Cambridge International Examinations
Cambridge Pre-U Certificate

PHYSICS (PRINCIPAL) **9792/01**

Paper 1 Part A Multiple Choice **May/June 2014**

1 hour 15 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 **20** printed pages.

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	$m_\mathrm{e} = 9.11 \times 10^{-31}\,\mathrm{kg}$
proton mass	$m_\mathrm{p} = 1.67 \times 10^{-27}\,\mathrm{kg}$
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	$N_\mathrm{A} = 6.02 \times 10^{23}\,\mathrm{mol^{-1}}$
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

$$s = ut + \tfrac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$s = \left(\frac{u+v}{2}\right)t$$

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 $x = A\cos\omega t$

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

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

$F = -m\omega^2 x$

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

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

electric force $F = \dfrac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$

electrostatic potential energy $W = \dfrac{Q_1Q_2}{4\pi\varepsilon_0 r}$

gravitational force $F = -\dfrac{Gm_1m_2}{r^2}$

gravitational potential energy $E = -\dfrac{Gm_1m_2}{r}$

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

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

$\Delta E \Delta t \geqslant \dfrac{h}{2\pi}$

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 Which row contains one vector quantity and one scalar quantity?

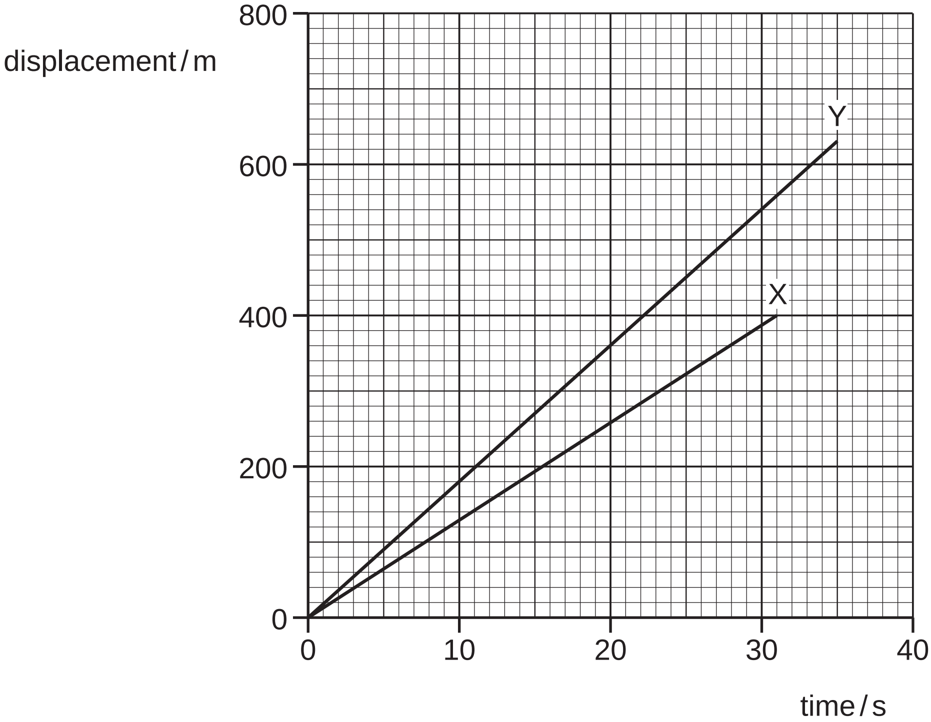
A acceleration, velocity

B displacement, force

C length, weight

D mass, time

2 A displacement-time graph is plotted for two lifts, X and Y.

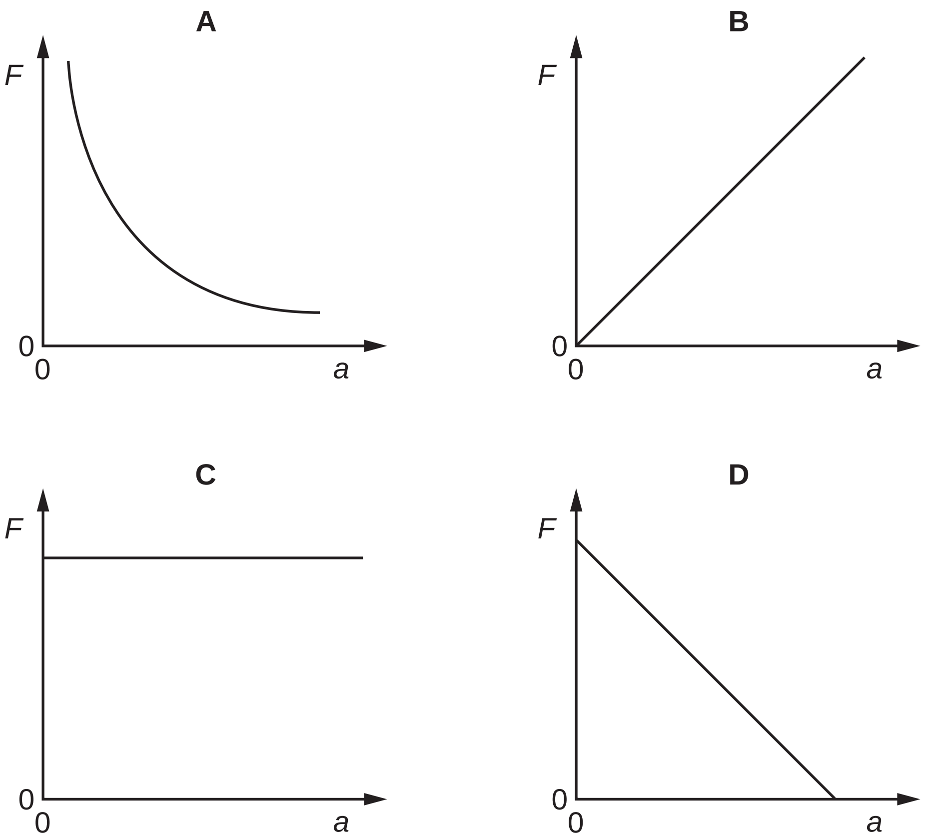


What is the value of the ratio $\dfrac{\text{lift X velocity}}{\text{lift Y velocity}}$?

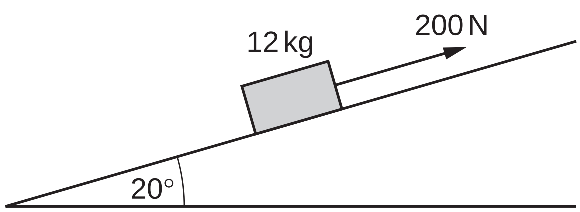
A 0.6 **B** 0.7 **C** 1.4 **D** 1.6

Space for working

3 Which graph shows the relationship between the resultant force *F* acting on an object and the acceleration *a* of the object? Assume that mass of the object does not change.



4 An object of mass 12 kg is pulled up a smooth inclined plane by a force of 200 N parallel to the plane. The plane is at an angle of 20° to the horizontal.



What is the resultant force on the object?

A 110 N **B** 160 N **C** 196 N **D** 200 N

Space for working

5 A ball is thrown vertically downwards at $4.0\,\mathrm{m\,s^{-1}}$ from a height of 120 cm.

With which speed does it hit the ground? Ignore air resistance.

A $4.8\,\mathrm{m\,s^{-1}}$ **B** $6.3\,\mathrm{m\,s^{-1}}$ **C** $40\,\mathrm{m\,s^{-1}}$ **D** $49\,\mathrm{m\,s^{-1}}$

6 Which statement about collisions is correct?

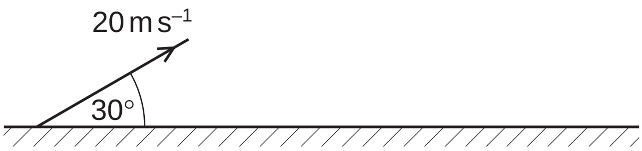
A In an inelastic collision, momentum may not be conserved.

B In any collision, kinetic energy is conserved.

C In any collision of two of more objects, the total momentum before and after cannot be zero.

D In any collision, total momentum is conserved.

