PART B Physics

19 An unstable nucleus X becomes a stable nucleus Y after a succession of decays, during which a total of 5 alpha particles and 2 beta (β^-) particles are emitted.

How many fewer protons does nucleus Y contain than nucleus X?

A 6

B 8

C 10

D 12

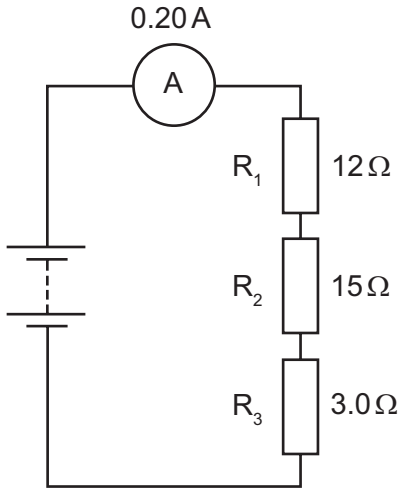
E 14

F 16

G 18

H 20

20 The diagram shows three resistors R_1, R_2 and R_3 connected in series with a battery of constant voltage. The resistance of each resistor and the corresponding current are also shown.



Resistor R_3 is now removed and the circuit is reconnected.

What is the new current in the circuit?

A 0.20 A

B 0.22 A

C 0.33 A

D 0.40 A

E 0.50 A

F 2.0 A

G 6.0 A

21 When travelling in a vacuum, visible light has a wavelength between 400 nm and 700 nm.

The speed of light in a vacuum is $3.0 \times 10^8\,\text{m s}^{-1}$.

What can be concluded about **ultraviolet** radiation from this information?

A It has a **maximum** frequency of $2.7 \times 10^{14}\,\text{Hz}$

B It has a **maximum** frequency of $4.3 \times 10^{14}\,\text{Hz}$

C It has a **maximum** frequency of $7.5 \times 10^{14}\,\text{Hz}$

D It has a **maximum** frequency of $1.0 \times 10^{15}\,\text{Hz}$

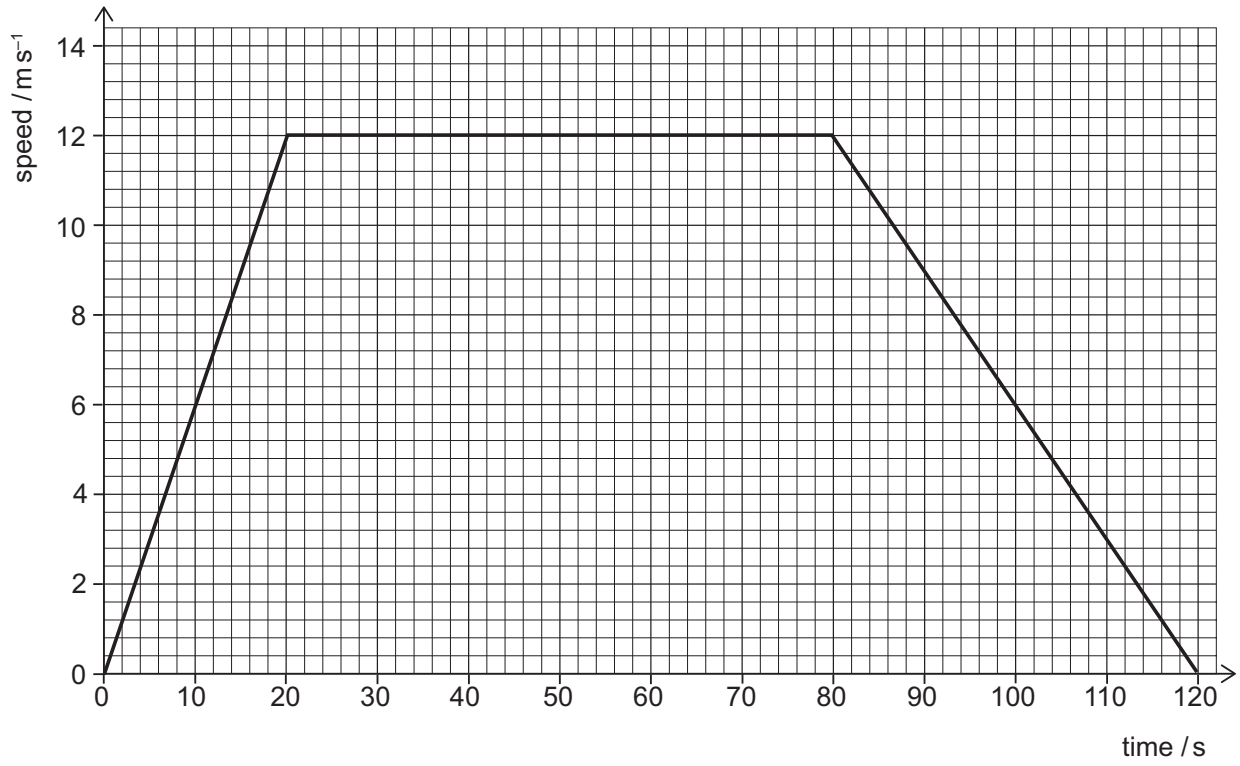
E It has a **minimum** frequency of $2.7 \times 10^{14}\,\text{Hz}$

