PHYSICS (PRINCIPAL) **9792/01**

Paper 1 Multiple Choice **May/June 2019**

1 hour 30 minutes

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.

This document consists of **21** printed pages and **3** blank pages.

Cambridge Assessment
International Education

[Turn over

Data

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

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
	$s = \left(\dfrac{u+v}{2}\right)t$
heating	$\Delta E = mc\Delta\theta$

change of state	$\Delta E = mL$
refraction	$n = \dfrac{\sin\theta_1}{\sin\theta_2}$
	$n = \dfrac{v_1}{v_2}$

| diffraction | | electromagnetic induction | $E = -\dfrac{d(N\varPhi)}{dt}$ |

diffraction

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

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

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

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

photon energy $\qquad E = hf$

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

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

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

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

$\qquad F = -m\omega^2 x$

$\qquad E = \frac{1}{2}mA^2\omega^2$

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

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

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

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

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

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

magnetic force $\qquad F = BIl \sin\theta$

$\qquad F = BQv \sin\theta$

electromagnetic induction $\qquad E = -\dfrac{d(N\varPhi)}{dt}$

Hall effect $\qquad V = Bvd$

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

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

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

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

radioactive decay $\qquad \dfrac{dN}{dt} = -\lambda N$

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

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

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

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

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

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

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

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

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

1   A small steel sphere is fixed to a large steel sphere.

Which point best represents the centre of gravity of the combined spheres?
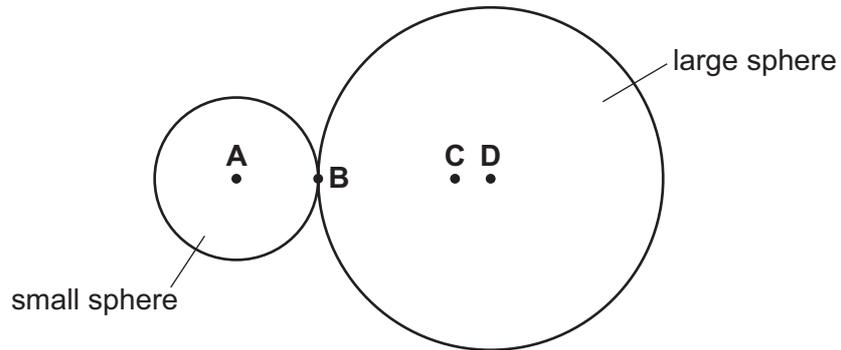
2   Four forces acting on an aeroplane are weight W, horizontal thrust T, vertical lift L, and horizontal drag D. Any other forces can be ignored.
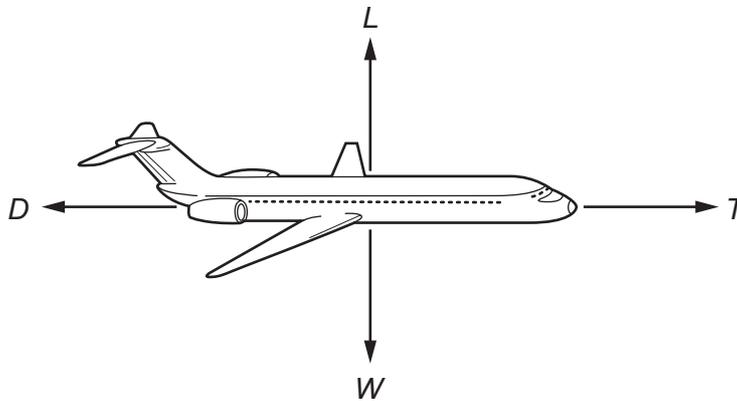
The aeroplane has a constant horizontal speed of $200 \, \text{m s}^{-1}$ and is ascending at a steady rate of four metres per minute.

Which statement is correct?

A $L > W$ and $T > D$

B $L > W$ and $T = D$

C $L > W$ and $T < D$

D $L = W$ and $T = D$

3 A ball is thrown with kinetic energy K from ground level at an angle of 45° to the horizontal.

Which statement is **not** correct?

Assume air resistance is negligible.

A The kinetic energy of the ball is $\frac{K}{2}$ at the maximum height.

B The kinetic energy of the ball is $\frac{K}{2}$ when the ball reaches a height equal to half the maximum height.

C The potential energy of the ball is $\frac{K}{2}$ at the maximum height.

D The potential energy of the ball is $\frac{K}{4}$ when the ball reaches a height equal to half the maximum height.

