Year 11 Physics

Practice Exam 2 (Unit 1 & 2) Answers

Unit 1

Area of Study 1 How can thermal effects be explained?

Question 1

a Heat transfer is always from areas of higher temperature to lower temperature. Therefore, by opening the door, the heat inside the room is let out. (1 mark)

b Statement should read, "Close the door, you are letting the heat out!". (1 mark)

Question 2 (4 marks)

	Average kinetic energy	Internal energy
bucket	same	less
pool	same	more

Question 3

a $Q_1 = mc\Delta t = 0.5 \times 4200 \times 25 = 52\,500$ J (2 marks)

b $Q_2 = mL = 0.5 \times 3.34 \times 10^5 = 167\,000$ J (2 marks)

c Power $= \frac{\text{energy}}{\text{time}} = \frac{52\,500 + 167\,000}{8 \times 60} = 457$ J s^{-1} $= 457$ W (3 marks)

d Power $= \frac{\text{energy}}{\text{time}}$

e So, energy = power × time = 1200 × (2 x 60) = 144 000 J

$Q = mc\Delta t$

$144\,000 = 0.75 \times 4200 \times \Delta t$

$\Delta t = 45.71$ so $t_{final} = 55.7°C$ (4 marks)

Question 4

a $\Delta U = Q - W$

$700 = Q - (-1000)$

$Q = -300$ J or 300 J lost to the surroundings (2 marks)

b No, they are not in thermal equilibrium. Thermal energy is being transferred from the substance to the surroundings. This will only occur if the temperature of the substance is greater than the surroundings, therefore not in thermal equilibrium. (2 marks)

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Question 5

a 70°C (1 mark)

b $Q = mc\Delta T$

$c = \frac{100 \times 10^3}{2 \times (70 - 20)}$

$= 1000 \text{ J kg}^{-1} \text{ K}^{-1}$ or $1 \text{ kJ kg}^{-1} \text{ K}^{-1}$ (2 marks)

c $Q = mL$

$L = \frac{Q}{m} = \frac{500 \times 10^3}{2}$

$= 2.5 \times 10^5 \text{ J kg}^{-1}$ or 250 kJ kg^{-1} (2 marks)

Question 6

a $\lambda_{max} T = 2.898 \times 10^{-3}$

$\lambda_{max} = \frac{2.898 \times 10^{-3}}{T} = \frac{2.898 \times 10^{-3}}{5000} = 579 \text{ nm}$

This is within the visible spectrum (3 marks)

b 500 nm is shorter than 579 nm, therefore light from object *Y* will have a higher frequency than light from object *X*. (3 marks)

Question 7 (1 mark)

D

900 ÷ 300 = 3

$P \propto T^4$

$P \propto 3^4$

$P \propto 81$, therefore **D** is the correct answer.

Question 8 (3 marks)

Radiation: heat transfer due to radiation is blocked as the curtain blocks the light. This is helpful in the summer months.

Conduction: warm air inside the house will have reduced contact with the cold window. This is helpful during winter months.

Convection: as curtains are close to the window, and there is a pelmet at the top, convection currents cannot form right near the window. This is helpful during winter months.

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Question 9

a $\frac{\text{potential difference across the 20 Ω resistor}}{\text{potential difference across the 10 Ω resistor}} = 1$ (2 marks)

b $V = I \times R$

$6 = I \times 30$

$I = 0.2$ A (2 marks)

c $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{10} + \frac{1}{20} + \frac{1}{30} = \frac{11}{60}$

$R_T = 5.45\ \Omega$ (3 marks)

Question 10 (2 marks)

$P = \frac{V^2}{R}$ and $R = \frac{300^2}{0.900} = 10\ \Omega$

Question 11

a 40 mA means 2 V across the LED (from graph)

So, there are 8 V across R

$V = IR$

$8 = 40 \times 10^{-3} \times R$

$R = 200\ \Omega$ (3 marks)

b 90 mA means 2.2 V across the LED (from graph)

So, there are 7.8 V across R

$V = IR$

$7.8 = 90 \times 10^{-3} \times R$

$R = 86.7\ \Omega$ (or 87 Ω) (3 marks)

c 1.7 V across the LED means approx. 9 mA (from graph)

$V = IR$

$V = 9 \times 10^{-3} \times 100$

$V = 0.9$ V

0.9 + 1.7 = 2.6 V supply (3 marks)

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Question 12

		Series	Parallel
a	Resistance	$R_T = R_1 + R_2$ $= 100 + 400$ $= 500\ \Omega$ The series circuit has greater total resistance	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ $= \frac{1}{100} + \frac{1}{400}$ $= \frac{5}{400}$ $R_T = 80\ \Omega$ (4 marks)
b	Current	$V = IR$ $10 = I \times 500$ $I = 0.02$ A	$V = IR$ $10 = I \times 80$ $I = 0.125$ A The parallel circuit draws greater current (3 marks)
c	Power	$P = VI$ $= 10 \times 0.02$ $= 0.2$ W	$P = VI$ $= 10 \times 0.125$ $= 1.25$ W The parallel circuit draws greater power (3 marks)

d In a series circuit, all appliances need to be on for the circuit to work. In a series circuit, the voltage is shared between appliances, so more appliances means each gets a smaller share of the voltage. (2 marks)

Question 13

a $V = IR$

$6 = I \times 2000$

$I = 0.003$ A or 3 mA (2 marks)

b $Q = It$

$= 3 \times 10^{-3} \times 60$

$= 0.18$ C (2 marks)

c $n_e = \frac{Q}{1.6 \times 10^{-19}} = \frac{0.18}{1.6 \times 10^{-19}} = 1.125 \times 10^{18}$ electrons (2 marks)

d $W = qV$

$W = 0.18 \times 6$

$= 1.08$ J (2 marks)