F It has a **minimum** frequency of $4.3 \times 10^{14}\,\text{Hz}$

G It has a **minimum** frequency of $7.5 \times 10^{14}\,\text{Hz}$

H It has a **minimum** frequency of $1.0 \times 10^{15}\,\text{Hz}$

22 The graph is the speed–time graph for a bus travelling in a straight line between two stops.



What is the average speed of the bus during this time?

A $3.0\,m\,s^{-1}$

B $4.5\,m\,s^{-1}$

C $6.0\,m\,s^{-1}$

D $8.0\,m\,s^{-1}$

E $9.0\,m\,s^{-1}$

F $11\,m\,s^{-1}$

G $12\,m\,s^{-1}$

23 A filament lamp working at its operating voltage converts electrical energy at a rate of 100 W.

The lamp has an efficiency of 5.0%.

How much energy is wasted by the lamp in 10 minutes?

A 50 J

B 950 J

C 1000 J

D 3000 J

E 57 000 J

F 60 000 J

24 A student is investigating heat flow along a solid uniform metal bar.

The bar has length l, cross-sectional area A, and has its ends maintained at temperatures T_1 and T_2 (where $T_1 > T_2$).

Which relationship represents the rate of heat flow P along the bar?

(Assume that there is no heat transfer through the sides of the bar.)

A $P \propto \frac{(T_1 - T_2)}{Al}$

B $P \propto \frac{(T_1 + T_2)}{Al}$

C $P \propto \frac{A(T_1 - T_2)}{l}$

D $P \propto \frac{A(T_1 + T_2)}{l}$

E $P \propto \frac{l}{A(T_1 - T_2)}$

F $P \propto \frac{l}{A(T_1 + T_2)}$

G $P \propto \frac{Al}{(T_1 - T_2)}$

H $P \propto \frac{Al}{(T_1 + T_2)}$

25 The potential difference across the motor in an electric car is 400 V and the current in the motor is 1250 A.

The car accelerates along a horizontal road from rest for 4.0 s.

The efficiency of the overall system is 45%.

What is the kinetic energy of the car at the end of the 4.0 s?

(Ignore energy losses due to air resistance and due to friction between the tyres and the road.)

A 225 000 J

B 500 000 J

C 900 000 J

D 1 250 000 J

E 2 000 000 J

26 The momentum of a small object moving in a straight line is 24 kg m s^{-1} and its kinetic energy is 96 J.

What is the mass of the object?

