PHYSICS

9749

SUGGESTED MARK SCHEME
Maximum Mark: 190

October/November 2021

Paper 1
Multiple Choice

Question	*Key*	*Question*	*Key*	*Question*	*Key*
1	**C**	6	**B**	11	**D**
2	**A**	7	**D**	12	**C**
3	**B**	8	**A**	13	**D**
4	**B**	9	**A**	14	**B**
5	**A**	10	**B**	15	**C**
16	**D**	21	**B**	26	**A**
17	**B**	22	**A**	27	**B**
18	**D**	23	**C**	28	**B**
19	**D**	24	**A**	29	**D**
20	**C**	25	**D**	30	**B**

1 Estimate mass ≈ 150 g = 0.15 kg
W = mg = (0.15)(9.81) ≈ 1.5 N = 150 cN

Notes: centi- means divide by 100 e.g. centimetre, deci- means divide by 10 hence decimal point

2 *One tesla* is the uniform magnetic flux density which, acting normally to a long straight wire carrying a current of 1 ampere, causes a force per unit length of 1 N m^{-1} to act on the conductor.

$$1\text{ T} = \frac{1\text{ N}}{(1\text{ A})(1\text{ m})(\sin 90°)}$$

units of B = T

$$= \frac{\text{N}}{\text{A m}} = \frac{\text{kg m s}^{-2}}{\text{A m}}$$

$$= \text{kg A}^{-1}\text{ s}^{-2}$$

3 air resistance acts in direction opposing relative motion so left

weight acts down constantly

Vector addition gives B

4 elastic collision so special result is speed of approach = speed of separation.
Let v_x be speed of X after collision.
$v - 0 = 0.67\ v - v_x$
$v_x = 0.33\ v$

5 N3L states that

force is of same *type* (gravity): eliminate **C** & **D**

force acts on another body (S acts on brick so N3L-pair *cannot* act on brick): eliminate **B** & **D**

6 forces acting on ball include tension read from newton meter, weight and upthrust

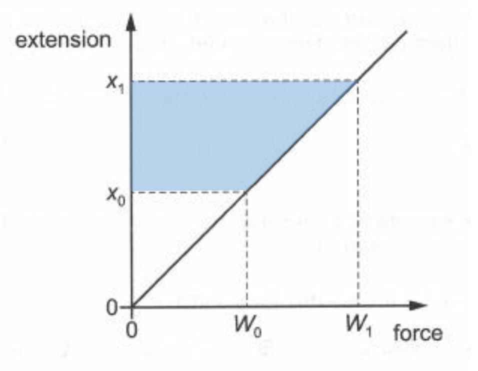
$$T + U = mg$$
$$0.75m\cancel{g} + \rho V_{\text{submerged}}\cancel{g} = m\cancel{g}$$
$$\rho V_{\text{submerged}} = 0.25m$$
$$V_{\text{submerged}}\ (\text{in cm}^3) = \frac{0.25m}{\rho} = \frac{(0.25)(100)}{1}$$
$$\frac{1}{2}V_{\text{total}} = V_{\text{submerged}}$$
$$V_{\text{total}} = 2V_{\text{submerged}} = 2\frac{(0.25)(100)}{1} = 50 \text{ cm}^3$$

Notes: ball is only half-submerged

7 Always check the axis on graphs.

Area under force-extension graph gives elastic potential energy stored.

Extra potential energy is difference in "area under graph"



8 constant speed so zero net force
force provided by engine has same magnitude as resistive forces

$$E = Pt$$

so work with time

$$t = \frac{s}{v} = \frac{1000}{20} = 50 \text{ s}$$

$$P_{\text{output}} = F_{\text{engine}}v = |F_{\text{resistive}}|v$$
$$\text{KE} = Pt = (|F_{\text{resistive}}|v)t$$
$$E_{\text{fuel}} = \frac{\text{KE}}{0.16} = \frac{F_{\text{resistive}}vt}{0.16}$$
$$m_{\text{fuel}} = \frac{E_{\text{fuel}}}{48\times10^6} = \frac{\frac{F_{\text{resistive}}vt}{0.16}}{48\times10^6} = \frac{(400)(20)(50)}{(0.16)(48\times10^6)} = 0.0052 \text{ kg}$$

9 magnetic force provides centripetal force

$$Bqv = mr\omega^2$$
$$Bq(\cancel{r}\cancel{\omega}) = m\cancel{r}\omega^{\cancel{2}}$$
$$\frac{Bq}{m} = \omega$$

10 field strength is numerically equal to potential gradient at that point

$$|g| = \frac{d\phi}{dr} \approx \frac{6}{10} = 0.6 \text{ m s}^{-2}$$
$$\text{w.d.} = Fd = (mg)d = (2)(0.6)(2.5) = 3.0 \text{ J}$$