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Question 14

As the particle and antiparticle come together, they annihilate each other and produce high-energy gamma photons (light). (2 marks)

Question 15

a **B** (1 mark)

b **A** (1 mark)

c **C** (1 mark)

d **D** (1 mark)

e **E** (1 mark)

Question 16

a $240 = 145 + 93 + X$

$X = 240 - 238 = 2$

Number of neutrons released is two. (1 mark)

b $E = mc^2$

$m = \frac{2.76 \times 10^{-11}}{(3 \times 10^8)^2} = 3.07 \times 10^{-28}$ kg (3 marks)

Question 17

a ${}^{1}_{0}n + {}^{238}_{92}U \rightarrow {}^{239}_{92}U$ (2 marks)

b ${}^{239}_{92}U \rightarrow {}^{239}_{93}Np + {}^{0}_{-1}\beta$ (2 marks)

c Fissile refers to nuclides that are capable of undergoing nuclear fission after absorbing a neutron. (3 marks)

Question 18

a Isotopes: All atoms of a particular element with the same number of protons, but different number of neutrons. For example, all strontium atoms have 38 protons, but different isotopes of strontium have different numbers of neutrons. (2 marks)

b ${}^{90}_{38}Sr \rightarrow {}^{90}_{39}Y + {}^{0}_{-1}\beta + \nu$ + energy (2 marks)

c 202 days is 4 half-lives

Activity = $\frac{150 \times 10^6}{2^4}$

Activity = 9.38 MBq (3 marks)

Question 19 (1 mark)

Synchrotron light is the electromagnetic radiation emitted when charged particles (such as electrons) moving at velocities close to the speed of light, such as electrons, are accelerated in curved paths under the action of a magnetic field in a synchrotron machine.

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Question 20 (3 marks)

n = 3 to ground: 10.4 – 3.7 = 6.7 eV

n = 2 to ground: 10.4 – 5.5 = 4.9 eV

$\frac{6.7}{4.9}$ = 1.37 or 1.4.

The light emitted when an electron jumps from n = 3 to ground is approx. 1.4 times as energetic as light emitted when an electron jumps from n = 2 to ground.

Question 21

a The speed of gamma rays is the same as the speed of ultra violet light in a vacuum. (1 mark)

b The frequency of ultraviolet is greater than the frequency of infrared light. (1 mark)

c The wavelength of visible light is greater than the wavelength of ultraviolet light. (1 mark)

d The energy of radio waves is less than the energy of visible light. (1 mark)

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Question 22 (3 marks)

$v^2 = u^2 + 2as$

u = 110 km h^{-1} = 30.556 m s^{-1}

$0^2 = (30.556)^2 + 2 \times a \times 1500$

a = - 0.311 m s^{-2}, which means a deceleration of 0.311 m s^{-2}

Question 23 (2 marks)

$F_g = mg$

$1764 = m \times 9.8$

m = 180 kg

Question 24

a a = gradient = 2.50 m s^{-2} (3 marks)

b s = area under curve = 25 squares × [0.5 × (2.5 × 5)] + 20 squares × [0.5 × (2.5 × 5)] + 25 squares × [0.5 × (2.5 × 5.0)] = 437.5 (3 marks)

c $F_{net} = ma$ = 1200 × (−2.08) = -2496 N = −2500 N (3 marks)

d $F_{net} = ma$ = 0 N as car is travelling at a constant speed. Gradient of v vs t graph is 0. (2 marks)

Question 25

a $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$0.15 \times 2 + 1.0 \times 0 = 0.15 \times 0.5 + 0.1\ v_2$

v_2 = 2.25 m s^{-1} (2 marks)

b $E_{k\ initial} = 0.5 \times 0.15 \times 2^2 + 0 = 0.300$ J

$E_{k\ final} = 0.5 \times 0.15 \times (0.5)^2 + 0.5 \times 0.10 \times (2.25)^2 = 0.272$ J

Kinetic energy is not conserved (kinetic energy before collision > kinetic energy after collision) so the collision is inelastic. (5 marks)

Question 26

a $F_{net} = ma = 5.0 \times 5 = 25$ N (2 marks)

b $F_{net} = ma$

$60 - f = 25$

f = 35 N (2 marks)

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

$= 0 \times 2 + \frac{1}{2} \times 5 \times 2^2$

= 10 m (2 marks)

d $W = F \times s$

$= 60 \times 10$

= 600 J (2 marks)

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e $W = f \times s$

$= 35 \times 10$

$= 350$ J (3 marks)

Question 27

a $E_s = \frac{1}{2}kx^2$

$= \frac{1}{2} \times 600 \times (0.1)^2$

$= 3$ J (2 marks)

b $E_s = E_g = mg\Delta h$

$3 = 0.2 \times 9.8 \times \Delta h$

$\Delta h = 1.53$ m, so yes, it does hit the target (3 marks)

Question 28 (4 marks)

$\tau_{clockwise} = rF = 1.2 \times 10 \times 10^3 = 12\,000$

$\tau_{anticlockwise} = rF + rF = 0.8F_1 + 0.8F_2 = 0.8F_1 + 0.8F_1 = 1.6F_1$

$\tau_{clockwise} = \tau_{anticlockwise}$

$12\,000 = 1.6F_1$

$F_1 = F_2 = 7500$ N

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