Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Standard level
Paper 1

Monday 15 May 2017 (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]**.

2217 – 6516

13 pages

1. A stone falls from rest to the bottom of a water well of depth *d*. The time *t* taken to fall is 2.0 ± 0.2 s. The depth of the well is calculated to be 20 m using $d = \frac{1}{2}at^2$. The uncertainty in *a* is negligible.

What is the absolute uncertainty in *d*?

A. ±0.2 m

B. ±1 m

C. ±2 m

D. ±4 m

$2 \times \left[\frac{0.2}{2.0} \times 100\%\right]$

$2 \times \frac{20}{2}\%$

20%

20% of $20\,m = \frac{20}{100} \times 20 = \frac{400}{100} = 4\,m$

2. Which is a vector quantity?

A. Pressure

B. Electric current

C. Temperature

D. Magnetic field

scalars

vector

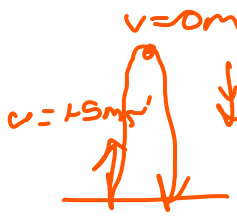
3. A ball is tossed vertically upwards with a speed of 5.0 m s^{-1}. After how many seconds will the ball return to its initial position?

A. 0.50 s

B. 1.0 s

C. 1.5 s

D. 2.0 s



$v = u + at$

$0 = 5 + (-10)t$

$0 = 5 - 10t$

$t = \frac{1}{2}$ sec for $\frac{1}{2}$ journey

so 1 second

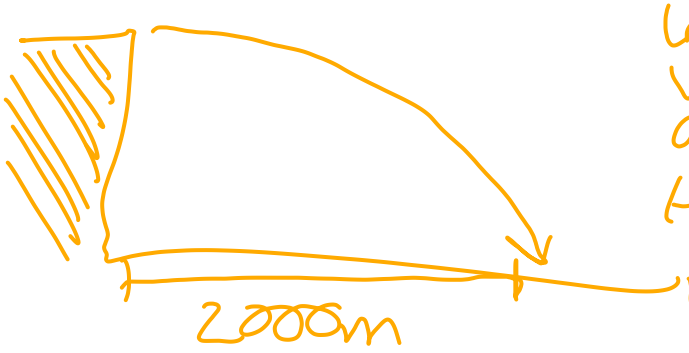
4. A projectile is fired horizontally from the top of a cliff. The projectile hits the ground 4 s later at a distance of 2 km from the base of the cliff. What is the height of the cliff?

A. 40 m

B. 80 m

C. 120 m

D. 160 m



$s = ?$

$u = 0$

$v =$

$a = -10$

$t = 4$

vertical

$s = ut + \frac{1}{2}at^2$

$s = \frac{1}{2}at^2$

$s = \frac{1}{2}(-10)(4)^2$

$s = -5 \times 16 = 80\,m$

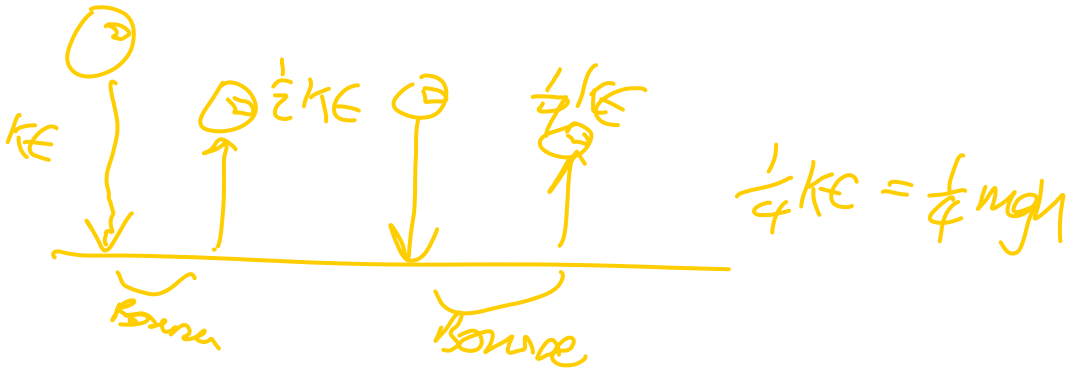
5. A tennis ball is released from rest at a height h above the ground. At each bounce 50 % of its kinetic energy is lost to its surroundings. What is the height reached by the ball after its second bounce?

