Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Standard level
Paper 1

Thursday 28 April 2022 (morning)

45 minutes

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for this examination paper is **[30 marks]**.

2222 – 6516

16 pages

1. The radius of a circle is measured to be $(10.0 \pm 0.5)\,\text{cm}$. What is the area of the circle?

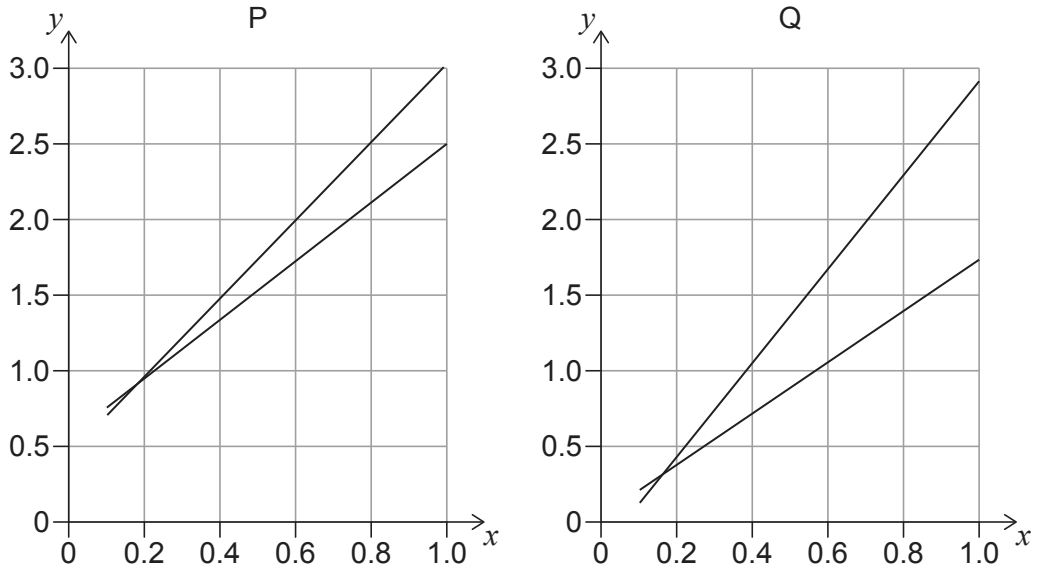
A. $(314.2 \pm 0.3)\,\text{cm}^2$

B. $(314 \pm 1)\,\text{cm}^2$

C. $(314 \pm 15)\,\text{cm}^2$

D. $(314 \pm 31)\,\text{cm}^2$

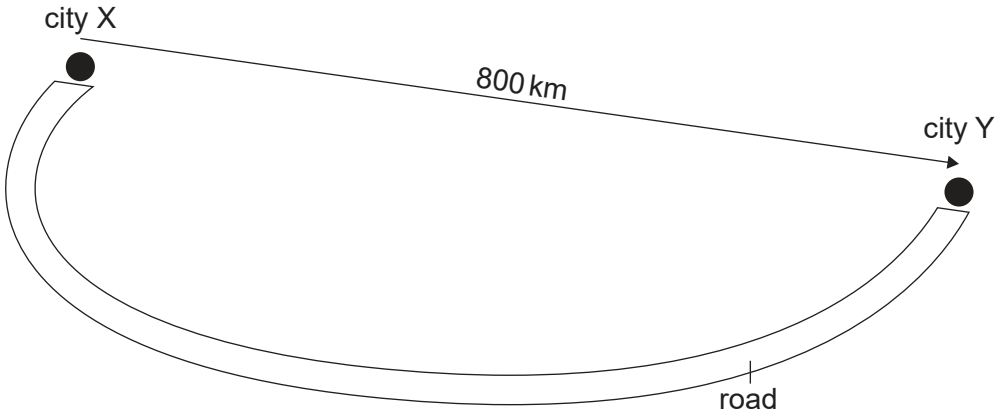
2. Two different experiments, P and Q, generate two sets of data to confirm the proportionality of variables x and y. The graphs for the data from P and Q are shown. The maximum and minimum gradient lines are shown for both sets of data.



