Physics

Standard level

Paper 1A

1 hour 30 minutes [Paper 1A and 1B]

Instructions to candidates

- Do not open the examination paper until instructed to do so.
- Answer all questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A calculator is required for this paper.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for paper 1A is **[25 marks]**.
- The maximum mark for paper 1A and paper 1B is **[45 marks]**.

1. Brother is running away from AAHL at 5 m s^{-1}. At the same time, Pablo starts chasing him, starting 50 m behind him and accelerating at 2 m s^{-2}. After how long will Pablo catch Brother and make him learn De Moivre's theorem?
   A. 6.4 s
   B. 10 s
   C. 5 s
   D. 3.7 s

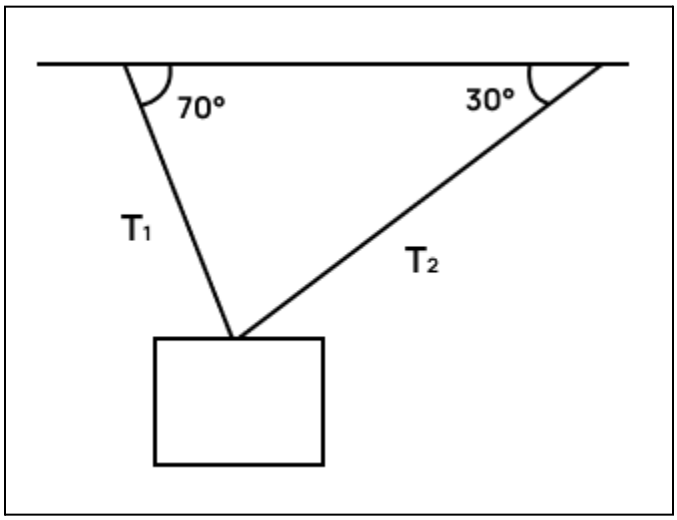
2. A car of mass 2000 kg travelling at 20 m s^{-1} collides with a stationary truck of mass 4000 kg. The two vehicles stick together after the collision. What is the final velocity after the collision?
   A. 10 m s^{-1}
   B. 6.7 m s^{-1}
   C. 20 m s^{-1}
   D. 13.3 m s^{-1}

3. A car is travelling at a constant speed of 20 m s^{-1}. Its engine takes 200 kW of power and the average resistive force acting on the car is 7500 N. What is the efficiency of the engine?
   A. 0.25
   B. 0.50
   C. 0.75
   D. 1.00

4. A stationary cube of mass 0.5 kg is sandwiched between a rough and a smooth (frictionless) wall. The coefficient of static friction between the cube and the rough wall is 0.5. What is the minimum normal force the smooth wall exerts on the cube?
   A. 9.8 N
   B. 4.9 N
   C. 0.98 N
   D. 0.48 N

5. A 2000 kg truck drives for 400 m up a hill inclined at 5.00° at 10.0 m s^{-1}. At what rate does the truck gain gravitational potential energy?
   A. 196 kW
   B. 17.1 kW
   C. 196 kW
   D. 188 kW

6. A box is held up by two wires as shown in the below diagram:



What is $\frac{T_1}{T_2}$?

A. $\frac{\sin 30º}{\sin 70º}$

B. $\frac{\cos 30º}{\cos 70º}$

C. $\frac{\sin 70º}{\sin 30º}$

D. $\frac{\cos 70º}{\cos 30º}$

7. Under which of the following conditions does an ideal gas best approximate a real gas?

	Pressure	Temperature
A	Low	Low
B	Low	High
C	High	Low
D	High	High

8. Which of the following does not contribute to the enhanced greenhouse effect?
   A. Deforestation for urban developments
   B. Exhaust from cars
   C. Intensive farming of animals
   D. Volcanic activity

9. 0.20 kg of an ideal gas in a 0.10 m^3 container has a pressure of 120 kPa at 320 K. What is the best estimate for the molar mass of the gas?
   A. 0.044 g mol^{-1}
   B. 0.90 g mol^{-1}
   C. 44 g mol^{-1}
   D. 900 g mol^{-1}

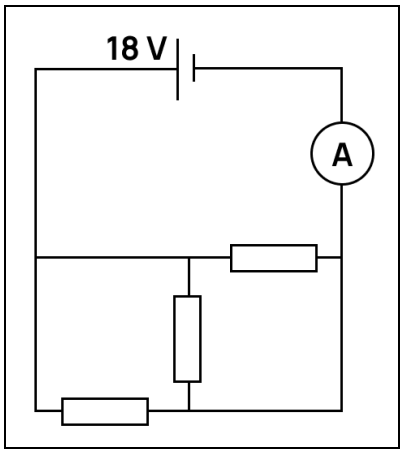
10. A black body X with temperature T emits radiative power P of peak frequency f. An otherwise identical black body Y has temperature 3T. What is the radiative power and peak frequency of black body Y?

