 0.25 cm **C** 0.53 cm **D** 1.2 cm

38 The diagram shows electron energy levels for a hydrogen atom.



Which electron transfers could occur with the emission of visible light?

A n = 2 to n = 3

B n = 3 to n = 2

C n = 3 to n = 4

D n = 4 to n = 3

39 When the emission spectrum of hydrogen gas is observed in the laboratory, a certain line is found at a wavelength of 656 nm.

The same line, viewed in the spectrum from a distant galaxy, is observed at 659 nm.

How far away is the galaxy? Use $H_0 = 65\,\mathrm{km\,s^{-1}\,Mpc^{-1}}$ for the Hubble constant.

A 21 Mpc

B 4.6×10^3 Mpc

C 21×10^3 Mpc

D 4.6×10^6 Mpc

40 Stars emit electromagnetic radiation across a range of wavelengths. For each star there is one wavelength λ_{max} at which the intensity of electromagnetic radiation is a maximum.

The table shows the values of λ_{max} and luminosity L for the Sun and another star.

	λ_{max} / nm	luminosity L / W
Sun	520	3.9×10^{26}
star	660	1.9×10^{26}

The radius of the Sun is 7.0×10^8 m.

What is the radius of the star?

A 3.0×10^8 m **B** 6.2×10^8 m **C** 7.9×10^8 m **D** 1.6×10^9 m