4 Two identical spheres, X and Y, are approaching one another as shown.
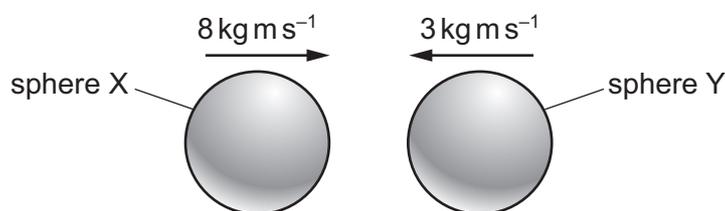
Immediately before the collision, sphere X has a momentum of $8\,\text{kg}\,\text{m}\,\text{s}^{-1}$ and sphere Y has a momentum of $3\,\text{kg}\,\text{m}\,\text{s}^{-1}$.

Immediately after the collision, one of the spheres has a momentum of $3\,\text{kg}\,\text{m}\,\text{s}^{-1}$ to the right.

What is the momentum of the other sphere?

A $2\,\text{kg}\,\text{m}\,\text{s}^{-1}$ to the left

B $2\,\text{kg}\,\text{m}\,\text{s}^{-1}$ to the right

C $8\,\text{kg}\,\text{m}\,\text{s}^{-1}$ to the left

D $8\,\text{kg}\,\text{m}\,\text{s}^{-1}$ to the right

5 Which statement is **not** correct?

A Cast iron is strong and brittle.

B Dry concrete is stiff and malleable.

C Window glass is hard but not tough.

D Mild steel is strong and ductile.

6 A 1.0 kg mass is hung from a wire resulting in a small extension.

A second wire is made of the same material and has the same length, but twice the diameter of the original wire.

What mass hung on the second wire will produce the same extension as that of the original wire?

A 0.25 kg **B** 0.50 kg **C** 2.0 kg **D** 4.0 kg

7 A stone falls from rest from height h.

Which graph shows the variation of the gravitational potential energy E_P and the kinetic energy E_K of the stone with the distance fallen by the stone?

Assume air resistance is negligible.
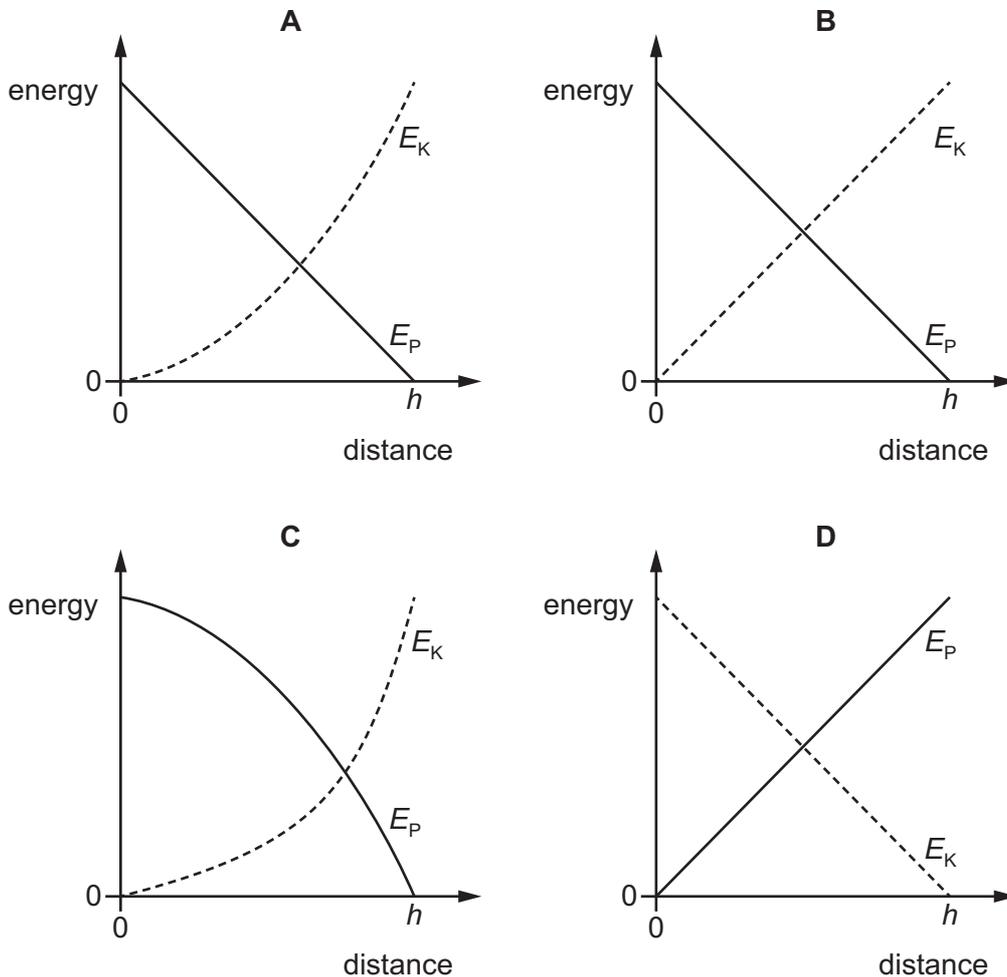
8 A vacuum flask contains 500 g of water at 10 °C.

