Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Standard level
Paper 1

Thursday 3 November 2022 (afternoon)

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]**.

8822 – 6504

1. A rectangular sheet of paper has dimensions of (30.0 ± 0.5) cm and (20.0 ± 0.5) cm.

What is the percentage uncertainty of the perimeter of the paper?

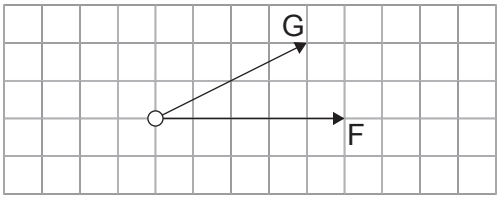
A. 1 %

B. 2 %

C. 2.5 %

D. 4 %

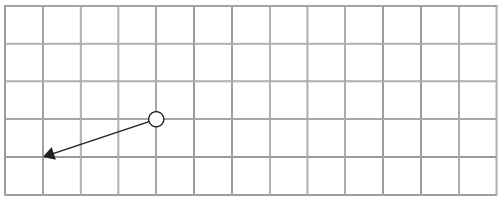
2. Two forces, F and G, act on a system.



F is reversed in direction and G is halved.

Which vector correctly represents the new resultant force?

A.



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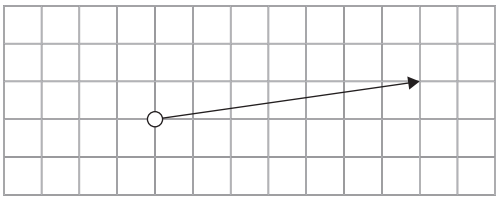

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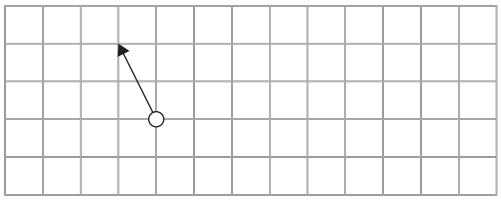
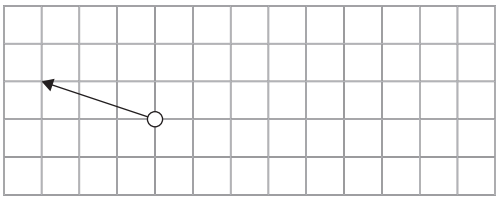
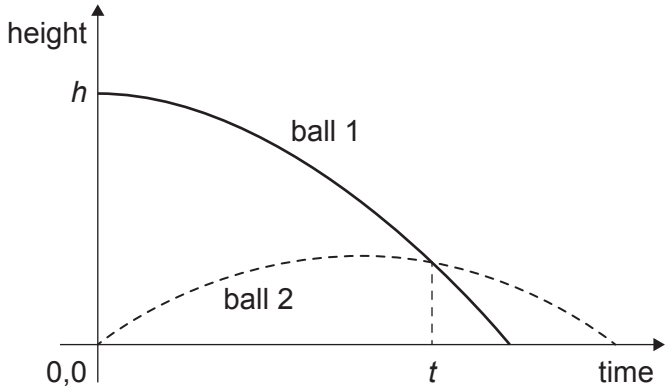


D.



3. Ball 1 is dropped from rest from an initial height h. At the same instant, ball 2 is launched vertically upwards at an initial velocity u.



At what time are both balls at the same distance above the ground?

A. $\frac{h}{4u}$

B. $\frac{h}{2u}$

C. $\frac{h}{u}$

D. $\frac{2h}{u}$

4. A projectile is launched with a velocity u at an angle θ to the horizontal. It reaches a maximum height s. What is the time taken to reach the maximum height?