	Radiative power	Peak frequency
A	3T	$\frac{f}{3}$
B	3T	3f
C	81T	$\frac{f}{3}$
D	81T	3f

11. What is true about the position and resistance of an ideal voltmeter?

	Position	Resistance
A	In series with component	Zero
B	In series with component	Infinite
C	In parallel with component	Zero
D	In parallel with component	Infinite

12. Three resistors each of resistance 6.0 Ω are connected as shown:



What is the ammeter reading?

A. 1.0 A

B. 2.0 A

C. 4.0 A

D. 9.0 A

13. A mass m is attached to a spring with spring constant 50 N m^{-1}. The natural frequency of oscillation of the system is 0.50 Hz. What is m?

A. 2.3 kg

B. 5.1 kg

C. 11 kg

D. 16 kg

14. Three statements about sound waves are:

I. The displacement of particles is parallel to the direction of energy transfer.

II. Sound waves can travel without a medium.

III. The displacement of particles is highest at the center of a compression.

Which of these statements is/are correct?

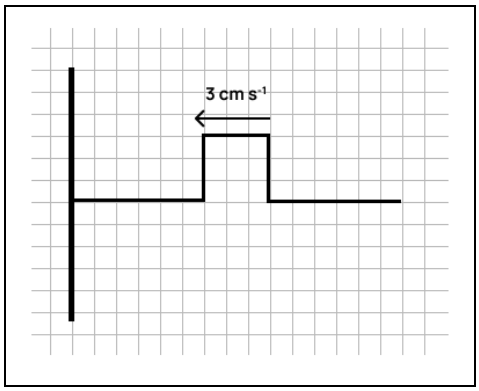
A. I only

B. II only

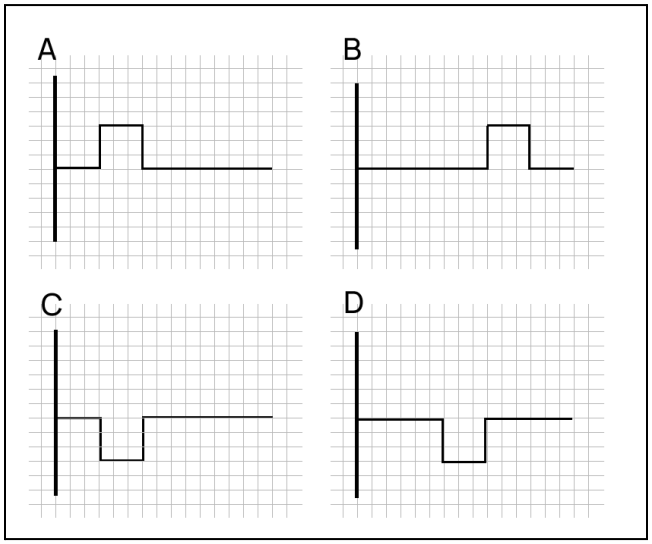
C. I and III only

D. II and III only

15. A square wave pulse moves along a string towards a fixed end as shown below. The length of one square is 1.0 cm.



What will be the position of the wave after 4.0 s?



16. Light of frequency f is normally incident on a single slit of width b. An interference pattern appears on a screen a distance D away from the slit, with a central maximum of width x m.

    Light of frequency 2f is shone on a single slit of width $\frac{b}{2}$. What will be the width of the central maximum on a screen a distance of $\frac{D}{2}$ away?

    A. $\frac{x}{8}$

    B. $\frac{x}{2}$

    C. x

    D. 2x

17. A standing wave of the fourth harmonic is formed in a pipe with two open ends. How many areas of rarefaction will be in the pipe?

    A. 1

    B. 2

    C. 4

    D. 8

18. A planet orbits a star. Three statements about the system are:

    I. The planet has an elliptical orbit.

    II. The planet's speed is inversely proportional to its distance from the star.

    III. The star remains stationary.

    Which of the above is/are correct?

