Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/01**

Paper 1 Multiple Choice **For examination from 2022**

SPECIMEN PAPER **1 hour 15 minutes**

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- 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 multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
- Any rough working should be done on this question paper.

This document has **18** pages. Blank pages are indicated.

Data

acceleration of free fall	$g = 9.81\,\text{m s}^{-2}$
speed of light in free space	$c = 3.00 \times 10^{8}\,\text{m s}^{-1}$
elementary charge	$e = 1.60 \times 10^{-19}\,\text{C}$
unified atomic mass unit	$1\,\text{u} = 1.66 \times 10^{-27}\,\text{kg}$
rest mass of proton	$m_\text{p} = 1.67 \times 10^{-27}\,\text{kg}$
rest mass of electron	$m_\text{e} = 9.11 \times 10^{-31}\,\text{kg}$
Avogadro constant	$N_\text{A} = 6.02 \times 10^{23}\,\text{mol}^{-1}$
molar gas constant	$R = 8.31\,\text{J K}^{-1}\,\text{mol}^{-1}$
Boltzmann constant	$k = 1.38 \times 10^{-23}\,\text{J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11}\,\text{N m}^2\,\text{kg}^{-2}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$ $\left(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\text{m F}^{-1}\right)$
Planck constant	$h = 6.63 \times 10^{-34}\,\text{J s}$
Stefan–Boltzmann constant	$\sigma = 5.67 \times 10^{-8}\,\text{W m}^{-2}\,\text{K}^{-4}$

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
hydrostatic pressure	$\Delta p = \rho g \Delta h$
upthrust	$F = \rho g V$
Doppler effect for sound waves	$f_\text{o} = \frac{f_\text{s} v}{v \pm v_\text{s}}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$

1 A student creates a table to show reasonable estimates of some physical quantities.

Which row is **not** a reasonable estimate?

	quantity	value
A	electric current in a fan heater	12A
B	mass of an adult person	70 kg
C	maximum speed of an Olympic sprint runner	$10\,\text{m}\,\text{s}^{-1}$
D	water pressure at the bottom of a garden pond	10^6 Pa

2 Which expression has the same SI base units as pressure?

A $\dfrac{\text{force}}{\text{length} \times \text{speed}}$

B $\dfrac{\text{force}}{\text{length} \times \text{time}}$

C $\dfrac{\text{mass}}{\text{length} \times (\text{time})^2}$

D $\dfrac{\text{mass} \times (\text{time})^2}{\text{length}}$

3 The speed v of a liquid leaving a tube depends on the change in pressure ΔP and the density ρ of the liquid. The speed is given by the equation

$$v = k\left(\frac{\Delta P}{\rho}\right)^n$$

where k is a constant that has no units.

What is the value of n?

A $\frac{1}{2}$ **B** 1 **C** $\frac{3}{2}$ **D** 2

4 Which row correctly describes the quantities momentum, power and temperature?

	momentum	power	temperature
A	scalar	scalar	vector
B	scalar	vector	vector
C	vector	scalar	scalar
D	vector	vector	scalar

5 A girl throws a ball vertically upwards. It takes a time of 3.20 s to return to her hand.

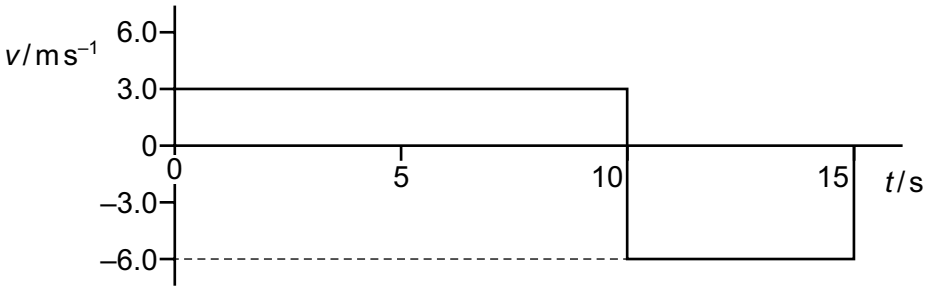
Assume air resistance is negligible.

What is the initial speed with which the ball is thrown?

