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PHYSICS
STANDARD LEVEL
PAPER 1

SPECIMEN PAPER

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]*.

1. An object falls freely from rest through a vertical distance of 44.0 m in a time of 3.0 s. What value should be quoted for the acceleration of free-fall?

A. $9.778\,m\,s^{-2}$

B. $9.780\,m\,s^{-2}$

C. $9.78\,m\,s^{-2}$

(D.) $9.8\,m\,s^{-2}$

$d = -44.0\,m$ $d = v_i^{\,0} t + \frac{1}{2} a t^2$

$t = 3.0\,s$ $-44.0 = \frac{1}{2} a (3.0\,s)^2$

$v_i = 0\ m/s$ $\frac{-44.0}{4.5} = \frac{4.5\,a}{4.5}$

$a = 9.777 \rightarrow a = 9.8\ m/s^2$

* with multiplication / division use the least number of sig figs

2. What is the order of magnitude for the frequency of visible light?

A. 10^{-15} Hz

B. 10^{-7} Hz

C. 10^{9} Hz

(D.) 10^{15} Hz

Used to memorize

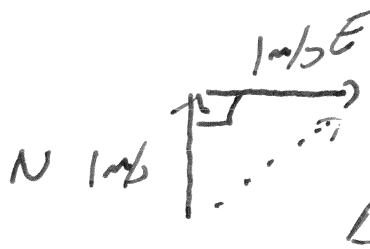
3. A woman walks due north at $1\,m\,s^{-1}$ before turning through an angle of 90° to travel due east without any change in speed. What is the change, if any, of her velocity?

A. No change

B. $1\,m\,s^{-1}$ to the west

C. $\sqrt{2}\,m\,s^{-1}$ to the north east

(D.) $\sqrt{2}\,m\,s^{-1}$ to the south east



$a^2 + b^2 = c^2$

$1\ m/s + 1\ m/s = c^2$

$\sqrt{2} = \sqrt{c^2}$

$\Delta V = V_f - V_i$

$\overrightarrow{SE}$ ↓ (Flip)

4. A toy car accelerates from rest down an inclined track at $2.0\,m\,s^{-2}$. What is the speed of the car after 3.0 s?

(A.) $6.0\,m\,s^{-1}$

B. $9.0\,m\,s^{-1}$

C. $45\,m\,s^{-1}$

D. $54\,m\,s^{-1}$

Given

$a = 2.0\ m/s^2$

$V_i = 0\ m/s$

$t = 3.0\,s$

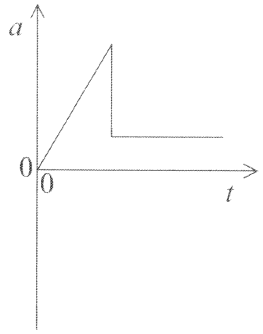
$V_f = V_i^{\,0} + at$

$V_f = 2.0\ m/s^2 (3.0\,s)$

$V_f = 6.0\ m/s$

5. A parachutist jumps out of an aircraft and falls freely for a short time, before opening his parachute. Which graph shows the variation of the acceleration a with time t of the parachutist from the time he leaves the aircraft until after the parachute is completely open?

A.



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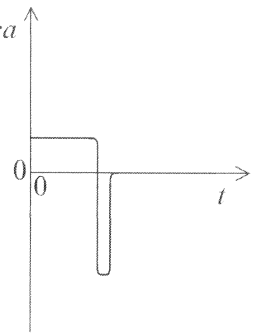

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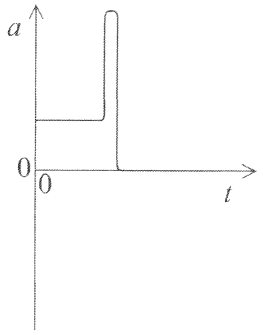
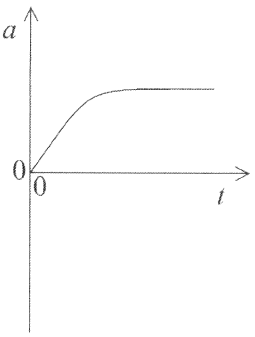


D.