What is true about the systematic error and the uncertainty of the gradient when P is compared to Q?

	Systematic error	**Uncertainty of the gradient**
A.	larger for set P	larger for set P
B.	larger for set Q	larger for set P
C.	larger for set P	larger for set Q
D.	larger for set Q	larger for set Q

3. The road from city X to city Y is 1000 km long. The displacement is 800 km from X to Y.



What is the distance travelled from Y to X and the displacement from Y to X?

	Distance travelled from Y to X / km	Displacement from Y to X / km
A.	800	800
B.	1000	800
C.	800	−800
D.	1000	−800

4. A car accelerates uniformly from rest to a velocity v during time t_1. It then continues at constant velocity v from t_1 to time t_2.

What is the total distance covered by the car in t_2?

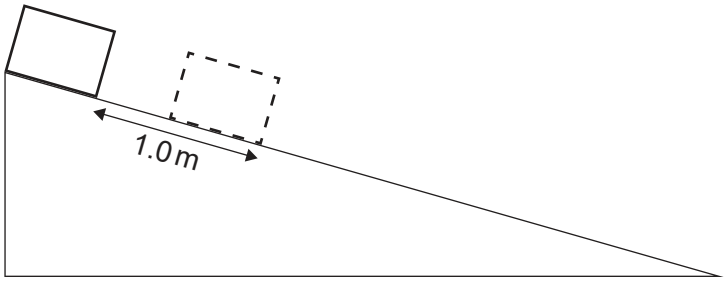
A. $v\ t_2$

B. $\frac{1}{2}v\left(t_2 - t_1\right) + v\ t_1$

C. $\frac{1}{2}v\left(t_2 + t_1\right)$

D. $\frac{1}{2}v\,t_1 + v\left(t_2 - t_1\right)$

5. An object is sliding from rest down a frictionless inclined plane. The object slides 1.0 m during the first second.



What distance will the object slide during the next second?

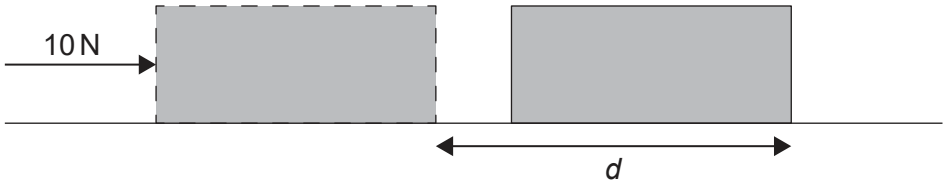
A. 1.0 m

B. 2.0 m

C. 3.0 m

D. 4.9 m

6. An object of mass 2.0 kg rests on a rough surface. A person pushes the object in a straight line with a force of 10 N through a distance *d*.



The resultant force acting on the object throughout *d* is 6.0 N.

What is the value of the sliding coefficient of friction μ between the surface and the object and what is the acceleration *a* of the object?

	μ	a / ms^{-2}
A.	0.20	3.0
B.	0.20	5.0
C.	0.40	3.0
D.	0.40	5.0

7. A rocket has just been launched vertically from Earth. The image shows the free-body diagram of the rocket. F_1 represents a larger force than F_2.

Which force pairs with F_1 and which force pairs with F_2, according to Newton's third law?

	Force pair with F_1	**Force pair with F_2**
A.	force of rocket on exhaust gases	force of exhaust gases on rocket
B.	force of rocket on exhaust gases	gravitational force of rocket on Earth
C.	gravitational force of Earth on rocket	force of exhaust gases on rocket
D.	gravitational force of Earth on rocket	gravitational force of rocket on Earth

8. An object is pushed from rest by a constant net force of 100 N. When the object has travelled 2.0 m the object has reached a velocity of 10 m s^{-1}.

What is the mass of the object?