A $3.07\,m\,s^{-1}$ **B** $7.85\,m\,s^{-1}$ **C** $15.7\,m\,s^{-1}$ **D** $31.4\,m\,s^{-1}$

6 A radio-controlled toy car travels along a straight line for a time of 15 s.

The variation with time t of the velocity v of the car is shown.



What is the average velocity of the toy car for the journey shown by the graph?

A $-1.5\,m\,s^{-1}$ **B** $0.0\,m\,s^{-1}$ **C** $4.0\,m\,s^{-1}$ **D** $4.5\,m\,s^{-1}$

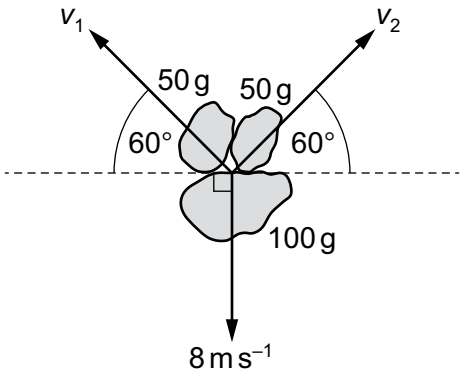
7 The acceleration of free fall on Pluto is $0.66\,m\,s^{-2}$.

An object weighs 6.0 N on Earth.

What would this object weigh on Pluto?

A 0.40 N **B** 0.93 N **C** 4.0 N **D** 39 N

8 A stationary firework explodes into three pieces moving in the same plane. The masses and the velocities of the three pieces immediately after the explosion are shown.



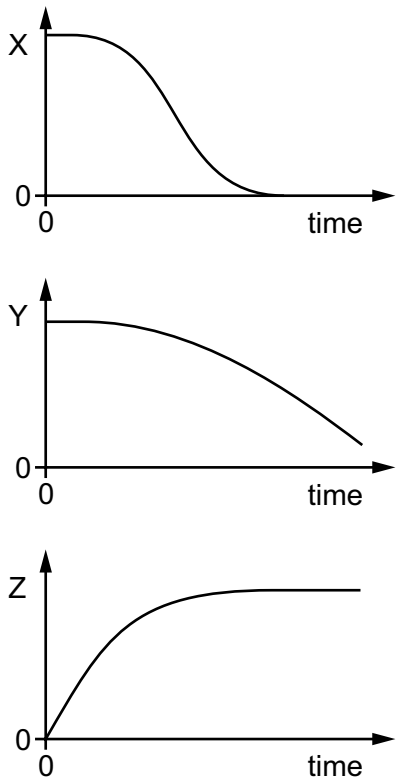
What are speeds v_1 and v_2?

	v_1 / m s^{-1}	v_2 / m s^{-1}
A	4.0	4.0
B	9.2	9.2
C	14	14
D	16	16

9 An object is dropped at time $t = 0$ from a high building. Air resistance is significant.

Three graphs are plotted against time:

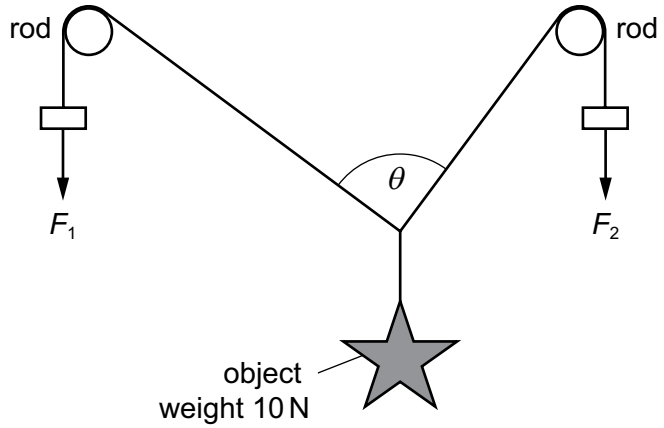
- the height of the object above the ground
- the speed of the object
- the magnitude of the resultant force on the object.



