2019 H2 9749 Physics Paper 1

1 [D]

From Measurement notes:

Prefix	Multiple	Symbol
femto	10^{-15}	f
pico	10^{-12}	p
nano	10^{-9}	n
micro	10^{-6}	μ
milli	10^{-3}	m
centi	10^{-2}	c
deci	10^{-1}	d
kilo	10^{3}	k
mega	10^{6}	M
giga	10^{9}	G
tera	10^{12}	T

2 [D]

$\pm 1\% = \frac{1}{100} \times 4.072 = 0.04072$

with an additional uncertainty of $\pm 10 \text{ mV} = 0.010 \text{ V}$

Total uncertainty $= 0.04072 + 0.010 = 0.05$ [1 s.f. for absolute uncertainty]

Reading $= (4.07 \pm 0.05)$ V [reading must be same d.p. as absolute uncertainty]

3 [D]

Taking downwards as positive.

s is the total distance to the ground and $u = 0$

$s = \frac{1}{2}at^2 = \frac{1}{2}(9.81)t^2 = 4.905t^2$ ---------(1)

$0.25s = \frac{1}{2}a(t - 1.00)^2 = 4.905(t - 1.00)^2$ ---------(2)

sub (1) into (2):

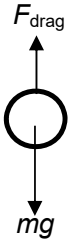
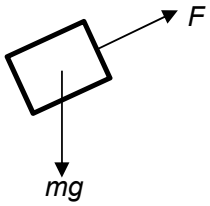
$0.25(4.905t^2) = 4.905(t - 1.00)^2$

$\sqrt{0.25(4.905t^2)} = \sqrt{4.905(t - 1.00)^2}$

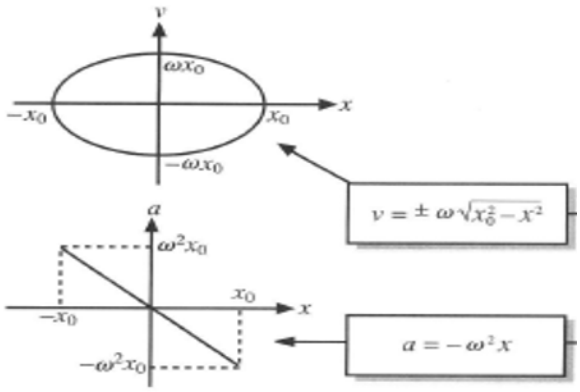
$\sqrt{0.25}(t) = t - 1.00$

$0.50t = t - 1.00$

$t = 2.00$ s

4	Speed = gradient of $s - t$ graph → increases $F_{net} = ma$ $mg - F_{drag} = ma$ As speed increases, F_{drag} also increases. From above equation, acceleration decreases.  	[C]
5	As the total momentum of the system is zero before the explosion, the centre of gravity cannot move. If it does, this would meant that an external force must have been applied to the system which is not the case in this question.	[A]
6	By conservation of momentum, $mu = mv + 2(mv)$ $mu = 3mv$ $u = 3v$ $KE_{initial} = \frac{1}{2}mu^2$ $KE_{final} = \frac{1}{2}mv^2 + \frac{1}{2}m(2v)^2 = 2.5mv^2$ $\frac{KE_{initial} - KE_{final}}{KE_{initial}} = \frac{0.5mu^2 - 2.5mv^2}{0.5mu^2} = \frac{0.5m(3v)^2 - 2.5mv^2}{0.5m(3v)^2} = \frac{2mv^2}{4.5mv^2} = \frac{4}{9}$	[B]
7	EPE = area under $F - x$ graph $= \frac{1}{2}(20 \times 10^{-3})(28)$ $= 0.28$ J	[A]
8	 $F - mg\sin\theta = ma$ $mg - mg\sin\theta = ma$ $g(1 - \sin\theta) = a = \frac{dv}{dt}$ As the object moves from X to Y, the angle θ increases, hence sin θ will increase and (1 – sin θ) will decrease and thus acceleration (the rate of change of velocity) will decrease.	[D]