11 consider distance from Earth's centre

$$v = r\omega = (R_E + h)\omega$$
$$= (36000\times10^3 + 6400\times10^3)\left(\frac{2\pi}{24\times60\times60}\right)$$
$$= 3100 \text{ m s}^{-1}$$

12 assume ideal behaviour:

$$pV = nRT$$

$$T = \frac{pV}{nR} = \frac{(1\times10^{5})(10\times3\times4)}{(5000)(8.31)}$$

$$= 289 \text{ K}$$

$$\frac{1}{\not{2}} m v_{rms}^{2} = \frac{3}{\not{2}} kT$$

$$v_{rms} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3(1.38\times10^{-23})(289)}{\frac{29\times10^{-3}}{N_A}}}$$

$$= 500 \text{ m s}^{-1}$$

Notes: need to change molar mass into SI units of kg.

13 thermal energy supplied goes to (i) heat liquid water up to 100 °C then (ii) boil

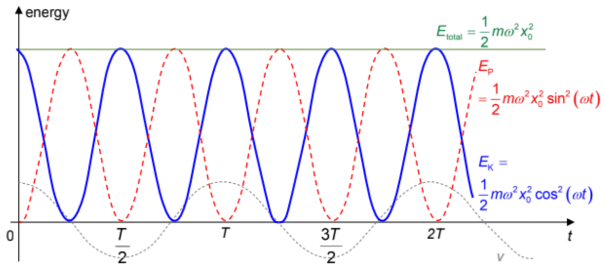
$$Q = mc\Delta T + mL_{vap} = m\left(c\Delta T + L_{vap}\right)$$

$$= (5.00)\left[(4190)(100-30) + \left(2260\times10^{3}\right)\right]$$

$$= 1.28\times10^{7} \text{ J}$$

14 the macroscopic "external" KE/PE does not affect internal energy (unchanged)

15 At max PE, KE = 0.
At max KE, PE = 0.
in simple(r) systems, by conservation of energy, PE + KE = constant total E



16 this works for laser light because the beam is coherent

$$v = f\lambda$$

$$\lambda = \frac{v}{f} = \frac{3\times10^{8}}{5\times10^{14}}$$

$$= 6\times10^{-7} \text{ m}$$

$$\frac{\Delta\phi}{2\pi} = \frac{\Delta x}{\lambda}$$

$$\Delta\phi = 2\pi\frac{\Delta x}{\lambda} = 2\pi\frac{1.5\times10^{-6}}{6\times10^{-7}}$$

$$= 5.0\pi \text{ rad}$$

$$= 1.0\pi \text{ rad}$$

17 Malus Law for Intensity:

$$I = I_0 \cos^2\theta$$

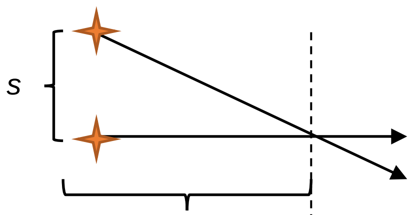
where θ is relative angle

X polarises incoming light vertically (0°)

From 45° to 90°, output intensity after rotated polarizer and before Y decreases to zero, because angle between X and rotated polarizer are 90° to each other: (**B**)

From 90° to 135°, output intensity after Y decreases to zero, because angle between rotated polarizer and Y are 90° to each other: (**B**)

18 sketch:



$r = 5.7\times10^{16}$ m

$$\frac{s}{r} \approx \frac{\lambda}{b}$$

$$s \approx r\frac{\lambda}{b} = \left(5.7\times10^{16}\right)\frac{620\times10^{-9}}{0.5}$$

$$= 7.1\times10^{10} \text{ m}$$

19 recall definition of electric field line.

20 take ratio:

$$F_{old} = \frac{1}{4\pi\varepsilon_0}\frac{Q_1Q_2}{r^2}$$

$$\frac{F_{new}}{F_{old}} = \frac{Q_3\cancel{Q_2}}{Q_1\cancel{Q_2}}\left(\frac{r_{old}}{r_{new}}\right)^2$$

$$F_{new} = F_{old}\left(\frac{Q_3}{Q_1}\right)\left(\frac{r_{old}}{r_{new}}\right)^2$$