What are the quantities X, Y and Z?

	height of the object above the ground	speed of the object	magnitude of the resultant force on the object
A	X	Y	Z
B	X	Z	Y
C	Y	Z	X
D	Z	Y	X

10 An object hangs by means of two cords around two rods, as shown.



The object is held in equilibrium by the forces F_1 and F_2. The object weighs 10 N. There is negligible friction between the rods and cords.

Which row of the table gives an angle θ of 90°?

	F_1 / N	F_2 / N
A	4.0	6.0
B	6.0	4.0
C	6.0	8.0
D	8.0	6.0

11 Which force is caused by a difference in hydrostatic pressure?

A friction **B** upthrust **C** viscous force **D** weight

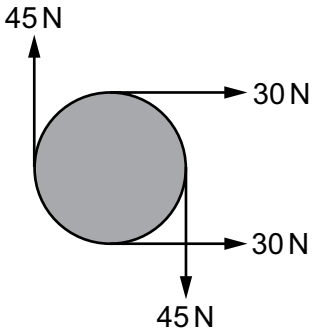
12 A car of mass 1400 kg is travelling on a straight, horizontal road at a constant speed of 25 m s^{-1}. The useful output power from the car's engine is 30 kW.

The car then travels up a slope at 2.0° to the horizontal, maintaining the same constant speed.

What is the useful output power of the car's engine when travelling up the slope?

A 12 kW **B** 31 kW **C** 42 kW **D** 65 kW

13 The diagram shows four forces applied to a circular object.

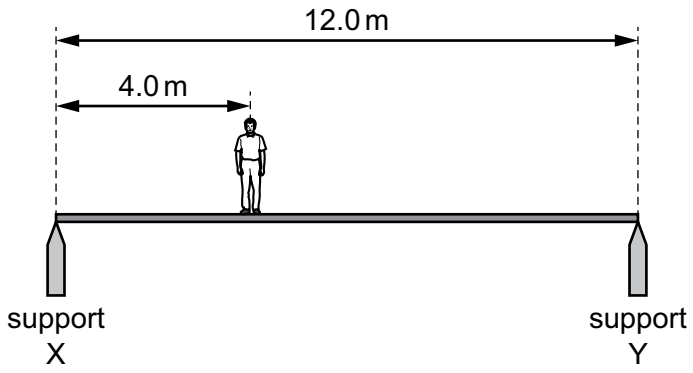


Which row describes the resultant force and resultant torque on the object?

	resultant force	resultant torque
A	non-zero	non-zero
B	non-zero	zero
C	zero	non-zero
D	zero	zero

14 A uniform horizontal footbridge is 12.0 m long and weighs 4000 N.

It rests on two supports X and Y, as shown.



A man of weight 600 N stands a distance of 4.0 m from support X.

What is the upward force on the footbridge from support X?

A 2200 N **B** 2300 N **C** 2400 N **D** 2600 N

15 A metal block has a mass of 750 g. Magnesium makes up 60% of the mass and the remaining 40% is copper.

The density of magnesium is $1.7\,g\,cm^{-3}$.

The density of copper is $9.0\,g\,cm^{-3}$.

What is the density of the block?

A $2.5\,g\,cm^{-3}$ **B** $4.6\,g\,cm^{-3}$ **C** $5.4\,g\,cm^{-3}$ **D** $10.7\,g\,cm^{-3}$

16 A man climbs slowly at a steady speed to the top of a ladder.

What is the **main** energy transfer taking place for the man as he climbs?

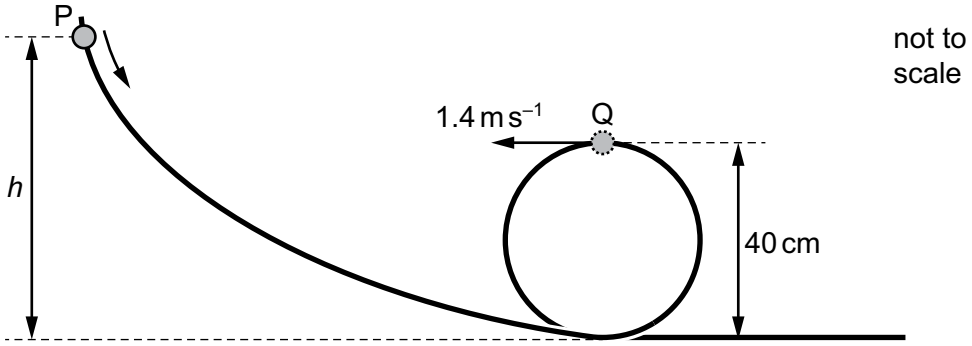
A chemical potential to gravitational potential