A. 2 kg

B. 4 kg

C. 40 kg

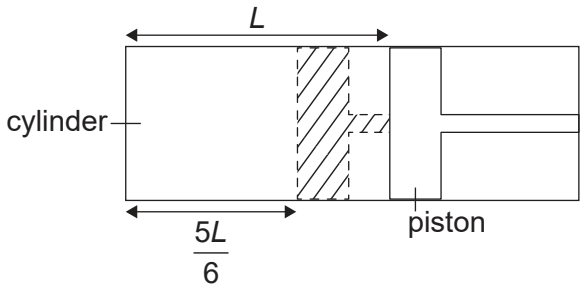
D. 200 kg

9. Two blocks of different masses are released from identical springs of elastic constant $k = 100\,Nm^{-1}$, initially compressed a distance $\Delta x = 0.1\,m$. Block X has a mass of 1 kg and block Y has a mass of 0.25 kg.

What are the velocities of the blocks when they leave the springs?

	Velocity of block X	Velocity of block Y
A.	$1.0\,ms^{-1}$	$1.0\,ms^{-1}$
B.	$2.0\,ms^{-1}$	$1.0\,ms^{-1}$
C.	$1.0\,ms^{-1}$	$2.0\,ms^{-1}$
D.	$2.0\,ms^{-1}$	$2.0\,ms^{-1}$

10. A quantity of an ideal gas is at a temperature T in a cylinder with a movable piston that traps a length L of the gas. The piston is moved so that the length of the trapped gas is reduced to $\frac{5L}{6}$ and the pressure of the gas doubles.



What is the temperature of the gas at the end of the change?

A. $\frac{5}{12}T$

B. $\frac{3}{5}T$

C. $\frac{5}{3}T$

D. $\frac{12}{5}T$

11. What is true for an ideal gas?

A. $nRT = Nk_B T$

B. $nRT = k_B T$

C. $RT = Nk_B T$

D. $RT = k_B T$

12. Which assumption is part of the molecular kinetic model of ideal gases?

A. The work done on a system equals the change in kinetic energy of the system.

B. The volume of a gas results from adding the volume of the individual molecules.

C. A gas is made up of tiny identical particles in constant random motion.

D. All particles in a gas have kinetic and potential energy.

13. **System X** is at a temperature of 40 °C. Thermal energy is provided to system X until it reaches a temperature of 50 °C. **System Y** is at a temperature of 283 K. Thermal energy is provided to system Y until it reaches a temperature of 293 K.

What is the difference in the thermal energy provided to both systems?

A. Zero

B. Larger for X

C. Larger for Y

D. Cannot be determined with the data given

14. A particle is moving in a straight line with an acceleration proportional to its displacement and opposite to its direction. What are the velocity and the acceleration of the particle when it is at its maximum displacement?

	Velocity	Acceleration
A.	maximum	zero
B.	maximum	maximum
C.	zero	zero
D.	zero	maximum

15. Three statements about electromagnetic waves are:

I. They can be polarized.

II. They can be produced by accelerating electric charges.

III. They must travel at the same velocity in all media.

Which combination of statements is true?