    A. I only

    B. I and II only

    C. I and III only

    D. II and III only

19. Which of the below is **not** a unit for the permittivity of free space ε_0?

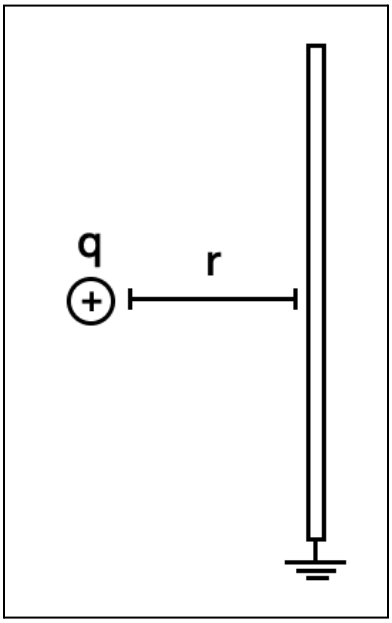
A. $C^2\ N^{-1}\ m^{-2}$

B. $C^2\ J^{-1}\ m^{-1}$

C. $A^2\ s\ W^{-1}\ m^{-1}$

D. $A^2\ kg^{-1}\ m^{-3}$

20. A particle with charge +q is a distance r away from a large grounded conducting plate as shown below.

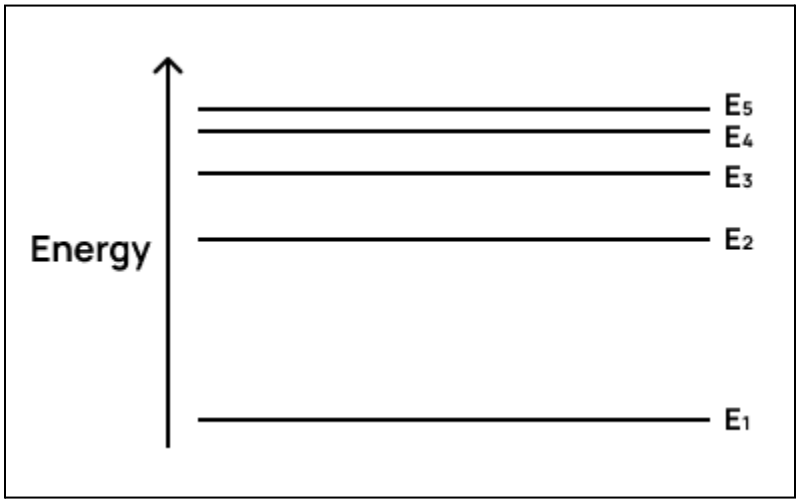


What is the magnitude and direction of the force on the particle?

	Magnitude	Direction
A	$k\frac{q^2}{r^2}$	Left
B	$k\frac{q^2}{r^2}$	Right
C	$k\frac{q^2}{4r^2}$	Left
D	$k\frac{q^2}{4r^2}$	RIght

21. Which of the following **cannot** be deduced from the results of the Geiger-Marsden-Rutherford experiment?
    A. The nucleus contains protons and neutrons
    B. The nucleus is very small and dense
    C. The nucleus is positively charged
    D. The nucleus contains most of the mass of the atom

22. A simple diagram of five atomic energy levels is shown below.



    Which of the below transitions emits the photon of the shortest wavelength?
    A. $E_3 \rightarrow E_1$
    B. $E_4 \rightarrow E_3$
    C. $E_3 \rightarrow E_2$
    D. $E_5 \rightarrow E_3$

23. Astatine-211 has a half-life of 7.2 hours. If the activity of a sample of astatine-211 is $8.0 \times 10^7\ Bq$, how many atoms of astatine-211 are in the sample?
    A. 2.1×10^3
    B. 3.1×10^3
    C. 2.1×10^{12}
    D. 3.0×10^{12}

24. Three statements about moderators in nuclear power plants are:

    I. A moderator is a good absorber of neutrons.

    II. A moderator slows down neutrons.

    III. Without a moderator, the power plant will undergo a meltdown.

    Which of these statements is/are correct?

    A. II only

    B. I and II only

    C. I and III only

    D. II and III only

25. A main sequence star has a mass of $60M_{\odot}$. What is a possible evolution for this star?

    A. Red giant → Planetary nebula → White dwarf

    B. Red giant → Supernova → Neutron star

    C. Red supergiant → Planetary nebula → Neutron star

    D. Red supergiant → Supernova → Black hole