B chemical potential to kinetic

C kinetic to gravitational potential

D thermal (heat) to kinetic

17 A bead is released from rest at point P and slides along a wire, as shown.



The wire loops around and forms a vertical circle of diameter 40 cm. At point Q, the bead has a speed of $1.4\,m\,s^{-1}$.

Air resistance and friction on the wire are negligible.

What is the height *h* from which the bead is released?

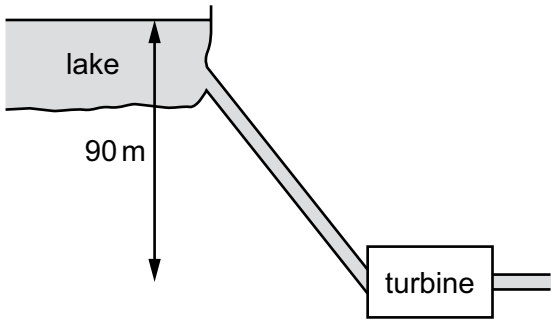
A 0.30 m **B** 0.40 m **C** 0.50 m **D** 0.60 m

18 A mass is raised vertically. In time t, the increase in its gravitational potential energy is E_p and the increase in its kinetic energy is E_k.

What is the average power input to the mass?

A $(E_p - E_k)t$ **B** $(E_p + E_k)t$ **C** $\frac{E_p - E_k}{t}$ **D** $\frac{E_p + E_k}{t}$

19 Water flows from a lake into a turbine that is a vertical distance of 90 m below the lake, as shown.



The mass flow rate of the water is 2400 kg min^{-1}. The turbine has an efficiency of 75%.

What is the output power of the turbine?

A 26 kW **B** 35 kW **C** 1.6 MW **D** 2.1 MW

20 A wire of diameter d and length l hangs vertically from a fixed point. The wire is extended by hanging a mass M on its end. The Young modulus of the wire is E. The acceleration of free fall is g.

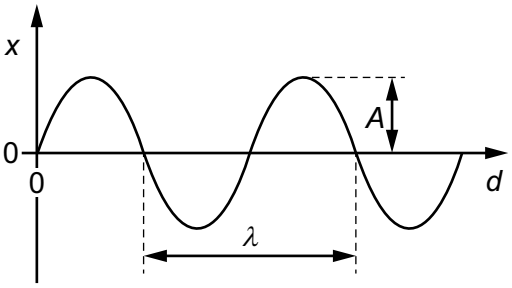
Which equation is used to determine the extension x of the wire?

A $x = \frac{Ml}{\pi dE}$ **B** $x = \frac{Mgl}{\pi d^2 E}$ **C** $x = \frac{4Mgl}{\pi dE}$ **D** $x = \frac{4Mgl}{\pi d^2 E}$

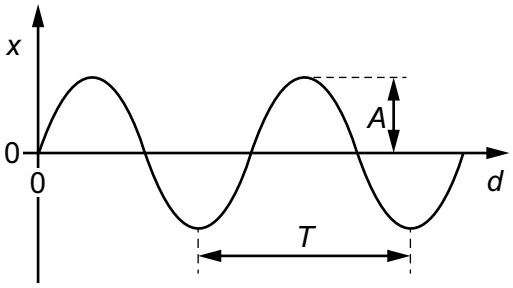
21 A wave has period T, wavelength λ and amplitude A. The wave is shown on a graph of displacement x against distance d.

Which graph is correctly labelled?