A. $\frac{2s}{u\cos\theta}$

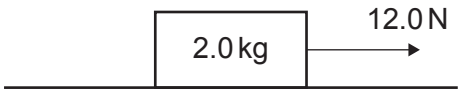
B. $\frac{2s}{g}$

C. $\frac{u\cos\theta}{g}$

D. $\frac{u\sin\theta}{g}$

5. An object of mass 2.0 kg is on a horizontal surface. The object is pulled by a force of 12.0 N and accelerates at 2.0 m s^{-2}.

What is the coefficient of dynamic friction between the object and the surface?



A. 0.3

B. 0.4

C. 0.6

D. 0.8

6. A person lifts a total mass of 20 kg through a vertical distance of 0.60 m. The person repeats the lift n times to transfer a total energy of 6.0×10^4 J.

What is n?

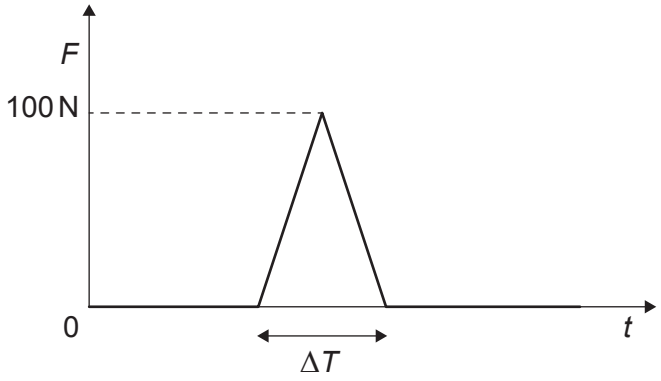
A. 5

B. 50

C. 500

D. 5000

7. A ball of mass 1.5 kg strikes a force sensor and bounces. The ball experiences a change in velocity of 10 m s^{-1}. The graph shows the variation with time t of the force F recorded by the sensor.



What is ΔT ?

A. 0.15 s

B. 0.30 s

C. 0.60 s

D. 3.0 s

8. A block of glass of mass 5 kg and temperature 30°C is brought into contact with a block of asphalt of mass 20 kg and temperature 75°C. The specific heat capacity of asphalt is twice that of glass. No energy is transferred to the surroundings. What is the final temperature of both blocks?

A. 35°C

B. 45°C

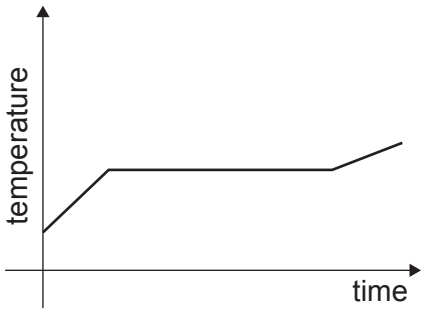
C. 60°C

D. 70°C

9. A solid mass gains energy at a constant rate until it reaches its liquid phase. The specific heat capacity in the solid phase is greater than in the liquid phase.

Which graph shows how the temperature of the mass varies with time?

A.



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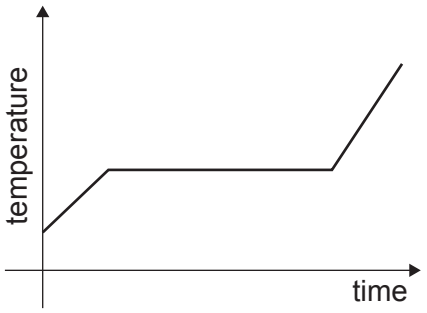

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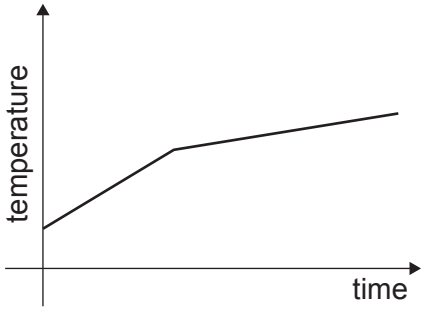