The water is cooled by adding 30 g of ice at 0 °C to the water.

What is the lowest temperature of the water as it cools?

specific latent heat of water = 330 kJ kg^{-1}
specific heat capacity of water = 4.2 kJ kg^{-1} K^{-1}

A 4.7 °C   **B** 5.0 °C   **C** 5.3 °C   **D** 9.4 °C

9 Kirchhoff's second law is based on a conservation law.

Which quantity is conserved?

A charge

B current

C energy

D momentum

10 A student is carrying out an experiment to measure the resistivity of a resistance wire.

A micrometer screw gauge is used to measure the diameter D of the wire.

A measured length L of the wire is connected in series with an ammeter and a power supply. A voltmeter is connected in parallel with the wire.

The current I and the voltage V are read from the meters.

Which expression can be used to find the resistivity of the material in the wire?

A $\dfrac{\pi D^2 V}{4IL}$ **B** $\dfrac{\pi D^2 I}{4LV}$ **C** $\dfrac{\pi DV}{IL}$ **D** $\dfrac{\pi D^2 V}{IL}$

11 A battery with internal resistance is connected to a fixed resistor.


battery
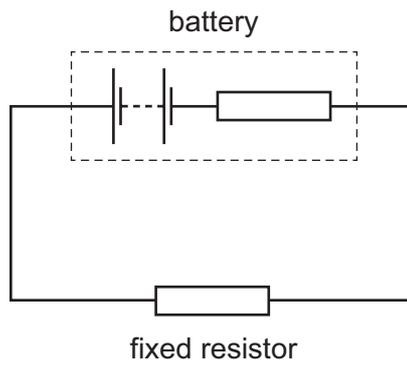
fixed resistor

The battery is replaced by one of the same e.m.f. but with a larger internal resistance.

What happens to the terminal potential difference across the battery and the current through the fixed resistor?

	terminal potential difference across the battery	current through the fixed resistor
A	decreases	decreases
B	decreases	stays the same
C	stays the same	decreases
D	stays the same	stays the same

12 In the circuit shown, the battery of e.m.f. 6.0 V has negligible internal resistance.

6.0 V
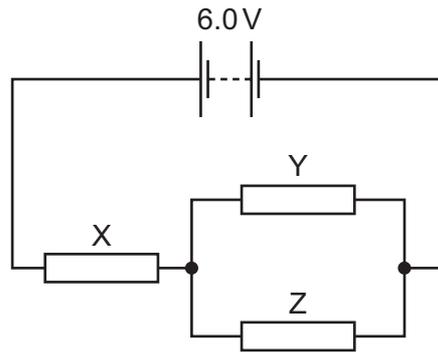
In a time of one minute, 150 C of charge passes through the battery. In the same time, 300 J of energy is dissipated in resistor X and a charge of 60 C passes through resistor Y.

What are the values of the charge that passes through resistor Z and the energy dissipated in resistor Z in this time?

	charge that passes through resistor Z / C	energy dissipated in resistor Z / J
A	60	300
B	60	360
C	90	300
D	90	360

13 Which statement about waves in the electromagnetic spectrum is always correct?

A Gamma rays have greater amplitude than X-rays.

B Microwaves have higher frequency than ultraviolet radiation.

C Radio waves have longer wavelength than infrared waves.

**D** Visible light waves travel faster in a vacuum than gamma rays.

14 A glass table top has a small pool of spilled water on its surface.

Which diagram shows the path of the light beam from a laser pen as it passes through the water, the glass and into the air below?