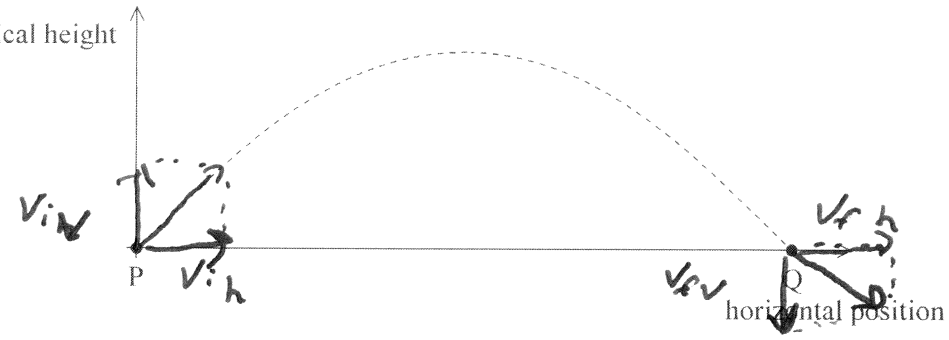


Uniform Accel in Freefall 9.8 m/s²

Continues to Fall @ a constant velocity

Rapid Deceleration From Opening the chute

6. A projectile of mass m is fired from a point P with a velocity having vertical component v_v and horizontal component v_h. The projectile reaches point Q as shown in the diagram.



Air resistance on the projectile is negligible. What is the magnitude of the change in momentum of the projectile in moving from P to Q?

A. Zero

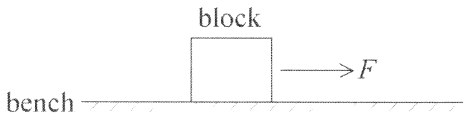
B. $2mv_v$

C. $2mv_h$

D. $2m\sqrt{v_v^2 + v_h^2}$

Vertical Velocities Cancel
Horizontal Velocity 2x
Mass Same

7. A block of wood is placed on a bench. A variable horizontal force F is applied to the block, which is initially at rest.



F is initially increased and then adjusted until the block moves at a constant horizontal speed. Which describes F as the block moves along the bench?

A. It continues to increase.

B. It reaches a constant value.

C. It decreases to zero.

D. It decreases to a constant value.

@ Constant Velocity
Forces are Balanced ← F_f →

$W_{static} > W_{Kinetic}$ so
$F_{fs} > F_{fK}$

As moves $F_{fs} \rightarrow F_{fk} \rightarrow$ Const F

8. The pound is a unit of mass equivalent to 0.454 kg. It is used in a limited number of countries but is rarely used by modern scientists. Which statement is correct?

A. Scientists cannot be sure that all other scientists will be able to work in pounds.

B. The pound cannot be defined precisely enough to be used.

C. The pound is too large a unit to be used for most masses.

D. The pound cannot be divided into metric portions. X 1.0kg = 2.2 lbs

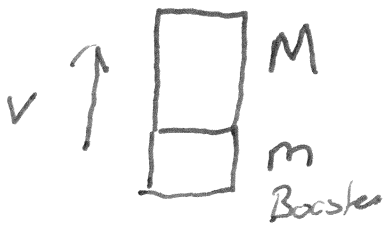
9. A rocket is made up of two stages, the main rocket of mass M and a booster rocket of mass m. While moving freely in space with a velocity v, the booster rocket disconnects from the main rocket leaving the booster rocket stationary. What is the velocity of the main rocket?

A. $\frac{mv}{M-m}$

B. $\frac{Mv}{M-m}$

C. $\frac{Mv}{M+m}$

D. $\frac{(M+m)v}{M}$



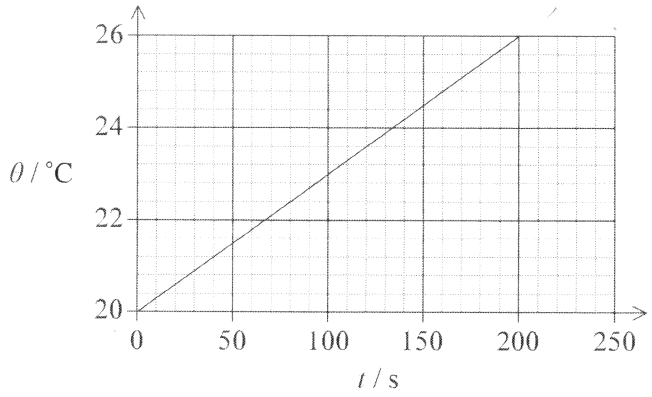
Conservation of Momentum (Separation)

Before = After

$(M+m)v = m(0) + M(x)$

$\frac{(M+m)v}{M} = \frac{M(x)}{M}$

10. An electrical heater of power 12 W is immersed in a liquid of mass 0.2 kg. The graph shows the variation of the temperature θ of the liquid with time t.