A. I and II only

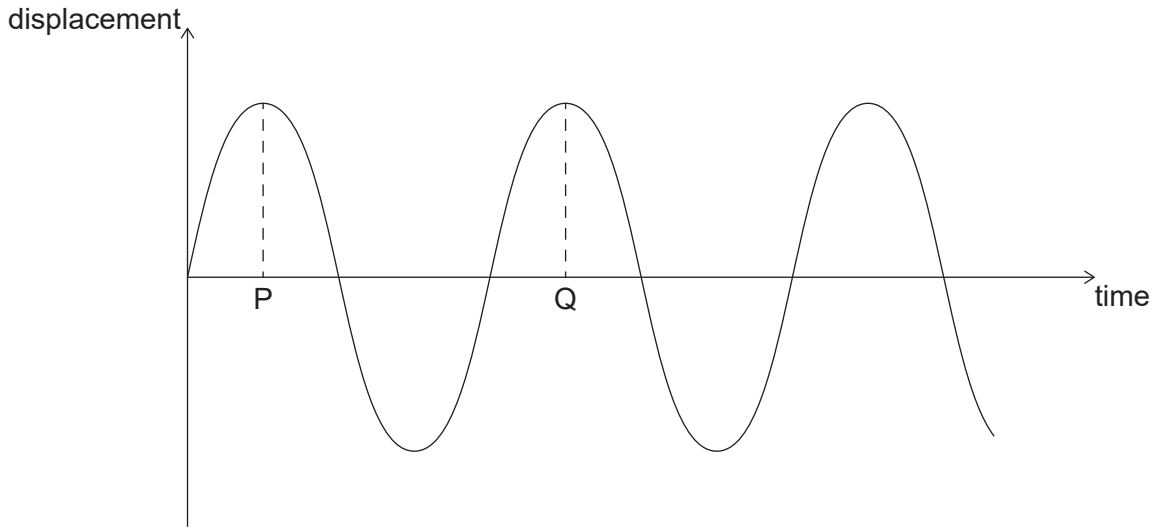
B. I and III only

C. II and III only

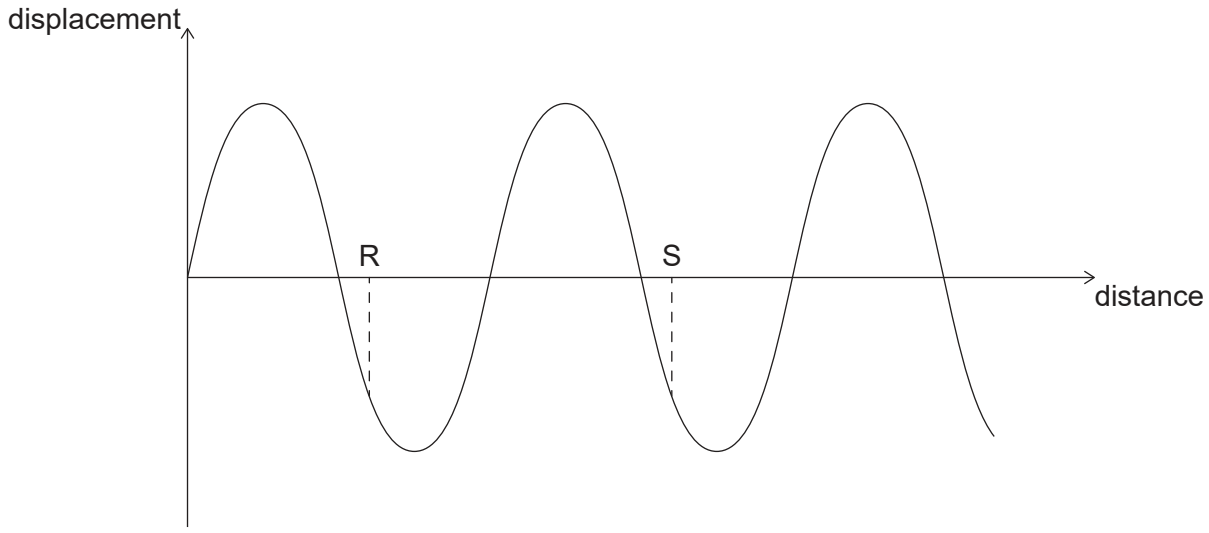
D. I, II and III

16. A wave travels along a string. Graph M shows the variation with time of the displacement of a point X on the string. Graph N shows the variation with distance of the displacement of the string. PQ and RS are marked on the graphs.

Graph M



Graph N



What is the speed of the wave?

A. $\frac{PQ}{RS}$

B. $PQ \times RS$

C. $\frac{RS}{PQ}$

D. $\frac{1}{PQ \times RS}$

17. The refractive index of glass is $\frac{3}{2}$ and the refractive index of water is $\frac{4}{3}$. What is the critical angle for light travelling from glass to water?