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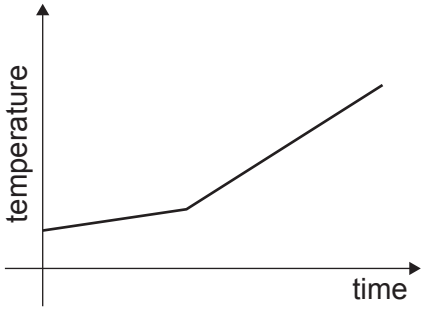


10. Three statements about Boltzmann's constant k_B are:

I. k_B has a unit of JK^{-1}

II. $k_B = \dfrac{\text{gas constant}}{\text{Avogadro's constant}}$

III. $k_B = \dfrac{\text{the average kinetic energy of particles}}{\text{temperature of the gas}}$

Which statements are correct?

A. I and II only

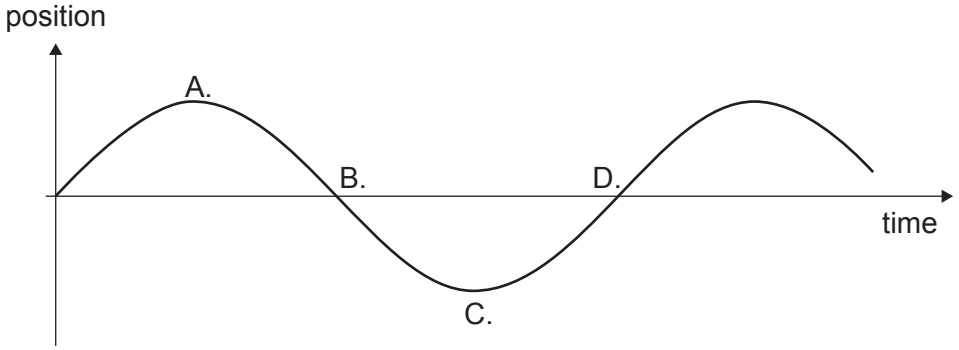
B. I and III only

C. II and III only

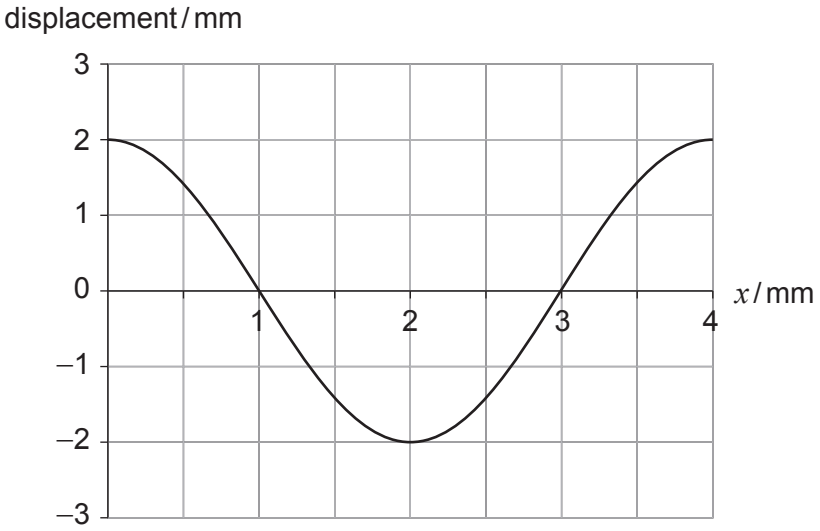
D. I, II and III

11. An object oscillates at the free end of a vertical spring. The graph shows the variation of the object's position with time.

At which position does the object have zero velocity and a negative acceleration?



12. The graph shows the variation with distance x of the displacement of the particles in a wave. The frequency of the wave is 600 Hz.



What is the speed of the wave?

A. $0.012\,\text{m s}^{-1}$

B. $0.024\,\text{m s}^{-1}$

C. $1.2\,\text{m s}^{-1}$

D. $2.4\,\text{m s}^{-1}$

13. A point source emits a sound wave of amplitude Z. A person stands a distance L from the source. The amplitude is changed to $2Z$.