refractive index of water = 1.3
refractive index of glass 1.5
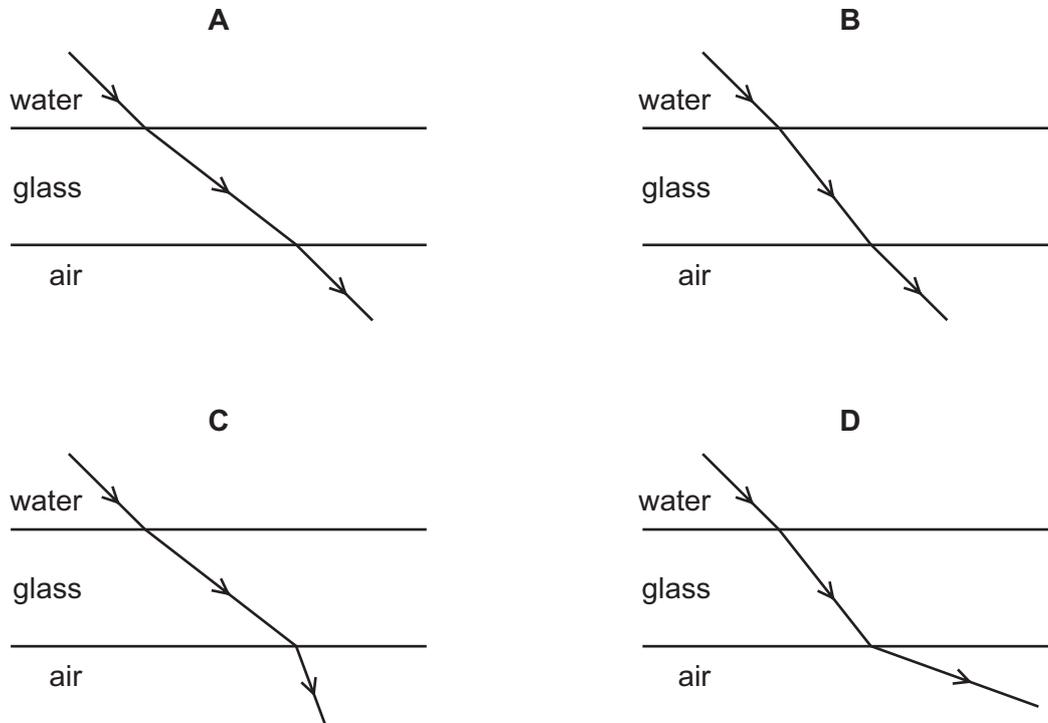
15 A note of frequency 170 Hz is played through two speakers, X and Y, as shown.
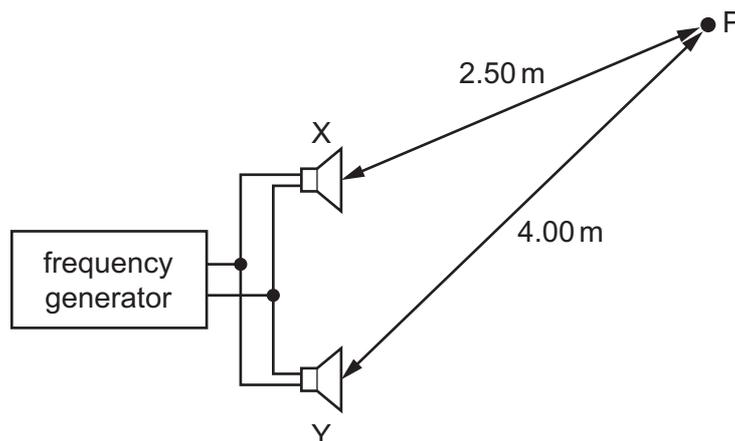
P is a point 2.50 m from X and 4.00 m from Y.

The speed of sound in air is $340\,\text{m}\,\text{s}^{-1}$.

What is the phase difference at point P between the sound waves arriving from the two speakers?

A $\dfrac{3\pi}{4}$ rad   **B** $\dfrac{3\pi}{2}$ rad   **C** 2π rad   **D** 6π rad

16 A thin beam of monochromatic light falls on a diffraction grating at normal incidence. The third order diffracted beam occurs at an angle of 50° to the normal.

What is the highest order visible with this grating at this wavelength?

A 3   **B** 4   **C** 5   **D** 6

17 A nuclear reaction that occurs frequently inside the hot core of stars is shown below.

$$_{1}^{2}\text{H} + {}_{1}^{2}\text{H} \rightarrow {}_{2}^{3}\text{He} + {}_{0}^{1}\text{n}$$
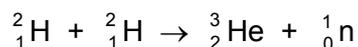
The reaction shows two nuclei of hydrogen joining together to make a nucleus of helium and a neutron.

Which statement about this reaction is correct?

A A large amount of energy is absorbed.

B The neutron can go on to produce a chain reaction.

C The reaction is an example of a fission reaction.

D Very high temperatures are required for this reaction to occur.

18 When exposed to neutrons of the appropriate energy, a uranium-238 nucleus, $^{238}_{92}U$, can absorb a neutron. The resulting nucleus then decays by emitting a series of beta-minus particles only.

What could represent a nucleus in the decay series?

A $^{237}_{94}X$ **B** $^{239}_{90}X$ **C** $^{239}_{94}X$ **D** $^{241}_{92}X$
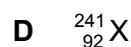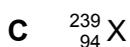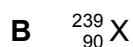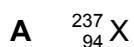
19 Monochromatic light of frequency f falls onto a metal surface causing photoelectrons to be emitted from the surface.

