PART B Physics

19 In the 1920s scientists discovered that the universe is expanding. One consequence of this expansion is that the intense gamma-ray radiation that filled the early universe has now been shifted to the microwave region of the electromagnetic spectrum.

Which line of the table describes how the expansion of the universe has affected the frequency and wavelength of these electromagnetic waves?

	effect on frequency	*effect on wavelength*
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase
E	no effect	decrease
F	no effect	increase

20 A nuclide $^{214}_{82}\text{Pb}$ changes by radioactive decay into the nuclide $^{210}_{82}\text{Pb}$.

Which combination of emissions produces this change?

A 3 alpha

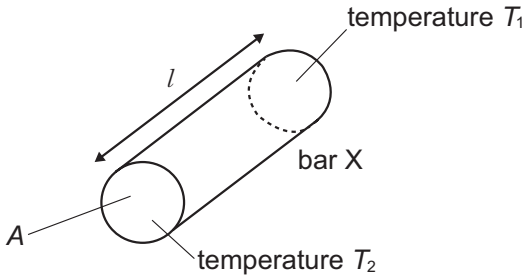
B 2 alpha and 1 beta

C 2 alpha and 2 beta

D 1 alpha and 2 beta

E 3 beta

21 A cylindrical copper bar X of length l has a cross-sectional area A. The colder end of the bar is kept at temperature T_1 and the hotter end is kept at temperature T_2.



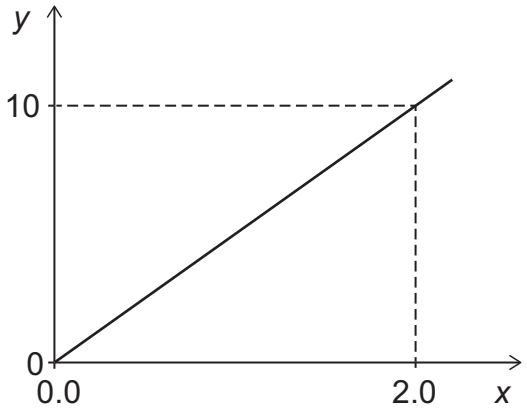
The curved surface of the bar is perfectly insulated and thermal energy is conducted from the hotter end of the bar to the colder end.

Changes in l, A, T_1 and T_2 may alter the rate at which thermal energy is conducted along the copper bar.

In which case is the rate of conduction of thermal energy along the insulated bar the same as for bar X?

	change in A	*change in l*	*change in T_1*	*change in T_2*
A	doubles	no change	no change	no change
B	halves	no change	no change	no change
C	no change	doubles	no change	no change
D	no change	halves	no change	no change
E	no change	no change	decreases by 10 °C	increases by 10 °C
F	no change	no change	decreases by 10 °C	no change
G	no change	no change	increases by 10 °C	decreases by 10 °C
H	no change	no change	increases by 10 °C	increases by 10 °C

22 The graph shown of quantity *y* against quantity *x* represents the motion of a body.



(The scales on both axes are in the appropriate S.I. units, and the gravitational field strength *g* is 10 N kg^{-1}.)

Which two of the following could the graph represent?

1 kinetic energy against velocity for an object of mass 10 kg undergoing free-fall

2 potential energy against height for an object of mass 20 kg being lifted by a constant external force

3 velocity against time for an object of mass 20 kg being accelerated by a resultant force of 100 N

4 work done by an external force of 5 N against distance moved for an object of mass 12 kg being moved at constant speed by (and in the direction of) the external force

A 1 and 2

B 1 and 3

C 1 and 4

D 2 and 3

E 2 and 4

F 3 and 4

23 A uranium-235 nucleus can undergo fission to produce two smaller nuclei.

Which of the diagrams, if any, could represent this process?

diagram 1

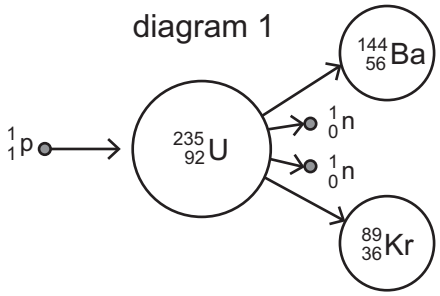


diagram 2

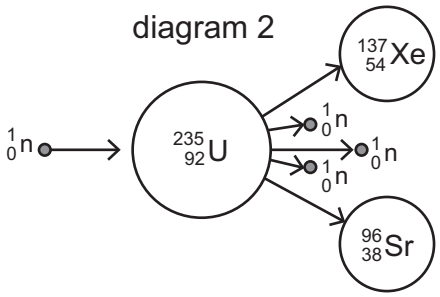
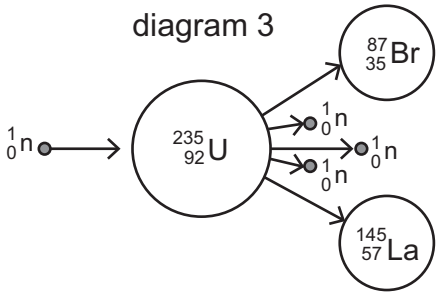