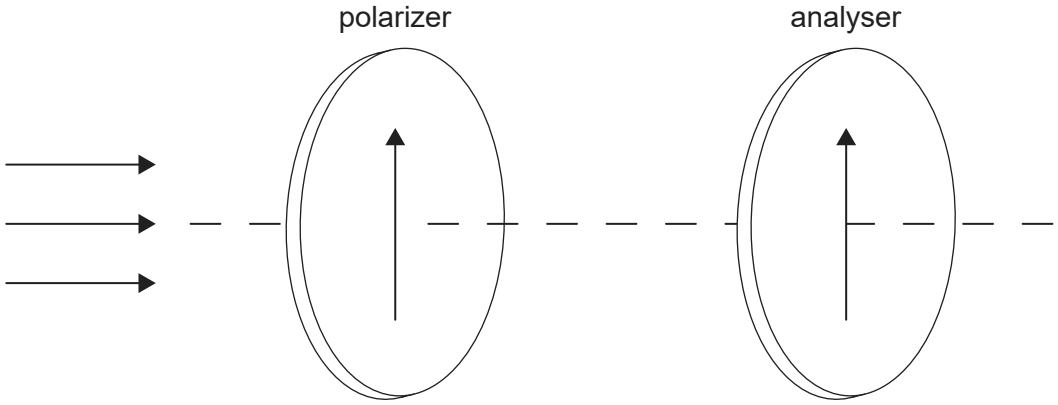
A. $\sin^{-1}\left(\frac{1}{2}\right)$

B. $\sin^{-1}\left(\frac{2}{3}\right)$

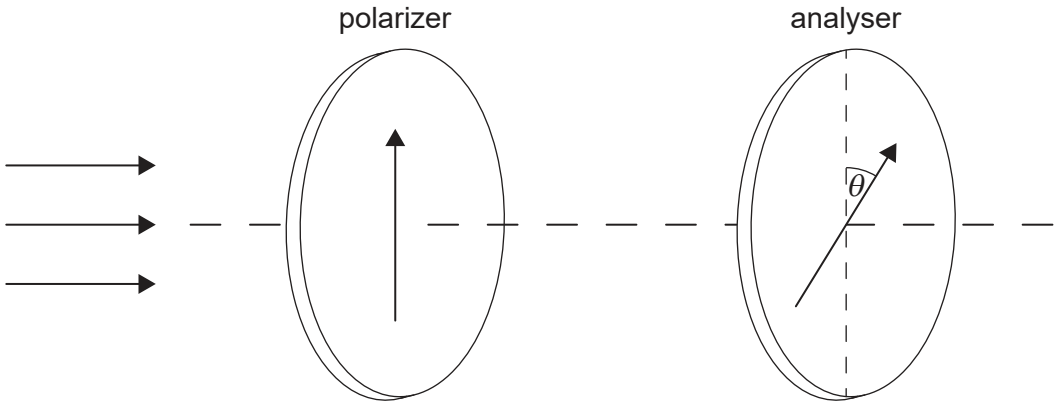
C. $\sin^{-1}\left(\frac{3}{4}\right)$

D. $\sin^{-1}\left(\frac{8}{9}\right)$

18. Unpolarized light with an intensity of $320\,\text{W}\,\text{m}^{-2}$ goes through a polarizer and an analyser, originally aligned parallel.



The analyser is rotated through an angle $\theta = 30°$. Cos $30° = \frac{\sqrt{3}}{2}$.



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(Question 18 continued)

What is the intensity of the light emerging from the analyser?

A. $120\,W\,m^{-2}$

B. $80\sqrt{3}\,W\,m^{-2}$

C. $240\,W\,m^{-2}$

D. $160\sqrt{3}\,W\,m^{-2}$

19. A charge Q is at a point between two electric charges Q_1 and Q_2. The net electric force on Q is zero. Charge Q_1 is further from Q than charge Q_2.

What is true about the signs of the charges Q_1 and Q_2 and their magnitudes?