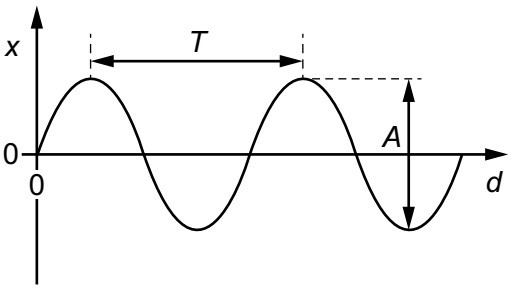
A



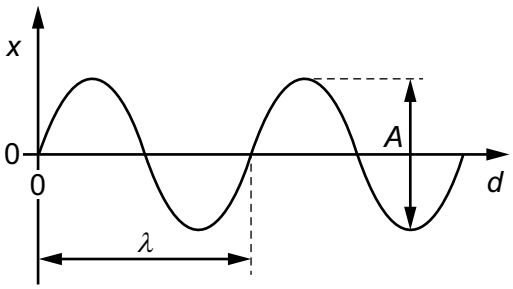
B



C



D



22 A vehicle emits sound of a constant frequency. A stationary observer hears the sound.

The vehicle moves directly towards the observer at constant speed. The observer hears sound of frequency f_o.

The vehicle then accelerates, still moving towards the observer, travels at a higher steady speed for a time and then decelerates until it stops.

What is the variation in the frequency of the sound that is heard by the observer?

A The observed frequency will fall, then remain steady then return to the frequency f_o.

B The observed frequency will fall, then remain steady then rise to a higher frequency than f_o.

C The observed frequency will rise, then remain steady then fall to a lower frequency than f_o.

D The observed frequency will rise, then remain steady then return to the frequency f_o.

23 A car travelling in a straight line at a speed of $30\,m\,s^{-1}$ passes near a stationary observer while sounding its horn. The frequency of sound emitted by the horn is 400 Hz.

The speed of sound in air is $336\,m\,s^{-1}$.

What is the change in the frequency of the sound heard by the observer as the car passes?

A 39 Hz **B** 66 Hz **C** 72 Hz **D** 78 Hz

24 Which list shows electromagnetic waves in order of increasing frequency?

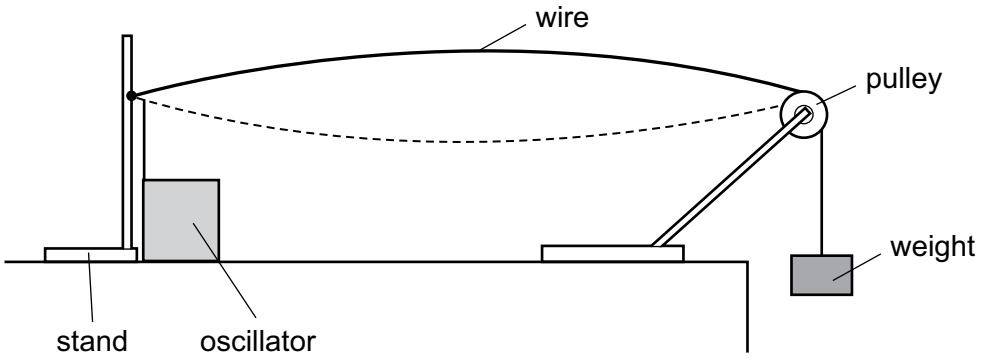
A radio waves → gamma-rays → ultraviolet → infrared

B radio waves → infrared → ultraviolet → gamma-rays

C ultraviolet → gamma-rays → radio waves → infrared

D ultraviolet → infrared → radio waves → gamma-rays

25 The diagram shows a steel wire fixed at one end. The other end is attached to a weight hanging over a pulley.



An oscillator is attached to the wire near the fixed end. A stationary wave with one loop is produced. The frequency of the oscillator is *f*.

Which frequency of the oscillator produces a stationary wave with two loops?

A $\frac{f}{4}$ **B** $\frac{f}{2}$ **C** $2f$ **D** $4f$

26 Which statement gives a condition that enables diffraction to occur?

A A source of waves moves towards a stationary observer.

B A wave is partially blocked by an obstacle.

C Two coherent waves are superposed.

D Two waves are travelling through the same part of a medium in opposite directions.

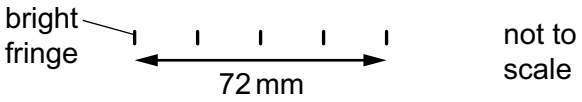
27 A parallel beam of light of wavelength 600 nm is incident normally on a diffraction grating. The grating has 300 lines per millimetre.

What is the total number of intensity maxima from the grating?

A 1 **B** 3 **C** 11 **D** 13

28 A pattern of interference fringes is produced using a red laser, a double slit and a screen. The screen is 3.5 m from the double slit. The light from the laser has a wavelength of 640 nm.

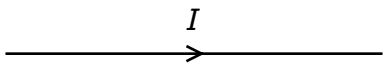
The pattern of fringes is shown.



What is the separation of the slits?

A 1.2×10^{-4} m **B** 1.6×10^{-4} m **C** 3.1×10^{-5} m **D** 3.3×10^{-9} m

29 The diagram shows the symbol for a wire carrying a current I.



What does this current represent?

A the charge flowing past a point in the wire per unit time

B the number of electrons flowing past a point in the wire per unit time

C the number of positive nuclei flowing past a point in the wire per unit time

D the number of protons flowing past a point in the wire per unit time

30 An electric current I is given by the formula $I = Anvq$.

What do each of the symbols represent for an electric current in a metal wire?

	A	*n*	*v*	*q*
A	area of cross-section	number of free electrons	voltage	charge of each nucleus
B	area of cross-section	number of free electrons per unit volume	average drift speed of free electrons	charge of each electron
C	current	number of free electrons	average drift speed of free electrons	charge of each nucleus
D	current	number of free electrons per unit volume	voltage	charge of each electron

31 Which values of current and resistance will produce a rate of energy transfer of $16\,J\,s^{-1}$?

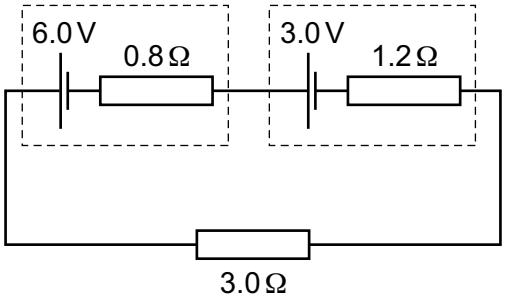
	current / A	resistance / Ω
A	1	4
B	2	2
C	2	8
D	4	1

32 A coil contains N turns of insulated copper wire wound on to a cylinder of diameter D. The copper wire has diameter d. The resistivity of copper is ρ. Diameter D is much greater than diameter d.

What is the total resistance between the two ends of the coil of copper wire?

A $\frac{4N\rho D}{d^2}$ **B** $\frac{4N\rho d}{D^2}$ **C** $\frac{8N\rho D}{d^2}$ **D** $\frac{8N\rho d}{D^2}$

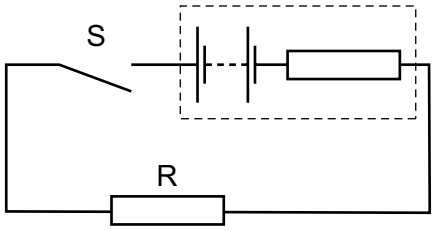
33 Two cells are connected to a load resistor of resistance 3.0 Ω. The electromotive force (e.m.f.) and the internal resistance of each of the cells are shown.



What is the current in the load resistor?

A 0.60A **B** 1.2A **C** 1.8A **D** 3.0A

34 The diagram shows a simple circuit.



Which statement is correct?

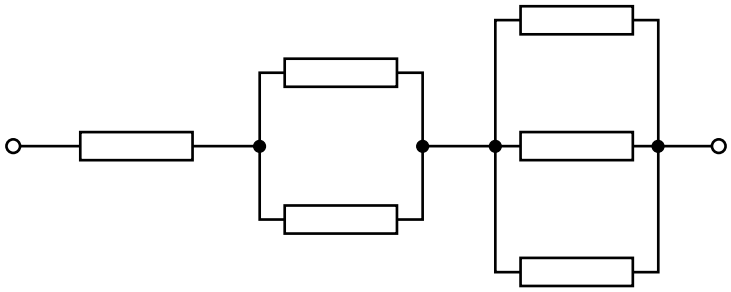
A When switch S is closed, the e.m.f. of the battery falls because work is done against the internal resistance of the battery.