diagram 3



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

24 A circuit consists of a 5.0 Ω resistor and a variable resistor connected in series with a 24 V battery. The variable resistor has a minimum resistance of 3.0 Ω and a maximum resistance of 15 Ω. The battery and the connecting wires have negligible resistance.

What is the maximum power dissipated in the 5.0 Ω resistor?

A 7.2 W

B 18 W

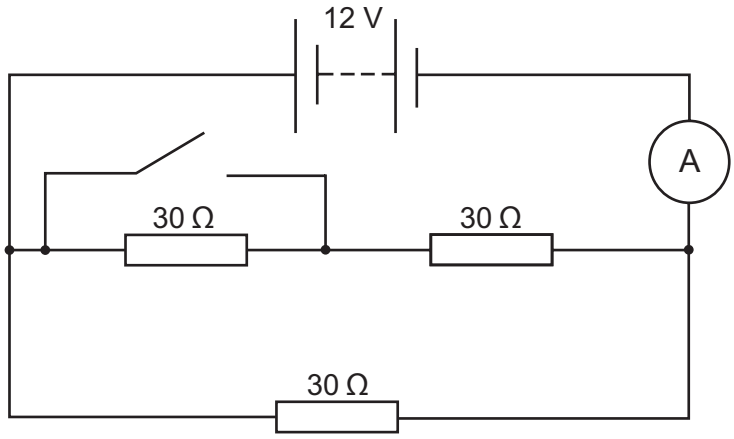
C 27 W

D 45 W

E 72 W

F 75 W

25 The diagram shows a 12 V battery, a switch and three resistors. Each resistor has a resistance of 30 Ω.



Initially the switch is open.

What happens to the reading on the ammeter when the switch is closed?

A It decreases by 0.20 A.

B It decreases by 0.40 A.

C It decreases by 0.60 A.

D It decreases by 0.80 A.

E It increases by 0.20 A.

F It increases by 0.40 A.

G It increases by 0.60 A.

H It increases by 0.80 A.

26 The total power P radiated by a star is given by:

$$P = kR^2T^4$$

where R is the radius of the star, T is its surface temperature and k is a constant.

The power currently radiated by the Sun is 4.0×10^{26} W. Towards the end of the Sun's life its radius will increase by a factor of a hundred and its surface temperature will decrease by a factor of two.

What will be the power radiated by the Sun when these changes have occurred?

A 2.5×10^{27} W

B 1.0×10^{28} W

C 2.0×10^{28} W

D 2.5×10^{29} W

E 1.0×10^{30} W

F 2.0×10^{30} W

G 2.5×10^{33} W

H 1.0×10^{34} W

27 A transverse wave travelling through a medium has a frequency of 5.0 Hz, a wavelength of 4.0 cm and an amplitude of 3.0 cm.

What is the total distance travelled by a particle of the medium in one minute?

A 900 cm

B 1200 cm

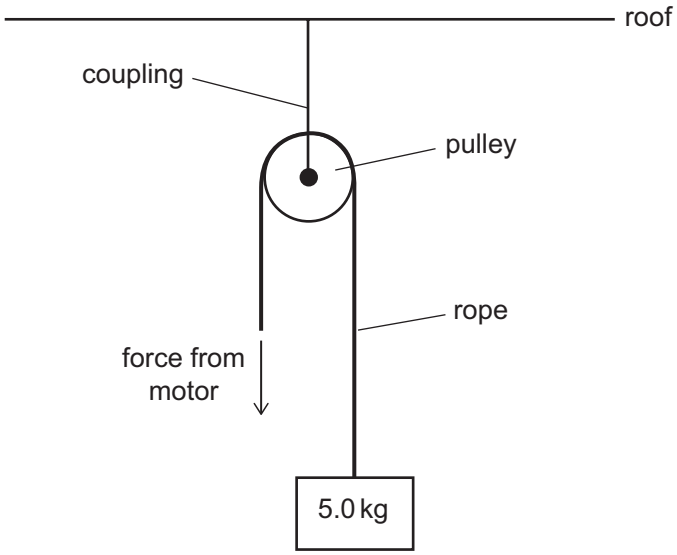
C 1800 cm

D 2400 cm

E 3600 cm

F 4800 cm

28 A motor is used to lift a mass of 5.0 kg using a pulley system as shown in the diagram. The pulley is secured to the roof using a coupling.