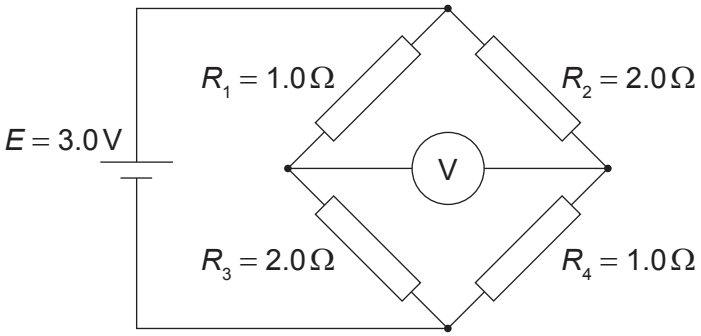
	Signs of charges Q_1 and Q_2	Magnitudes
A.	same	$Q_1 > Q_2$
B.	same	$Q_1 < Q_2$
C.	opposite	$Q_1 > Q_2$
D.	opposite	$Q_1 < Q_2$

20. A battery of negligible internal resistance is connected to a lamp. A second identical lamp is added in series. What is the change in potential difference across the first lamp and what is the change in the output power of the battery?

	Change in potential difference	Output power of battery
A.	decreases	decreases
B.	decreases	increases
C.	no change	decreases
D.	no change	increases

21. A circuit consists of a cell of emf $E = 3.0\,\text{V}$ and four resistors connected as shown. Resistors R_1 and R_4 are $1.0\,\Omega$ and resistors R_2 and R_3 are $2.0\,\Omega$.

What is the voltmeter reading?



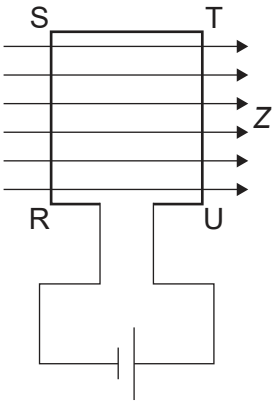
A. 0.50 V

B. 1.0 V

C. 1.5 V

D. 2.0 V

22. A rectangular coil of wire RSTU is connected to a battery and placed in a magnetic field Z directed to the right. Both the plane of the coil and the magnetic field direction are in the same plane.



What is true about the magnetic force acting on the sides RS and ST?

	Force acting on RS	**Force acting on ST**
A.	into the page	into the page
B.	out of the page	no force acts
C.	into the page	no force acts
D.	out of the page	out of the page

23. A satellite is orbiting Earth in a circular path at constant speed. Three statements about the resultant force on the satellite are:

I. It is equal to the gravitational force of attraction on the satellite.

II. It is equal to the mass of the satellite multiplied by its acceleration.

III. It is equal to the centripetal force on the satellite.

Which combination of statements is correct?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

24. Three statements about Newton's law of gravitation are:

I. It can be used to predict the motion of a satellite.

II. It explains why gravity exists.

III. It is used to derive the expression for gravitational potential energy.

Which combination of statements is correct?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

25. Three statements about electrons are:

I. Electrons interact through virtual photons.

II. Electrons interact through gluons.

III. Electrons interact through particles W and Z.

Which statements identify the particles mediating the forces experienced by electrons?

A. I and II only

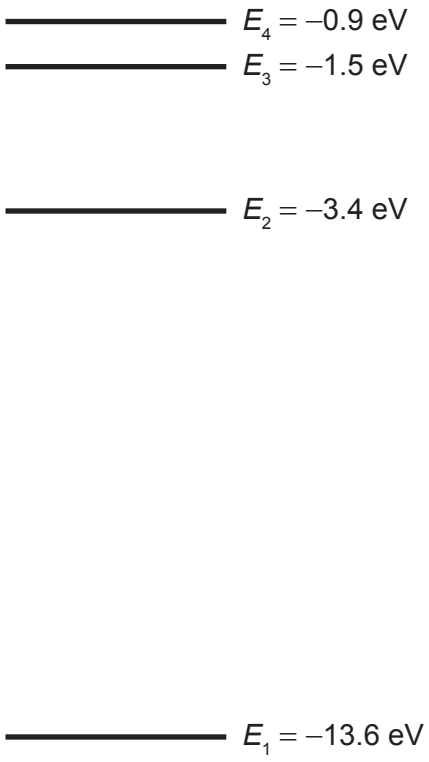
B. I and III only

C. II and III only

D. I, II and III

26. The energy levels of an atom are shown. How many photons of energy **greater** than 1.9 eV can be emitted by this atom?

diagram not to scale



A. 1

B. 2

C. 3

D. 4

27. What statement is **not** true about radioactive decay?

A. The percentage of radioactive nuclei of an isotope in a sample of that isotope after 7 half-lives is smaller than 1%.

B. The half-life of a radioactive isotope is the time taken for half the nuclei in a sample of that isotope to decay.

C. The whole-life of a radioactive isotope is the time taken for all the nuclei in a sample of that isotope to decay.

D. The half-life of radioactive isotopes range between extremely short intervals to thousands of millions of years.

28. The age of the Earth is about 4.5×10^9 years.

What area of physics provides experimental evidence for this conclusion?