The maximum kinetic energy of the photoelectrons can be determined by bringing them to rest by the use of a stopping potential V. A graph of V against f is a straight line.
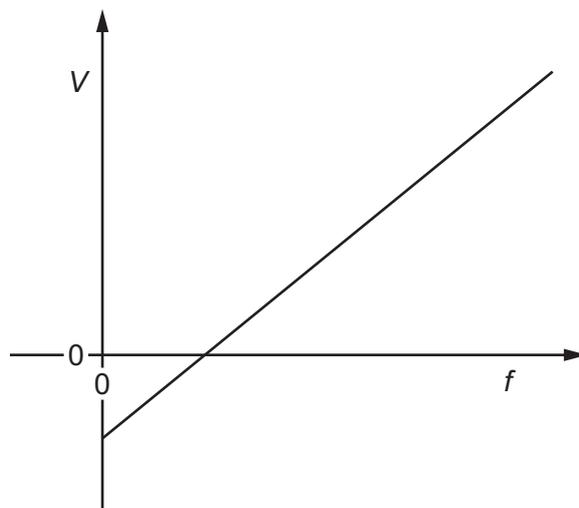
What are the gradient and y-intercept of this graph?

h = Planck constant
e = magnitude of electron charge
Φ = work function of the metal surface

|	gradient	y-intercept
A	h	$\dfrac{\Phi}{e}$
B	h	$\dfrac{-\Phi}{e}$
C	$\dfrac{h}{e}$	$\dfrac{\Phi}{e}$
D	$\dfrac{h}{e}$	$\dfrac{-\Phi}{e}$

20 Two electrons, X and Y, are ejected from an atom with de Broglie wavelengths λ_X and λ_Y respectively.

The kinetic energy of X is double the kinetic energy of Y.

What is the ratio $\dfrac{\lambda_Y}{\lambda_X}$ of their de Broglie wavelengths?

A   0.50   **B**   0.71   **C**   1.4   **D**   2.0

21 The two graphs are for the motion of a body undergoing simple harmonic motion.
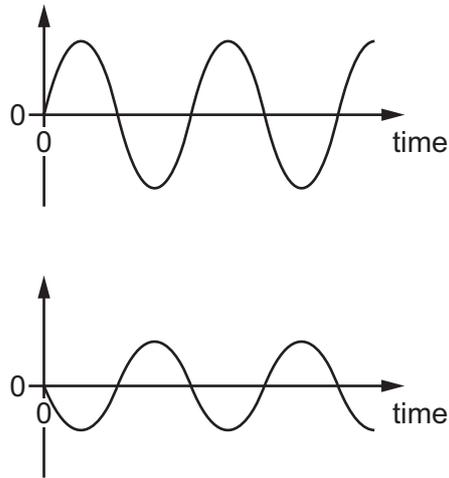
What could the two graphs show?

A   acceleration with time and displacement with time

B   acceleration with time and velocity with time

C   displacement with time and velocity with time

D   resultant force with time and velocity with time

22 Which graph best shows a vibrating system undergoing critical damping?

A

amplitude / cm

B

amplitude / cm

C

amplitude / cm

D

amplitude / cm
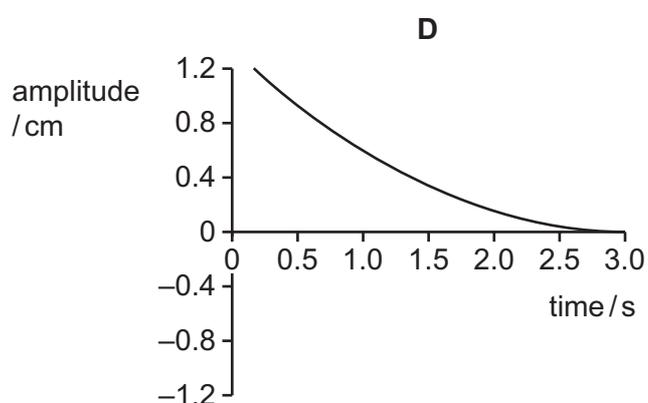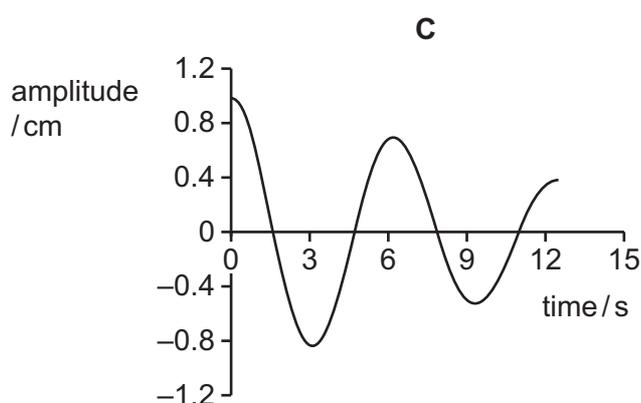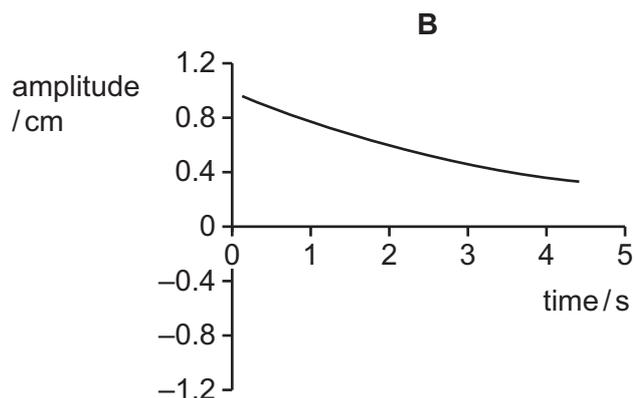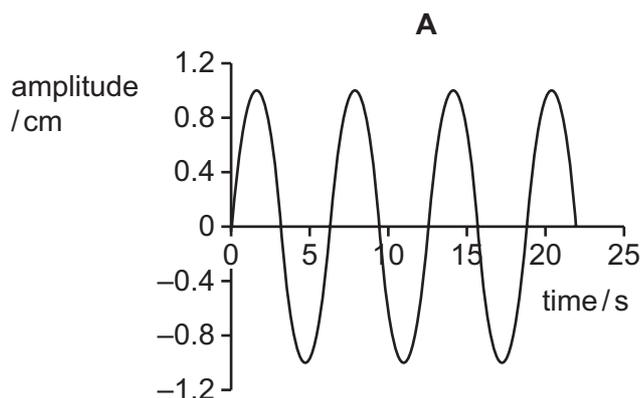
23 The Moon has a mass of 7.35×10^{22} kg. Its orbital radius, as it moves around the Earth, is 3.84×10^{8} m.

The moon completes one orbit in a time of 27.3 days. Assume this orbit to be circular around a stationary Earth.

What is the gravitational force of attraction between the Moon and the Earth?

A 2.00×10^{20} N

B 1.15×10^{23} N

C 7.21×10^{23} N

D 7.52×10^{25} N

24 A simple pendulum of length l is attached to a bob of mass m. It is displaced sideways so that the bob rises through a vertical distance h and then released.
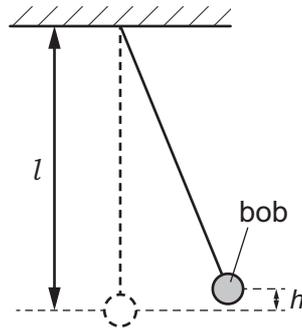
What is the tension in the string as the bob passes through its lowest position?

A mg **B** $mg - \dfrac{2mgh}{l}$ **C** $mg + \dfrac{2mgh}{l}$ **D** $\dfrac{2mgh}{l}$

25 A polar molecule can be modelled by two point charges $+Q$ and $-Q$ separated by a distance $2r$ as shown.
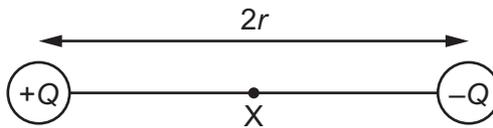

Point X is the midpoint between the two charges.

Which expression gives the magnitude of the electric field strength at point X?

A 0 **B** $\dfrac{Q^2}{16\pi\varepsilon_o r^2}$ **C** $\dfrac{Q}{8\pi\varepsilon_o r^2}$ **D** $\dfrac{Q}{2\pi\varepsilon_o r^2}$

26 A uniform electric field is set up between two parallel metal plates separated by a distance d.
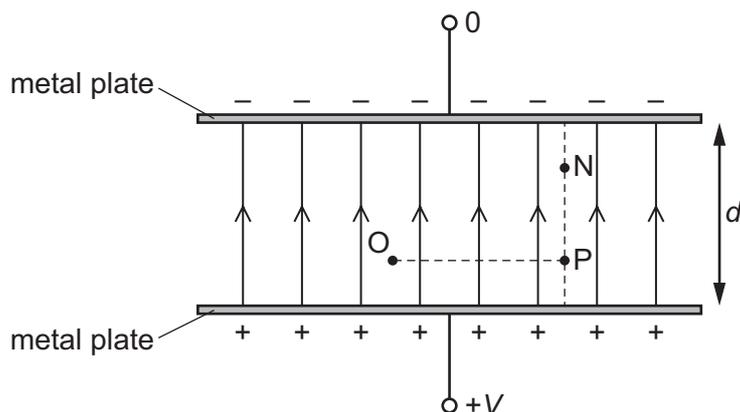
The potential difference between the plates is V.

A small charge is moved a distance OP from point O to point P. The charge is then moved a distance PN to point N. The total displacement of the charge is ON.

What is the change in potential of the charge as it moves from point O to point N?

A $\quad +\dfrac{PN}{d} \times V$ 　　　 B $\quad -\dfrac{PN}{d} \times V$ 　　　 C $\quad +\dfrac{ON}{d} \times V$ 　　　 D $\quad -\dfrac{ON}{d} \times V$

27 A capacitor in series with a resistor has a time constant of 5.0 s. The capacitor is charged to a potential difference (p.d.) V_0.

It is then discharged through the resistor until the p.d. across the capacitor is $\dfrac{V_0}{4}$.

How long does this discharge take?

A　0.22 s 　　　　 B　3.0 s 　　　　 C　6.9 s 　　　　 D　10 s

28 A spacecraft moves along a straight line from X to Y through the gravitational field of a planet.

spacecraft

X ● - - - - - - - - - ● - - - - - - - - - - - - - - - - ● Y

○ small
planet
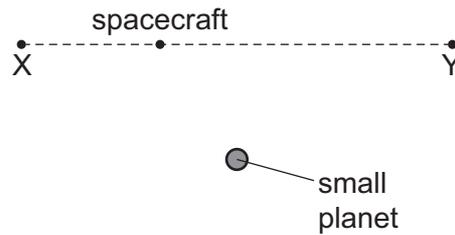
What happens to the magnitude and direction of the gravitational force on the spacecraft as it moves from X to Y?

|	magnitude of force	direction of force
A	decreases then increases	always away from the planet
B	decreases then increases	always towards the planet
C	increases then decreases	always away from the planet
D	increases then decreases	always towards the planet

29 When a very massive star reaches the end of its life it undergoes a supernova explosion and its core collapses. The collapsing spherical core will become a black hole if the escape velocity at its surface is equal to the speed of light, c. Assume that relativistic effects can be ignored.

Which equation gives the radius r at which a core of mass M becomes a black hole?

A $r = \dfrac{2GM}{c^2}$ **B** $r = \dfrac{\sqrt{GM}}{c}$ **C** $r = \dfrac{c^2}{2GM}$ **D** $r = \dfrac{c}{\sqrt{GM}}$

30 A rectangular slice of semiconductor is placed in a uniform magnetic field of flux density 0.32 T. The magnetic field is perpendicular to the shaded section of the slice shown. The dimensions of the semiconductor are also shown.
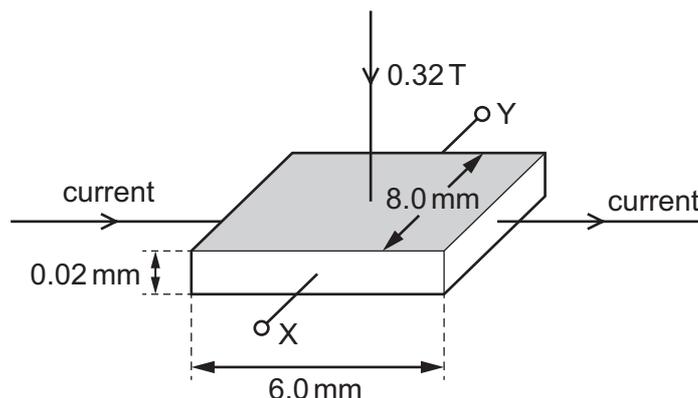

A constant current is passed through the semiconductor.

A Hall voltage of 48 μV is measured between the terminals X and Y.

What is the mean drift speed of the charge carriers within the semiconductor?