The motor needs to cause the mass to accelerate upwards at 0.80 m s^{-2}.

What is the minimum tension force that the coupling must be able to withstand without breaking?

(The gravitational field strength g is 10 N kg^{-1}. The pulley system is frictionless and has negligible mass. The rope has negligible mass and is inextensible.)

A 4.0 N

B 8.0 N

C 46 N

D 50 N

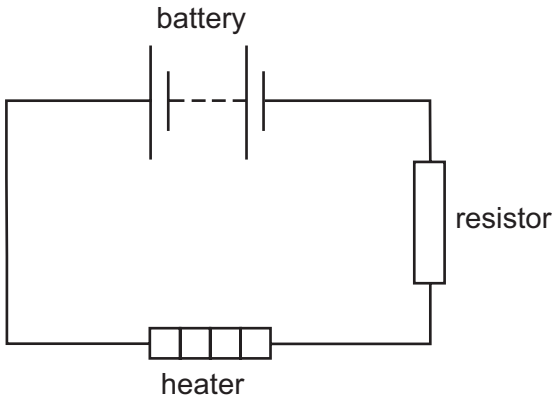
E 54 N

F 92 N

G 104 N

H 108 N

29 A heater is connected in series with a resistor and a 6.0 V battery in the circuit shown.

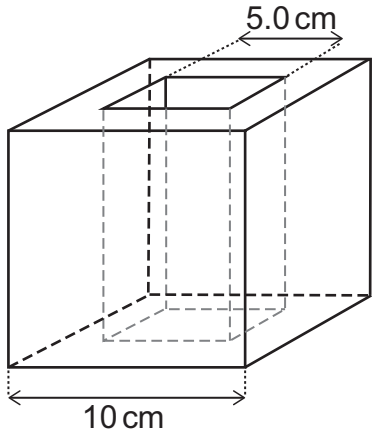


The total resistance of the circuit is 15 Ω. In 3.0 minutes, 180 J of electrical energy is transferred into other forms in the heater.

How much charge flows through the heater in the 3.0 minutes and what is the voltage across the heater?

	charge / C	*voltage* / V
A	1.2	150
B	1.2	216
C	7.5	0.041
D	7.5	24
E	72	0.40
F	72	2.5
G	450	0.40
H	450	2.5

30 A cubic block has a hole through it with a square cross-section. The dimensions are shown on the diagram. The weight of the block is 30 N.



What is the density of the material from which the block is made?

(The gravitational field strength g is 10 N kg^{-1}.)

A 0.30 g cm^{-3}

B 0.40 g cm^{-3}

C 0.60 g cm^{-3}

D 1.2 g cm^{-3}

E 3.0 g cm^{-3}

F 4.0 g cm^{-3}

G 6.0 g cm^{-3}

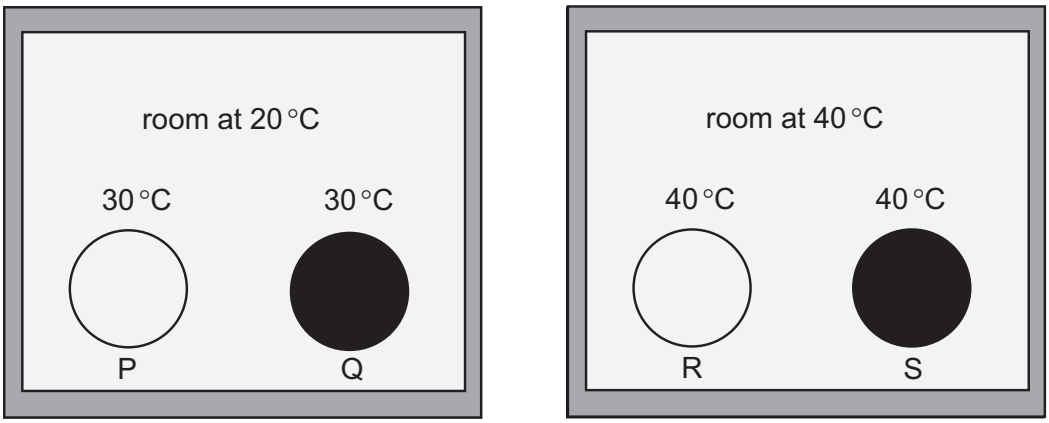
H 12 g cm^{-3}

31 The diagram shows four solid steel balls P, Q, R and S which are of identical size.

Balls P and R have shiny surfaces. Balls Q and S have dull surfaces.