A 3.0 kg

B 4.0 kg

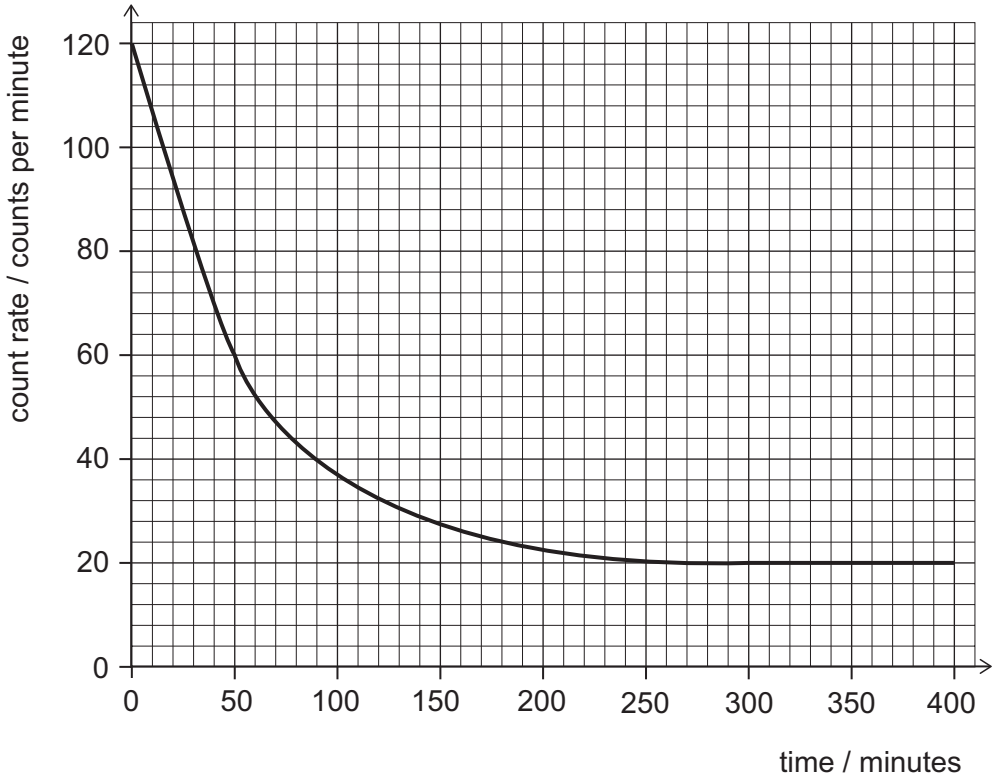
C 6.0 kg

D 8.0 kg

E 12 kg

27 A radioactive isotope decays in a single step to a stable isotope.

A radiation detector is placed very near to a sample of the radioactive isotope in a laboratory. The count rate on the detector changes as time elapses. The graph shows how the measured count rate changes with time.



What is the background count rate and what is the half-life of the isotope?

	background count rate / counts per minute	*half-life of isotope* / minutes
A	20	40
B	20	50
C	20	60
D	20	65
E	120	40
F	120	50
G	120	60
H	120	65

28 A rock falling vertically experiences an air resistance force of 12 N at an instant when its acceleration is 2.0 m s^{-2} downwards.

What is the mass of the rock?

(gravitational field strength = 10 N kg^{-1})

A 1.0 kg

B 1.2 kg

C 1.5 kg

D 6.0 kg

E 10 kg

F 12 kg

G 15 kg

H 60 kg

29 A transverse wave with an amplitude of 4.0 cm and a frequency of 10 Hz travels along a rope at a speed of 2.4 m s^{-1}.

What is the total distance travelled by a particle in the rope in a time of 20 s?

A 2.4 m

B 4.8 m

C 8.0 m

D 16 m

E 32 m

F 48 m

30 A student places a measuring cylinder on a balance. She pours a volume *V* of water into the measuring cylinder, and finds that the mass of the measuring cylinder and water together is 290 g.

She then empties the measuring cylinder and dries it before putting it back on the balance.

She now pours the same volume *V* of olive oil into the measuring cylinder, and finds that the mass of the measuring cylinder and olive oil together is 270 g.

What is the mass of the measuring cylinder?