7 A projectile of mass 10 kg is fired at $20\,\mathrm{m\,s^{-1}}$ at an angle of 30° to the horizontal.

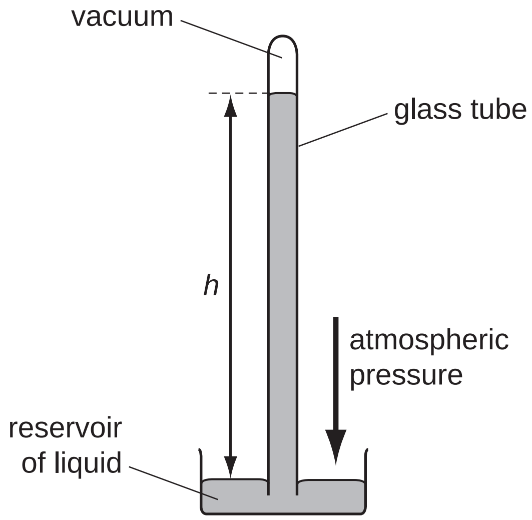


What is its kinetic energy at the top of its flight?

A 0 J **B** 500 J **C** 1500 J **D** 2000 J

Space for working

8 A barometer can be used to measure atmospheric pressure as shown.



The pressure of the column of liquid exerted on the reservoir surface is equal to the atmospheric pressure.

For a barometer containing water the height h is 10.4 m. A second barometer, with a glass tube which has twice the cross-sectional area, contains alcohol.

density of water = $1.0 \times 10^3\,\text{kg}\,\text{m}^{-3}$
density of alcohol = $0.8 \times 10^3\,\text{kg}\,\text{m}^{-3}$

What is the height h of the alcohol?

A 4.2 m **B** 6.5 m **C** 8.3 m **D** 13 m

9 A satellite is in a circular orbit around the Earth at a height where the Earth's gravitational field strength is $9.0\,\text{N}\,\text{kg}^{-1}$.

What is the weight of the satellite at this point?

A zero

B much smaller than its weight on the surface of the Earth, but not zero

C slightly less than its weight on the surface of the Earth

D equal to its weight on the surface of the Earth

Space for working

10 A piece of rock, which weighs 15.0 N on the Earth, weighs 2.46 N on the Moon.

What is the mass of the rock and the gravitational field strength on the Moon?

	mass / kg	gravitational field strength / $N\,kg^{-1}$
A	1.53	1.61
B	1.53	6.10
C	147	0.0167
D	147	6.10

11 A force of 20.0 N stretches a spring by 5.0 cm. The spring obeys Hooke's law.

Which row gives the spring constant and the work done in stretching the spring?

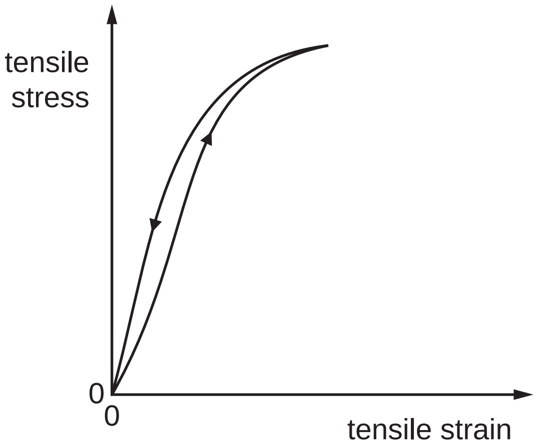
	spring constant / $N\,m^{-1}$	work done / J
A	4	0.5
B	400	0.5
C	4	50
D	400	50

Space for working

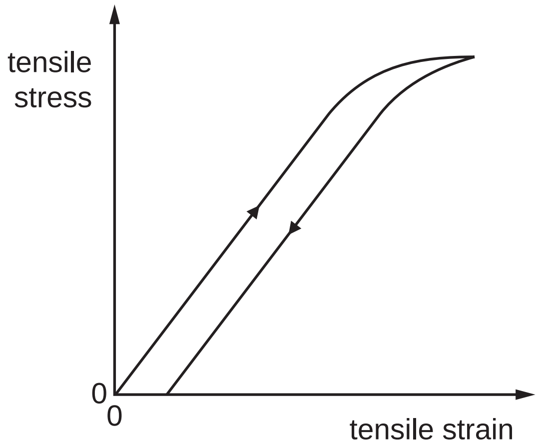
12 The graphs show stress-strain characteristics for four different materials.

Which characteristic is most likely to be that of a sample of copper wire?