Balls P and Q are in a room at 20 °C. Balls R and S are in a room at 40 °C.

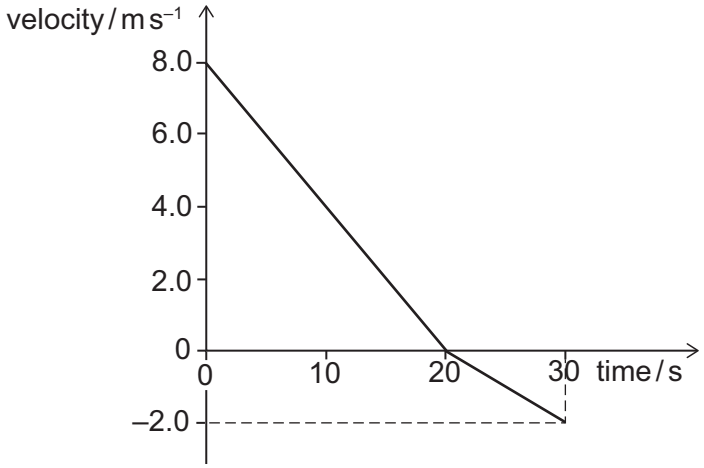
The temperature of each ball at a given moment in time is shown on the diagram.



Which two balls lose thermal energy by convection, and which ball emits thermal radiation at the greatest rate?

	lose thermal energy by convection	*greatest rate of emission of thermal radiation*
A	P and Q	P
B	P and Q	Q
C	P and Q	R
D	P and Q	S
E	R and S	P
F	R and S	Q
G	R and S	R
H	R and S	S

32 The diagram shows the velocity-time graph for an object travelling in a straight line over a period of 30 s.



What total distance did the object travel in the 30 s, how far from its starting position was it at the end of the 30 s, and what was its average speed over the 30 s?

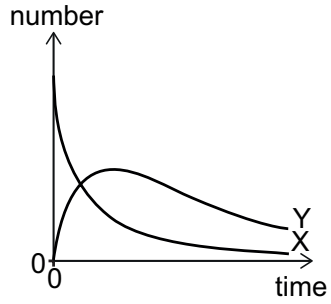
	total distance travelled / m	*distance from starting position* / m	*average speed* / m s^{-1}
A	90	70	3.0
B	90	70	5.0
C	90	90	3.0
D	90	90	5.0
E	180	140	5.0
F	180	140	6.0
G	180	180	5.0
H	180	180	6.0

33 A sample of a radioactive isotope X decays to one other radioactive isotope Y. Y has a half-life that is double that of X. Initially only X is present.

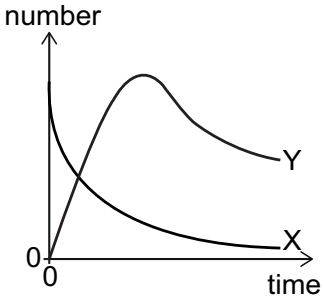
Which graph could represent how the numbers of nuclei of X and Y that are present in the sample vary with time?

(All graphs cover the same period of time.)

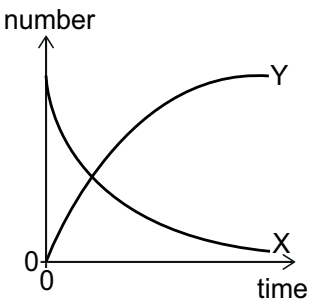
A



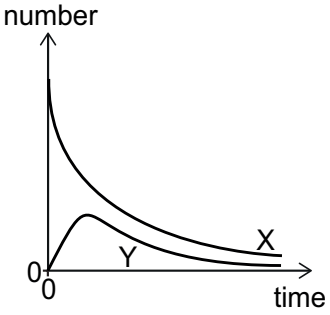
B



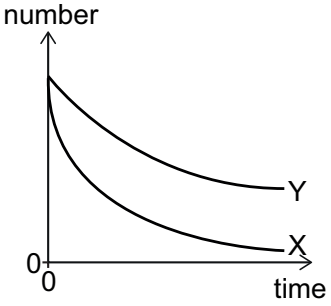
C



D



E



34 Bronze is a mixture of tin and copper.

A particular sample of bronze contains 10% tin by volume. (In other words, 10% of the total volume of the sample is tin and 90% of it is copper.)