(densities: olive oil = 0.90 g cm^{-3}; water = 1.0 g cm^{-3})

A 18 g

B 20 g

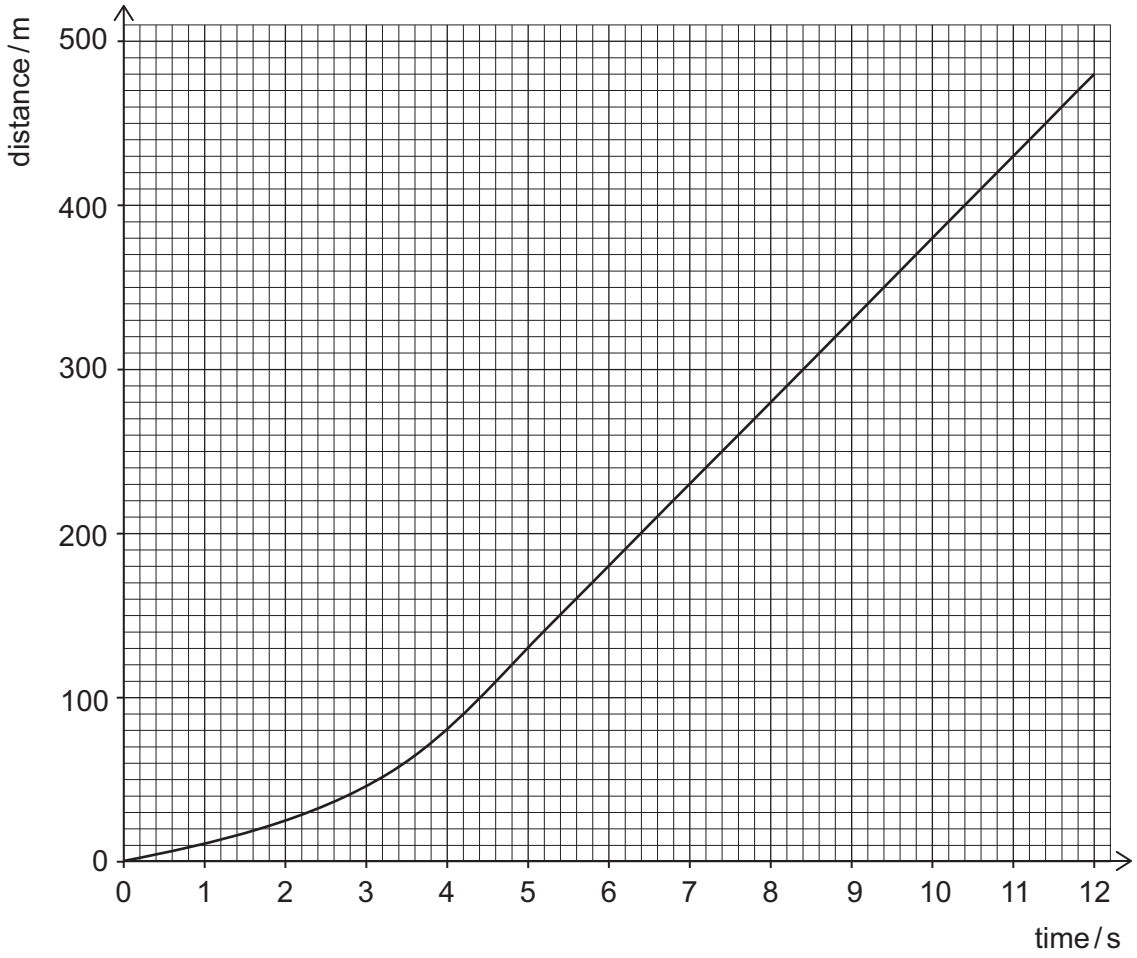
C 90 g

D 180 g

E 200 g

31 A skydiver of weight 1000 N falls vertically.

The distance–time graph for the skydiver is shown below.



The air resistance F (in N) acting on the skydiver travelling at velocity v (in $\mathrm{m\,s^{-1}}$) is given by the equation

$$F = kv^2$$

where k (in $\mathrm{N\,m^{-2}\,s^2}$) is a constant.

What is the numerical value of k for the skydiver?

A 0.050

B 0.40

C 0.63

D 2.5

E 20

32 A source generates water waves of fixed frequency that have a wavelength of 1.5 cm.

As they cross a boundary into shallower water their frequency does not change, but their speed is reduced by 18 cm s^{-1}.

The new wavelength is 1.2 cm.