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

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

C. $\frac{h}{2}$

D. zero



6. The initial kinetic energy of a block moving on a horizontal floor is 48 J. A constant frictional force acts on the block bringing it to rest over a distance of 2 m. What is the frictional force on the block?

A. 24 N

B. 48 N

C. 96 N

D. 192 N

$W = Fd$

$48 = F \times 2$

$24N = F$

7. The efficiency of an electric motor is 20 %. When lifting a body 500 J of energy are wasted. What is the useful work done by the motor?

A. 100 J

B. 125 J

C. 250 J

D. 400 J

80% = 500J wasted

÷4 ↓ ÷4

20% = 125J useful

8. A net force acts on a body. Which characteristic of the body will definitely change?

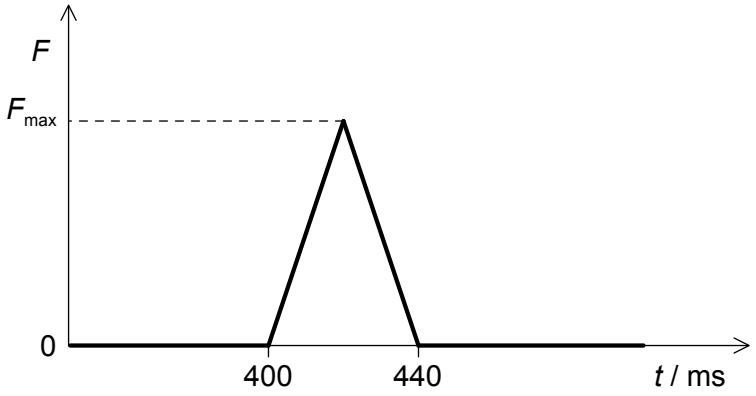
A. Speed scalar

B. Momentum vector

C. Kinetic energy scalar

D. Direction of motion scalar

9. A ball of mass 0.2 kg strikes a force sensor and sticks to it. Just before impact the ball is travelling horizontally at a speed of 4.0 $m\,s^{-1}$. The graph shows the variation with time t of the force F recorded by the sensor.



What is F_{max}?

A. 2 N

B. 4 N

C. 20 N

D. 40 N

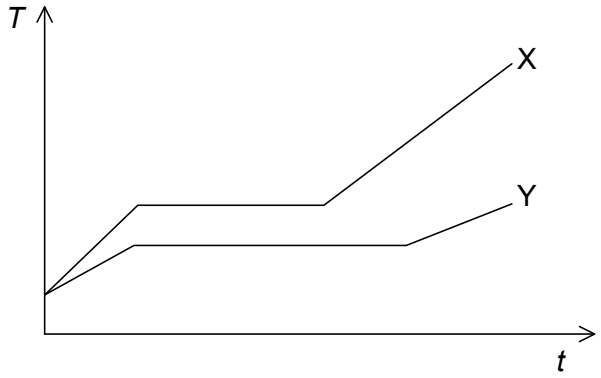
$F_{AVG} \times \Delta t = \Delta p$

$F_{AVG} = \frac{\Delta p}{\Delta t} = \frac{0.2 \times 4}{\frac{1}{2} \times 40 \times 10^{-3}}$

$= \frac{0.8 \times 10^{3}}{\frac{1}{2} 40}$

$= \frac{800}{20} = 40\,N$

10. The graph shows the variation with time t of the temperature T of two samples, X and Y. X and Y have the same mass and are initially in the solid phase. Thermal energy is being provided to X and Y at the same constant rate.



What is the correct comparison of the specific latent heats L_X and L_Y and specific heat capacities in the liquid phase c_X and c_Y of X and Y?

A.	$L_X > L_Y$	$c_X > c_Y$
B.	$L_X > L_Y$	$c_X < c_Y$
C.	$L_X < L_Y$	$c_X > c_Y$
D.	$L_X < L_Y$	$c_X < c_Y$

11. A mass m of ice at a temperature of –5 °C is changed into water at a temperature of 50 °C.

Specific heat capacity of ice $= c_i$
Specific heat capacity of water $= c_w$
Specific latent heat of fusion of ice $= L$

Which expression gives the energy needed for this change to occur?

A. $55\,m\,c_w + m\,L$

B. $55\,m\,c_i + 5\,m\,L$

C. $5\,m\,c_i + 50\,m\,c_w + m\,L$

D. $5\,m\,c_i + 50\,m\,c_w + 5\,m\,L$

12. A sealed container contains a mixture of oxygen and nitrogen gas.

The ratio $\frac{\text{mass of an oxygen molecule}}{\text{mass of a nitrogen molecule}}$ is $\frac{8}{7}$.