A $1.9 \times 10^{-2}\,\mathrm{m\,s^{-1}}$

B $2.5 \times 10^{-2}\,\mathrm{m\,s^{-1}}$

C $7.5\,\mathrm{m\,s^{-1}}$

D $53\,\mathrm{m\,s^{-1}}$

31 A charged particle is accelerated through a potential difference V and injected into a uniform magnetic field of flux density B at 90° to its velocity. The particle follows a curved path of radius r.
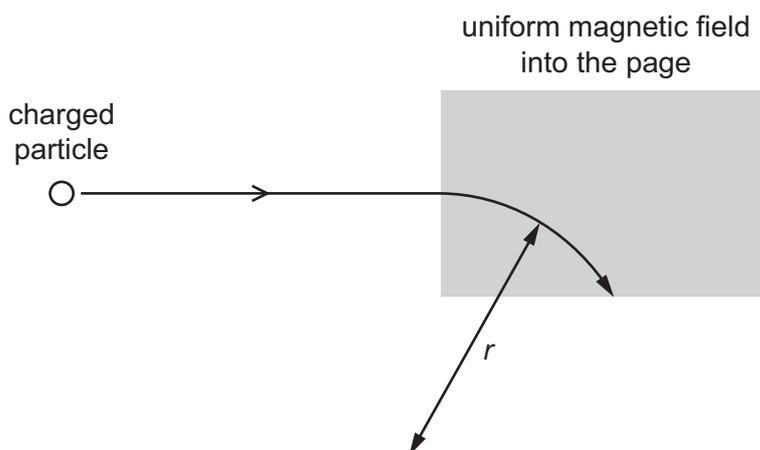
A second identical particle with the same charge is accelerated though a potential difference of $2V$ and injected into the same magnetic field.

Which expression gives the radius of the path followed by the second particle?

A $\dfrac{r}{2}$ 　　　　 B $r\sqrt{2}$ 　　　　 C $2r$ 　　　　 D $4r$

32 Which statement about gases is **not** correct?

   A Brownian motion is caused by imbalances in molecular bombardment.

   B In theory, an ideal gas would exert zero pressure at absolute zero.

   C Molecules of different gases have the same root mean square (r.m.s.) speed at the same pressure.

   D Work must be done to compress a gas at constant temperature.

33 At 20 °C molecules of helium have a r.m.s. speed of $1800\,\text{m}\,\text{s}^{-1}$. The mass of a neon molecule is five times the mass of a helium molecule.

What is the r.m.s. speed of molecules of neon at the same temperature?

   A $360\,\text{m}\,\text{s}^{-1}$ **B** $800\,\text{m}\,\text{s}^{-1}$ **C** $4000\,\text{m}\,\text{s}^{-1}$ **D** $9000\,\text{m}\,\text{s}^{-1}$

34 Which list includes the three families of particles in the Standard Model of Particle Physics?

   A baryons, leptons and nucleons

   B leptons, quarks, and force carriers

   C nucleons, leptons and quarks

   D quarks, force carriers and baryons

35 An electron and a positron meet and annihilate.

What will be the energy of each of the two gamma photons emitted?

   **A** $4.1 \times 10^{-14}\,\text{J}$

   B $8.2 \times 10^{-14}\,\text{J}$

   C $1.6 \times 10^{-13}\,\text{J}$

   D $3.2 \times 10^{-13}\,\text{J}$

36 A sample of Europium-144 is prepared, then left to decay.

Its half-life is 612 s.

How long will it take for 90% of the isotope to decay?

   A 40 s   **B** 93 s   **C** 883 s   **D** 2030 s

37 The energy level diagram shows four energy levels for the electrons.
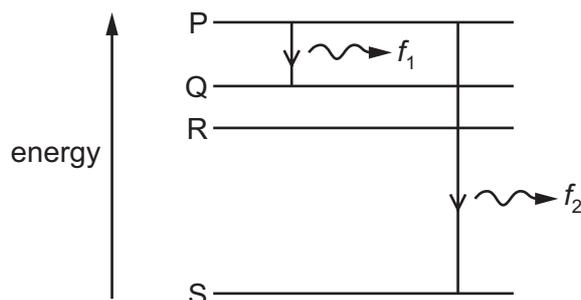
Two electron transitions are also shown together with the frequencies f_1 and f_2 of the emitted photons.

Which statement is **not** correct?

A All the emitted photons have the same speed.

B The frequency of the photon emitted is $f_2 - f_1$ for the transition Q to S.

C The longest wavelength is for the transition Q to R.

D There are five possible spectral lines for these four energy levels.

38 An electron in a hydrogen atom falls from the $n = 3$ energy state to the ground state.

The energy levels of the hydrogen atom can be described by the empirical equation

$$E_n = \frac{-13.6\,\text{eV}}{n^2}.$$

What is the wavelength, to two significant figures, of the photon emitted?

A 91 nm **B** 100 nm **C** 140 nm **D** 820 nm

39 The age of the Universe is estimated to be about 14 billion years.

Which statement is correct?

A The age of the Universe can be estimated from Wein's displacement law.

B The age of the Universe is approximately equal to the Hubble constant.

C The Universe has been expanding into pre-existing empty space for the last 14 billion years.

D The idea that the Universe is expanding can be explained by galactic redshift.

40 Two stars, X and Y, have equal luminosity but the radius of star X is four times greater than the radius of star Y.

What is the ratio $\dfrac{\text{surface temperature of X}}{\text{surface temperature of Y}}$?

A $\dfrac{1}{16}$ **B** $\dfrac{1}{4}$ **C** $\dfrac{1}{2}$ **D** $\dfrac{1}{\sqrt{2}}$

BLANK PAGE

BLANK PAGE

BLANK PAGE