What is the speed of the waves in the shallower water?

A 42 cm s^{-1}

B 50 cm s^{-1}

C 54 cm s^{-1}

D 60 cm s^{-1}

E 72 cm s^{-1}

F 90 cm s^{-1}

33 A neutron is absorbed by a uranium-235 ($^{235}_{92}U$) nuclide.

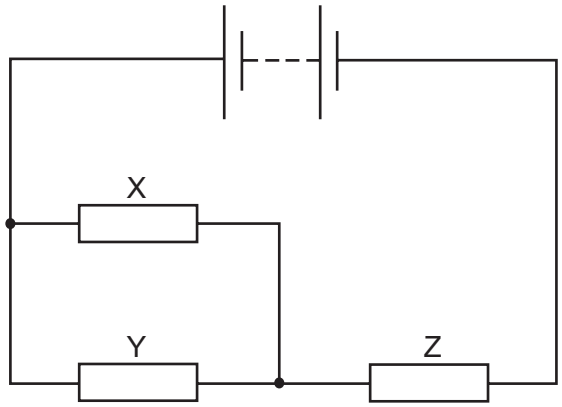
The resulting nuclide undergoes fission to produce a bromine-88 ($^{88}_{35}Br$) nuclide, a lanthanum-145 nuclide and some neutrons.

The lanthanum-145 nuclide is radioactive and emits a beta (β^-) particle.

How many neutrons are emitted in the fission reaction and how many protons are there in the nuclide formed by the decay of lanthanum-145?

	neutrons	*protons*
A	2	55
B	2	56
C	2	57
D	2	58
E	3	55
F	3	56
G	3	57
H	3	58

34 The diagram shows a circuit containing a battery and three identical resistors X, Y and Z.



The total power supplied by the battery is 18 W.

What is the power dissipated as heat in resistor X?

A 1.5 W

B 2.0 W

C 3.0 W

D 4.5 W

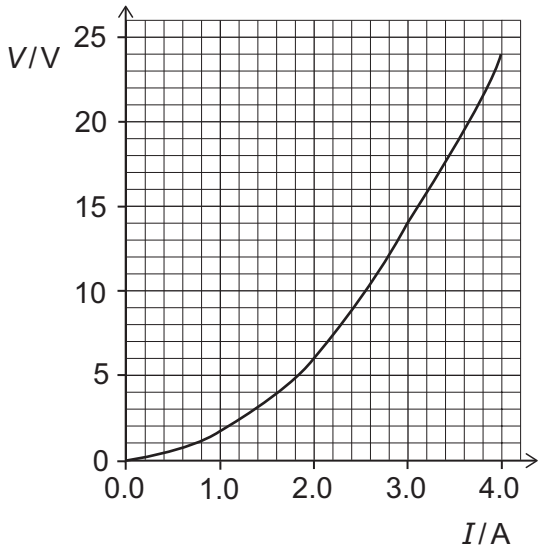
E 6.0 W

F 8.0 W

G 12 W

35 A filament lamp and a 0-10 Ω variable resistor are connected in series with a power supply of constant voltage.

The graph shows the voltage–current (*V*–*I*) characteristic of the filament lamp.



When the resistance of the variable resistor is 4.0 Ω, the current in the lamp is 2.0 A.

What is the power dissipated in the lamp when the resistance of the variable resistor is zero?

A 12 W

B 14 W

C 16 W

D 28 W

E 42 W

F 96 W

36 Three detectors X, Y and Z are separated by large distances.

Each of the detectors records a seismic wave from the same earthquake whose epicentre (source) is very close to the surface of the Earth.

The wave travels out from the epicentre at $4.0\,km\,s^{-1}$.

Detectors X and Y start to detect the wave at the same time, but detector Z starts to detect it one minute later.

Which of the following statements **must** be correct?

1 The epicentre is at the midpoint of the line XY.

2 Z is equidistant from X and Y.

3 Z is no more than 240 km away from X and from Y.

A none of them

B 1 only

C 2 only

D 3 only

E 1 and 2 only

F 1 and 3 only

G 2 and 3 only

H 1, 2 and 3