The ratio $\frac{\text{average kinetic energy of oxygen molecules}}{\text{average kinetic energy of nitrogen molecules}}$ is

A. 1.

B. $\frac{7}{8}$.

C. $\frac{8}{7}$.

D. dependent on the concentration of each gas.

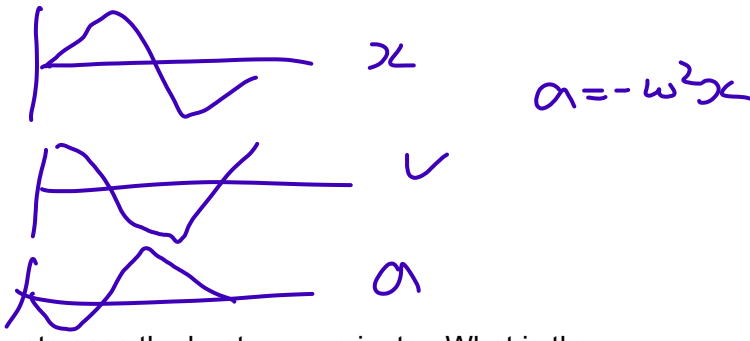
13. In simple harmonic oscillations which two quantities always have opposite directions?

A. Kinetic energy and potential energy

B. Velocity and acceleration

C. Velocity and displacement

D. Acceleration and displacement



14. A girl in a stationary boat observes that 10 wave crests pass the boat every minute. What is the period of the water waves?

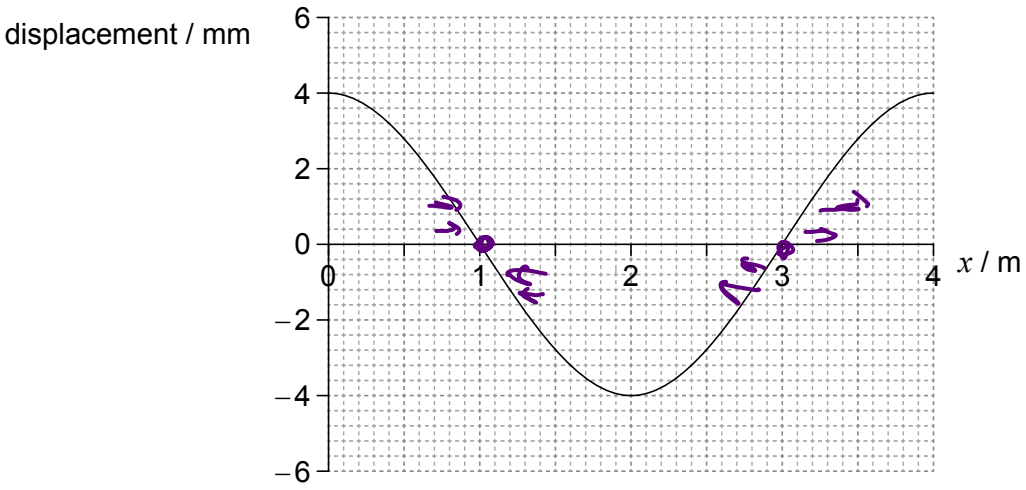
A. $\frac{1}{10}$ min

B. $\frac{1}{10}$ min^{-1}

C. 10 min

D. 10 min^{-1}

15. The graph shows the variation with distance x of the displacement of the particles of a medium in which a longitudinal wave is travelling from left to right. Displacements to the right of equilibrium positions are positive.



Which point is at the centre of a compression?

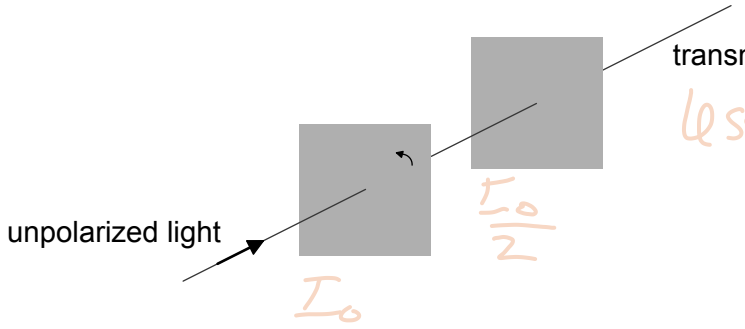
A. $x = 0$

B. $x = 1\,\text{m}$

C. $x = 2\,\text{m}$

D. $x = 3\,\text{m}$

16. A beam of unpolarized light is incident on the first of two parallel polarizers. The transmission axes of the two polarizers are initially parallel.



The first polarizer is now rotated about the direction of the incident beam by an angle smaller than 90°. Which gives the changes, if any, in the intensity and polarization of the transmitted light?

	Intensity	Polarization
A.	different	no change
B.	different	different
C.	no change	no change
D.	no change	different

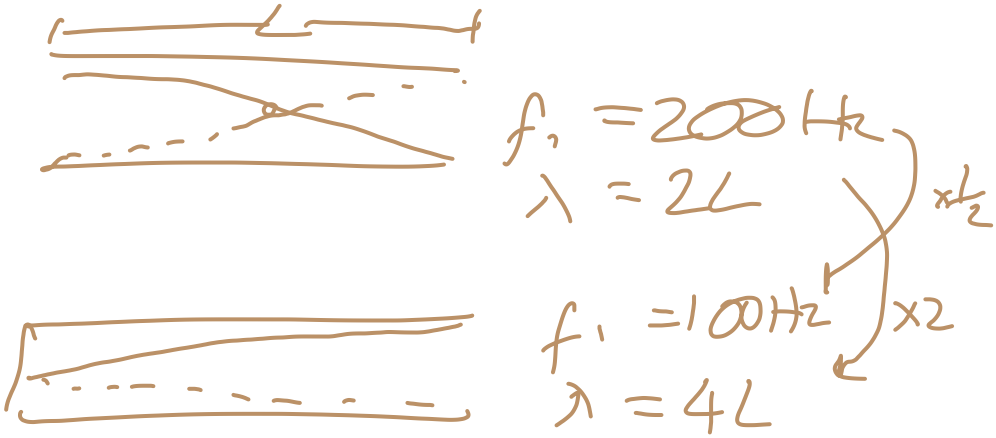
17. The frequency of the first harmonic standing wave in a pipe that is open at both ends is 200 Hz. What is the frequency of the first harmonic in a pipe of the same length that is open at one end and closed at the other?

A. 50 Hz

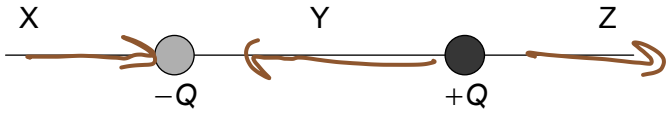
B. 75 Hz

C. 100 Hz

D. 400 Hz



18. The diagram shows two equal and opposite charges that are fixed in place.



At which points is the net electric field directed to the right?

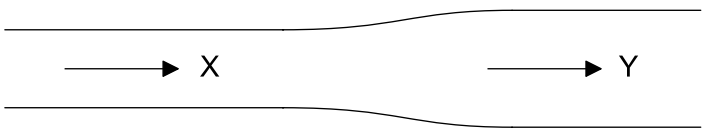
A. X and Y only

B. Z and Y only

C. X and Z only

D. X, Y and Z

19. A wire has variable cross-sectional area. The cross-sectional area at Y is double that at X.



At X, the current in the wire is I and the electron drift speed is v. What is the current and the electron drift speed at Y?

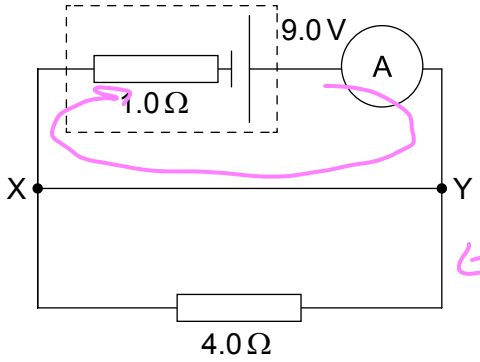
	Current	Drift speed
A.	I	v
B.	I	$\frac{v}{2}$
C.	$2I$	v
D.	$2I$	$\frac{v}{2}$

$I = nAvq$

$I = n2A\left(\frac{v}{2}\right)q$

$I = nAvq$

20. A circuit contains a cell of electromotive force (emf) 9.0 V and internal resistance 1.0 Ω together with a resistor of resistance 4.0 Ω as shown. The ammeter is ideal. XY is a connecting wire.



What is the reading of the ammeter?

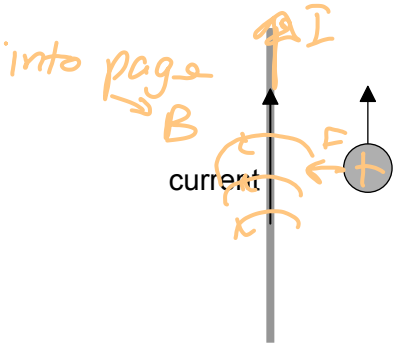
A. 0 A

B. 1.8 A

C. 9.0 A

D. 11 A

21. A positively-charged particle moves parallel to a wire that carries a current upwards.



What is the direction of the magnetic force on the particle?

A. To the left

B. To the right

C. Into the page

D. Out of the page

22. Two satellites of mass m and $2m$ orbit a planet at the same orbit radius. If F is the force exerted on the satellite of mass m by the planet and a is the centripetal acceleration of this satellite, what is the force and acceleration of the satellite with mass $2m$?

	Force	Acceleration
A.	$2F$	a
B.	$2F$	$\frac{a}{2}$
C.	F	a
D.	F	$\frac{a}{2}$

$F = \frac{GMm}{r^2}$ mass(m)

$a = \frac{GM}{r^2}$

$F = \frac{GM \times 2M}{r^2}$ mass($2m$)

$a = \frac{GM}{r^2}$

23. The gravitational field strength at the surface of Earth is g. Another planet has double the radius of Earth and the same density as Earth. What is the gravitational field strength at the surface of this planet?

A. $\frac{g}{2}$

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

C. $2g$

D. $4g$

$g_1 = \frac{GM}{r^2}$ $g_2 = \frac{G \times 8M}{(2r)^2} = \frac{8GM}{4r^2}$ $g_2 = \frac{2GM}{r^2}$

$\rho = \frac{M}{(\frac{4}{3}\pi r^3)}$ $\rho = \frac{xM}{(\frac{4}{3}\pi(2r)^3} = \frac{8M}{\frac{4}{3}\pi 8r^3}$

24. Atomic spectra are caused when a certain particle makes transitions between energy levels. What is this particle?

A. Electron

B. Proton

C. Neutron

D. Alpha particle

25. The half-life of a radioactive element is 5.0 days. A freshly-prepared sample contains 128 g of this element. After how many days will there be 16 g of this element left behind in the sample?

A. 5.0 days

B. 10 days

C. 15 days

D. 20 days

128 → 64 → 32 → 16

#1 #2 #3

3 × 5 = 15 days

26. The binding energy per nucleon of $^{11}_{4}$Be is 6 MeV. What is the energy required to separate the nucleons of this nucleus?

A. 24 MeV

B. 42 MeV

C. 66 MeV

D. 90 MeV

11 × 6 = 66 MeV

27. The reaction $p^+ + n^0 \rightarrow p^+ + \pi^0$ does **not** occur because it violates the conservation law of

A. electric charge.

B. baryon number.

C. lepton number.

D. strangeness.

6 quark to 5 quarks

28. The main role of a moderator in a nuclear fission reactor is to

A. slow down neutrons.

B. absorb neutrons.

C. reflect neutrons back to the reactor.

D. accelerate neutrons.

29. A room is at a constant temperature of 300 K. A hotplate in the room is at a temperature of 400 K and loses energy by radiation at a rate of P. What is the rate of loss of energy from the hotplate when its temperature is 500 K?

A. $\frac{4^4}{5^4}P$

B. $\frac{5^4+3^4}{4^4+3^4}P$

C. $\frac{5^4}{4^4}P$

D. $\frac{5^4-3^4}{4^4-3^4}P$

$P \propto T^4$

$P = k(400-300)^4$ $P_A = k(500-300)^4$

$\frac{P_A}{P} = \frac{(500-300)^4}{(400-300)^4} = \frac{(5^4-3^4)}{(4^4-3^4)}$

take out common factor of 10^6

30. In physics, a paradigm shift denotes the introduction of radically new ideas in order to explain a phenomenon. Which introduces a paradigm shift?

A. Multi-loop circuits

B. Standing waves

C. Total internal reflection

D. Atomic spectra ← changed how we looked at matter structure