A. Newtonian mechanics

B. Optics

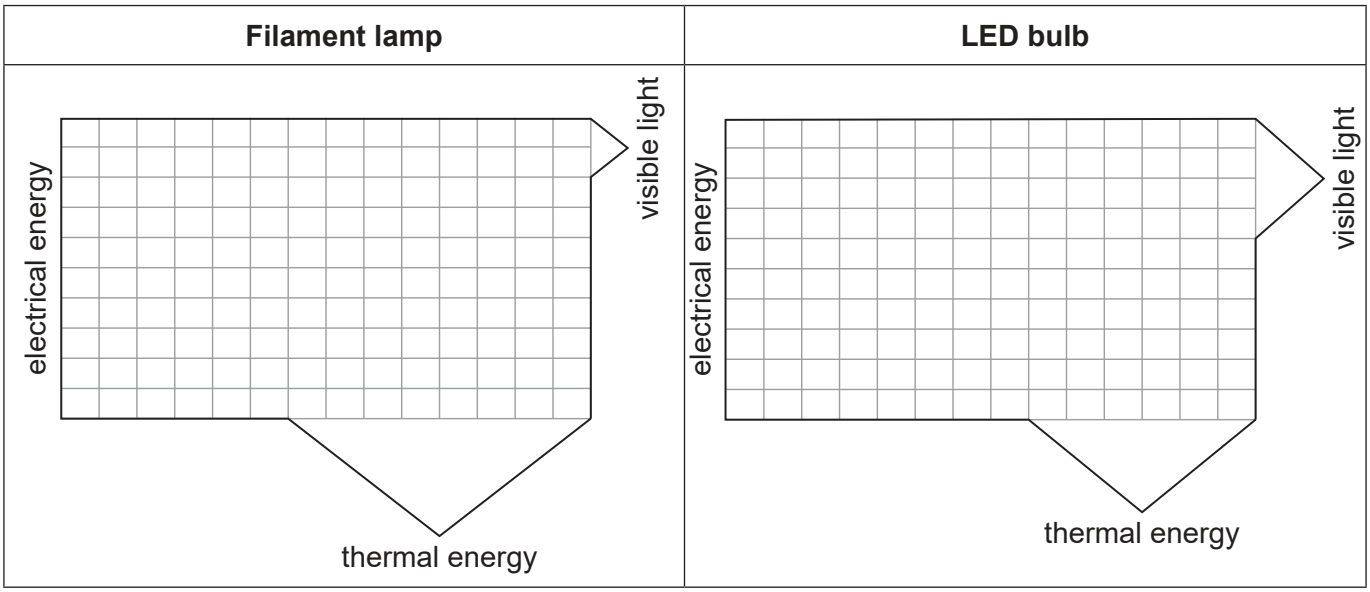
C. Radioactivity

D. Electromagnetism

29. Photovoltaic cells and solar heating panels are used to transfer the electromagnetic energy of the Sun's rays into other forms of energy. What is the form of energy into which solar energy is transferred in photovoltaic cells and solar heating panels?

	Photovoltaic cells	**Solar heating panels**
A.	electrical energy	thermal energy
B.	thermal energy	thermal energy
C.	electrical energy	electrical energy
D.	thermal energy	electrical energy

30. The Sankey diagrams for a filament lamp and for an LED bulb are shown below.



What is the efficiency of the filament lamp and the LED bulb?

	Filament lamp	LED bulb
A.	20 %	40 %
B.	25 %	40 %
C.	20 %	67 %
D.	25 %	67 %

References: