Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Standard level
Paper 1

Thursday 10 May 2018 (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]**.

2218 – 6516

1. What is the best estimate for the diameter of a helium nucleus?

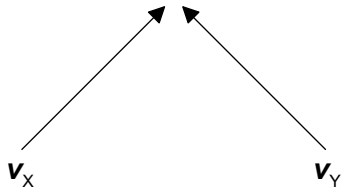
A. 10^{-21} m

B. 10^{-18} m

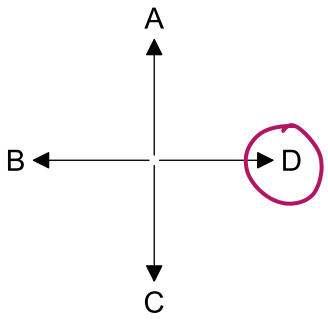
C. 10^{-15} m → use Fermi radius

D. 10^{-10} m

2. The velocities $\boldsymbol{v}_X$ and $\boldsymbol{v}_Y$ of two boats, X and Y, are shown.



Which arrow represents the direction of the vector $\boldsymbol{v}_X - \boldsymbol{v}_Y$?



3. A motor of input power 160 W raises a mass of 8.0 kg vertically at a constant speed of 0.50 m s^{-1}. What is the efficiency of the system?

A. 0.63 %

B. 25 %

C. 50 %

D. 100 %

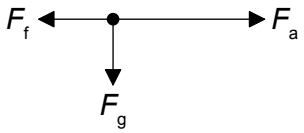
$160\text{W} = 160\text{J s}^{-1}$

$P = \frac{mgh}{t} = \frac{8 \times 10 \times \frac{1}{2}}{1} = 40\text{J s}^{-1}$

$\frac{40}{160} \times 100 = 25\%$

4. A box is accelerated to the right across rough ground by a horizontal force F_a. The force of friction is F_f. The weight of the box is F_g and the normal reaction is F_n. Which is the free-body diagram for this situation?

A.



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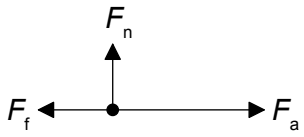

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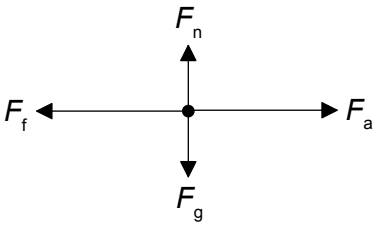
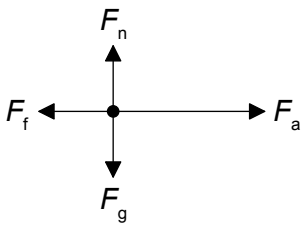
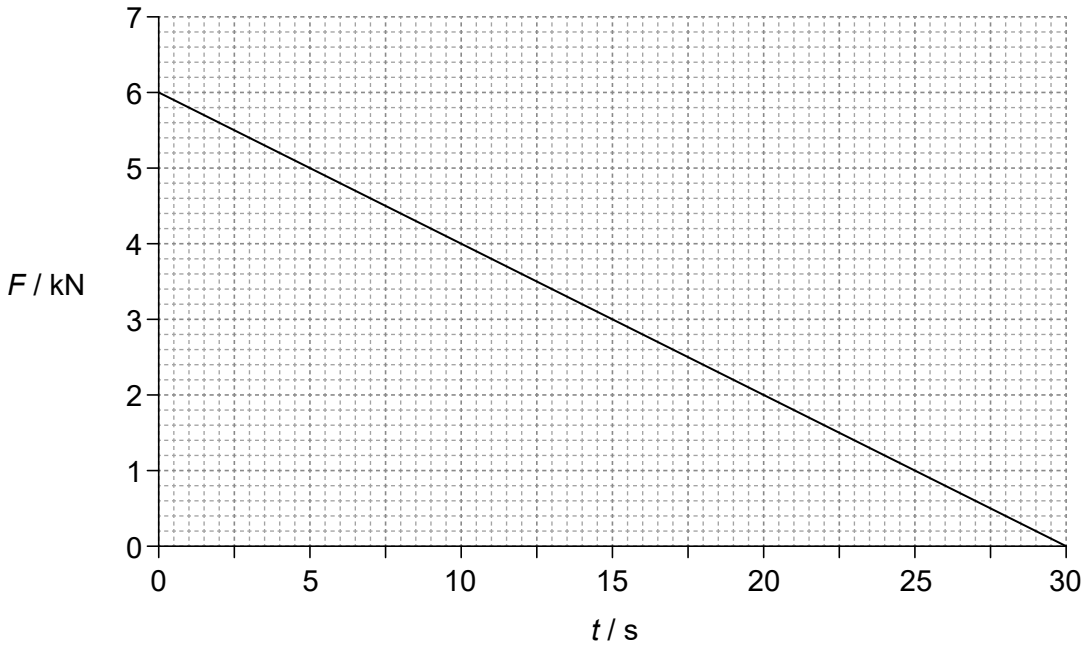


D.



5. The graph shows the variation with time t of the force F acting on an object of mass 15 000 kg. The object is at rest at $t = 0$.



What is the speed of the object when $t = 30$ s?

A. 0.18 m s^{-1}

B. 6 m s^{-1}

C. 12 m s^{-1}

D. 180 m s^{-1}

$\Delta p = mv = F\Delta t$

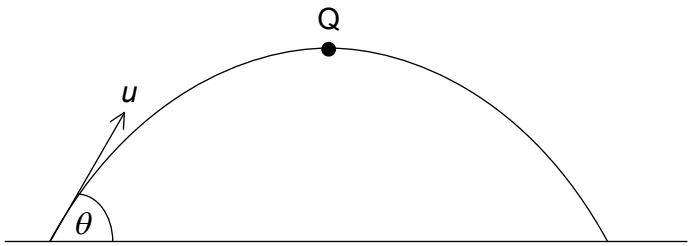
$= \frac{6000 \times 30}{2}$

$mv = 90,000$

$v = \frac{90,000}{15,000}$

$v = 6 \text{ m s}^{-1}$

6. A ball of mass *m* is thrown with an initial speed of *u* at an angle θ to the horizontal as shown. Q is the highest point of the motion. Air resistance is negligible.



What is the momentum of the ball at Q?

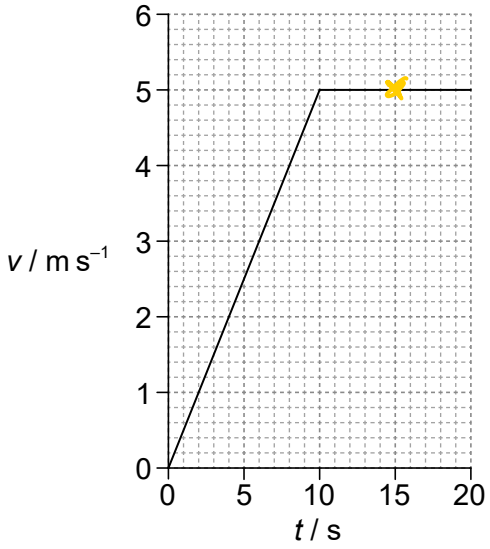
A. zero

B. $mu\cos\theta$ → horizontal component

C. mu

D. $mu\sin\theta$

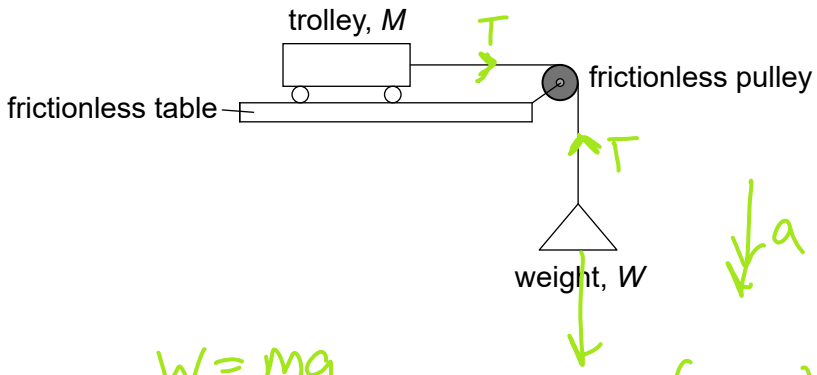
7. A boy runs along a straight horizontal track. The graph shows how his speed v varies with time t.



After 15 s the boy has run 50 m. What is his instantaneous speed and his average speed when $t = 15$ s?

	Instantaneous speed / m s^{-1}	Average speed / m s^{-1}
A.	3.3	3.3
B.	3.3	5.0
C.	5.0	3.3
D.	5.0	5.0

8. A weight *W* is tied to a trolley of mass *M* by a light string passing over a frictionless pulley. The trolley has an acceleration *a* on a frictionless table. The acceleration due to gravity is *g*.



What is *W*?

A. $\frac{Mag}{(g-a)}$

B. $\frac{Mag}{(g+a)}$

C. $\frac{Ma}{(g-a)}$

D. $\frac{Ma}{(g+a)}$

$W = mg$

$\frac{W}{g} = m$

$W = (m+M)a$

$W = \left(\frac{W}{g}+M\right)a$

$gW = (W+Mg)a$

$gW = Wa + Mag$

$gW - Wa = Mag$

$W(g-a) = Mag$

$W = \frac{Mag}{(g-a)}$

9. Two balls X and Y with the same diameter are fired horizontally with the same initial momentum from the same height above the ground. The mass of X is greater than the mass of Y. Air resistance is negligible.

What is correct about the horizontal distances travelled by X and Y and the times taken by X and Y to reach the ground?

	Horizontal distances	Time to reach ground
A.	X and Y the same	X and Y times the same
B.	X and Y the same	X takes a shorter time than Y
C.	X less than Y	X and Y times the same
D.	X less than Y	X takes a shorter time than Y

10. Which is a unit of force?

A. J m

B. J m^{-1}

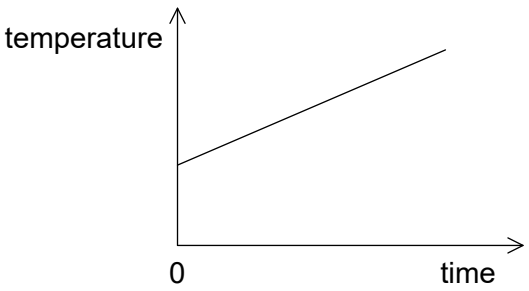
C. J $m\,s^{-1}$

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

$W = Fd$

$\frac{W}{d} = F$

11. The graph shows how the temperature of a liquid varies with time when energy is supplied to the liquid at a constant rate P. The gradient of the graph is K and the liquid has a specific heat capacity c.



What is the mass of the liquid?

A. $\frac{P}{cK}$

B. $\frac{PK}{c}$

C. $\frac{Pc}{K}$

D. $\frac{cK}{P}$

$\frac{Q}{t} = \frac{mc\Delta T}{t}$

$P = \frac{mc\Delta T}{t}$

$\Delta T = \frac{Pt}{mc}$

$\Delta T = \frac{P}{mc}(t)$

$K = \frac{P}{mc}$

$m = \frac{P}{Kc}$

12. A container that contains a fixed mass of an ideal gas is at rest on a truck. The truck now moves away horizontally at a constant velocity. What is the change, if any, in the internal energy of the gas and the change, if any, in the temperature of the gas when the truck has been travelling for some time?

	Change in internal energy	Change in temperature
A.	unchanged	unchanged
B.	unchanged	increased
C.	increased	unchanged
D.	increased	increased

13. A sealed container contains water at 5 °C and ice at 0 °C. This system is thermally isolated from its surroundings. What happens to the total internal energy of the system?

A. It remains the same.

B. It decreases.

C. It increases until the ice melts and then remains the same.

D. It increases.

14. Two sound waves from a point source on the ground travel through the ground to a detector. The speed of one wave is 7.5 km s^{-1}, the speed of the other wave is 5.0 km s^{-1}. The waves arrive at the detector 15 s apart. What is the distance from the point source to the detector?

A. 38 km

B. 45 km

C. 113 km

D. 225 km

$s = \frac{d}{t}$ | $s = \frac{d}{t}$

$t \times 7500 = d$ | $(t+15) \times 5000 = d$

$7500t = 5000t + 75000$

$2500t = 75000$

$2st = 750$

$t = 750 \div 25 = 30secs$

$d = 30 \times 7500$

$d = 225{,}000$

$d = 225km$

15. What is true about the acceleration of a particle that is oscillating with simple harmonic motion (SHM)?

A. It is in the opposite direction to its velocity

B. It is decreasing when the potential energy is increasing

C. It is proportional to the frequency of the oscillation

D. It is at a minimum when the velocity is at a maximum

16. What are the changes in the speed and in the wavelength of monochromatic light when the light passes from water to air?

	Change in speed	Change in wavelength
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

$v = f\lambda$

$v \propto \lambda$

$\uparrow v \propto \uparrow \lambda$

17. A sound wave has a wavelength of 0.20 m. What is the phase difference between two points along the wave which are 0.85 m apart?

A. zero

B. 45°

C. 90°

D. 180°

$\lambda = 0.20\text{m}$

$4\lambda = 0.80\text{m}$

$\therefore$ 0.05m is $\frac{\lambda}{4}$ $\therefore$ $\frac{360^\circ}{4} = 90^\circ$

18. A pair of slits in a double slit experiment are illuminated with monochromatic light of wavelength 480 nm. The slits are separated by 1.0 mm. What is the separation of the fringes when observed at a distance of 2.0 m from the slits?