$$= (2.0)\left(\frac{2}{1}\right)\left(\frac{1}{2}\right)^2 = 1.0 \text{ N}$$

21 Identify quantity related to gradient G:

$$R = \left(\frac{\rho}{A}\right)l$$

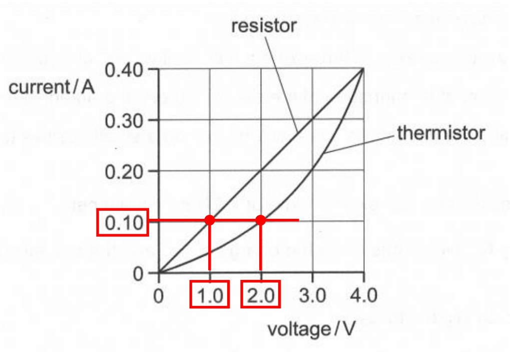
gradient $G = \dfrac{\rho}{A}$

4 wires are parallel (current “splits up” and rejoins”) so effective resistance is 1/4 original

$$R_{eff} = \frac{R}{4} = \frac{Gl}{4}$$

22 thermistor and resistor have same current flowing through them

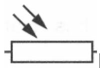
At current = 0.1 A, total p.d. across them is 3.0 V, equal to emf of battery.



23 $P = \dfrac{V^2}{R}$

for bulb to glow more, the p.d. across it must increase, then the effective resistance between it and the variable resistor in parallel must increase

by potential divider concepts,

> LDR  must be brighter to decrease its resistance

> thermistor must be cooler to increase its resistance and consequentially the resistance of the parallel branch comprising bulb and thermistor

24 By Right Hand Grip Rule on circular coil, *B* points out into plane of paper

by FLHR, upwards force on short wire

25 units of *BA* = T m^2

26 by faraday’s law

$$E = -\frac{d}{dt}N\Phi$$

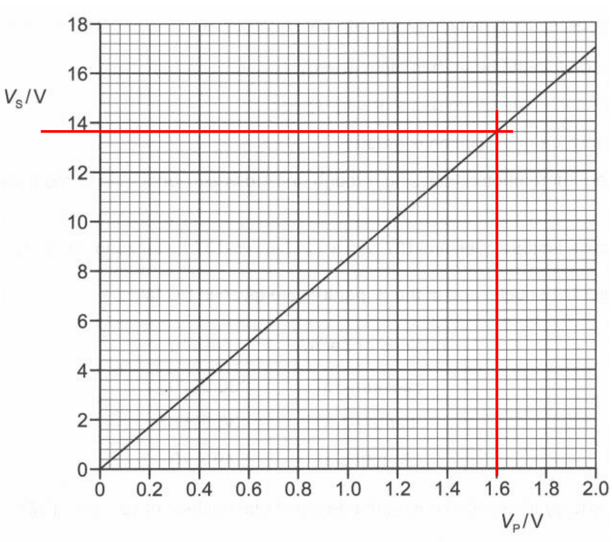
$$\approx -\frac{\Delta NBA}{\Delta t} = -N\frac{0 - BA}{\Delta t}$$

$$= N\frac{B\left(\pi r^2\right)}{\Delta t}$$

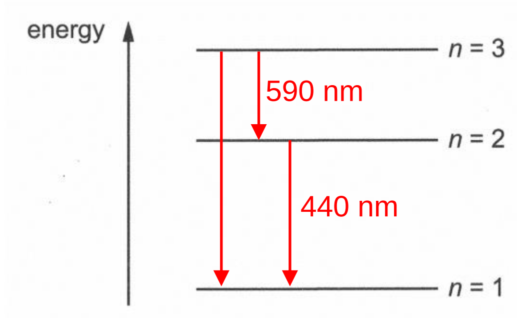
$$= (3000)\frac{(1.8)\left[\pi(0.01)^2\right]}{0.6} = 28 \text{ V}$$

27 ideal so no loss of energy

$$P_{pri} = P_{sec}$$
$$I_{pri}V_{pri} = I_{sec}V_{sec}$$
$$I_{sec} = I_{pri}\left(\frac{V_{pri}}{V_{sec}}\right)$$
$$= (0.32)\left(\frac{1.6}{13.6}\right)$$



28 visualise the 3 possible transitions. longer wavelength is lower in energy:



$$E_{3\to1} = E_{2\to1} + E_{3\to2}$$
$$\frac{\cancel{h}\cancel{c}}{\lambda} = \frac{\cancel{h}\cancel{c}}{\lambda_{440\text{ nm}}} + \frac{\cancel{h}\cancel{c}}{\lambda_{590\text{ nm}}}$$
$$\lambda = \left[\frac{1}{440\times10^{-9}} + \frac{1}{590\times10^{-9}}\right]^{-1}$$
$$= 250\text{ nm}$$

29

$$I = \frac{P}{A} = \frac{nhf}{tA}$$
$$I = \left(\frac{hf}{A}\right)\frac{n}{t}$$

30 working with mass:

$$E = (m_{rxtnt} - m_{pdt})c^2$$
$$= (m_{Ca} - m_{Ba} - m_{\beta})uc^2$$
$$= 1.1\times10^{-13}\text{ J}$$