B When switch S is closed, the e.m.f. of the battery falls because work is done against the resistance of R.

C When switch S is closed, the potential difference across the battery falls because work is done against the internal resistance of the battery.

D When switch S is closed, the potential difference across the battery falls because work is done against the resistance of R.

35 Six resistors, each of resistance *R*, are connected as shown.



The combined resistance is 66 kΩ.

What is the value of *R*?

A 11 kΩ **B** 18 kΩ **C** 22 kΩ **D** 36 kΩ

36 A cell has a constant electromotive force and a constant internal resistance.

A thermistor is connected between the terminals of the cell.

The temperature of the thermistor is increased.

Which statement about the change of the cell's terminal potential difference (p.d.) is correct?

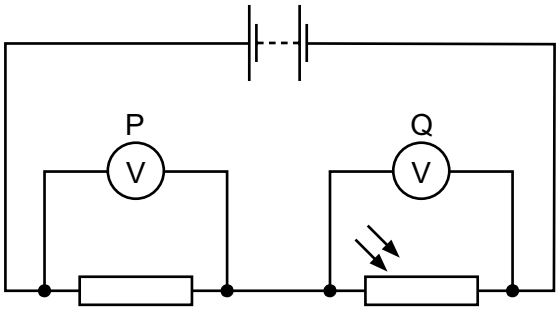
A The terminal p.d. is decreased because more work is done moving unit charge through the internal resistance of the cell.

B The terminal p.d. is decreased because the current in the thermistor is decreased.

C The terminal p.d. is increased because more work is done moving unit charge through the thermistor.

D The terminal p.d. is increased because the current in the thermistor is increased.

37 A battery with negligible internal resistance is connected in series with a resistor and a light-dependent resistor (LDR) as shown.



The light intensity on the LDR is decreased.

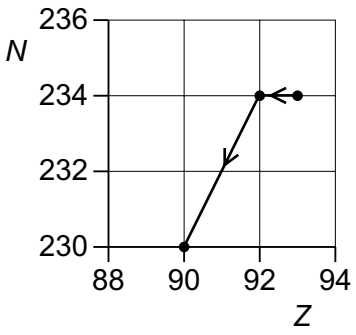
How do the readings of the voltmeters change?

	reading on voltmeter P	reading on voltmeter Q
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

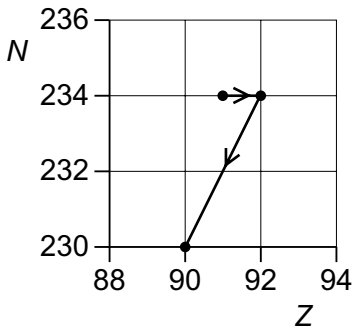
38 A radioactive nucleus is formed by β^- decay. This nucleus then decays by α-emission.

Which graph of nucleon number *N* plotted against proton number *Z* shows the β^- decay followed by the α-emission?

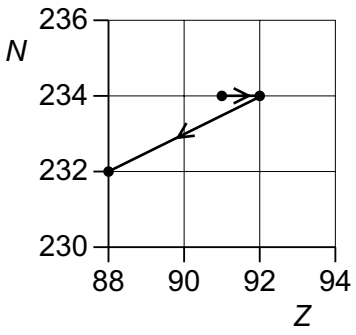
A



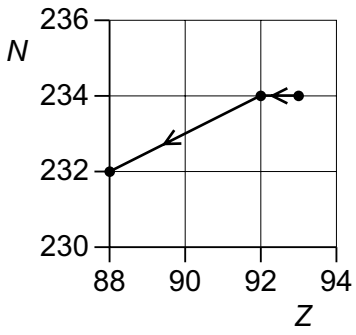
B



C



D



39 What are the structures of the proton and of the neutron in terms of quarks?

	proton		neutron	
	up quark	down quark	up quark	down quark
A	1	1	2	2
B	1	2	2	1
C	2	1	1	2
D	2	2	1	1

40 What is the charge of a top antiquark?

A $-\frac{2}{3}$ **B** $-\frac{1}{3}$ **C** $+\frac{1}{3}$ **D** $+\frac{2}{3}$

BLANK PAGE