9	$P = \frac{\Delta E}{t} = \frac{mg\Delta h}{t}$ $= \frac{1.3 \times 10^9 (9.81)(2.0)}{24 \times 60 \times 60}$ $= 295208$ W $= 300$ kW	[D]
10	$\omega = \frac{v}{r}$, v is constant $\Rightarrow \omega \propto \frac{1}{r}$	[B]
11	Centripetal acceleration a = 20 g = $r\,\omega^2$ where r is measured from the centre of the circle $\Rightarrow \omega = \sqrt{}(20 \times 9.81 / 7.0) = 5.3$ rad s^{-1}	[D]
12	Escape speed is the minimum speed that a mass *m* must be launched vertically from the surface of the planet of mass *M* if it is to reach an infinite distance away from that planet. By Conservation of Energy, total energy (KE+GPE) at surface = total energy (KE+GPE) at infinity. $\frac{1}{2}mv^2 + \left(-\frac{GMm}{R}\right) = 0 + \left(-\frac{GMm}{\infty}\right)$ $\frac{1}{2}v^2 = \frac{GM}{R}$ $v = \sqrt{\frac{2GM}{R}}$	[A]
13	$pV = \frac{1}{3} Nm\langle c^2 \rangle = nRT$ $\Rightarrow$ Root mean square speed $c_{rms} = \sqrt{}(3 \times nRT / Nm)$ where [*T*] = K and [*Nm*] = kg $= \sqrt{}(3 \times 1 \times 8.31 \times (273+30) / 0.0040)$ $= 1374 \approx 1400$ ms^{-1}	[C]
14	Internal energy of a system is the sum of a random distribution of <u>kinetic and potential energies</u> associated with the <u>molecules</u> of the system. $\Rightarrow$ Internal energy = $N(E_k + E_p)$	[C]
15	First Law of Thermodynamics: $\Delta U = Q + W$ $\Delta U =$ <u>increase</u> in internal energy of the system $Q =$ heat supplied <u>to</u> the system $W =$ work done <u>on</u> the system Heat supplied to system $Q = \Delta U - W$ $\Rightarrow$ Heat transferred from (by) the gas to the surroundings = $-Q = W - \Delta U$	[B]

16	 Displacement x = 0 (i.e. equilibrium position), a = 0, v = maximum, E_k = maximum Displacement x = maximum (i.e. amplitude), v = 0, a = maximum, restoring force = maximum	[B]
17	At t = 0, resultant is maximum $\Rightarrow$ in phase and constructive interference If resultant is zero $\Rightarrow$ 180° out of phase (i.e. path or time difference of 0.5λ or $0.5T$) and destructive interference First time *t* when both waves become 180° out of phase will be when the 480 Hz wave made 120 oscillations and the 482 Hz wave made 120.5 oscillations and this is when *t* = 0.25 s. The next time will be *t* = 0.75 s where 360 oscillations and 360.5 oscillations are made respectively. Subsequent times will be 1.25 s and 1.75 s.	[B]
18	Stationary wave formed when emitted microwaves superpose with reflected microwaves (by the metal sheet). Maximum detected voltage indicates the antinode and minimum detected voltage indicates the node in the stationary wave. Wavelength = 2 x distance between two adjacent nodes/antinodes = 2 x 60 mm = 120 mm	[C]
19	$d\sin\theta = n\lambda$ *d* = line spacing (i.e. slit separation) of the diffraction grating *n* = order of diffraction, an integer θ = angle between the n^{th} order beam and the normal to the grating λ = wavelength of the incident beam = c / f $(4.0 \times 10^5)^{-1} \sin\theta = 3\ (3.0 \times 10^8 / 6.0 \times 10^{14})$ $\theta = 36.9°$ $2\theta = 73.7°$	[D]
20	$\sin\theta = \frac{\lambda}{b}$ Decrease in sin $\theta \Rightarrow$ decrease in $\theta \Rightarrow$ wavelength λ must decrease and gap size *b* must increase.	[C]

21	uniform electric field $\Rightarrow$ constant force $\Rightarrow$ constant acceleration so graph B	B
22	$E = V/d \Rightarrow$ p.d. $= Ed \Rightarrow$ p.d. $\propto d$ so p.d. $= 2/10 \times 1000 = 200$ V	B
23	before 2V, $I \propto V$ (just 4Ω as diode no current), after 2V just add fixed current	C
24	when rheostat = 0, $V = 1/(1+0) \times 12 = 12$ V when rheostat = 1, $V = 1/(1+0.5) \times 12 = 8$ V	D
25	$V = NA\Delta B/\Delta t = (1)(2.0\times10^{-2})(10.0\times10^{-3})/4.0 = 5.0 \times 10^{-5}$ V	B
26	at first field at O points opposite to field at P and Q without loss of generality, suppose field at O is out of, at P and Q is into with current Y, field at O decreases that means current in Y is opposite to X so current in Y produces field into at O and P, and out of at Q thus at P both field point into, $\therefore$ increase; at Q, fields opposite so decrease	C
27	$N_S/N_P = V_S/V_P = I_P/I_S$ so if N_S/N_P is doubled, V_S/V_P is doubled and I_S/I_P halved	B
28	more max speed means more KE converted to single X-ray photon at one go, single X-ray photon more energy means shorter wavelength	C
29	both Δp and Δx cannot be zero at the same time, so answer B	B
30	$A = \lambda N$, λ is the constant of proportionality between A and N	A