What is the value for the specific heat capacity of the liquid?

A. $20\,\text{J kg}^{-1}\text{K}^{-1}$

B. $500\,\text{J kg}^{-1}\text{K}^{-1}$

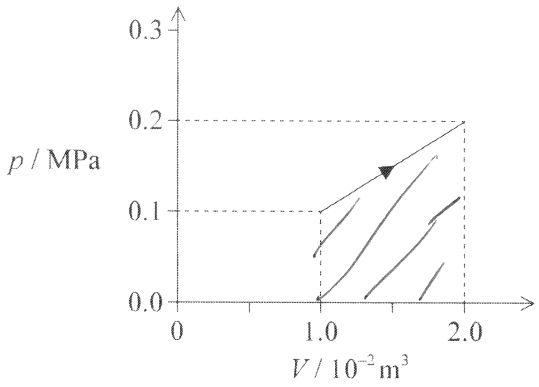
C. $2000\,\text{J kg}^{-1}\text{K}^{-1}$

D. $12\,000\,\text{J kg}^{-1}\text{K}^{-1}$

11. A balloon develops a tiny hole and molecules leak into the surrounding air. The temperature is unchanged. The initial volume and pressure of the balloon are V_0 and p_0. How are the new volume and pressure of the balloon related to the initial values?

	Volume	Pressure
A.	$< V_0$	$< p_0$
B.	$< V_0$	p_0
C.	V_0	$< p_0$
D.	V_0	p_0

12. The graph shows the variation with volume V of the pressure p of a fixed mass of an ideal gas as the temperature of the gas is raised.



What is the work done by the gas during the process?

A. 0.5 kJ

B. 1.0 kJ

C. 1.5 kJ

D. 2.0 kJ

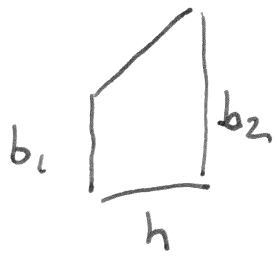
Work = P · ΔV

Area under the curve (trapezoid)

$A = \frac{1}{2}(b_1 + b_2)h$

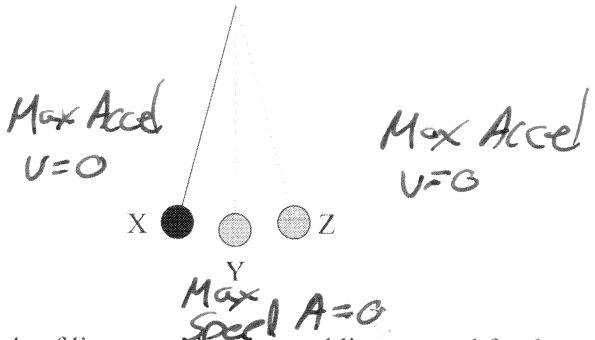
$= \frac{1}{2}(.1 + .2)(1.0)$

.15



Need to convert out of Mega Pascals to Pascals for Joules then to Kilo Joules

13. The diagram shows a simple pendulum undergoing simple harmonic motion between positions X and Z. Y is the rest position of the pendulum.



Which describes the magnitude of linear acceleration and linear speed for the pendulum bob?

	Linear acceleration	Linear speed
A.	zero at Y	zero at Y
B.	maximum at X and Z	zero at X and Z
C.	maximum at X and Z	maximum at X and Z
D.	zero at X and Z	maximum at X and Z

14. Some of the properties that can be demonstrated using waves are

I. refraction
II. polarization
III. diffraction.

You can polarize a transverse wave
Only allow vibration in 1 plane
Sound is longitudinal

Which properties can be demonstrated using **sound** waves?

A. I and II only
B. I and III only
C. II only
D. III only

15. The amplitude of a wave at a certain distance for a source is A and its intensity is I. At this position the amplitude increases to $4A$. What is the intensity of the wave?

A. I

B. $2I$

C. $4I$

D. $16I$

Relationship between Amplitude & Intensity

$I \sim A^2$

$I \sim 4^2$

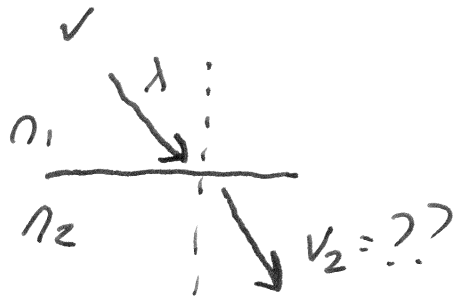
$16I$

$A \rightarrow 4A$

From Reference Table 4.3

16. Light travels with speed v and wavelength λ in a medium of refractive index n_1. The light then enters a second medium of refractive index n_2. What is the speed and the wavelength of the wave in the second medium?

	Speed	Wavelength
A.	$v\frac{n_1}{n_2}$	$\lambda\frac{n_1}{n_2}$
B.	$v\frac{n_1}{n_2}$	$\lambda\frac{n_2}{n_1}$
C.	$v\frac{n_2}{n_1}$	$\lambda\frac{n_1}{n_2}$
D.	$v\frac{n_2}{n_1}$	$\lambda\frac{n_2}{n_1}$



From Reference Table 4.4

Let $V_1 = V$

$\frac{n_1}{n_2} = \frac{V_2}{V_1}$

Cross multiply

$V_2 = \frac{n_1}{n_2} V$

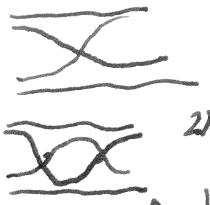
Since $v = f\lambda$ and Frequency is set @ the source

$V \propto \lambda$

So

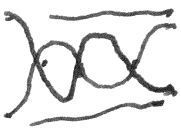
$\lambda_2 = \frac{n_1}{n_2} \lambda$

17. The diagram shows two pipes of equal length. Pipe X is open at both ends and pipe Y is closed at one end.

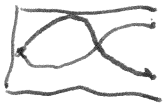


pipe X

pipe Y



Which is correct about the harmonics that each pipe can produce?



	Pipe X	Pipe Y
A.	all harmonics	all harmonics
B.	all harmonics	odd harmonics only
C.	odd harmonics only	all harmonics
D.	odd harmonics only	odd harmonics only

18. Two wires of different diameters are made from the same metal. The wires are connected in series with a cell. Which quantity will be **smaller** in the **thicker** wire?

A. The current

B. The drift velocity of the electrons

C. The number of free electrons per unit volume

D. The number of free electrons passing through any cross-section of the wire per second

19. A heating coil is connected to a battery of electromotive force (emf) 10 V and negligible internal resistance. The power dissipated in the coil is 25 W. What is the resistance of the coil?

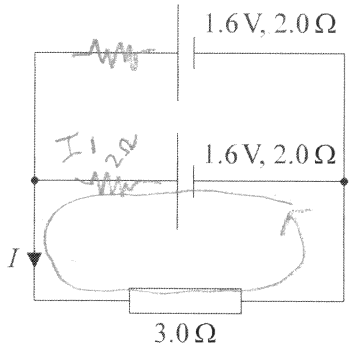
A. 0.25 Ω

B. 2.5 Ω

C. 4.0 Ω

D. 250 Ω

20. Two identical cells, each of emf 1.6 V and internal resistance 2.0 Ω, are connected in parallel with a 3.0 Ω resistor.



What is the current I?

A. 0.4 A

B. 0.6 A

C. 0.8 A

D. 1.6 A

21. A current-carrying conductor is at right angles to a magnetic field. The force on the conductor is F. The conductor is turned so that it is parallel to the field with no other changes. In what way, if any, does the force on the conductor change?

A. It is unchanged.

B. It increases so that it is greater than F.

C. It decreases so that it is greater than zero but less than F.

D. It becomes zero.

22. An astronaut orbits the Earth in a space capsule. Which statement is correct?

still orbiting the earth

A. There are no gravitational forces acting on the space capsule or the astronaut. ✗

B. The space capsule and the astronaut each have the same acceleration.

C. The space capsule and the astronaut are each in equilibrium. Circular motion, have a force $F_G = F_c$

D. The gravitational force on the space capsule is equal to that on the astronaut.

23. The table shows four of the energy levels for the hydrogen atom with their corresponding energies.

Energy level	Energy / 10^{-19} J
6	−0.6
4	−1.4
2	−5.4
1	−21.8

When an electron changes from level 6 to level 1 the spectral line emitted has a wavelength of 9.4×10^{-8} m. What is the approximate wavelength of the spectral line emitted when an electron changes from level 4 to level 2?