What distance must the person move through in order to hear the original intensity again?

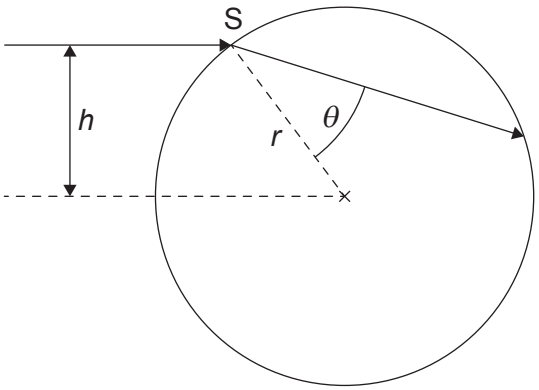
A. L

B. $2L$

C. $3L$

D. $7L$

14. A ray of light enters from air into a water droplet of radius r at point S. S is a vertical distance h from the centre of the droplet. The droplet has a refractive index n and the angle of refraction is θ.



What is $\sin\theta$?

A. $\frac{nh}{r}$

B. $\frac{r}{nh}$

C. $\frac{h}{nr}$

D. $\frac{nr}{h}$

15. A standing wave is formed in a pipe closed at one end. The third harmonic has a frequency of 400 Hz when the speed of sound is 300 $m\,s^{-1}$. What is the length of the pipe?

A. $\frac{3}{16}$ m

B. $\frac{9}{16}$ m

C. $\frac{3}{4}$ m

D. $\frac{14}{16}$ m

16. Wire X and wire Y are connected in series in a circuit. Wire X has three times the radius and one third the charge carrier density of wire Y.

What is $\frac{\text{drift speed in X}}{\text{drift speed in Y}}$?

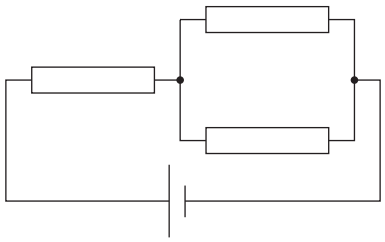
A. $\frac{1}{9}$

B. $\frac{1}{3}$

C. 1

D. 3

17. A cell of negligible internal resistance is connected to three identical resistors. The current in the cell is 3.0A.



The resistors are now arranged in series.

What is the new current in the cell?

A. 1.0A

B. 1.5A

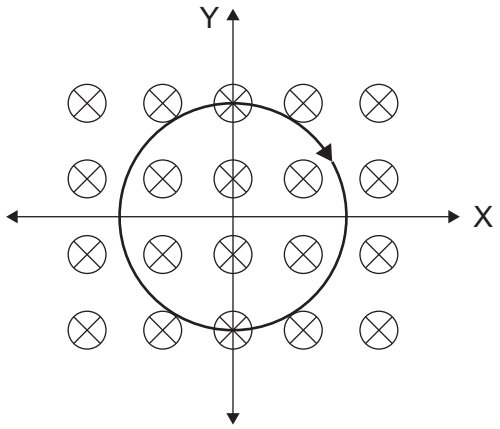
C. 3.0A

D. 9.0A

18. What is correct about the energy changes and the terminal potential difference during the discharge of a practical electrical cell?

	Energy changes	**Terminal potential difference**
A.	Chemical energy is transferred to electrical energy	Decreases uniformly over the cell lifetime
B.	Chemical energy is transferred to electrical energy	Decreases significantly at the end of the cell lifetime
C.	Electrical energy is transferred to chemical energy	Decreases uniformly over the cell lifetime
D.	Electrical energy is transferred to chemical energy	Decreases significantly at the end of the cell lifetime

19. A loop of wire lies in a magnetic field directed into the plane of the page. The loop carries a current in a clockwise direction.