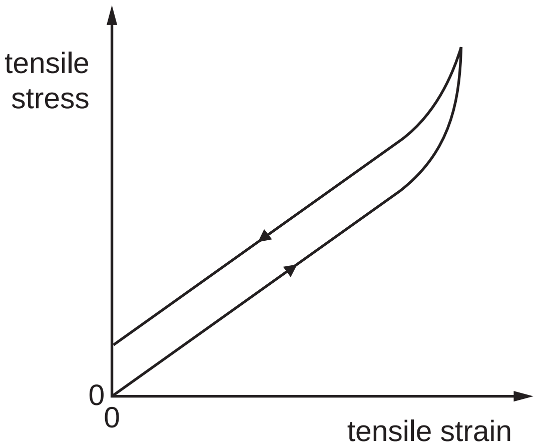
A



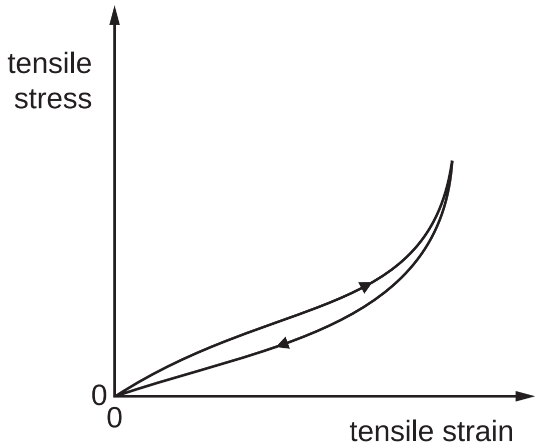
B



C



D



Space for working

13 Two cylindrical wires, X and Y, are made of the same material.

Wire X is twice as long as wire Y, but it has half the diameter. When the same load is applied to each wire, the stress in wire X is 2.0 GPa and its extension is 4.0 mm.

Which row is correct for wire Y?

	stress in wire Y / GPa	extension of wire Y / mm
A	0.5	0.5
B	0.5	1.0
C	1.0	0.5
D	1.0	1.0

14 A stone is attached to one end of a piece of elastic thread. The other end of the thread is fixed.

The stone is dropped.

When is the elastic strain energy in the thread greatest?

A as the stone is dropped

B when the thread first becomes taut

C at the lowest point of the stone's fall

D when the stone finally comes to rest in equilibrium hanging from the thread

15 An electric motor is 40% efficient. When operating at full power, it has a useful 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

Space for working

16 A metal block X of mass m, specific heat capacity c and temperature 80°C is placed in good thermal contact with a second metal block Y of mass $2m$, specific heat capacity $2c$ and temperature 30°C.

Assume no energy losses to the surroundings.

What will be the final temperature of both blocks?

A 30 °C **B** 40 °C **C** 55 °C **D** 70 °C

17 A refrigeration system requires heat to be extracted from a cool-box at a rate of 2.5 kW. This is achieved by having a special fluid, called the refrigerant, vaporise into a gas. The energy required for this vaporisation is extracted from the cool-box.

The specific latent heat of vaporisation of the refrigerant is 150 kJ kg^{-1}.

What is the mass of refrigerant that needs to be vaporised in one minute?

A 17 g **B** 1.0 kg **C** 17 kg **D** 1000 kg

18 In a body-armour test, a bullet of mass 1.9 g is fired with a velocity of 530 m s^{-1} into a fixed block of Kevlar. The bullet comes to rest within the Kevlar block, causing the temperature of the block to rise by 0.38 °C.

The block has a mass of 0.50 kg.

What is the specific heat capacity of the Kevlar?

A 1.4 kJ kg^{-1} K^{-1}

B 1.4 MJ kg^{-1} K^{-1}

C 2.7 kJ kg^{-1} K^{-1}

D 2.7 J kg^{-1} K^{-1}

Space for working

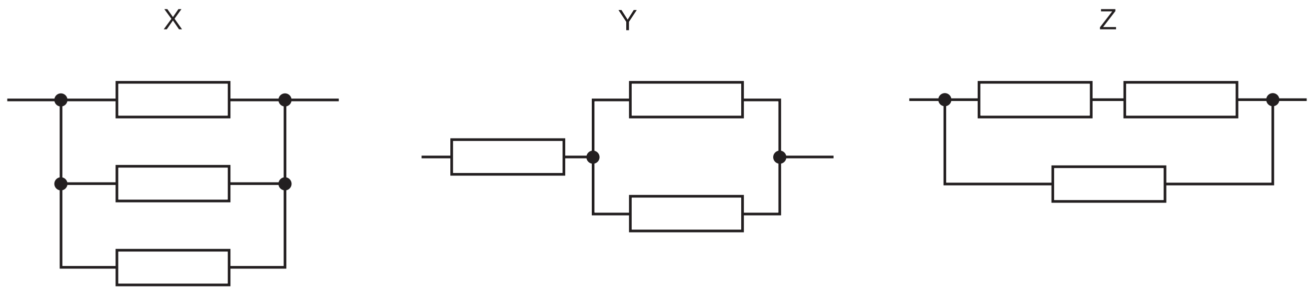
19 A torch is switched on and left until its battery is flat.

During this time, the current in the lamp remains steady at 0.60 A for three hours and then decreases uniformly to zero in the next hour.

What is the total charge passing through the lamp?

A 1.2×10^2 C **B** 4.3×10^3 C **C** 7.6×10^3 C **D** 8.6×10^3 C

20 All of the resistors in the circuits X, Y and Z below are identical.



Which list shows these circuits in order of increasing resistance, lowest to highest?

A X → Y → Z

B X → Z → Y

C Y → X → Z

D Y → Z → X

21 A long piece of wire has a resistance of 2.0 Ω. It is cut into 40 equal lengths and these are connected in parallel to form a multi-stranded cable.

What is the resistance of the cable?

A 1.3×10^{-3} Ω **B** 0.05 Ω **C** 80 Ω **D** 3.2×10^3 Ω

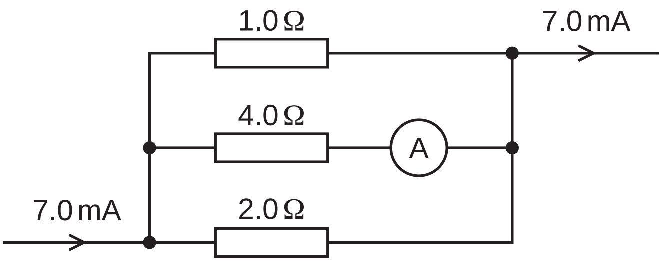
22 A battery of emf 12 V is connected across a 22 Ω resistor. The battery has an internal resistance that is **not** negligible. A current in the resistor is 0.50 A.

At which rate is heat dissipated in the internal resistance of the battery?

A 0.50 W **B** 5.5 W **C** 6.0 W **D** 6.5 W

Space for working

23 The diagram shows a current of 7.0 mA flowing through a parallel arrangement of resistors. The ammeter and connecting wires are of negligible resistance.



What is the reading on the ammeter?

A 0.6 mA **B** 1.0 mA **C** 2.3 mA **D** 4.0 mA

24 A heater is rated 220 V, 500 W.

When the heater is connected to a 220 V power supply, the current is I_0.

When the heater is connected to a 110 V power supply, what is the current and what is the power? Assume the resistance of the heater does not change.

	current	power / W
A	$\frac{I_0}{2}$	125
B	$\frac{I_0}{2}$	250
C	$\frac{I_0}{4}$	125
D	$\frac{I_0}{4}$	250

Space for working

25 Four lamps have filaments made from the same material. The lamps are connected in parallel across a battery.

Which filament lamp transfers the most energy into heat and light per second?

	length of filament	cross-sectional area of filament
A	l	A
B	$2l$	A
C	l	2A
D	$2l$	2A

26 A torch has a 6 V battery made up of four cells, each with emf 1.5 V and internal resistance 1.0 Ω.

If one of the cells is reversed, which row shows the emf and the internal resistance of the battery?

	emf / V	internal resistance / Ω
A	3.0	2.0
B	3.0	4.0
C	4.5	2.0
D	4.5	4.0

Space for working

27 Early CD players used a laser with a wavelength of 950 nm. Modern DVD players use a laser with a wavelength of 650 nm.

Which statement is correct?

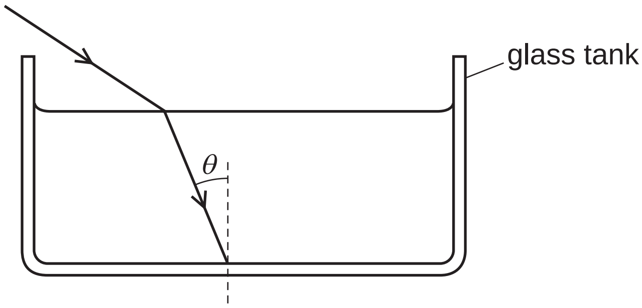
A CD players used infra-red light, and DVD players use infra-red light of a higher frequency.

B CD players used infra-red light, and DVD players use visible light.

C CD players used red light, and DVD players use blue light.

D CD players used visible light, and DVD players use ultra-violet light.

28 A light ray enters the water in a tank. The ray strikes the glass bottom of the tank at an angle of incidence θ.



speed of light in air = $3.00 \times 10^8\,\mathrm{m\,s^{-1}}$
speed of light in water = $2.25 \times 10^8\,\mathrm{m\,s^{-1}}$
speed of light in glass = $1.97 \times 10^8\,\mathrm{m\,s^{-1}}$

What is the maximum value of θ at which the ray will emerge from the other side of the glass into the air below?

A 41.0° **B** 41.4° **C** 48.6° **D** 61.1°

Space for working

29 A beam of light goes through a polarising filter, then through a sugar solution, then through a second polarising filter. The polarising axes of the two filters are initially aligned.

The sugar solution has the effect of rotating the light's plane of polarisation clockwise by 45°.

Through which angle must the second filter be rotated to block the beam?

A 45° clockwise

B 45° anticlockwise

C 90° clockwise

D 90° anticlockwise

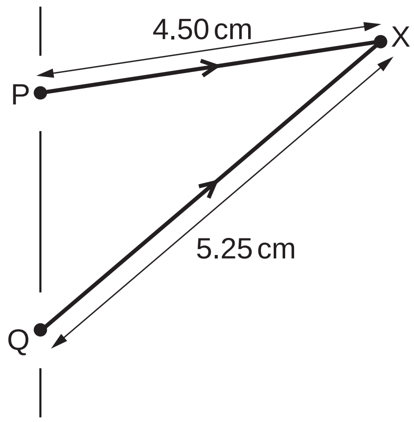
30 A telescope on Earth receives radiation from two distant sources. The sources are 1.0×10^{15} m from Earth and are separated by 1.0×10^{12} m.

The telescope dish has a diameter 40.0 m and can just resolve the two sources.

What is the wavelength of the radiation emitted by the sources?

A 2.5×10^{-5} m **B** 4.0×10^{-2} m **C** 25 m **D** 4.0×10^{4} m

31 Two coherent microwaves of wavelength 1.5 cm are in phase at points P and Q in the diagram. They interfere with each other at point X.



What is the phase difference, in radians, of the waves at point X?

A 0.75π **B** π **C** 1.5π **D** 2π

Space for working

32 Which statement about standing waves is correct?

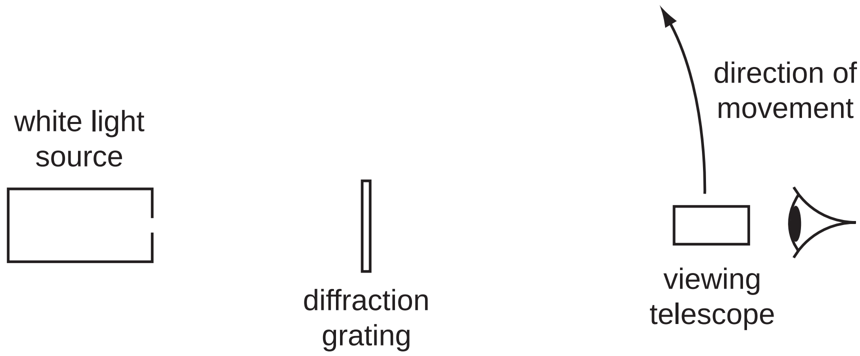
A A standing wave can be produced on a string fixed at two end points, when plucked at the middle.

B In a standing wave, nodes are separated by one wavelength.

C In a standing wave, points of zero amplitude are called antinodes.

D Standing waves can only be produced by the superposition of two transverse waves travelling in opposite directions.

33 The diagram shows a source of white light. The light is incident on a diffraction grating.



Which diagram represents the spectrum observed when the viewing telescope is moved from the position shown and in the direction shown on the diagram?

A 

B 

C 

D 

key
w = white
r = red
v = violet

Space for working

34 A radioactive source is placed 5 cm from a Geiger-tube, and various absorbers are placed in between. For each absorber, a one-minute count is taken of the total number of decays, and this is repeated several times.

The table shows the results of the experiment. The background count was 5 Bq.

absorber	average number of decays detected in one minute
none	1043
0.1 mm paper	1038
1 mm aluminium	497
2 cm lead	301

What nuclear radiation does this suggest the source was emitting?

A alpha and beta only

B beta only

C beta and gamma only

D alpha, beta and gamma

35 Carbon-14 decays by the β^- emission.

Which statement about this process is correct?

A The nucleon number decreases by one.

B The nucleon number increases by one.

C The number of neutrons increases by one.

D The number of neutrons decreases by one.

Space for working

36 A fission reaction is shown.

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{144}_{56}Ba + ^{89}_{36}Kr + X$$

What does X represent?

A $^{1}_{0}n$ **B** $^{3}_{0}n$ **C** $2\,^{1}_{0}n$ **D** $3\,^{1}_{0}n$

37 Carbon-14 is a naturally occurring radioactive isotope of carbon. The proportion of it in living organisms is constant. Once the organism dies, the activity of the carbon decreases.

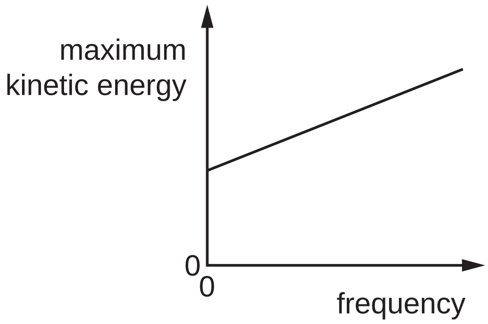
An 18 000-year-old sample of carbon is found to have roughly an eighth of the activity of a sample of modern-day carbon of the same mass.

What is the approximate half-life of carbon-14?

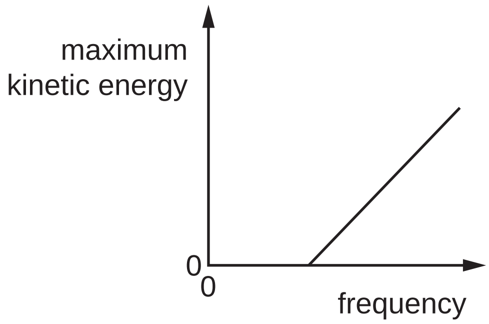
A 3000 years **B** 6000 years **C** 24 000 years **D** 48 000 years

38 Which graph shows how the maximum kinetic energy of electrons ejected from a metal surface depends on the frequency of electromagnetic radiation absorbed by the surface?

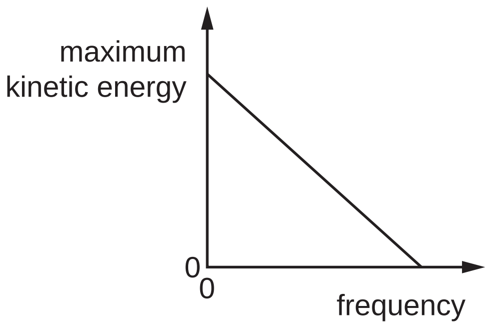
A



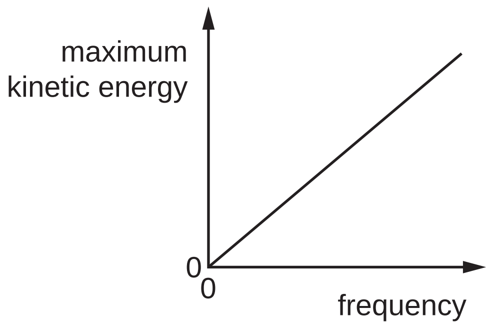
B



C



D



Space for working

39 Electrons are accelerated from rest through a potential difference V.

How is the de Broglie wavelength λ of the electrons related to V?

A $\lambda \propto V$ **B** $\lambda \propto \dfrac{1}{V}$ **C** $\lambda \propto \sqrt{V}$ **D** $\lambda \propto \dfrac{1}{\sqrt{V}}$

40 Monochromatic light of wavelength 650 nm is incident on a clean potassium surface.

The work function of potassium is 1.81 eV.

What is the maximum velocity of the electrons emitted?

A $1.3 \times 10^{5}\,\mathrm{m\,s^{-1}}$

B $1.9 \times 10^{5}\,\mathrm{m\,s^{-1}}$

C $5.2 \times 10^{5}\,\mathrm{m\,s^{-1}}$

D $8.2 \times 10^{5}\,\mathrm{m\,s^{-1}}$

Space for working