What percentage of the mass of the sample is tin?

(Density of tin $= Y$ and density of copper $= X$.)

A $\frac{X}{9X - Y} \times 100$

B $\frac{X}{9Y - X} \times 100$

C $\frac{Y}{9X - Y} \times 100$

D $\frac{Y}{9Y - X} \times 100$

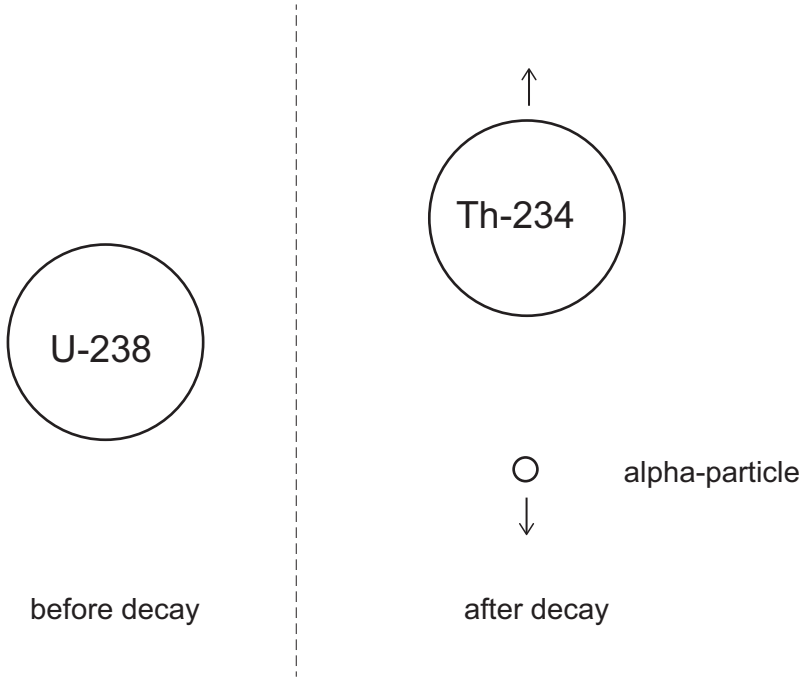
E $\frac{X}{9X + Y} \times 100$

F $\frac{X}{9Y + X} \times 100$

G $\frac{Y}{9X + Y} \times 100$

H $\frac{Y}{9Y + X} \times 100$

35 When a stationary uranium-238 nucleus decays by alpha emission it forms a nucleus of thorium-234. The total kinetic energy produced by the decay is E.



What is the kinetic energy of the alpha particle?

A $\frac{4E}{238}$

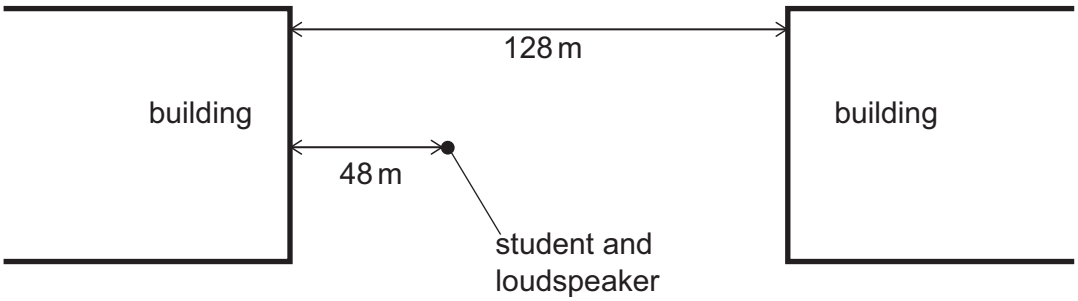
B $\frac{4E}{234}$

C $\frac{E}{2}$

D $\frac{234E}{238}$

E E

36 A student carries out an experiment to measure the speed of sound. A loudspeaker that emits sound in all directions is placed between two buildings that are 128 m apart as shown. The student and loudspeaker are 48 m from one of the buildings.



The loudspeaker is connected to a signal generator that causes it to emit regular clicks. The student notices that each click results in two echoes, one from each building. The rate at which the clicks are produced is gradually increased from zero until each echo coincides with a new click being emitted by the loudspeaker.

What is the frequency of emission of clicks when this happens?

(The speed of sound in air $= 320\,\text{m}\,\text{s}^{-1}$.)

A 2.0 Hz

B 2.5 Hz

C 3.3 Hz

D 4.0 Hz

E 5.3 Hz

F 6.7 Hz

G 10 Hz