The magnetic force acting on the wire tends to

A. rotate the loop about the X axis.

B. rotate the loop about the Y axis.

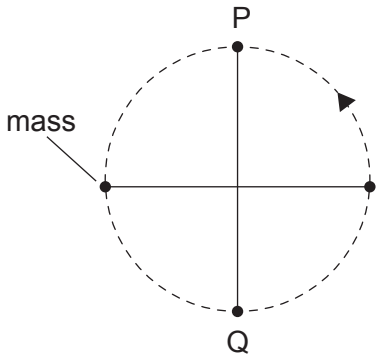
C. reduce the radius of the loop.

D. increase the radius of the loop.

20. A car on a road follows a horizontal circular path at a constant speed. What is the direction of the net force acting on the car and the direction of the instantaneous velocity of the car?

	Direction of net force	**Direction of instantaneous velocity**
A.	Away from centre of the circle	Tangent to the circle
B.	Away from centre of the circle	Toward centre of the circle
C.	Toward centre of the circle	Tangent to the circle
D.	Toward centre of the circle	Toward centre of the circle

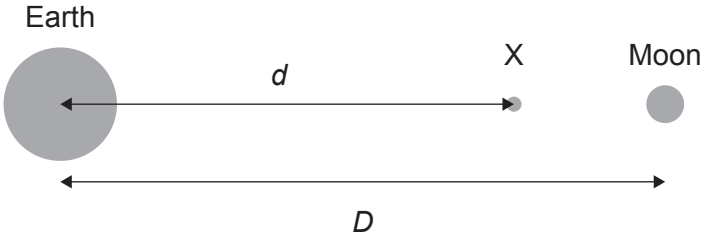
21. A mass attached to a string rotates in a gravitational field with a constant period in a vertical plane.



How do the speed of the mass and the tension of the string compare at P and Q?

	Speed of the mass	Tension in the string
A.	Equal	Equal
B.	Equal	Greater at Q
C.	Greater at Q	Equal
D.	Greater at Q	Greater at Q

22. The centre of the Earth and the Moon are a distance D apart. There is a point X between them where their gravitational fields cancel out. The distance from the centre of the Earth to X is d. The mass of the Earth is M_E and the mass of the Moon is M_M.



What is correct at X?

A. $\frac{M_E}{d} = \frac{M_M}{D-d}$

B. $\frac{M_E}{D-d} = \frac{M_M}{d}$

C. $\frac{M_E}{d^2} = \frac{M_M}{(D-d)^2}$

D. $\frac{M_E}{d^2} = \frac{M_M}{D^2-d^2}$

23. A nucleus of krypton (Kr) decays to a nucleus of bromine (Br) according to the equation

$$^{84}_{36}\text{Kr} \rightarrow {}^{84}_{35}\text{Br} + \text{Y} + \text{Z}$$

What are Y and Z?

	Y	Z
A.	e^+	ν_e
B.	e^-	ν_e
C.	e^+	$\overline{\nu}_e$
D.	e^-	$\overline{\nu}_e$

24. Which development in physics constituted a paradigm shift?

A. The classification of variables into scalars and vectors

B. The determination of the velocity of light in different media

C. The equivalence of $F = ma$ to $F = \frac{\Delta p}{\Delta t}$ when the mass of the system is constant

D. The equivalence of mass and energy

25. A fusion reaction of one nucleus of hydrogen-2 and one nucleus of hydrogen-3 converts 0.019 u to energy. A fission reaction of one nucleus of uranium-235 converts a mass of 0.190 u to energy.

What is the ratio $\frac{\text{specific energy of this fusion of hydrogen}}{\text{specific energy of this fission of uranium}}$?

A. 0.1

B. 0.2

C. 5

D. 10

26. Three statements about the atom are:

I. The nucleus of the atom is positively charged.

II. The electrons provide only a small fraction of the mass of an atom.

III. Most of the atom is free space.

Which statements are correct?