6 to 1

$\Delta E = E_i - E_f$

$-.6 - (-21.8)$

$\Delta E = 21.2\times10^{-19}$ J

$f = 9.4\times10^{-8}$ m

4 to 2

$\Delta E = E_i - E_f$

$-1.4 - (-5.4)$

$\Delta E = 4\times10^{-19}$ J

$E = \frac{hc}{\lambda}$

$4.0\times10^{-19} = \frac{6.63\times10^{-34}(3\times10^{8})}{\lambda}$

$\lambda = 5.0\times10^{-7}$ m

A. 5×10^{-4} m

B. 5×10^{-7} m

C. 5×10^{-8} m

D. 5×10^{-10} m

24. All isotopes of a particular element have the same

Element can not change

A. mode of radioactive decay.

B. half-life.

C. number of protons.

D. number of neutrons.

$^{4}_{2}He$ $^{5}_{2}He$

Total Binding Energy / number of Nucleons

25. The magnitude of the binding energy per nucleon is

A. a maximum for nuclides having nucleon numbers around 60.

B. directly proportional to the neutron to proton ratio of nuclides.

C. a maximum for nuclides with high nuclear charges.

D. a maximum for nuclides with low nuclear charges.

For a nuclear Rxn, products are always in a low energy state than the reactants

$^{56}_{26}Fe$ - One of the largest binding energy per nucleon

26. A positive pion is a meson consisting of an up quark and an anti-down quark. A student suggests that the decay of the positive pion is represented by the following equation.

$$\pi^+ \rightarrow \mu^+ + \overline{\nu}_\mu$$

The suggestion is incorrect because one of the quantities is not conserved. Which quantity is **not** conserved in the student's equation?

A. Charge $1 \rightarrow 1+0$ ✓ $u\bar{d} \rightarrow \mu^+ + \overline{\nu}_\mu$ Both Anti-Leptons

B. Baryon number $\frac{1}{3} \frac{-1}{3} \rightarrow 0 + 0$ ✓

C. Lepton number $0 \rightarrow -1_{\mu} + -1_{\mu}$ $0 \rightarrow -2$ ✗

D. Strangeness $0 \rightarrow 0 + 0$ ✓

27. The blade length of a wind turbine is doubled. By what factor will the maximum power output increase?

A. 2

B. 4

C. 8

D. 16

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

so

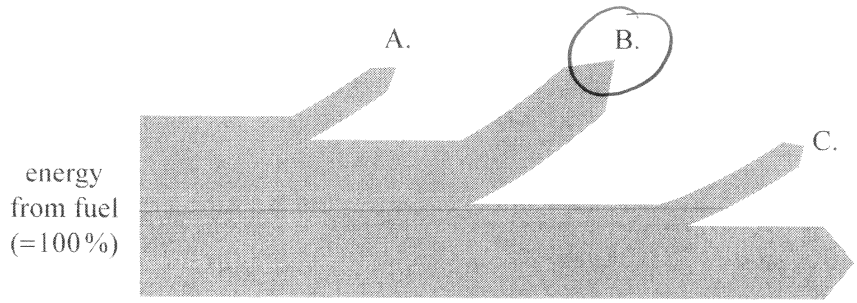
$P = 4X$

$A = \pi r^2$ $r = 2X$

$A = \text{Const } 2^2$

$A = 4X$

28. The Sankey diagram shows a typical fossil-fuel plant of total efficiency 40%. There are frictional, electrical transmission and energy losses to the lower temperature surroundings. Which branch represents energy losses to the surroundings?



29. The absolute temperature of a black body increases by 2%. What is the percentage increase in the power emitted by the black body?

A. 2

B. 4

C. 8

D. 16

30. What is thermal conduction mainly due to in a gas?

A. The motion of free electrons

B. Fast molecules transferring energy to slower molecules

C. Slow molecules transferring energy to faster molecules

D. Lattice vibrations causing collisions with neighbouring molecules