A. 2.4×10^{-4} mm

B. 9.6×10^{-4} mm

C. 2.4×10^{-1} mm

D. 9.6×10^{-1} mm

$s = \frac{\lambda D}{d}$

$= \frac{480 \times 10^{-9} \times 2}{1 \times 10^{-3}}$

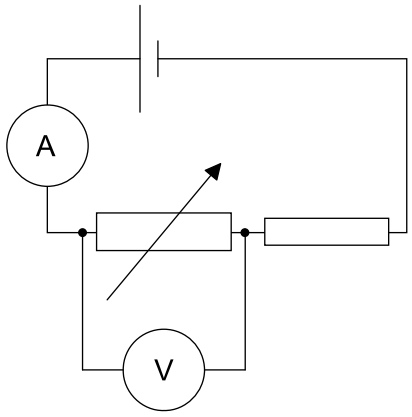
$= 480 \times 10^{-6} \times 2$

$= 960 \times 10^{-6}$ m

$= 9.6 \times 10^{-4}$ m

$= 9.6 \times 10^{-1}$ mm

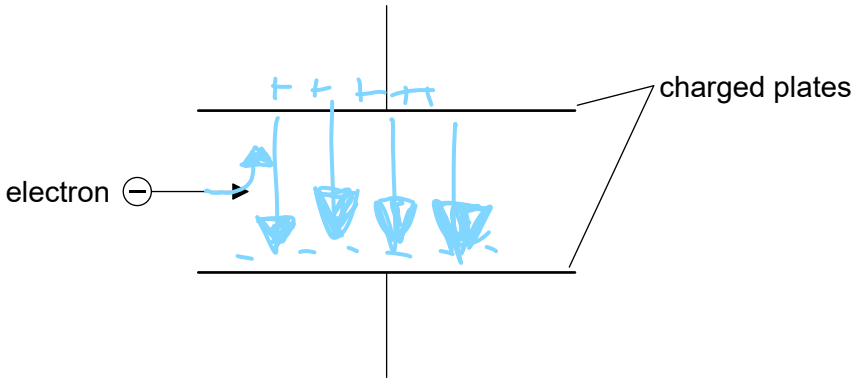
19. A cell with negligible internal resistance is connected as shown. The ammeter and the voltmeter are both ideal.



What changes occur in the ammeter reading and in the voltmeter reading when the resistance of the variable resistor is increased?

	Change in ammeter reading	Change in voltmeter reading
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

20. An electron enters the region between two charged parallel plates initially moving parallel to the plates.



The electromagnetic force acting on the electron

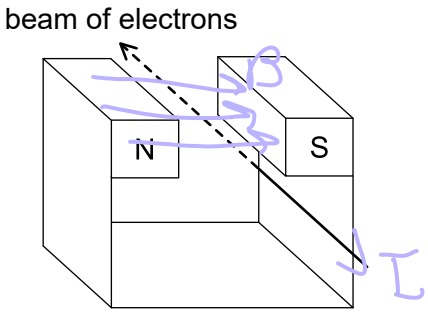
A. causes the electron to decrease its horizontal speed.

B. causes the electron to increase its horizontal speed.

C. is parallel to the field lines and in the opposite direction to them.

D. is perpendicular to the field direction.

21. A beam of electrons moves between the poles of a magnet.



What is the direction in which the electrons will be deflected?

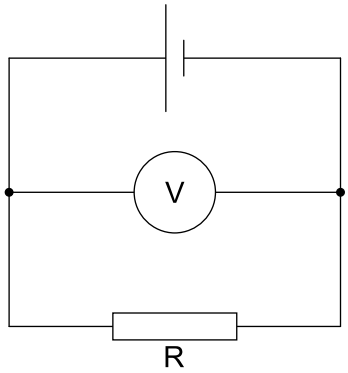
A. Downwards

B. Towards the N pole of the magnet

C. Towards the S pole of the magnet

D. Upwards

22. A cell has an emf of 4.0 V and an internal resistance of 2.0 Ω. The ideal voltmeter reads 3.2 V.



What is the resistance of R?

A. 0.8 Ω

B. 2.0 Ω

C. 4.0 Ω

D. 8.0 Ω

$4 = I(R+2)$ $\quad V = IR$

$4 = IR + 2I \quad 3.2 = IR$

$4 = 3.2 + 2I$

$0.8 = 2I$

$0.4 = I$

$4 = 0.4(R+2)$

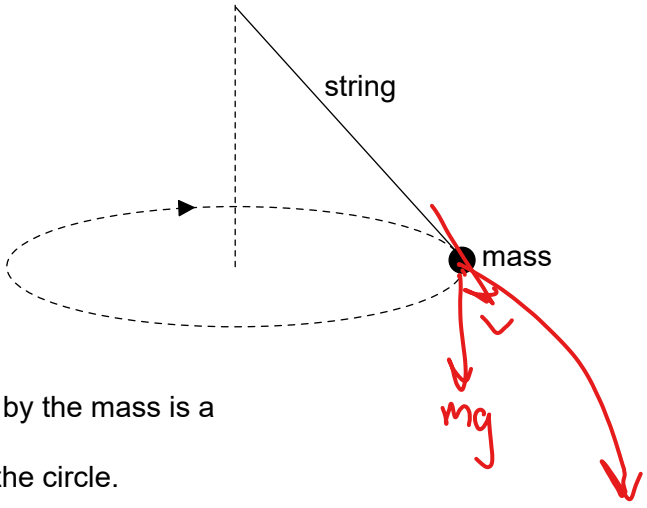
$40 = 4(R+2)$

$40 = 4R + 8$

$32 = 4R$

$8 = R$

23. A mass at the end of a string is swung in a horizontal circle at increasing speed until the string breaks.



The subsequent path taken by the mass is a

A. line along a radius of the circle.

B. horizontal circle.

C. curve in a horizontal plane.

D. curve in a vertical plane.

24. A detector, placed close to a radioactive source, detects an activity of 260 Bq. The average background activity at this location is 20 Bq. The radioactive nuclide has a half-life of 9 hours. What activity is detected after 36 hours?

A. 15 Bq

B. 16 Bq

C. 20 Bq

D. 35 Bq

260 − 20 = 240 Bq

$\frac{36}{9} = 4$ half lives

240 → 120 → 60 → 30 → 15

1 2 3 4

15 + 20 = 35 Bq

25. Element X decays through a series of alpha (α) and beta minus (β^-) emissions. Which series of emissions results in an isotope of X?

A. 1α and $2\beta^-$

B. 1α and $4\beta^-$

C. 2α and $2\beta^-$

D. 2α and $3\beta^-$

$^4_2\alpha \; ^0_{-1}\beta \; ^0_{-1}\beta = X$ ✓

26. A graph of the variation of average binding energy per nucleon with nucleon number has a maximum. What is indicated by the region around the maximum?

A. The position below which radioactive decay cannot occur

B. The region in which fission is most likely to occur

C. The position where the most stable nuclides are found

D. The region in which fusion is most likely to occur

27. Three of the fundamental forces between particles are

I. strong nuclear ✗ ← only in nucleus

II. weak nuclear ✓

III. electromagnetic. ✓

What forces are experienced by an electron?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

28. A wind turbine has a power output p when the wind speed is v. The efficiency of the wind turbine does not change. What is the wind speed at which the power output is $\frac{p}{2}$?

A. $\frac{v}{4}$

B. $\frac{v}{\sqrt{8}}$

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

D. $\frac{v}{\sqrt[3]{2}}$

$P = \frac{1}{2}A\rho v^3$

$\frac{P}{2} = \frac{1}{2}A\rho\left(\frac{v}{\sqrt[3]{2}}\right)^3$

$\frac{1}{2} = x^3$

$\sqrt[3]{\frac{1}{2}} = x$

$\frac{1}{\sqrt[3]{2}} = x$

29. Three gases in the atmosphere are

I. carbon dioxide (CO_2)

II. dinitrogen monoxide (N_2O)

III. oxygen (O_2). ← nope!

Which of these are considered to be greenhouse gases?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

30. Mars and Earth act as black bodies. The $\frac{\text{power radiated by Mars}}{\text{power radiated by the Earth}} = p$ and $\frac{\text{absolute mean temperature of the surface of Mars}}{\text{absolute mean temperature of the surface of the Earth}} = t$.

What is the value of $\frac{\text{radius of Mars}}{\text{radius of the Earth}}$?

A. $\frac{p}{t^4}$

B. $\frac{\sqrt{p}}{t^2}$

C. $\frac{t^4}{p}$

D. $\frac{t^2}{\sqrt{p}}$

$P_m = e\sigma A_m T_m^4$

$P_E = e\sigma A_E T_E^4$

$\frac{P_M}{P_E} = \frac{A_m}{A_E}\frac{T_m^4}{T_E^4}$

$p = \frac{A_m}{A_E} t^4$

$\frac{p}{t^4} = \frac{\pi r_m^2}{\pi r_E^2}$

$\frac{\sqrt{p}}{t^2} = \frac{r_m}{r_E}$