A. I and II only

B. I and III only

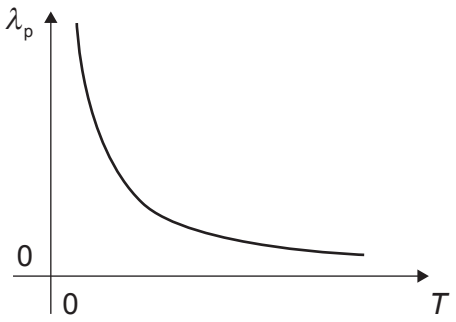
C. II and III only

D. I, II and III

27. The electromagnetic spectrum radiated by a black body at temperature T shows a peak at wavelength λ_p.

What is the variation of λ_p with T?

A.



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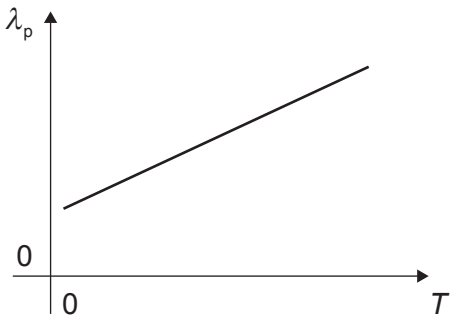

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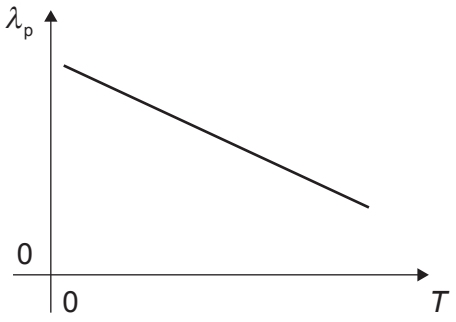

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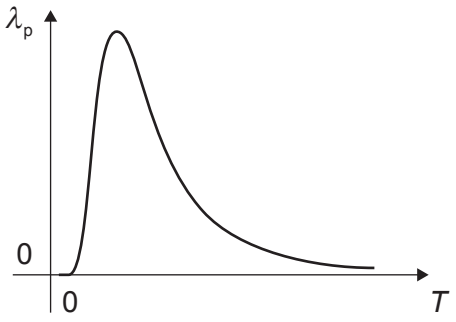


28. Water is to be pumped through a vertical height difference of 12.5 m. The pump is driven by a wind turbine that has an efficiency of 50 % and an area swept by the blades of 100 m^2. The average wind speed is 5.0 $m\,s^{-1}$ and the air density is 1.2 $kg\,m^{-3}$.

What is the maximum mass of water that can be pumped every second?

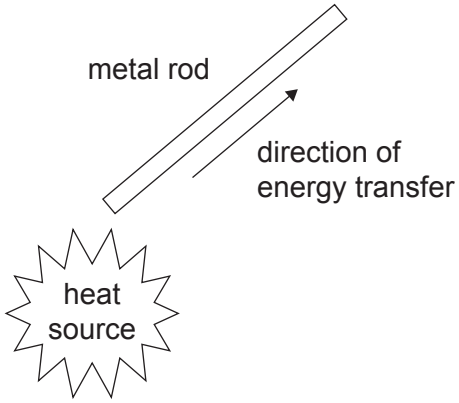
A. 3 kg

B. 30 kg

C. 60 kg

D. 120 kg

29. When heating a metal rod at one end, thermal energy is transferred along the rod.



Which statement explains this transfer?

A. Free electrons transfer kinetic energy to the ions in the metal

B. Intermolecular potential energy increases throughout the metal

C. Intermolecular potential energy is transferred to kinetic energy

D. Ions in the metal radiate energy in all directions

30. Planet X and planet Y both emit radiation as black bodies. Planet Y has twice the surface temperature and one third of the radius of planet X.

What is $\frac{\text{power radiated by planet X}}{\text{power radiated by planet Y}}$?

A. $\frac{9}{16}$

B. $\frac{3}{4}$

C. $\frac{4}{3}$

D. $\frac{16}{9}$

References: